1962

PONTIAC

CHASSIS SHOP MANUAL

PONTIAC MOTOR DIVISION

1962 PONTIAC

CHASSIS SHOP MANUAL

GENERAL

This shop manual applies on 1962 models and includes all pertinent subject matter available at the time it was prepared for publication.

CONTENTS

Arrangement of the material is shown by the table of contents on the right side of this page. Black tabs on the first page of each section can be seen on the edge of the book below the section title. More detailed table of contents precedes each section, and an index is included in the back of the manual.

BODY
HYDRA-MATIC
HEATING, VENTILATING AND
AIR CONDITIONING

Information on Body, Hydra-Matic, and Heating, Ventilating and Air Conditioning is published in separate manuals.

AIR CONDITIONING CAUTION

Before attempting any service work requiring the disconnecting of units of the air conditioning system, check the information published concerning air conditioning service. It is extremely important that proper methods and precautions be observed when disconnecting any refrigerant lines or units. Failure to properly perform these operations may result in injury to personnel and the necessity of expensive repair work on the air conditioning system.

PONTIAC MOTOR DIVISION
GENERAL MOTORS CORPORATION
PONTIAC 11, MICHIGAN

S-6204 AUGUST, 1961 Litho in U.S.A.

Table of Contents

GENERAL INFORMATION

CONTENTS OF THIS SECTION

CAR MODEL INFORMATION

General information and specifications appear in this section. Detailed specifications are given on major units at the end of each section of this manual.

VEHICLE IDENTIFICATION PLATE

Series identification can be made by the Manufacturer's Motor Vehicle Identification Number embossed on a metal strip fastened to the left front hinge pillar post which is visible when the left door is open (Fig. 1-1).

BODY IDENTIFICATION PLATE

Information as to body style, etc., is stamped on a plate attached to the left side of the cowl just under the rear edge of the hood (Fig. 1-2). Body styles, as available on various series cars, are described in the Body Shop Manual.

CAR MODEL IDENTIFICATION

Certain publications carry "series" numbers to identify models and others carry sales department names. Figure 1-3 below shows both methods of identification.

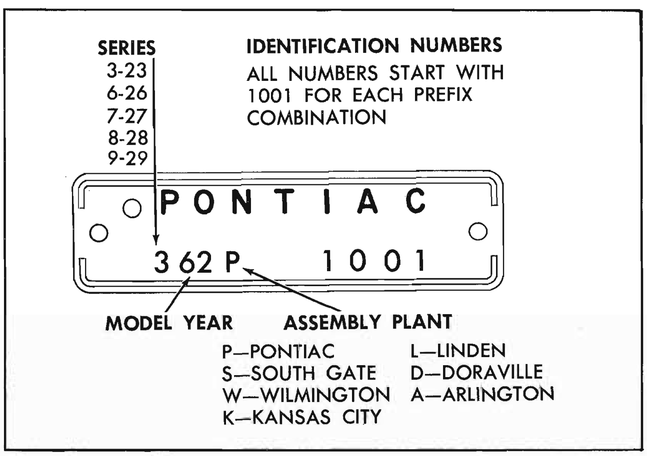


Fig. 1-1 Vehicle Identification Number Plate

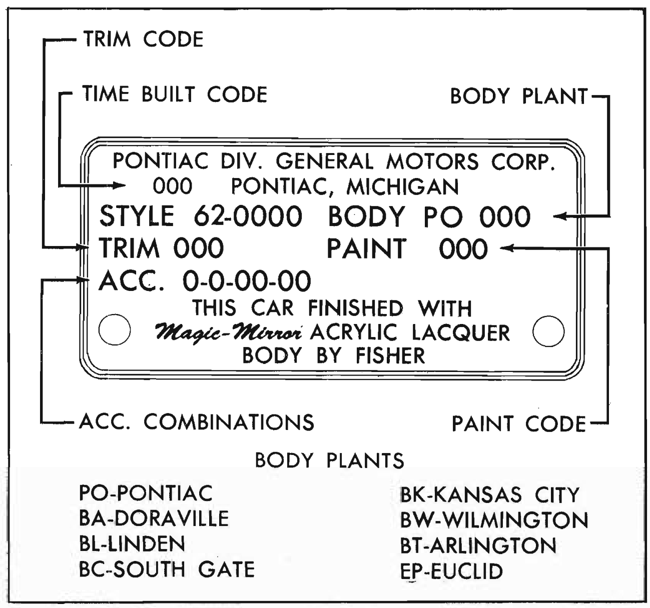
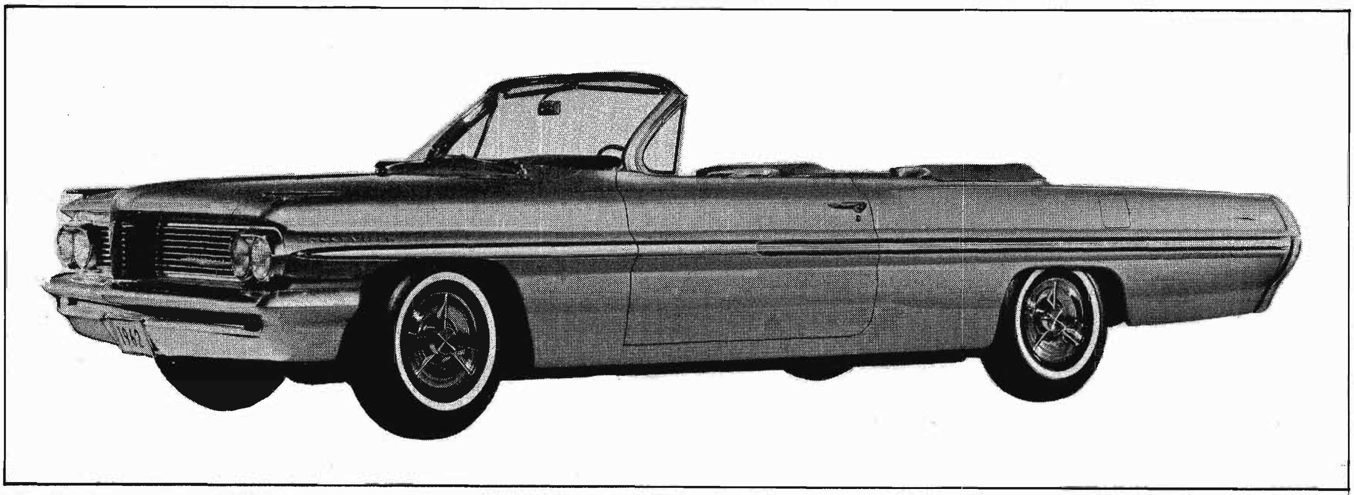


Fig. 1-2 Body Identification Plate

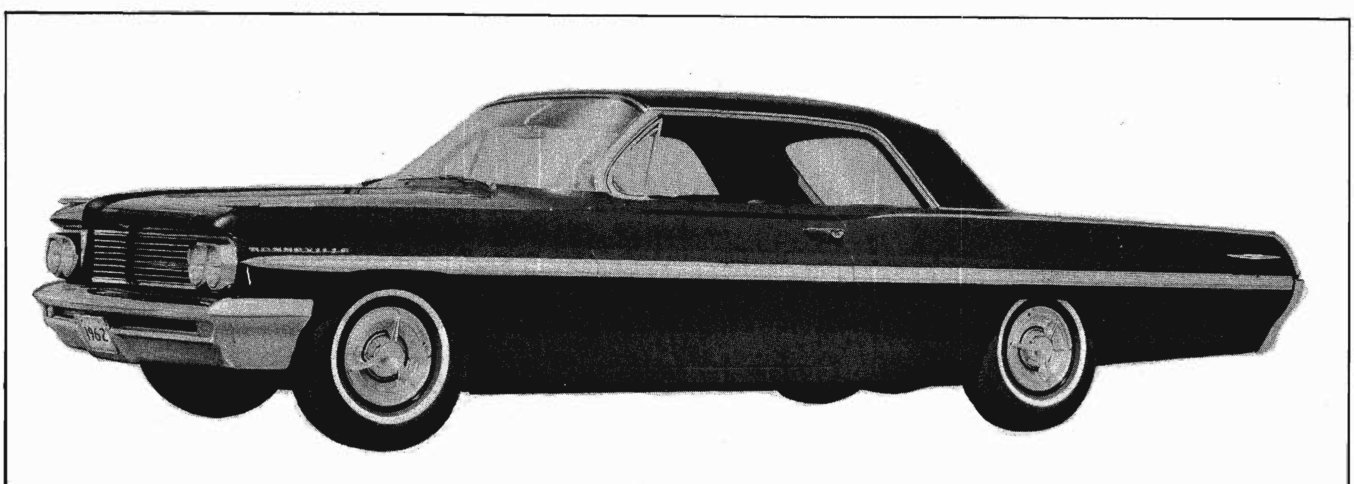
MODEL AND BODY STYLE	BODY STYLE NUMBER	MODEL AND BODY STYLE	BODY STYLE NUMBER
Catalina 2 Door Sport Sedan	2311	Star Chief 4 Door Sedan	2669
Catalina 2 Door Sport Coupe	2347	Star Chief 4 Door Vista Sedan	2639
Catalina 4 Door Sedan	2369	Bonneville Safari—2-seat	2735
Catalina 4 Door Vista Sedan	2339	Bonneville 4 Door Vista Sedan	2839
Catalina Convertible Coupe	2367	Bonneville 2 Door Sport Coupe	2847
Catalina Safari—2-seat	2335	Bonneville Convertible Coupe	2867
Catalina Safari—3-seat	2345	Grand Prix 2 Door Sport Coupe	2947

Fig. 1-3 Car Model Identification

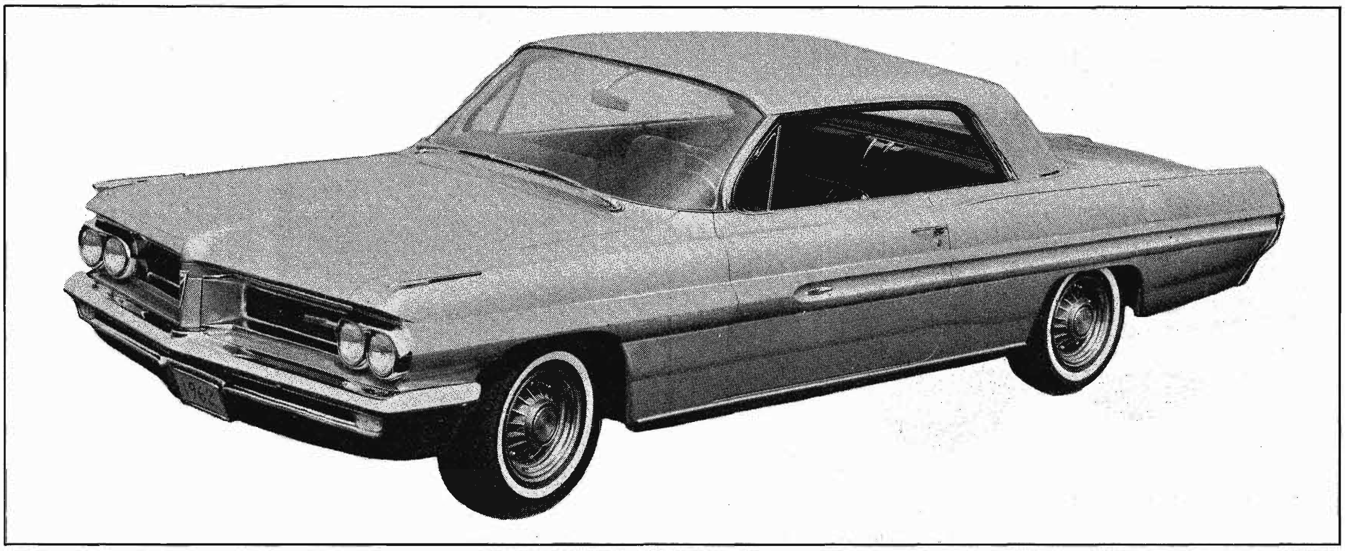


1962 BONNEVILLE CONVERTIBLE COUPE, SERIES 28

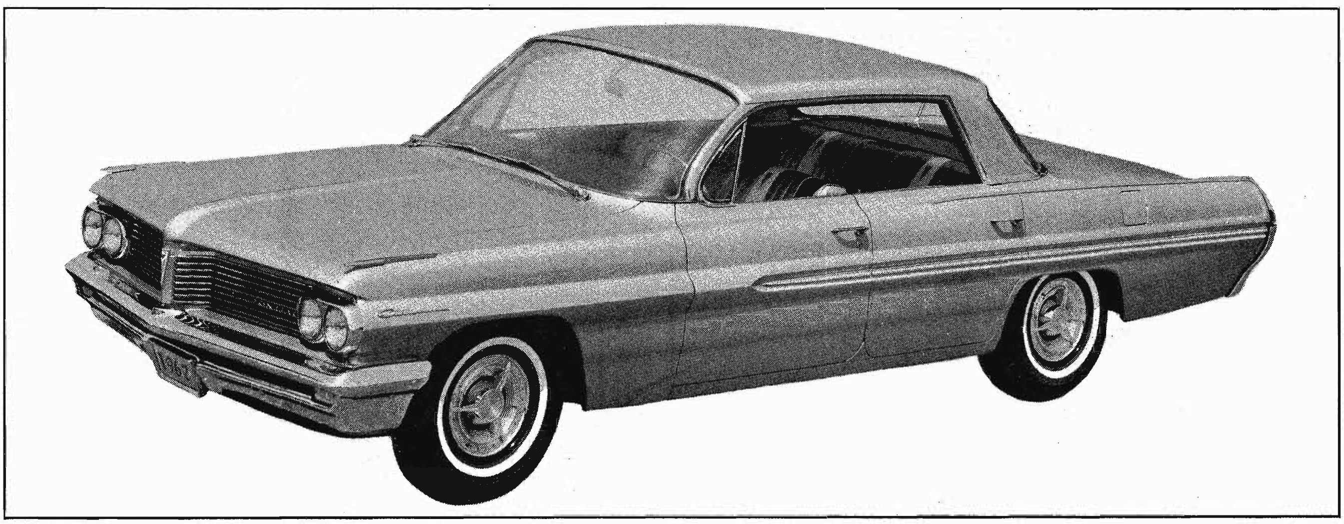
1962 STAR CHIEF FOUR DOOR SEDAN, SERIES 26



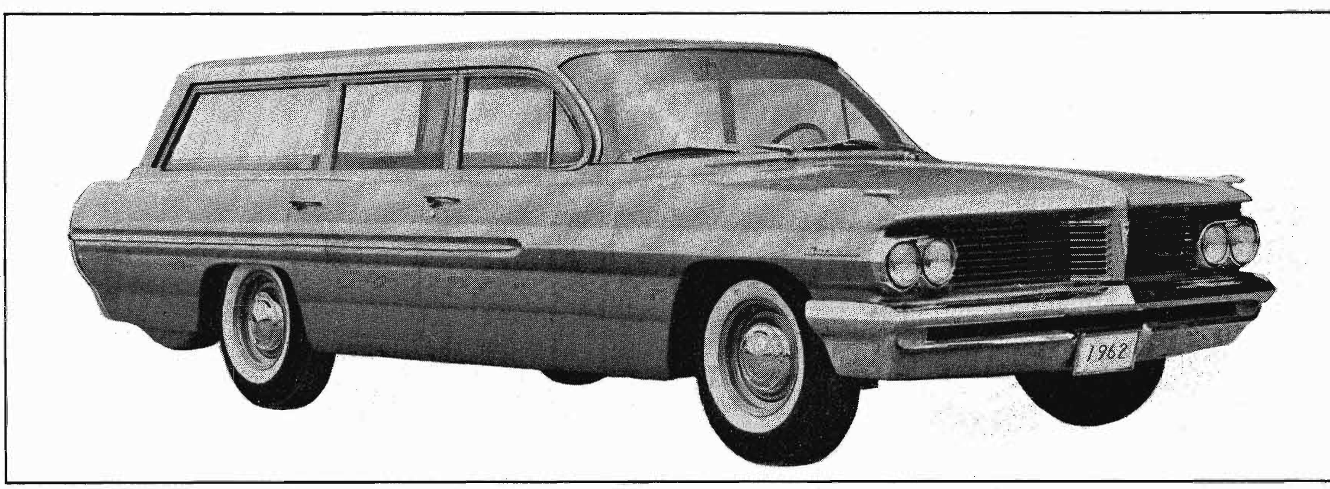
1962 BONNEVILLE TWO DOOR SPORT COUPE, SERIES 28



1962 GRAND PRIX TWO DOOR SPORT COUPE, SERIES 29



1962 CATALINA FOUR DOOR SEDAN, SERIES 23



1962 CATALINA SAFARI, SERIES 23

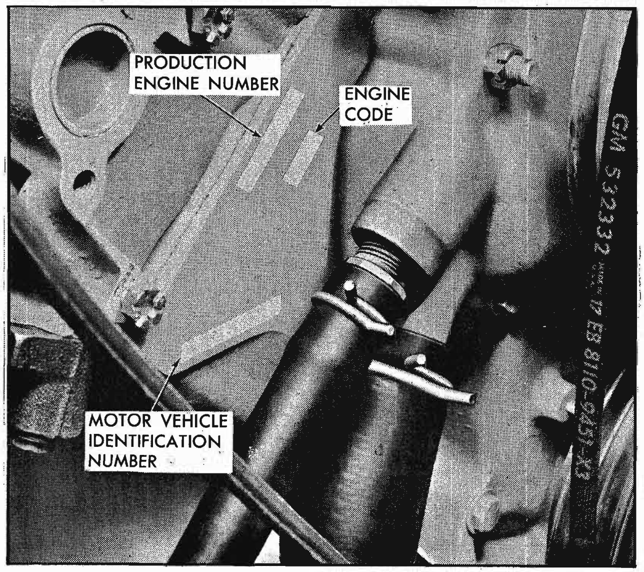


Fig. 1-4 Engine Serial Number Location

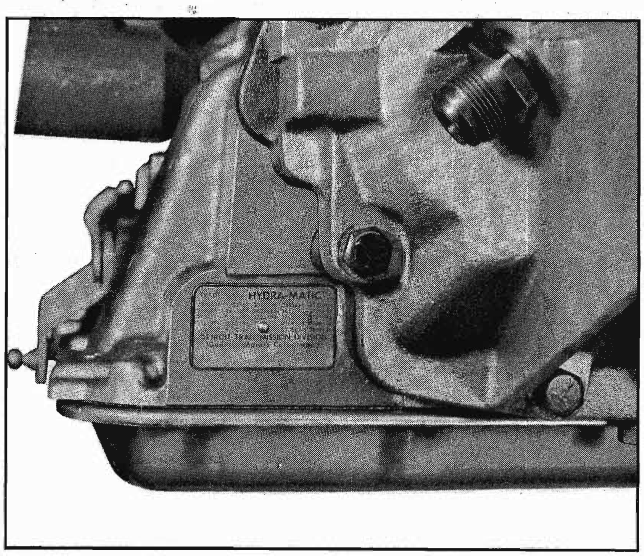


Fig. 1-5 Super Hydra-Matic Serial Number Location

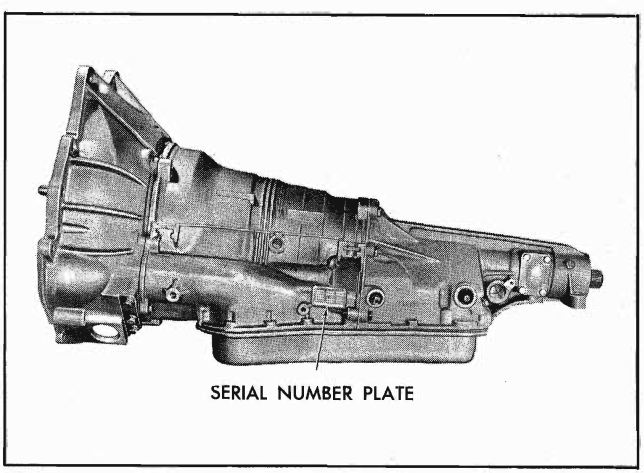


Fig. 1-6 Roto Hydra-Matic Serial Number Location

ENGINE SERIAL NUMBERS

The manufacturer's motor vehicle identification number is located on a machined pad on the front of the right-hand bank of the block.

The production engine number will also be found in the same area. This number is used for production control purposes during manufacture.

HYDRA-MATIC SERIAL NUMBERS

The serial number plate is located at the left side of rear face of the Super Hydra-Matic transmission case and at the center of the left side of the Roto Hydra-Matic transmission case. The serial numbers begin with P (for standard two barrel installation) followed by number 62 (year). The letters E, A and B (immediately after P) designate that the transmission is used with economy, 425A or tri-power, or four barrel carburetor respectively. The Super Hydra-Matic transmission is indicated by the letter S, which follows above letters. The above model designations and the year (62) are followed by the numerical serial number.

PUSHING CAR TO START ENGINE

HYDRA-MATIC

Due to the design of the Hydra-Matic transmission, the engine cannot be started by pushing the car.

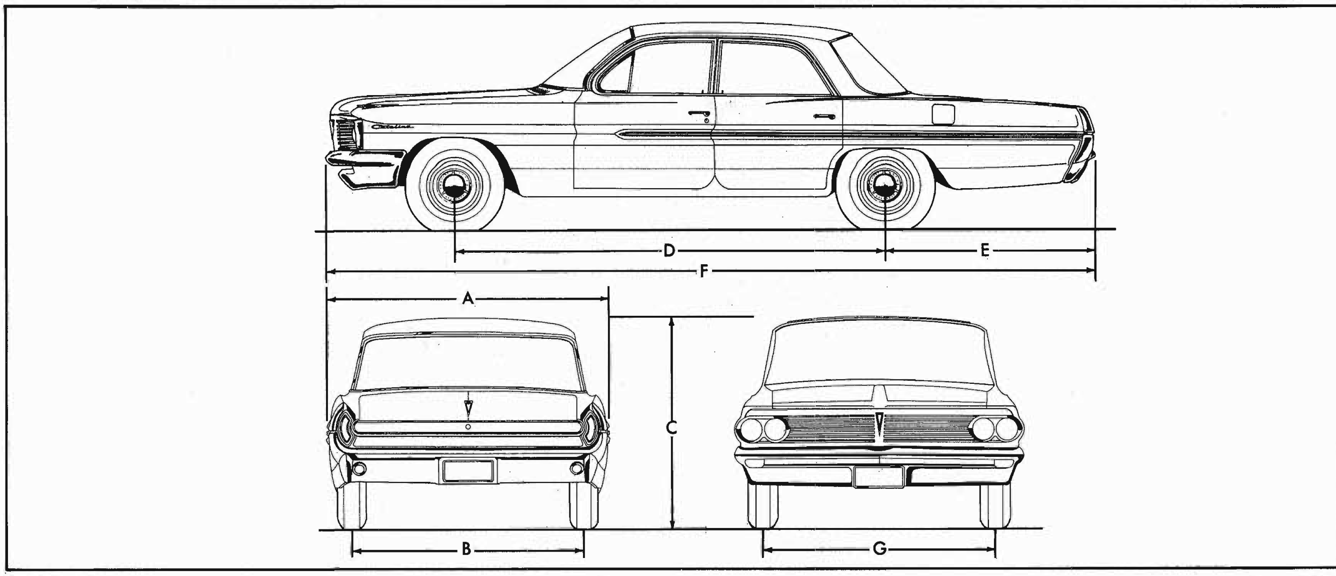
SYNCHRO-MESH

To start the engine by pushing the car, move the gearshift lever to high gear, disengage the clutch and turn on the ignition switch. When vehicle reaches a speed of 10-15 mph, engage the clutch.

TOWING PRECAUTIONS

Always place a rubber mat or other suitable material between the bumper and the tow chains or cables. For front end lifting, place the chains or cables around the ends of the frame side rails at both sides. All models can be towed without disconnecting the propeller shaft except in cases where the transmission or propeller shaft has possibly been subject to failure or damage. In such cases, the propeller shaft must be disconnected from the differential and wired to the tail pipe or the car must be towed with the rear wheels off the ground. If the propeller shaft is disconnected and the "U" joint bearing retaining strap is broken, wrap tape around the bearing caps to prevent loss. When towing with the rear wheels off the ground, the steering wheel must be centered and held in position by a steering wheel holding clamp or by tying it to the window division channel. Tire to ground clearance should not exceed 6 inches while towing the car and speeds should not exceed 30 mph.

GENERAL SPECIFICATIONS



DIMENSION	Series No.	KEY	23 SERIES	26 SERIES	28 SERIES	29 SERIES	23 and 27 SERIES SAFARI
Overall Length							
Catalina, all except Safari		F	211.6″	— —	— —	— —	— —
Star Chief		F	— —	218.6″	— —	— —	— —
Bonneville, all except Safari		F	— —	— —	218.6″	— —	— —
Grand Prix Sport Coupe		F	— —	— —	— —	211.6″	— —
Catalina and Bonneville Safari		F	— —	— —	— —	— —	212.3″
Width		A	78.6″	78.6″	78.6″	78.6″	78.6″
Height (With Passengers)	Series No.						
Catalina Sport Sedan	2311	C	55.4″	— —	— —	— —	— —
Catalina 4 Door Sedan	2369	C	55.4″	— —	— —	— —	— —
Catalina Convertible Coupe	2367	C	55.2″	— —	— —	— —	— —
Catalina Sport Coupe	2347	C	54.2″	— —	— —	— —	— —
Catalina Vista Sedan	2339	C	55.3″	— —	— —	— —	— —
Catalina Safari—2 seat	2335	C	— —	— —	— —	— —	56.6″
Catalina Safari—3 seat	2345	C	— —	— —	— —	— —	56.5″
Star Chief 4 Door Sedan	2669	C	— —	55.6″	— —	— —	— —
Star Chief Vista Sedan	2639	C	— —	55.5″	— —	— —	— —
Bonneville Safari	2735	C	— —	— —	— —	— —	57.1″
Bonneville Sport Coupe	2847	C	— —	— —	54.4″	— —	— —
Bonneville Convertible Coupe	2867	C	— —	— —	55.3″	— —	— —
Bonneville Vista Sedan	2839	C	— —	— —	55.4″	— —	— —
Grand Prix Sport Coupe	2947	C	— —	— —	— —	53.4″	— —
Wheelbase (Nominal)		D	120″	123″	123″	120″	119″
Tread		B and G	62.5″	62.5″	62.5″	62.5″	62.5″
Turning Circle							
Curb to Curb			42.8″	43.7″	43.7″	42.8″	42.5″
Wall to Wall			45.5″	46.4″	46.4″	45.5″	45.2″
Road Clearance (Minimum) All except Safari			5.9″	5.9″	5.9″	5.9″	— —
(5 passenger load at rear lower control arm) Safari			— —	— —	— —	— —	6.3″
Overhang (Rear)							
Catalina		E	55.9″	— —	— —	— —	— —
Star Chief		E	— —	55.9″	— —	— —	— —
Bonneville		E	— —	— —	59.9″	— —	— —
Grand Prix		E	— —	— —	— —	55.9″	— —
Safari		E	— —	— —	— —	— —	57.6″

Fig. 1-7 Car and Body Overall General Specifications

RELATION OF CAR SPEED TO ENGINE RPM

CAR SPEED MPH	REAR WHEEL RPM		ENGINE RPM FOR GIVEN AXLE RATIOS AND TIRES													
			2.56		2.688		2.867		3.077		3.231		3.417	
	8.00	8.50	8.00	8.50	8.00	8.50	8.00	8.50	8.00	8.50	8.00	8.50	8.00	8.50
10	125	123	320	315	336	331	358	353	384	379	403	398	426	421
20	250	247	640	632	672	662	716	706	769	758	806	795	853	841
30	375	370	960	947	1107	993	1173	1061	1152	1138	1210	1193	1279	1262
40	499	492	1277	1259	1342	1223	1431	1411	1535	1514	1612	1590	1705	1681
50	624	616	1597	1577	1677	1656	1789	1766	1920	1896	2016	1990	2132	2105
60	749	739	1917	1892	2013	1986	2147	2119	2305	2274	2420	2388	2559	2525
70	874	862	2237	2207	2349	2317	2506	2471	2689	2652	2824	2785	2986	2945
80	999	986	2557	2524	2685	2650	2864	2827	3074	3034	3228	3186	3417	3369
90	1124	1109	2877	2839	3021	2981	3223	3180	3459	3412	3632	3583	3841	3789
100	1248	1231	3195	3151	3355	3309	3578	3529	3840	3788	4032	3977	4264	4206

AXLE RATIO	N/V RATIO* TIRE SIZE	
	8.00-14	8.50-14
2.56	32.0	31.6
2.69	33.6	33.1
2.87	35.8	35.3
3.08	38.4	37.9
3.23	40.3	39.9
3.42	42.7	42.1

*N = Engine RPM: V = Car Speed MPH

MISCELLANEOUS DATA

Tire Size.................................. 8.00-14 8.50-14
Rolling Circumference.................... 84.60″ 85.74″
Rolling Radius.......................... 13.46″ 13.64″

Generator to Engine Ratio:
Standard Generator 2.56:1
Heavy Duty Generator 2.75:1
Air Conditioned Cars 2.97:1

Fan to Engine Ratio:
Standard .... .88:1
Air Conditioned Car .... .94:1

Air Conditioner
Compressor Pulley to Engine Ratio
Circ-L-Aire......................... 1.52:1
Cool Pack.......................... 1.52:1

FRAME AND BODY MOUNTINGS

GENERAL DESCRIPTION

FRAME

Eight basic frame designs are available to meet demands of particular body styles. These frames, referred to as the perimeter design, have the passenger compartment encircled by heavy steel side members, which permit lowering the floor in the passenger area and provide marked improvement in seat height. Five crossmembers join parallel side bars of the frame to provide for mounting engine and chassis components and for structural rigidity.

Material thickness of frame members provides ideal balance of beaming and torsional strength without compromising ride quality. This new perimeter design permits easier servicing because of the rails at the side. It also permits use of a simplified two joint propeller shaft and simplified exhaust system.

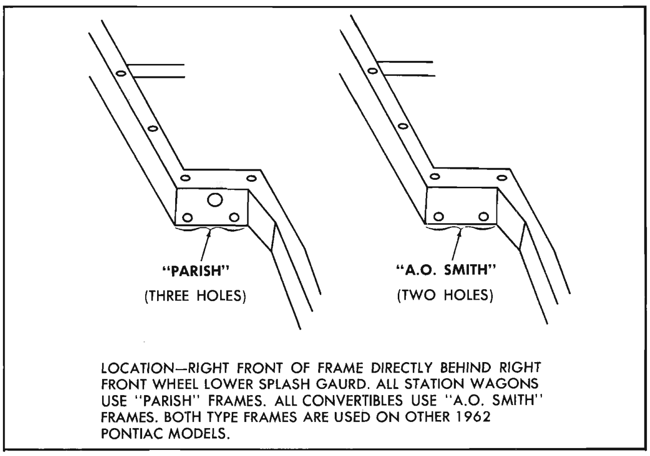


Fig. 1A-1 Identification of Frames

Two types of frames are used on 1962 Pontiac models. All convertibles are equipped with A. O. Smith frames while station wagons are equipped with Parish frames. Other models utilize both types.

The frames can be identified by the number of holes located at right front of frame behind front wheel lower splash guard (Fig. 1A-1).

The dimensions given in Fig. 1A-2 may be used in checking frames. Alphabetical reference for dimensions listed in the chart are taken from the following reference points:

A. Outside width of frame at front of frame.

B. Center line of frame to outside edge at front of frame.

C. Center to center distance of body mounting bracket bolt holes.

D. Center line of frame to outside edge at rear of frame.

E. Outside width of frame at rear cross member.

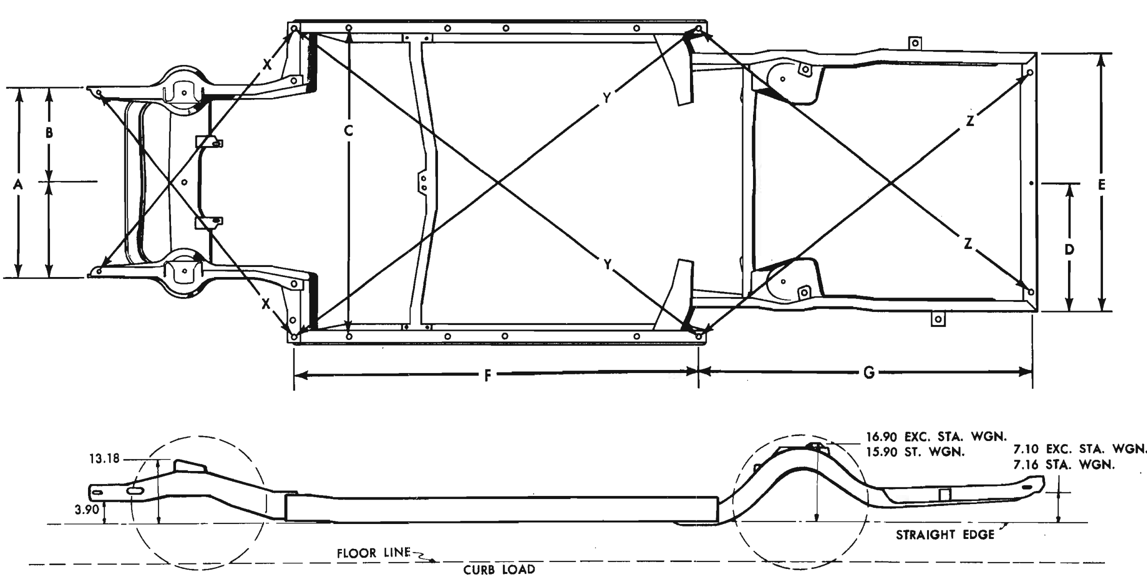
F. Center of number one outboard body mount hole to center of number six body mount hole.

G. Center of number six body mount hole to center of number nine body mount hole.

BODY STYLES		A	B	C	D	E	F	G
23 SERIES	Exc. Station Wagon	38.00	19.00	60.56	26.10	52.20	79.48	68.18
23 SERIES	Station Wagon	38.00	19.00	60.56	23.54	47.08	79.48	70.60
29 SERIES	All	38.00	19.00	60.56	26.10	52.20	79.48	68.18
26 SERIES	All	38.00	19.00	60.56	26.10	52.20	79.48	75.18
27 SERIES	All	38.00	19.00	60.56	23.54	47.08	79.48	70.60
28 SERIES	All	38.00	19.00	60.56	26.10	52.20	79.48	75.18

Fig. 1A-2 Frame Checking Chart

FRAME DIMENSIONS



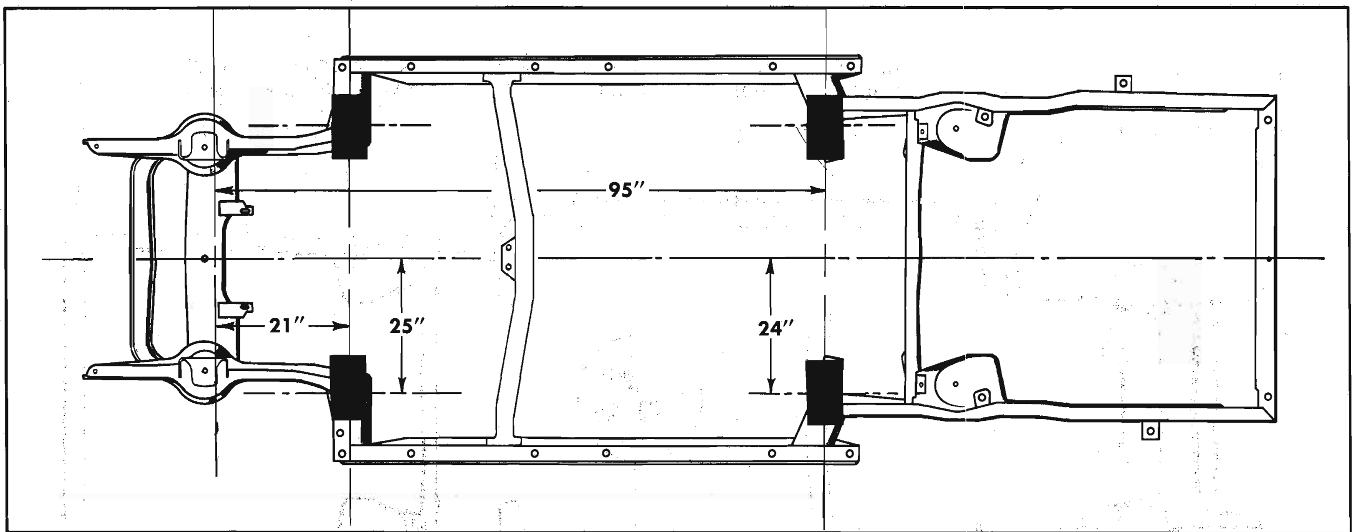


Fig. 1A-3 Proper Location for Adapters

Dimensions for X, Y and Z are not given, but are used merely to illustrate the points for taking diagonal measurements for checking the squareness of a frame. Holes or rivet heads are located on the frame at the approximate terminal point of the arrowheads, and can be used for this purpose.

LIFTING PONTIAC CARS WITH HOISTS

Lifting can be accomplished without adapters with drive-on type or twin post type hoists, or with hoists or lifts making contact with the front suspension lower arms or rear axle. Since the frame is the perimeter type, some hoists designed to contact side rails require adapters to raise the car without damage to parts of the exhaust system, body, floor, etc. Suppliers of the original lifting equipment should have information on adapters to use with Pontiac cars.

Fig. 1A-2 shows the proper location for placing adapters so that they correctly contact the perimeter type frame. At front of car, the supports should be 21" behind the center line of the front wheels and 25" to each side of the center line of the car. The rear supports should be placed 95" from the center line of the front wheels and 24" to each side of the center line of the car. The clearance at these points is 7½" at front and 6" at rear.

BODY TO FRAME MOUNTINGS

The perimeter type frame permits use of better and more durable body mounts. As many as twenty body bolt mounts are used, depending on body style, and each is insulated with rubber to reduce transmission of vibration to the body.

The installation detail and position of body bolts are shown in Figures 1A-3 and 1A-4.

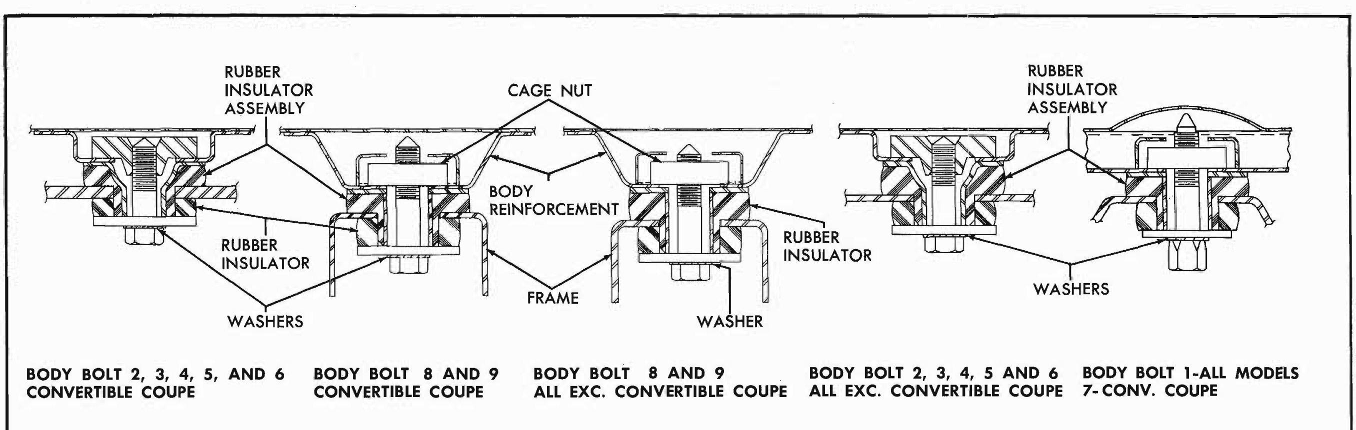


Fig. 1A-4 Body Bolt Installation

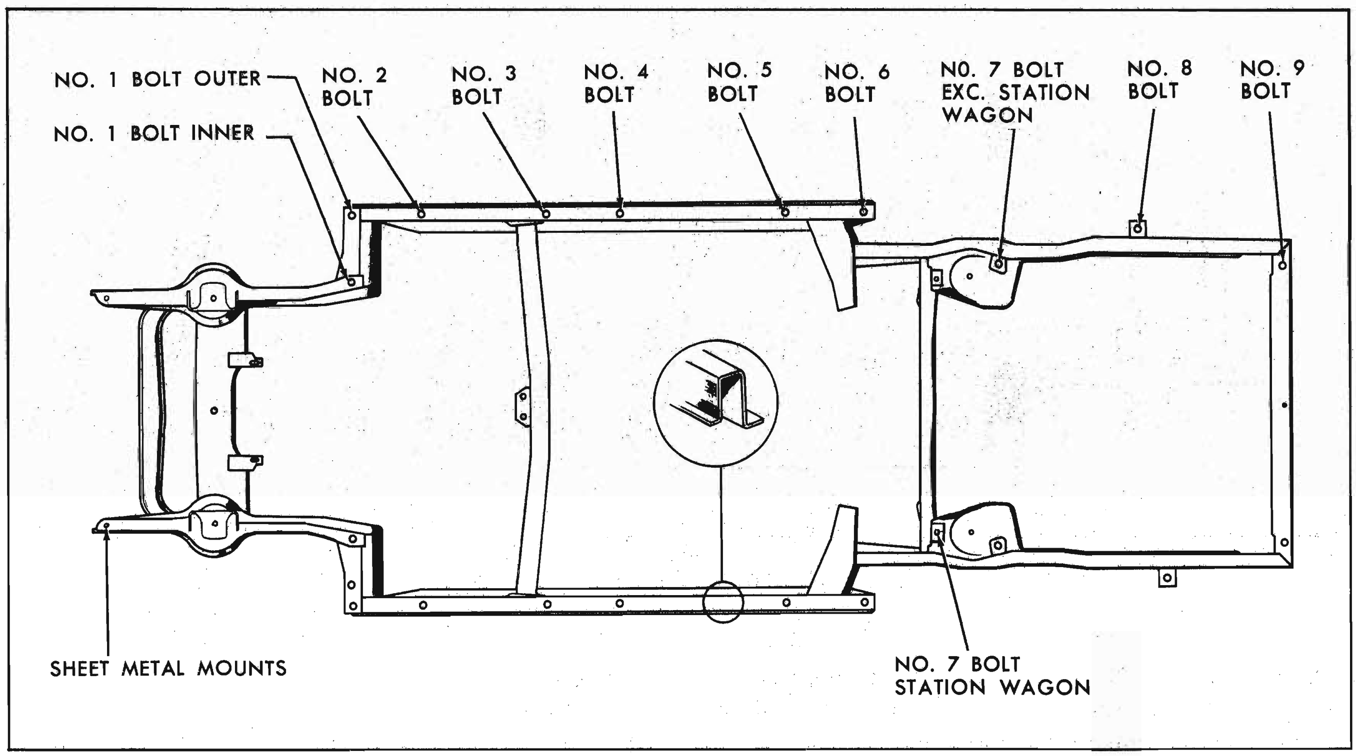


Fig. 1A-5 Location of Body Bolts on Frame

The size of body bolts varies with location and model. A $\frac{7}{16}$-14 x $1\frac{13}{16}$ hex bolt is used at positions 2, 3, 4, 5 and 6 on all models. At position 1, $\frac{7}{16}$-14 x $2\frac{5}{16}$ bolts are used and at positions 8 and 9, $\frac{7}{16}$-14 x $2\frac{1}{8}$ hex bolts are used.

On all models, except convertibles and Safaris, the number 7 bolt is omitted on both sides, but the rubber body to frame insulators are installed. On convertibles and Safaris, a special $\frac{7}{16}$-14 x $2\frac{5}{16}$ hex bolt is used at position 7.

Body bolts at positions 7, 8 and 9 should be tightened to 40-60 lb. ft. torque and all others tightened to 25-60 lb. ft. torque.

All other information concerning the body, such as removing glass, trim, hardware, etc., is covered in the Pontiac Body Shop Manual.

GENERAL LUBRICATION

CONTENTS OF THIS SECTION

Various parts on Pontiac cars should be lubricated periodically to retain all the built-in value. However, as with changing engine oil, the need for this vital service varies according to the conditions under which the car is driven.

WHEN TO LUBRICATE

All Pontiacs are thoroughly and completely lubricated at the factory with a special long-lasting chassis grease and under normal conditions chassis lubrication will not be required for a period up to 35,000 miles unless a noisy condition develops.

For additional extended chassis lubrication periods, the specially formulated Pontiac chassis grease is recommended.

NOTE: If conventional chassis lubricant is used, relubrication at 4,000 mile intervals is recommended.

ENGINE

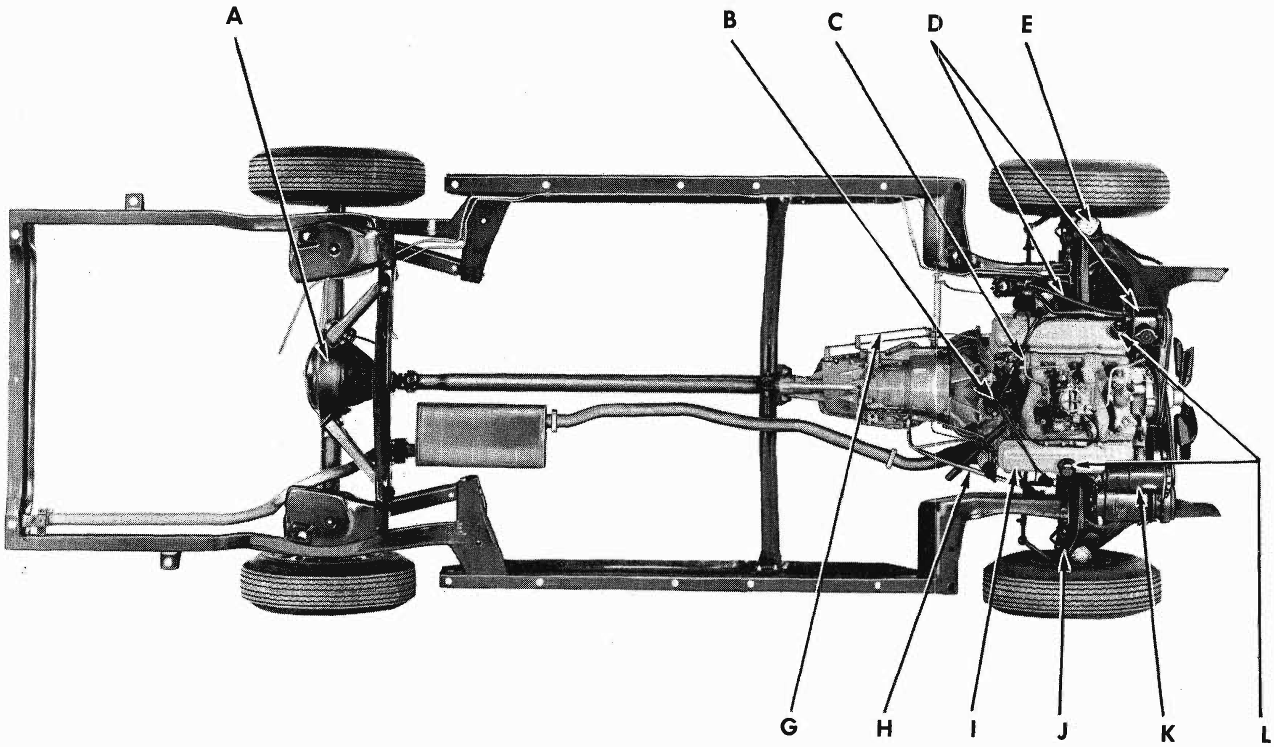
CRANKCASE

The terms "For Service ML", "For Service MM" and "For Service MS or DG" are used by the oil industry to designate the types of engine oil supplied to meet the requirements of various service conditions.

Petroleum based engine oils of type MS, as supplied by reputable marketers and represented as passing car manufacturer's tests (General Motors Standard – G.M. 4745M), are suitable for use in Pontiac engines.

S.A.E. OIL NUMBER SYSTEM

The numerical designations such as 10W, 20W and 20, etc., adopted by the Society of Automotive Engineers, classify lubricating oil only according to fluidity (viscosity). The oils with the lower numbers are lighter and flow more readily than do the oils with the higher numbers. The letter "W" after the number indicates an oil adapted for cold weather starting. Multi-viscosity type crankcase oils such as 5W-20, 10W-20, and 10W-30 are designed to combine the easy starting characteristics of the low number with the warm weather operating characteristics of the higher number.



A—Differential
B—Distributor
C—Accelerator Linkage
D—Upper Control Arm Pivot Shaft
E—Upper Control Arm Ball

F—Steering Idler Arm
G—Hydra-Matic Linkage
H—Transmission
I—Manifold Heat Control

J—Lower Control Arm Ball
K—Generator
L—Crankcase Ventilators and Oil Fill
M—Tie-rod Ends
N—Steering Connecting Rod

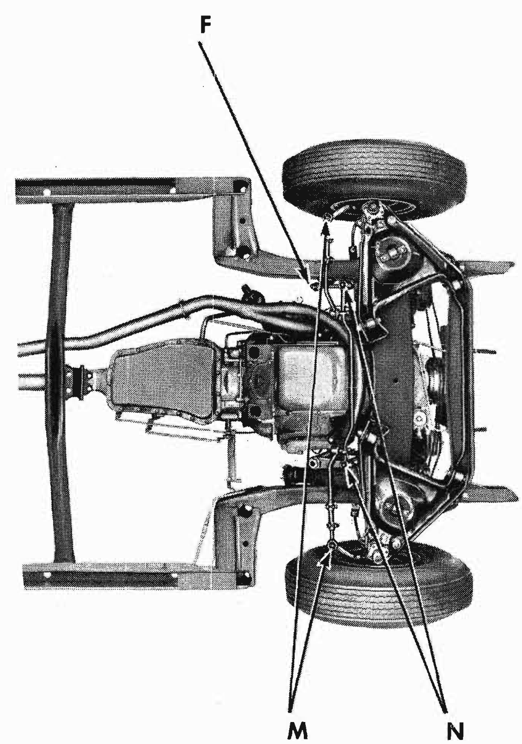


Fig. 2-1 Chassis Lubrication Chart

Atmospheric Temperatures Expected	S.A.E. Number Recommended	Acceptable Multigrade
10°F. 110° F.	20W	10W-30
10°F. below zero to 93° above zero	10W	10W-30
10°F. below zero and colder	5W	5W-20

NOTE: Petroleum based oils which are identified as "For Service MS or DG" are recommended for the Pontiac Engine.

Fig. 2-2 Engine Oil Chart

Summer—with avg. daytime temp. over 32°F.	Winter—with avg. daytime temp. below 32°F.
Every 4,000 miles or 2 months—whichever occurs first	Every 4,000 miles or 30 days—whichever occurs first

Fig. 2-3 Oil Change Intervals

SELECTING OIL OF THE PROPER NUMBER

An oil should be used which provides safe lubrication, satisfactory oil economy under warm climatic conditions, and easy starting at the lowest atmospheric temperatures expected during the period the oil is to remain in the engine. Based on these considerations, the numbers of engine oil which are recommended for the Pontiac engine under various climatic conditions are shown in Fig. 2-2.

OIL CHANGE RECOMMENDATIONS

After the first 4,000 miles of driving, the original break-in oil should be drained from the engine and the crankcase refilled with oil as recommended in Figs. 2-2 and 2-3. Thereafter, when prevailing daylight temperatures average above 32°F., change oil every 60 days or every 4,000 miles, whichever occurs first. When prevailing daylight temperatures average below 32°F., change oil every 30 days or every 4,000 miles, whichever occurs first.

It is always advisable to drain the crankcase only after the engine is thoroughly warmed. The benefit of draining is lost, to a large extent, if the crankcase is drained when the engine is cold as the oil will be thick and will not drain properly.

The crankcase refill capacity is 4 quarts except when the oil filter cartridge is changed. The refill capacity with an oil filter cartridge change is 5 quarts.

OIL FILTER (DISPOSABLE TYPE)

The full flow oil filter (optional at extra cost) is highly recommended for use on the Pontiac Engine. This filter removes harmful particles of dirt, grit or other foreign material before they can cause undue engine wear by imbedding themselves in bearing surfaces or otherwise harmfully affect engine performance.

The filter cartridge should be replaced at the initial oil change, then every six months or 4,000 miles thereafter (Fig. 2-4).

ADDING OIL BETWEEN CHANGES

Since the lubrication system in a Pontiac is a full pressure system, it is not necessary to keep oil level up to the "FULL" mark on the dipstick. It is only necessary to keep oil level above "ADD OIL" mark. It takes one quart to bring the oil level from "ADD OIL" to "FULL" mark. Each time the gas tank is filled, the oil level should be checked.

It is good economy to let the oil level approach the "ADD OIL" mark before having oil changed.

CAUTION: Do not overfill.

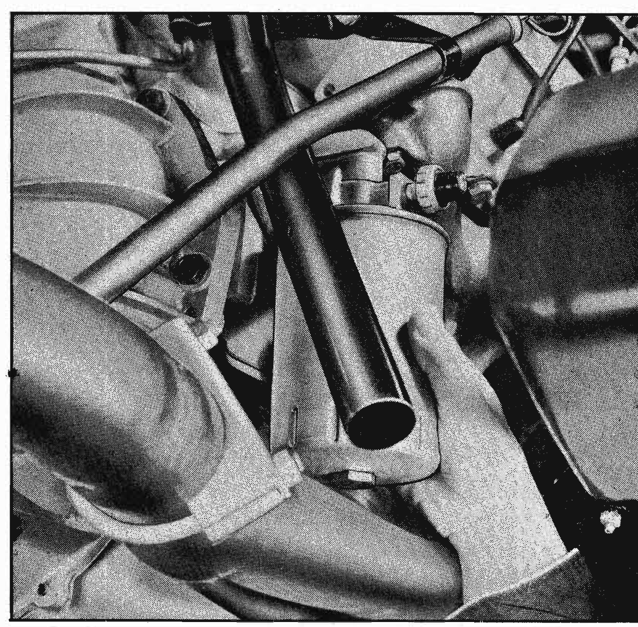


Fig. 2-4 Replacing Filter Cartridge

CRANKCASE VENTILATOR

The crankcase breather elements, built into the oil filler caps, should be cleaned at 2,000 mile intervals, oftener in dusty areas.

Clean oil filler and ventilator cap filters by plunging them up and down several times in a can of kerosene or other suitable solvent. Re-oil elements by dipping in engine oil and allowing to drain thoroughly.

ENGINE ELECTRICAL

GENERATORS—STANDARD AND HEAVY DUTY

At each lubrication period fill the oil cups with engine oil. If the oil reservoir in the commutator end bearing becomes completely exhausted through failure to lubricate at regular intervals, it will require more than a single filling to restore the reservoir. In such a case, the oil cup should be filled three times consecutively, allowing time between fillings for the oil to soak down into the wick.

CAUTION: Do not oil with engine running.

The 30 and 35 amp generators have an oiler at the drive end only. The 28-45 and 45 (low cut-in) amp generators have oilers at both the drive end and commutator end.

STARTING MOTOR

No lubrication required except on overhaul. When overhauling starting motor add a few drops of engine oil to the bronze bushings in both end frames.

DISTRIBUTOR

The hinge cap oiler should be filled with S.A.E. 20 oil at each lubrication. When replacing contact points add a trace of special cam and ball bearing lubricant to the breaker cam. No other lubrication is required. Contact points should be completely free of lubricant at all times (Fig. 2-5).

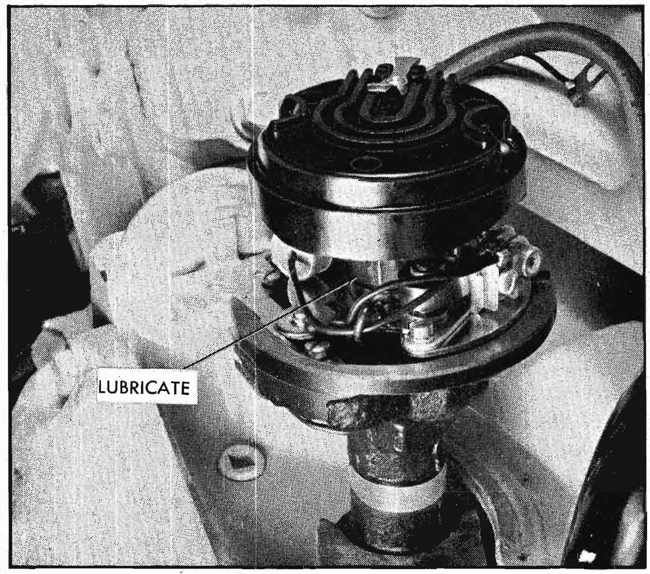


Fig. 2-5 Lubricating Distributor

ENGINE FUEL SYSTEM

CARBURETOR AIR CLEANER

STANDARD AIR CLEANER

The carburetor standard air cleaner should be serviced in the spring and fall or every 10,000 miles —under extremely dusty conditions service every 2,000 miles or oftener. Clean as follows:

1. Remove filter element from air cleaner.

2. Clean element by plunging up and down in a can of gasoline or kerosene.

3. Re-oil element by dipping in engine oil and allowing excess oil to drain off before assembly.

4. Clean dirt out of element seat in silencer body and reassemble.

HEAVY DUTY AIR CLEANER (Paper)

The heavy duty air cleaner paper filter element (on triple-two barrel carburetors only) should be replaced or cleaned every 15,000 miles or yearly.

HEAVY DUTY AIR CLEANER (Foam)

This cleaner element may be used in place of the standard element on two or four barrel equipped units. The new element is made of a sponge-like material (polyurethane) and is very readily cleaned.

At initial installation in air cleaner, remove the screen from the cleaning element. Dip element in SAE 10W-30 oil and squeeze to remove excess oil. Reinstall screen in element with element sealing edges evenly overlapping screen. Remove air cleaner from engine and discard paper cleaning element. Clean all dirt from inside of air cleaner body. Install the new cleaning element and reinstall entire cleaner on engine.

After each occasion of driving during dust storms or at most every 5,000 miles, remove the cleaner from the engine, remove the cleaner element from the cleaner, and remove the screen from the cleaning element. Wash the element in suitable solvent such as kerosene at room temperature to remove oil and dirt. Squeeze element (do not wring) dry. Dip in SAE 10W-30 oil and squeeze to remove excess oil.

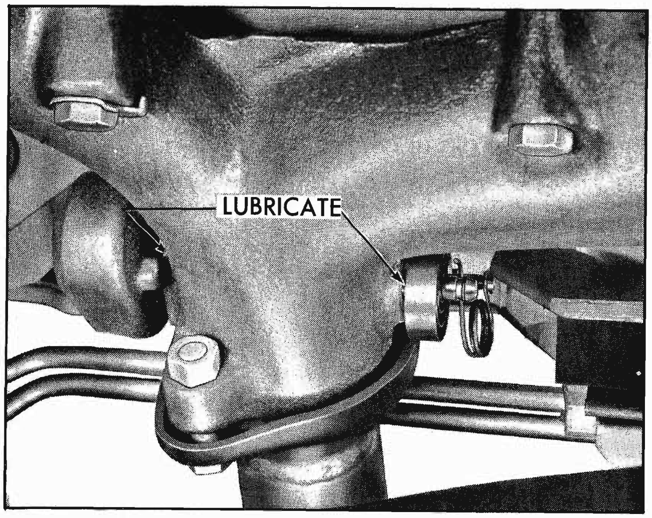


Fig. 2-6 Lubricating Manifold Heat Valve

Replace screen in cleaner element with element sealing edges evenly overlapping screen. Clean all dirt from inside air cleaner body, install cleaner element, and reinstall entire cleaner on engine.

FUEL FILTER (DISPOSABLE TYPE)

The disposable type fuel filter assembly should be replaced at 12,000 mile intervals or yearly. If premature plugging occurs, a change in brand of fuel is suggested.

MANIFOLD HEAT VALVE

Check heat valve in right bank manifold at 4,000 mile inspection for freedom of movement; if sticking, lubricate bushing with graphite in alcohol (Fig. 2-6).

CLUTCH AND LINKAGE

CLUTCH RELEASE BEARING

The clutch release bearing requires no periodic lubrication. It is a ball bearing, lubricated and sealed with enough lubricant for life.

CLUTCH LINKAGE—SYNCHRO-MESH

Every 4,000 miles, lubricate all pivot points with engine oil. Use light grease at push rod to clutch fork ball joint, and chassis grease at high pressure lubrication fitting.

SHIFT LINKAGE

Every 8,000 miles, lubricate all joints below the steering column shift levers with engine oil.

GEAR SHIFT CONTROLS

The gear shift control linkage is lubricated at assembly and requires no further lubrication unless the parts become dry and sticky. Lubricate with wheel bearing grease as necessary.

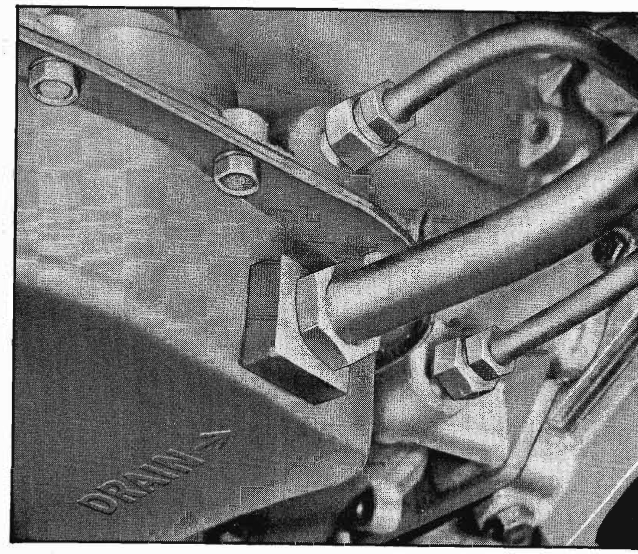


Fig. 2-7 Hydra-Matic Drain at Bottom of Oil Pan

ACCELERATOR LINKAGE

Lubricate every 8,000 miles with light engine oil. NOTE: Do not lubricate carburetor linkage.

HYDRAMATIC TV LINKAGE

Lubricate every 8,000 miles with engine oil.

TRANSMISSION

HYDRA-MATIC

Check for leaks and correct oil level as outlined in the Hydra-Matic Manual. If level is at lower mark or below, add Automatic Transmission Fluid "AQ-ATF" (Type A) to bring to full mark. (Approximately one pint required to raise level from lower mark to full mark.)

Change oil every 25,000 miles (Fig. 2-7). Refill capacity for the Roto Hydra-Matic is 11 pints; for the Super Hydra-Matic, 18 pints. The filler tube is located on right hand side of engine (Fig. 2-8).

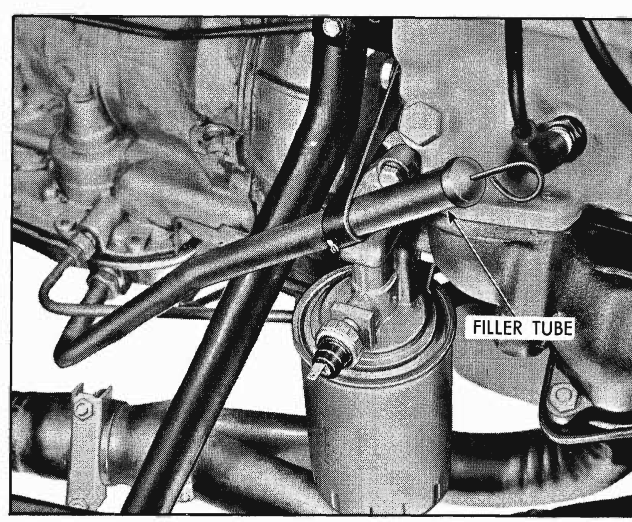


Fig. 2-8 Location of Hydra-Matic Filler Tube

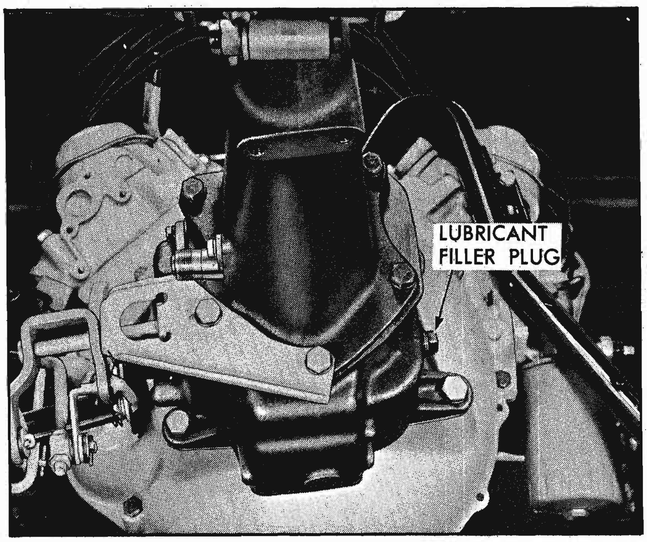


Fig. 2-9 Location of Synchro-mesh Filler Plug

STANDARD AND HEAVY DUTY SYNCHRO-MESH

Lubricant change in the synchro-mesh transmission is not recommended unless repair work is being done. Check transmission for leaks at each 4,000-mile inspection period. If there is evidence of leakage, the leak should be corrected and lubricant added, if needed. The filler plug for both transmissions is located on side of transmission case (Fig. 2-9).

Refill capacity is: Standard—1.8 pints; Heavy Duty —2.8 pints. Lubricant should be level with bottom of filler plug hole.

Use SAE 80 "Multi-purpose Gear Lubricant". No special additive to this lubricant is required or recommended.

4-SPEED SYNCHRO-MESH

Lubricant change is not recommended unless repair work is being done. Check transmission for leaks at each 4,000-mile inspection period. If leakage is detected, make proper repairs and add lubricant as necessary.

The lubricant filler plug for the 4-speed synchromesh transmission is located on side of transmission case.

Refill capacity is 2.5 pints. Use SAE 80 "Multi-purpose Gear Lubricant". No special additive is required. Lubricant should be level with bottom of filler plug hole.

SPEEDOMETER DRIVE CABLE

Lubricate speedometer cable if noise or needle flicker is noticed. In some cases the lubricant placed in the conduit at the factory may become dry causing a slight binding of the cable. This condition will usually result in wavering of the speedometer needle. A very dry cable, of course, will be noisy. When lubricating the speedometer cable, first remove it from the top and wipe all of the old grease from the cable.

Use a suitable speedometer cable grease which will not become hard and stiff when cold, coating the lower two-thirds of the cable with a generous amount of lubricant. Apply a limited amount of lubricant to the upper one-third of cable to assure adequate lubrication in area of bend at speedometer head.

CAUTION: Do not over-lubricate the upper portion of cable as lubricant may seep into speedometer head.

FRONT SUSPENSION

WHEEL BEARINGS

Front wheel bearings require no periodic lubrication. They should be lubricated only when it is necessary to remove wheels for other work, such as brake relining. The bearings should then be thoroughly cleaned and rollers coated with high melting point water resistant wheel bearing lubricant. Do not fill the wheel hub cavity.

Wheel bearings that are not properly adjusted, i.e., too tight or too loose, are usually the cause of wheel bearing failure and accordingly wheel bearing adjustment and lubrication should only be undertaken by authorized Pontiac dealers.

BALL JOINTS

Both the upper and lower control arm balls should be lubricated every 35,000 miles with specially formulated chassis grease, unless noise develops.

CONTROL ARMS

The upper control arm pivot shafts should be lubricated every 35,000 miles with specially formulated chassis grease, unless noise develops.

NOTE: If conventional chassis lubricant is used, relubrication at 4,000 mile intervals is recommended.

REAR SUSPENSION

STANDARD DIFFERENTIAL

Lubricant change in the standard differential is not recommended unless repair work is being done. The differential should be checked for leaks at each 4,000 mile inspection period. If there is evidence of leakage, the leak should be corrected and lubricant added if needed. Level should be even with bottom of filler plug hole. Rear axle capacity is 5¾ pints.

Use factory recommended lubricant (suitable for passenger car duty) in the standard differential. Because of the importance of using factory recommended lubricant in the standard differential, a container of this lubricant is furnished with each service ring gear and pinion set or differential carrier assembly. This lubricant is also available in 1 quart cans through regular parts channels if for any reason a refill is required.

SAFE-T-TRACK DIFFERENTIAL

Lubricant change in the Safe-T-Track differential is not recommended unless repair work is being done. The differential should be checked for leaks at each chassis lubrication. If there is evidence of leakage, the leak should be corrected and lubricant added if needed. Level should be even with bottom of filler plug hole. Rear axle capacity is 5½ pints.

Use only "Multi-purpose Hypoid Gear Lubricant".

If a regular hypoid lubricant is used in Safe-T-Track differentials for refills, severe "chatter" on turns will result.

STEERING GEAR

MANUAL STEERING

Lubricant change is not necessary unless the unit is disassembled for repair. At each 4,000 mile inspection period, unit should be checked for leaks. If there is evidence of leakage from the steering gear, the leak should be corrected and all-season steering gear lubricant added to bring to proper level.

If unit does not leak, it is only necessary to check level once yearly (preferably in the fall).

POWER STEERING

It is not necessary to change fluid unless the unit is disassembled for repairs. However, if there are

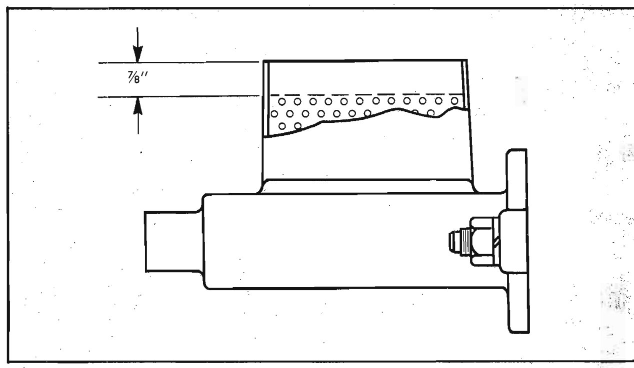


Fig. 2-10 Master Cylinder Fluid Level

any leaks in the system they should be corrected and the fluid level checked. Add automatic transmission fluid, AQ-ATF (Type A), to bring level up to mark near top of reservoir.

BRAKES

MASTER CYLINDER

If there is evidence of leakage in the brake hydraulic system, the leak should be corrected and fluid added as needed. Otherwise fluid level should be checked at the time of brake adjustment or every 4,000 miles.

When adding fluid, bring level to 1" from gasket surface of filler neck (Fig. 2-10).

NOTE: Always use heavy duty brake fluid which meets the S.A.E. 70R1 specification.

POWER AND STANDARD BRAKE LINKAGE

Apply light engine oil on power brake pedal and linkage pivot points when dry or sticky.

CABLES

Brake cables should be lubricated when the rear wheels and drums are off to replace brake shoes and linings or to make a major adjustment. Light grease is recommended.

Lubricate as follows:

1. Thoroughly clean cable from conduit to cable spreader.

2. Remove retainers at forward end of conduits.

3. Pry apart the two fingers of the anchor which are clinched around the cable conduit, then loosen

(but do not remove) the two bolts which hold the conduit anchor to the brake backing plate.

NOTE: If the anchor is removed, the cable tension spring on the brake cable will expand through the hole in the backing plate. Care should be taken so that the cable end does not disconnect from the brake operating lever. This would require removal of drums to permit re-engaging the cable with the operating lever.

4. Slide the conduit forward on the brake cable.

5. Clean the cable, examine for broken strands, and apply light grease to the cable.

6. If conduit anchor at backing plate has been removed, see that rear brake drums are removed. Inspect cable connections to hand brake actuating lever to be certain lever is seated in lever hook.

7. Slide brake cable conduit back in position and secure at forward end with retainer.

8. Tighten two bolts holding anchor to backing plate and then clinch two fingers of anchor around cable conduit. See that rubber boot is in place over front end of cable conduit.

BATTERY

Every 30 days, observe liquid level and, if low, add distilled water to bring level to bottom of vent well. At high ambient temperatures or exended trip operation more frequent additions may be required. Inspect top of battery and retainer. If damp or corroded, clean with soda solution or diluted ammonia water; dry thoroughly.

Check the specific gravity of the battery. The battery should be kept at or near a full charge at all times (1.240-1.280 hydrometer reading). This is especially important in cold weather when the demands on the battery are high. A battery can freeze in extreme cold if it is not in a fully charged condition.

CAUTION: Battery fumes are flammable and toxic.

BODY

DOOR LOCK AND STRIKER

Wipe lock and striker parts clean and apply a light coat of stick-type lubricant to the mating surfaces of the rotary lock bolt and the striker teeth of each door. Clean off excess lubricant.

CAUTION: Do not use oil.

DOOR HINGE HOLD OPEN SPRINGS AND STRAPS.

Coat front door hinge hold open springs and friction surface on rear door hold open straps with light grease.

DOOR HINGE PINS

Apply light engine oil every 8,000 miles or when hinge is dry.

DOOR AND REAR DECK LOCKS

Whenever it becomes difficult to insert the key into the lock, a small amount of powdered graphite should be blown into the lock cylinder.

HOOD LATCH AND SAFETY HOOK

Every 8,000 miles apply light engine oil to all pivot and spring anchor points.

HOOD HINGE

Apply light engine oil every 8,000 miles.

FUEL TANK DOOR

Apply light engine oil to hinge pin every 8,000 miles.

SAFARI REAR GATE HINGES

Apply light engine oil to rear gate hinges every 8,000 miles. Wipe off all excess lubricant.

SAFARI FOLDING SEAT

Every 8,000 miles apply engine oil sparingly to the pivot points of the folding rear seat assembly. Wipe off all excess lubricant.

CONVERTIBLE COUPE HYDROELECTRIC PUMP MOTOR

The hydroelectric pump motor does not require service unless malfunction develops.

SUSPENSION

CONTENTS OF THIS SECTION

DESCRIPTION

The suspension system employs coil springs front and rear. Ball joints are used on the steering knuckle at outer ends of upper and lower control arms in front.

The rear suspension consists of a basic four-link suspension, made up of two lower control arms, one on each side, and two upper control arms which are held by pivot bolts at rear axle and frame cross member.

FRONT SUSPENSION

The ball joints, located at the outer ends of the upper and lower controls arms (Fig. 3-1), serve as pivot points for both the vertical movement of the wheel and rotation of the steering knuckle. Construction of the upper and lower ball joints is similar except that load is maintained on the upper joints by an integral pressure ring while the lower joints are under load due to weight of car on the springs which are supported by the lower control arms (Fig. 3-1).

The spherical joints take thrust from any angle and have phenolic resin seats for bearing and wearing quality. Lubrication fittings are provided at ball joints, and rubber seals, enclosing the lower half of ball studs, serve as grease retainers (Fig. 3-2). The steering knuckles and spindles are of integral design and the brake cylinders are rigidly attached to the knuckles with the backing plate serving principally as a support for brake shoes and as a protective cover (Fig. 3-3).

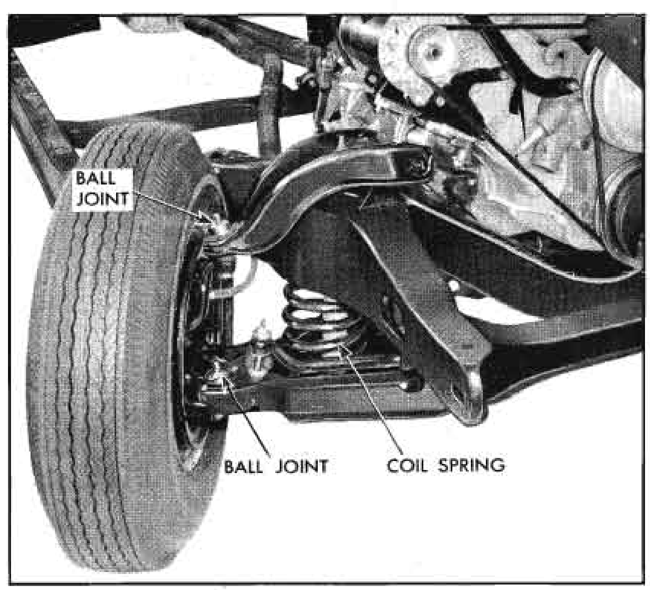


Fig. 3-1 Front Suspension Ball Joints

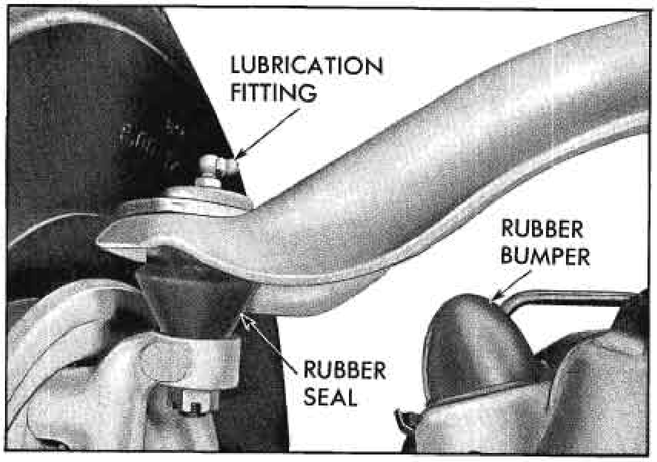


Fig. 3-2 Upper Control Arm Lubrication Fitting

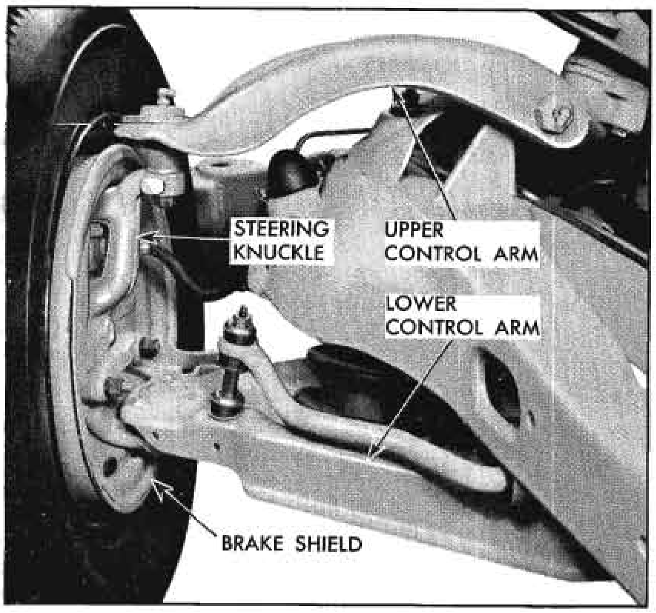


Fig. 3-3 Attachment of Front Suspension to Wheel

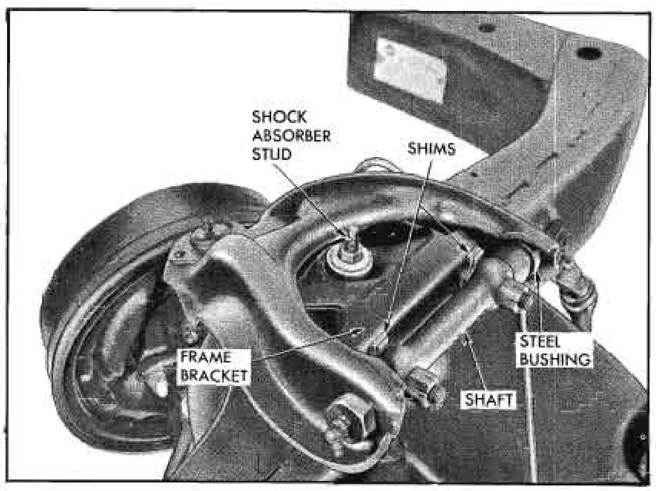


Fig. 3-4 Shimming of Upper Control Arm

Steel bushings at the inner ends of the upper control arms pivot on shafts attached to the car frame. Caster and camber adjustments are made with shims at this point (Fig. 3-4).

The inner ends of the lower control arms are rubber mounted to the two front cross members of frame thus avoiding metal to metal contact. The front bushings of these control arms are oval while the rear bushings are round.

The upper ends of the front coil springs seat in the frame side members; the lower ends of these springs rest on the lower control arms (Fig. 3-1).

A direct acting shock absorber of sealed construction is carried inside each front coil spring. The upper stud of the shock absorber is fastened to a bracket on the frame by a nut. The lower end of shock absorber is attached to the lower control arm with two bolts, plain washers and lock washers. Noise insulation is provided by rubber bushings which fit over the shock absorber upper studs to prevent metal to metal contact between each stud and metal bracket.

A stabilizer shaft, mounted in rubber to the frame forward of front springs and connected to the lower control arms by links at each end, provides roll stability (Fig. 3-5).

Rubber bumpers attached to the frame below the upper control arm cushion downward movement of the suspension system, and bumpers attached to the front lower control arms cushion the upward movement.

REAR SUSPENSION

The two rear axle upper control arms and two lower control arms (Fig. 3-6) form the basic links of rear suspension. The functions of the lower control arms are to carry the load of car at rear, maintain

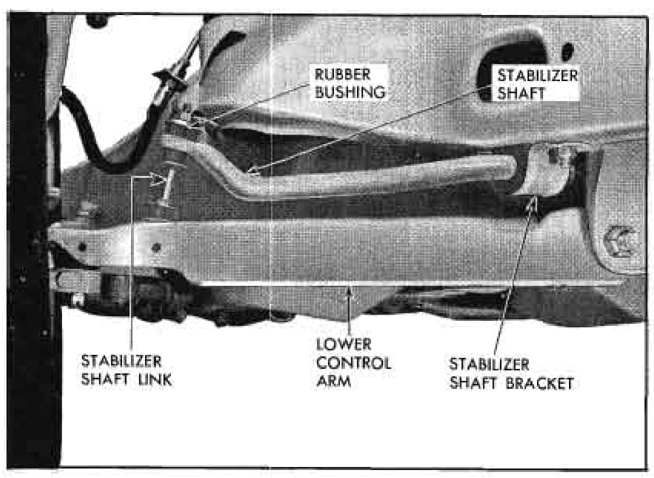


Fig. 3-5 Stabilizer Shaft Assembly

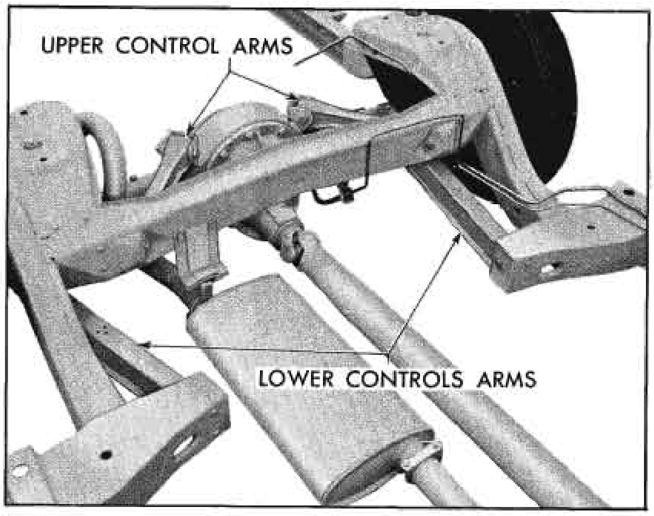


Fig. 3-6 Upper and Lower Rear Control Arms

the axle in line relative to frame, and oppose torque reaction of the rear axle. The main function of the upper control arms is to control rear axle "windup."

Rubber bushings are used at all connecting pivot points of the two upper and two lower control arms.

The upper ends of rear springs are retained in seats welded to the frame while the lower ends are attached to braces welded to the rear axle (Fig. 3-7).

Direct acting sealed shock absorbers are mounted with upper ends inclined toward center of car. Rubber bumpers, attached to the frame above the rear axle, cushion extreme downward movement of the frame and body. Safari models incorporate a stabilizer shaft in the rear suspension. Other body styles have stabilizer shafts on the front only.

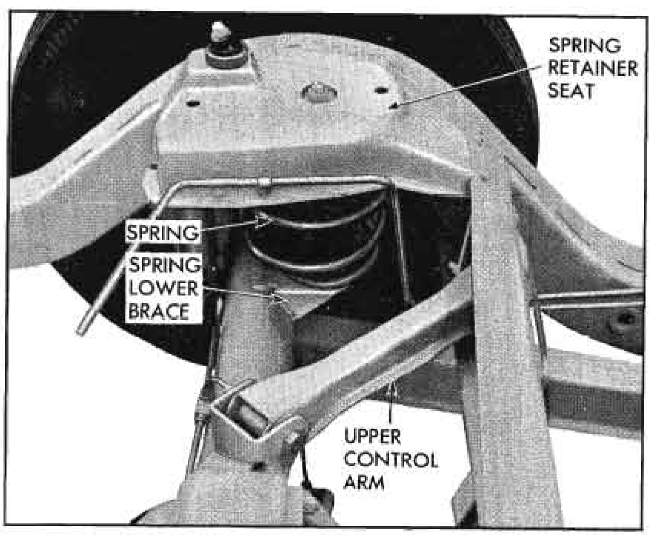


Fig. 3-7 Position of Rear Coil Spring

PERIODIC SERVICE

Periodic service of the suspension system consists of regular lubrication as outlined in the GENERAL LUBRICATION section.

Lubrication fittings are provided at the front suspension ball joints and inner ends of the upper control arms. Shock absorbers do not require lubrication and, in case of leaks or malfunction, they should be replaced.

ADJUSTMENTS AND CHECKS ON CAR

The following adjustments and checks are made with the suspension parts on the car:

CHECK AND ADJUST FRONT WHEEL BEARINGS

A slight looseness in the lower ball joint when weight of car is taken off wheels is normal and does not necessarily indicate excessive wear or looseness.

To check:

1. Place lift or car jack under lower frame front cross member and raise wheel just off floor. This will load the ball joints.

2. Grip tire at top and bottom and rock. If movement of tire at outer periphery exceeds ¼", the wheel bearing, ball joints or both may be worn excessively.

If bearing looseness is excessive, adjustment of wheel bearings can be made by either of the following two methods, the first being the preferred method.

TORQUE WRENCH METHOD

1. Remove dust cap.

2. Check for slip fit of bearing cones on spindles. Bores of bearing cones should have a light coat of wheel bearing lubricant to allow cones to creep on spindle.

3. If nut turns hard on spindle, check for and remove any burrs from spindle threads and cotter pin holes or key slots in nut.

4. With tire off ground adjust bearing:

   a. While rotating drum in both directions, tighten nut with torque wrench to approximately 10-12 lb. ft. to insure all parts are properly seated.

   b. Back off nut one flat (1/6) of a turn. If locking holes line-up, insert cotter pin. If holes do not line-up, continue to back off the adjusting nut to the nearest locking hole. Final adjustment should be one flat to 1½ flats turn, backed off from the

4. With tire off ground adjust bearing:

a. Tighten nut with torque wrench to approximately 325 lb. in. (27 lb. ft.) to insure all parts are properly seated. Turn drum.

b. Back off nut to finger loose and retighten to 25-35 lb. in. (Fig. 3-8).

c. If a slot in nut lines up with a cotter pin hole in spindle, insert new cotter pin; otherwise tighten nut only enough to permit cotter pin to enter first hole and insert new cotter pin. Do not exceed 110 lb. in.

d. Clinch cotter pin and cut off extra length to ensure ends will not interfere with static collector or dust cap.

5. Install dust cap and lower tire to ground.

HAND FEEL METHOD

1. Remove dust cap.

2. Check for slip fit of bearing cones on spindles. Bores for bearing cones should have a light coat of wheel bearing lubricant to allow cones to creep.

3. If nut turns hard on spindle, check for and remove any burrs from spindle threads and cotter pin holes or key slots in nut.

4. With tire off ground adjust bearing:

a. Tighten nut with an 8" or 10" wrench using enough arm length leverage to ensure parts are properly seated.

b. Back off nut finger loose. Then tighten finger tight.

c. Tighten nut with wrench until next slot of nut lines up with cotter pin hole in spindle and insert new cotter pin.

NOTE: Do not apply force on wrench greater than ten pounds at a point 10" from center of spindle.

d. Clinch cotter pin and cut off extra length to ensure ends will not interfere with static collector in dust cap.

5. Install dust cap and lower tire to ground.

CHECK WHEEL AND TIRE RUN OUT

Check run out of each front wheel and tire using dial indicator against rim felloe band. If run out exceeds allowable ⅛", correction may be made by rotating tire on wheel.

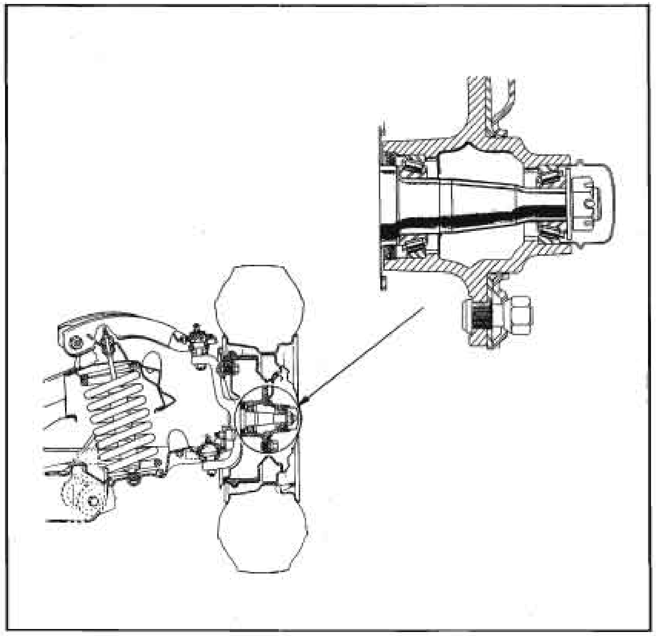


Fig. 3-8 Cross Section of Front Wheel Assembly

When minimum run-out has been obtained, mark point of greatest run-out so wheels can be positioned as shown in Fig. 3-9 when checking front end alignment. Hold a piece of chalk near wheel rim or tire sidewall while spinning wheel. Chalk can be moved inward to mark rim or tire at point of greatest run-out.

CHECK WHEEL AND TIRE BALANCE

During tire break-in or after tires have been repaired they may lose their original static balance—equal distribution of weight of a wheel and tire about its axis of rotation—resulting in pounding action or "tramp".

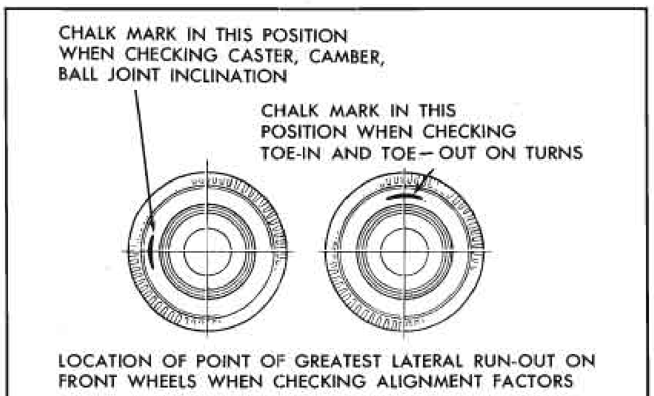


Fig. 3-9 Wheel Position for Checking Alignment

3. Adjust bearings so that wheel will rotate with minimum friction.

4. Check tire for correct pressure and remove stones from tread grooves.

5. Start wheel several times allowing it to stop by itself. If stop position is always the same, wheel assembly is not in static balance.

6. Mark low (heavy) and high (light) points.

7. Install weight on rim inner felloe at light point to compensate for unbalance.

8. If only slight unbalance exists, install weights at opposite sides of rim inner felloe 90° from light point. Then move these weights toward light point until wheel is in balance.

9. Repack bearing and install wheel assembly. Adjust wheel bearing.

CHECK SPHERICAL BALL JOINTS

1. Check and lubricate all ball joints.

2. Raise car at the lower control arm, supporting outside of the spring seat, so that the upper control arm is not touching rebound rubber bumper and front wheels are free from contact with lift or floor.

3. Check movement of each front wheel by moving top and bottom of tire in and out, using sufficient hand load to take up any clearance, but not in excess to deform tire or suspension parts. An excess of 1/4" travel (measured at the periphery of the tire) indicates a worn or loose wheel bearing, worn ball joints, looseness at the upper or lower control arm shafts, or a combination of all these. When moving tire, as mentioned above, observe each ball joint and each bushing on upper arm shaft to check each part independently for looseness.

4. If above check indicates looseness, check wheel bearings using torque wrench or hand feel method. Replace bearings if worn excessively.

5. If excessive looseness still exists at periphery of tire, make sure front end is properly lubricated and that no excessive play exists in the upper control arm inner shaft. If excessive wear and/or looseness (.020" maximum) exists between the threads of the shaft and the bushing assembly, correct by following procedures outlined on pages 3-8 through 3-10.

6. If wheel bearings or upper arm shafts were not the cause of looseness, use J-6627 ball stud remover to remove the upper ball stud, and disconnect the upper arm from steering knuckle.

7. Make sure that the upper ball joint is properly lubricated, then install a nut (snug against the upper ball joint) and rotate the ball stud in its socket with a torque wrench. If the torque required is less than 1/2 lb. ft. or more than 6 lb. ft. the ball joint should be replaced.

8. Install upper ball stud in knuckle and tighten stud nut to 60-95 lb. ft. torque.

9. If excessive looseness still exists at periphery of tire, then use J-6627 ball stud remover to disconnect lower ball stud from steering knuckle.

NOTE: It is permissible to support the suspension assembly anywhere on the lower arm.

10. Install nut on lower ball stud and check for excessive wear or looseness by measuring the ball joint end play.

a. When the ball joint is new, it is permissible to have a maximum of .035" end play.

b. When checking a used or worn ball joint, it is permissible to have a maximum of .045" end play.

11. Replace lower ball joint in control arm, if necessary.

12. Install lower ball stud in knuckle and tighten stud nut to 60-95 lb. ft. torque.

Whenever performing a front wheel alignment or inspection, it is necessary that the front end be properly lubricated, and that there is no excessive play in the upper control arm shafts, wheel bearings, or ball joints. Before checking front wheel alignment, check front suspension spherical ball joints as decribed above.

CHECK CAR HEIGHT

To determine whether height of front and rear suspension is normal, compare measurement on the car in question with others of the same body type and having comparable equipment. Measurements should be taken as follows:

1. At front, measure height from top of lower control arm to underside of frame at a point directly behind center line of spring. (See SPECIFICATIONS and Fig. 3-10).

2. At rear, measure height from top of axle housing to top of spring seat at a point approximately

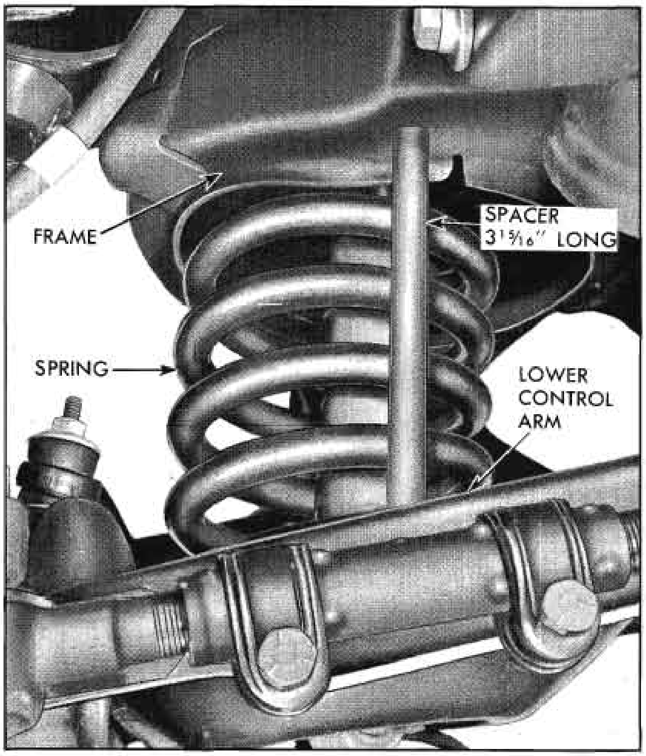


Fig. 3-10 Spacer Inserted to Set Front Suspension

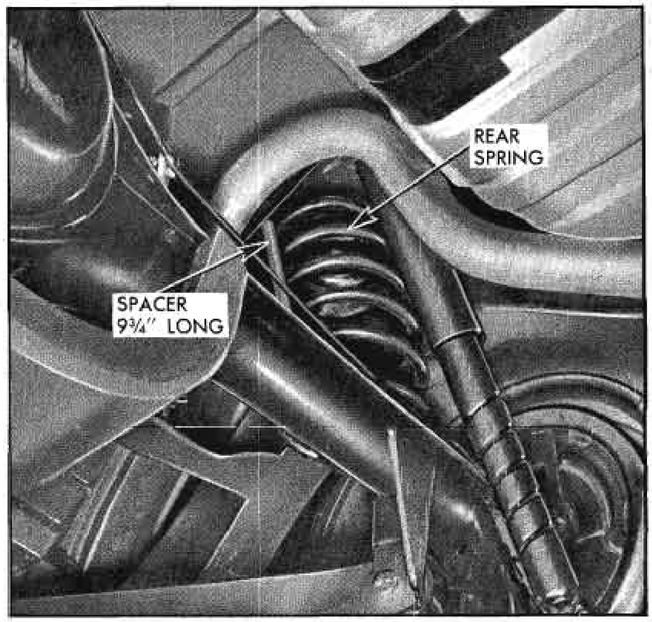


Fig. 3-11 Spacer Inserted to Set Rear Suspension

1½" outward from rubber bumper on frame. (See SPECIFICATIONS and Fig. 3-11).

It is important to have the suspension parts in the normal curb height position when checking wheel alignment. This can be obtained by jouncing the front and rear of the car up and down, decreasing the amount of movement until the parts reach normal curb height position.

The tendency to remain upward or downward will be more noticeable on new cars on which the suspension joints have not yet become burnished and completely free. For this reason, checking of caster and camber on new cars should not be done unless the *height is set* to correspond with the height of the front end of a similar model which has freed up after usage. (See SPECIFICATIONS and Figs. 3-10 and 3-11). Blocks, or spacers made of rod or tubing, will be useful in positioning parts.

WHEEL ALIGNMENT—DEFINITIONS

TOE-IN

Toe-in is the drawing together of the front wheels so that they are closer at the front "B" than at the back "A" as shown in Fig. 3-12.

CASTER AND CAMBER

Forward tilt of the front ball joints relative to the true vertical is negative caster; backward tilt is positive caster (Fig. 3-13). Camber is the outward tilt of front wheels at top; steering axis inclination is the inward tilt (Fig. 3-14).

TOE-OUT ON TURNS

Toe-out on turns is the relationship between front wheels on turns (Fig. 3-15). Since the front wheels must turn on different radius circles, the steering arms are inclined inward at the back to provide the correct turning angles in degrees.

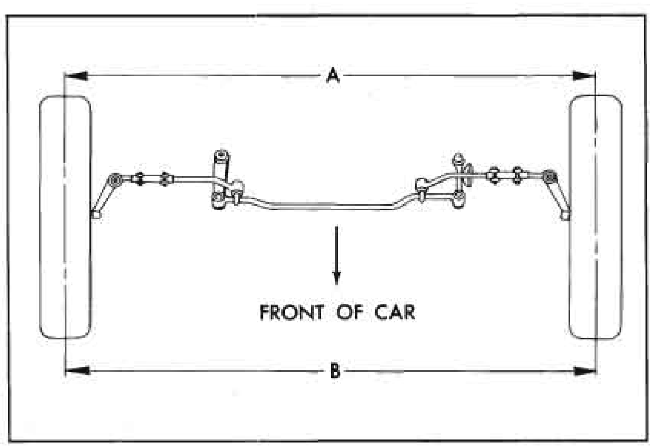


Fig. 3-12 Toe-In

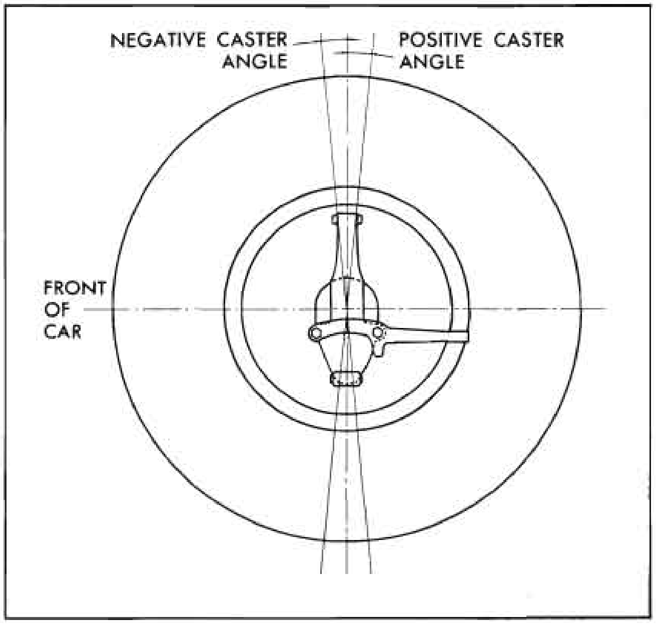


Fig. 3-13 Caster Angle

INSPECTION BEFORE CHECKING FRONT WHEEL ALIGNMENT

Before any checking or corrective work is started on wheel alignment elements, including toe-in, caster, camber, steering axis inclination, and toe-out on turns, the following items which will affect steering should be considered:

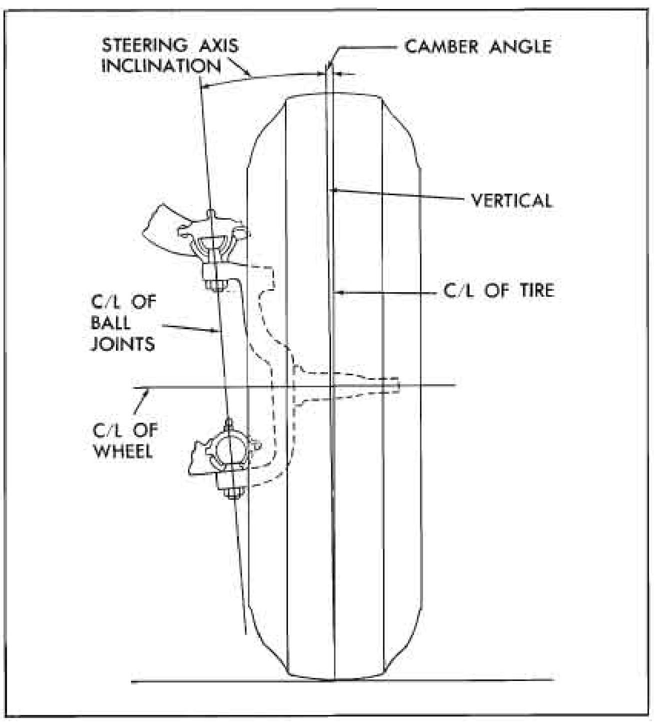


Fig. 3-14 Camber Angle and Steering Axis Inclination

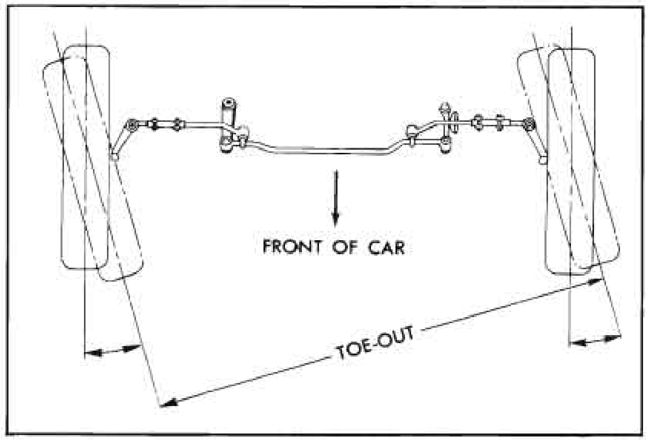


Fig. 3-15 Toe-Out on Turns

1. Check tire inflation and bring to recommended pressure.

2. Check front wheel bearing adjustment and correct if necessary.

3. Check wheel and tire run out.

4. Check wheel and tire for excessive unbalance which would affect steering.

5. Check spherical ball joints.

6. Check steering linkage for looseness. Replace or tighten parts.

7. Check shock absorbers for leaks or lack of control.

8. Check for extraordinary load in car. Remove load or compensate by setting height. (Samples, tools, etc., carried regularly should not be considered extraordinary load.)

9. Check car height.

CHECK AND SET TOE-IN

Check and set toe-in (see SPECIFICATIONS) with a trammel or with other reputable front end aligning equipment, measuring from sidewall of tire or wheel felloes using methods given below.

MEASURING BY TRAMMEL

1. After moving car forward on level floor, chalk tread on both front tires at point 9" above floor.

2. With trammel set at center to center distance of front tires, make mark with chalk on each front tire exactly trammel width apart.

3. Push car forward (never backward) until chalk with trammel marks is 9" above floor at rear of wheels.

4. Measure difference from trammel marks made when chalk was in front of wheel; if trammel marks are now greater than when marked at front, wheels toe-in by this amount (see SPECIFICATIONS).

EQUIPMENT MEASURING FROM SIDEWALL OR WHEEL FELLOES

When using this type of equipment, wheel run out will have a very direct bearing on the readings. Since the allowable run out is 1/8" the readings could possibly be off as far as 1/8" on each wheel if the effect of run out is not cancelled. By taking the average of three readings with the wheel rotated 120° for each reading, the error due to wheel run out can be cancelled. This should be done as follows:

1. After moving the car forward on level floor, take first reading.

2. Mark sidewall of both tires with the number "1" at rear of tire where instrument bears.

3. At 120° intervals (i.e. 1/3 and 2/3 distance around the tire) mark the numbers "2" and "3" on both tires.

4. Jack up and turn wheels until the number "2" is in the position which number "1" occupied when the first reading was taken.

5. Push car back one foot and bring forward to position and take second reading. This reading will then be taken with the instrument bearing 120° around the wheel from where the first reading was taken.

6. Use the same procedure for taking the third reading.

7. Average the three readings to find the actual toe-in.

SET TOE-IN

1. Remove horn button and set gear on high point of worm by turning steering wheel until mark on shaft is exactly at top. This mark locates the high point, or middle of gear travel.

2. Loosen tie rod end clamp bolts and turn tie rod tubes an equal amount until toe-in is 0-1/8". Turn right tie rod in direction of rotation of wheels, when car moves forward, to increase toe-in; turn left tie rod in opposite direction to increase toe-in.

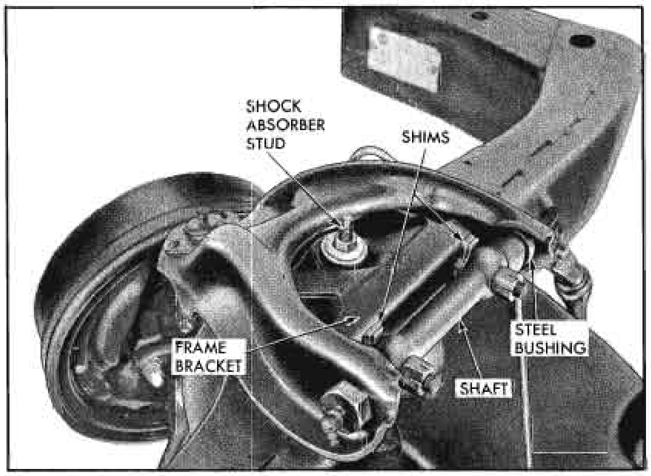


Fig. 3-16 Caster and Camber Shim Location

3. Make sure front wheels are straight ahead by measuring from a reference point at same place on each side of frame center to front of wheel rims. If measurements are not equal, turn both tie rod tubes in same direction (so as not to change toe-in) until measurements become equal. Re-check toe-in since toe-in measurement is accurate only with wheels in straight-ahead position.

4. Tighten tie rod adjuster sleeve bolts to 14-20 lb. ft. torque, making sure bolts are to lower rear side of tie rod and at a 45° angle to horizontal, head of bolts down.

ADJUST CASTER AND CAMBER

Caster and camber are adjusted to specifications by placing shims between the upper pivot shafts and the frame (Fig. 3-16). Both adjustments can be made at the same time. In order to remove or install shims, raise car to remove weight from front wheel then loosen the control arm shaft to frame bolts. Addition to camber angle moves top of wheel out–subtraction in.

1. To decrease positive caster add shims to front bolt.

2. To increase positive caster remove shims from front bolt.

3. To increase camber remove shims from both front and rear bolts.

4. To decrease camber add shims to both front and rear bolts.

NOTE: By adding or subtracting an equal amount of shims from front and rear bolts camber will be changed without affecting caster.

Refer to the shim chart (Fig. 3-17) to determine the amount of shim necessary to correct the adjustment. After the correct number of shims have been installed, torque the pivot shaft mounting bolts to 80-95 lb. ft.

CHECK TOE-OUT ON TURNS

Check toe-out after any necessary corrections to camber, caster, and toe-in have been made.

1. Check with any reputable front end aligning equipment using full floating turn tables. With front wheels resting on turn tables, turn wheels to left until left wheel has been turned 20° from straight ahead. The right wheel should then be turned 18° to 19°.

2. Turn wheels to right until right wheel has been turned 20° from straight ahead. Left wheel should now be turned 18° to 19°.

3. Incorrect toe-out on turns may be caused by other incorrect front end adjustments, but generally indicates bent steering arms which must be replaced.

Replacement of one or both steering arms should be followed by a complete front end check.

MINOR REPAIRS

FRONT SHOCK ABSORBER—REMOVE AND REPLACE

1. Raise car on hoist, or jack up front end so weight of car is fully off front wheels.

2. Remove nut, retainer and grommet which attach upper end of shock absorber to frame bracket.

NOTE: Shock absorber piston rod must not turn while loosening nuts. If necessary, use pliers or wrench to hold top of shock absorber stud mounting while removing nuts.

3. Remove two lower bolts and washers retaining shock absorber and remove shock absorber through lower control arm.

4. Install new shock absorber by reversing the above procedure. Make sure all grommets and retainers are correctly installed.

NOTE: Upper stud nuts must be pre-tightened until they bottom at end of steel threads.

5. Tighten upper stud nuts 60-120 lb. in. torque and lower bolts 15-25 lb. ft. torque.

FRONT SPRING—REMOVE AND REPLACE

1. Raise front end of car with jack placed under frame front cross member.

SHIM THICKNESS	ONE SHIM CHANGE AT BOTH BOLTS WILL CHANGE CAMBER	ONE SHIM CHANGE FRONT BOLT ONLY WILL CHANGE CAMBER	CASTER	ONE SHIM CHANGE REAR BOLT ONLY WILL CHANGE CAMBER	CASTER
.030"	10′ ⅙°	2′	23′	12′	23′
.060"	21′ APPROX. ⅓°	4′	45′	25′	45′
.164"	56′ APPROX. 1°	11′	2° 7′	1° 7′	2° 7′

Fig. 3-17 Caster and Camber Shim Chart

2. Remove wheel.

3. Remove shock absorber.

4. Disconnect lower end of stabilizer link from control arm.

5. Disconnect steering linkage from knuckle.

6. Install spring compressor J-7592 (Fig. 3-18).

a. Locate one compressor plate in one of upper coils of spring so that ramp faces down against coil.

b. Locate other plate in one of lower coils with ramp facing up.

NOTE: Plates must be parallel and radially aligned. Also, center of hole in plates must be aligned with center line of spring (Fig. 3-18).

c. Place retainer J-7592-6, cup side up, over thread end of rod J-7592-5 followed by bearing; then start long nut J-7592-3 on rod.

d. Insert rod, hex end first, up through both plates.

e. Slide retainer J-7592-4, cup side down, over hex end of rod and secure with C-clip. Clip must seat down in retainer.

7. While holding upper end of rod, turn nut at lower end to compress spring.

8. Disconnect inner end of lower control arm from frame front cross members by removing nuts and withdrawing two special $\frac{9}{16}$" dia. pivot bolts.

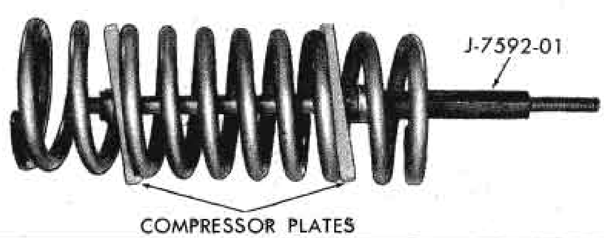


Fig. 3-18 Compressor J-7592 Inserted in Front Coil Spring

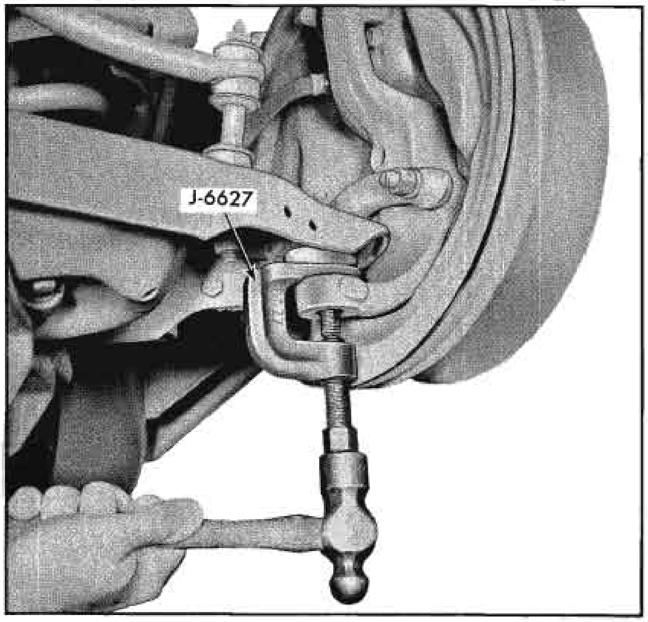


Fig. 3-19 Pressing Lower Ball Stud from Steering Knuckle

9. Swing inner end of arm down; coil spring will drop from its seat in frame side member at same time.

NOTE: Spring can also be removed by pressing lower control arm ball stud from steering knuckle with tool J-6627 (Fig. 3-19) and swinging outer end of arm down.

10. If spring is to be replaced, assemble compressor J-7592 on new spring (Fig. 3-18).

11. Install spring on car by following removal procedure in reverse order.

12. Tighten bolts which attach inner ends of control arm to frame front cross members to 150-175 lb. ft. torque. Tighten shock absorber lower bolts to 15-25 lb. ft. torque and upper nut to 60-120 lb. in. torque.

Tighten stabilizer link nut to 60-120 lb. in. torque.

Tighten steering arm to knuckle nut to 60-95 lb. ft. torque.

FRONT UPPER CONTROL ARM AND SHAFT—REMOVE AND REPLACE

1. Place jack under lower control arm, raise wheel off floor and remove wheel.

2. Remove ball stud from steering knuckle, using tool J-6627 (Fig. 3-19).

3. Remove two bolts and self-locking nuts holding control arm shaft to frame and remove arm and shaft assembly.

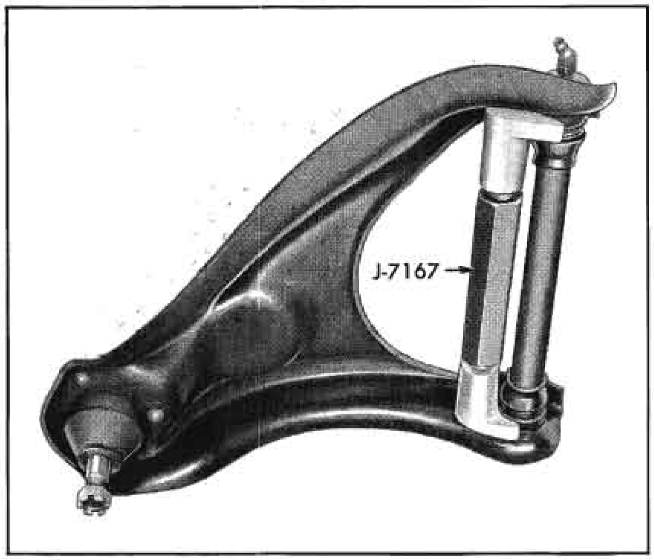


Fig. 3-20 Upper Control Arm Spreader Installed

4. Remove shaft from control arm by removing front and rear threaded bushings.

5. Install shaft in new control arm as follows:

a. Place tool J-7167 in position (Fig. 3-20) and expand until distance between inner faces of arms is $8^{31}/_{32}''$ (Fig. 3-21).

b. Place pivot shaft with new rubber seals in position in control arm.

c. After lubricating pivot shaft threads with flake graphite grease, start bushing on pivot shaft and into arm at same time. Tighten so head of bushing is firmly seated against control arm (150-175 lb. ft. torque).

d. Center pivot shaft in control arm and install other bushing, being sure threads index so there is no bind. Tighten so head of bushing is firmly seated against control arm (150-175 lb. ft. torque). Remove special spreader tool.

e. Check to see that distance between inner faces of shaft ends of control arms is correct (Fig. 3-21). Also check to see that pivot shaft is equalized in arm by measuring from bolt hole to arm at each end of shaft. Turn shaft in arm to centralize if distances from each bolt hole to arm are not equal.

NOTE: Frictional drag of shaft in bushings should not exceed 50 lb. in.

6. Position upper control arm and shaft on frame cross member and install two bolts and self-locking nuts. Tighten nuts to 80-95 lb. ft. torque.

7. Assemble control arm to upper ball stud, tightening stud nut to 80-95 lb. ft. torque.

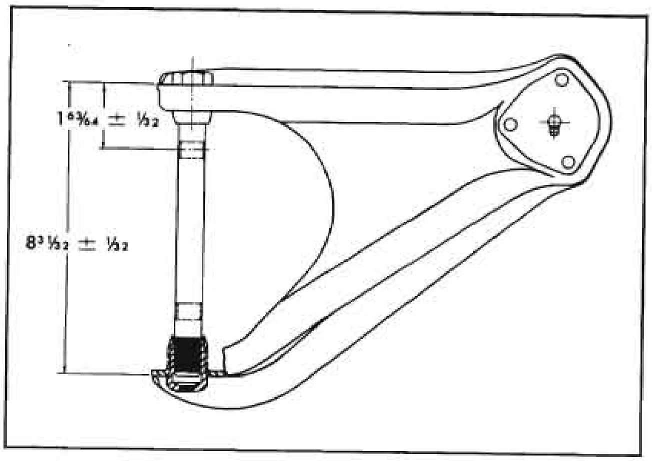


Fig. 3-21 Correct Installation of Upper Control Arm Shaft

8. Lubricate control arm shaft and ball studs, replace wheel, lower car, and check front wheel alignment.

FRONT LOWER CONTROL ARM– REMOVE AND REPLACE

1. Perform steps 1 through 7 under FRONT SPRING–REMOVE AND REPLACE.

2. Press lower control arm ball stud from steering knuckle with tool J-6627 (Fig. 3-19).

3. Swing steering knuckle out and lower control arm; coil spring will drop from its seat in frame side member at same time.

4. Disconnect inner ends of lower control arm by removing nuts and withdrawing two special $\frac{9}{16}''$ dia. bolts.

5. Install front lower control arm by following removal procedure in reverse order.

6. Tighten lower ball stud nut to 80-95 lb. ft. torque and control arm to frame bolts to 150-175 lb. ft. torque.

NOTE: Lower control arm should be positioned at curb height to centrally locate before tightening control arm to frame bolts.

FRONT LOWER CONTROL ARM REAR BUSHING– REMOVE AND REPLACE

1. Remove control arm from car as outlined above.

2. Rest arm on remover J-7022-1 as shown in Fig. 3-22. Place spacer J-7022-7 around bushing. Then, with sleeve J-7022-3 between control arm and arbor, press bushing from arm. Remove other bushing from arm in same manner.

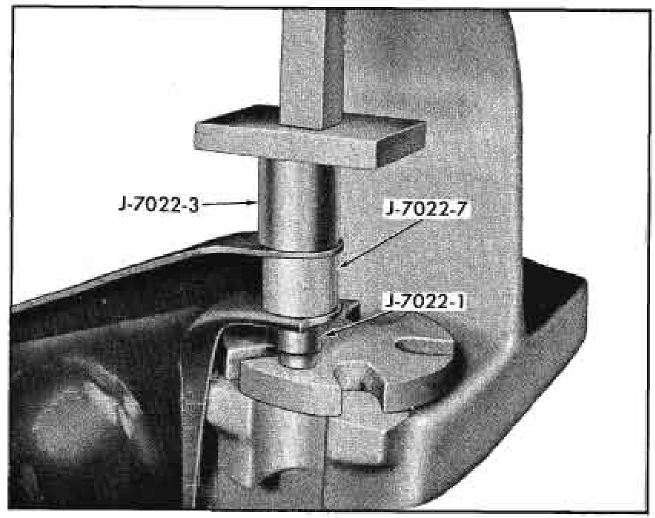


Fig. 3-22 Removing Rear Bushing from Front Lower Control Arm

3. Install new bushing in control arm using components of tool J-7022 in manner illustrated in Fig. 3-23.

4. Install control arm on car.

FRONT LOWER CONTROL ARM FRONT BUSHING– REMOVE AND REPLACE

1. Remove control arm from car as outlined above.

2. Rest arm on remover J-9584-1 as shown in Fig. 3-24. Place spacer J-9584-3 around bushing, then with sleeve J-8481-2 between control arm and arbor press, press bushing from arm.

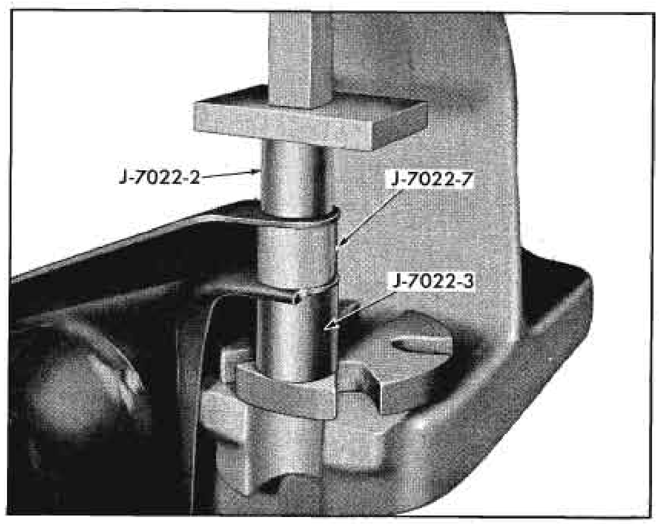


Fig. 3-23 Installing Rear Bushing in Front Lower Control Arm

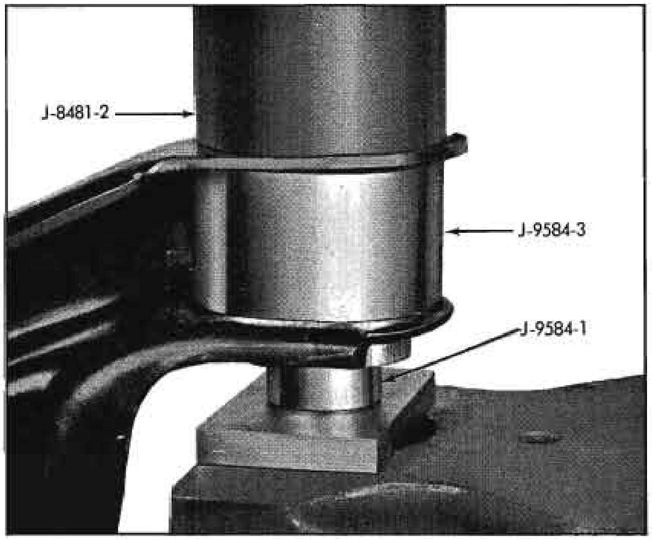


Fig. 3-24 Removing Bushing from Control Arm

3. Install new bushing in control arm using the arrangement of tools as shown in Fig. 3-25.

4. Install control arm on car.

UPPER AND/OR LOWER BALL JOINT—REMOVE AND REPLACE

1. With control arm removed, chisel or drill heads of rivets retaining ball joint to control arm and drive out rivets.

2. Remove ball joint assembly.

3. Install new ball joint, retaining with special bolts, nuts and washers supplied with new joints.

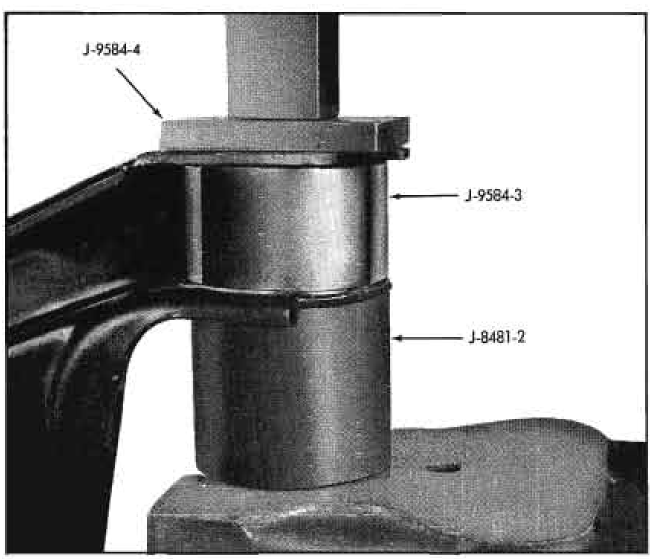


Fig. 3-25 Installing Bushing in Control Arm

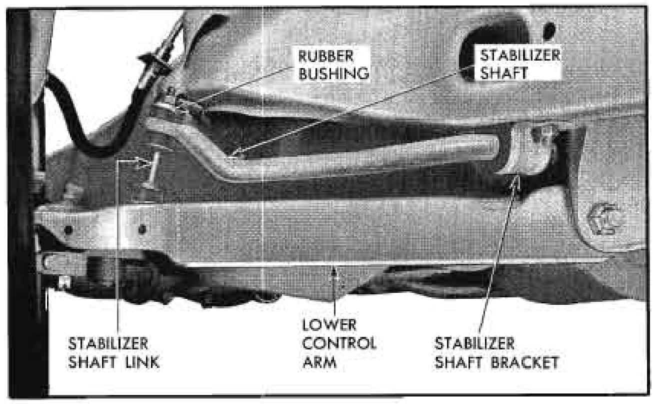


Fig. 3-26 Stabilizer Shaft Assembly

CAUTION: Use only special alloy bolts supplied with stud package for this operation.

4. Torque nuts to 10-12 lb. ft.

FRONT STABILIZER SHAFT—REMOVE AND REPLACE

1. Disconnect both links from stabilizer shaft by removing nut from bottom of link and rotating link up from lower control arm (Fig. 3-26).

2. Disconnect inner ends of one front lower control arm from frame crossmember.

3. Remove bolts holding two stabilizer shaft brackets to frame and remove shaft.

4. Attach stabilizer shaft to frame by placing two brackets over rubber insulators on bar and installing mounting bolts to frame. Tighten bolts to 20-35 lb. ft. torque. When properly installed the central portion of the shaft will be toward the front of car (Fig. 3-27).

5. Place rubber grommet above and below lower control arm bracket and above and below eye of shaft with link spacer in between and insert link.

6. Install nut on each link, tightening to 60-120 lb. in. torque.

REAR SHOCK ABSORBER—REMOVE AND REPLACE

1. Remove nut, bolt and lock washer at upper end of shock absorber.

2. Remove self-locking nut from lower end and remove shock absorber (Fig. 3-28).

3. Clean and inspect rubber inserts. If inserts have shifted from their original position in either eye, discard old shock absorber and replace with new one.

4. Install shock absorber by reversing above steps.

5. Tighten lower self-locking nut 70-85 lb. ft. torque and upper bolt 45-60 lb. ft. torque.

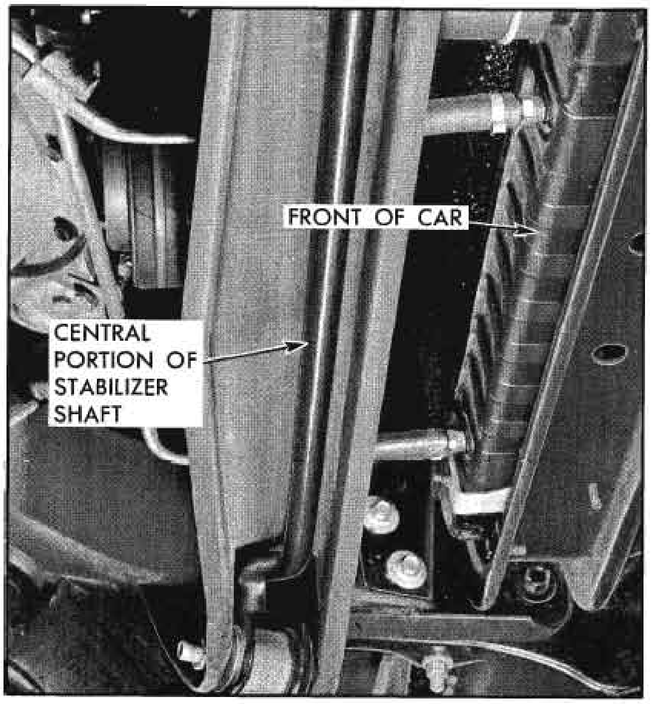


Fig. 3-27 Stabilizer Shaft Properly Positioned

REAR SPRING—REMOVE AND REPLACE

1. Raise car with chain fall until rear wheels are approximately 8" off floor.

2. Place safety stands under frame at both sides to support car.

3. Remove wheel assembly.

4. Remove brake tube bracket and line from cross member (Fig. 3-29).

5. Remove self-locking nuts at lower end of right and left shock absorbers and disconnect shock absorbers from axle housing brackets.

6. Remove pivot bolt from rear end of lower control arm.

7. Raise car as necessary and carefully lower rear axle assembly to allow spring to expand.

8. Remove upper spring retainer nut and remove bolt, lock washer, flat washer, rubber insulator and spring clamp with fabric insulator (Fig. 3-30).

9. Remove nut, bolt, lock washer, flat washer and spring clamp at bottom of spring.

10. Remove spring, (it may be necessary to force the axle down slightly to assist in removing the spring).

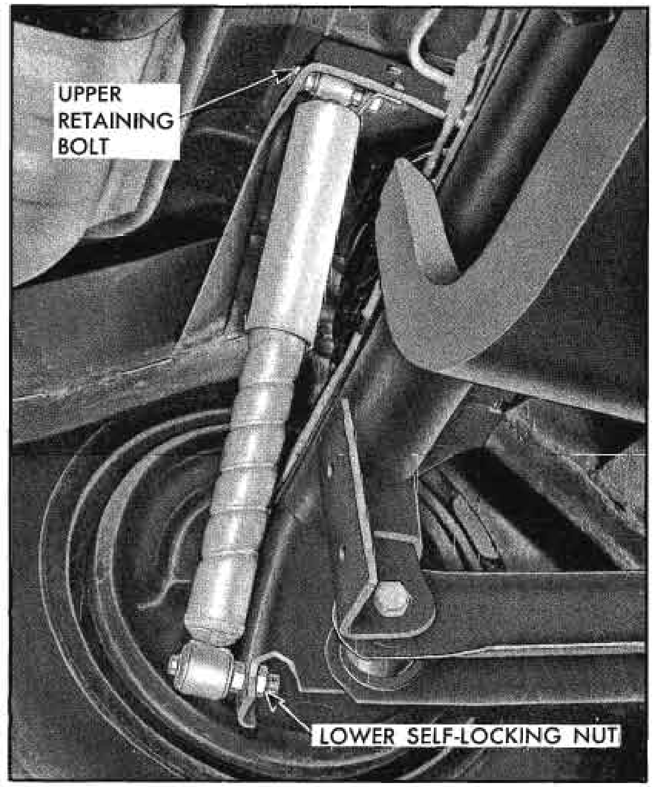


Fig. 3-28 Removal of Rear Shock Absorber

11. Place the upper spring clamp in each end of the new spring to determine at which end the clamp fits best. After selecting the best end for the upper clamp, scribe a mark on the spring and also on the spring clamp (Fig. 3-31). When the spring and upper

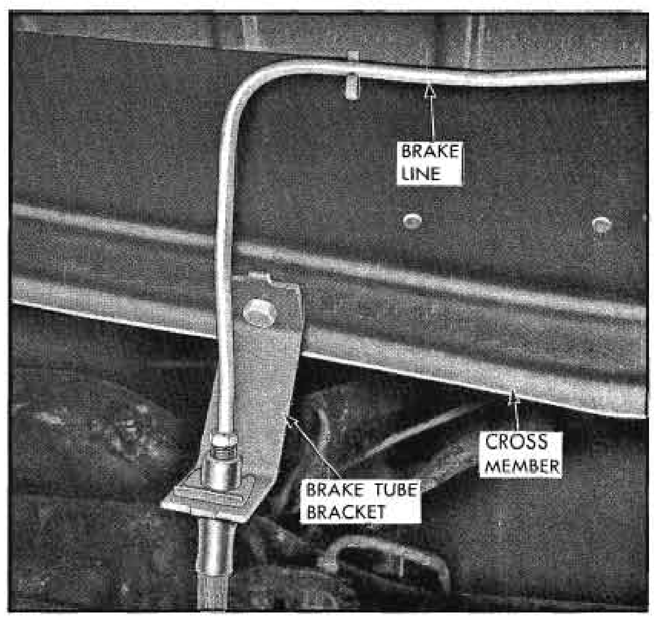


Fig. 3-29 Brake Tube Bracket and Line

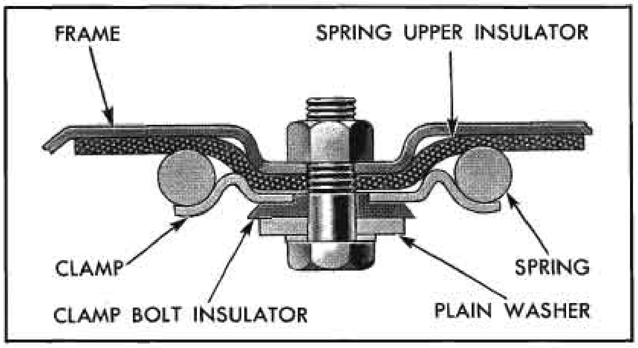


Fig. 3-30 Cross Section of Upper Rear Spring Assembly

clamp are installed, alignment of the marks will insure proper mating of the parts and seating of the upper clamp on the spring.

12. Position upper clamp on the spring, aligning marks on spring and clamp in the following manner:

a. Thread lock washer, flat washer and rubber insulator onto bolt.

b. Insert bolt through upper clamp, aligning marks on upper clamp and spring.

c. Holding this assembly in position, place fabric upper insulator over end of bolt.

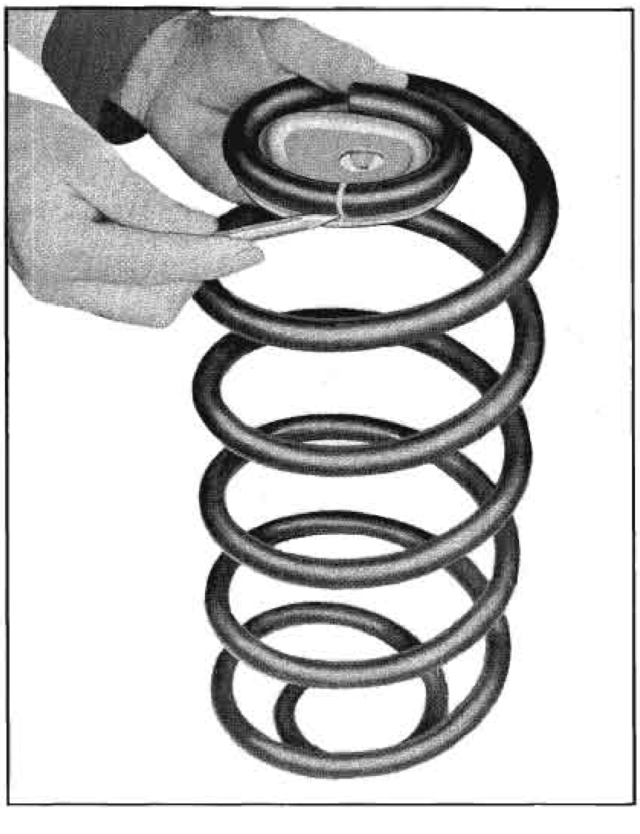


Fig. 3-31 Scribing Mark on Spring and Clamp

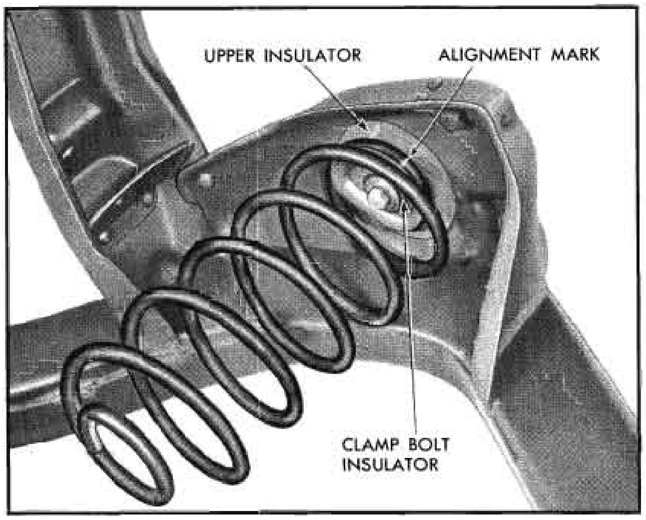


Fig. 3-32 Installing Rear Spring

13. Install upper bolt and clamp as an assembly into position on the spring. Turn spring, maintaining alignment of scribe marks, to give maximum clearance between front of rear spring and frame (Fig. 3-32).

14. Tighten rear spring upper clamp bolt to 45-55 lb. ft. torque.

15. Install lower clamp on spring and insert bolt, lock washer and flat washer and tighten bolt 45-55 lb. ft. torque.

16. Raise rear axle assembly.

17. Attach both shock absorbers to axle housing brackets and tighten self-locking nuts 45-60 lb. ft. torque.

18. Attach brake tube bracket and line to cross member.

19. Install wheel assembly.

REAR UPPER CONTROL ARM— REMOVE AND REPLACE

If both control arms are to be replaced, the axle may roll or slip sideways with both upper control arms removed making replacement difficult. Remove and replace one control arm at a time.

1. Place car on hoist and raise rear end.

2. Remove bolt at rear axle housing and lift upper control arm to clear mounting bracket.

3. Disconnect rear upper control arm at frame crossmember and remove upper arm assembly.

4. Clean and inspect rubber bushings (Fig. 3-33) and, if worn, replace.

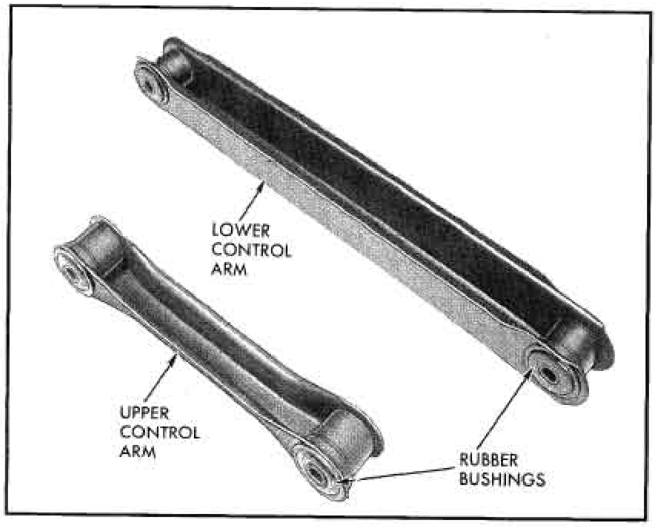


Fig. 3-33 Rear Upper and Lower Control Arm Bushings

5. To remove rear upper control arm bushing, proceed as follows:

a. Press out bushing with J-8481-4 as shown in Fig. 3-34.

b. Press in new bushing, using J-8481-1, as shown in Fig. 3-35.

6. Replace rear upper control arm by reversing above steps.

7. Tighten pivot bolts 150-175 lb. ft. torque.

REAR LOWER CONTROL ARM— REMOVE AND REPLACE

If both control arms are to be replaced, the axle may roll or slip sideways with both lower control arms removed making replacement difficult. Remove and replace one control arm at a time.

1. Place car on hoist and raise rear end.
2. Remove bolt at rear end of rear lower control arm (below axle housing).
3. Remove bolt from front of rear lower control arm at frame and remove control arm assembly.
4. Clean and inspect rubber bushings (Fig. 3-33) and, if worn, replace.
5. To remove rear lower control arm bushing proceed as follows:

a. Press out bushing with J-8481-4 as shown in Fig. 3-34.

b. Install new bushing with J-8481-1 as shown in Fig. 3-35.

6. Reverse above procedures for replacement of rear lower control arm. Tighten pivot bolts 150-175 lb. ft. torque.

NOTE: Before tightening control arm pivot bolts, lower car to curb height.

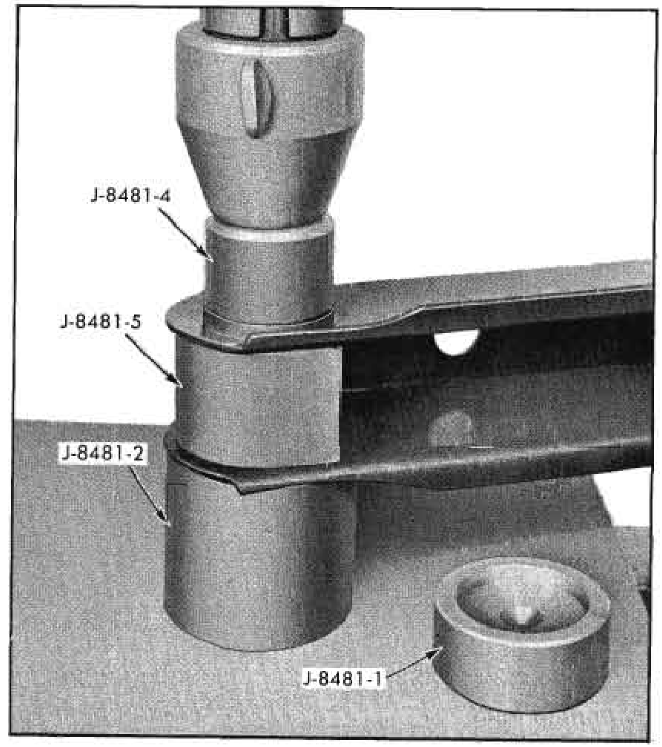


Fig. 3-34 Removing Rear Upper and Lower Control Arm Bushing

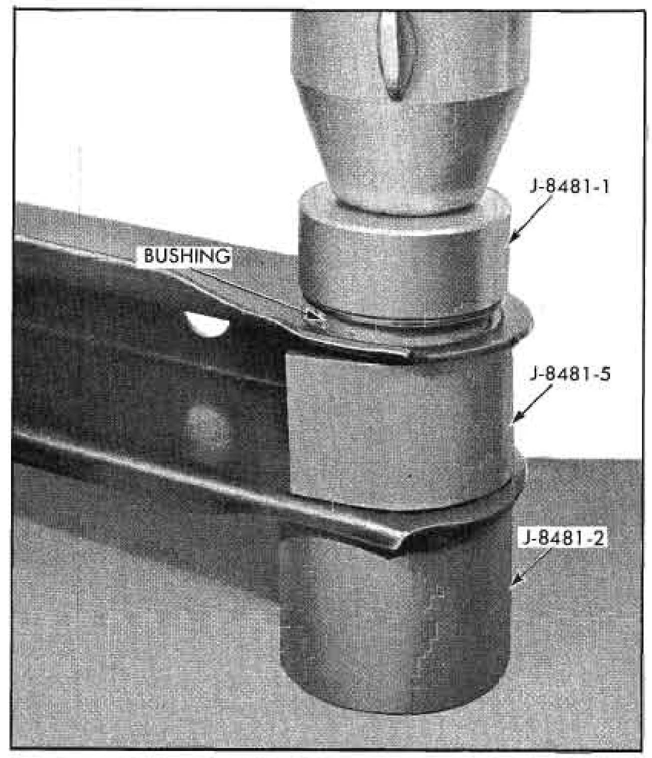


Fig. 3-35 Installing Rear Upper and Lower Control Arm Bushing

TROUBLE DIAGNOSIS AND TESTING

HARD STEERING

CAUSE	REMEDY
1. Low or uneven tire pressure.	1. Inflate tires to recommended pressure, section 10.
2. Steering gear or connections adjusted too tight.	2. Test steering system for bind with front wheels off floor. Adjust, as necessary, and lubricate.
3. Insufficient or incorrect lubricant used.	3. Check lubricant in steering gear and lubricate steering system as required.
4. Excessive caster.	4. Check caster and adjust as necessary.
5. Suspension arms bent or twisted.	5. Check camber and caster. If arms are out of car, compare with new arms and replace if bent.
6. Front spring sagged.	6. Check front end jounce height. Jounce height should be approximately the same at both wheels. Compare dimensions with those on car having about same mileage and equipment and believed to be standard. Replace front springs if sagged.
7. Frame bent or broken.	7. Repair or replace frame as necessary.
8. Steering knuckle bent.	8. Install new knuckle.
9. Ball joint galled or too tight.	9. Replace ball joint.

EXCESSIVE PLAY OR LOOSENESS IN STEERING

CAUSE	REMEDY
1. Steering gear or connections adjusted too loose or worn.	1. Adjust or install new parts as necessary.
2. Ball joints too loose.	2. Install new ball joints.
3. Front wheel bearings incorrectly adjusted or worn.	3. Adjust or replace bearings as necessary.

ERRATIC STEERING ON APPLICATION OF BRAKES

CAUSE	REMEDY
1. Oil or brake fluid on brake lining.	1. Replace lining and correct leak.
2. Brakes incorrectly or unevenly adjusted.	2. Adjust brakes.
3. Front springs weak.	3. Replace with new springs.
4. Low or uneven tire pressure.	4. Inflate tires to recommended pressure.
5. Incorrect or uneven caster.	5. Check and adjust caster as necessary.
6. Steering knuckle bent.	6. Install new knuckle.
7. Front wheel bearings incorrectly adjusted.	7. Adjust bearings as necessary.

CAR PULLS TO ONE SIDE

CAUSE	REMEDY
1. Low or uneven tire pressure.	1. Inflate tires to recommended pressure.
2. Incorrect or uneven caster or camber.	2. Check caster and camber and correct by adjustment or by replacing worn or faulty parts.

CAR PULLS TO ONE SIDE (Cont.)

CAUSE	REMEDY
3. Wheel bearings adjusted too tight.	3. Adjust wheel bearings.
4. Front springs sagged.	4. Check as outlined under HARD STEERING.
5. Toe-in incorrect.	5. Adjust toe-in as required.
6. Oil or brake fluid on brake lining.	6. Replace linings and correct leak.
7. Brakes incorrectly or unevenly adjusted.	7. Adjust brakes.
8. Steering knuckle bent.	8. Install new knuckle.
9. Frame bent or broken.	9. Check frame for proper alignment, and repair or replace frame as necessary.
10. Shock absorbers inoperative.	10. Check and replace shock absorbers if necessary.
11. Rear wheels not tracking with front wheels.	11. Check alignment of rear wheels with front wheels and correct as necessary. Check alignment of frame.
12. Rear axle shifted.	12. Check entire rear suspension.

SCUFFED TIRES

CAUSE	REMEDY
1. Tires improperly inflated.	1. Inflate tires to recommended pressure.
2. Toe-in incorrect.	2. Adjust toe-in as required.
3. Excessive wheel or tire runout.	3. Check wheels and tires for wobble and proper mounting.
4. Ball joints too loose.	4. Install new ball joints.
5. Uneven camber.	5. Check camber and adjust as necessary.
6. Incorrect toe-out on turns.	6. Install new steering knuckle arms.
7. Arms bent or twisted.	7. Check camber, ball joint inclination and caster. Replace arms with new ones if bent.
8. Steering knuckle bent.	8. Install new knuckle.
9. Excessive speed on turns.	9. Caution driver.

CUPPED TIRES

CAUSE	REMEDY
1. Toe-in incorrect.	1. Adjust toe-in as required.
2. Tires improperly inflated.	2. Inflate tires to recommended pressure.
3. Worn ball joints, or wheel bearings incorrectly adjusted or worn.	3. Adjust or replace parts as necessary.
4. Uneven camber.	4. Check camber and adjust as necessary.
5. Steering knuckle bent.	5. Install new knuckle.
6. Excessive mileage without rotating tires.	6. Rotate tires every 4000 miles.

FRONT WHEEL SHIMMY

CAUSE	REMEDY
1. Low or uneven tire pressure.	1. Inflate tires to recommended pressure.
2. Wheels, tires or brake drums out of balance. (Near 70 mph)	2. Balance wheels and tires. Also check for out-of-balance brake drums.
3. Eccentric or bulged tires.	3. Replace tires as necessary.
4. Excessive wheel or tire runout.	4. Check wheels and tires for wobble, radial runout, and proper mounting.
5. Shock absorbers inoperative.	5. Check and replace shock absorbers if necessary.
6. Steering linkage incorrectly adjusted or worn.	6. Adjust or install new parts as necessary.
7. Steering gear incorrectly adjusted.	7. Adjust steering gear.
8. Front wheel bearings incorrectly adjusted or worn.	8. Adjust or replace bearings as necessary.
9. Incorrect or uneven caster.	9. Check and adjust caster as necessary.
10. Ball joints too loose.	10. Install new ball joints.
11. Toe-in incorrect.	11. Adjust toe-in as required.
12. Steering knuckle bent.	12. Install new knuckle.
13. Stabilizer shaft inoperative.	13. Inspect bushings and links and replace worn parts.

FRONT WHEEL TRAMP

CAUSE	REMEDY
1. Wheels, tires or brake drums out of balance. (Near 70 mph)	1. Balance wheels and tires. Also check for out-of-balance brake drums.
2. Eccentric or bulged tires.	2. Replace tires as necessary.
3. Wheel or tire not concentric.	3. Replace wheel or tire.
4. Shock absorbers inoperative.	4. Install new shock absorbers.
5. Stabilizer shaft inoperative.	5. Inspect bushings and links and replace worn parts.

CAR WANDERS

CAUSE	REMEDY
1. Low or uneven tire pressure.	1. Inflate tires to recommended pressure.
2. Steering gear or connections adjusted too loose or worn.	2. Adjust or install new parts as necessary.
3. Steering gear or connections adjusted too tight.	3. Test steering system for bind with front wheels off floor. Adjust as necessary and lubricate.
4. Ball joints too loose.	4. Install new ball joints.
5. Toe-in incorrect.	5. Adjust toe-in as required.
6. Incorrect or uneven caster or camber.	6. Check caster and camber and correct by adjustment or by replacing worn or faulty parts.
7. Steering knuckle bent.	7. Install new knuckle.
8. Rear axle shifted.	8. Check entire rear suspension.

CAR WANDERS (Cont.)

CAUSE	REMEDY
9. Stabilizer shaft inoperative.	9. Inspect bushings and links and replace worn parts.
10. Ball joints too tight.	10. Install new ball joints.
11. Bind in upper or lower control arm shaft.	11. Free up or replace parts.
12. Excessive backlash in steering gear.	12. Adjust steering gear.

ROAD SHOCKS

CAUSE	REMEDY
1. High air pressure in tires.	1. Bleed tires to recommended pressure but not when warm.
2. Steering gear or connections incorrectly adjusted.	2. Adjust steering gear and connections.
3. Excessive caster.	3. Check caster and adjust as necessary.
4. Shock absorbers inoperative.	4. Install new shock absorbers.
5. Front springs sagged.	5. Check as outlined under HARD STEERING.
6. Wrong type or size tires used.	6. Install new tires of correct type and size.
7. Steering knuckle bent.	7. Install new knuckle.

SPECIFICATIONS

Caster angle ....—1½° ± ½°

Camber angle ....+¼° ± ½°

NOTE: Give left wheel up to ¼° maximum more than right wheel to correct for road crown.

Toe-in ....0″ to ⅛″
(with trammel 9″ above floor) Set to $\frac{1}{16}$″.

Toe-out on turns ....1°
(difference in left to right in direction of toe-out at 20° turning of inside wheel)

Steering Axis Inclination at 0° Camber........4°50′

Curb height (Fig. 3-10) Front—3¾″ to 4″ (3$\frac{15}{16}$″)
(Fig. 3-11) Rear—9⅝″ to 9⅞″ (9¾″)

NOTE: Adjust for caster, camber and toe-in with car at curb height. Compensate for drift to right due to road camber by setting left camber angle ¼° greater than right. See INSPECTIONS before checking or correcting wheel alignment.

Front Shock Absorber

Collapsed length (end of stud to mounting bracket)........Approx. 11$\frac{11}{16}$″

Extended length (end of stud to mounting bracket).........Approx. 17$\frac{7}{16}$″

Travel ....Approx. 5¾″

Rear Shock Absorber (exc. sta. wagon)

Collapsed length (center of eyes) ....Approx. 13$\frac{3}{16}$″

Extended length (center of eyes) ....Approx. 21$\frac{15}{16}$″

Travel ....Approx. 8¾″

Rear Shock Absorber (sta. wagon)

Collapsed length (center of eyes) ....Approx. 12$\frac{3}{16}$″

Extended length (center of eyes) ....Approx. 19$\frac{15}{16}$″

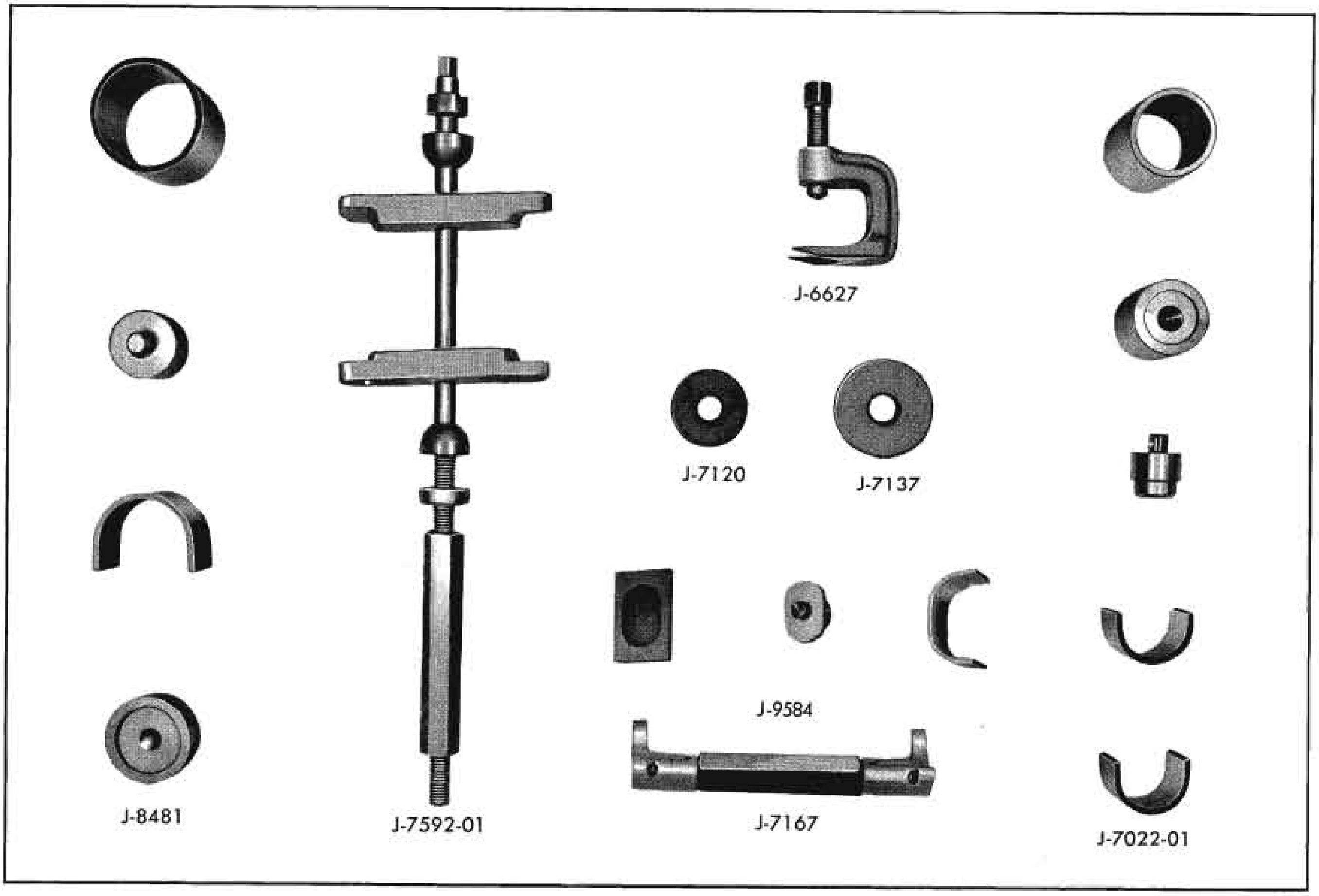
Travel ....Approx. 7¾″

TORQUE SPECIFICATIONS

Torque in lb. ft. unless otherwise specified.

TORQUE	SIZE	APPLICATION
		Front Suspension
150-175	Special	Bushing—Front Suspension Upper Control Arm
80-95	½-20	Bolt and Nut—Frt. Susp. Upper Cont. Arm Shaft to Upper Cont. Arm Frame Brkt.
150-175	9/16-18	Bolt and Nut—Front Susp. Lower Control Arm Assy.
60-120 Lb. In.	⅜-16	Nut—Lower Control Arm Frame Bumper to Arm
55-70	½-20	Nut—Steering Knuckle to Ball Stud Assembly
		Front Wheels, Hubs and Bearings
70-85	½-20	Nut—Front Wheel to Hub—R.H. and L.H.
		Front Shock Absorbers
60-120 Lb. In.	⅜-24	Nut—Front Shock Absorber to Frame
15-25	5/16-18	Bolt—Front Shock Absorber to Lower Arm
		Front Stabilizer
20-35	⅜-24	Bolt and Nut—Front Stabilizer Bracket to Frame
60-120 Lb. In.	5/16-24	Nut—Front Stabilizer Link
		Rear Spring Installation Parts
150-175	9/16-18	Bolt and Nut—Rear Axle Upper Control Arm Assy. to Axle Hsg.
150-175	9/16-18	Bolt and Nut—Rear Axle Lower Control Arm Assy. to Axle Hsg.
150-175	9/16-18	Bolt and Nut—Rear Axle Lower Control Arm Assy. to Frame
150-175	9/16-18	Bolt and Nut—Rear Axle Upper Control Arm Assy. to Frame
10-20	5/16-18	Screw—Rear Axle Bumper to Frame
45-55	½-20	Bolt and Nut—Rear Spring Lower Clamp to Axle Hsg.
45-55	½-20	Bolt and Nut—Rear Spring Upper Clamp to Frame
		Rear Shock Absorbers
70-85	½-20	Nut—Rear Shock Absorber (To Axle Hsg. Brkt.)
45-60	7/16-20	Bolt and Nut—Shock Absorber to Frame

SPECIAL TOOLS



J-6627	Ball Stud Remover	J-7137	Front Wheel Bearing Cup Installer (Inner)
J-7022-01	Control Arm Bushing Remover and Replacer	J-7167	Front Upper Control Arm Spreader
J-7120	Front Wheel Bearing Cup Installer (Outer)	J-7592-01	Front Spring Compressor
J-9584	Front Lower Control Arm Front Bushing Remover and Replacer	J-8481	Control Arm Bushing Service Set

Fig. 3-36 Suspension Special Tools

WHEELS AND TIRES

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

All models use drop center rim steel wheels secured by left hand thread nuts on the left side of the car and right hand thread nuts on the right side. The rim width is 6" measured between the inside surfaces of the wheel bead. The diameter of the wheel is 14" except on the heavy duty chassis and police cars which have a rim width of 6" and a wheel diameter of 15".

Low pressure 8.00 x 14, 4 ply tires are standard equipment on all models except the Safari, police, heavy duty chassis, and air conditioned cars. 8.50 x 14, 4 ply tires are standard on all air-conditioned and Safari models. The 7.60 x 15, 6 ply rating tire is standard equipment on the heavy duty chassis. 7.10 x 15, 4 ply tires are standard on all police cars. All tires are of tubeless construction (Fig. 3A-1).

NOTE: White sidewall tires should have the protective coating washed off before being placed in service. This coating is not as flexible as rubber and checks, and may introduce sidewall check if not removed.

Owners who want to use 6 ply rating tires usually do so with the idea of securing longer tire life. 6 ply rating tires should not be used unless extraordinarily heavy loads are to be carried. To obtain longer life from these tires, it is necessary to carry higher inflation pressures. When this is done the owner sacrifices the easy riding qualities afforded by 4 ply tires with lower air pressure.

Six ply rating tires are, therefore, not recommended except on the heavy duty chassis or on other models used to carry heavy loads, such as pulling a trailer which imposes a heavy load on the rear of the car.

Wheels having heavier rims are used with 6 ply rating tires. These wheels can be identified by an "H" stamped on the inboard side of the wheel approximately 90° from the valve opening.

PERIODIC SERVICE

INFLATION OF TIRES

Maintenance of correct inflation pressure is one of the most important elements of tire care. The inflation pressure recommended for any model of car is carefully worked out as the best pressure to give a correct balance of those factors in good car performance which are affected by inflation pressure.

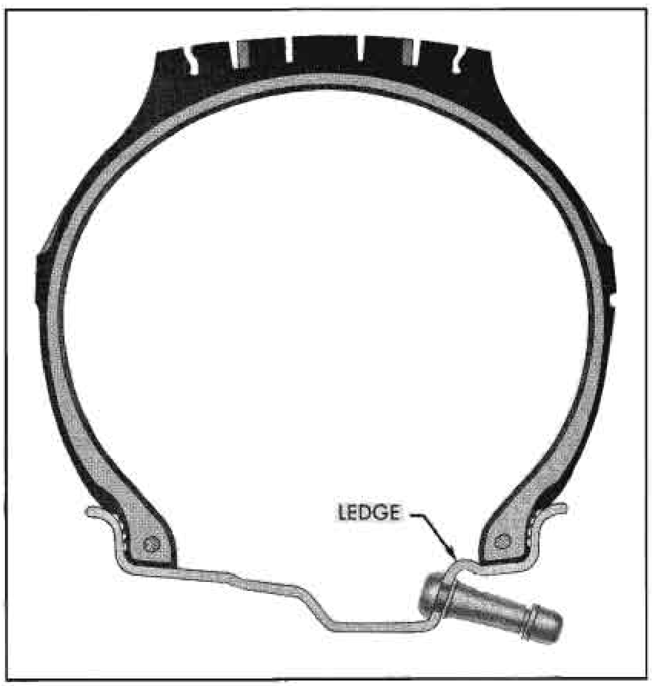


Fig. 3A-1 Cross Section of Typical Tubeless Tire

Tire Size		Starting Pressure (After car has been standing for three hours)	City Pressure (After driving car three miles or more below 40 mph)	Highway Pressure (After driving car three miles or more above 40 mph)
8.00 x 14—4 ply (Except Cool Pack conditioned cars) front and rear		22 lbs.	25 lbs.	27 lbs.
8.00 x 14—4 ply (with Cool Pack Conditioned Cars)	front	24 lbs.	27 lbs.	29 lbs.
	rear	22 lbs.	25 lbs.	27 lbs.
8.50 x 14—4 ply (Except Safari and Air Conditioned Cars) front and rear		20 lbs.	23 lbs.	25 lbs.
8.50 x 14—4 ply (With Air Conditioned Cars Except Safari)	front	22 lbs.	25 lbs.	27 lbs.
	rear	20 lbs.	23 lbs.	25 lbs.
8.50 x 14—4 ply (Safari)	front	22 lbs.	25 lbs.	27 lbs.
	rear	24 lbs.	27 lbs.	29 lbs.

NOTE: IT IS NORMAL FOR AIR PRESSURE TO BUILD UP IN A TIRE DUE TO DRIVING CONDITIONS; THEREFORE, DO NOT LET AIR OUT OF TIRES TO REDUCE THIS INCREASE IN PRESSURE.

Fig. 3A-2 Tire Application and Pressure Chart

Some of these factors are: satisfactory ride, stability, acceptable steering, even tread wear, tire carcass cord life and resistance to stone bruises.

Common opinion is that inflating the tire above the manufacturer's recommended pressure will give increased life. This, however, is in error as overinflation can be as bad as underinflation, since it not only results in wear at the center of the tread but also makes the tire more subject to casing breaks.

Tires should be checked once a month and, if necessary, inflated to the recommended pressures.

Wherever possible, tire pressure should be checked with tires at atmospheric temperature and corrected if necessary. It is normal for air pressure to increase in a tire due to driving conditions. This fact has been considered in recommending the pressure for cold tires.

When not possible to check air pressure at atmospheric temperature, it may be checked with tires warm using pressure recommended for city and highway driving given in specifications. It must be recognized that this method is not as accurate as checking pressure at atmospheric temperature since one driver's tires may get warmer than another driver's due to differences in speed, acceleration, and braking.

Tire valve caps and valve extensions which are installed on all cars with wheel discs should always be reinstalled on the valve and tightened finger tight as they assist in keeping air in the tire in case of a valve leak, and keep dust and water out of the valve.

***IMPORTANT:* Always check tires as recommended above and with an accurate gauge.**

Higher inflation pressures than recommended will result in:

1. A harder riding car.

2. A tire carcass more susceptible to bruising or carcass damage directly under the tread.

3. Poorer traction at rear wheels resulting in uneven wear.

4. Fast tread wear at center.

Lower inflation pressures than recommended will result in:

1. Rapid and uneven wear on the edges of tire tread.

2. A tire more susceptible to rim bruises and various types of rupture.

3. Increased cord fatigue or broken tire cords.

4. Harder steering.

5. Higher tire temperatures.

6. Increased tramp and shimmy troubles.

7. Increased car roll when turning a corner or making a sharp swerve in traffic.

8. Increased tire squeal on turns.

TIRE SWITCHING

Uneven tire wear is frequently the cause of tire noises which are attributed to rear axle gears, bearings, wheels, etc., and at times unnecessary work has been done on rear axle assemblies in an endeavor to correct this noise.

To minimize the possibility of tire noise and equalize wear, it is recommended that tires be interchanged, as shown in Fig. 3A-3, at regular intervals of approximately 4000 miles and more frequently in the case of an owner that gives his tires extremely hard wear. This will effectively prevent undue wear on any particular tire which might cause excessive noise.

More important from the owner's viewpoint will be equalization of wear on all tires and the saving resulting from getting some use from the spare tire which all too often is allowed to remain as a spare until the other tires are worn out. When this occurs, the spare tire, while appearing to be new, will actually have deteriorated through disuse.

Note that if the interchanging of tires is practiced each 4,000 miles in accordance with Fig. 3A-3, all tires will have had the same number of miles in each wheel position at the end of the fourth change or when ready to interchange tires for the fifth time. The car will have been driven 20,000 miles but each tire will have only 16,000 miles of use.

When tires are switched they should be inspected for signs of abnormal wear, bulging, etc., and all stones, nails, glass etc., removed before reinstalling tire and wheel on car.

MINOR REPAIRS

TIRE MOUNTING AND DISMOUNTING INSTRUCTIONS

The wheel assembly has a hump-type bead seat on the outboard (valve hole) side of the rim. This design provides a tight tire fit making it necessary to use a rubber lubricant or a vegetable oil soap solution for tire mounting and dismounting. This design also makes it mandatory that tire mounting and dismounting are done with the outboard (valve hole) side of the wheel up.

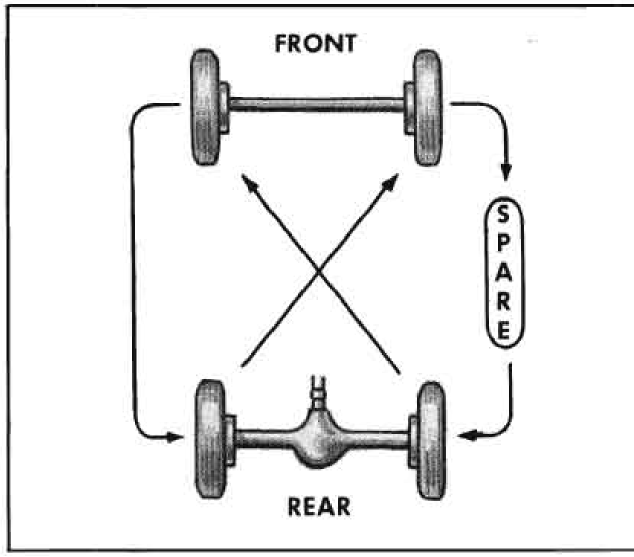


Fig. 3A-3 Diagram for Switching Tires

TEST FOR LEAKS

1. Use soapy water to check valve area for leaks. In many cases air loss can be corrected by simply tightening the valve core.

2. If the reason for air loss is not immediately discernible, submerge the complete wheel assembly in a tank of water.

3. Mark the tire and rim at the point where air is escaping.

REMOVE TIRE FROM WHEEL

1. Remove valve cap and valve core. Let out all the air.

2. With valve hole side of tire up, break beads away from rim. Use only conventional bead-breaker type machine. Do not use hammer or tire irons.

3. Apply a liberal amount of rubber lubricant or thin vegetable oil soap solution to both beads and remove the first bead, using the machine method.

4. During the entire operation of breaking beads away from the rim and removing tire from rim, special care should be taken not to damage the rubber "rim-seal" ridges which are molded to the outside of the tire along the beads.

PUNCTURE REPAIRS

Puncture repairs may be quickly and permanently performed using one of several kits available through tire manufacturers' dealer outlets.

AIR LEAKS AT WHEEL

Examine rim flanges for sharp dents. Any dent visible to the eye should be straightened. The rim flanges should be thoroughly cleaned with No. 3 coarse steel wool thereby removing all oxidized rubber, soap solution, etc. If the flange is rusted, it can be cleaned with a wire brush or in extreme cases of pitted rims a file can be used.

CAUTION: Under no condition should loose rivets or wheels be brazed, welded or peened.

MOUNTING TIRE ON WHEEL

PREPARATION OF TIRE

Remove excess "strings" of rubber hanging from tire bead.

PREPARATION OF RIM

Check these points to prevent air loss:

1. Using a small piece of steel wool or emery cloth, clean all particles of foreign matter from rim ledges and flanges.

2. Straighten the rim if it is bent or damaged.

3. Apply a liberal amount of rubber lubricant or thin vegetable oil soap solution to both beads and remove the first bead, using the machine method.

MOUNTING AND INFLATING THE TIRE

The general procedure for inflating tubeless tires is to mount the casing on the rim so that the beads are resting uniformly on the bead ledge and quickly apply a large volume of air. This forces the bead over the bead seat and against the flanges where the air seal for the tire is obtained. Rubber lubricant or a thin vegetable oil soap solution should be used for bead lubrication.

1. Mount the tire on the wheel with valve hole side up using the machine method.

2. Remove valve core from stem to increase flow of air during inflation.

3. Inflate with wheel in vertical position until beads are completely forced against rim flanges.

CAUTION: Do not exceed 40 pounds air pressure when inflating tire and do not stand over tire when inflating. If 40 pounds pressure will not seat beads properly, deflate, lubricate and reinflate.

4. Once the beads are seated against the rim flanges, the air can be released from the valve, the valve core inserted and inflation completed in a normal fashion.

5. General precautions in mounting tires:

   a. Use tire mounting and dismounting machine.

   b. Do not use hammer or tire irons.

   c. Work bead over rim flange so that the section nearest the valve stem will be applied last.

TIRE INSPECTION AND WEAR PATTERNS

A careful inspection of tires will often indicate poor driving practice such as improper wheel alignment, grabbing brakes, fast cornering, etc., which should be given attention. Below are listed several common types of irregular tire wear and possible causes:

UNDERINFLATION

The result of underinflation is shown in Fig. 3A-4. Car weight distorts the normal contour of the tire body and the tire bulges or "bellies out" with an extreme flexing action. This wears the tread at the edges more than the center and generates excessive internal heat weakening the cords and resulting in bruises, broken cords or ply separation. Underinflation also leads to rim bruises as insufficient resistance is provided to prevent the tire from being jammed against the rim and crushed or cut when the tire strikes a curb, rock, or rut.

OVERINFLATION

The result of overinflation is shown in Fig. 3A-5. When a tire is overinflated, increased tension caused by excessive pressure prevents proper deflection of the sidewalls. This results in wear in the center of the tread and the tire also loses its ability to absorb road shocks. Under this increased strain, cords in the tread area eventually snap under impact, causing either a characteristic X-break or diagonal break.

SIDE WEAR (CAMBERING OR CORNERING WEAR)

There are three reasons why tires wear more rapidly on one side of the tread than on the other.

1. Wheel camber causes the tires to run at a certain angle from the perpendicular, resulting in side wear.

2. Side thrust when rounding turns causes wear on the sides of the treads. In making a turn to the left, especially at high speeds, the outside shoulder of the right tire and the inside shoulder of the left tire take most of the wear. When making a right-hand turn, the opposite shoulders of the tires are worn.

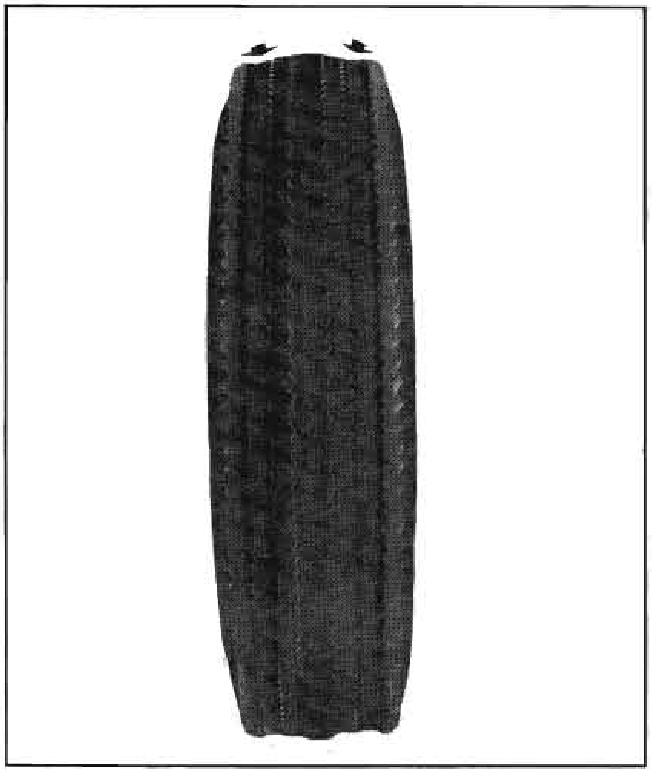


Fig. 3A-4 Wear from Underinflation

3. High crowned roads cause increased wear on the side of the right front tire. This is particularly true when there is too much toe-in on front wheels or when positive camber of right front wheel is greater than the left.

Cornering wear can usually be differentiated from camber wear because cornering wear affects both sides of the tire giving it a very round appearance (Fig. 3A-6). When camber is incorrect it will cause excessive wear only on one side of the tire tread. Camber wear does not leave the tread rounded as cornering wear does.

When cornering wear is encountered, the owner should be shown, by the rough tire surface and rounded shoulders, that he is severely abrading his tires by fast or sharp turns, and told that he could greatly prolong the useful life of his tires by taking the turns a little slower. The tires and wheels should be switched and continued in service the same as with normal camber wear.

TOE-IN OR TOE-OUT MISALIGNMENT WEAR

Front wheels should be straight ahead or toe-in slightly. When there is excessive toe-in or toe-out, tires will revolve with a side motion and scrape the

Fig. 3A-5 Wear from Overinflation

tread rubber off. If the misalignment is severe, the rubber on both tires will be scuffed off, but if the misalignment is slight, the rubber on only one tire will be scuffed off.

In general, if front right tire shows most wear, toe-in or right camber is excessive. If front left shows most wear, toe-out or left wheel camber is excessive.

Fig. 3A-6 Cornering Wear

Fig. 3A-7 Toe-in or Toe-out Misalignment Wear

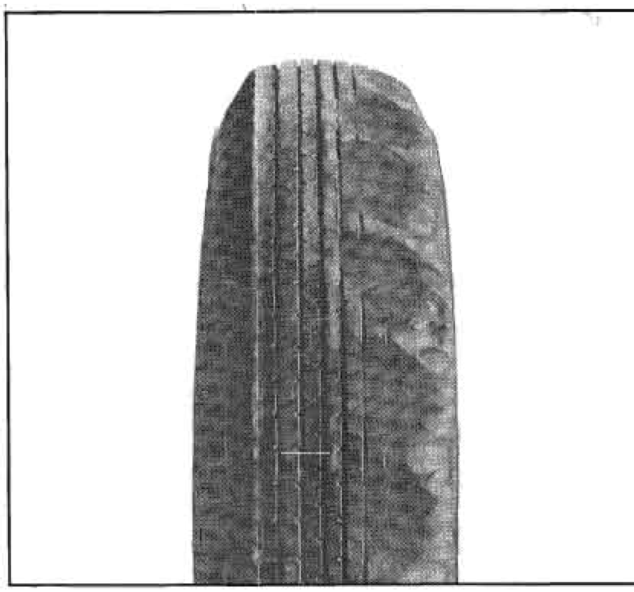


Fig. 3A-8 Spot Wear

The scuffing action against the face of the tire causes a small feather edge of rubber to appear on one side of the tread design. This feather edge is the evidence of irregularity as shown in Fig 3A-7.

UNEVEN TIRE WEAR

Other types of uneven tread wear, such as a single spot or series of cuppings around the tire circumference (Fig. 3A-8), may also be noted on some tires. Such uneven wear may be due to excessive toe-in or toe-out with underinflation, uneven camber, or such irregularities as bent suspension, wobbly wheels, out-of-round brake drums, and unequally adjusted brakes.

EFFECTS OF HIGH SPEED DRIVING ON TIRES

Sustained high speed driving can drastically reduce tire mileage and, unless care is exercised, can result in sudden, dangerous tire failures!

A tread view of tire running at high speed on a test wheel is shown in Figs. 3A-9 and 3A-10. Notice how the tread is stretched and contracted in the distorted area. This can cause separation of the tread from the tire body, ply separation, tread cracking and other tire failures.

High speed causes dangerous distortion in tires. This distortion is more severe when tires are overloaded or underinflated. This tremendous strain of tire distortion builds up excessive heat in the tire which, if allowed to continue, may cause the tire literally to come apart.

While these illustrations shown are at high speeds and present an extreme condition, they do illustrate tire distortion which increases as speed is increased above recognized legal limits.

High speed driving with high distortion has an effect on tire wear as shown in Fig. 3A-11. Data on this chart shows the approximate relationship of speed and atmospheric temperature, the two most important factors affecting tire mileage. The figures represented are averages, since some tires will show a slower rate of wear and others a much faster rate of wear.

It is interesting to note that tires will wear 3 times faster at 80 mph than at 30 mph. Also, they will wear 3 times as fast at 100°F. than at 40°F. When both high speed and high atmospheric temperature are combined, tires will wear 9 times faster at 80 mph at 100°F. than tires operated at 30 mph at 40°F.

IMPORTANT: High speed distortion and its dangerous effects can be reduced (but not eliminated) by following this recommendation:

WHEN HIGH SUSTAINED SPEEDS ARE ANTICIPATED, INCREASE AIR PRESSURE FOUR (4) POUNDS ABOVE NORMALLY RECOMMENDED COLD STARTING PRESSURE.

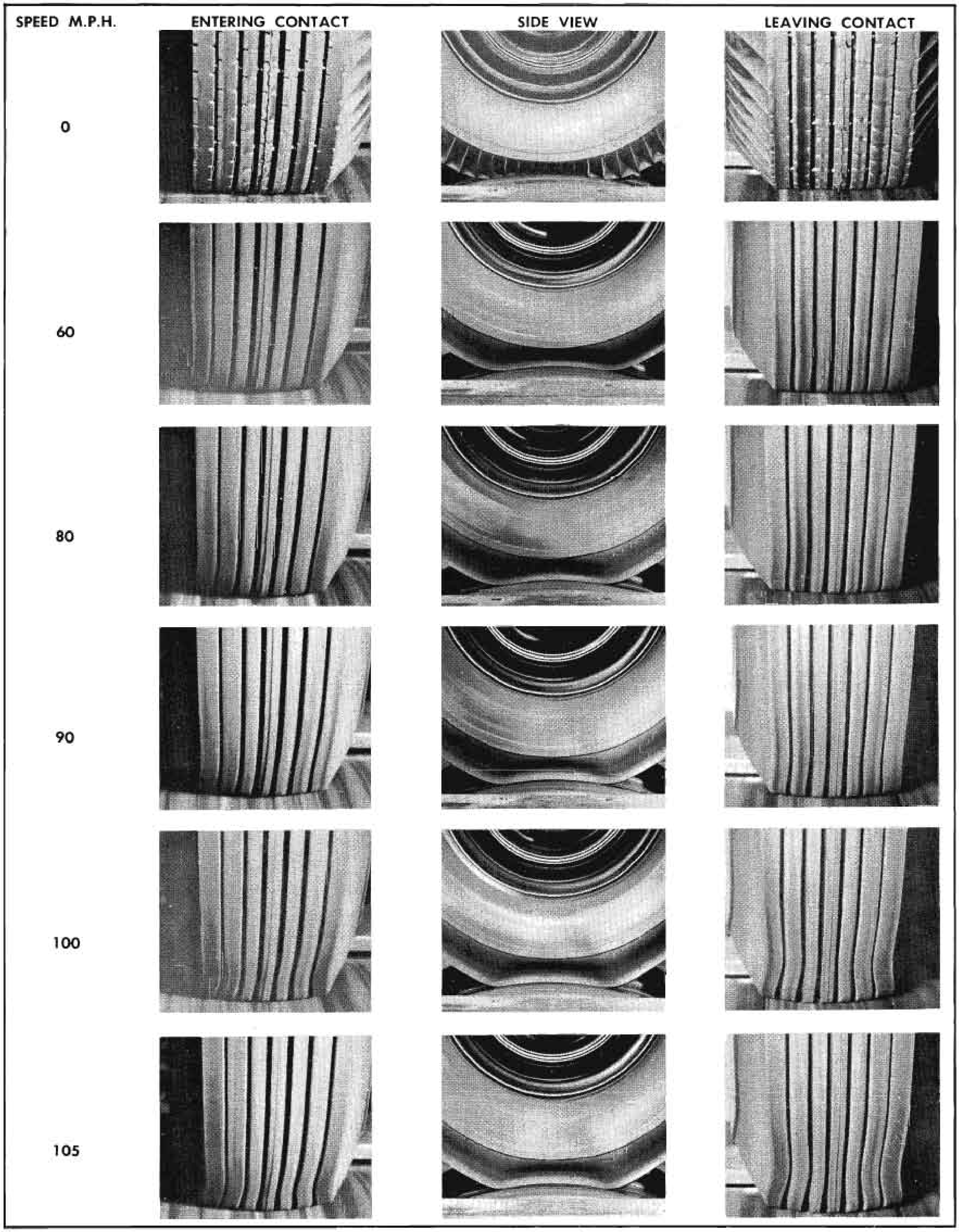


Fig. 3A-9 Tire Distortion at Various Speeds

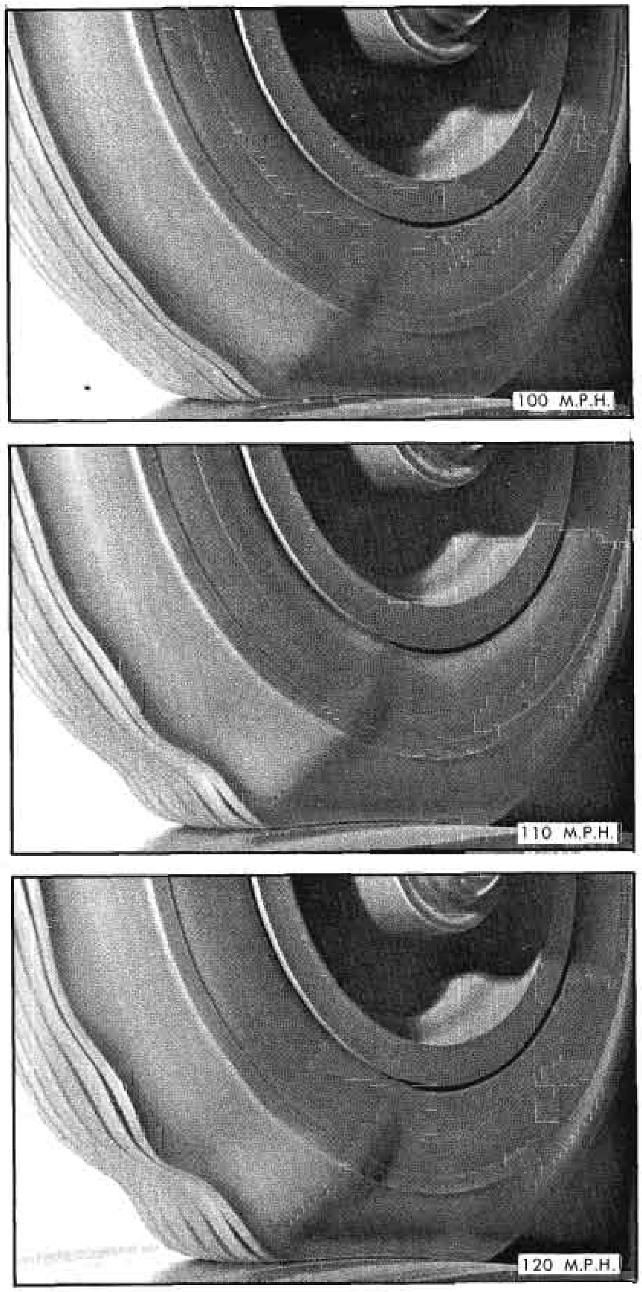


Fig. 3A-10 Tire Distortion at High Speed (Tire Entering Contact)

TROUBLE DIAGNOSIS AND TESTING

Interpretation of various types of tire conditions as revealed by detailed inspection has been covered under **TIRE INSPECTION AND WEAR PATTERNS.** There are other considerations in diagnosing tire troubles on tire wear, shimmy, etc., which should be kept in mind. These conditions as discussed in the SUSPENSION Section. See also SUSPENSION TROUBLE DIAGNOSIS for additional information on diagnosis.

TREAD WEAR

While tread wear is affected by wheel alignment, cornering, inflation pressure, etc., as mentioned previously, there are several other factors which must be considered in analyzing tread wear.

A careful driver may obtain many times the mileage from his tires as would be obtained by a severe driver. Also, tires wear much faster in some localities depending on the type of road (some of which are more abrasive than others), whether the road is wet (rain or snow), the number of sharp turns, hills or mountains the car must go up or down, and the prevailing temperature. Fast driving, quick starting, and hard stopping are generally recognized as a definite cause of rapid tread wear. Temperature is often not considered to be as great a factor in tire life as it actually is. By actual test an increase of 40°F in temperature reduces tread mileage by 33%.

TIRE BALANCING

Factory specifications call for wheel and tire assemblies to be in balance within 8 inch ounces maximum. When outside this maximum, balance weights are applied to the inside rim flange to bring the balance within production limits. Since a sensitive wheel balancer will indicate out of balance less than the production limit of 8 inch ounces, wheels on a new car (if checked on such equipment) may indicate an unbalanced condition when the wheels are within acceptable production limits.

Tramp or shimmy may be caused by radial run-out or eccentricity of the tire and wheel assembly as well as out of balance. This will be seen as a variation in the radius of the tire and wheel assembly when revolving the wheel with the car jacked up. Radial run-out may be caused by a variation in tire tread surface caused by skidding, a bent or distorted wheel, or an improperly mounted tire.

TESTING FOR TIRE NOISES

The question of whether tires are causing the noise complained of can be determined by the following procedure:

Check car to see if snow tires are being used. These tires have a characteristic noise which the owner will have to ignore or overlook. If not equipped with snow tires, drive the car at various speeds and note the effect of throttle opening, sudden acceleration, and deceleration on the noise. Axle and exhaust noise show definite variations under these conditions

	40°F.	50°F.	60°F.	70°F.	80°F.	90°F.	100°F.
30 mph	79,000	65,500	52,500	41,000	32,000	26,000	20,500
40 mph	68,500	57,000	45,500	35,000	28,000	22,500	18,000
50 mph	58,000	48,000	38,500	30,000	24,000	19,500	16,000
60 mph	47,500	39,000	31,500	24,500	20,000	16,500	13,500
70 mph	36,500	30,500	25,000	19,500	16,000	13,000	11,000
80 mph	26,000	20,500	18,500	14,000	12,000	10,000	8,500

Fig. 3A-11 Relationship of Speed and Atmospheric Temperature Affecting Tire Mileage

while tire noise will remain constant. Tire noise generally is more pronounced on smooth black top roads at speeds between 15 and 40 miles per hour.

Carefully inspect the tire making the noise for bulges, irregular wear, low air pressure, toe and heel (saw tooth) wear, and unusual tread design (ribbed tread gives less noise than some all weather treads; mud and snow treads are very noisy). Checking wheel alignment and interchanging tires will usually cure tire noises unless caused by tire tread design, heavy irregular tread wear, or tire bulges.

Tire thump is the periodic noise at wheel speed and is prominent only on smooth black top pavement that is free of surface irregularities. Tire thump may be checked by driving the car over smooth black top pavement with the tires at normal pressure, and again over the same stretch of road with the tires inflated to 50 lbs. and dropping the pressure in one tire at a time to normal.

CAUTION: Be careful not to strike any obstructions or rocks in road with tire at 50 lbs. pressure as this will lead to a rupture in the casing. Operate car with higher inflation only while testing. Do not operate car over 50 mph with high tire pressure.

If the noise is caused by tires, it will noticeably decrease when tire pressure is increased. By lowering tire pressure one wheel at a time the noise can be traced to the tire or tires in which it reappears as tire pressure is lowered.

SPECIFICATIONS

SUBJECT	ALL MODELS
Wheels	Steel Disc
Type	Drop Center
Diameter	14"
Width	6"

REAR AXLE

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

The rear axle assembly is of modified Hotchkiss drive construction utilizing a hypoid ring gear and pinion set as a means of transmitting power (torque) from the propeller shaft through a differential and then to semi-floating axle shafts.

Two rear axle upper control arms and two lower control arms (Fig. 4-1), with rubber bushings at connecting pivot points, form the basic links of rear suspension. The functions of the lower control arms are to maintain the axle in line relative to frame and to oppose torque reaction of the rear axle. The main purpose of the upper control arms is to control rear axle "windup".

The upper ends of rear coil springs are retained in seats formed in the frame while the lower ends ride on spring pads welded to the housing just forward of the center line of axle assembly.

Direct-acting sealed shock absorbers are mounted with upper ends inclined toward center of vehicle. Rubber bumpers, attached to the frame above the rear axle, cushion extreme downward movement of the frame and body.

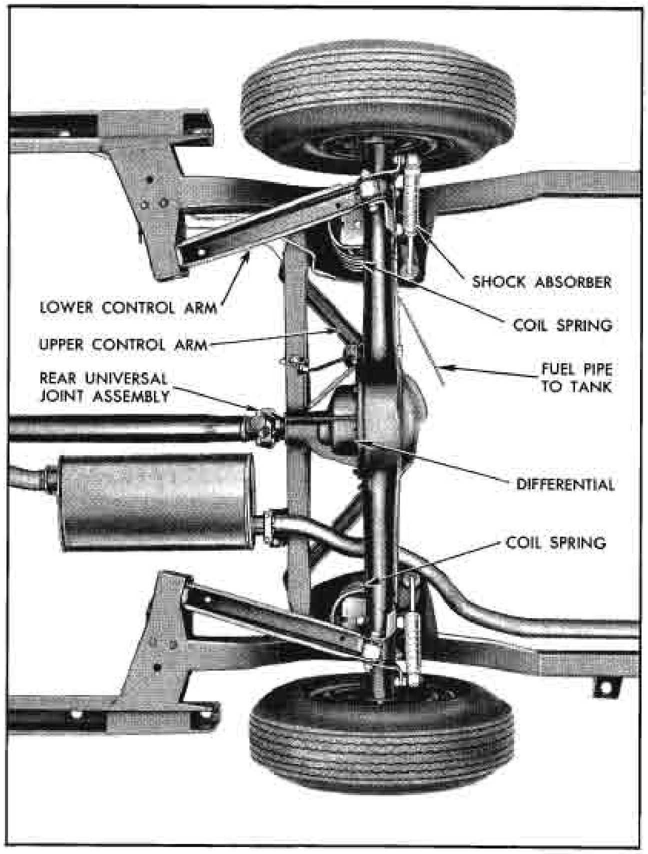


Fig. 4-1 Identification of Rear Suspension Parts

All parts necessary to transmit power from the propeller shaft to the rear wheels are enclosed in a one-piece axle housing. Rear axle shafts are mounted on heavy duty ball bearings located at the outer ends of the rear axle housing. Each bearing is pressed to a shoulder on the shaft and is additionally held in place by a pressed-on inner retainer ring. An outer retainer, which also clamps the brake backing plate to the axle housing, secures the bearing in the end of the axle housing. Axle shaft bearings are pre-lubricated and are backed by oil seals (pressed into the outer ends of the axle housing) which prevent oil seepage from the axle housing into the wheel bearing cavity and onto the brake assembly.

A breather bolt with cap, to prevent entrance of dirt and water, is provided at the right side of the axle housing.

DESIGN

Hotchkiss drive is the basic design used to transmit power from the drive shaft to the rear wheels but design is modified by torque reaction links (upper and lower control arms) rather than leaf springs. A universal joint (Fig. 4-2) connects the end of the propeller shaft to a companion flange having a splined end which fits over, and drives, the rear axle drive pinion gear. This companion flange is securely fastened to the pinion shaft by a special self-locking nut which bears against a special washer.

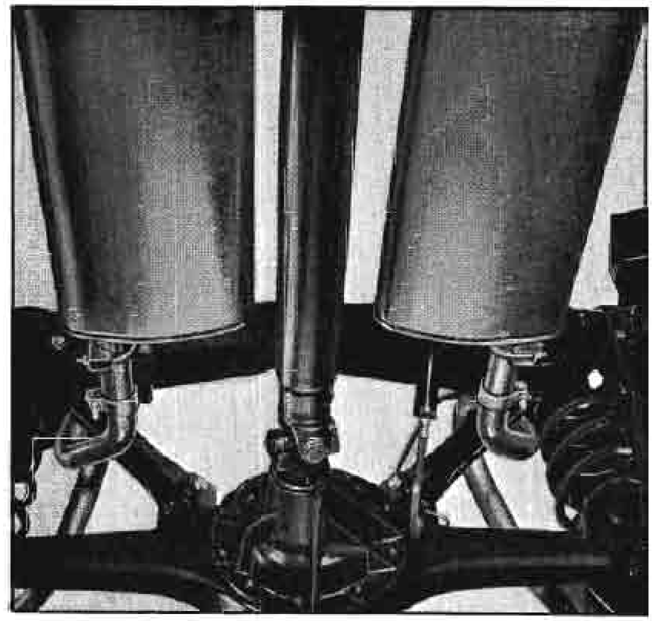


Fig. 4-2 Universal Joint Assembly

Two pre-loaded taper roller bearings support the drive pinion gear in the carrier. The inner race of the rear bearing is a tight press-fit on the pinion stem. The inner race of the front bearing combines a light press-fit to a close sliding fit on the companion flange end of the pinion stem. The outer race of each bearing is pressed against a shoulder recessed in the carrier. Tightening the pinion nut compresses a collapsible spacer (Fig. 4-3), which bears against the inner race of the front bearing and a shoulder on the pinion stem. This spacer is used to maintain a load on the front bearing inner race and the pinion stem and to prevent the inner race of the front bearing from turning on the pinion stem.

Adjustment of the pinion along its axis is obtained by placing shims between the pinion rear bearing inner race and the pinion gear. Torque from the pinion gear is transmitted to a ring gear attached to a differential case by twelve special hex head bolts.

The differential is a device to provide a torque ratio between axle shafts. It permits the rear wheels to turn together, at the same speed, or to turn at different speeds; as when making turns, etc.

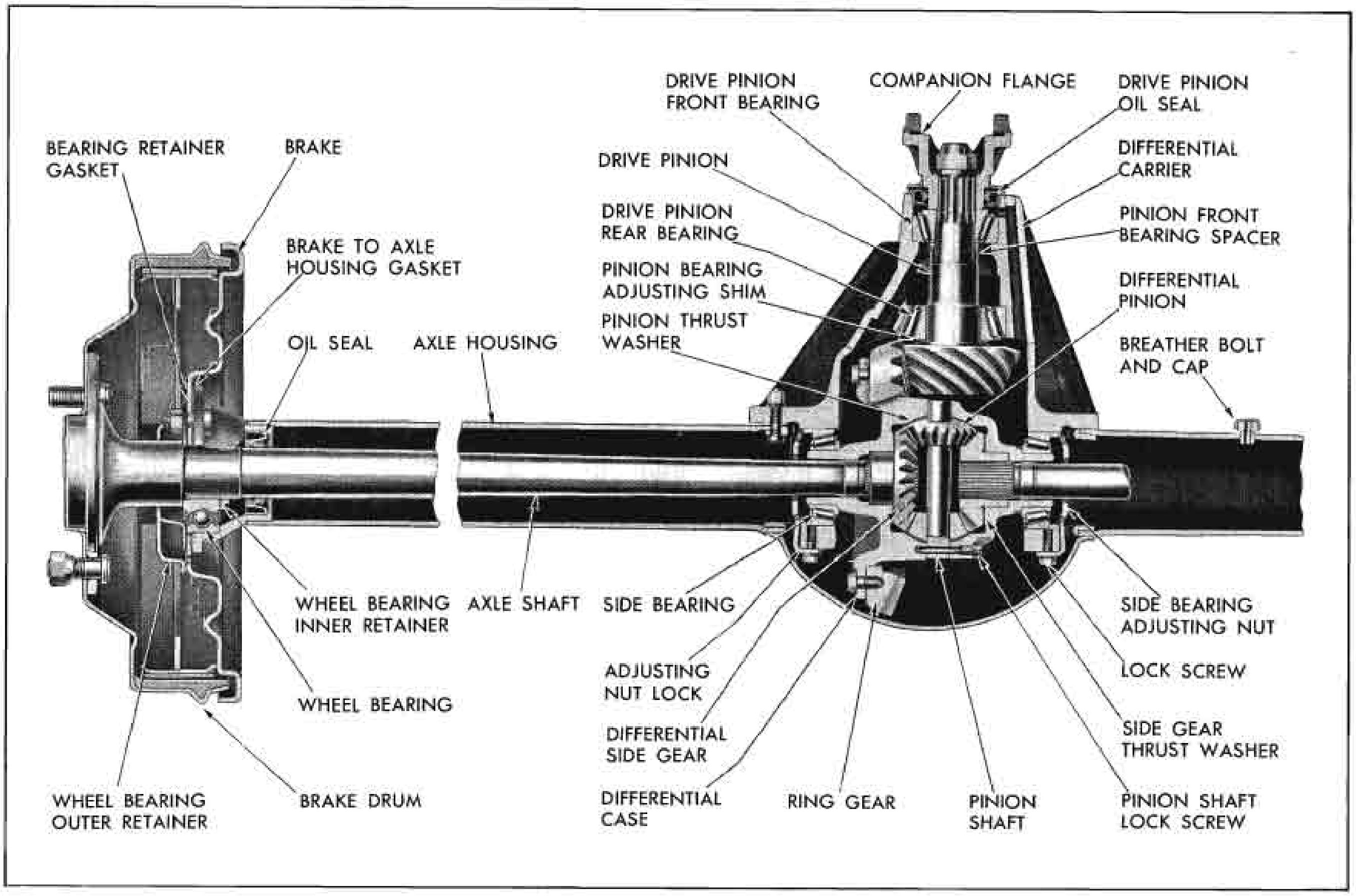


Fig. 4-3 Cross Section of Rear Axle

The *standard or conventional differential* divides torque to the rear wheels equally and is so designed that it will exert no more propelling effort than can be applied to the wheel having the least traction. The differential case is of one piece construction. Four small gears are housed within the case; two side gears and two pinion gears. The two side gears have splined bores for indexing with each of the axle shafts and are positioned to turn in counterbored cavities in the case. The two differential pinion gears have smooth bores and are held in position by a solid pinion cross shaft mounted and locked in the differential case. All four gears are in mesh with each other and, because the pinion gears turn freely on their shaft, they act as idler gears when rear wheels are turning at different speeds.

The *Safe-T-Track differential* is designed to provide a proportionate torque ratio between the axle shafts, based on the amount of friction in the differential and the tractive effort available at the wheels. The Safe-T-Track differential case is of two piece construction; a flange half and a button half. A set of three tabbed plates separated by clutch friction discs (having splined holes) nestle into each case half. The clutch plate adjacent to the differential case half is a Belleville spring (dished) while the other two plates are flat.

Each of the two side gear rings has a hole splined for the axle shaft end. These rings also have a shoulder with splines on the outside diameter which indexes with the clutch friction discs. A side gear having a hole splined for the axle shaft end fits adjacent to the side gear ring and is in constant mesh with four pinion gears; two each on two cross shafts mated at right angles to each other (Fig. 4-4).

AXLE SHAFT

A rear axle shaft fits into the splined hole of the differential side gear at one end and is held secure at the outer end by a heavy duty bearing pressed onto the axle shaft and held in place by an inner retainer. This entire assembly is further held by an outer retainer which also clamps the brake backing plate to the axle housing to secure the heavy duty bearing in the end of the axle housing.

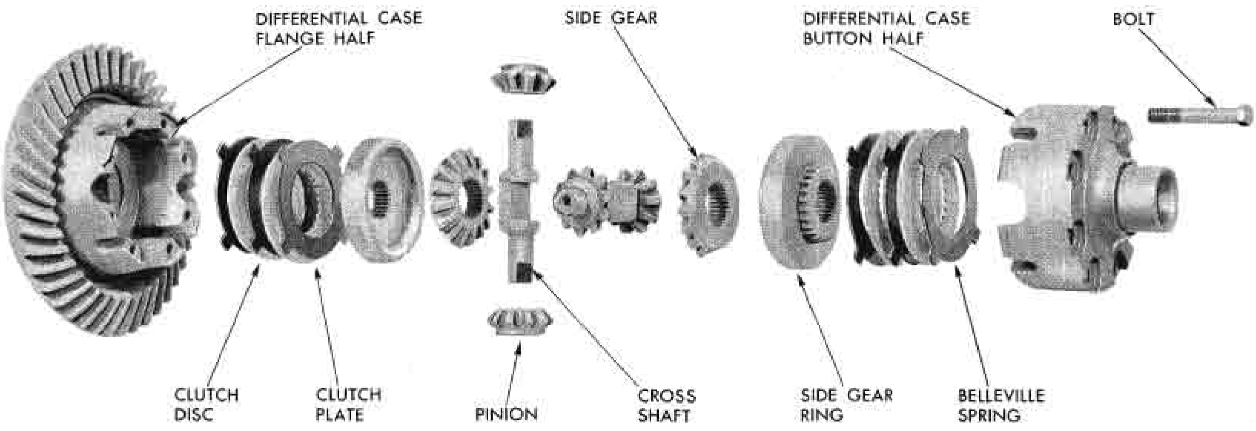


Fig. 4-4 Safe-T-Track Differential—Exploded View

OPERATION

Power from the engine is transmitted to the transmission via a clutch or, in the case of a Hydra-Matic transmission, a fluid coupling. The transmission then provides the transfer of power to its output shaft which is splined to the propeller shaft by means of a universal joint connection. Since the rear of the propeller shaft is connected to the differential pinion gear at the companion flange, the transmission output shaft, propeller shaft and the differential pinion all turn at the same speed.

STANDARD DIFFERENTIAL

Power from the pinion gear is transmitted to the differential ring gear which is bolted to the differential case. When there is equal resistance on each rear wheel, the force through the pinion and ring gear turns the axle shafts at the same rate of speed. Since the same amount of power is being transmitted to each wheel, the differential gears are "locked" together and there will be no rolling of the differential pinion gear teeth over the differential side gear teeth (the two pinion gears are secured inside the differential case by a pinion shaft locked to the case).

When the vehicle turns a corner, the outer rear wheel must turn faster than the inner one. The inner wheel, turning slower with respect to the outer wheel, slows up the differential side gear (as the axle shaft is splined to the side gear) and the differential pinion gear will roll over the slowed up differential side gear driving the other differential side gear and wheel faster.

SAFE-T-TRACK DIFFERENTIAL

Power transmitted from the pinion gear is transmitted to the differential ring gear which is bolted to the differential case flange half. When there is equal resistance on each wheel, the force through the pinion and ring gear tends to force both cross pins to move up a ramp of a cam surface at the same time applying the same load to a disc clutch on each side of the differential which, in effect, locks the related axle shafts in normal, straight ahead position. If one wheel loses traction, its disc tends to disengage, due to reduced load, thereby decreasing wheel torque on this wheel. Torque on the other wheel is consequently increased, since its clutch disc remains engaged. Thus, a higher proportion torque is always applied to the wheel which has traction. In cornering with the Safe-T-Track differential, the load is so distributed that the outside wheel turns faster, as in the standard or conventional differential.

Although the conventional (standard) and Safe-T-Track differentials vary in design, with different kinds and number of gears, the action of both is fundamentally the same. The differential allows both wheels to be mounted on individual axles and driven by a single shaft, yet it permits each wheel to move independently and at different speeds when the need arises.

AXLE RATIOS

Axle ratios differ for various car models. Standard axles can be identified by a color marking on the end of the axle shaft as well as by a code number that is stamped on a pad on differential carrier (Fig 4-5).

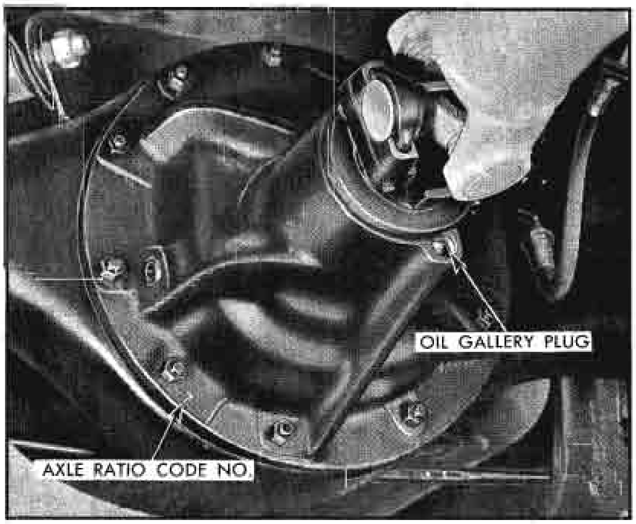


Fig. 4-5 Location of Axle Ratio Code on Differential

Safe-T-Track differentials are identified by an identification tag next to the oil filler plug.

The different axle ratios that are available are shown in Fig. 4-7.

INSPECTION AND PERIODIC SERVICE

INSPECTION

NEW CAR PRE-DELIVERY INSPECTION

TORQUE

Check torque specifications at rear axle.

1. All rear suspension control arms should be tightened to 150-175 lb. ft. torque.

2. Rear shock absorber bolts should be tightened to 50-65 lb. ft. torque.

3. Universal joint U-bolt nuts should be tightened to 14-20 lb. ft. torque if bolts are found loose.

LUBRICATION

Check differential oil level and, if necessary, add sufficient amount of multi-purpose hypoid gear lubricant to bring level to bottom of filler plug hole.

PERIODIC SERVICE

LUBRICATION

Lubricant change in the differential is not recommended unless repair work is being done. The differential should be checked for leaks at each chassis lubrication. If there is evidence of leakage the leak should be corrected and lubricant added if needed. Level should be even with bottom of filler plug hole. Rear axle capacity is 5¾ pints.

Use multi-purpose hypoid gear lubricant in the standard and Safe-T-Track differentials. Because of the importance of using factory recommended lubricant in both differentials, a container of this lubricant is furnished with each service ring gear and pinion set or differential carrier assembly. This lubricant is also available through regular parts channels.

SHOCK ABSORBERS

Give visual inspection for leaks and jounce car at each lubrication period to see that shock absorbers are in operative condition. If inoperative or if leaks are found, the unit should be replaced.

MINOR SERVICES AND REPAIRS

COMPANION FLANGE—REMOVE AND REPLACE

NOTE: When replacing companion flange, it is important that new flange be properly installed to provide correct pinion bearing preload. The following procedure must be used to insure correct pinion bearing adjustment.

1. With rear wheels off the floor, turn rear wheels and rap brake backing plates with a soft hammer to ensure that brakes are free.

2. Turn down lock plates and remove "U" bolts which hold rear universal joint to companion flange. Use a heavy rubber band or tape to hold bearings onto journal to prevent loss of bearing rollers when joint is disconnected if retainer strap has been removed (Fig. 4-6).

3. Using pound inch torque wrench KMO-652 with adapter KMO-653 and socket placed over drive

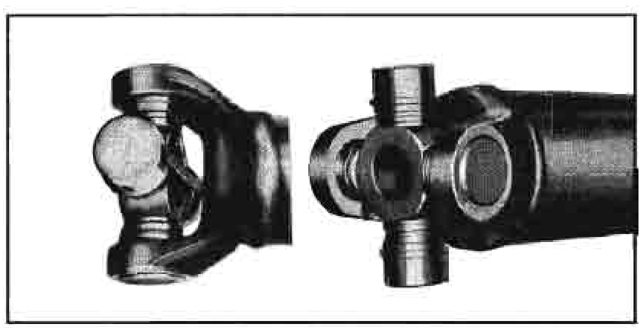


Fig. 4-6 Bearings Held in Place by Retainer Strap

REAR AXLE USAGE AND IDENTIFICATION CHART WITH STANDARD BRAKES

Rear Axle Gear		Usage															Std. Differential		Safe-T-Track Differential	
		Model					Trans.		Ratio Release			Engine			Air Cond.		Code		Code	
Comb.	Ratio	Taxi	23	29	26 28	27	SM	HM	Econ.	Std.	Perf.	425	425A (A)	425E	Without	With	Color	No.	Color	No.
41-16	2.56		X					X		X				X	X		Gray	3	Gray & Green	3
			X					X	X			X			X		"	"	" "	"
		X						X		X				X	X		"	"	" "	"
43-16	2.69				X	X		X	X			X			X		Red	2	Red & Green	2
			X					X		X		X			X		"	"	" "	"
				X				X	X			X			X		"	"	" "	"
		X						X		X		X			X		"	"	" "	"
					X	X		X		X				X	X		"	"	" "	"
				X				X		X				X	X		"	"	" "	"
43-15	2.87				X	X		X		X		X			X	X	Orange	7	Orange & Green	7
				X				X		X		X			X	X	"	"	" "	"
				X		X		X		X				X		X	"	"	" "	"
				X		X		X		X				X		X	"	"	" "	"
		X	X					X		X		X		X		X	"	"	" "	"
		X	X					X		X		X		X		X	"	"	" "	"
40-13	3.08	X				X		X			X	X			X	X	Yellow	0	Yellow & Green	0
		X	X	X	X	X	X		X			X			X		"	"	" "	"
			X	X		X		X		X			X		X		"	"	" "	"
			X	X				X			X	X			X	X	"	"	" "	"
					X			X		X		X	X		X	X	"	"	" "	"
					X			X		X				X		X	"	"	" "	"
42-13	3.23	X	X	X	X	X	X			X		X			X	X	Brown	9	Brown & Green	9
41-12	3.42	X	X	X	X	X	X				X	X			X	X	White	8	White & Green	8
			X	X	X	X	X			X			X		X		"	"	" "	"
40-11	3.64		X	X	X	X	X			Spec. Order		X			X		Blue	6	Blue & Green	6
			X	X	X	X		X		Spec. Order		X			X		"	"	" "	"
			X	X	X	X		X		Spec. Order		X			X		"	"	" "	"
39-10	3.90		X	X	X	X	X			Spec. Order		X			X		None	4	None	4
			X	X	X	X		X		Spec. Order		X			X		"	"	" "	"
			X	X	X	X	X			Spec. Order			X		X		"	"	" "	"
			X	X	X	X		X		Spec. Order			X		X		"	"	" "	"

REAR AXLE USAGE AND IDENTIFICATION CHART WITH HEAVY DUTY BRAKES

Rear Axle Gear		Usage													Std. Differential		Safe-T-Track Differential	
		Model			Trans.		Ratio Release			Engine			Air Cond.		Code		Code	
Comb.	Ratio	Police		2890	SM	HM	Econ.	Std.	Perf.	425	425A (A)	425E	Without	With	Color	No.	Color	No.
43-16	2.69	X				X	X			X			X		Red	2	Red & Green	2
43-15	2.87	X				X		X		X			X	X	Orange	7	Orange & Green	7
40-13	3.08	X			X		X			X			X		Yellow	0	Yellow & Green	0
		X				X			X	X			X	X	Yellow	0	Yellow & Green	0
				X		X		X		X			X	X	Yellow	0	Yellow & Green	0
42-13	3.23	X			X			X		X			X	X	Brown	9	Brown & Green	9
				X		X			X	X			X	X	Brown	9	Brown & Green	9
41-12	3.42	X			X				X	X			X	X	White	8	White & Green	8
39-10	3.90			X	X			X		X			X	(A)	None	4	None	4

(A) Air Conditioning is not available on 2890 Model with S.M. Trans.
Air Conditioning is not available with 425A Engine.

Fig. 4-7 Rear Axle Usage and Identification Chart pinion nut, turn pinion two or three revolutions to ensure free movement, and then take a torque reading while rotating pinion to measure bearing preload (Fig. 4-8). Record reading.

NOTE: Additional clearance to check preload can be obtained between differential and body by raising body a few inches by means of a jack or stand placed under frame at rear.

4. Hold companion flange with tool J-6289 (Fig. 4-9) and remove drive pinion nut and washer using heavy duty socket.

5. Remove companion flange using puller J-6295 (Fig. 4-10).

6. Install new companion flange and install washer and nut. Hold companion flange with tool J-6289 and tighten nut only a little at a time, stopping frequently to check preload (step 3). Tighten nut to reading noted in step 3; however, if reading obtained in step 3 was less than 10 lb. in., increase preload to 10-12 lb. in.

7. Connect universal joints. Use new lock plates and tighten U-joint to companion flange "U" bolt nuts to 14 to 20 lb. ft. torque. Turn up lock plate ears against flats of "U" bolt nuts.

PINION BEARING OIL SEAL— REMOVE AND REPLACE

NOTE: Since inspection of companion flange after removal may reveal damage to this part necessitating its replacement, preload reading of pinion bearings must be checked prior to removing flange so proper preload can be maintained should new flange be required.

1. With rear wheels off the floor, turn rear wheels and rap brake backing plates with a soft hammer to ensure that brakes are free.

2. Turn down lock plates and remove "U" bolts which hold rear universal joint to companion flange. Use a heavy rubber band or tape to hold bearings onto journal to prevent loss of bearing rollers when joint is disconnected if retainer strap has been removed (Fig. 4-11).

3. Scribe a line on the end of the pinion stem extending down along the side of the stem threads and onto the companion flange nut.

4. Punch a small mark on the line at the pinion stem end, and at the top of the lock nut close to the pinion stem threads.

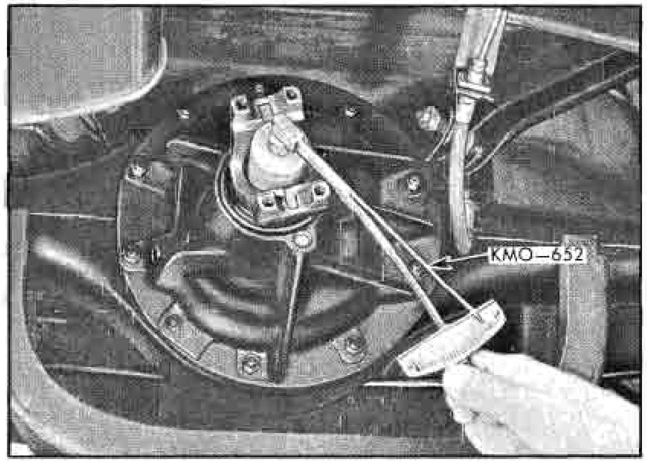


Fig. 4-8 Measuring Pinion Bearing Preload

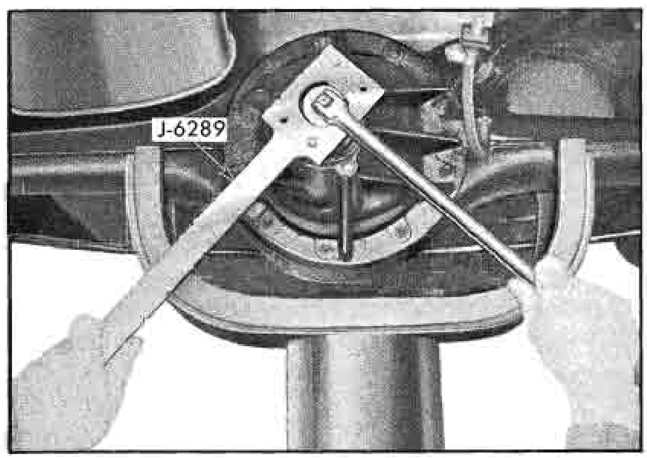


Fig. 4-9 Holding Companion Flange with J-6289

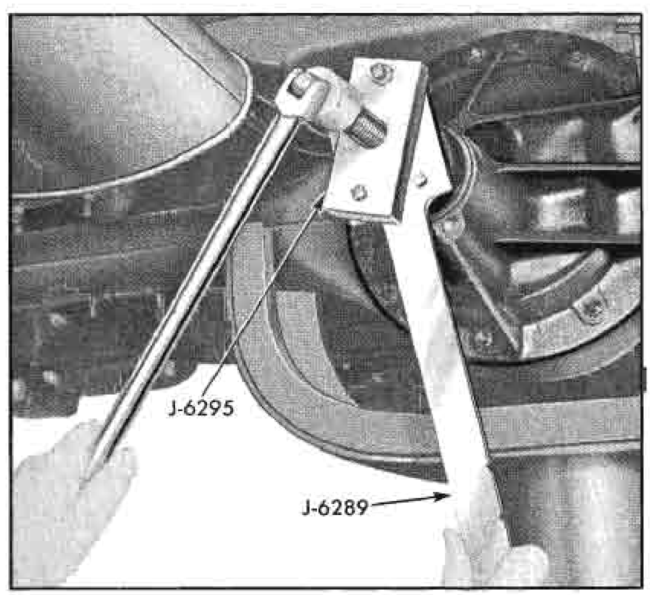


Fig. 4-10 Removing Companion Flange with Puller J-6295

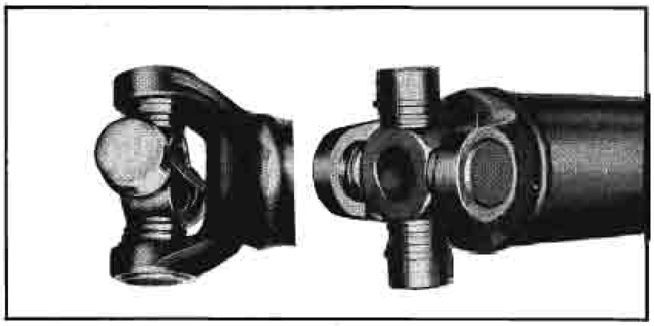


Fig. 4-11 Bearings Held in Place by Retainer Strap

5. Using pound inch torque wrench KMO-652 with adapter KMO-653 and socket placed over drive pinion nut, turn pinion two or three revolutions to ensure free movement, and then take a torque reading while rotating pinion to measure bearing preload (Fig. 4-8). Record reading.

NOTE: Additional clearance to check preload can be obtained between differential and body by raising body a few inches by means of a jack or stand placed under the frame at rear.

6. Count the number of exposed threads from the top of the pinion stem to the lock nut and remove the lock nut with a heavy duty socket while holding the companion flange with J-6289 (Fig. 4-12).

7. Remove companion flange using puller J-6295 (Fig. 4-13).

8. Remove oil seal by prying it out of carrier with a pointed tool applied between the rear of the seal retainer in front of carrier, using care to keep tool away from the exposed front bearing.

CAUTION: Use care to keep dirt and other foreign matter out of exposed front pinion bearing.

9. Oil lip of new seal with clean engine oil. Coat outer diameter of seal case with suitable sealer. Install seal by tapping into place, using J-5395.

10. Before installing companion flange, inspect for nicks, scratches or burred surfaces that may damage the seal. If any such damage is evident, hone carefully or install new flange.

a. If a new companion flange is installed, refer to the appropriate steps under COMPANION FLANGE–REMOVE AND REPLACE.

b. If inspection shows the original companion flange to be satisfactory, replace by holding companion flange with J-6289 and install nut to exactly the same position with the old companion flange,

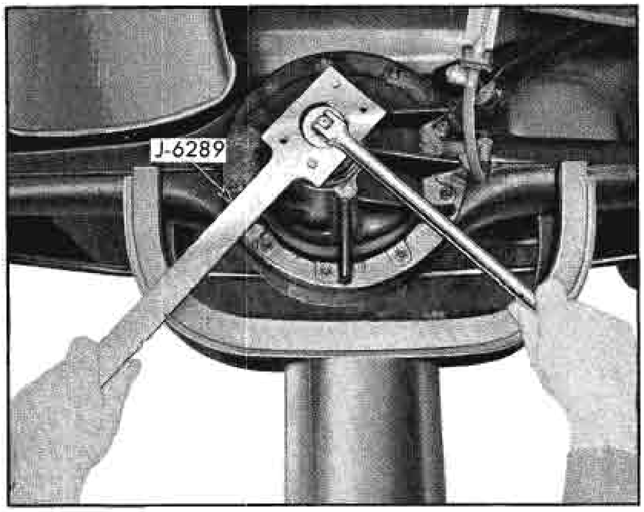


Fig. 4-12 Holding Companion Flange with J-6289

making sure punched holes and scribe line are in alignment. Tighten lock nut an additional $\frac{1}{32}''$ beyond this alignment.

CAUTION: DO NOT exceed the additional tightening of the nut by a distance of $\frac{1}{32}''$ from its original position as tightening the nut in excess of this amount will disturb the pinion and ring gear tooth contact pattern.

11. Connect rear universal joint. Use new lock plates and tighten U-joint to companion flange "U" bolt nut to 14 to 20 lb. ft. torque. Turn up lock plate ears against flats of "U" bolt nuts.

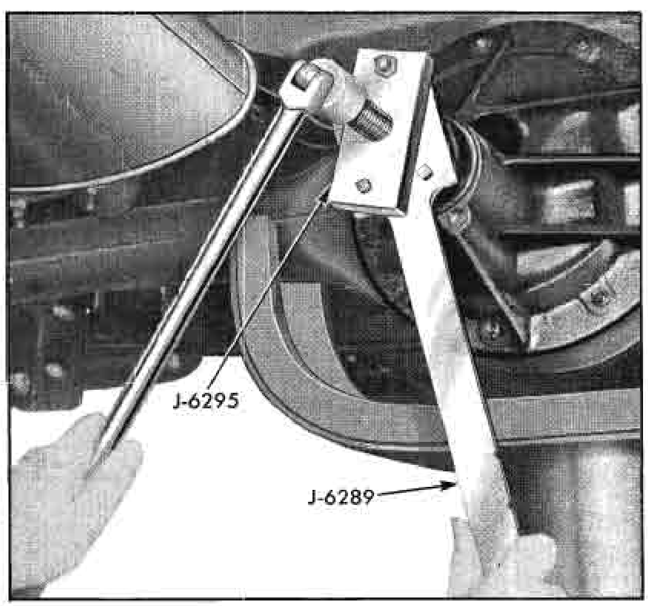


Fig. 4-13 Removing Companion Flange with Puller J-6295

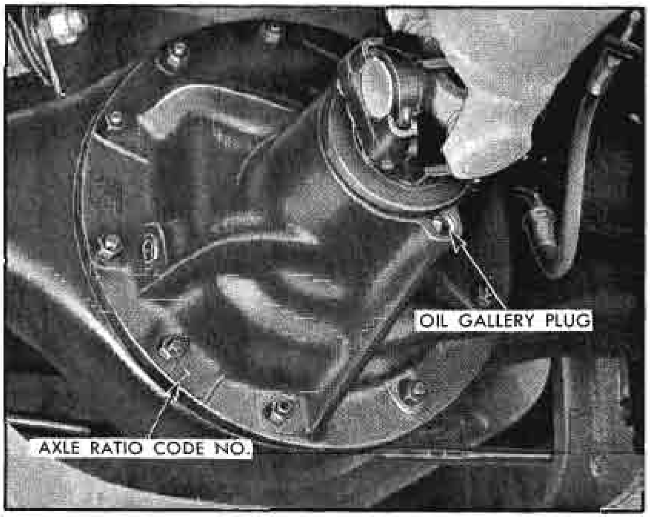


Fig. 4-14 Carrier Oil Gallery Plug

CARRIER OIL GALLERY PLUG— REMOVE AND REPLACE

1. Remove companion flange. (See appropriate steps under COMPANION FLANGE–REMOVE AND REPLACE.)

2. Thread a half inch bottom tap into plug (Fig. 4-14) until plug starts to turn and remove plug by turning tap and pulling at same time.

CAUTION: Do not attempt to drill a hole in plug for removal as drill shavings will fall down oil hole causing severe damage to gears and bearings.

3. Apply a light coat of sealer to carrier oil hole and to plug, and install new plug making certain plug does not enter drain hole.

4. Replace companion flange.

AXLE SHAFT AND/OR AXLE SHAFT BEARING AND/OR BEARING OIL SEAL— REMOVE AND REPLACE

1. Remove rear wheel.

2. Clean away all dirt from area where brake backing plate seats against flanged end of axle housing to prevent any possible entry of dirt into wheel bearing.

3. Remove brake drum.

4. Remove four nuts from bearing outer retainer bolts.

5. Remove axle shaft assembly, using puller J-942-1, if necessary (Fig. 4-15). Do not dislodge backing plate or brake pipe may be damaged.

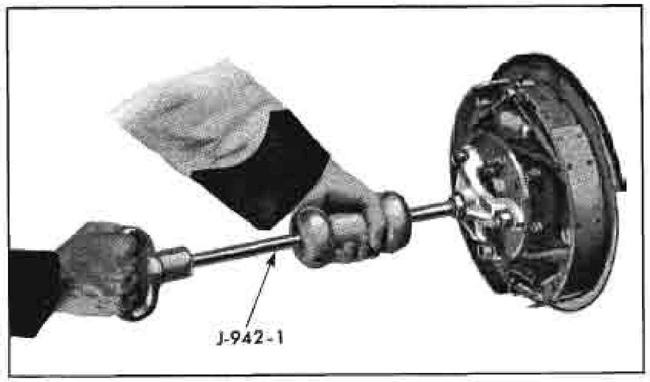


Fig. 4-15 Removing Axle Shaft with Puller J-942-1

6. Remove oil seal using J-943.

a. Apply oil to seal lip and coat outside of seal retainer which seats in axle housing with a suitable sealer. Be sure that the sealer does not get smeared on seal lip. The surface of axle shaft which contacts seal must be smooth; if it is nicked or burred, hone carefully or replace axle shaft.

b. Install new seal using tool J-5818.

7. Remove axle shaft or axle shaft bearing.

a. With tool J-947-P engaging outer race of bearing and ring enclosing bearing (Fig. 4-16), press shaft from bearing using arbor press.

b. If removed, install bearing outer retainer on shaft. Install bearing on shaft using tool J-947-P to bear only on inner race and press bearing firmly against shoulder on shaft (Fig. 4-17).

c. Press a new bearing inner retainer ring in place firmly against bearing using tool J-947-P.

NOTE: DO NOT press bearing and retainer on in one operation, because edge radius of the retainer

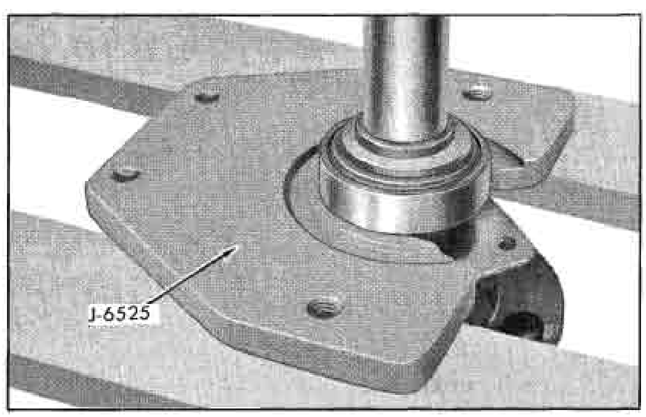


Fig. 4-16 Pressing Bearing From Axle

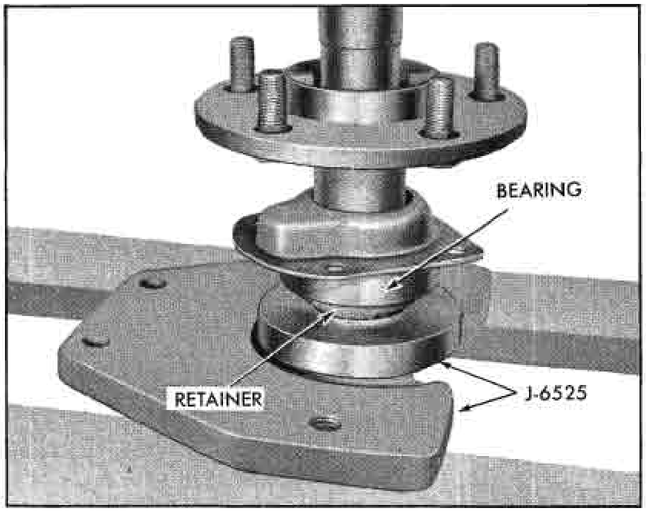


Fig. 4-17 Installing Bearing on Axle Shaft

will climb over the corner of the bearing inner race and force the grease seals into the bearing balls.

8. Place bearing retainer gasket over bearing on axle shaft.

9. Install axle shaft. If both axle shafts have been removed, shaft with left hand threads on wheel bolts must be on left side of car.

CAUTION: Do not damage seal in axle housing when installing axle shaft. Do not allow axle shaft to rest on or drag on lip of seal.

10. Position bearing outer retainer and gasket and tighten self-locking bearing retainer nuts to 30-45 lb. ft. torque.

11. Install brake drums and wheels.

MAJOR REPAIRS

If diagnosis reveals irregularities in the differential itself, the differential must be removed from the vehicle.

REMOVE DIFFERENTIAL

1. With rear wheels off the floor, turn rear wheels and rap brake backing plates with a soft hammer to ensure that brakes are free.

2. Remove both axle shafts.

NOTE: Mark the axle shafts so that they can be returned to the same respective side upon reassembly. (Studs on left axle shaft have left hand threads and are stamped "L" on end of stud.)

3. Turn down lock plates and remove "U" bolts which hold rear universal joint to companion flange. Use a heavy rubber band or tape to hold bearings onto journal to prevent loss of bearing rollers when joint is disconnected if retainer strap has been removed.

4. Thoroughly clean differential carrier bolt flange and surrounding area of axle housing to avoid dirt entering housing or falling on the gears.

5. Drain oil by loosening all differential attaching nuts and then pulling carrier out about 1/8 inch.

6. Allow oil to drain thoroughly then remove attaching nuts and remove carrier assembly from housing.

PRE-REPAIR INVESTIGATION

A close examination of the differential prior to disassembly will often reveal valuable information as to the extent and type of repairs or adjustments necessary. The information thus gained, coupled with the report of malfunctioning, will provide a basis for determining the degree of disassembly required. Since the *frequent causes of axle noise are improper backlash or side bearing preload,* or both, a few simple adjustments may be all that is necessary to correct a discrepancy.

Use care at all times to keep dirt and other foreign matter, such as grinder dust, soot, or sand, away from differential to prevent possibility of subsequent failure of differential.

CHECK AND ADJUST PINION BEARING PRELOAD

1. Remove differential assembly if not already removed.

2. Wash interior parts of assembly with cleaning fluid and mount in carrier fixture J-6571 (Fig. 4-18).

3. Check pinion nut for tightness (pinion bearing preload), using inch pound torque wrench. If reading is less than 10-12 in lbs., increase preload reading to 10-12 in. lb.

NOTE: Hold companion flange with J-6289 and tighten nut only a little at a time, stopping frequently to check preload.

CHECK AND ADJUST DIFFERENTIAL SIDE BEARING PRELOAD

1. See that ring gear attaching screws are tightened evenly and alternately across the diameter to 55-60 lb. ft. torque.

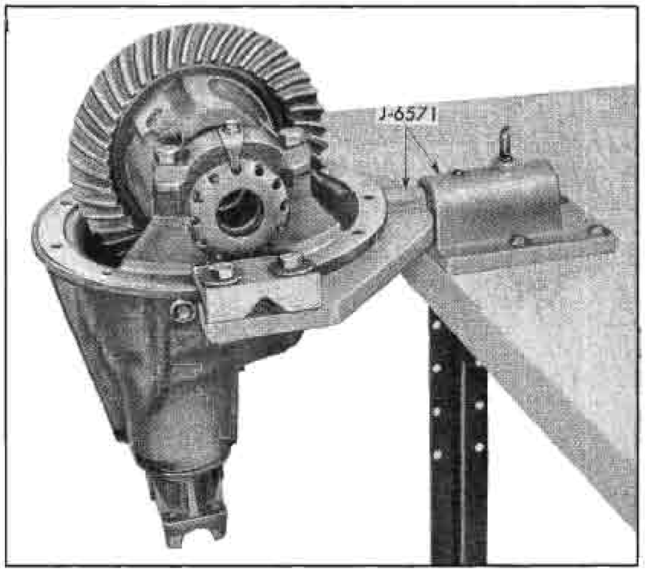


Fig. 4-18 Differential Mounted in Fixture J-6571

2. Mount dial indicator on backside of ring gear as shown in Fig. 4-19 and check ring gear runout. Runout should not exceed .002". Excessive runout could be the result of warped ring gear or mounting flange on case, worn side bearings, misaligned carrier cross-bore, or burrs on case mounting flange or side bearing hubs.

3. Examine ring gear and pinion teeth for nicks or scoring. If no scoring is present, the gear and pinion should be checked for evidence of excessive wear.

NOTE: Any of these conditions will require replacement of ring gear and pinion set. Relatively new gears that are noisy due to improper tooth contact, but have not run long enough to damage the original lapped surfaces, can usually have the noise level reduced to the point where it is not objectional by correct adjustment.

7. Remove adjusting nut locks and mark adjusting nuts for lock location.

8. Loosen each bearing cap bolt, retighten a little more than finger tight, and tap caps lightly to assure freedom of bearings and nuts.

9. Back off right hand adjusting nut (farthest from the ring gear) using tool J-972-A (Fig. 4-20) and watch outer race of side bearing to see if it turns with adjusting nut. Race should turn with the nut, as nut is backed off, until nut is turned two to three notches (holes in adjusting nut). Count notches from original mark to point where race stops turning to check original adjustment and retighten two to three notches.

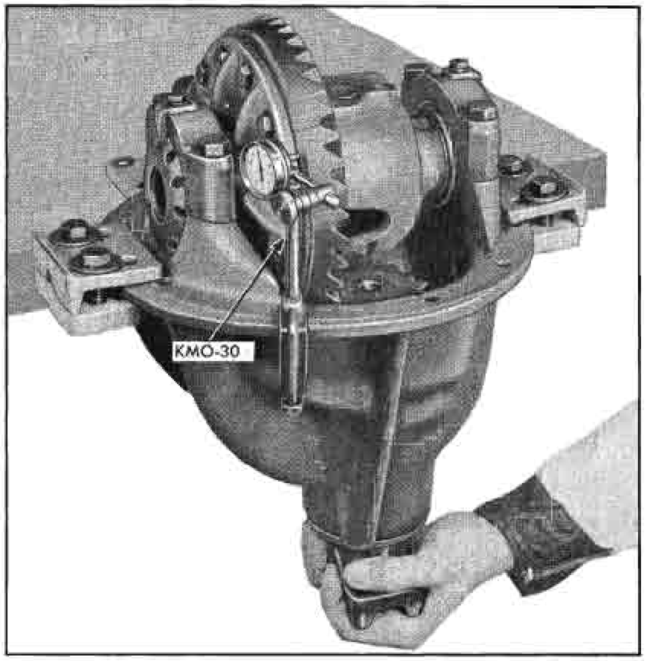


Fig. 4-19 Checking Ring Gear Run-out with KMO-30 Set

10. Check backlash between ring gear and pinion before retightening bearing cap bolts and installing nut locks. Backlash should be between .005" and .009", checked at two or more equally spaced points around the ring gear.

11. Tighten bearing cap bolts to 65-85 lb. ft. torque. Tap bolts with steel hammer while tightening to ensure caps seating properly and producing a correct torque reading.

12. Recheck backlash between ring gear and pinion.

13. Check ring and pinion gear tooth contact by red lead test.

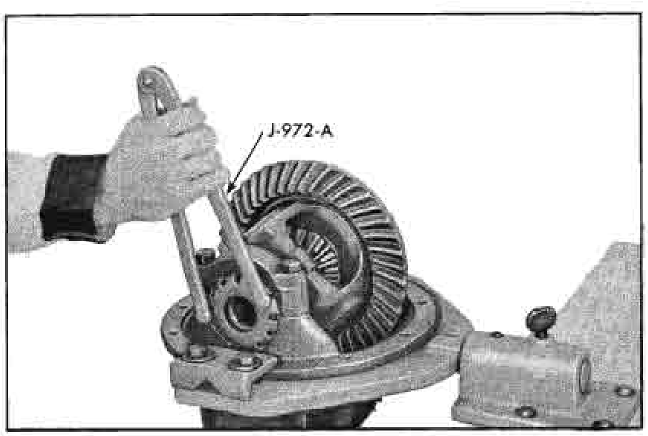


Fig. 4-20 Turning Adjusting Nut with J-972-A

CHECK AND ADJUST RING GEAR AND PINION BACKLASH

1. Remove differential assembly if not already removed.

2. Wash interior parts of assembly with cleaning fluid and mount in carrier fixture J-6571.

3. Mark pinion nut and end of pinion with a punch or other suitable means for reference purposes.

4. See that ring gear attaching screws are tightened evenly and alternately across the diameter to 55-60 lb. ft. torque.

5. Mount dial indicator on backside of ring gear as shown in Fig. 4-19 and check ring gear runout. Runout should not exceed .002". Excessive runout could be the result of warped ring gear or mounting flange on case, worn side bearings, misaligned carrier cross-bore, or foreign material or burrs on case mounting flange or side bearing hubs.

6. Examine ring gear and pinion teeth for nicks or scoring. If no scoring is present, the gear and pinion should be checked for evidence of excessive wear. Any of these conditions will require replacement of ring gear and pinion set. Relatively new gears that are noisy due to improper tooth contact, but have not run long enough to damage the original lapped surfaces, can usually have the noise level reduced to the point where it is not objectionable by correct adjustment.

7. Check and adjust side bearing preload.

8. Check backlash between ring gear and pinion, using indicator set KMO-30 (Fig. 4-21).

NOTE: Mount dial indicator at right angles to the ring gear and also as close to the gear as possible. Backlash readings will vary as much as .003" if indicator is not positioned properly.

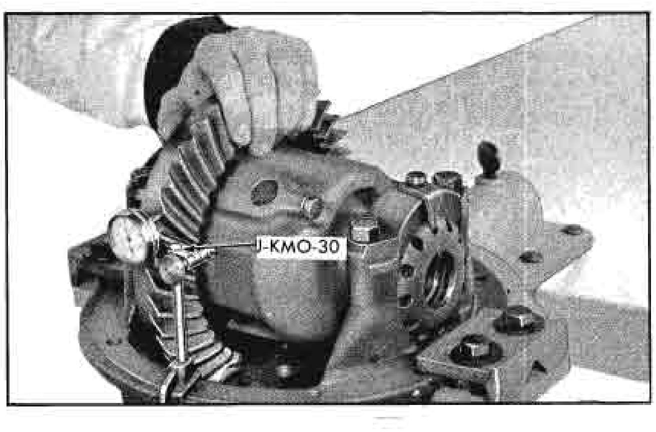


Fig. 4-21 Checking Backlash with KMO-30 Set

9. Backlash should be between .005" and .009", checked at two or more equally spaced points around ring gear.

10. If backlash is outside limits, it will be necessary to move gear away from the pinion to increase backlash or toward pinion to decrease it.

11. To change backlash, move adjusting nuts in same direction one notch at a time until correct backlash is obtained; that is if left nut is backed off one notch, the right nut must be tightened one notch.

12. Tighten bearing cap bolts to 65-85 lb. ft. torque. Tap bolts with steel hammer while tightening to ensure caps seating properly and producing a correct torque reading.

13. Check ring and pinion gear tooth contact by red lead test.

TOOTH CONTACT PATTERNS

Tooth contact pattern is revealed by observing teeth on ring gear after conducting a red lead test.

RED LEAD TEST

It is very important that tooth contact be tested *before* differential carrier assembly is disassembled and before it is installed. Allowable variations in the carrier or pinion rear bearing may cause pinion to be too far away from, or close to, ring gear. Thus, tooth contact must be tested and corrected if necessary or the gears may be noisy. Review GEAR TOOTH NOMENCLATURE before proceeding.

1. Mix a small amount of powdered red lead (available from paint manufacturers and suppliers) with a drop of engine oil and apply this mixture sparingly to all ring gear teeth using a medium stiff brush (Fig. 4-22). When properly used, area of pinion tooth contact will be visible when hand load is applied.

2. Tighten bearing cap bolts to 65-85 lb. ft. torque and tap heads of bolt intermittently while tightening to ensure proper seating of caps and sufficient tightness.

3. Insert crank (Fig. 4-23) in companion flange and, while turning, apply pressure to back side of ring gear with hand (Fig. 4-24). A test made without loading the gears will not give a satisfactory pattern.

NOTE: The crank in Fig. 23 may be easily made as follows:

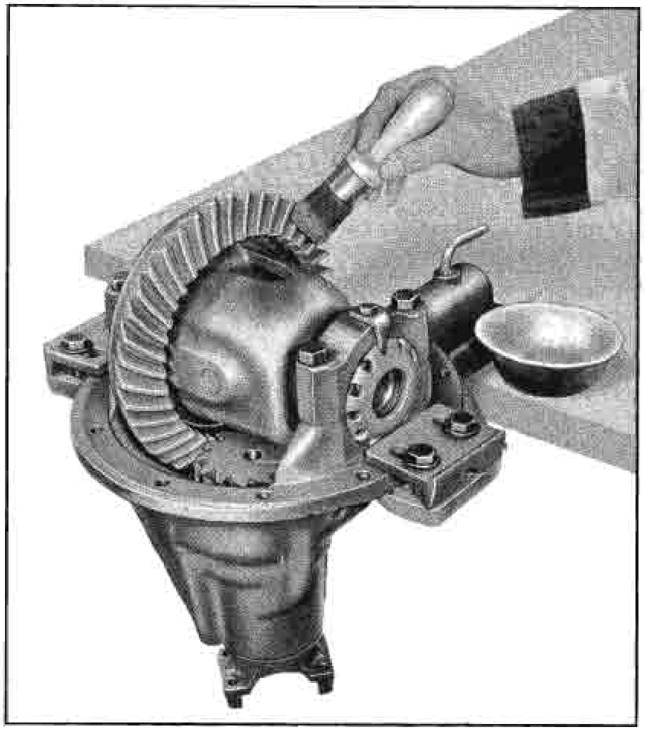


Fig. 4-22 Applying Red Lead to Gear Teeth

a. Weld a 3/8" heavy duty flat washer to a piece of 1/4" diameter rod approximately 6" long and form as shown.

b. Tap door knob for 3/8" bolt and attach knob to crank as shown. Leave bolt loose enough to permit knob to turn.

4. Turn companion flange with crank so that ring gear rotates *one* full revolution, then reverse rotation so that ring gear rotates *one* revolution in opposite direction. Excessive turning of ring gear may indicate good tooth pattern because one or two teeth are making proper contact.

5. Closely inspect tooth pattern on ring gear to determine whether pressure lines are apparent.

NOTE: If observation reveals pressure lines are present (dark narrow band at edge of pattern), examine for pressure line position on drive side (gear curving outward or outside of arc, or convex) and also coast side of ring gear (side curving inward or inward side of arc, or concave). If lines on drive side are too deep and coast side are too high (near the heel and toe respectively), then additional shims to bring pinion gear out (to provide a more centrally located tooth pattern on ring gear) will only place the pressure line deeper into the tooth on drive side and farther out on the coast side which will result in a noisy operating axle. This

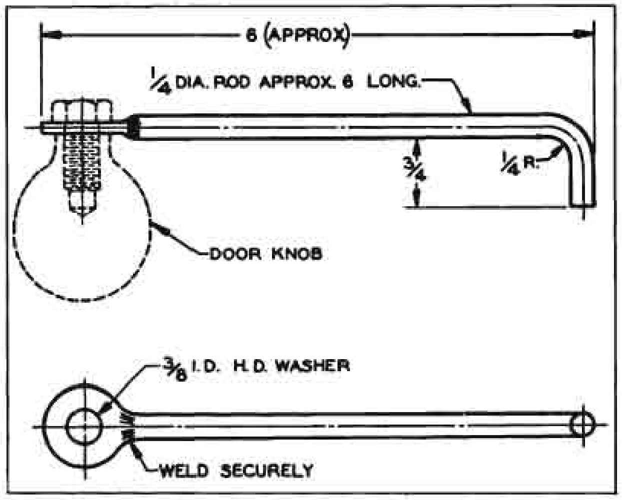


Fig. 4-23 Differential Cranking Tool

does not mean the ring gear and pinion are not good or should be destroyed. It only means that they will not operate quietly in the carrier in which they are presently installed. These same parts may operate quietly in another carrier when tooth pattern is checked.

Removing backlash moves ring gear into pinion gear, driving the pinion deeper into the ring gear. Whenever pressure lines are noted, as explained above, install another ring gear and pinion set.

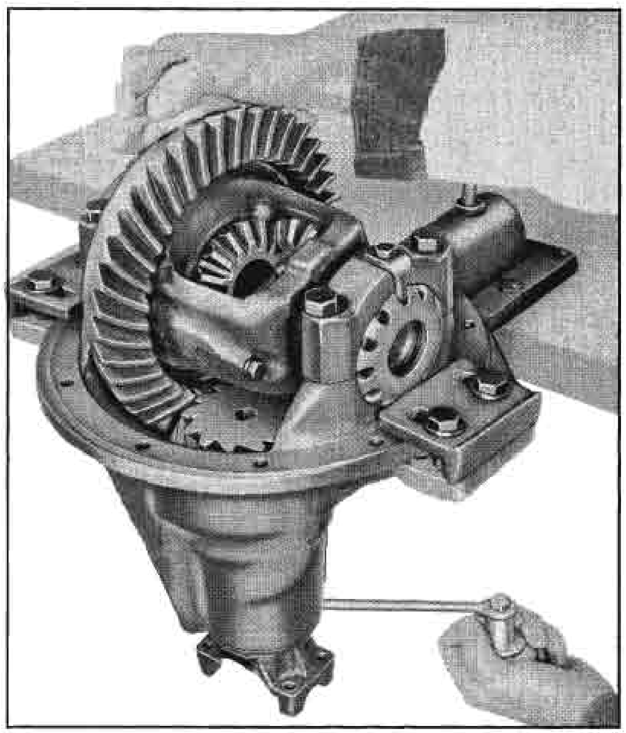


Fig. 4-24 Checking Tooth Contact Pattern

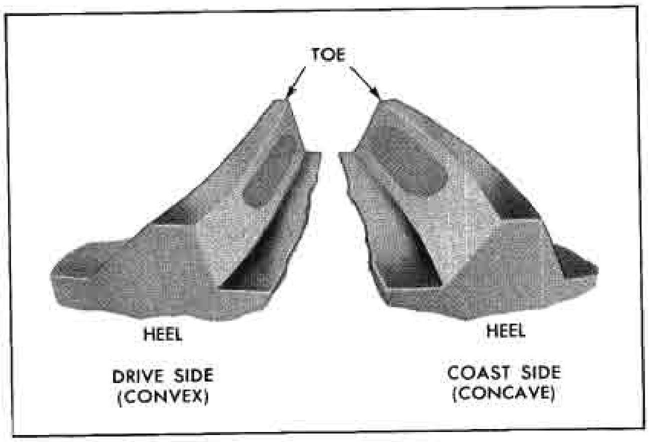


Fig. 4-25 Desired Tooth Contact Pattern Under Light Load

6. Observe pattern on ring gear teeth and compare with Fig. 4-25.

GEAR TOOTH NOMENCLATURE

The side of the ring gear tooth which curves outward, or is convex, is referred to as the "drive" side; concave side is "coast" side. The end of the tooth nearest center of ring gear is referred to as the "toe" end; end of tooth farthest away from center is "heel" end. Toe end of tooth is smaller than heel end. Nomenclature of ring gear teeth is shown in (Fig. 4-26).

EFFECTS OF INCREASING LOAD ON TOOTH CONTACT PATTERN

When "load" on ring and pinion gear is increased, such as when car is accelerated from standstill or from normal drive, the tooth contact will tend to spread out, and under very heavy load will extend from near toe to near heel. The entire contact also tends to shift toward heel under increasingly heavier loads and will become somewhat broader with respect to tops and bottoms of teeth. The patterns obtained by red lead test, dependent upon degree of "loading", approximate a normal light load, and for this reason will not cover the entire face of the ring gear, but will extend only about halfway (Fig. 4-25). The important thing to note is that the contact pattern is centrally located up and down on the face of the ring gear.

ADJUSTMENTS EFFECTING TOOTH CONTACT

Two adjustments can be made which will affect tooth contact pattern: backlash, and position of drive pinion in carrier. The effects of bearing preloads are

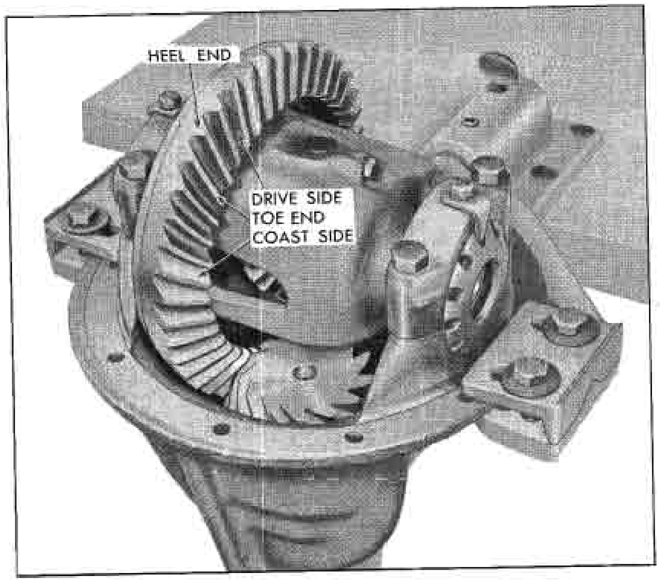


Fig. 4-26 Nomenclature of Ring Gear Teeth

not readily apparent on (hand loaded) red lead tests; however, these adjustments should be within specifications before proceeding with backlash and drive pinion adjustments.

Backlash is adjusted by means of the side bearing adjusting nuts which move the entire case and ring gear assembly closer to or farther from drive pinion. (The adjusting nuts are also used to set side bearing preload.)

The position of the drive pinion is adjusted by increasing or decreasing the shim pack between the pinion head and inner race of rear bearing. The shim pack is used in the differential to compensate for manufacturing tolerances. Increasing shim pack thickness will move pinion closer to centerline of ring gear (Fig. 4-27). Decreasing shim pack thickness will move pinion farther away from centerline of ring gear.

EFFECTS OF BACKLASH ON TOOTH PATTERN

The terms "excess" and "insufficient" refer to settings which are greater than .009″ or less than .005″ as specified. With respect to tooth contact patterns, "excess" refers to backlash which, although less than .009″, is more than necessary to provide desired pattern. Similarly, "insufficient" refers to backlash which, although .005″ or more, is less than necessary to provide desired pattern.

Excess backlash, provided pinion is properly positioned, will give a high heel pattern on both drive and

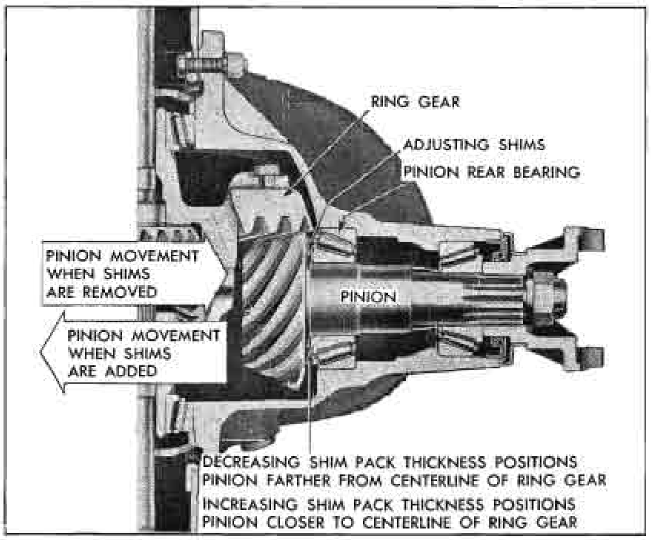


Fig. 4-27 Effects of Shim Pack Thickness on Pinion Bearing

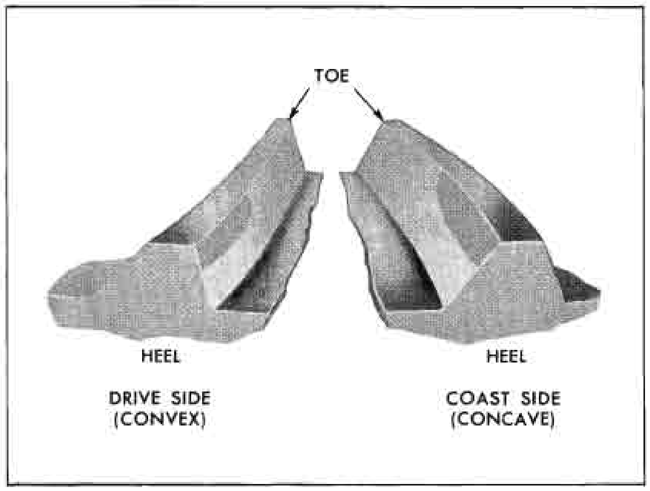


Fig. 4-28 Tooth Pattern When Backlash is Excessive

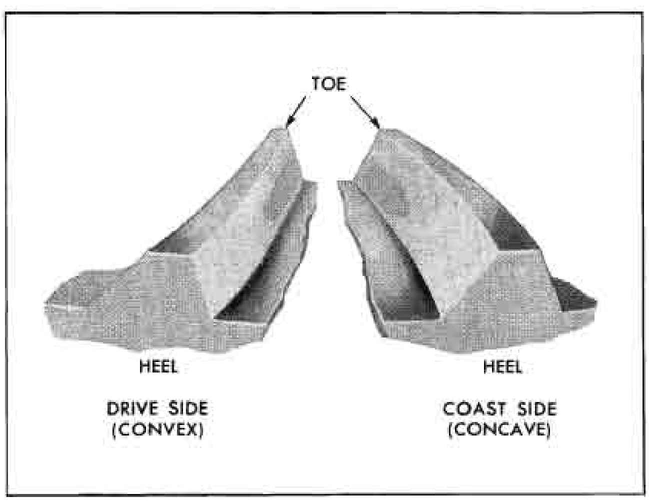


Fig. 4-29 Tooth Pattern when Backlash is Insufficient

coast sides (Fig. 4-28). Decreasing backlash by moving case and ring gear assembly closer to pinion will cause pattern to move toward toe end and down toward center of tooth on both drive and coast sides.

Insufficient backlash, provided pinion is properly positioned, will give a low toe pattern on both drive and coast sides (Fig. 4-29). Increasing backlash will cause pattern to move toward heel end and up toward top of tooth on both drive and coast sides.

EFFECTS OF PINION POSITION ON TOOTH PATTERN

When drive pinion is too far away from centerline of ring gear, the pattern will be a high heel contact on drive side and a high toe contact on coast side (Fig. 4-30), provided backlash is within specifications of .005" to .009". Moving pinion closer to centerline of ring gear by increasing shim pack thickness will cause the high heel contact on drive side to lower and move toward toe; the high toe contact on coast side will lower and move toward heel (Fig. 4-31).

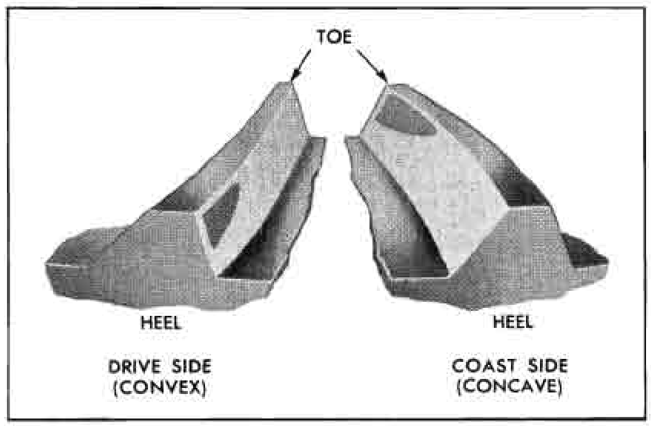


Fig. 4-30 Tooth Pattern When Pinion is too Far Away From Ring Gear (Shim Pack Thickness Insufficient)

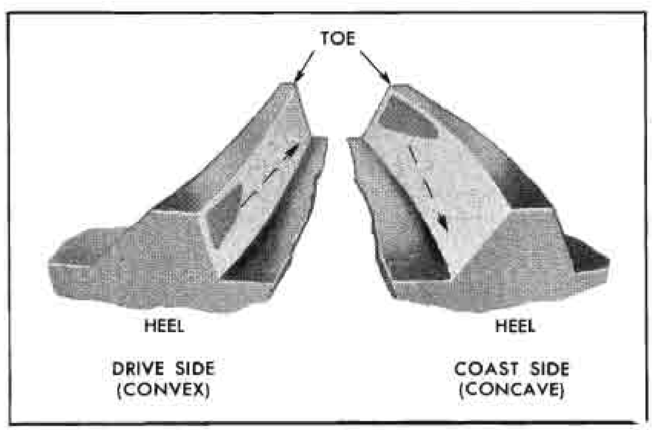


Fig. 4-31 Direction of Movement of Tooth Contacts when Shim Pack Thickness is Increased

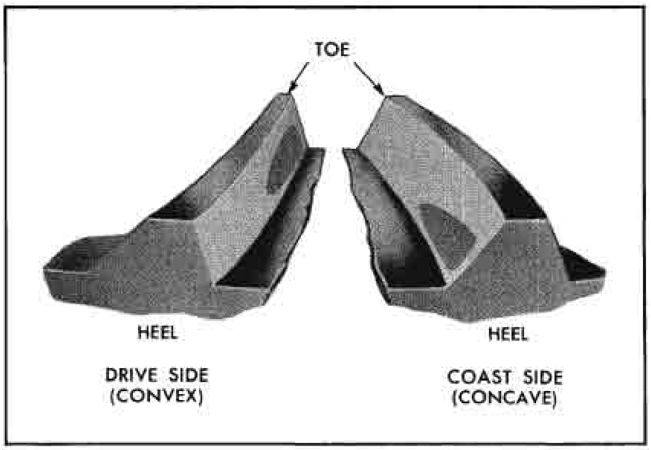


Fig. 4-32 Tooth Pattern when Pinion is Too Close to Ring Gear (Shim Pack Thickness Excessive)

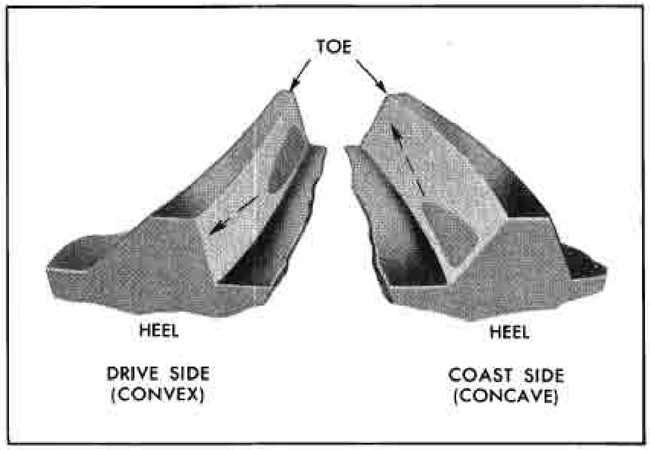


Fig. 4-33 Direction of Movement of Tooth Contacts when Shim Pack Thickness is Decreased

When pinion is too close to ring gear, pattern will be a low toe contact on drive side, and a low heel contact on coast (Fig. 4-32), provided backlash is within specifications of .005" to .009". Moving pinion farther away from ring gear by decreasing shim pack thickness will cause low toe contact on drive side to raise and move toward heel; low heel contact on coast will raise and move toward toe (Fig. 4-33).

ADJUSTING TOOTH CONTACT BY CHANGING BACKLASH

If tooth contact pattern does not look exactly like those illustrated in Figs. 4-25 through 4-33, adjust backlash to several different values, from minimum to maximum, testing tooth contact after each adjustment. By this means, a pattern should be found which will look similar to one of those illustrated in the above figures.

Correction can then be made by changing backlash or pinion position as may be required.

CORRECTION FOR EXCESSIVE BACKLASH

If red lead test produces a tooth pattern on heel of tooth, similar to that in Fig. 4-28, backlash is excessive. To correct this condition proceed as follows:

1. Loosen bearing cap bolts and retighten slightly more than finger tight.

2. Back off right hand adjusting nut (Fig. 4-34) one notch and tighten left hand adjusting nut one notch (each notch of adjustment will change backlash .002"–.004"), depending on ratio.

CAUTION. Do not decrease backlash below minimum specifications of .005". Tap each bearing cap and rock case to ensure proper seating of bearings.

3. Tighten bearing cap bolts to 65-85 lb. ft. torque and tap heads of bolts intermittently while tightening to ensure proper seating of caps and sufficient tightness.

4. Recheck backlash.

5. Recheck tooth contact pattern by red lead test.

6. Repeat adjustments one notch at a time, rechecking pattern by red lead test to determine whether backlash will give correct pattern.

CAUTION: Do not reduce backlash below minimum specification of .005". If backlash adjustment does not give desired pattern, pinion position will have to be adjusted.

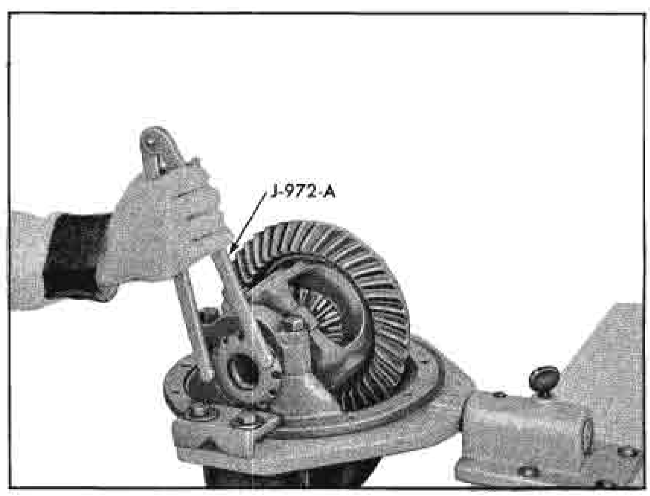


Fig. 4-34 Backing Right Adjusting Nut with J-972-A

7. If correct contact pattern is obtained reinstall differential carrier assembly in housing.

8. Road test for noise appraisal.

CORRECTION FOR INSUFFICIENT BACKLASH

If red lead test produces a tooth pattern on toe of tooth, similar to that in Fig. 4-30, backlash is insufficient. This type of pattern may be the result of carrying adjustment for backlash, too far (less than .005″ lash). Increase lash by backing off left adjusting nut one notch and tighten right adjusting nut one notch (each notch of adjustment will change backlash .002″–.004″ depending on ratio).

Do not exceed maximum backlash specification of .009″.

NOTE: On very high mileage gear sets, where a definite wear pattern has been established, it is permissible to exceed .009″ backlash if so doing will give desired pattern. It is important, however, that backlash not be exceeded except on very high mileage gear sets.

If backlash adjustment does not give desired pattern, pinion position will have to be adjusted by reshimming between the pinion gear and pinion rear bearing inner race.

ADJUSTING TOOTH CONTACT BY CHANGING PINION POSITION

Should differential side bearing preload correction (or backlash adjustment) fail to give correct tooth contacts, pinion adjustment by reshimming is necessary.

Examine gear tooth contacts after adjusting backlash to best condition (red lead test) and compare with Fig. 4-30 and 4-32.

NOTE: Changing position of drive pinion will cause a change in backlash if case is replaced in same position in carrier cross bore as it was before pinion was shimmed. For example, if backlash is .006″ and pinion is shimmed from .010″ to .013″ and case is replaced in same position in carrier cross bore, backlash will decrease to less than .006″. Since there is only one combination of shim thickness and backlash (that is, pinion position and case position) which will give correct pattern, it will be necessary to adjust backlash to several values and check pattern after each adjustment in order to obtain correct pattern or to determine if a different shim thickness is required to obtain correct pattern.

CORRECTION FOR PINION ADJUSTMENT TOO FAR AWAY FROM CENTERLINE OF RING GEAR

If there is insufficient shim thickness between pinion head and bearing race, contact between gear teeth will be similar to that shown in (Fig. 4-30). Note that tooth contact is on heel of drive side and high, and on toe of coast and high.

Increase by adding or exchanging shims between the pinion gear and pinion rear bearing inner race to secure .002″ to .003″ greater total thickness. Shims are available in thicknesses of .004″, .005″, .006″, .007″ and .010″. Always measure shims being used to determine exact size.

CORRECTION FOR PINION ADJUSTMENT TOO CLOSE TO CENTERLINE OF RING GEAR

If there is too much shim thickness back of pinion rear bearing inner race, contact between gear teeth will be similar to that shown in Fig. 4-32. Note that tooth contact is low on toe of drive side and low on heel of coast side. To remedy this condition follow the procedure for CORRECTION FOR PINION ADJUSTMENT TOO FAR AWAY FROM CENTERLINE OF RING GEAR, except that shim thickness should be reduced .002″ to .003″ at a time to obtain correct pattern.

DIFFERENTIAL ASSEMBLY—OVERHAUL

DIFFERENTIAL CARRIER ASSEMBLY—DISASSEMBLE

1. Remove differential assembly and clean exterior of assembly.

2. Clean interior of differential.

3. Perform a good pre-repair investigation:

a. Check and adjust side bearing preload.

b. Check and adjust ring gear and pinion backlash.

4. Make good red lead test observing tooth contact pattern.

5. With differential assembly positioned in holding fixture J-6571, mark pedestal caps and side bearing adjusting nuts with punch, or other suitable tool, to distinguish right from left so they can be replaced on correct sides (Fig. 4-35).

6. Remove side bearing adjusting nut retainers.

7. Loosen pedestal cap bolts and back off on left adjusting nut to relieve side bearing preload.

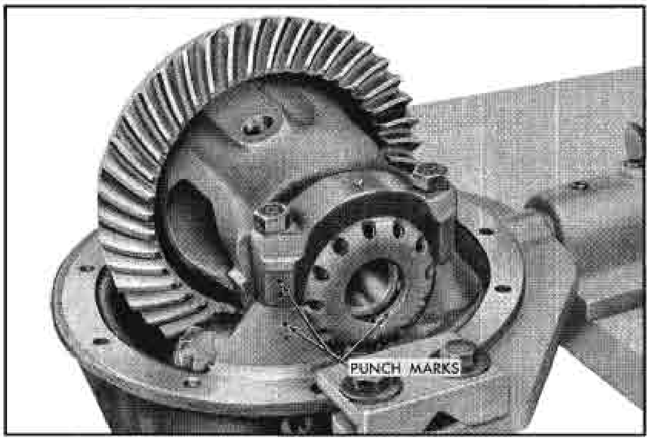


Fig. 4-35 Bearing Cap and Adjusting Nut Marked for Side Location

8. Remove four pedestal cap bolts, pedestal caps and side bearing adjusting nuts.

9. Remove differential case and ring gear assembly.

CAUTION: Keep side bearing outer races with mated side bearings so these mating parts can be correctly replaced if, after inspection they are found to be in good condition.

10. Before removing pinion gear from carrier, oil pinion bearings with engine oil and turn pinion several revolutions, (Fig. 4-36). If pinion turns smoothly, a visual inspection of the pinion bearings, after pinion has been removed, will be sufficient.

NOTE: If roughness is detected when turning pinion, pinion bearings and outer races should be carefully inspected, after pinion is removed, to determine whether a change is necessary.

11. Rotate carrier holding fixture J-6571 and remove drive pinion nut and washer, using heavy duty socket and companion flange holding tool J-6289 (Fig. 4-37).

12. Remove companion flange, using puller J-6295 and holding tool J-6289 (Fig. 4-38).

13. Carefully remove pinion from carrier so as not to injure threads.

NOTE: If pinion stem does not slide freely from front bearing, temporarily reinstall pinion nut and lightly tap pinion out of bearing with a soft-faced hammer. If necessary, use an arbor press to press pinion through bearing. (Use washer and nut on pinion stem to prevent pinion from dropping.)

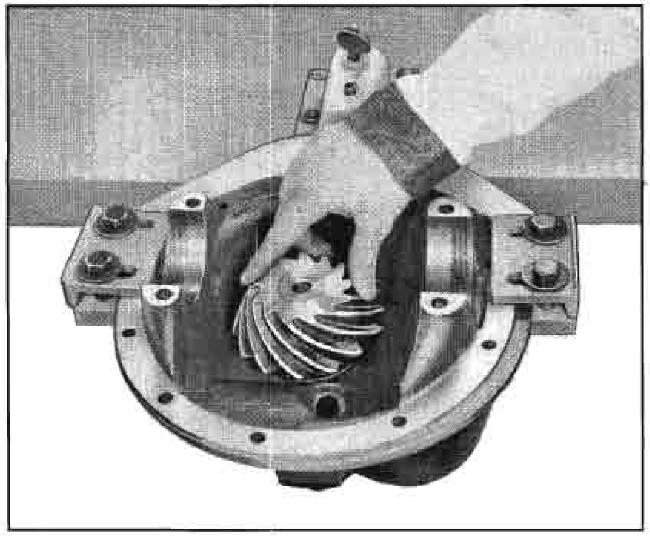


Fig. 4-36 Checking Pinion Rear Bearing for Roughness

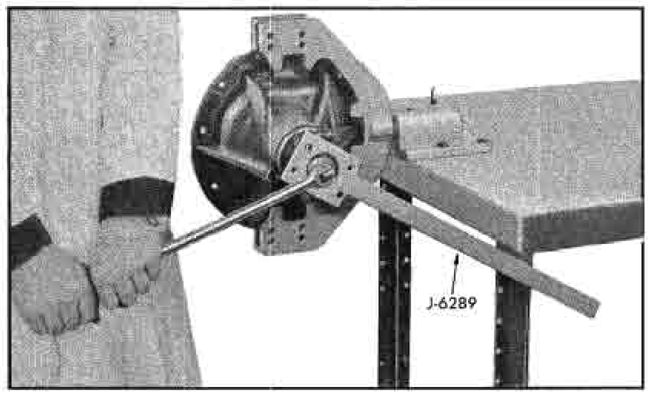


Fig. 4-37 Holding Companion Flange with J-6289

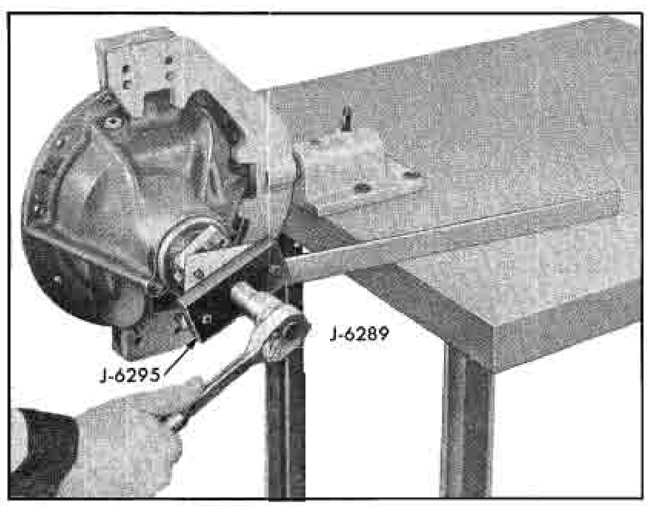


Fig. 4-38 Removing Companion Flange with Puller J-6295

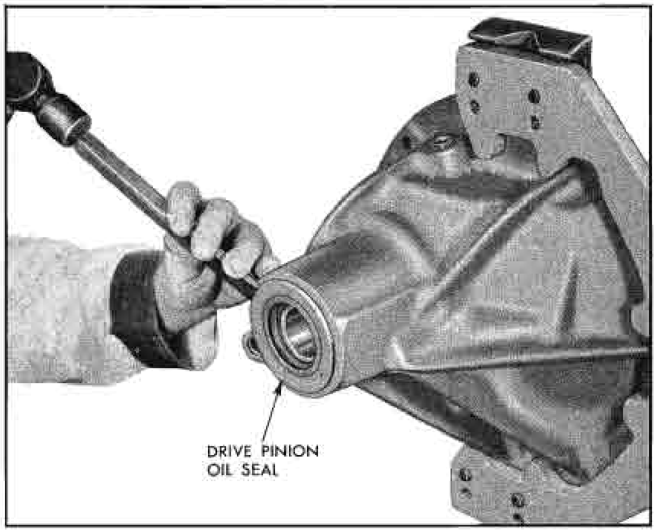


Fig. 4-39 Removing Pinion Oil Seal

14. Remove spacer and spacer washer, if washer was installed.

15. Using chisel or other suitable tool, remove pinion oil seal from bore in carrier (Fig. 4-39).

NOTE: Always install new seal when assembling differential.

16. Lift front bearing inner race and roller assembly from carrier.

17. Wash front bearing inner race in cleaning fluid and examine for damaged rollers or pitted inner race.

18. Clean front bearing outer race in carrier and examine for failure.

19. Place inner race in outer race and turn while pressing.

20. If excessive wear is noted and bearing is to be replaced, remove carrier from holding fixture and place on supporting plate in arbor press.

21. Using remover J-6198 and drive handle J-8092, press outer race from carrier (Fig. 4-40).

22. Without removing rear bearing from pinion shaft, wash inner race and roller assembly in cleaning fluid and examine for damaged rollers.

23. Clean rear bearing outer race and examine visually for failure.

24. Position drive pinion, with rear bearing assembly installed, in rear bearing outer race in carrier and rotate pinion while exerting pressure on bearing (Fig. 4-36).

NOTE: If bearing turns smoothly and has no visual defects, do not remove outer race from carrier unless carrier is to be replaced.

25. To remove pinion rear bearing from pinion stem, place bearing remover J-6555 and press plate holder J-6407, less insert, between bearing and pinion gear (Fig. 4-41).

NOTE: Flanged sides of bearing remover J-6555 should be adjusted to grip rear side of bearing.

26. Using arbor press, press rear bearing from pinion stem.

27. Remove adjusting shims from pinion.

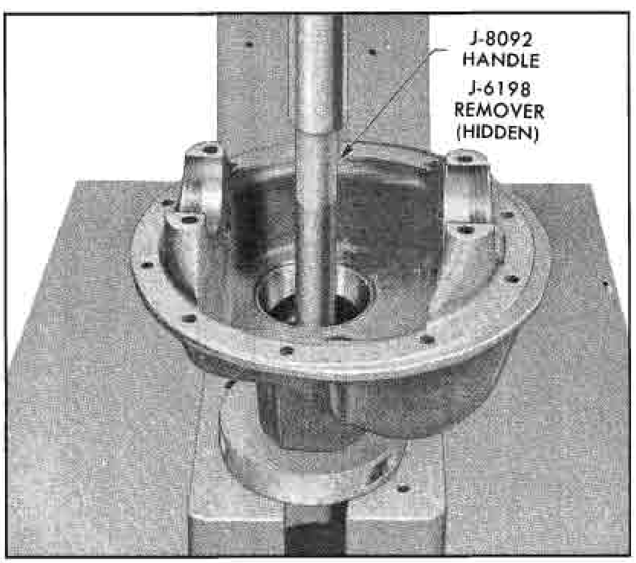


Fig. 4-40 Removing Front Pinion Bearing Outer Race with J-6198 and Drive Handle J-8092

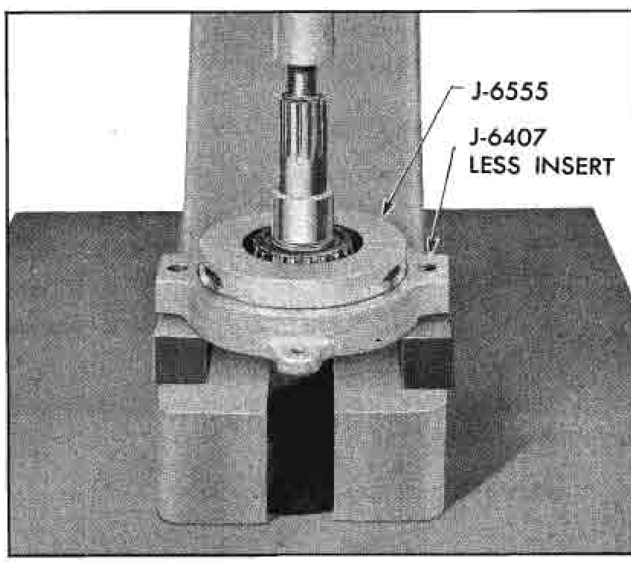


Fig. 4-41 Removing Rear Bearing with J-6555 and Press Plate J-6407 Less Insert

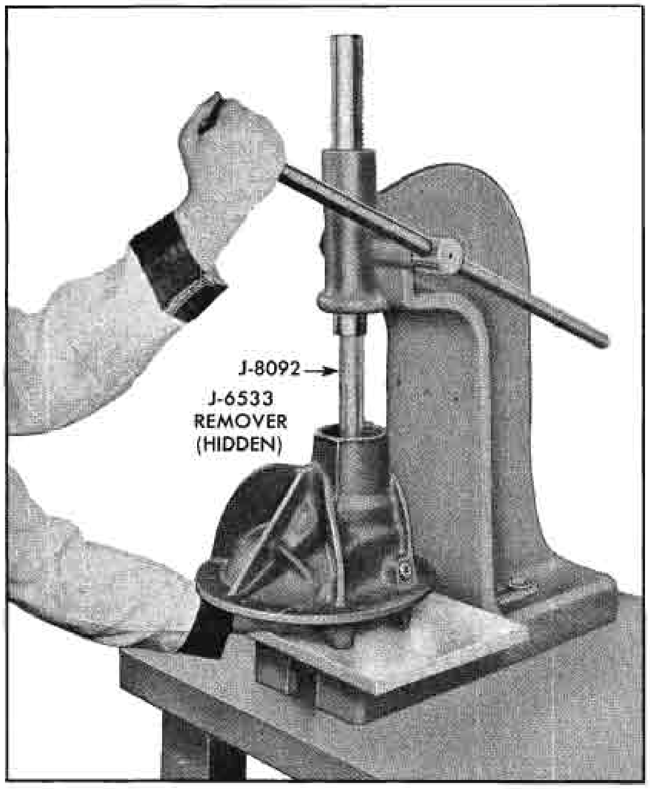


Fig. 4-42 Removing Rear Bearing Outer Race with J-6533 and J-8092

28. If, during visual inspection, it was determined to replace rear pinion bearing, press rear bearing outer race from carrier, using remover J-6533 and drive handle J-8092 (Fig. 4-42).

NOTE: Both front bearing and outer race and rear bearing and outer race are mated parts. If either bearing is to be replaced, its mating outer race must also be replaced.

CLEANING AND INSPECTION

1. Check drive pinion stem and gear for excessive wear.

NOTE: Ring gears and pinions are matched in sets at the factory and are serviced only in sets. Never attempt to replace either a ring gear or pinion without its mating member.

2. Thoroughly clean and inspect carrier for cracks or other damage.

3. Ensure that oil passages in carrier are clean and clear.

4. Inspect threads in pedestals and caps to ensure that differential bearing adjusting nuts will turn freely.

5. Carefully inspect pinion bore and shoulders against which pinion bearing outer races seat to ensure they are free of burrs, nicks, or material which would prevent proper seating of bearing outer races.

NOTE: If carrier is being replaced, thoroughly clean and inspect new carrier, paying particular attention to machined surfaces in bearing caps and pedestals. Be sure all metal filings and foreign material are removed in the pedestal cap screw holes in the carrier. Ensure that caps seat squarely on pedestals; use mill file lightly to remove nicks and burrs.

DIFFERENTIAL CARRIER ASSEMBLY–ASSEMBLE

1. If front and rear bearing outer races were removed for replacement, lubricate cavity for outer race of rear pinion bearing with clean engine oil.

2. Install new rear pinion outer race inside carrier, making certain race is started squarely in bore.

NOTE: If not square in bore, race may shave sides of counterbore as it is driven in resulting in an improperly seated race.

3. Using J-8092 and J-6255, drive outer race into cavity until firmly seated (Fig. 4-43).

4. Lubricate cavity for outer race of front pinion bearing and start new front bearing outer race squarely in bore.

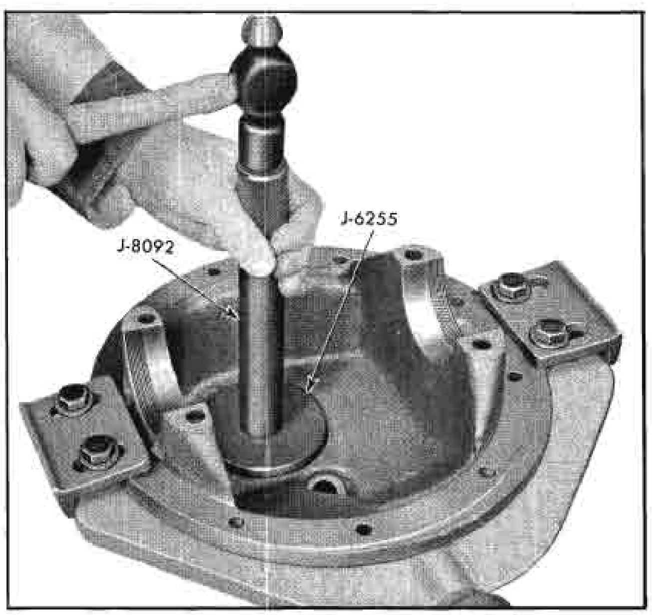
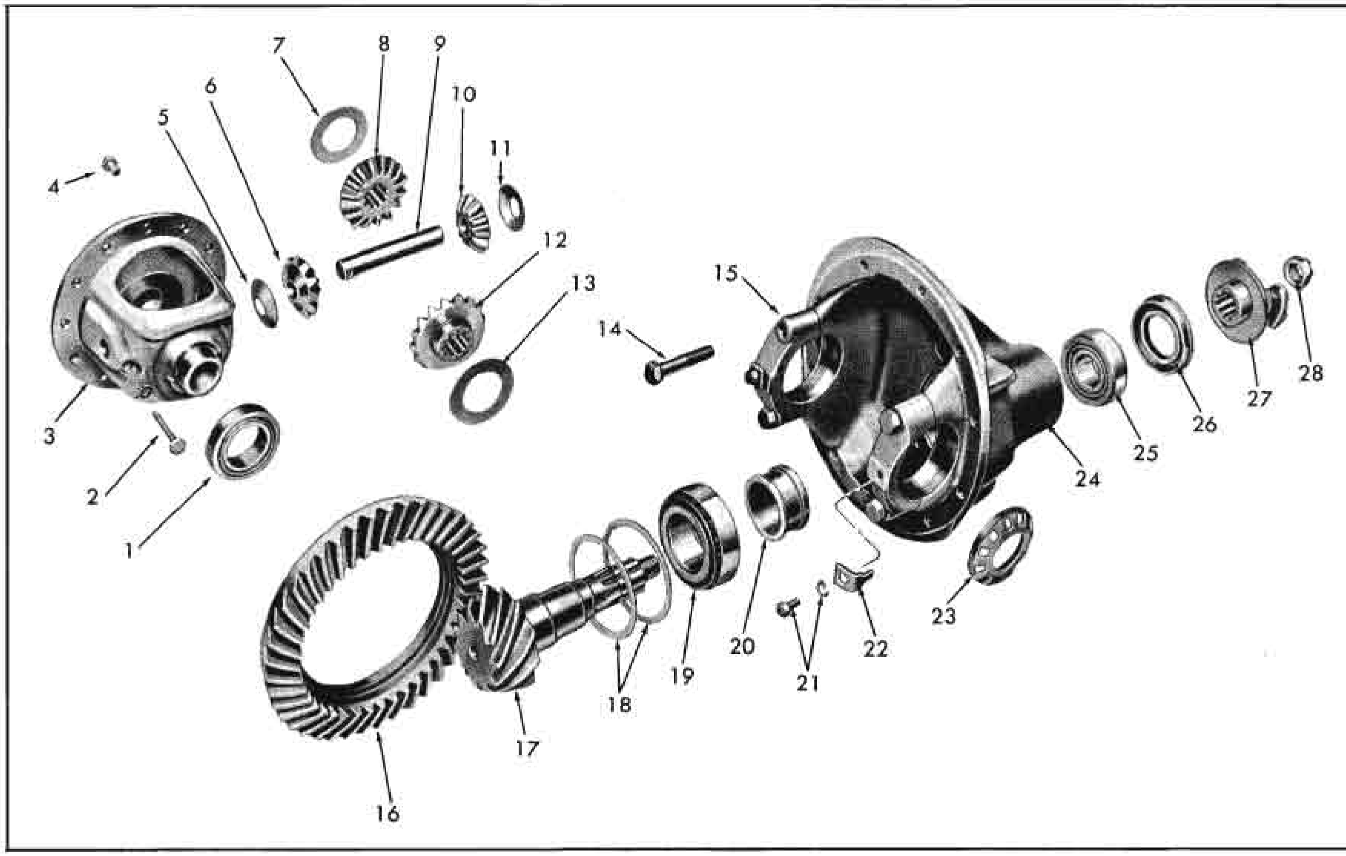


Fig. 4-43 Installing Rear Bearing Outer Race with J-6255 and J-8092



1. Differential Side Bearing
2. Pinion Shaft Lock Screw
3. Differential Case
4. Ring Gear to Case Bolt
5. Pinion Gear Thrust Washer
6. Differential Pinion Gear
7. Side Gear Thrust Washer
8. Differential Side Gear
9. Pinion Shaft
10. Differential Pinion Gear
11. Pinion Gear Thrust Washer
12. Differential Side Gear
13. Side Gear Thrust Washer
14. Cap to Carrier Bolt
15. Side Bearing Cap
16. Ring Gear
17. Pinion Gear
18. Drive Pinion Bearing Shims
19. Pinion Rear Bearing
20. Pinion Bearing Spacer
21. Lock Bolt and Washer
22. Adjusting Nut Lock
23. Side Bearing Adjusting Nut
24. Differential Carrier Assembly
25. Pinion Front Bearing
26. Pinion Oil Seal
27. Companion Flange Assembly
28. Pinion Nut (Companion Flange)

Fig. 4-44 Differential—Exploded View

5. Using J-8092 and J-6197, drive outer race of front pinion bearing until firmly seated in cavity (Fig. 4-45).

6. If old ring gear and pinion assembly is to be replaced, use shim pack removed at disassembly, placing them between pinion gear and pinion rear bearing inner race.

NOTE: If new ring gear and pinion assembly is being installed, start with shim pack thickness of .015" to .017".

7. Lubricate front and rear bearing inner race surfaces of pinion shaft with clean engine oil.

8. Place initial (or new shim pack of .015" to .017") on pinion shaft and install rear bearing on pinion stem with wide side of bearing toward pinion gear (Fig. 4-46).

9. Using bearing installer J-6547 and press plate J-6407, press rear pinion bearing into place (Fig. 4-47).

10. Install new collapsible spacer on pinion stem.

11. Lubricate pinion stem splined end with clean engine oil.

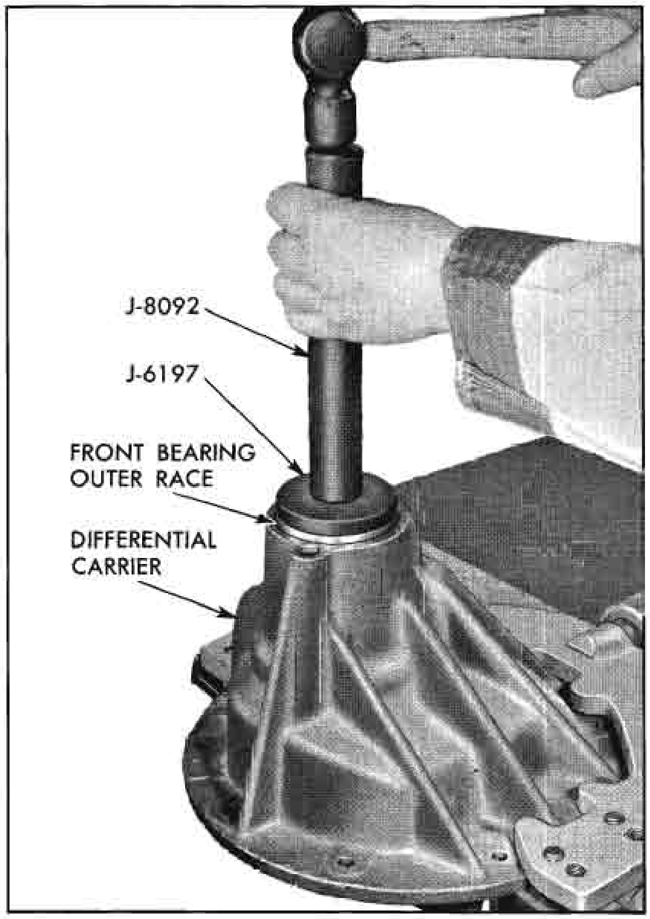


Fig. 4-45 Installing Front Bearing Outer Race with J-6197 and J-8092

12. Lubricate rear pinion bearing with differential lubricant.

13. Lubricate front pinion bearing with differential lubricant.

14. Install suitable sealer on outside diameter of new front seal.

15. With carrier positioned in holding fixture J-6571, insert pinion gear assembly, holding pinion gear to prevent its falling out.

16. Place front pinion bearing into position in carrier, using hand pressure.

17. Install new front seal using J-5395-A (Fig. 4-48).

18. Lubricate outer surface of companion flange with engine oil and tap in position far enough to permit installation of washer and lock nut.

19. Install companion flange lock nut washer and lock nut.

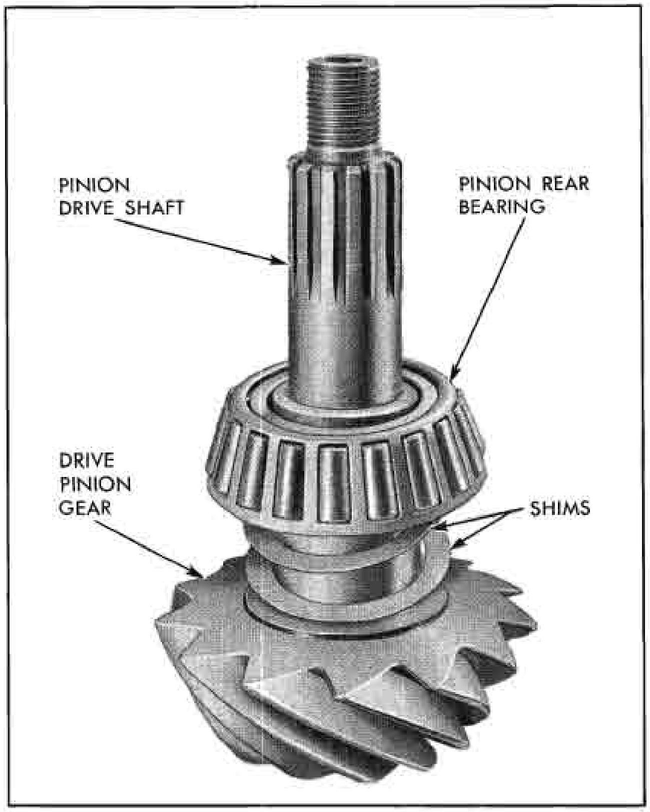


Fig. 4-46 Location of Pinion Shims

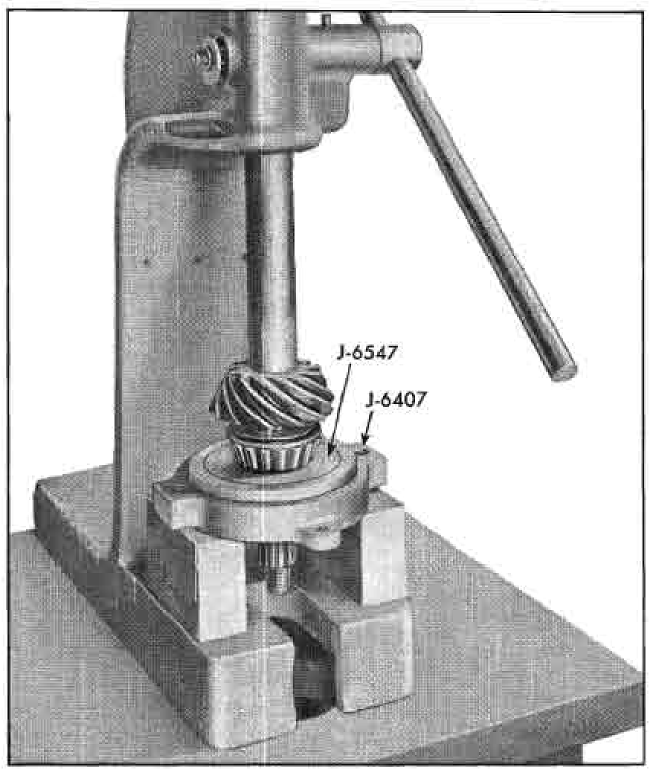


Fig. 4-47 Installing Rear Bearing with J-6547 and J-6407

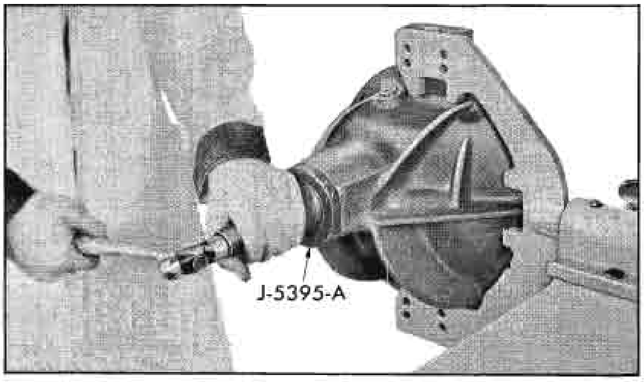


Fig. 4-48 Installing Pinion Oil Seal

20. Using companion flange holding tool J-6289, tighten the nut a little at a time (Fig. 4-49), stopping frequently to turn the pinion several revolutions to seat rollers and to check turning effort with pound-inch torque wrench KMO-652. Repeat until torque required to keep turning is as follows:

NOTE: Torque measurement may be taken using steering gear adjusting spring scale J-544-A hooked to holding tool J-6289 at a point 10 inches from pinion shaft center (Fig. 4-50). Reading in pounds times 10 inches will give pound-inches; thus three pounds on spring scale will indicate thirty pound-inches. Readings between pound graduations must be read in tenths rather than in ounces, for example, 3 pounds 8 ounces is read 3.5 pounds or 35 pound-inches.

TORQUE	CONDITION
10-12 lb. in.	Old bearings and old pinion oil seal. (2000 miles or more).
12-15 lb. in.	Old bearings and new pinion oil seal.

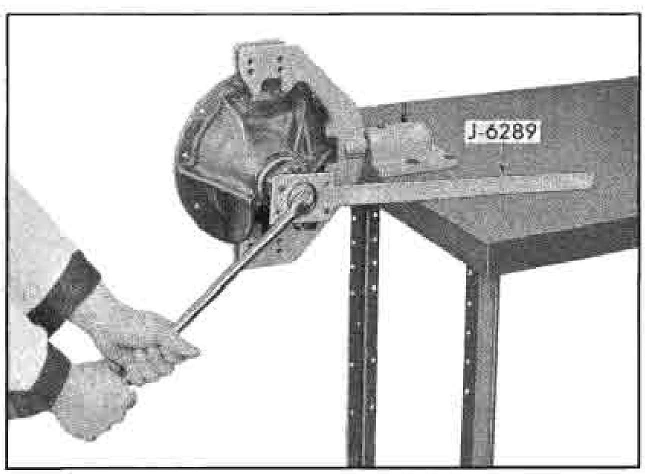


Fig. 4-49 Tightening Drive Pinion Nut

TORQUE	CONDITION
22-26 lb. in.	New bearings and old pinion oil seal.
24-32 lb. in.	New bearings and new pinion oil seal.

If torque required to keep pinion turning exceeds maximum of above specifications, it will be necessary to install a new bearing spacer.

CAUTION: Extreme care must be used in tightening pinion nut to preload the bearings correctly. Incorrect preload may result in bearing failure. Never back off nut to reduce preload—replace spacer.

STANDARD DIFFERENTIAL CASE ASSEMBLY—OVERHAUL

STANDARD DIFFERENTIAL CASE ASSEMBLY–DISASSEMBLE

1. Before disassembling differential case, inspect differential side bearings for visible damage of rollers and outer races.

2. Place one outer race onto its mated inner race and roller assembly and turn slowly, applying hand load.

3. If bearing outer race turns smoothly and no visible damage is found, bearing can probably be reused.

4. Repeat above operation with other outer race and mated bearing and check for smoothness.

NOTE: Both side bearings and their races are mated parts. If either bearing is to be replaced, its mating outer race must also be replaced.

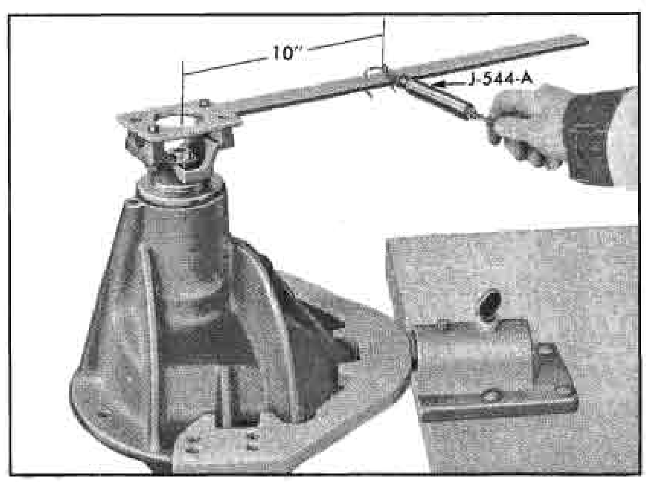


Fig. 4-50 Checking Pinion Bearing Preload with J-544-A

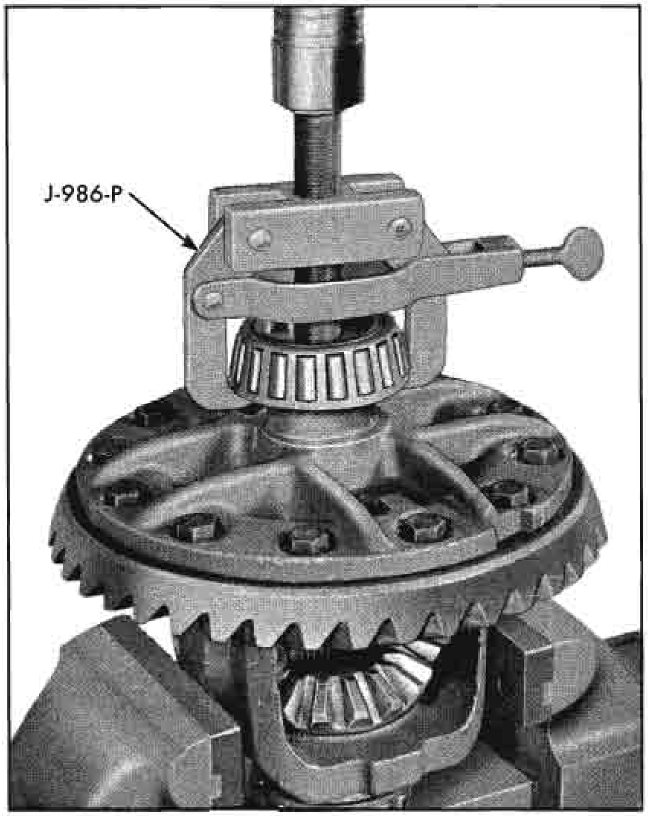


Fig. 4-51 Removing Differential Case Side Bearing with J-986-P

5. Inspect fit of inner races on case hubs by prying against shoulders at puller recesses. Bearing inner races must be tight on case hubs.

NOTE: If either bearing is loose on case, the entire case must be replaced.

6. If bearing inspection indicates that bearings should be replaced, insert differential case in vise and, using side bearing puller J-986-P, remove side bearing (Fig. 4-51).

CAUTION: Make certain ends of puller arms are firmly seated in recesses in sides of hubs and fully against inner race of bearing.

7. Turn differential case in vise and remove other side bearing in same manner.

8. Remove pinion shaft lock screw and washer.

9. Drive pinion shaft out of case, using brass drift (Fig. 4-52).

10. Remove differential pinion gears, thrust washers and side gears.

11. Clamp case in vise so jaws are 90° to pinion shaft holes (Fig. 4-53), and remove twelve ring gear retaining screws and remove ring gear.

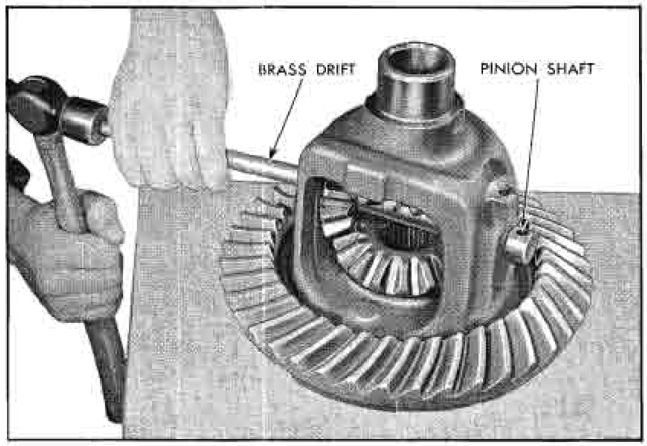


Fig. 4-52 Removing Differential Case Pinion Shaft

CLEANING AND INSPECTION

1. Thoroughly clean differential case and inspect, paying particular attention to ring gear mounting flange, ring gear pilot, and side bearing hubs.

2. Remove nicks and burrs with mill file (Fig. 4-54).

NOTE: If new case is to be used, thoroughly clean new case in suitable solvent, making certain bolt holes and bolts are clean of steel filings and foreign material.

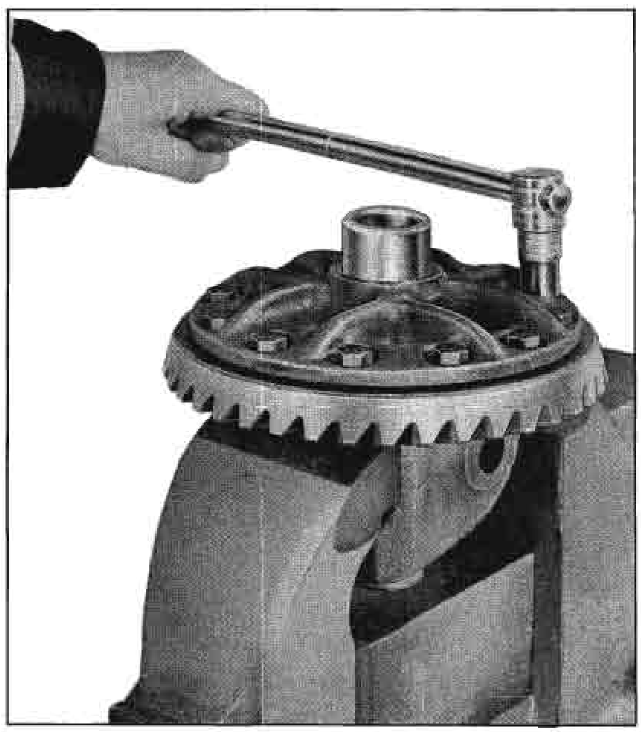


Fig. 4-53 Removing Ring Gear From Case

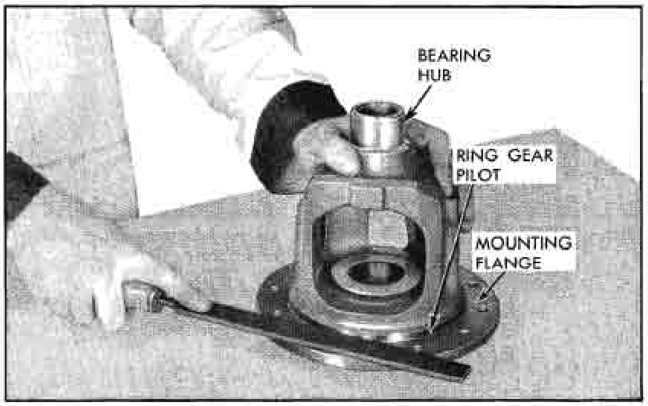


Fig. 4-54 Removing Burrs and Nicks From Mounting Flange

3. Clean side gears, pinion gears and thrust washers with suitable solvent and inspect for excessive wear.

4. Check fit of side gears in counterbores of case. If excessive radial looseness (.006" or more) is evident, it will be necessary to replace side gears or case.

5. Thoroughly clean ring gear and inspect back side for any adhering material which may effect runout.

6. Position ring gear on case and check fit of gear on flange and pilot.

CAUTION: Do not use hammer to force ring gear on case.

7. Replace parts as necessary and coat with clean engine oil before installing in case.

STANDARD DIFFERENTIAL CASE ASSEMBLY–ASSEMBLE

1. Make certain burrs and high spots are removed from differential case and ring gear pilot. Wipe or blow filings from surface.

2. Position ring gear on case and check fit of gear on flange and pilot.

CAUTION: Do not use hammer to force ring gear on case.

3. Install ring gear attaching bolts (Fig. 4-55). Tighten all bolts evenly and alternately to 55-60 lb. ft. torque.

NOTE: Tighten bolts finger tight, then tighten evenly and alternately across the diameter in progressive stages of tightness until final torque is reached.

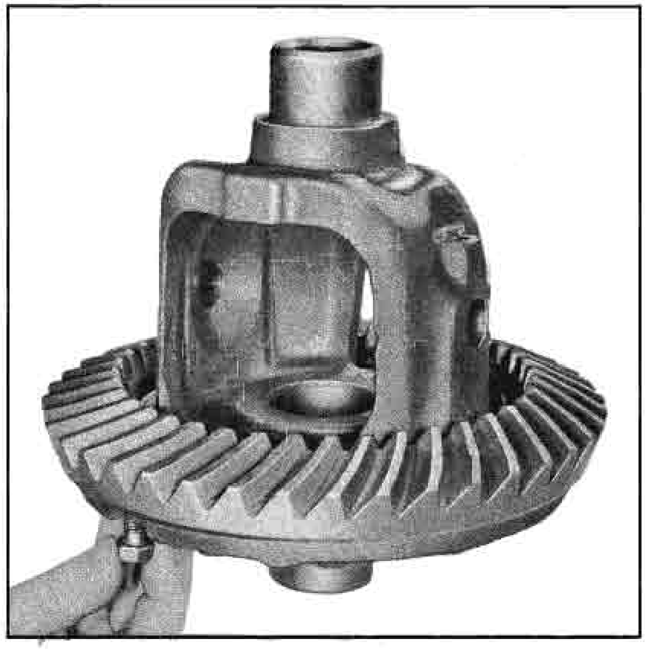


Fig. 4-55 Installing Ring Gear

4. Remove differential case from vise and lubricate outer bearing surfaces.

5. Using J-5292, press on left side bearing with arbor press.

6. Reverse differential case and press on right side bearing, using J-5292, (Fig. 4-56).

7. Install pinion shaft lock screw and lock washer finger tight.

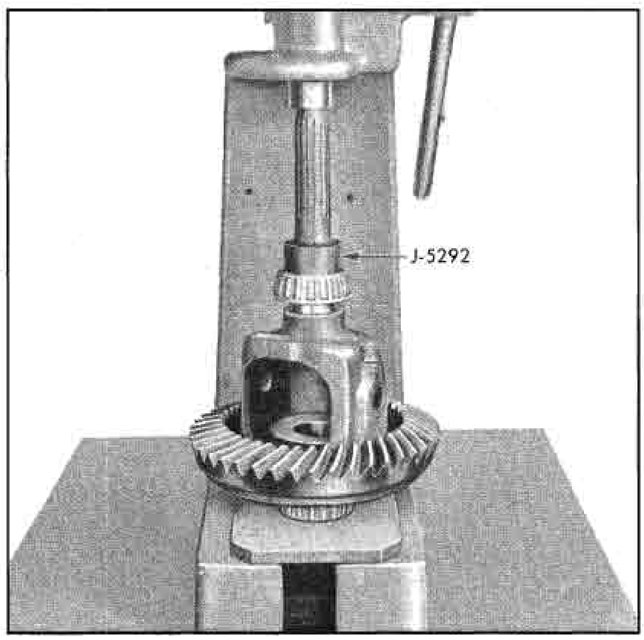


Fig. 4-56 Installing Side Bearings with J-5292

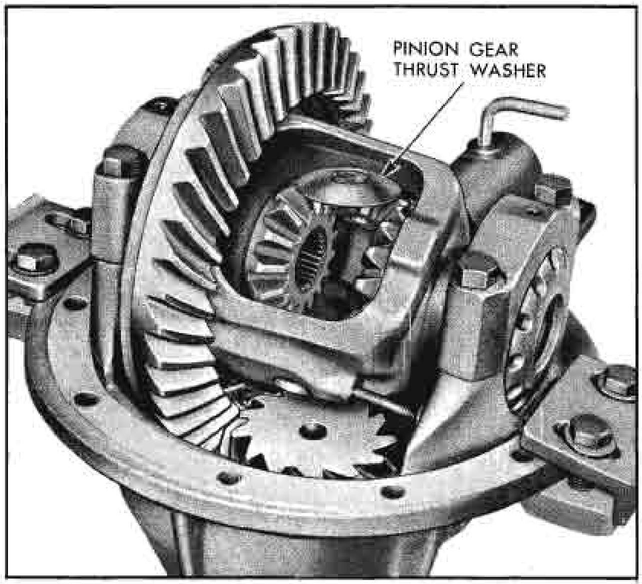


Fig. 4-57 Placing Pinion Gear Thrust Washer in Position

8. Lubricate side bearing crossbore of carrier with clean engine oil.

9. Install differential case in differential carrier.

10. Lubricate inner and outer surfaces of side bearing races and install over bearings. Be sure that parts are properly mated.

11. Lubricate machined area of side bearing adjusting nuts and position them in threaded portion at ends of differential carrier, making certain threads are lined up.

NOTE: Make certain adjusting nuts are installed in their respective positions as indicated by markings made before disassembly.

12. Before installing pedestal caps, adjust side bearing adjusting nuts until backlash between ring gear and pinion is nearly zero.

13. Lubricate inner surface of left pedestal cap and install on differential carrier.

NOTE: Check markings made at disassembly, making certain pedestal caps are installed in their proper place.

14. Install two cap bolts and tighten until snug.

15. Lubricate inner surface of right pedestal cap and install on differential carrier. Insert two cap bolts and tighten until snug.

16. Lubricate hub, inner bore and outer face of left differential side gear and install in differential case.

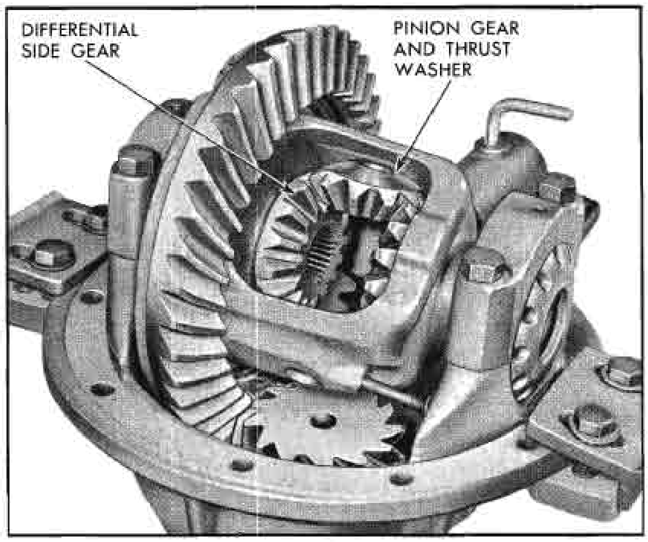


Fig. 4-58 Installing Pinion Gear Thrust Washer

17. Lubricate hub, inner bore and outer face of right differential side gear and install in differential case.

18. Lubricate outer side and inner bore of both differential pinion gears.

19. Install one pinion gear and rotate side gears until pinion gear is positioned on far side of case.

20. Install second pinion gear directly opposite first pinion gear, making certain they line up.

21. Lubricate both sides of pinion gear thrust washers and rotate side gears so that one pinion gear is positioned to receive washer, and install **(Fig. 4-57)**.

22. Position second pinion gear to receive washer by rotating side gears in opposite direction and insert second washer **(Fig. 4-58)**.

23. Loosen pinion shaft lock screw.

24. Lubricate and install differential pinion shaft, lining up hole in shaft with lock screw (Fig. 4-59). Tighten pinion shaft lock screw to 10-20 ft. lbs. torque.

25. Adjust side bearing preload as follows:

a. Tighten right adjusting nut, backing off left nut if necessary, to bring adjusting nuts in full contact with outer races and to provide a slight amount of backlash. (When turning nuts keep nuts in contact with races to maintain a slight amount of preload on side bearings.)

b. Tighten left nut, backing off on right nut, if necessary, but keeping nuts against races to main-

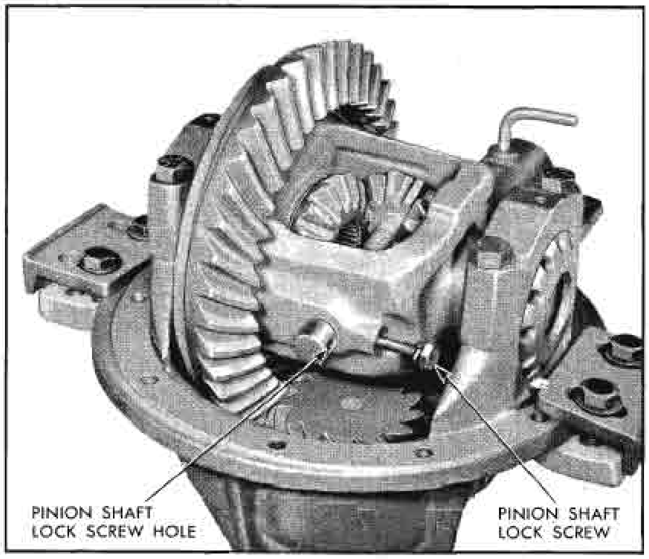


Fig. 4-59 Installing Pinion Shaft

tain preload while rocking case until backlash has just been eliminated. If left nut is not in a locking position when backlash has been eliminated, back off to nearest locking position.

c. Back off right nut to ensure that nut and outer race do not turn together. Retighten right nut until outer race just starts to turn with nut; mark this point on adjusting nut.

d. Tighten right nut one notch, tap each bearing cap, and rock ring gear for backlash check.

e. Repeat above step until right nut has been tightened a total of two to three notches to properly spot bearing and correctly preload bearings.

26. Position indicator KMO-30 at side of ring gear and check ring gear run-out. Run-out should not exceed .002" (Fig. 4-60).

27. Using indicator KMO-30, check variance of ring gear backlash. Backlash should not exceed .005"-.009" (Fig. 4-61).

NOTE: After taking one reading, indicator should be placed 180° around ring gear for second reading to determine variance of backlash. Variation should not exceed .002".

28. Torque four pedestal cap to differential carrier bolts 65-85 ft. lbs.

29. Tap heads of bolts firmly to properly seat pedestal caps.

30. Perform red lead test and obtain proper tooth pattern.

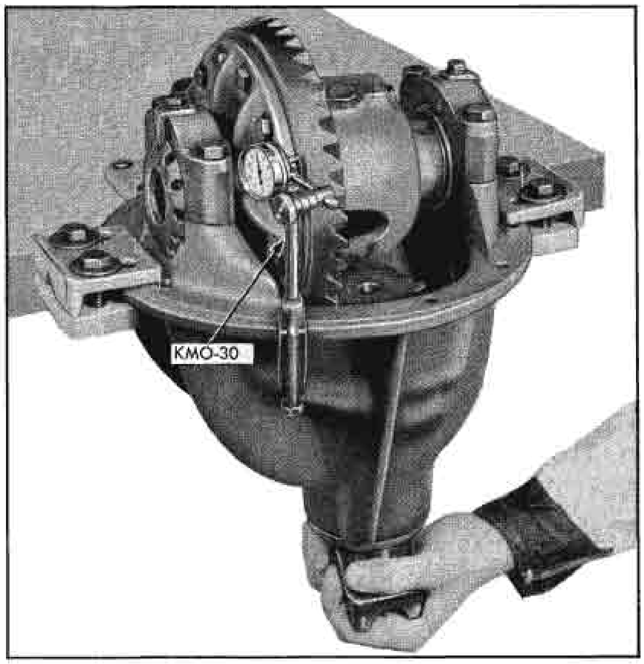


Fig. 4-60 Checking Ring Gear Run-out with KMO-30 Set

31. Install side adjusting nut retainers and tighten retainer screws to 10-20 lb. ft. torque.

SAFE-T-TRACK CASE ASSEMBLY—OVERHAUL

SAFE-T-TRACK DIFFERENTIAL CASE ASSEMBLY—DISASSEMBLE

1. If not previously done, mark right and left bearing caps and adjusting nuts; remove adjusting nut locks.

2. Loosen bearing cap bolts and back off on left adjusting nut to relieve side bearing preload.

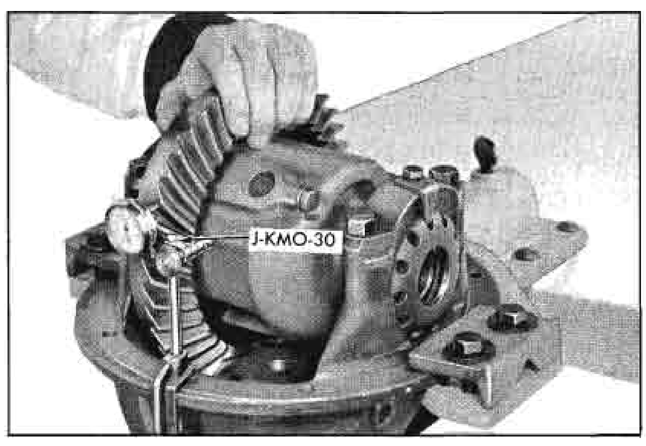


Fig. 4-61 Checking Backlash with KMO-30 Set

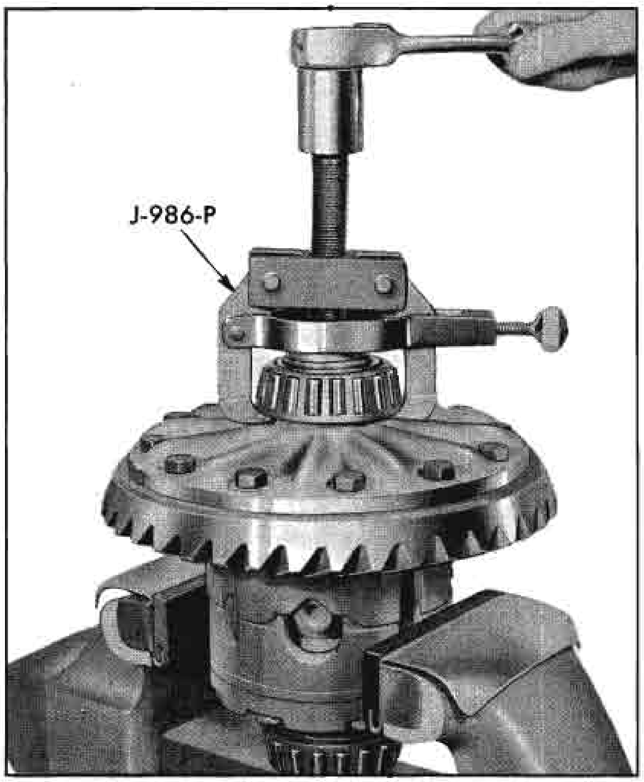


Fig. 4-62 Removing Side Bearings Using J-986-P

3. Remove bearing caps and adjusting nuts; remove case and ring gear assembly.

NOTE: Keep side bearing outer races with side bearings so these mating parts can be correctly replaced during build-up.

1. Before disassembling differential case, inspect differential side bearings for visible damage of rollers and outer races.

2. Place one outer race onto its mated inner race and roller assembly and turn slowly, applying hand load.

3. If bearing outer race turns smoothly and no visible damage is found, bearing can probably be reused.

4. Repeat above operation with other outer race and mated bearing and check for smoothness.

NOTE: Both side bearings and their outer races are mated parts. If either bearing is to be replaced, its mating outer race must also be replaced.

5. Inspect fit of inner races on case hubs by prying against shoulders at puller recesses. Bearing inner races must be tight on case hubs.

NOTE: If either bearing is loose on case, the entire case must be replaced.

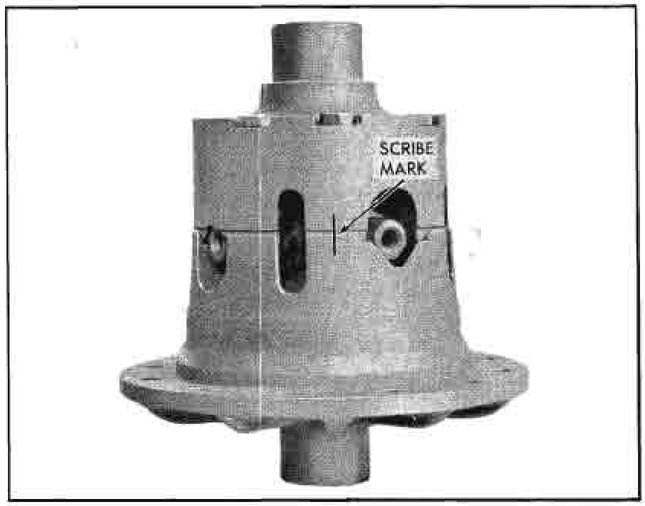


Fig. 4-63 Alignment Marks on Differential Case Halves

6. If bearing inspection indicates that bearings should be replaced, insert differential case in vise and, using side bearing puller J-986-P, remove side bearing (Fig. 4-62).

CAUTION: Make certain ends of puller arms are firmly seated in recesses in sides of hubs and fully against inner race of bearing.

7. Turn differential case in vise and remove other side bearing in same manner.

8. Remove ring gear.

9. Scribe mark differential case halves (Fig. 4-63) to aid in alignment of case when assembling.

10. Remove eight differential case button half attaching bolts.

11. Separate the case halves and remove the pinion mate cross shafts, bevel pinion mate gears, bevel side gears, side gear rings, clutch friction plates, and clutch friction discs.

NOTE: Care should be taken to note how the friction plates and friction discs are assembled (See Fig. 4-64). The exact location and orientation of the Belleville Spring Plate used on each side should be noted here. Each pinion cross shaft should also be marked or scribed so that each pin cam surface will match with the same "V" ramp in the case when reassembling.

CLEANING AND INSPECTION

1. Thoroughly clean differential case and inspect, paying particular attention to ring gear mounting flange, ring gear pilot, and side bearing hubs.

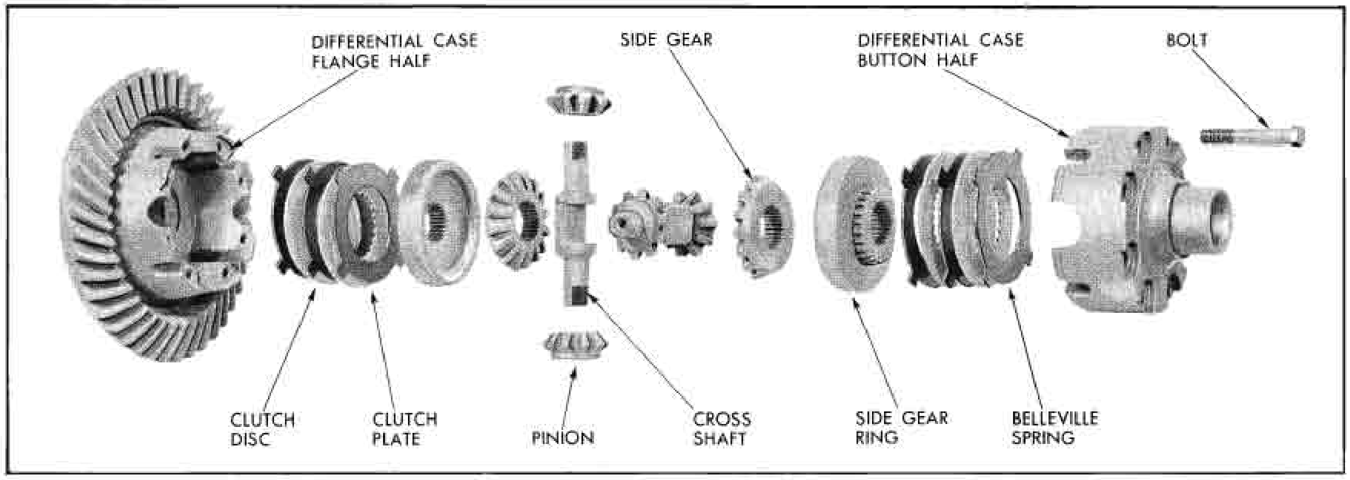


Fig. 4-64 Safe-T-Track Differential—Exploded View

2. Remove nicks and burrs from ring gear flange with mill file (Fig. 4-65).

NOTE: If a new case half is to be used, thoroughly clean new case in suitable solvent, making certain bolt holes and bolts are clean of steel filings.

3. Clean side gears, side gear rings, pinion gears, pinion shafts and clutch discs and plates with suitable solvent and inspect for excessive wear.

4. Inspect clutch discs, plates and Belleville spring for worn surfaces, cracked, or distorted condition.

5. Inspect side gear rings and differential case half for excessive wear at the Belleville contact surface. Replace worn or damaged parts.

NOTE: In the event that one or more of the clutch friction plates, discs or spring plates need replacing, it is suggested that the entire stack of plates, discs and spring plates on each side be replaced.

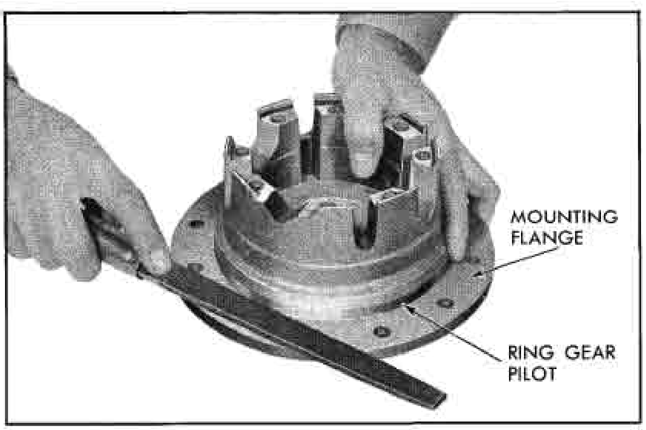


Fig. 4-65 Removing Nicks and Burrs from Mounting Flange

6. Thoroughly clean ring gear and inspect back side for any adhering material which may effect run-out.

7. Position ring gear on case and check fit of gear on flange and pilot.

CAUTION: Do not use hammer to force ring gear on case.

8. Replace parts as necessary and coat with clean engine oil before installing in case.

SAFE-T-TRACK DIFFERENTIAL CASE ASSEMBLY—ASSEMBLE

NOTE: It is important that all clean parts be placed on clean paper or cloth to prevent the possibility of dirt being assembled into the unit.

As each part is reassembled in its proper position, it is necessary that it be lightly coated with the correct lubricant.

1. Hold differential case flange half on its side and install Belleville spring clutch discs and plates as shown in Fig. 4-66.

NOTE: Install Belleville spring first with convex side toward case and (so that the I.D. of the spring is in contact with case) then a clutch disc, clutch plate, disc and plate in this order as shown in Fig. 4-64.

2. Install side gear ring making sure it has a slight drag when rotating.

3. Install side gear in side gear ring and one cross shaft and pinions making sure recess in center of shaft is up.

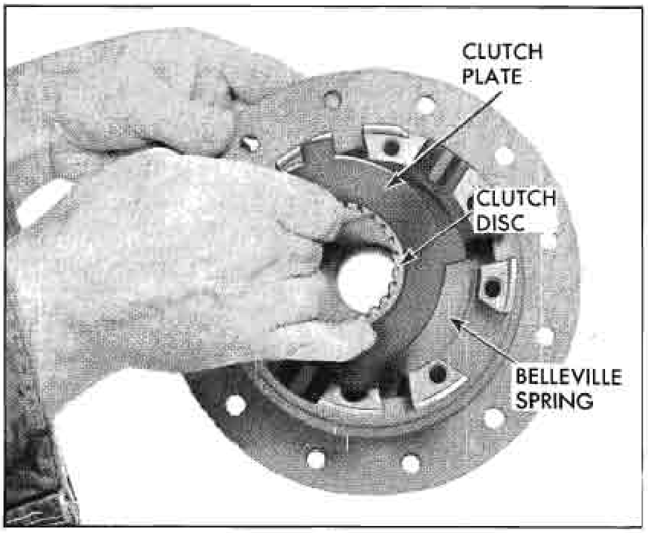


Fig. 4-66 Installing Belleville Spring, Clutch Discs and Plates

4. Then install remaining cross shaft, pinions bevel gear, side gear (splined end up) then stack plates, discs, and Belleville spring over splines of side gear.

5. Assemble differential case flange and button halves as shown in Fig. 4-67, making sure scribe marks are in alignment.

6. Install the case bolts loosely.

7. Use the axle shafts from the vehicle and align the splines of the side gear with the side gear ring. (See Fig. 4-68.)

8. With these axle shafts in position, tighten the differential case bolts evenly, and alternately to 40 lb. ft. torque (Fig. 4-69). Remove the axle shafts.

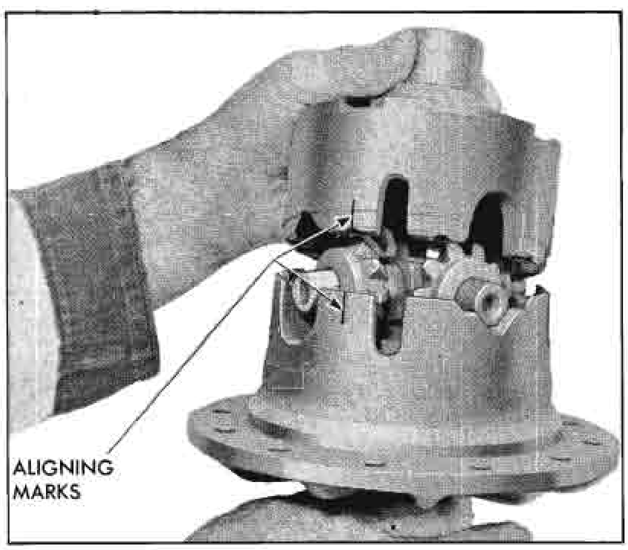


Fig. 4-67 Assembly of Differential Case Halves

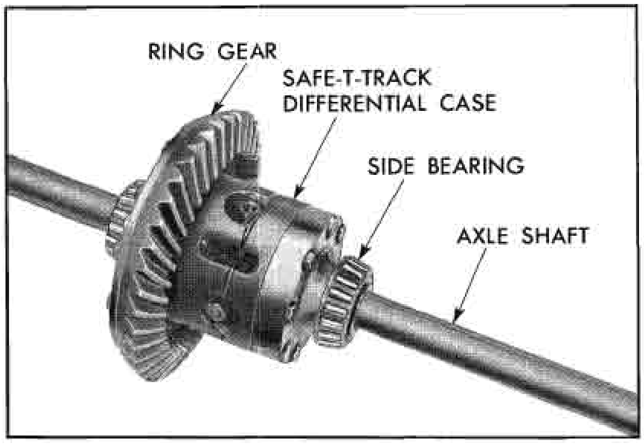


Fig. 4-68 Aligning Differential Case Parts

NOTE: A visual check can be made here to determine whether or not the Safe-T-Track components have been assembled properly. Each pinion mate cross shaft can be tight on its ramp or in the event there is clearance between the cross shaft and the ramp it should be only .002".

9. If side bearings were removed, lubricate outer bearing surfaces and, using J-5292, press on bearings with arbor press.

10. Position ring gear on flange half and install ring gear attaching bolts, tightening alternately and evenly to 55-60 lb. ft. torque.

DIFFERENTIAL CASE ASSEMBLY—INSTALL IN CARRIER

1. Lubricate side bearing crossbore of carrier with clean engine oil.

2. Install differential case in differential carrier.

3. Lubricate inner and outer surfaces of side bearing races and install over bearings. Be sure that parts are properly mated.

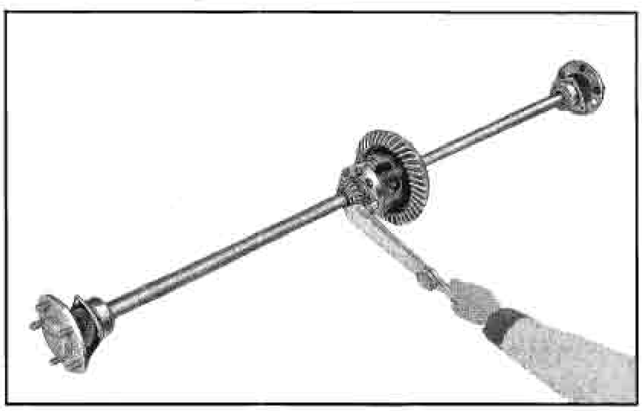


Fig. 4-69 Torquing Differential Case Half Bolts

4. Lubricate machined area of side bearing adjusting nuts and position them in threaded portion at ends of differential carrier, making certain threads are lined up.

NOTE: Make certain adjusting nuts are installed in their respective positions as indicated by markings made before disassembly.

5. Lubricate inner surface of left pedestal cap and install loosely on differential carrier.

6. Adjust side bearing adjusting nuts until backlash between ring gear and pinion is nearly zero.

NOTE: Check markings made at dissembly, making certain pedestal caps are installed in their proper place.

7. Tighten two cap bolts until snug.

8. Lubricate inner surface of right pedestal cap and install on differential carrier. Insert two cap bolts and tighten until snug.

9. Adjust side bearing preload as follows:

a. Tighten right adjusting nut, backing off left nut if necessary, to bring adjusting nuts in full contact with outer races and to provide a slight amount of backlash. (When turning nuts keep nuts in contact with races to maintain a slight amount of preload on side bearings.)

b. Tighten left nut, backing off on right nut, if necessary, but keeping nuts against races to maintain preload while rocking case until backlash has just been eliminated. If left nut is not in a locking position when backlash has been eliminated, back off to nearest locking position.

c. Back off right nut to ensure that nut and outer race do not turn together. Retighten right nut until outer race just starts to turn with nut; mark this point on adjusting nut.

d. Tighten right nut one notch, tap each bearing cap, and rock ring gear for backlash check.

e. Repeat above step until right nut has been tightened a total of two to three notches to properly seat bearing and correctly preload bearings.

10. Position indicator KMO-30 at side of ring gear and check ring gear run out. Run out should not exceed .001" (Fig. 4-70).

11. Using indicator KMO-30, check variance of ring gear backlash. Backlash should not exceed .005"-.009" (Fig. 4-71).

NOTE: After taking one reading, indicator should be placed 180° around ring gear for second reading to determine variance of backlash. Variation should not exceed .002".

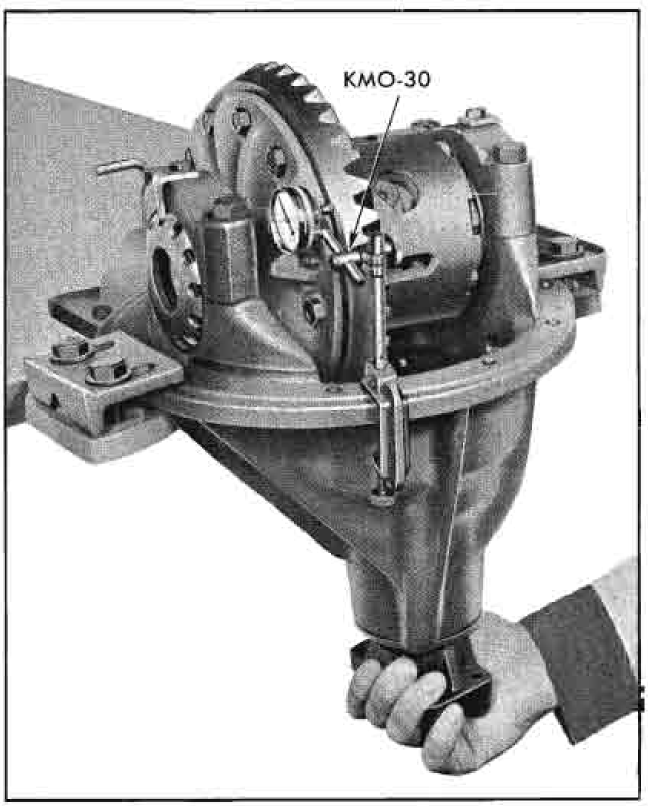


Fig. 4-70 Checking Ring Gear Run-out with KMO-30 Set

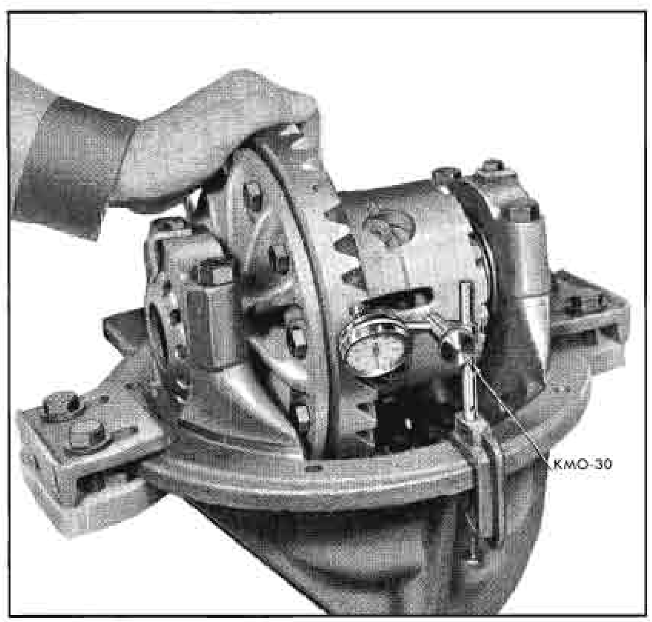


Fig. 4-71 Checking Backlash with KMO-30 Set

12. Torque four pedestal cap to differential carrier bolts 65-85 lb. ft.

13. Tap heads of bolts firmly to properly seat pedestal caps.

14. Perform red lead test and obtain proper tooth pattern.

15. Install side adjusting nut retainers and tighten retainer screws to 10-20 lb. ft. torque.

DIFFERENTIAL ASSEMBLY—INSTALL IN VEHICLE

1. Thoroughly wash interior of axle housing with cleaning fluid. Clean surface of housing contacting carrier gasket and install new gasket.

2. Install carrier over attaching bolts in housing and tighten attaching nuts evenly and alternately with 45 — 60 lb. ft. torque.

3. Install axle shafts, rear axle bearing retainers, brake drums and wheels.

4. Connect rear universal joint to companion flange, using new lock plates. Tighten nuts to 14-20 lb. ft. torque. Ensure that ears of lock plate are bent up against flat side of nuts.

5. Fill axle housing to filler plug level with recommended lubricant.

6. Road test for noise appraisal.

TROUBLE DIAGNOSIS AND TESTING

Many noises reported as coming from the differential actually result from other sources such as tires on certain road surfaces, body drumming, muffler roar, transmission rear bearing, wheel bearing, Hydra-Matic transmission rear oil pump, engine fan, intake silencer, etc. A careful check should be made to ensure that noise is in the differential before disassembling. It should be remembered that rear axle gears, like any other mechanical device, are not absolutely quiet and should be accepted as being commercially quiet unless some abnormal noise is present.

To make a systematic check for axle noise under standard conditions observe the following:

1. Select a level tarvia or asphalt road to reduce tire noise and body drumming.

2. Drive car far enough to thoroughly warm up rear axle lubricant.

3. If noise is present, note speed at which it occurs. With car standing and clutch disengaged, or Hydra-Matic in neutral, accelerate engine to approximate speed where noise was noticed to determine if it is caused by exhaust or muffler roar or other engine condition. Repeat while engaging and disengaging clutch, transmission in neutral, to see if noise is in transmission. (Transmission rear bearing noise can be isolated only by removing propeller shaft and operating transmission in "high".) See Hydra-Matic Transmission Manual for distinguishing between Hydra-Matic transmission and axle noises.

4. Distinguish between tire noise and differential noise by noting if noise varies with various speeds, sudden acceleration and deceleration; exhaust and axle noise show variations under these conditions while tire noise remains constant and is more pronounced at speeds of 20 to 30 miles per hour. Further check for tire noise by driving car over smooth pavements or dirt roads (not gravel) with tires at normal pressure. If noise is caused by tires, it will noticeably change or disappear and reappear with changes in road surface.

5. Rear suspension rubber bushings and coil spring insulators dampen out rear axle noise when correctly installed. Check to see that no metallic contact exists between the springs and spring opening in frame or between upper and lower control arm bushings and frame or axle housing brackets. Metal-to-metal contact at those points may result in "telegraphing" road noise and normal axle noise which would be objectionable if dampened by bushings.

NOTE: It is important that a check also be made to ensure that the floor of body is not in metallic contact with frame.

AXLE NOISES

GEAR NOISE

After the noise has been determined as being in the axle by following the above appraisal procedure, the type of axle noise should be determined to aid in making repairs if necessary.

Gear noise (whine), is audible from 20 to 65 mph under four driving conditions.

1. Drive—Acceleration or heavy pull.

2. Road Load—Car driving load or constant speed.

3. Float—Using enough throttle to keep the car from driving the engine—car slows down gradually but engine still pulls slightly.

4. Coast—Throttle closed and car in gear.

Gear noise most frequently has periods where noise is more prominent, usually 30 to 40 mph and 50 to 60 mph.

When objectionable axle noise is encountered, the driving condition and speed range should be noted and then differential removed for a red lead check. Shim and adjust to obtain best possible tooth pattern. If noise still persists, replace gear set.

BEARING NOISE

Bad bearings generally produce more of a rough growl or grating sound rather than the whine typical of gear noise. Bearing noise frequently "wow-wows" at bearing rpm which indicates a pinion or differential side bearing.

NOTE: This noise could easily be confused with rear wheel bearing noise. Inspect and replace as required. A preponderance of axle noise is gears rather than bearings.

BEARING FAILURE

Bearings fail by "lapping", "spalling" or "locking".

LAPPING. Lapping is caused by fine particles of abrasive material such as scale, sand or emery which are circulated by oil and which cause wearing away of roller and race surfaces. Bearings which are worn loose but remain smooth without spalling or pitting are clear evidence of dirty oil.

SPALLING. Spalling failure of bearings is caused by overload or faulty assembly. Bearings which failed by spalling have either flaked or pitted rollers or races. Faulty assembly consists of misalignment or cocking of bearings, or adjustments which are too tight.

LOCKING. Locking of bearings is caused by large particles of foreign material becoming wedged between rollers and race usually causing one of the races to turn. Preloading of taper roller bearings higher than specified can also cause locking of bearings.

KNOCK AT LOW SPEEDS

Low speed knock can be caused by worn and brinelled universal joints or a side gear hub counterbore in case worn oversize. Inspect and replace universal joint or case and side gear as required.

DRIVE-LINE SNAP

A snap on sudden start either forward or reverse may be caused by loose companion flange. Remove flange, turn 180°, apply white lead and oil to spline and reinstall. Pinion nut must be tightened to original position.

BACKLASH CLUNK

Excessive clunk with acceleration and deceleration is caused by worn differential pinion shaft, excessive clearance between axle shaft and side gear splines, excessive clearance between side gear hub and counterbore in case, worn pinion and side gear teeth, worn thrust washers and excessive drive pinion and ring gear backlash. Remove worn parts and replace as required selecting close fitting parts when possible. Adjust pinion and ring gear backlash.

DRIVE-LINE SQUEAL AND SQUEAK

Squeals and squeaks are audible only at low speeds, seldom over 20 mph. A continuous squeal is from the pinion oil seal and an intermittent squeak is caused by dry cork washer in the universal joint. Seal squeaks frequently correct themselves but replace persistent squealing seal. Universal joint cork washers should be replaced and lubricated.

SAFE-T-TRACK

ELIMINATING CHATTER

1. Drain the axle housing thoroughly of the old lubricant. It is necessary to rotate the wheels of the vehicle (by hand only) to allow the lubricant in the Safe-T-Track itself to drain.

CAUTION: DO NOT flush the unit with solvents due to the undesirable effect the solvents may have on the new lubricant. In the event an attempt is made to eliminate chatter by flushing, prior to a complete teardown, use a light engine oil as the flushing agent.

2. After the axle housing has been thoroughly drained of old lubricant, refill axle housing with the correct amount of the proper lubricant.

NOTE: In the event the above procedure is not effective after 200 miles of operation it is recommended the Safe-T-Track differential be disassembled and thoroughly cleaned as outlined below.

EXTREME CASES OF CHATTER WILL REQUIRE EXAMINATION OR REPLACEMENT OF FRICTION DISCS OR PLATES.

A SIMPLE PROCEDURE FOR TESTING SAFE-T-TRACK DIFFERENTIALS

OPERATION UNDER IMMOBILE CONDITION

When one wheel is slipping, the Safe-T-Track will automatically increase the power to the gripping wheel. This increased power, always of the same ratio, is several times that required to drive the slipping wheel. However, there may be times when the spinning wheel is on an excessively slippery surface and does not provide enough resistance to transfer sufficient power to the gripping wheel. Under these conditions, the Safe-T-Track offers an additional advantage for cars equipped with the parking brake at the rear wheels. By lightly applying the brake (usually three or four notches), enough additional resistance can be applied to the slipping wheel to greatly increase the power to the wheel with the better traction.

A light throttle application on starting is recommended to provide maximum traction by preventing "break away" of the non-slipping wheel.

TESTING FOR CORRECT OPERATION

The Safe-T-Track can be effectively tested for correct operation by placing one rear wheel on good dry pavement and the other on ice, snow, mud, gravel, grease, etc.

It can easily be determined whether or not the non-slipping wheel is providing pulling power. The procedure should then be repeated with the opposite wheels on the dry and slippery surfaces.

CAUTION: Do not attempt to test the Safe-T-Track while one wheel is on a jack. Under certain conditions, the unit could possibly cause the vehicle to jump off the jack.

Be sure the transmission is in neutral. Raise one wheel off the floor and place a block in the front and rear of the opposite wheel. Remove the hub cap and install a tool across two wheel studs if the axle shaft is the flanged type. Apply a torque wrench to special tool. Disregard breakaway torque and observe only the torque required to continuously turn the wheel smoothly.

If the torque reading is less than 40 ft. lbs., the unit should be disassembled and the necessary repairs made.

SPECIFICATIONS

REAR AXLE

Type	Semi-Floating
Type of drive	Modified Hotchkiss
Drive—Final	Hypoid Gear
Lubricant capacity	92 oz. or 5¾ pints
Lubricant	See Lubrication Section
Lubricant Level	Bottom of filler plug hole

RING AND PINION GEAR

Backlash	.005"-.009"
Ring gear run-out maximum	.002"
Ratios	See Fig. 4-7

WRENCH TORQUE SPECIFICATIONS

(All torque in lb. ft. unless otherwise specified.)

TORQUE	SIZE	APPLICATION
		Rear Axle Diff. Carrier and Axle Shafts
5-15	7/16-20	Bolt—Rear Axle Breather
65-85	½-13	Bolt—Differential Carrier Bearing Cap
*	½ PTF	Plug—Rear Axle Oil Filler
55-65	⅜-24	Bolt—Rear Axle Ring Gear to Case
10-20	5/16-18	Bolt—Differential Bearing Adj. Nut Lock
10-20	5/16-18	Screw—Differential Pinion Shaft Lock
45-60	⅜-24	Nut—Carrier to Axle Housing Bolt

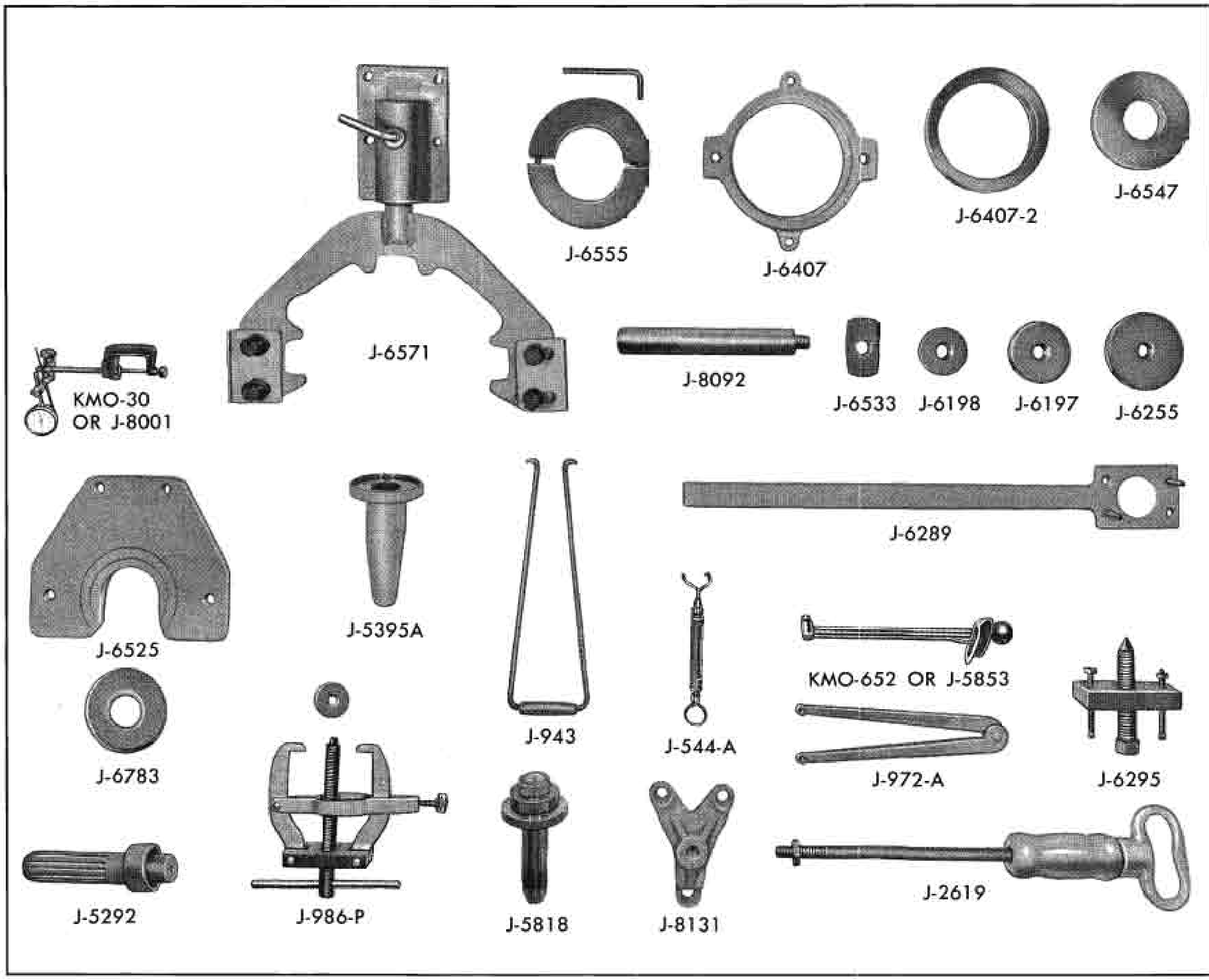
NOTE (*) Torque not a requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.

WRENCH TORQUE SPECIFICATIONS

(All torque in lb. ft. unless otherwise specified.)

		Universal Joints & Propeller Shaft
*	7/8-14	Nut—Rear Axle Drive Pinion Flange Retaining
14-20	5/16-24	Nut—Rear Universal Joint Companion Flange Clamp
14-20	5/16-24	Nut—Front Universal Joint Companion Flange Clamp
		Rear Axle Shaft Wheel Bearings
70-85	1/2-20	Nut—Rear Wheel to Hub—RH and LH.
		Rear Shock Absorbers
70-85	1/2-20	Nut—Rear Shock Absorber (To Axle Hsg. Brkt.)
45-60	7/16-20	Bolt and Nut—Shock Absorber to Frame

NOTE (*) Torque not a requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.



KMO-30 or J-8001	Dial Indicator Set	J-6197	Front Pinion Bearing Race Installer
KMO-652 or J-5853	Tension Wrench (0-50 in. lbs. with ⅜" sq. drive)	J-6198	Front Pinion Bearing Race Remover
		J-6255	Rear Pinion Bearing Race Installer
KMO-653 or J-8068	Adapter (for ⅜" Drive KMO-652 Tension Wrench)	J-6289	Companion Flange Holding Tool
		J-6295	U-Joint Companion Flange Puller
J-544-A	Tension Checking Scale (Differential Bearing Preload)	J-6407	Press Plate Holder and Insert
		J-6525 or J-947P	Axle Bearing Remover and Installer
J-943	Oil Seal Remover	J-6533	Rear Pinion Bearing Race Remover
J-972-A or J-0972	Differential Side Bearing Adjusting Wrench	J-6547	Rear Pinion Bearing Installer
		J-6555	Rear Pinion Bearing Remover
J-986-P or J-8206	Differential Side Bearing Puller	J-6571	Differential Carrier Holding Fork, Clamps and Fixture Assembly
J-2619	Slide Hammer		
J-5292-01	Differential Side Bearing Installer	J-6783	Axle Bearing Installer
J-5395-A	Differential Pinion Oil Seal Installer	J-8092	Drive Handle
J-5818	Oil Seal Installer	J-8131 or J-942-1	Axle Shaft and Bearing Puller

Fig. 4-72 Special Tools

PROPELLER SHAFT

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

The propeller shaft is the connecting link between, and transmits the power from, the transmission to the differential. Two basic designs are used. One shaft is of one piece tubular steel construction. The other shaft incorporates five rubber torsional dampeners (Fig. 4A-1). Application of the "solid steel" and "rubber" propeller shafts is shown in Fig. 4A-3.

All shafts have a universal joint and a splined yoke on the transmission end and are held in alignment by a bushing in the transmission rear bearing retainer (or rear extension housing), and a universal joint at the differential end (Fig. 4A-2).

Fifteen propeller shaft assemblies are used to accommodate various transmission installations on all model cars (including super duty shafts). Each attaches to the transmission and differential in the same manner.

A U-bolt type clamp and locking plate is used to attach the universal joint to the companion flange at the differential. The front joint attaches to the output shaft of the transmission by means of a splined yoke, which permits fore and aft movement of the propeller shaft when the rear axle assembly moves up and down. This splined connection is lubricated from the transmission. An oil seal pressed into the transmission rear bearing retainer protects the transmission yoke from dust as well as loss of transmission lubricant.

Differences in the propeller shafts are in length of the shaft assembly, yoke at the transmission, and diameter of the shaft. Comparison of propeller shafts and their usage is shown in Fig. 4A-3.

INSPECTION

No periodic inspection of the propeller shaft assembly is required. Since the propeller shaft assembly is a balanced unit, it should be kept free of undercoating and other foreign material which could upset shaft balance.

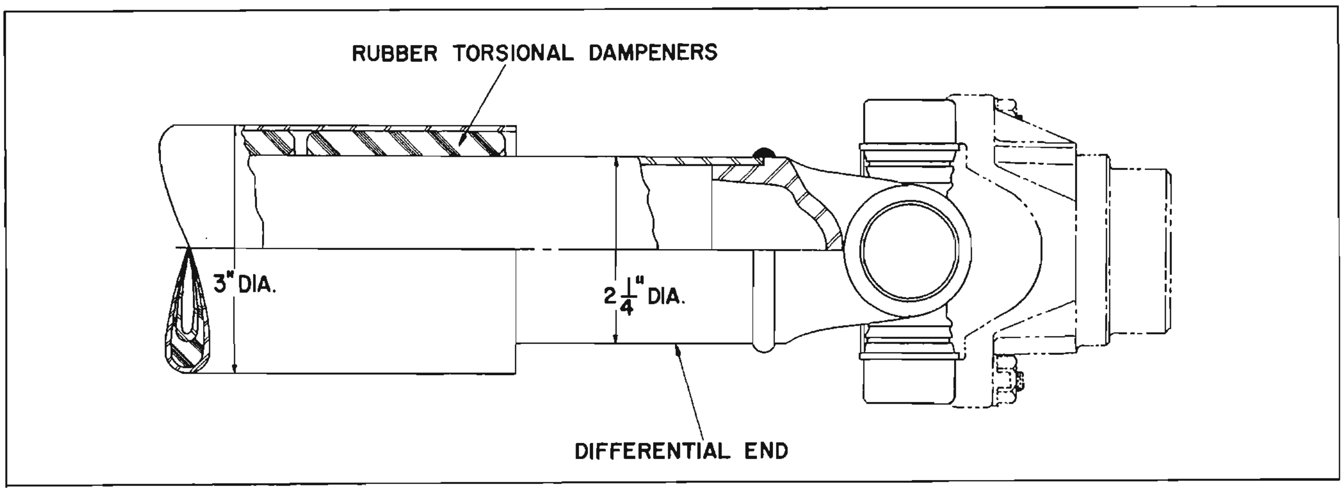


Fig. 4A-1 Insulated Propeller Shaft

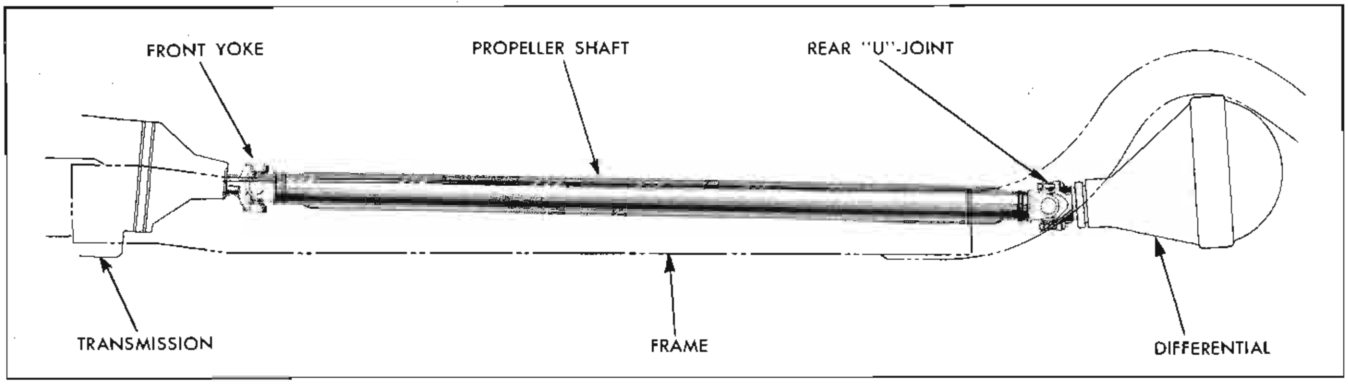


Fig. 4A-2 Relationship of Propeller Shaft to Transmission, Differential and Frome

TRANSMISSION	COLOR CODE	WHEEL BASE	TYPE INSULATOR	USAGE	LENGTH (Inches)	DIAMETER (Inches)
Synchro-Mesh 3- and 4-Speed	Orange	119″	Solid	23-27 Safari	60.6	3.25
	2 Orange	120″	Solid	23-29 Series	61.4	3.25
	2 Purple	120″	Solid	23-29 Series Super Duty	61.4	3.25
Synchro-Mesh Heavy Duty 3-Speed	Green	119″	Solid	23-27 Safari	54.96	3.00
	2 Gray	120″	Solid	23-29 Series	55.76	3.00
	Gray	123″	Solid	26-28 Series	58.96	3.25
	Brown	120″	Solid	23-29 Series	55.76	3.00
	Purple	123″	Solid	26-28 Series	58.96	3.25
Synchro-Mesh 4-Speed	2 Orange	123″	Solid	26-28 Series	61.4	3.25
	2 Purple	123″	Solid	26-28 Series Super Duty	61.4	3.25
10 Hydra-Matic	Blue	119″	Rubber	23-27 Safari	57.4	3.00
	2 Brown	120″	Rubber	23-29 Series	58.2	3.00
	2 Blue	120″	Solid	23-29 Series Super Duty	58.2	3.00
315 Hydra-Matic	None	119″	Rubber	23-27 Safari	57.4	3.00
	2 Black	120″	Rubber	23-29 Series	58.2	3.00
	Yellow	123″	Solid	26-28 Series	61.4	3.25
	2 Yellow	123″	Solid	26-28 Series Super Duty	61.4	3.25

Fig. 4A-3 Propeller Shaft Usage and Comparison Information

PERIODIC SERVICE

Universal joints should be lubricated every 25,000 miles. To lubricate joints they must be completely disassembled and packed with high melting point wheel bearing lubricant. Caution should be exercised in disassembling U-joints to mark mating joint parts so that they will be reassembled correctly to maintain propeller shaft balance.

MINOR SERVICES AND REPAIRS

ALIGNMENT OF ENGINE AND PROPELLER SHAFT

Adjustment of the propeller shaft angle, such as shimming, cannot be made at the rear axle and is not required at the front (engine and transmission).

All necessary differential pinion angle requirements are designed and built into the rear upper and lower control arm geometry. Slots in the engine front motor mounts provide for fore and aft move-

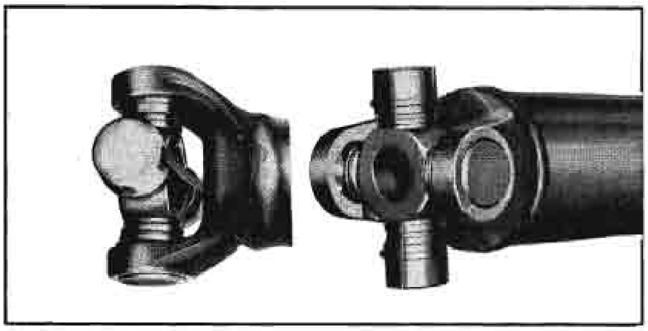


Fig. 4A-4 Bearings Held in Place by Tie Wire

ment of the engine and transmission assembly to give allowance for variation of the positioning of the transmission rear crossmember. The relationship of engine crankshaft angle to propeller shaft angle is maintained within specification by design.

MAJOR REPAIRS

REMOVE PROPELLER SHAFT DRIVE LINE ASSEMBLY

1. Remove U-bolt nuts, lock plates and U-bolts from rear axle drive pinion flange.

2. Use a suitable rubber band to hold bearing onto journals if tie wire has been removed to prevent loss of needle bearings when rear joint is disconnected (Fig. 4A-4).

3. Remove complete drive line assembly by sliding rearward to disengage from splines on transmission main shaft.

DISASSEMBLE PROPELLER SHAFT UNIVERSAL JOINTS

NOTE: When removing bearings from universal joint yokes, use extreme care so as not to lose needle rollers from bearings.

1. Remove snap ring from yoke members by using screwdriver or similar tool.

2. Remove bearings from splined yoke member as follows:

a. Lay or clamp end of shaft in vise so fixed yoke member welded to tube bears against vise. (Do not lay or clamp tubular member in vise.) Shaft should be horizontal and splined yoke member must be free to move vertically between jaws of vise.

b. Using a piece of pipe or similar tool with diameter sufficiently large to encircle bearing (slightly larger than $1\frac{1}{8}$ inch), apply force on yoke around bearing (Fig. 4A-5). This will drive yoke

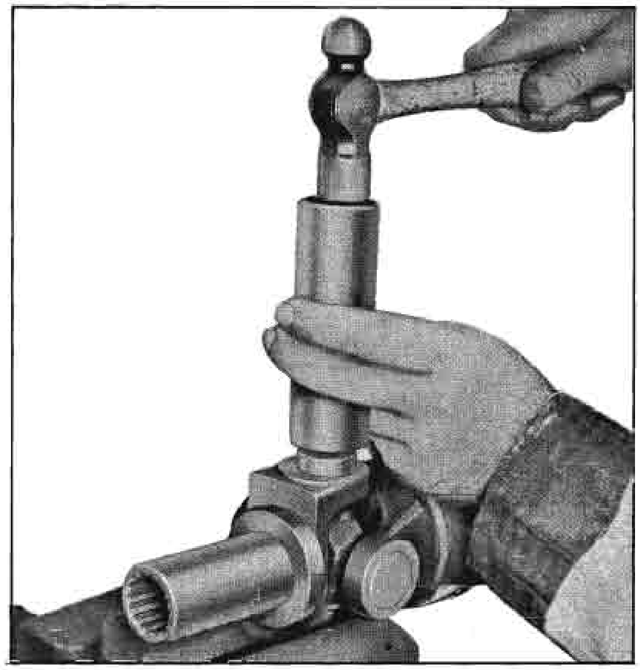


Fig. 4A-5 Removing Bearing From Splined Yoke Member

down causing journal assembly (spider) to force bearing partially out of yoke.

c. Rotate shaft 180° and repeat above step to partially remove opposite bearing.

d. With yoke down as far as possible, place one or more flat washers ($\frac{9}{16}$" O.D.) inside lower bearing (Fig. 4A-6).

NOTE: Total thickness of washers should be $\frac{1}{8}$"-$\frac{3}{16}$".

e. Rotate shaft 180° and again apply force around bearing in which washers were installed. This will completely remove bearing from yoke.

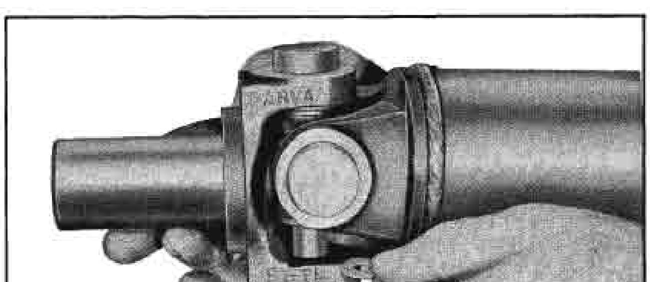


Fig. 4A-6 Placing Washers Inside Bearing of Splined Yoke Member

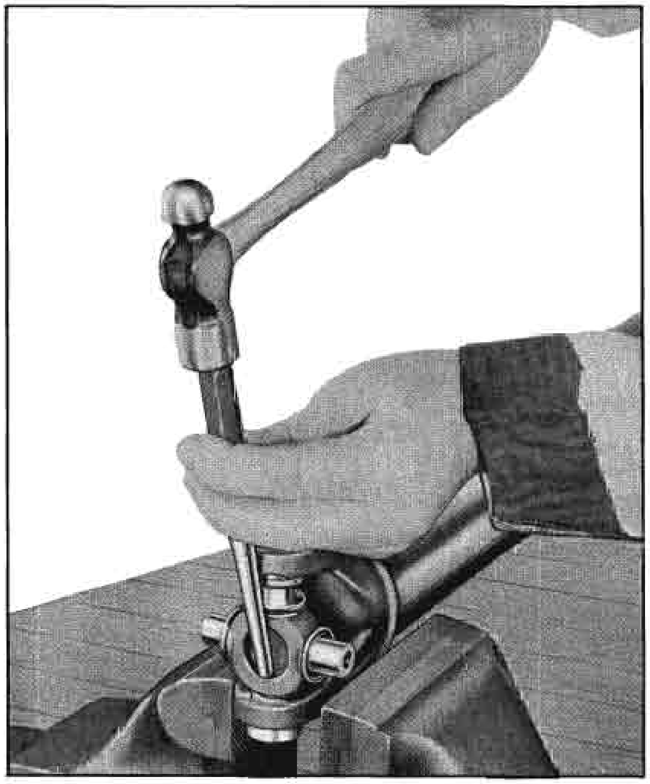


Fig. 4A-7 Removing Bearing From Fixed Yoke Member

f. Remove splined yoke member from journal.

g. Remove remaining bearing from splined yoke member using brass drift.

3. Remove bearings and journal (spider) from fixed yoke member, which is welded to tubular shaft, as follows:

a. With yoke member clamped or supported in vise, drive bearing out as far as possible using drift applied to center part of journal (Fig. 4A-7).

b. Rotate shaft 180° and drive opposite bearing out as far as possible using drift in same manner as in above step.

c. Hold journal up and install three or four small flat washers (Fig. 4A-8). Lower journal onto washers and drive bearing out using drift applied to journal.

d. Remove journal from yoke.

e. Remove remaining bearing using brass drift.

CLEANING AND INSPECTION

1. Wash all parts thoroughly in a cleaning fluid. Probe holes in journals to remove any hardened grease.

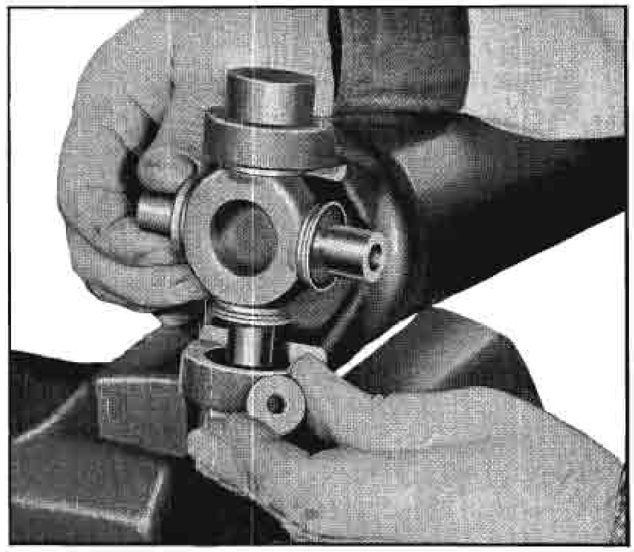


Fig. 4A-8 Placing Washers Inside Bearing of Fixed Yoke Member

2. Inspect roller bearing surfaces of journals, inner bearing surfaces of outer races, and rollers for wear, scores, flat spot or other damage.

3. Inspect packings (cork washers) and journal dust shields for wear and injury. Replace if necessary. Packing should be flexible, if brittle or hard replace with new packing.

4. Inspect outer surface of propeller shaft splined yoke to ensure that it is not burred since burrs will damage seal. Also inspect splines for freedom from dirt.

ASSEMBLE PROPELLER SHAFT

1. Repack roller bearings and fill holes in ends of journal with high melting point wheel bearing lubricant (18 rollers are used for each bearing).

2. Install bearing journal and bearings in fixed yoke member as follows:

a. Press cork washer into position in recess of bearing and install bearing about one quarter way in on one side of fixed yoke using soft faced hammer.

b. Position journal, with dust shields installed, between arms of yoke and place journal in partially installed bearing.

NOTE: Journal assembly must be installed so locating lugs are facing toward propeller shaft (Fig. 4A-9).

c. Hold journal in place and complete installing bearing.

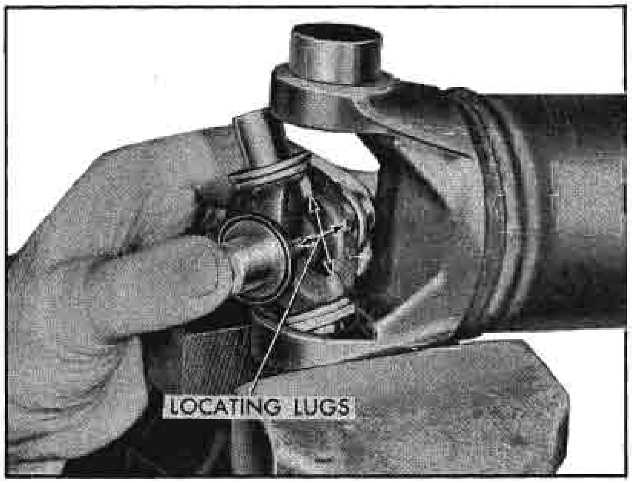


Fig. 4A-9 Correct Installation of Journal to Yoke

d. Install opposite bearing, with cork washer in place, ensuring that bearing rollers do not bind on journal. Check movement of journal in bearings for smoothness.

NOTE: It may be necessary to tap fixed yoke with hammer to free joints of bind.

3. Install bearings in splined yoke member as follows:

a. Press cork washer into bearing and start bearing into place in splined yoke member with a soft faced hammer.

b. Position yoke over journal so arm of journal seats in bearing. Support yoke on opposite side and complete installation of bearing.

c. Press cork washer in place in remaining bearing and install bearing, ensuring that bearing rollers do not jam on journal. Check for free movement of universal joint.

4. Install snap rings in yoke members with gap toward yoke.

PROPELLER SHAFT DRIVE LINE ASSEMBLY—INSTALL

1. Inspect outer diameter of splined yoke to ensure that its is not burred so as to damage transmission seal.

2. Apply engine oil to spline and outside diameter of yoke and slide propeller shaft front joints onto transmission output shaft.

3. Position rear universal joint to rear axle companion flange making sure trunnion bearings are properly aligned in companion flange yoke.

4. Install U-bolts, lock plates and nuts and tighten U-bolt nuts to 14-20 lb. ft. torque. Ensure that ears of lock plates are bent up against flat side of nuts.

TROUBLE DIAGNOSIS AND TESTING

OIL LEAK AT FRONT YOKE

CAUSE	REMEDY
Rough outside surface on splined yoke or defective transmission rear oil seal. An occasional drop of oil dripping from the spline yoke is normal and requires no correction.	Replace seal if cut by burrs on yoke. Replace yoke if outside surface is rough and burred badly. Minor burrs can be smoothed by careful use of crocus cloth or honing with a fine stone.

KNOCK IN DRIVE LINE

CAUSE	REMEDY
Worn universal joints. NOTE: "Clunking" noise when car is operated under "floating" condition at approximately 10 mph in high gear or neutral.	Disassemble universal joints, inspect and replace worn parts.

PROPELLER SHAFT VIBRATION

If vibration comes in at definite speed while car is moving, check by driving car at speed above which vibration came in, shutting off engine and coasting in neutral down through speed where vibration came in. If vibration comes in at same speed when coasting, it is probably caused by propeller shaft or tires.

Tires may give a vibration at certain high speeds which could be mistaken for propeller shaft vibration. By inflating tires above normal pressure and retesting, it may be possible to distinguish tire noise from propeller shaft vibration. When it has been established that the tires are not the cause of vibration, then check propeller shaft assembly for balance and replace shaft.

WRENCH TORQUE SPECIFICATIONS

(Torque in lb. ft.)

TORQUE	SIZE	APPLICATION
*	7/8-14	Nut, Rear Axle Drive Pinion Flange Retaining
14-20	5/16-24	Nut, Rear Universal Joint Companion Flange Clamp

NOTE: (*) Torque not a requirement, other means of control and/or specifications used; checked for alignment bottoming, height and/or leaks.

BRAKES

CONTENTS OF THIS SECTION

STANDARD BRAKES

Proper procedure when servicing the brake system cannot be overemphasized because of its importance to safe, dependable operation. It is, therefore, every mechanic's responsibility to be thoroughly familiar

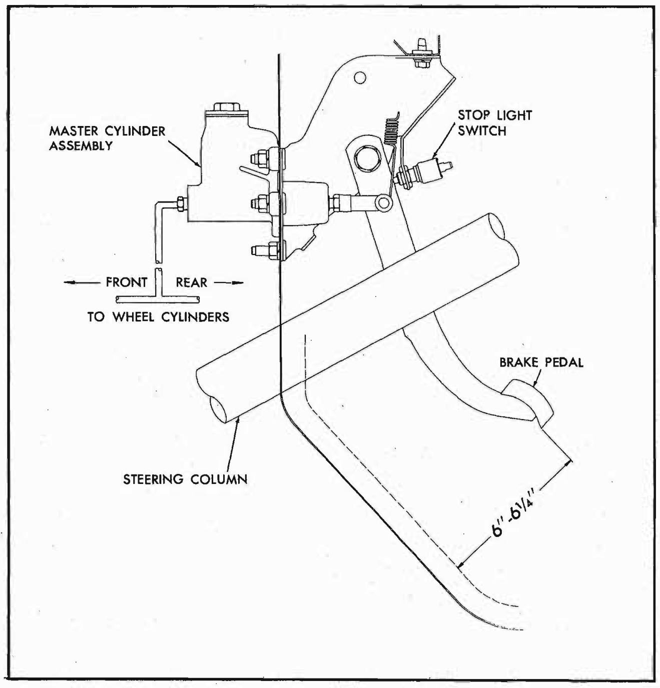


Fig. 5-1 Schematic of Manual Brake System

with all procedures of brake service repairs and perform all operations as carefully and accurately as possible.

GENERAL DESCRIPTION

All models are equipped with duo-servo hydraulic brakes.

The brake and clutch pedal mounting bracket is attached to the dash and supported by a plenum bracket. The pedals are suspended with nylon bushings at the pivot points which eliminates grease fittings and assures quiet smooth operation.

The brake master cylinder is attached to the engine side of the dash. A push rod connects the brake pedal to the master cylinder. The brake light switch is mounted on the brake pedal mounting bracket (under the instrument panel above the steering column).

There are two adjustments at each front brake, the adjusting screw and the anchor pin. Since the anchor pin is stationary at each rear brake, the only adjustment is at the adjusting screw.

DRUM DESIGN

More effective brake cooling and water sealing have been achieved with the backing plate. It combines one piece construction with the multi-seal design.

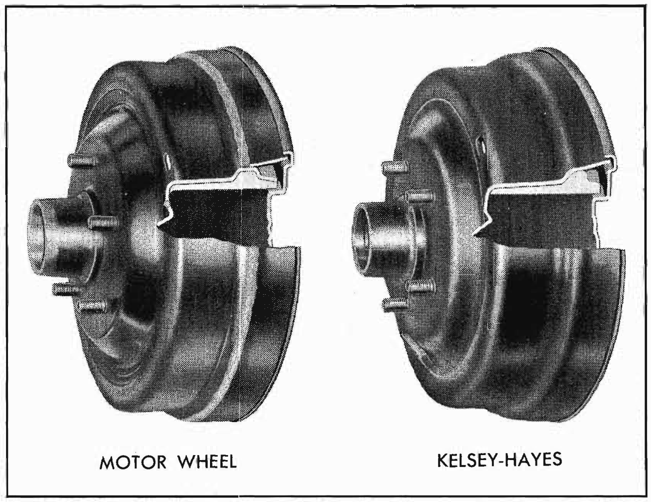


Fig. 5-2 Cross Section of Front Drums

Braking surface of the front brake drums is cast iron in a steel shell which extends beyond the drum to provide a cooling flange. The 11″ drums are so located in the air stream as to provide excellent heat dissipation and therefore cooling, since a greater volume of air is allowed to pass over the brake drums. Drums are wide and heavy for added thermal capacity.

SHOES-LINING

Brake shoe web contour provides precise conformity of brake linings to drums for true contour effect. This brake shoe flexibility requires less pedal effort because of uniform pressure on linings. Lining wear is more uniform.

In cases of severe brake usage it is possible for shoes to take the shape of worn linings permanently.

PARKING BRAKE

The parking brake operates the rear brakes through a system of levers and cables. This brake is foot operated and is mounted under the left side of the instrument panel.

OPERATION OF HYDRAULIC SYSTEM

Depressing the brake pedal moves the master cylinder push rod and piston, forcing hydraulic fluid out through a check valve (Fig. 5-3). This fluid flows through the hydraulic lines into the wheel cylinders, forcing the wheel cylinder pistons outward from the center of the cylinder and expanding the brake shoes and linings against the brake drums.

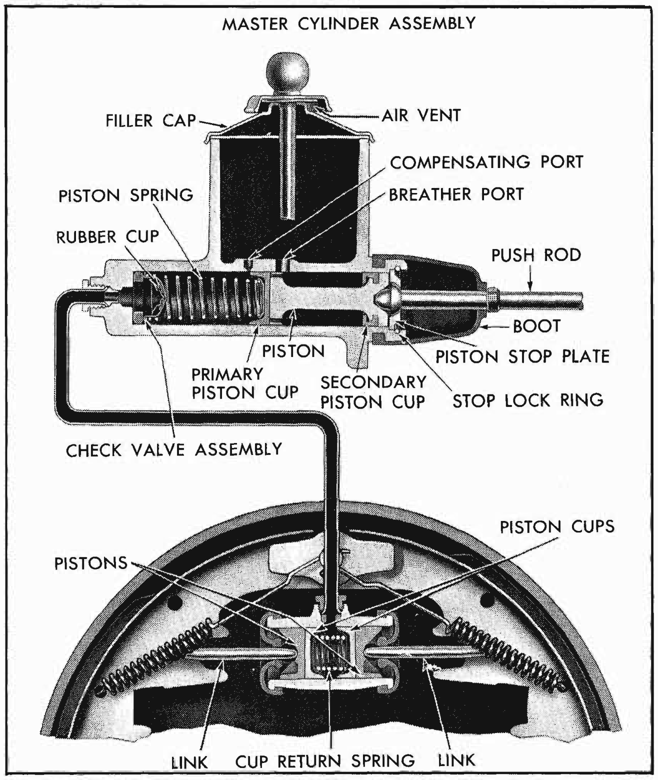


Fig. 5-3 Schematic Diagram of Hydraulic System

When the brake pedal is released quickly, the master cylinder piston returns to the released position, faster than fluid returns from the lines. Holes in the piston head allow fluid to pass from the rear to the front of the piston head, past the primary cup to fill in this space.

At the same time (when the pedal is released) the brake shoe return springs force the wheel cylinder pistons to return toward the center of the wheel cylinder (released position). Fluid forced out of the wheel cylinders by this action returns to the master cylinder by overcoming the pressure of the master cylinder piston spring which holds the check valve closed. As this fluid returns, the excess portion will return to the reservoir through the compensating port which is uncovered when the master cylinder piston is in the released position. The piston spring will close the check valve when the pressure in the lines is reduced to 8 to 12 lbs., maintaining a slight pressure in the lines at all times. The purpose of this pressure is to keep wheel cylinder cups from leaking fluid and to reduce the possibility of air entering the system.

OPERATION OF PARKING BRAKES

When the parking brake lever is depressed with foot pressure, the action of the parking brake lever pulls cables to the rear brakes tight to actuate the rear brake.

Each cable attaches to a rear brake actuating lever which pivots about a lever pin. When the bottom of the lever is moved forward (when pulled by the brake cable) the top of the lever engages the secondary shoe (rear) and forces the secondary shoe against the brake drum. At the same time the actuating lever forces the primary (front) to contact the brake drum by means of a strut between the actuating lever and the primary shoe.

To release the parking brake, apply a slight upward pressure to the release lever handle (just below the lower left side of the instrument panel).

PERIODIC SERVICE

The brake system should be checked visually each time the car is lubricated. When the car is raised on a lift for lubrication, brake lines, hoses, and cables should be inspected for signs of chafing, deterioration, or other damage. *A careful check for leaks should be made.* Repairs as necessary should be performed as outlined in this section.

Each time the car is serviced for any reason there is an opportunity and obligation to check the operation of the brake system. If the brake pedal can be depressed to within less than 2″ of floor mat when brakes are applied, or if pulls, grabs, or other irregularities are noted, a need for brake service exists. No car should leave the Service Department with brakes that are not safe. Corrections should be made as outlined in this section.

The parking brake cables must be lubricated yearly or when brakes are relined. The procedure for lubricating cables is outlined in LUBRICATION SECTION.

ADJUSTMENTS ON CAR

ADJUSTMENT OF PEDAL AND STOP LIGHT SWITCH

Specified pedal height for normal usage (Fig. 5-4) may be changed to accommodate special owner requirements. The pedal may be raised or lowered. If pedal is raised it is essential to reset stop light switch. DO NOT lower pedal more than absolutely necessary as insufficient brake pedal travel may result when used at high speed with worn linings. Do not raise pedal to point where stop light switch cannot be adjusted properly.

After changing pedal height or stoplight switch position, lubricate end of switch plunger sparingly and adjust stop light switch so switch plunger extends $\frac{3}{16}$″ beyond switch body (Fig. 5-5) with fully

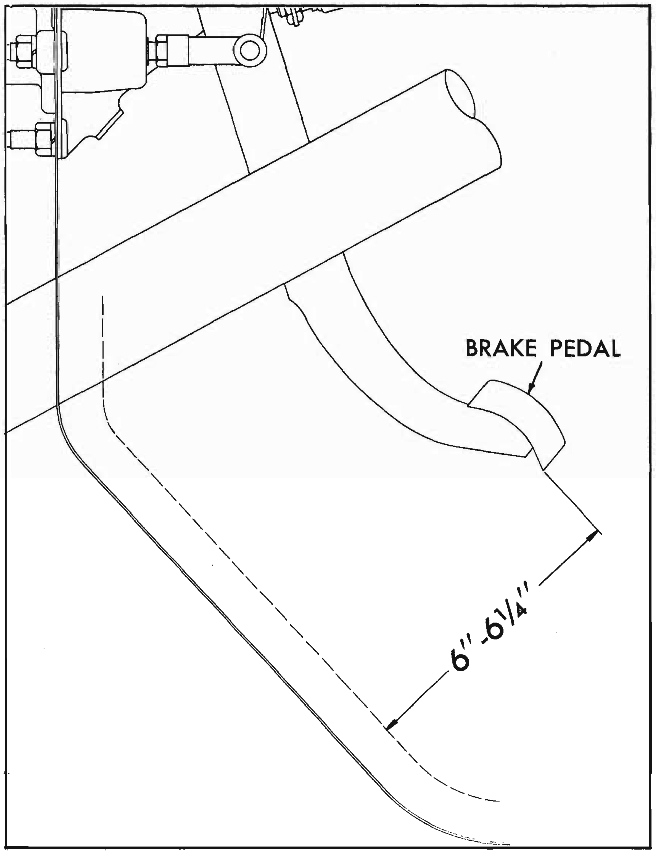


Fig. 5-4 Correct Brake Pedal Height

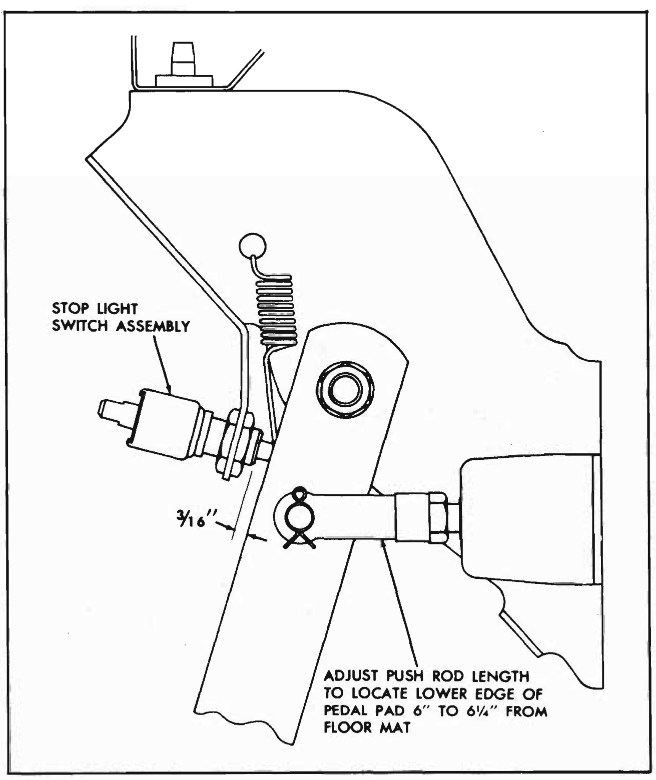


Fig. 5-5 Correct Adjustment of Stop Light Switch

released brake pedal. Tighten locknut securely and check pedal for freedom of movement.

CAUTION: If stop light switch or pedal bracket prevents full return of brake pedal and master cylinder push rod, the master cylinder piston may be prevented from returning to its stop. This can block off the compensating port which prevents brake shoes from returning fully when the pedal is released (see Fig. 5-3). A further complication which follows a blocked compensating port is lining drag and complete brake burnup on the first prolonged drive. It is necessary that the primary cup be entirely clear of the compensating port to provide a safety factor against normal rubber swell and expansion and deflection of body parts and pedal linkage.

ADJUSTMENT TO COMPENSATE FOR LINING WEAR

Remove one front wheel then remove the drum separately being careful to avoid damaging grease seal. If linings are worn more than half way remove the other drums for lining inspection. If brakes have been giving satisfactory mileage between adjustments and are worn uniformly (but not to the point where new linings are needed) anchor pin adjustment should not be needed and the following procedures should give a satisfactory adjustment. If service has been unsatisfactory, use procedure outlined for BRAKE ADJUSTMENT INCLUDING ANCHOR PIN.

1. Remove remaining wheels, front hub and drum, and rear brake drums and blow out dust from all drums and brake assemblies. Pull all shoe assemblies away from support assembly and apply a small amount of lubriplate to pads where brake shoes contact backing plates. Check to see that parking brake cables are not too tight as this would cause the rear brakes to drag when adjusting screws are expanded.

CAUTION: Take extreme care to prevent oil, grease, or brake fluid from getting on linings or drums. Even finger prints on linings may upset an otherwise perfect brake adjustment.

2. Remove adjusting hole covers from backing plates.

3. Replace brake drums and wheels and adjust front wheel bearings.

4. Adjust brake as follows:

a. Insert an adjusting tool in slot of the brake backing plate until it engages star wheel on adjusting screw and move outer end of tool upward to expand brake shoes (Fig. 5-6).

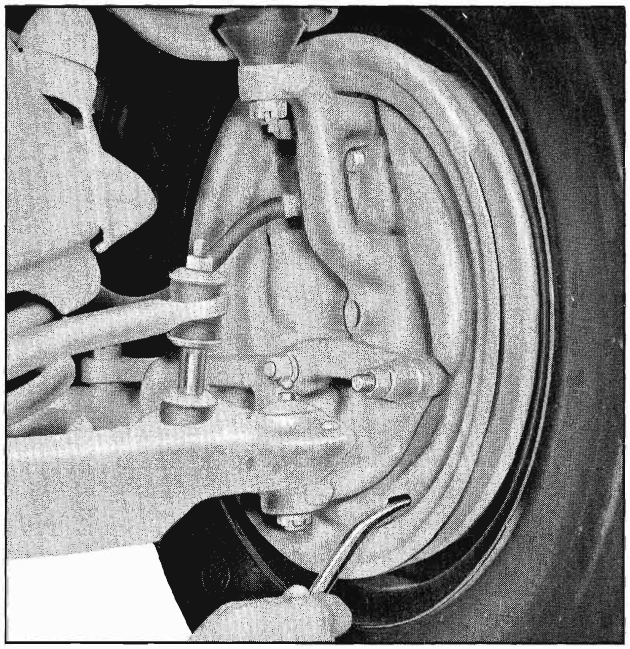


Fig. 5-6 Expanding Adjusting Screw

b. Expand until the car wheel can just be turned by hand, then back off adjusting screw 12 notches.

NOTE: Brake adjusting screws on right side of car have left hand threads. Direction of moving adjusting tool will be the same on both sides of the car.

c. After completing adjustment, check to see that wheel turns freely without drag. It may be necessary to tap the brake backing plate to permit shoes to centralize before brake will be free.

5. Repeat Step 4 at each wheel, checking after adjustment to see that each wheel turns freely without drag.

6. Apply the parking brake slightly and check equalization by turning the rear wheels by hand.

a. Close adjustment for tension may be secured by adjusting the clevis at the rear end of the front cable. In adjusting here, be certain to turn clevis on or off cable end and do not twist cable. Coarse adjustment is secured by selecting the correct hole in the equalizer.

7. Add sufficient brake fluid in the master cylinder to bring fluid level to within ⅞" of top of gasket surface on filler neck (Fig. 5-7). Bleed brakes if necessary to get proper pedal reserve and remove "spongy pedal".

8. Replace all four brake adjusting hole covers. These rubber plugs may be installed by starting top and one end by hand and by pushing other end and bottom lips with screwdriver.

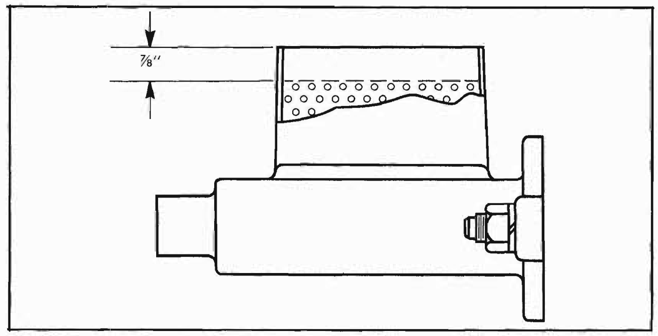


Fig. 5-7 Correct Fluid Level in Master Cylinder

9. Road test car by making three or four stops from speeds not to exceed 40 mph.

BRAKE SHOE AND ANCHOR PIN ADJUSTMENT

If brakes have been pulling to one side, the adjustment to compensate for lining wear given above might not give correct adjustment. In such cases adjust as follows:

1. Remove one front wheel, then remove the drum separately being careful to avoid damaging grease seal. If linings are worn more than half way remove the other drums for lining inspection.

2. Remove remaining wheels, front hub and drum, and rear brake drums and blow out dust from all drums and brake assemblies. Pull all shoe assemblies away from support assembly and apply a small amount of lubriplate to pads where brake shoes contact backing plates. Check to see that parking brake cables are not too tight as this would cause the rear brakes to drag.

CAUTION: Take extreme care to prevent oil, grease or brake fluid from getting on linings or drums. Even oily finger prints on linings may upset an otherwise perfect brake adjustment.

3. Remove adjusting hole covers from backing plates.

4. Install drums, checking for proper installation of front wheel bearings. Retain rear drums during adjustment with one wheel nut.

5. Adjust front wheel bearings with brake shoes free.

6. Proper lining to drum gap is .015"±.005" measured between secondary (long) lining and drum

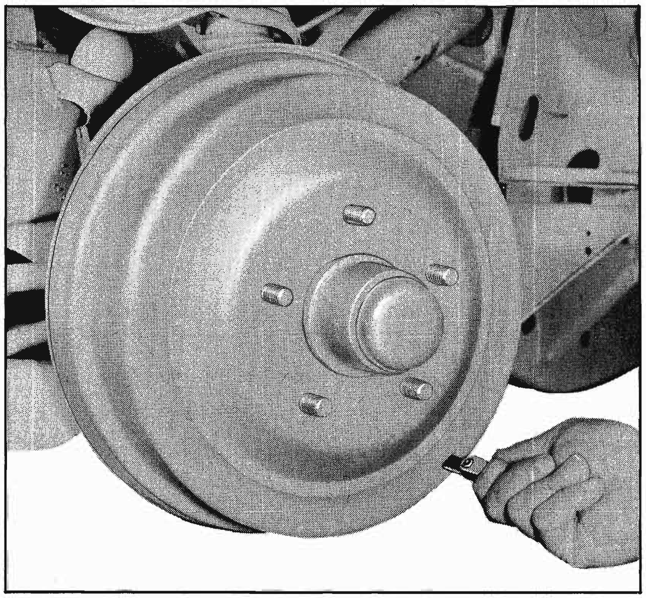


Fig. 5-8 Checking Lining to Drum Clearance

while primary (short) lining is against drum (Fig. 5-8). Proper gap is required at both ends of the secondary lining. A five to ten lb. drag on a .015" feeler during initial withdrawal from full lining width insures holding primary against drum.

7. Change clearance at adjusting screw end of lining by shortening or lengthening adjusting screw.

8. Change clearance at anchor pin end of lining by rotating anchor pin (Fig. 5-9). Rear brakes having fixed anchors require replacement of any parts preventing proper clearances.

9. Interaction of adjustments requires rechecking clearance after large changes.

10. The rear fixed anchor brake having drum with no feeler slot may be adjusted by lengthening adjusting screw to create a heavy drag (14-20 lb. on O.D. of drum as it is rotated) then backing off 12 notches.

11. At completion of adjustment the following should be true.

a. Drum rotation free from drag.

b. Anchor pin lock nut at front (with adjustable anchor) tightened to 60-90 lb. ft. torque.

c. Plug in adjusting slot.

PARKING BRAKE ADJUSTMENT

The procedure for brake adjustment shown above automatically adjusts the parking brake. There may be a condition where the parking brake system will

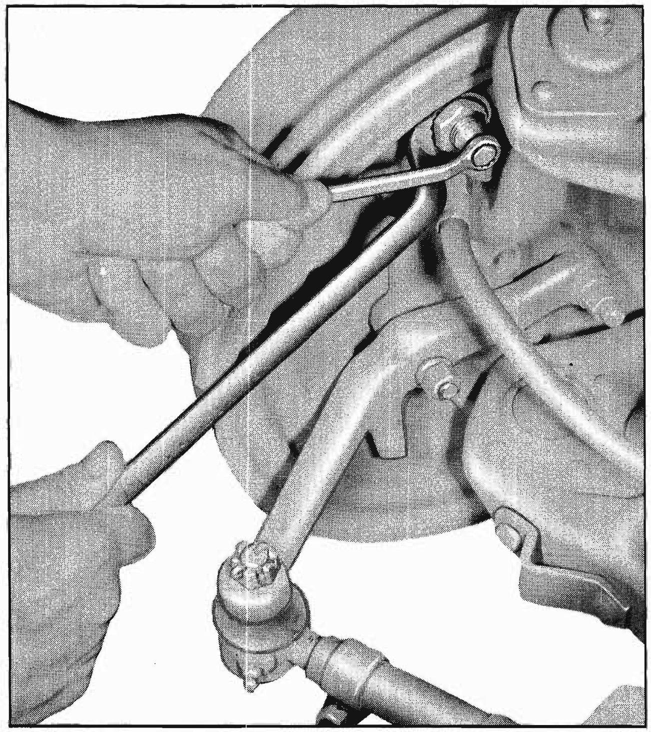


Fig. 5-9 Adjusting Anchor Pin

require additional adjustment even though the foot brakes are perfectly satisfactory.

1. Apply the parking brake slightly and check equalization by turning the rear wheels by hand.

2. If only a slight difference exists, loosen the adjusting screw of the tighter brake.

3. If equalization requires more than a few notches movement, retighten adjusting screw to point for proper adjustment of that brake and equalize rear cable by loosening the cable clamp screws at the equalizer clevis (Fig. 5-11), and pulling downward on the tight side of the cable. It may be necessary to open the clamp with a screwdriver to allow the cable to equalize.

4. Tighten the clamp screws on the equalizer while the parking brake lever is still in the applied position. When parking brake lever is released, it should be possible to turn each wheel by hand without feeling drag when rear cable is pulled downward by the other hand, gripping cable midway between conduit and guide on frame.

5. Close adjustment for tension may be secured by adjusting the clevis at the rear end of the front cable. In adjusting here, be certain to turn clevis on or off cable end and do not twist the cable. Coarse adjustment is secured by selecting the correct hole in the equalizer.

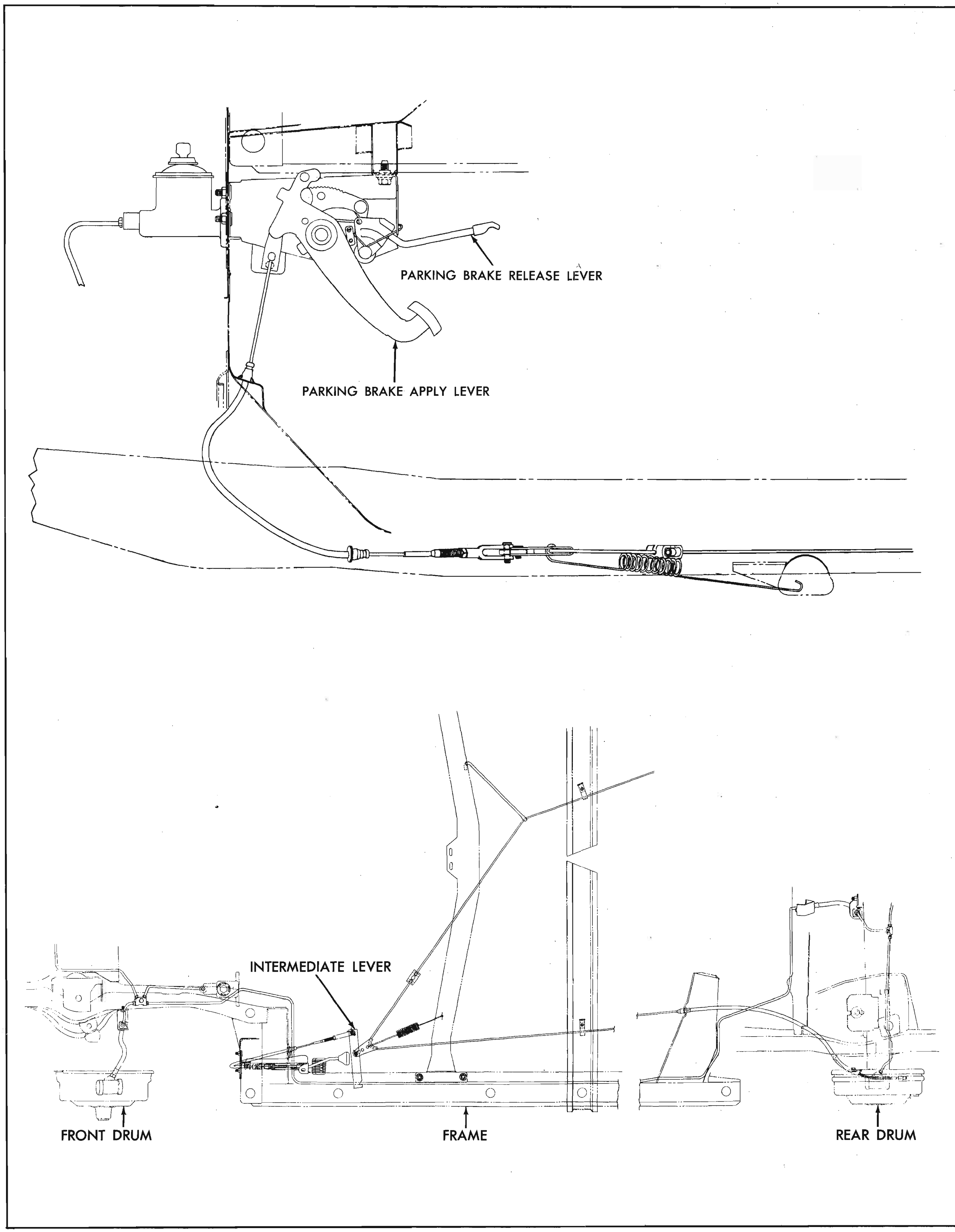


Fig. 5-10 Schematic Diagram of Parking Brake System

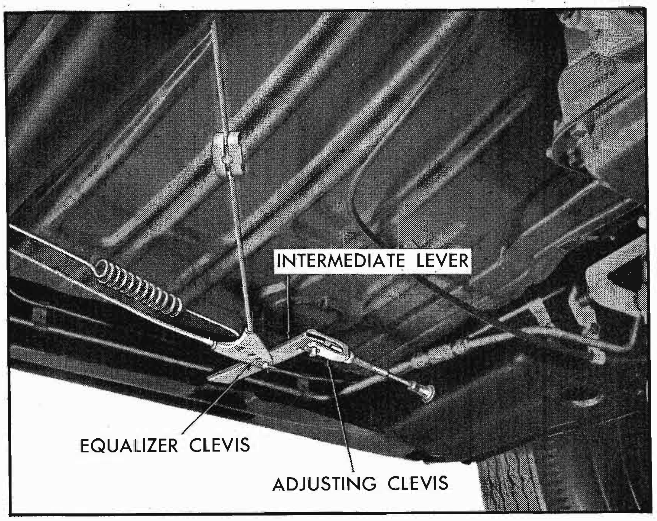


Fig. 5-11 Parking Brake Linkage Under Car

MINOR REPAIRS

BRAKE CAUTIONS

1. Do not use a substitute for recommended brake fluid or reclaimed brake fluid.

2. Do not allow grease, paint, oil or brake fluid to come in contact with brake lining.

3. Do not handle brake shoes or drums with greasy hands.

4. Do not clean rubber parts or inside of cylinders with anything but clean alcohol.

5. Do not use any linings other than those specified by the factory.

6. Do not allow master cylinder reservoir to become less than half full of brake fluid.

7. Under no circumstances should brakes be severely tested after new linings are installed. They should be given moderate use for several hundred miles until linings become well burnished. Repeated severe applications will cause erratic brake action and may permanently injure brake linings. Under no circumstances should severe testing be done that will burn the linings.

8. When linings of one brake require replacement, the linings should also be replaced on the other brake at the same end of the car (except on very low mileage new cars and only when the brakes have not been abused).

BLEEDING BRAKES

Depressing the pedal with a low fluid level in master cylinder reservoir or disconnecting any part of the hydraulic system permits air to enter the system. Air may also enter the system occasionally when brake shoes are replaced. This air must be removed by bleeding.

Bleeding may either be done by hand pumping the brake pedal using bleeder tube as outlined below, or by using pressure bleeding equipment.

CAUTION: Always clear away any dirt around master cylinder filler cap before removing cap for any reason. Never depress pedal while brake drums are removed unless bleeder valve is open.

When using pressure bleeding equipment follow instructions of the equipment manufacturer and always use bleeder tube attached to wheel cylinder to prevent brake fluid from running down backing plate.

When bleeding by operating pedal proceed as outlined below:

1. Fill master cylinder reservoir with recommended brake fluid.

CAUTION: Never use an inferior or reclaimed brake fluid as this will positively result in brake trouble. Even though reclaimed fluid may look clear, tests have shown such fluid to be corrosive. If there is doubt as to the grade of fluid in the system, flush out system and fill with recommended brake fluid complying with SAE 70R3 specifications.

2. Starting at left front wheel, attach bleeder tube, allowing tube to hang submerged in brake fluid in a clean quart glass jar. Unscrew bleeder valve three quarters of a turn, depress pedal full stroke and allow it to return slowly making sure end of bleeder tube is under surface of liquid in container. Continue operating pedal, refilling reservoir after each five strokes (unless an automatic filling device is used), until liquid containing no air bubbles emerges from bleeder tube.

CAUTION: Bleeder tube must always be used when bleeding brakes, and end of tube must be below level of brake fluid in glass jar when bleeding other than by pressure.

3. Close bleeder valve securely. Remove bleeder tube, and proceed one brake at a time to right front, left rear and right rear in order given.

4. When bleeding operation is completed, refill reservoir to within ⅞″ of top of master cylinder filler neck gasket surface (Fig. 5-12) then replace filler cap.

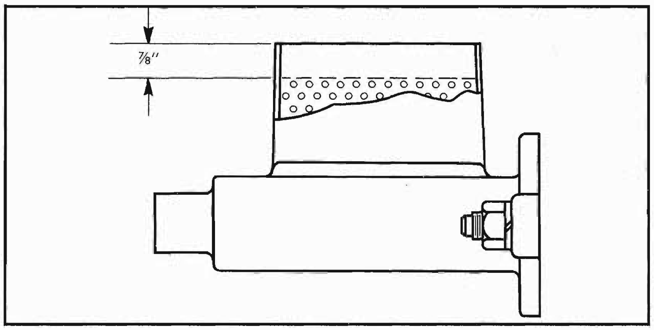


Fig. 5-12 Correct Fluid Level in Master Cylinder

FLUSHING HYDRAULIC SYSTEM

It may sometimes become necessary to flush out the brake hydraulic system due to the presence of mineral oil, kerosene, gasoline, carbon tetrachloride, etc., which will cause swelling of rubber piston cups and valves so they become inoperative.

To flush hydraulic system, proceed as follows:

1. Attach bleeder tube and open bleeder valve at left front wheel.

2. Flush out system thoroughly with clean denatured alcohol, pumping the fluid from master cylinder reservoir and out of wheel cylinder bleeder valve.

3. Repeat steps 1 and 2 at remaining wheel cylinders. To ensure thorough flushing, approximately ½ pint of alcohol should be bled through each wheel cylinder.

4. Replace all rubber parts in master and wheel cylinders. Thoroughly clean cylinders and pistons in alcohol before installing new parts.

5. After installing parts, fill system with recommended brake fluid and follow Steps 2 through 4 under BLEEDING BRAKES to flush system of cleaning solution and to bleed brakes. In doing this, pump brake fluid from wheel cylinder bleeder valves until clear fluid flows from bleeder tube and then, if necessary, continue until no air bubbles emerge from bleeder tube.

BRAKES—OVERHAUL

BRAKE SHOES—REMOVE

1. Raise all four wheels off ground. Remove front wheels, front hub and drum assemblies, rear wheels and rear drums.

CAUTION: Extreme care must be taken to prevent oil, grease, or brake fluid from getting on linings. Even oily finger prints on linings may effect the operation of brakes.

2. Inspect linings for wear. Clean brake shoes, drums and backing plates, removing any foreign particles that may have become imbedded in lining surface. Examine shoes for loose rivets which must be replaced. Install new shoes or reline if linings are badly burned or worn nearly flush with rivets or if linings show evidence of oil, grease or brake fluid on the surface.

CAUTION: In cases of severe brake usage it is possible for shoes to take the shape of worn linings permanently. Before relining a shoe, particularly if it is discolored, check for distortion by laying it against a new shoe. Discard the shoe if its radius has opened up more than the thickness of the rim metal.

3. Loosen parking brake cables sufficiently to remove all tension from brake cable.

4. Remove brake shoe pull back springs using tool J-8049.

5. Remove brake shoe hold down cup and spring assembly.

6. Spread apart brake shoes to clear wheel cylinder connecting links and remove shoes from backing plate.

7. Separate the brake shoes by removing adjusting screw and spring.

8. Remove parking brake lever from secondary brake shoe (rear only).

BRAKE SHOES—INSPECT

1. Inspect drums for scoring. Road dirt frequently cuts grooves in drums which do not impair operation of brakes unless grooving is extremely severe. When drums are badly scored, inspect brake shoe linings carefully for imbedded foreign material. Replace or recondition as necessary.

CAUTION: Removing material from brake drum reduces strength of drum and also the ability of drum to transfer heat, so this operation should not be done unnecessarily.

2. Inspect front wheel bearings and oil seals and replace as necessary.

3. Carefully pull edges of wheel cylinder boots away from cylinders and note whether interior is wet with brake fluid. Excessive amounts of fluid at this point indicates leakage past piston cups.

NOTE: A slight amount of fluid is nearly always present and acts as lubricant for the piston.

4. If an excessive amount of fluid is present, overhaul wheel cylinder.

5. Inspect hoses and hydraulic lines for wear or damage and replace as necessary.

6. Check and make sure all bolts and nuts securing backing plate to steering knuckle are tightened to 50-70 lb. ft. torque at lower bolt and 80-120 lb. ft. torque at upper bolt.

NOTE: Before relining a shoe, particularly if it is discolored, check for distortion by laying it against a new shoe. Discard the shoe if its radius has opened up more than the thickness of the rim metal.

BRAKE SHOES—ASSEMBLE

1. Inspect new linings and make sure there are no nicks or burrs on shoe edge where contact is made with backing plate.

2. Use a file, hand grinder, or emery cloth to remove grooves from brake shoe ledges on backing plates. Apply a small amount of brake lubricant or wheel bearing lubricant on shoe ledges.

3. Nuts and threads of all adjusting screws should be lubricated with a small amount of oil or grease.

4. On rear brakes lubricate parking brake lever fulcrum, link, and cable ramp with petroleum base lubricant or grease.

CAUTION: Do not apply too much lubricant as it may get on linings. This will result in unequalized brakes and necessitates replacement of linings.

5. Connect brake shoes together with adjusting screw spring, then place adjusting screw in position so that star wheel will line up with slot in backing plate.

6. When replacing shoes, always be certain to assemble secondary shoes to the rear and primary shoes to the front. Note that linings of primary shoes are shorter than secondary linings.

CAUTION. Do not permit oil or grease to come in contact with linings.

7. Attach brake shoes to backing plate with cup and spring hold down assemblies. Grease under nail-heads. Engage shoes with wheel cylinder connecting links.

8. On rear brakes, connect parking brake lever to secondary shoe and install strut and spring between lever and primary shoe.

9. Install brake return springs. New brake shoe return springs should be installed if old springs have been overheated or strength is doubtful. Overheated springs may be indicated by end of coils opened up or failure of shoes to return to anchor pin.

10. Sand linings lightly to remove any trace of oil.

11. When new shoes or linings have been installed, shorten adjusting screw until drum will slide freely over shoes.

12. Install drums, observing instructions for front wheel bearing lubrication and adjustment.

13. Adjust brake shoes as described in section on adjustment.

14. If wheel cylinder has been replaced or repaired, or hydraulic line has been replaced, bleed brakes as described in section on bleeding brakes.

CAUTION: New linings must be protected from severe usage for several hundred miles. Stops from high speeds or repeated stops from low speed may permanently injure new linings. This information should be conveyed to owner.

WHEEL CYLINDERS—REMOVE AND REPLACE

REMOVE

1. Raise wheels of vehicle.

2. Remove drum.

3. Disconnect hose from wheel cylinder.

4. Remove brake shoes to protect them from dripping fluid. (On front brakes, remove backing plate from steering knuckle.)

5. Remove screws and lock washers which hold cylinder to backing plate and remove wheel cylinder.

DISASSEMBLE

1. Remove wheel cylinder connecting link.

2. Remove rubber boots.

3. Remove pistons, rubber cups, and spring.

4. Wash all parts in clean alcohol and lay on a clean surface (such as a sheet of clean paper).

CAUTION: Before cleaning parts, clean hands. Do not wash hands in gasoline or oil before cleaning parts. Use soap and water to clean hands.

INSPECT WHEEL CYLINDER

1. Inspect piston rubber cups for softening distortion, or swelling. This condition indicates oil, gasoline, carbon tetrachloride, etc., in hydraulic system

which would require flushing of system, and replacing of rubber parts in wheel cylinders as well as in master cylinder.

2. See that rubber cups are flared so they will have tension against the cylinder bore. Loss of flare may be caused by overheating.

3. Examine spring, cylinder bore, and pistons for signs of scoring, rust, pitting or etching. Any of these require replacement of wheel cylinder.

NOTE: A new brake cylinder has a "bearingized" surface. This is accomplished by diamond boring the cylinder then rolling it under heavy pressure to obtain a hard surface. Honing this surface destroys the "skin" and leaves a softer surface which will roughen and cause more rapid piston wear than the "bearingized" surface. Honing also enlarges the bore and oversize pistons are not available.

ASSEMBLE

1. Apply clean brake fluid to cylinder bore, pistons, and rubber cups before assembly.

2. Place a boot over one end of cylinder.

3. Place a piston in cylinder so that flat side will be toward center of cylinder when piston is in normal position.

4. Insert a rubber cup with flat side against flat side of piston.

5. Insert spring and expander assembly.

6. Insert a rubber cup with flat side away from spring.

7. Install piston with flat side against cup.

8. Place rubber boot over end of cylinder.

INSTALL

1. Install wheel cylinder on backing plate with screws and lock washers. Tighten to 60-90 lb. in. torque. On front brake, install backing plate to knuckle using new gasket.

2. Replace wheel cylinder connecting links.

3. Install brake shoes and springs.

4. Connect hose or pipe to wheel cylinder. (Use new gasket with hose.)

5. Install brake drums. Adjust wheel bearings (as described in front suspension section), if front drum was removed.

6. Bleed all brake lines as described in brake bleeding section.

7. Adjust and test brakes as previously described in this section.

MASTER CYLINDER—REMOVE AND REPLACE

REMOVE

1. Disconnect stoplight switch wire.

2. Disconnect brake pedal return spring.

3. Remove cotter pin and clevis pin from clevis and disconnect master cylinder push rod from brake pedal.

4. Remove hydraulic brake line from end of master cylinder. Cover line to prevent entrance of foreign material.

5. Remove two nuts and lock washers holding master cylinder to cowl.

6. Remove master cylinder from automobile.

DISASSEMBLE

1. Remove filler cap from top of master cylinder.

2. Drain and pump fluid from master cylinder.

3. Clamp cylinder in vise.

4. Remove boot from master cylinder and push rod.

5. Remove push rod stop plate lock ring from end of cylinder with care. Ring may fly off.

CAUTION: When lock ring is removed piston spring will force piston and stop plate out of cylinder with 10-15 lbs. of force.

6. Remove piston, piston cups, piston spring, check valve assembly, and check valve washer from cylinder.

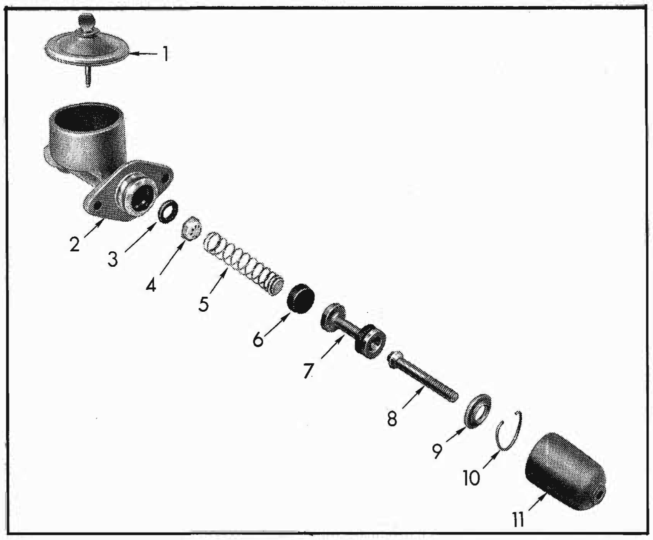
7. Wash all parts in clean alcohol.

CAUTION: Before cleaning parts, clean hands. Do not wash hands in gasoline or fuel oil before cleaning parts. Use soap and water to clean hands.

8. Place clean parts on clean surface (such as sheet of clean paper).

INSPECT

1. Inspect piston rubber cups and check valve for softening, distortion or swelling. (Compare with new similar parts.) They indicate oil, gasoline, carbon tetrachloride, etc. in hydraulic system which would require flushing of entire system and replacing of rubber parts in wheel cylinders as well as in master cylinder.



1.Filler Cap
2.Filler Cap Gasket
3.Master Cylinder Housing
4.Valve Seat Washer
5.Check Valve Assembly
6.Piston Spring
7.Primary Cup
8.Piston and Secondary Cup
9.Push Rod
10.Piston Stop Plate
11.Stop Plate Lock Ring
12.Boot

Fig. 5-13 Master Cylinder—Exploded View

2. Inspect master cylinder bore for signs of scoring, rust, pitting, or etching. Any of these will require replacement of master cylinder. Presence of pitting, rust, or etching in master cylinder calls for a careful inspection for similar conditions in all wheel cylinders.

CAUTION: A new brake cylinder has a "bearingized" surface. This is accomplished by diamond boring the cylinder then rolling it under heavy pressure to obtain a hard surface. Honing this surface destroys the "skin" and leaves a softer surface which will roughen and cause more rapid piston wear than the "bearingized" surface. Honing also enlarges the bore and oversize pistons are not available.

ASSEMBLE

1. Dip all internal parts in clean brake fluid before installing parts.

2. Install check valve washer, check valve and spring in cylinder.

3. Install primary cup in cylinder with flat side out, making certain cup seats over end of spring.

4. Coat secondary cup with clean brake fluid and install on piston with sharp edges of lip pointing toward perforated end of piston.

5. Install secondary cup and piston in cylinder, perforated end of piston first.

6. Install push rod and stop plate in cylinder. (A trace of silicone grease on ball end of push rod will help keep it quiet in service.)

7. Install push rod stop plate lock ring in cylinder, being careful lock ring does not fly off.

NOTE: Inspect piston stop washer in end of master cylinder to see that it is held firmly in place by lock ring bottoming fully in groove seat in master cylinder.

8. Place rubber boot on end of cylinder.

9. Install lock nut and clevis on push rod loosely.

10. Fill reservoir with new heavy duty fluid and bleed brakes.

11. Install reservoir cap.

INSTALL

1. Install master cylinder on dash and secure with two nuts and lock washers and tighten to 15-25 lb. ft. torque.

2. Connect master cylinder push rod clevis to brake pedal with clevis pin and secure pin with cotter pin.

3. Connect brake pedal return spring.

4. Connect stoplight switch wire.

5. Check and adjust pedal height and stop light switch.

6. Connect hydraulic line to master cylinder.

7. Check fluid level to within ⅞" of top of cylinder (Fig. 5-14).

8. Bleed brake system if necessary as described in section on bleeding brakes.

9. Adjust and test brakes as outlined previously in this section.

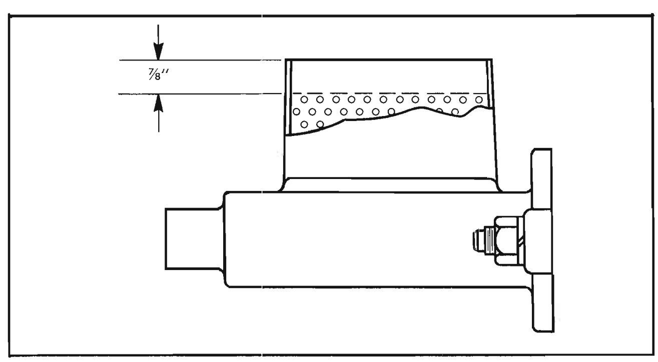


Fig. 5-14 Correct Fluid Level in Master Cylinder

TROUBLE DIAGNOSIS AND TESTING

TESTING FOR LEAK IN HYDRAULIC SYSTEM

NOTE: If there is any evidence of air in system, brakes must be bled before making this test.

1. Apply brakes manually, holding as steady a force as possible.

2. If pedal sinks slowly toward floor, a leak is indicated. Check for location of the leak by examining all lines, connections and wheel cylinders. If external leak is not found, remove master cylinder, disassemble and inspect parts. Leak will usually be past primary piston cup due to porus or damaged cup or cylinder bore.

NOTE: If leak at wheel cylinder has allowed fluid to reach lining, they must be replaced.

The following is a list of common troubles occurring in the brake system with possible causes and remedies:

PEDAL GOES TO TOE BOARD

CAUSE	REMEDY
Normal wear of lining.	Readjust or replace lining.
Low fluid level in master cylinder reservoir.	Low fluid level in reservoir will permit air to be pumped into hydraulic lines. This necessitates refilling reservoir and bleeding lines. Find cause of low fluid and correct.
External leak in hydraulic system, or leak past master cylinder primary piston cup.	Check for leak in system as outlined above.
Air trapped in hydraulic system.	Air trapped in hydraulic system gives pedal a very soft feel at the beginning of travel. Bleed brakes.

ALL BRAKES DRAG AFTER BRAKE ADJUSTMENT IS CHECKED AND FOUND TO BE CORRECT OR PEDAL BUILDS UP WITH USE

CAUSE	REMEDY
Mineral oil, etc., in system.	The presence in the hydraulic system of any mineral oil, kerosene, gasoline, shock absorber or transmission fluid, or carbon tetrachloride will cause swelling of rubber piston cups and valves, so they become inoperative. This is first noticed in the master cylinder. Brakes will not release freely if master cylinder primary piston cup has swollen sufficiently to obstruct the compensating port. Flush system thoroughly with a good grade of clean denatured alcohol and replace all internal rubber parts in brake system.

ALL BRAKES DRAG AFTER BRAKE ADJUSTMENT IS CHECKED AND FOUND TO BE CORRECT OR PEDAL BUILDS UP WITH USE (Continued)

CAUSE	REMEDY
Pedal does not return freely or push rod is adjusted too long.	Lubricate pedal linkage and make certain no bind exists. Also, see that pedal return spring has not lost its tension and promptly returns pedal to stop. See that stoplight switch is not defective, incorrectly adjusted or that switch plunger is not binding on pedal due to lack of lubrication.
Compensating port of master cylinder closed.	The compensating port in master cylinder must be completely clear when pedal is in released position. 1. See that pedal returns freely and is not stopped by contact with stop light switch body or pedal bracket. 2. See that push rod is not adjusted too long. 3. See that compensating port is not plugged by dirt. To check compensator port, remove master cylinder reservoir cover and watch the fluid in the cylinder as the brake pedal is moved. A "geyser" should be seen as the pedal is first depressed. If no geyser is seen, the compensating port is blocked. 4. Inspect master cylinder primary piston cup and if found to be swollen or elongated, flush system and replace damaged parts.

ONE WHEEL DRAGS

CAUSE	REMEDY
Improperly adjusted parking brake cables (rear wheels only) or stuck cable.	Adjust parking brake cables and lubricate.
Weak or broken brake shoe return springs.	Replace damaged brake shoe springs and lubricate brake shoe ledges and shoe contact at anchor pin with wheel bearing grease or brake lubricant.
Brake shoe to drum clearance too small.	Readjust brakes to secure complete freedom from drag.
Loose or incorrect front wheel bearings.	Adjust front wheel bearings or replace.
Wheel cylinder piston cups swollen or distorted or piston stuck.	Replace inoperative or damaged parts. Look for evidence of dirt in hydraulic system which could cause damage to the cylinders or cups. See first item under ALL BRAKES DRAG . . .
Obstruction in line.	Obstruction in line may be caused by foreign material in line or flattened or kinked tube. If dirt is found in line, remove obstruction and flush hydraulic system with fresh brake fluid. If tube is flattened or kinked, replace damaged parts.

ONE WHEEL DRAGS (Continued)

CAUSE	REMEDY
Support assembly shoe ledges grooved.	Grind or file ledges smooth and lubricate.
Incorrect brake shoe radius.	Replace malfunctioning brake shoe.

CAR PULLS TO ONE SIDE

CAUSE	REMEDY
Grease or fluid on lining.	Replace with new linings. Except on new cars it is almost always necessary to replace linings of both front brakes if one is damaged. See **BRAKE CAUTIONS**. Linings with even a slight trace of grease or fluid will cause trouble and can seldom be salvaged by cleaning. Correct cause of grease or fluid reaching linings.
Anchor pin adjustment on front brakes not correct.	Adjust all brakes (including anchor pin on front brakes). The anchor pin position is of great importance in maintaining equalized brakes.
Wheel bearings excessively loose.	Adjust wheel bearings.
Loose backing plate at rear axle or front knuckle.	Tighten backing plate.
Linings not to specifications, or primary and secondary shoes reversed. New and used linings mixed on one end of car.	Various kinds of linings have different friction effect on the drums and on each other. Each wheel must have similar linings. The primary and secondary linings must not be interchanged. Use only factory specified linings.
Tires not properly inflated or unequal wear of tread. Different tread non-skid design.	Inflate tires to specified pressures. Rearrange tires so that a pair with non-skid tread surfaces of similar design and equal wear will be installed on front wheels and another pair with like tread will be installed on rear wheels.
Linings charred or drums scored.	Sand surfaces of linings and drums. Remove particles of metal that have become imbedded in surfaces of linings. Seriously charred linings should be replaced. Replace springs which have been overheated.
Wheel cylinder link off shoe.	Check boot for holes. Check for burrs on wheel cylinder piston caused by piston forced against stop. Reinstall link.
Water, mud, etc., in brakes.	Remove any foreign material from all brake parts and the inside of drums. Lubricate shoe ledges and rear brake cable ramps with grease. Examine support assembly for damage.
Weak chassis springs, loose steering gear, etc.	Replace springs, adjust steering gear, etc.
Incorrect geometry setting of front suspension.	Adjust geometry so that car does not have a tendency to "lead" when driven on a level road.
Rigid and flexible shoes intermixed.	Use only approved parts.

SPONGY PEDAL

CAUSE	REMEDY
Air trapped in hydraulic system.	Remove air by bleeding (check compensating port for clearance of cup to provide full open port).
Brake adjustment not correct.	Adjust brakes (including anchor pin on front brakes).
Bent shoes.	Replace.

EXCESSIVE PEDAL PRESSURE REQUIRED TO STOP CAR

CAUSE	REMEDY
Brake adjustment not correct.	Adjust brakes (including anchor pin on front brakes).
Improper lining.	Install factory specified lining.
Improper shoes.	Install factory specified shoes.
Grease or fluid soaked linings.	Correct cause and replace linings. See BRAKE CAUTIONS.
Rusted wheel cylinder.	Replace necessary parts.
Wheel cylinder link incorrectly aligned.	Check wheel cylinder piston and boot for damage. Install link.
Compensating port not cleared.	Check pedal linkage, stoplight switch adjustment. See also COMPENSATING PORT under ALL BRAKES DRAG.

LIGHT PEDAL PRESSURE—BRAKES TOO SEVERE

CAUSE	REMEDY
Brake adjustment not correct.	Adjust brakes.
Loose support assembly on rear axle or front spindle.	Adjust front wheel bearings and tighten front backing plates. Tighten rear backing plates. Adjust brakes (including anchor pin).
Small amount of grease or fluid on linings.	Correct cause and replace linings.
Charred linings or scored drums.	Sand surfaces of linings and drums. Clean loose dust from brakes and drums. In severe cases replace shoes. Warn owner regarding abuse of brakes. Remove all particles of metal that have become imbedded in surfaces of linings. Slightly scored drums do not require replacing or turning.
Improper linings.	Install factory specified linings.

BRAKE NOISES

NOISE	CAUSE	REMEDY
1. *Squeak in brake with car stationary (sometimes mistaken for pedal squeak).	Shoe pads on backing plates dry and rusty.	Pry shoes out with screwdriver—apply grease sparingly to shoe pads with feeler stock.
2. *Creak when brakes are applied at low car speed.	Anchor pins dry.	Grease anchor pins where shoes bear.
3. *Snaps in brakes as pedal is applied, car stationary.	Hold down nail heads dry.	Lubricate.
4. Pedal squeak.	Return spring or stoplight switch rubbing pedal.	Lubricate.
5. Crunch or groan, holding car on hill.	Brake dust and possibly linings which have been overheated.	Sand linings and remove dust from brakes.
6. High pitch squeak while brakes operate.	A. New linings not yet fully burnished.	Let run or sand off high spots of linings.
	B. Persistent squeak — no apparent cause.	Sand linings for temporary cure or mild cases. Install drum springs for stubborn cases of high pitch squeak. (Pkg. No. 514278)
	C. Bonded linings.	
	D. Rigid brake shoes.	Install factory specified shoes.
7. Loud low pitch squeal at end of high rate stop.	A. New linings not fully burnished.	Check adjustment. Sand lining high spots.
	B. Incorrect adjustment.	Adjust.
	C. Bent backing plate (top of shoe webs should be in line with each other looking down on them. Check after pushing shoes toward backing plate at top).	Straighten or replace. NOTE: Drum springs not effective against low pitch squeal or howl.
8. Clicks during high rate stops, usually once per wheel revolution in one wheel only.	Threaded drum.	Disappears with usage as drum surface is conditioned by lining wear.
9. Chatter at high speed.	Drum out-of-round with 2 or more distinct high spots in circumference.	Sometimes corrects with usage. Turn drum.
With integral aluminum drums.	Drums out-of-round with mounting surfaces on wheels.	Replace wheels.

*Although adjusting brakes temporarily changes these noises, lubrication will remedy the noise.

BRAKE NOISES (Continued)

NOISE	CAUSE	REMEDY
10. Pedal throb at light applications at low speed.	Drum out-of-round or simply off center.	Turn drum.
With integral aluminum drums.	Drums out-of-round with mounting surfaces on wheels.	Replace wheels.
11. "Rough feel" during high rate stops from moderate speed.	Tool chatter. Look for faint light and darker stripes running across the braking surface.	Usually corrects with usage.
12. Loud clank as foot is slipped off depressed manual brake.	Normal for design.	For special complaints, stretch pedal return spring (make sure pedal returns strongly enough to positively operate stoplight switch even when pedal is eased back slowly).
13. Hissing noise as power brake unit operates.	Normal for design.	
14. *Click, first application after reversing.	Shoes holding out from anchor pins.	File shoe pads on backing plates; lubricate.

*Although adjusting brakes temporarily changes these noises, lubrication will remedy.

SPECIFICATIONS

NEW DRUMS

Inside diameter—Front .... 11″
—Rear .... 11″

Out-of-round including taper for full width (max.)—Front .... .005″
—Rear .... .006″

Indicator shall not change more than .0005″ in any inch of circumference.

Braking surface area .... 355 sq. in.

FLUID .... Fluid which complies with heavy duty standards of SAE 70R3 SPECIFICATIONS.

LINING

Width—Front .... 2½″
—Rear .... 2″

Thickness (front and rear) .... .220″

Braking surface area .... 173.6 sq. in.

Lining to Drum Gap .... .005″-.015″

MASTER CYLINDER BORE .... 1″

PEDAL HEIGHT (underside of standard pedal pad to floor mat) .... 6″-6¼″

WHEEL CYLINDER BORE—Front .... 1³⁄₁₆″
—Rear .... 1″

TORQUE SPECIFICATIONS

(Torque in lb. ft. unless otherwise specified)

TORQUE	SIZE	APPLICATION
		Wheel Brakes—Front and Rear
60-120 Lb. In.	3/8-24	Valve Assembly—Wheel Brake Cylinder Bleeder
60-90	5/8-18	Nut—Brake Shoe Anchor Pin Front
50-70	7/16-20	Bolt and Nut—Front Brake Assy. to Strg. Knuckle Lower
80-120	9/16-18	Bolt—Front Brake Assy. to Strg. Knuckle Upper
30-45	3/8-24	Bolt and Nut—Rear Brake Assy. to Axle Housing
		Brake Pedal and Connections to Master Cyl.
20-35	7/16-20	Bolt and Nut—Brake and Clutch Pedal Shaft
10-25	5/16-18	Bolt—Brake and Clutch Pedal Mtg. Brkt. to Plenum Chamber
60-120 Lb. In.	3/8-24	Nut—Master Cylinder Push Rod Trunnion Jam
20-35	3/8-24	Nut—Brake and Clutch Pedal Mtg. Brkt. to Dash
		Parking Brake Lever and Conn. to Interm. Lever
60-120 Lb. In.	5/16-24	Nut—Parking Brake Front Cable End to Clevis Jam
20-35	3/8-16	Bolt—Parking Brake Lever Assy. to Plenum Chamber Brkt.
10-25	5/16-18	Nut—Parking Brake Lever Assy. to Dash
		Brake Master Cyl. and Parking Interm. Lever
*		Cap Assembly—Brake Master Cylinder Filler
20-35	3/8-24	Nut—Brake Master Cylinder Assembly to Dash
		Brake Hook-up (From Master Cyl. and Interm. Lever)
5-15	5/16-24	Bolt—Parking Brake Rear Cable Anchor to Brake
10-15	5/16-18	Screw—Front and Rear Brake Hose Bracket to Frame
10-15	5/16-18	Screw—Rear Brake Hose Brkt. to Frame
10-15	5/16-18	Screw—Master Cylinder Brake Pipe Conn. to Frame
50-100 Lb. In.	No. 14-10	Screw—Parking Brake Rear Cable Guide to Frame
*	1/4 (Tube)	Nut—Brake Pipe Connector

HEAVY DUTY BRAKES

GENERAL

Provision has been made for heavy duty brakes on vehicles subjected to severe braking such as ambulances and police cars. These brakes consist of the conventional brake system plus special heavy duty drums.

The massive front drums are aluminum. Rear drums are of special alloy heavy iron construction to control thermal expansion (Fig. 5-16). 15" wheels are required with these drums.

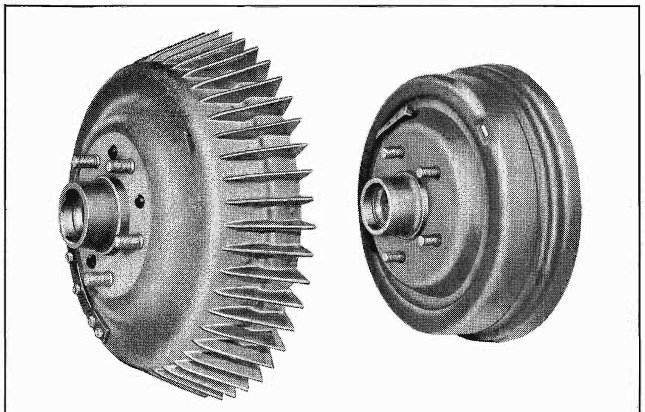


Fig. 5-15 Comparison of Heavy Duty and Standard Front Brake Drums

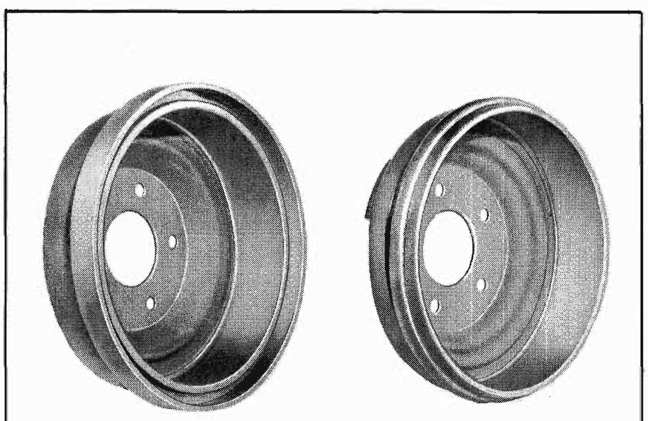


Fig. 5-16 Comparison of Heavy Duty and Standard Rear Brake Drums

ALUMINUM INTEGRAL HUB AND DRUM ASSEMBLIES

These special drum and wheel combinations have exceptional brake performance characteristics. However, for appearance reasons, feeler gauge slots have been omitted.

If it is necessary to check anchor pin adjustment, substitute a conventional drum of equivalent diameter. Brakes may be adjusted using procedure for fixed anchor pin.

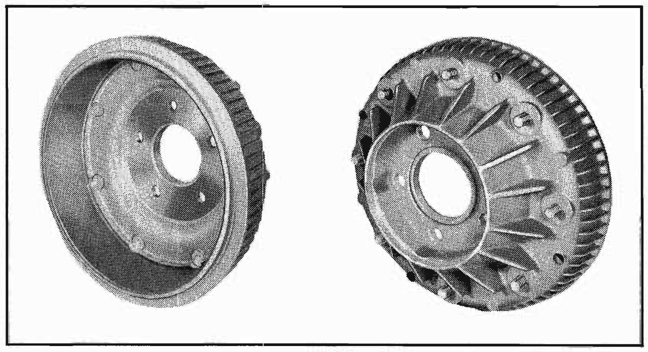
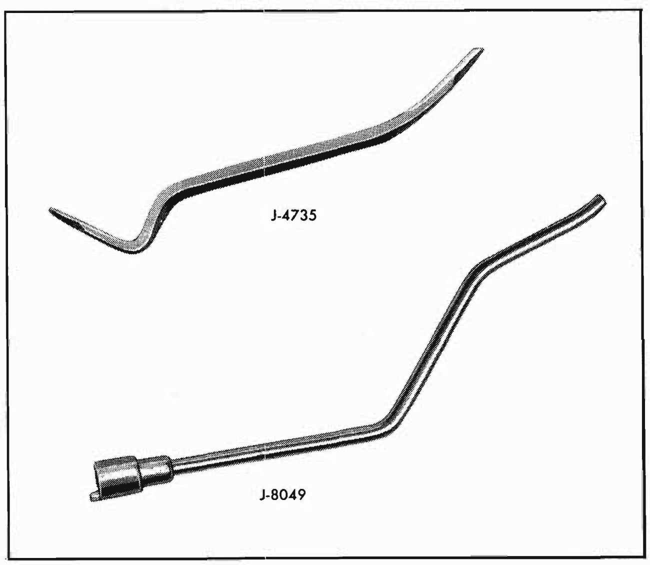


Fig. 5-17 Drum Assembly for Integral Wheel

SPECIAL TOOLS



J-4735 Brake Adjusting Tool

J-8049 Brake Spring Remover and Replacer

Fig. 5-18 Special Tools

BENDIX POWER BRAKE

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

The Bendix power brake unit can be identified by its all-black color and vacuum cylinder housing cover fastened on with screws, (Fig. 5-B-1).

The power brake unit is a combined vacuum and hydraulic unit for power braking and replaces the conventional master brake cylinder. This brake assembly has an overall ratio of 2¾ to 1 (2¾″ of pedal travel moves the power piston 1″). The wheel brakes are the same, manual or power.

Pedal travel compared to the conventional braking system is greatly reduced. Its height is approximately ⅞ inch above the accelerator pedal, permitting the driver to shift his toe from one pedal to the other without lifting his heel from the floor. Lighter pedal pressures are also required for normal stops.

The power brake unit utilizes engine intake manifold vacuum, and atmospheric pressure for its operation. These units are self-contained, requiring no additional rods or levers. Two external vacuum line connections to this unit are necessary. One is a connection to the carburetor, the other to the vacuum reservoir. A hydraulic connection into the hydraulic brake system is also required.

A vacuum check valve is connected to the engine intake manifold to prevent loss of vacuum when manifold vacuum falls below that in the power brake system. A tube leads from the check valve to the vacuum exhaust tube on the power brake unit which is also connected to the vacuum reservoir.

In case of engine failure and consequent loss of engine vacuum, several applications of the brakes are possible by using vacuum retained in the vacuum reservoir. In case of complete vacuum loss, brakes can be applied in the conventional manner, although more effort is required due to loss of power assist.

DESIGN

The Bendix power unit is composed of two main sections, a vacuum power cylinder and a hydraulic master cylinder. (A cross sectional view of the Bendix "Master-Vac" is shown in Fig. 5-B-2.)

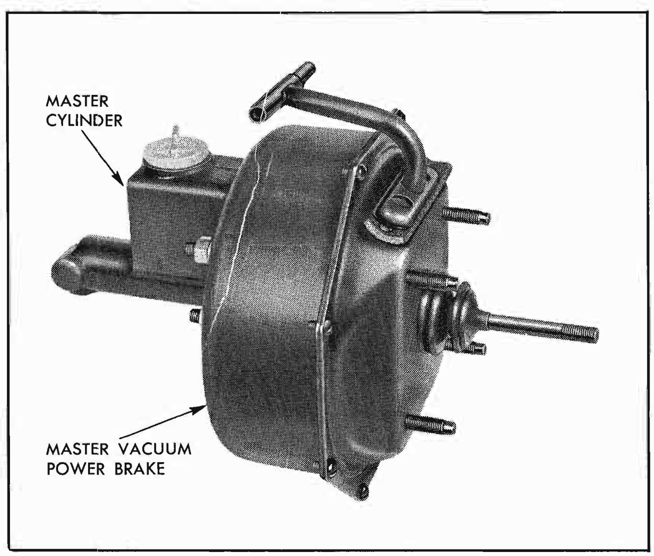


Fig. 5-B-1 Bendix Power Brake Assembly

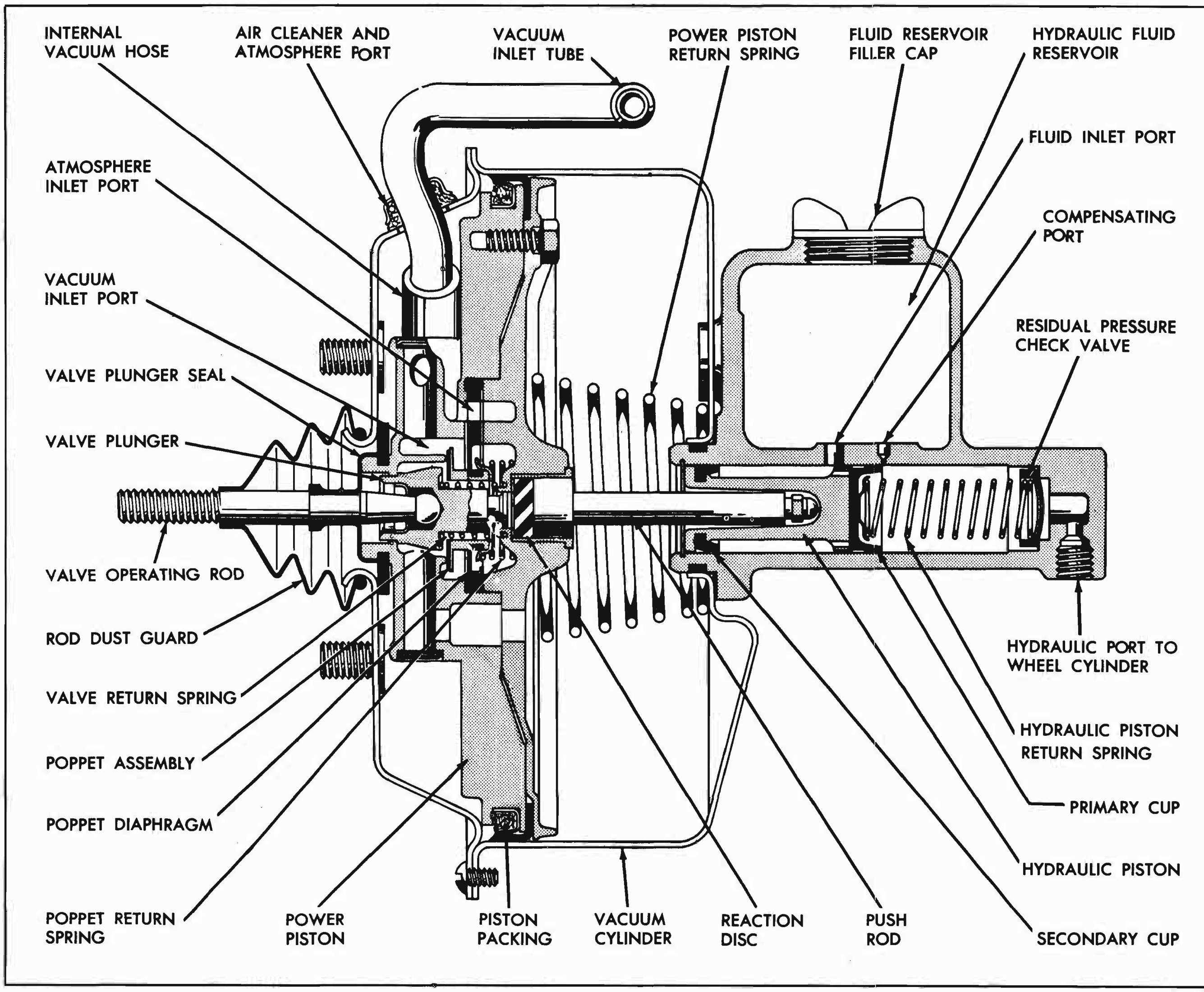


Fig. 5-B-2 Bendix Power Brake Cross Sectional View

The vacuum power cylinder contains the power piston assembly which houses the control valve and reaction mechanism, the power piston return spring and the master cylinder push rod which contacts the piston in the hydraulic master cylinder. A power piston and return spring gives quick response, lighter pedal effort and improved control. The control valve is made up of the air valve and a floating control valve assembly.

The reaction mechanism consists of a soft rubber disc, an air filter and a tube for connection to the vacuum source on the outside of the power cylinder housing. A push rod, which operates the air valve, projects out the end of the power cylinder housing through a boot and attaches to the brake pedal.

The master cylinder attaches to the vacuum power cylinder. A rubber ring between these two units seals against atmospheric pressure leaks. A secondary seal around the master cylinder piston prevents hydraulic fluid in the master cylinder from entering the vacuum area in the power cylinder.

A fluid reservoir is cast integrally with the master cylinder. Inside the master cylinder are the conventional parts; a snap ring which retains a piston and secondary seal, a primary cup, check valve spring and retainer, and check valve.

PRINCIPLES OF OPERATION

The operation of the Master-Vac power brake unit is basically one that uses differences in air pressure to

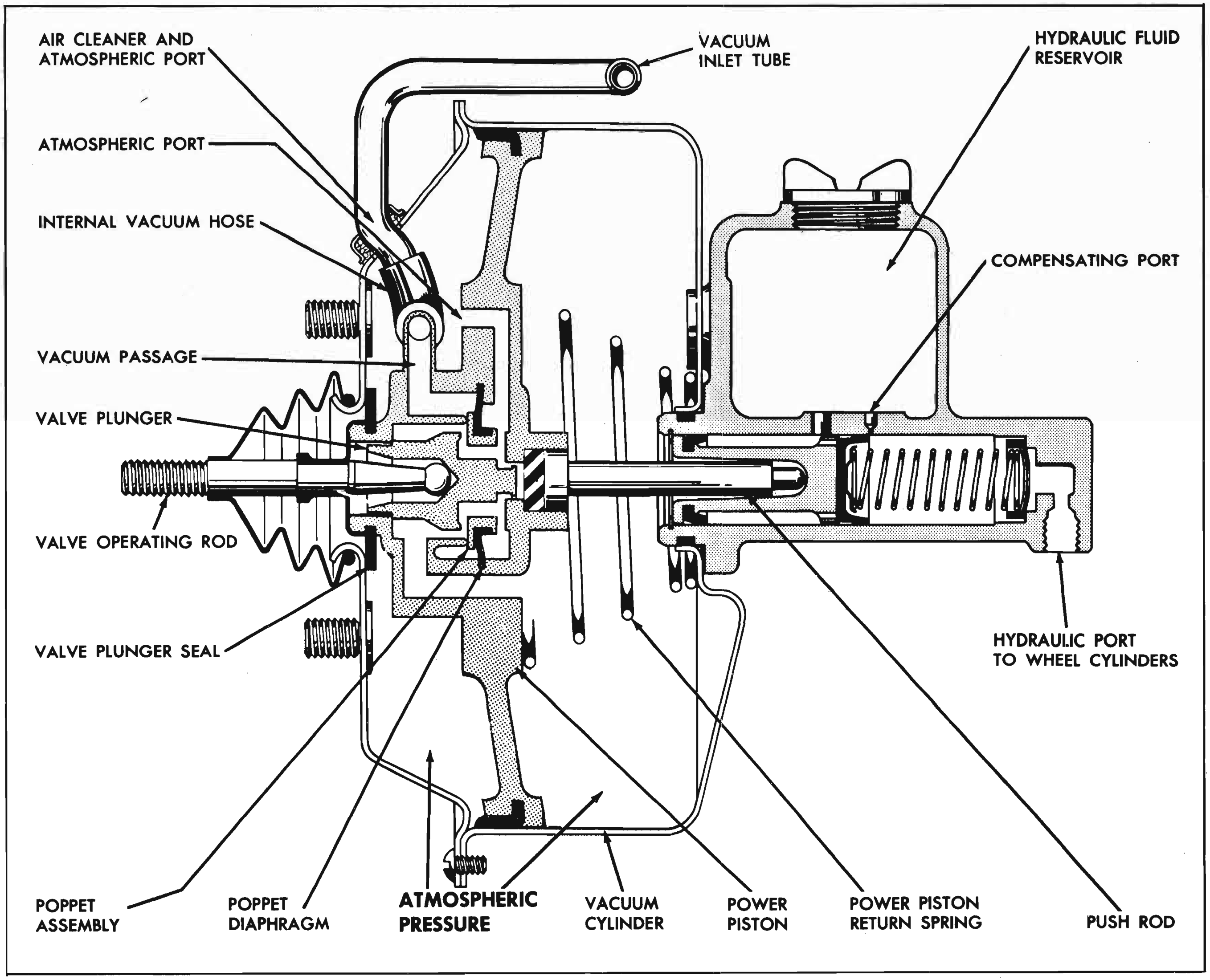


Fig. 5-B-3 Released Position

assist in braking and incorporates a "disc reaction" which is covered in APPLYING.

***RELEASED POSITION* (See Fig. 5-B-3)**

The valve seat for vacuum passage is a part of the vacuum power piston. The seat for the atmospheric passage is a part of the valve plunger which moves within the power piston. The valve plunger is connected to the brake pedal through the valve operating rod and linkage. A rubber boot forms a seal between the vacuum power piston and the valve operating rod. The valve poppet is supported within the power piston by a rubber diaphragm. In the released position, a poppet return spring and atmospheric pressure hold the poppet against the vacuum port seat. The large power piston return spring returns the vacuum power piston to the released position. A valve return spring normally holds the valve plunger in the released position but is overcome when pedal force is applied to the valve operating rod from the pedal.

Atmospheric air which supplies the push for operation of the Master-Vac is admitted to the rear of the power cylinder chamber (left in the diagrams) through an air cleaner attached to the vacuum cylinder shell. Vacuum is admitted to the Master-Vac from the intake manifold via the carburetor throttle body through a check valve, a vacuum reservoir, tubing and hose and is led to the vacuum side of the control valve.

With the engine running and the brakes released, the valve operating rod and plunger are held toward the dash in the power piston by the valve return spring to CLOSE the vacuum port and OPEN the

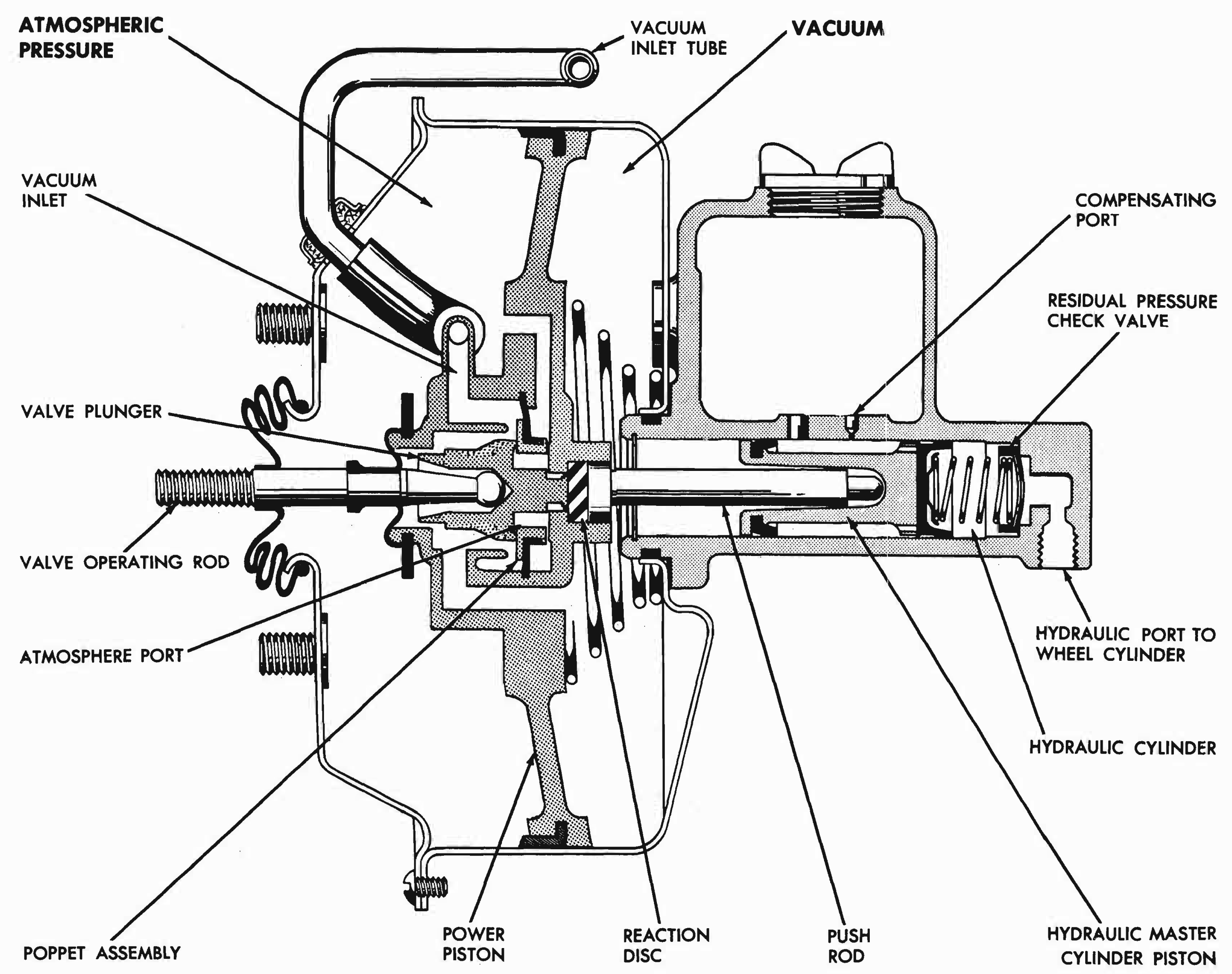


Fig. 5-B-4 Applying Position

atmospheric port. The atmosphere present in the cylinder chamber to the left of the power piston is then free to pass through to the chamber at the right of the piston. The power piston is held in the released position by the large power piston return spring, since atmospheric pressure is present on both sides of the piston.

The hydraulic push-rod is also in the released position and the compensating port in the hydraulic master cylinder is open to permit fluid to equalize, between the brake system and the fluid reservoir. This free flow prevents dragging brakes and eventual lockup when the fluid expands due to rising temperature.

APPLYING (See Fig. 5-B-4)

As the brakes are applied by the driver, the valve operating rod and valve plunger moves into the power piston to compress the valve return spring and bring the valve plunger seat in contact with the poppet valve to CLOSE the atmospheric port. Any additional movement of the valve operating rod and valve plunger in the apply direction will move the poppet away from the vacuum valve seat to open the vacuum port and establish direct communication through the power piston and valve to the forward side of the power piston.

With vacuum on the forward side of the power piston, atmospheric pressure on the back side of the

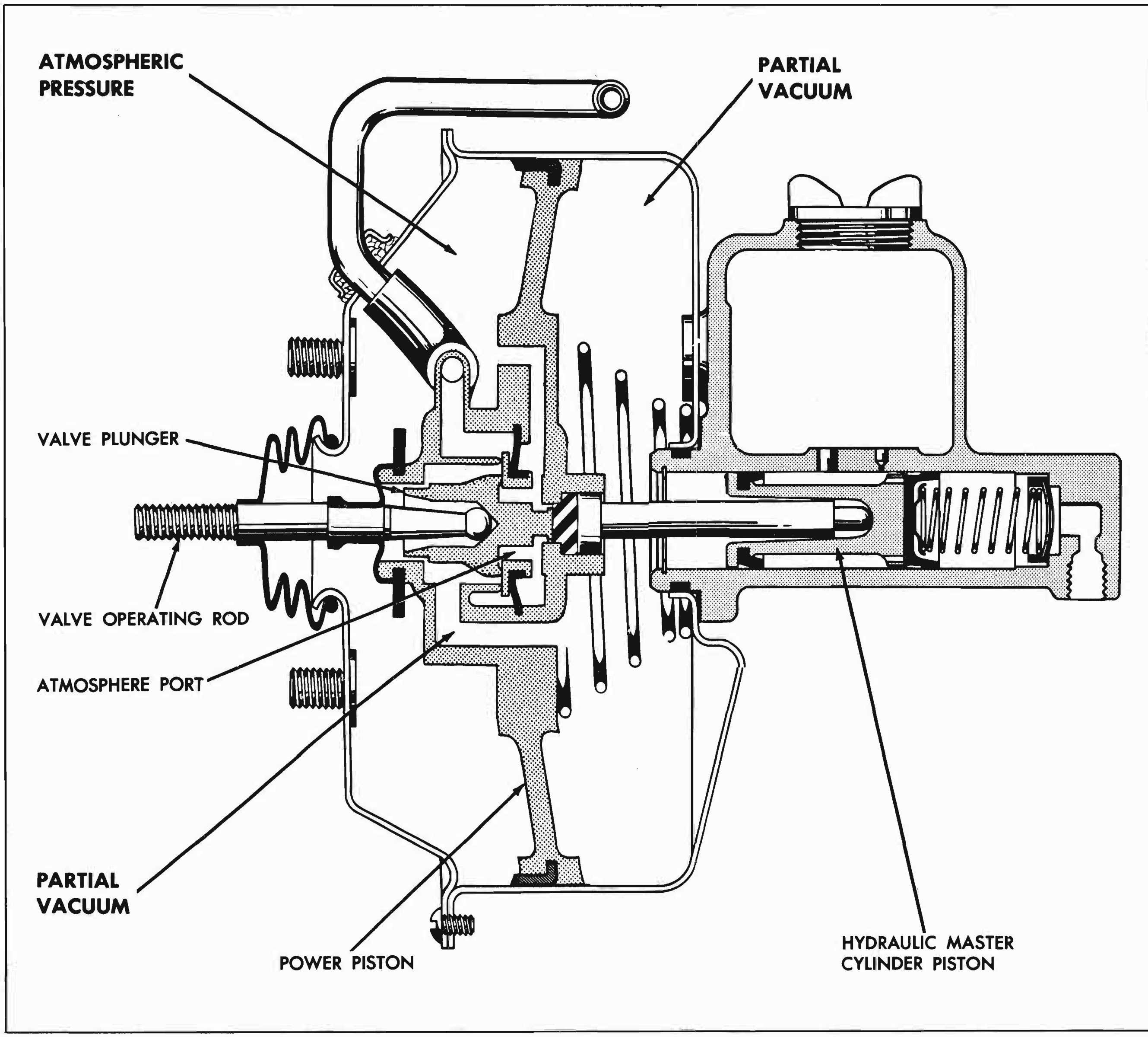


Fig. 5-B-5 Holding Position

piston, moves the power piston. This movement carries the hydraulic push rod and piston to the right to close the compensating port and force hydraulic fluid under pressure through the residual pressure check valve and brake tubes into the wheel cylinders.

As hydraulic pressure is developed in the hydraulic cylinder, the load in the hydraulic push rod increases correspondingly and in effect pushes back against the reaction disc. The soft rubber reaction disc bulges through the small hole in the center of the power piston and presses on the end of the valve plunger. The hole is small so only a fraction of the total reaction force finds its way back to the driver's foot.

VACUUM RUNOUT (See Fig. 5-B-4)

When the driver calls for more braking than the available vacuum can supply, the valve plunger holds the vacuum port full open, bottoms against its seat on the power piston, and transmits all of the driver's excess pedal force directly into the master cylinder. Because all braking beyond this point of vacuum runout is "manual," much greater effort is required.

HOLDING (See Fig. 5-B-5)

In an actual brake application the driver's foot moves the pedal with a force calculated through

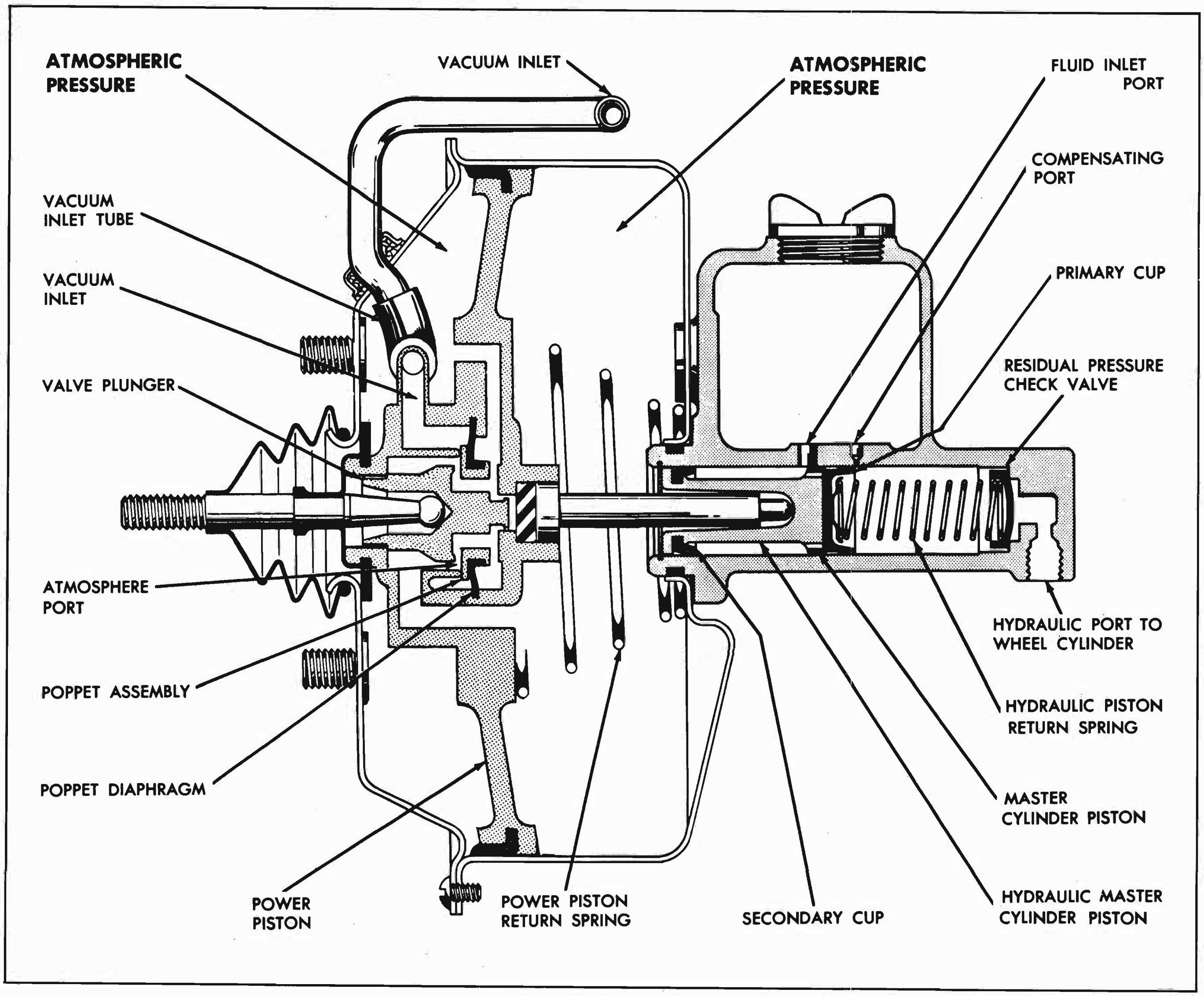


Fig. 5-B-6 Releasing

experience to provide the desired braking. Hydraulic pressure and reaction force build up rapidly as the pistons move to the right under full vacuum flow. When the driver's effort and the reaction force balance each other the valve plunger is shifted slightly to the left by the bulging reaction disc and vacuum is shut off.

The power unit remains in this holding position until the driver changes his load on the pedal signalling need for more or less braking. When this occurs, the resultant upset balance between driver pedal load and power unit reaction moves the valve plunger to open either vacuum or atmospheric port. Air flow then repositions the pistons to a new hold position corresponding to the new pedal load.

RELEASING (See Fig. 5-B-6)

As the force on the pedal is released, the valve return spring forces the air valve away from its contact with the poppet assembly. The poppet diaphragm is held against the power piston, shutting off the vacuum to the area between the power piston assembly and the master cylinder. The valve being away from the poppet assembly allows atmospheric pressure to enter into the vacuum cylinder. Since both sides of the power piston are now open to atmospheric pressure, the power piston return spring forces the piston assembly back against the mounting bracket and cover assembly.

As the power piston and hydraulic master cylinder piston move back, the fluid from the wheel cylinders flows back into the hydraulic master cylinder (by unseating the residual pressure check valve) and into the reservoir.

The fluid reservoir, cast integrally with the master cylinder, supplies fluid to the space between a primary and secondary seal through a by-pass hole in the casting. When the brake pedal is released quickly, fluid pressure, check valve spring and the power piston return spring force the master cylinder piston to return immediately (to the released position). If hydraulic fluid from the lines cannot return as quickly as the master cylinder piston, compensation is provided for by a flow of fluid from the space between the primary cup and secondary seals through the holes in the master cylinder piston. The excess fluid in the brake system can flow back through the compensating port.

CHECKS AND ADJUSTMENTS ON CAR

1. Check for free operation of brake pedal. If binding exists, check all pivot points for binding and lubricate as required.

2. Check stop light switch for proper setting and operation.

3. Check fluid level in hydraulic cylinder reservoir. Fluid level should be 1″ from top of filler plug opening.

4. Check vacuum lines and connections between carburetor, check valve, vacuum reserve tank and vacuum power cylinder for possible vacuum leaks.

5. Check engine for good stall-free idle, correct as required.

6. Check condition of air cleaner element and insert new element if necessary.

MINOR REPAIRS

BLEEDING BRAKES

Brakes should be bled in the same manner as standard brakes.

STOP SWITCH—REMOVE AND REPLACE

REMOVE

1. Disconnect wires from switch.

2. Remove nut retaining switch to bracket.

3. Remove switch.

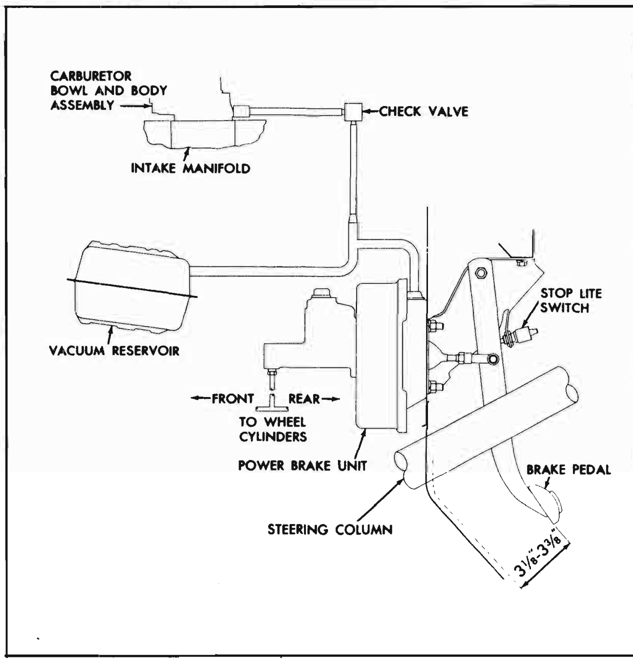


Fig. 5-B-7 Simple Schematic of Power Brake System

REPLACE

1. Install first nut on new switch assembly.

2. Position switch in stop light switch bracket and install second nut.

3. Connect wires to stop light switch.

4. Ensure that brake pedal is retracted (out) to its fully released position, and position switch so that approximately $\frac{3}{16}$″ of the plunger extends from the switch body.

5. Tighten lock nut to 15-40 in. lb. torque.

OVERHAUL BENDIX POWER BRAKE

MASTER CYLINDER—REMOVE

Certain repair operations, such as replacement of master cylinder internal parts, permit the master cylinder to be removed by itself, leaving the power cylinder and brackets in the car.

1. Remove hydraulic connection from master cylinder. Cover opening and pipe end to exclude dust, dirt, etc.

2. Remove four nuts and lock washers from vacuum cylinder studs extending through master cylinder assembly.

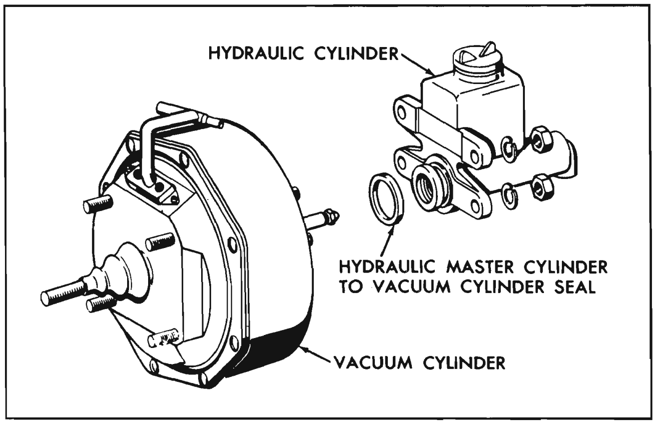


Fig. 5-B-8 Master Cylinder and Power Brake Assembly Separated

3. Remove master cylinder from vacuum power section. Cover opening in power cylinder to exclude dirt.

POWER BRAKE ASSEMBLY—REMOVE

1. Disconnect vacuum hose from reservoir and carburetor pipe at vacuum inlet manifold. Cover hose and pipe openings to exclude dust, dirt, etc.

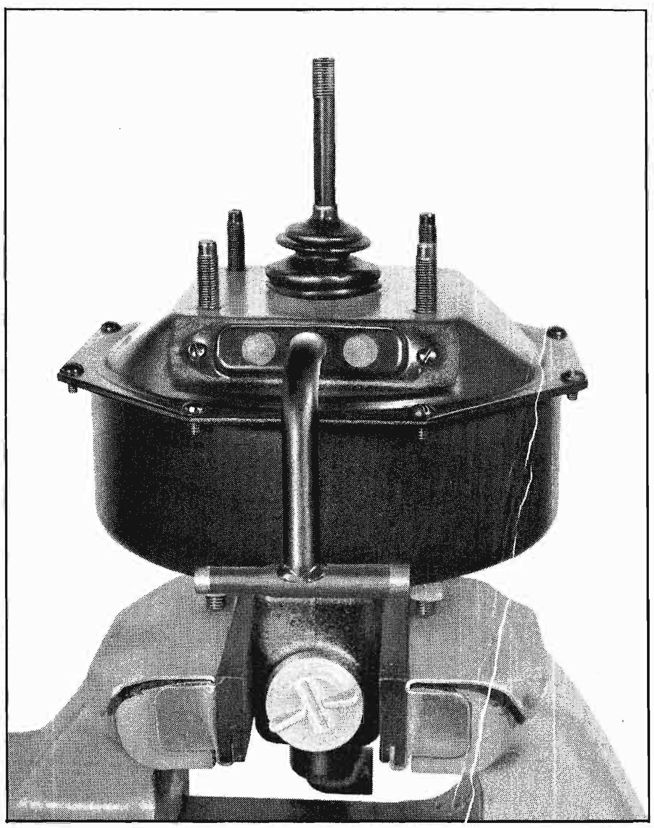


Fig. 5-B-9 Bendix Brake Assembly Mounted in Vise

2. Disconnect pipe from master cylinder hydraulic port and cover opening and pipe end to exclude dust, dirt, etc.

3. Remove clevis pin from brake pedal inside the car.

4. Remove four nuts and lock washers from vacuum cylinder studs and remove vacuum cylinder assembly. See Fig. 5-B-8.

5. Clean exterior of power brake assembly and drain reservoir of hydraulic fluid.

DISASSEMBLE OVER-ALL UNIT

1. Mount power brake assembly in vise clamping on sides of master cylinder reservoir with valve operating rod up (Fig. 5-B-9).

2. Remove dust cover from valve operating rod.

3. Remove six of the eight end plate attaching screws, leaving two opposite screws. Press down on end plate while removing remaining two because end plate is under 13 lb. spring load.

4. Remove end plate with power piston assembly still connected by the vacuum tube. (The hydraulic master cylinder piston push rod is now free to fall out of the power piston assembly. Use caution so ends of push rod are not damaged. See Fig. 5-B-10.)

5. Remove piston return spring.

6. Pull vacuum hose from fitting on inside of end plate. Separate end plate from power piston assembly and lay power piston aside, on a clean, smooth surface.

7. Reposition master cylinder in vise and remove four (4) nuts and lock washers from vacuum cylinder studs extending through master cylinder assembly and remove vacuum cylinder.

8. If under-hood area is dusty and on high mileage units remove air cleaner attaching screws, vacuum tube and air cleaner assembly, and replace air filter.

DISASSEMBLE POWER PISTON ASSEMBLY

CAUTION: Exercise extreme care in handling of power piston seal and all rubber surfaces and metal parts in this assembly. They should be guarded against grease, oil and foreign matter and must be protected from nicks or cuts that might be caused by rough surfaces or damaged tools.

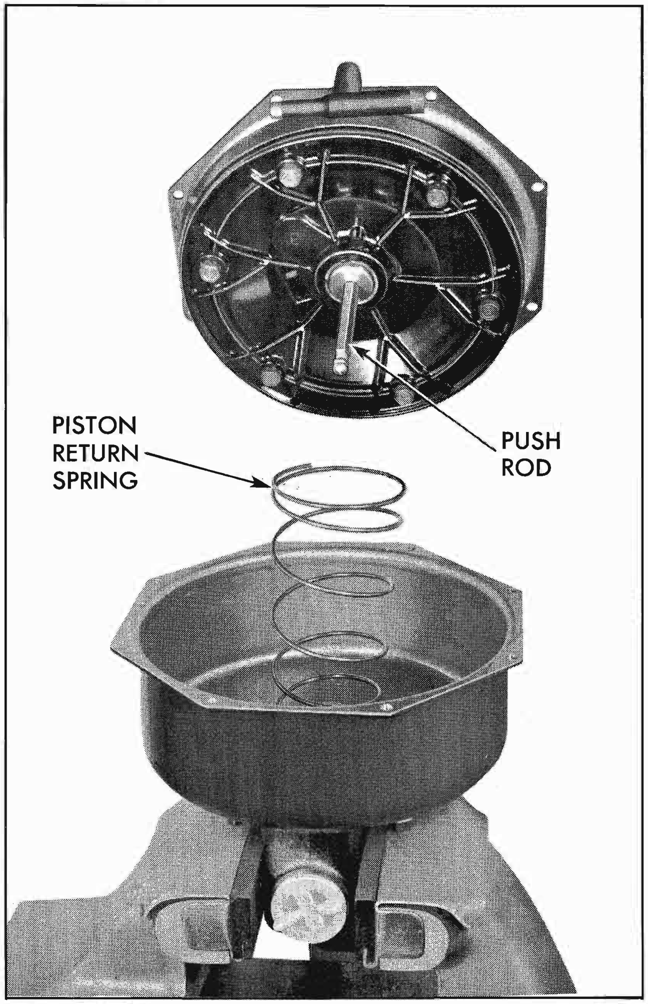


Fig. 5-B-10 Separating Power Piston and End Cover from Vacuum Cylinder

1. Gently mount power piston in a vise with plugged ends of vacuum passages against one vise jaw (Fig. 5-B-11).

CAUTION: DO NOT *tighten any more than necessary to hold power piston in position.*

2. Remove six piston plate attaching screws and lockwashers and separate front piston plate from piston.

NOTE: The piston plate is under spring tension.

3. Remove valve return spring, poppet spring, diaphragm support plate, and poppet and diaphragm assembly.

4. Remove felt retaining ring (leather), expanding ring and felt.

5. Do not further disassemble poppet and diaphragm assembly unless it is necessary to replace damaged or faulty parts.

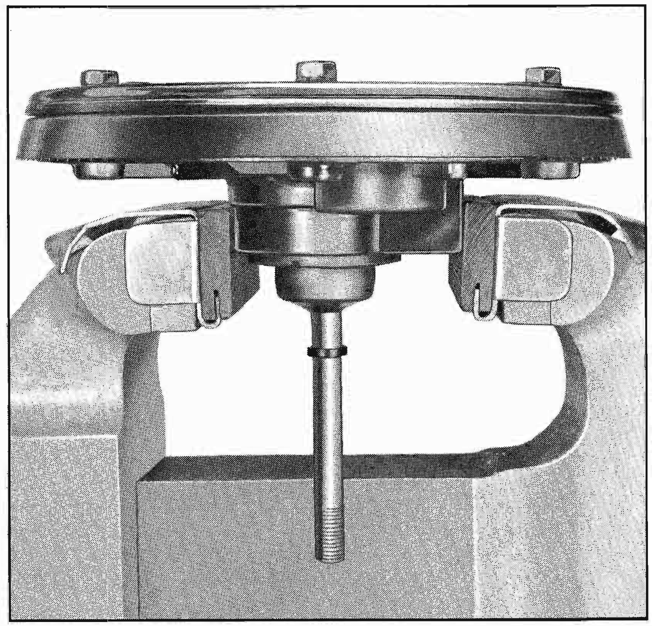


Fig. 5-B-11 Power Piston in Vise

6. Remove power piston from vise.

7. When it is found necessary to replace either valve operating rod or valve plunger, remove valve rod seal from groove in piston plate. Pull seal over end of rod. Remove valve plunger and rod from piston plate.

8. Hold assembly with rod up and pour alcohol in valve plunger and rotate rod to wet the rubber lock in the plunger. Clamp rod in vise with about 1/8 inch between vise and valve. Pry valve plunger off with large screwdriver using care not to nick or burr valve.

DISASSEMBLE MASTER CYLINDER (SEE Fig. 5-B-13)

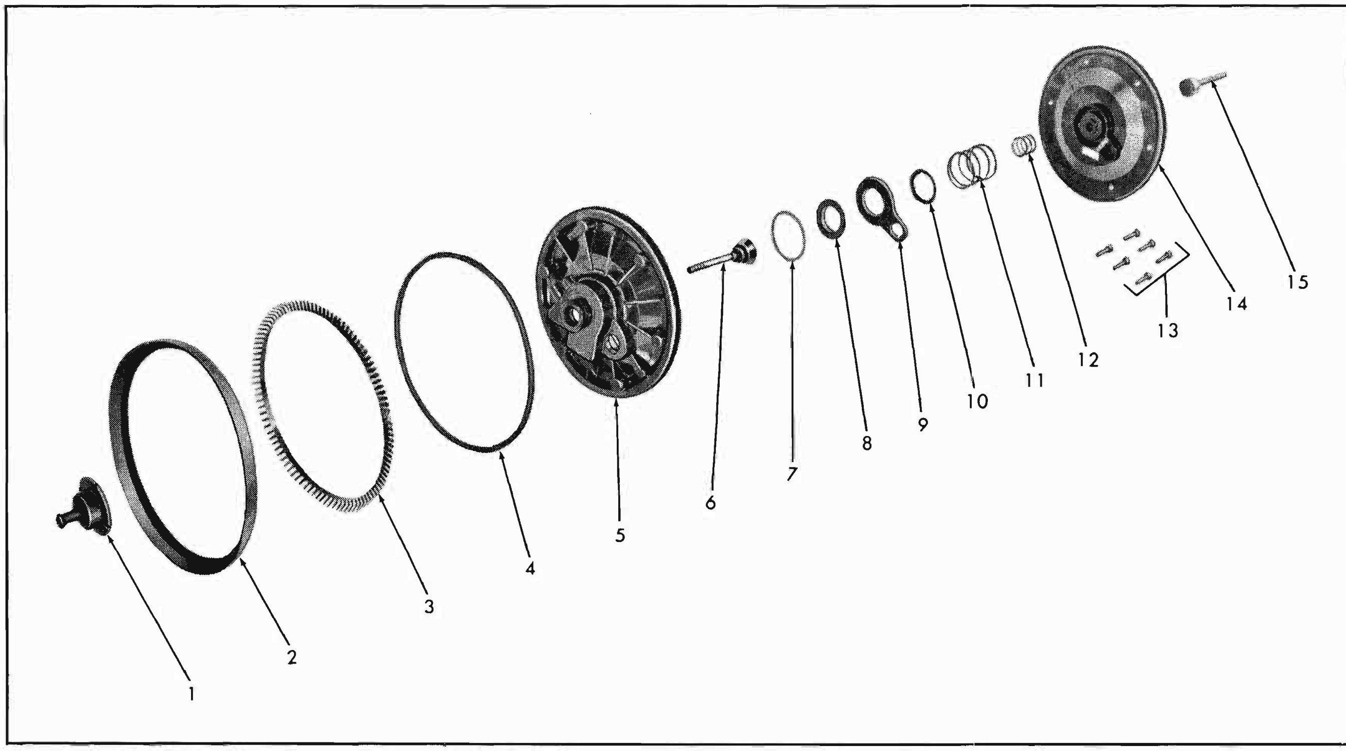
1. Remove master cylinder to vacuum cylinder seal from hub on master cylinder.

2. Remove snap ring from groove in bore at rear of master cylinder.

3. Remove piston assembly, primary cup, piston return spring assembly and residual pressure check valve from master cylinder.

4. Do not further disassemble the piston assembly, return spring assembly, or the check valve assembly unless it is necessary to replace damaged or faulty parts.

5. If necessary, remove the secondary cup from the piston using a thin blade screwdriver or a scribing tool to lift the cup out of the piston groove.



1. Valve Plunger Seal
2. Leather Piston Packing
3. Felt Expanding Ring
4. Felt
5. Front Piston Plate
6. Valve Operating Rod and Valve Plunger
7. Diaphragm Support Plate
8. Poppet
9. Poppet Diaphragm
10. Poppet Spring Retainer
11. Poppet Return Spring
12. Valve Return Spring
13. Piston to Front Piston Plate Screws
14. Piston
15. Push Rod

Fig. 5-B-12 Power Piston Assembly—Exploded View

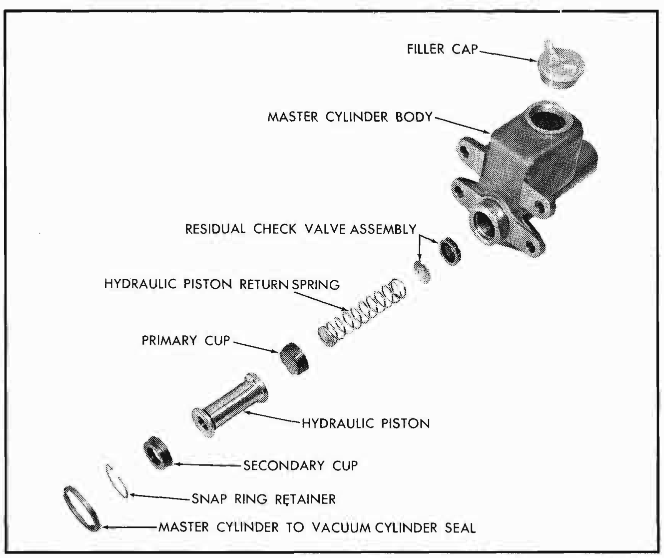


Fig. 5-B-13 Master Cylinder Assembly—Exploded View

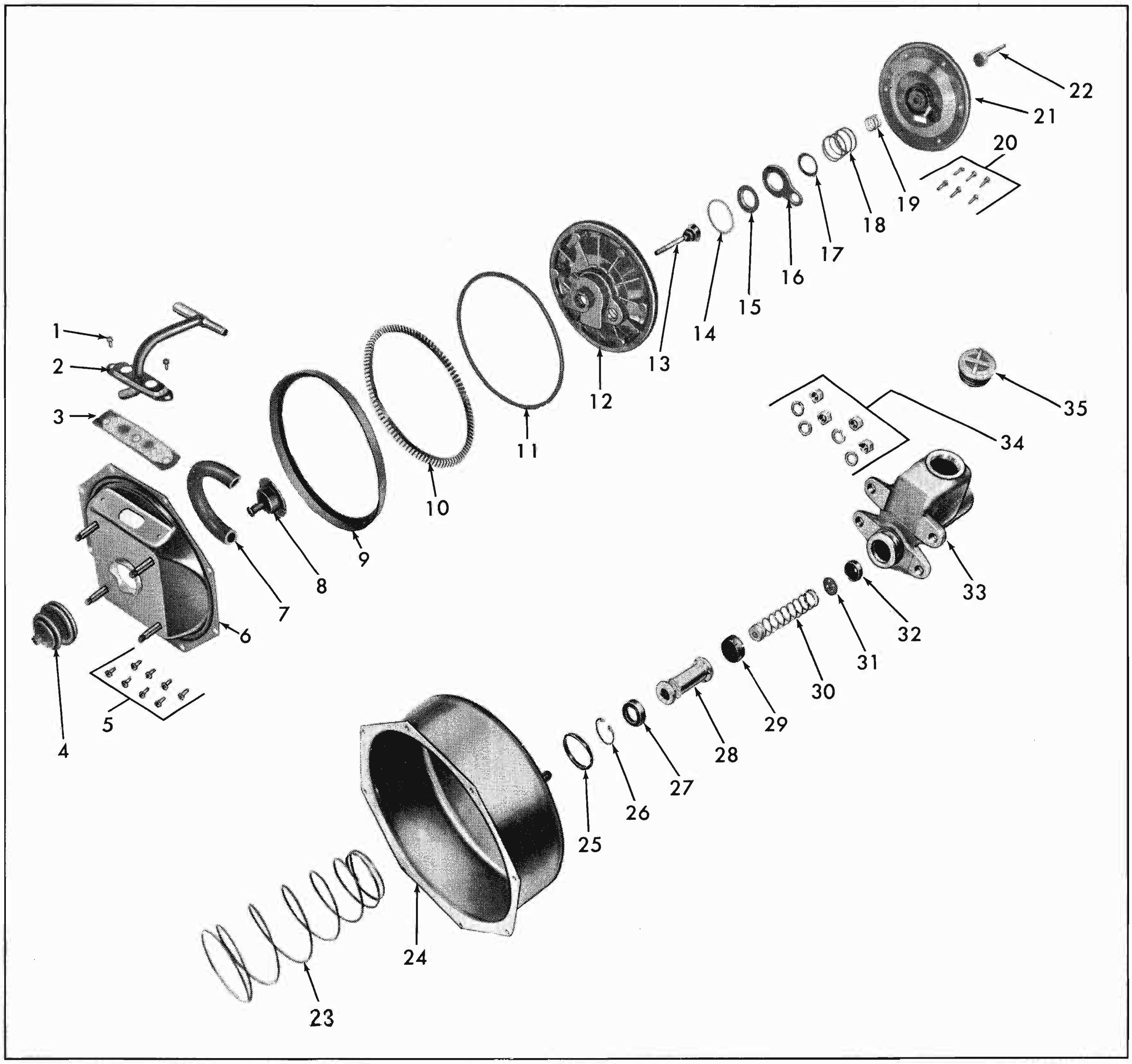
INSPECTION—CLEANING

Thoroughly wash all parts in alcohol and air dry. Blow dust and cleaning fluid out of all internal passages. If inside of front housing is slightly scored or scratched, clean with crocus cloth or fine emery cloth. If scratches in front housing cannot be removed, replace housing.

CAUTION: It is important that all parts be placed on a clean paper or cloth after being cleaned to prevent the possibility of dirt being assembled into unit or grease contacting any rubber parts.

INSPECTION—POWER BRAKE ASSEMBLY

Inspect all parts for scoring, pitting, dents or nicks. Small imperfections can be smoothed out with fine emery cloth or replaced if badly nicked, scored, or otherwise damaged.



1. Exhaust Manifold Screws
2. Exhaust Manifold Assembly
3. Air Filter Element
4. Auxiliary Push Rod Dust Cover
5. End Plate to Vacuum Cylinder Screws
6. End Plate Assembly
7. Internal Vacuum Hose
8. Valve Plunger Seal
9. Leather Piston Packing
10. Felt Expander Ring
11. Felt
12. Front Piston Plate
13. Valve Operating Rod
14. Diaphragm Support Plate
15. Poppet Assembly
16. Poppet Diaphragm
17. Poppet Spring Retainer
18. Poppet Return Spring
19. Valve Return Spring
20. Piston to Front Piston Plate Screws
21. Piston Front Plate
22. Push Rod
23. Piston Return Spring
24. Vacuum Cylinder
25. Master Cylinder to Vacuum Cylinder Seal
26. Snap Ring Retainer
27. Secondary Cup
28. Hydraulic Piston
29. Primary Cup
30. Hydraulic Piston Return Spring Assembly
31. Residual Check Valve Retainer
32. Residual Check Valve Diaphragm
33. Master Cylinder Body
34. Master Cylinder to Power Cylinder Nuts and Lock Washers
35. Filler Cap

Fig. 5-B-14 Bendix Power Brake Assembly—Exploded View

INSPECTION—HYDRAULIC MASTER CYLINDER ASSEMBLY

Inspect bore from the open end. The bore should be free from scores, deep scratches and corrosion. If it appears that brake fluid has damaged the bore, replace damaged parts and flush out entire brake system including wheel cylinders.

The sealing surfaces should be clean and smooth. Check for cracks and damaged threads. Be sure that the by-pass and compensating ports to the master cylinder are not restricted.

Check for distortion of all springs and deterioration of all rubber parts. Any evidence of soft or swollen rubber parts indicates contaminated brake fluid requiring flushing of the entire brake system and replacement of wheel cylinder cups as well as all rubber parts in master cylinder.

Replace primary cup if worn.

AIR FILTER

Replace air filter element if dirty.

ASSEMBLE BRAKE ASSEMBLY

MASTER CYLINDER—ASSEMBLE (See Fig. 5-B-15)

1. Clamp master cylinder in vise with front end slightly below horizontal.

2. If secondary cup has been removed, dip cup in brake fluid and assemble over end of piston.

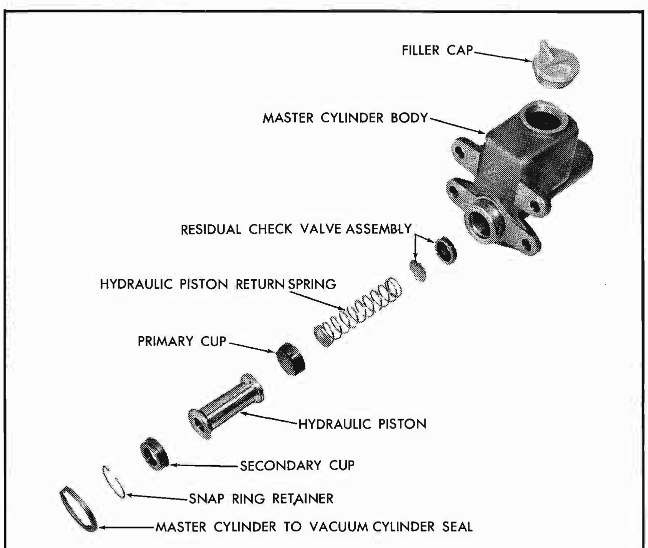


Fig. 5-B-15 Master Cylinder Assembly—Exploded View

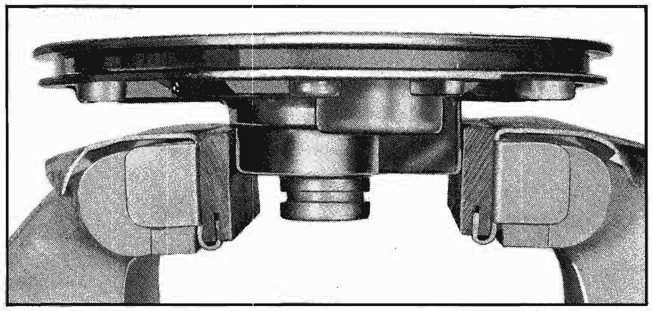


Fig. 5-B-16 Rear Piston Plate in Vise

3. Dip piston assembly, primary cup and residual check valve in brake fluid. Stack parts on piston in order shown and assemble in master cylinder far enough to clear snap ring groove.

4. Install snap ring in groove of cylinder. Make certain snap ring is firmly seated in groove.

5. Install master cylinder to power cylinder seal in groove on master cylinder body. Lubricate outer edge of seal with silicone grease.

6. Fill reservoir with brake fluid and operate piston by hand until no more bubbles arise in reservoir. If this is done carefully, bleeding brakes on car may not be required.

7. Replace filler cap.

8. Remove master cylinder assembly from vise.

ASSEMBLE POWER PISTON

1. *Gently* clamp rear piston plate in vise with plugged ends of vacuum passage against one vise jaw. (Fig. 5-B-16).

2. If valve operating rod and valve plunger were separated, check for damaged rod ball retainer then assemble these parts as follows: Dip valve plunger in alcohol and assemble to ball end of valve rod. Make certain ball end of rod is locked in place in valve plunger. It may be necessary to tap end of valve operating rod to seat ball end of rod in valve plunger. Avoid burring small end of valve plunger.

3. Insert valve and rod assembly through power piston with threaded end of operating rod down.

4. Assemble poppet diaphragm and related parts as follows (Figs. 5-B-17 and 5-B-18).

a. Place diaphragm back-up washer into power piston.

b. Make certain poppet is in recess of diaphragm.

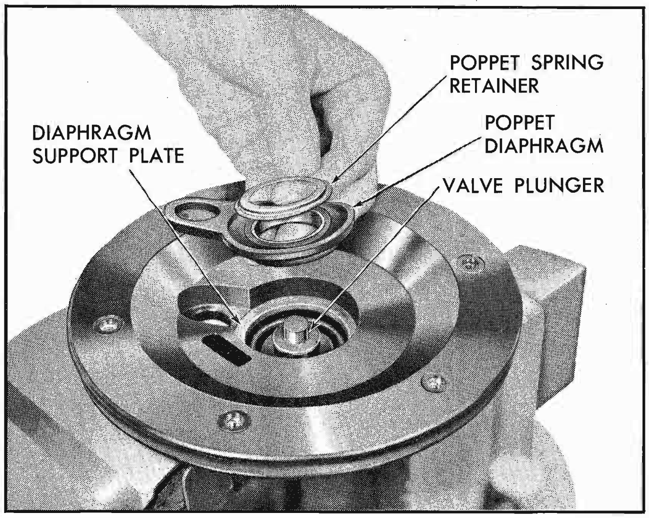


Fig. 5-B-17 Installing Poppet Assembly Parts

c. Install poppet spring retainer by pressing poppet spring retainer over end of poppet and diaphragm.

5. Install valve return spring over end of valve plunger and poppet spring over retainer.

6. Lay leather piston packing on rear plate with lip down (Fig. 5-B-19).

7. Align and assemble front piston plate with rear piston plate as follows:

a. Center poppet spring on front piston plate and center valve plunger stem in hole of front piston.

b. If new felt is installed, cut to length of original part and saturate in Hydra-Matic fluid or power brake lubricant. Let the excess oil drip off. Keep Hydra-Matic fluid away from rubber parts.

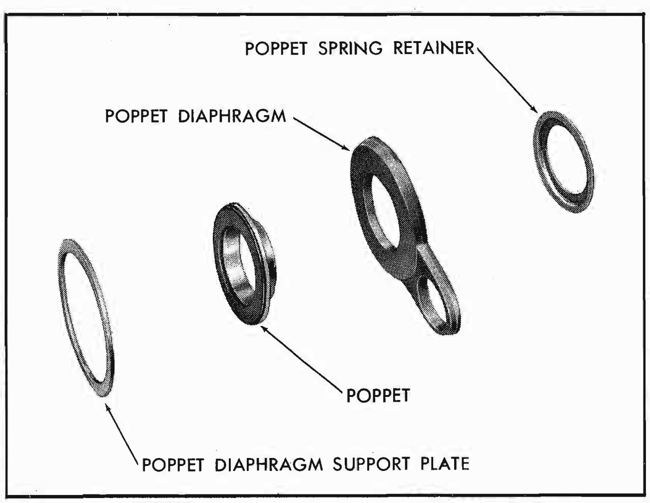


Fig. 5-B-18 Poppet Assembly—Exploded View

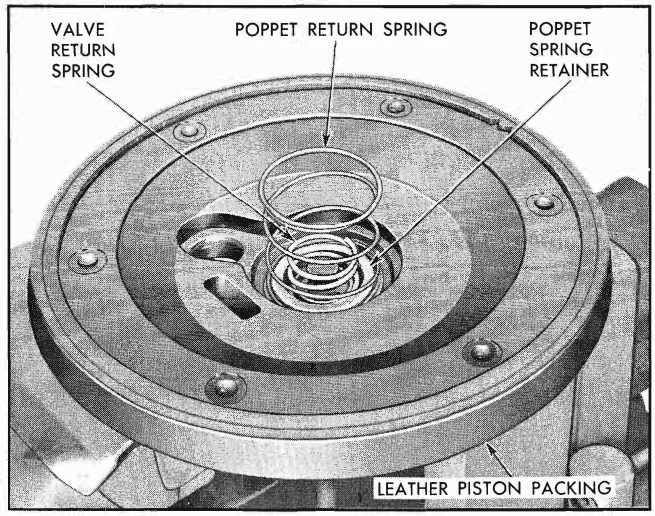


Fig. 5-B-19 Parts Installed on Rear Piston Plate

c. Replace expander ring (ends may overlap).

d. Install felt so ends are diametrically opposite to the overlap of the expander ring (Fig. 5-B-20).

e. Align poppet diaphragm boss on front piston plate with the poppet cavity in the rear piston plate.

f. Gently force front piston plate onto rear piston plate until plate seats. Center leather piston packing and secure plate with six screws. Tighten to 45-70 in. lbs. torque.

8. Replace valve plunger seal. Be sure seal is properly seated in groove of rod and on boss of piston assembly.

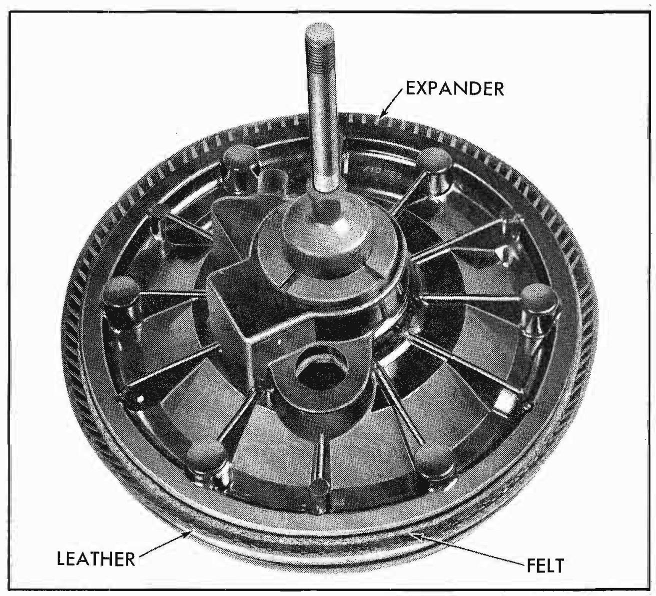
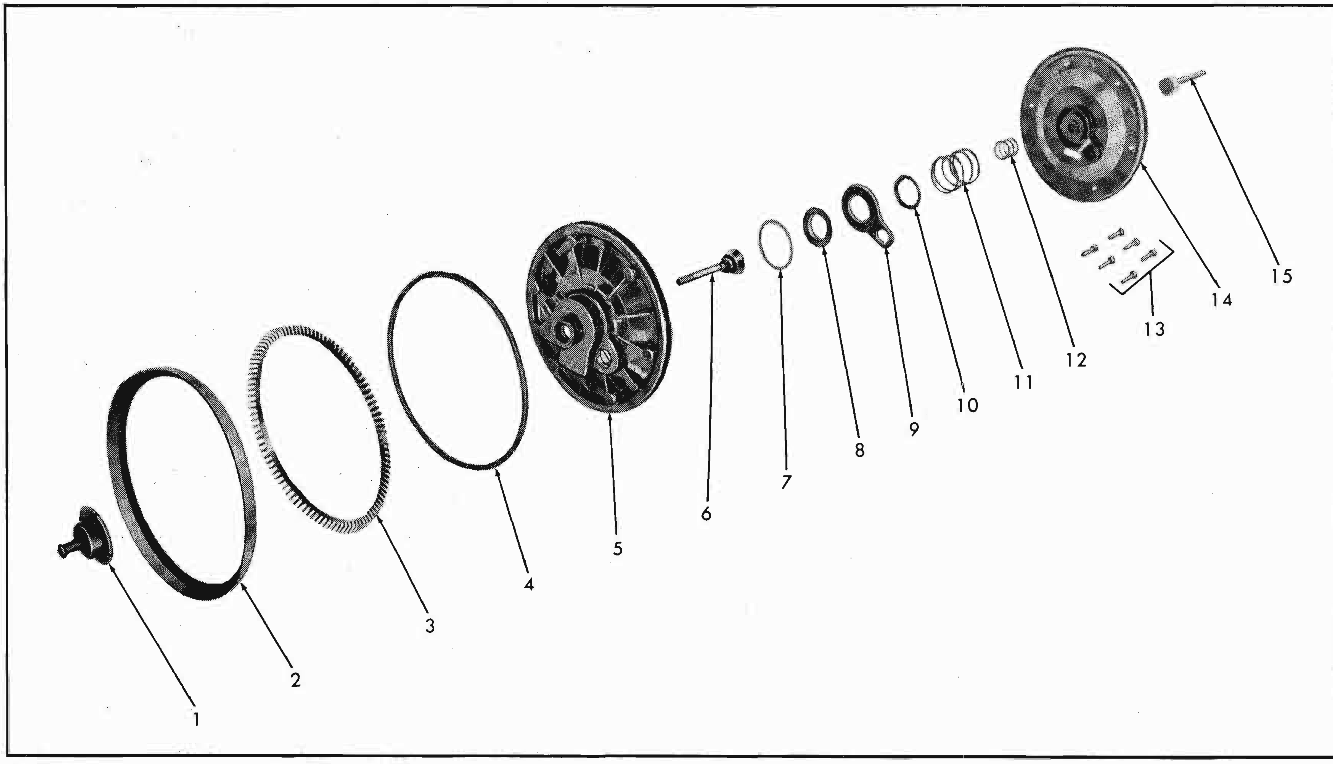


Fig. 5-B-20 Leather, Expander and Felt Installed



1. Valve Plunger Seal
2. Leather Piston Packing
3. Felt Expanding Ring
4. Felt
5. Front Piston Plate
6. Valve Operating Rod and Valve Plunger
7. Diaphragm Support Plate
8. Poppet
9. Poppet Diaphragm
10. Poppet Spring Retainer
11. Poppet Return Spring
12. Valve Return Spring
13. Piston to Front Piston Plate Screws
14. Piston
15. Push Rod

Fig. 5-B-21 Power Piston Assembly—Exploded View

9. Insert rubber reaction disc in recess at center of front piston plate. Use push rod as an installation tool. Both parts should be lubricated with a silicone grease.

ASSEMBLE VACUUM CYLINDER, POWER PISTON, AND END PLATE

1. Put air cleaner filter over vacuum tube of air cleaner and tube assembly and attach air cleaner to cylinder end plate with screws.

2. Make sure vacuum hose is fully on vacuum inlet tube of power piston and align hose to lie flat against piston.

3. Install end plate over end of valve operating rod and attach vacuum hose to tube on inside of end plate at least 5/8 inch.

4. Apply thin coat of vacuum cylinder oil or Hydra-Matic fluid to bore of vacuum cylinder and to leather piston packing.

NOTE: Before proceeding farther, make certain rubber reaction disc and push rod are in place in front piston plate.

5. Attach vacuum cylinder to end plate as follows:

a. Align power piston to take all strain out of the hose.

b. Position end plate so piston faces up.

c. Center large diameter end of piston return spring on power piston.

d. Align vacuum cylinder so master cylinder filler plug will point up when installed and press cover into place and install two of eight attaching screws at opposite sides (through end plate into vacuum cylinder) to hold end plate and cylinder together.

e. Replace balance of screws then tighten all screws uniformly.

6. Assemble dust guard over end of valve operating rod and over flange on end plate. Long nose pliers simplify installation.

ASSEMBLE MASTER CYLINDER TO POWER BRAKE ASSEMBLY

NOTE: Before proceeding with assembly of master cylinder to power section, check the distance from the outer end of the push rod to the master cylinder as explained under PUSH ROD ADJUSTMENT below.

PUSH ROD ADJUSTMENT

The push rod is designed with a self-locking adjustment screw to provide the correct relationship between the vacuum power piston and master cylinder piston. The adjustment screw is set to the correct height at the time of original assembly of the power unit. *Under normal service conditions the adjustment screw does not require any further attention providing the push rod assembly remains in the original unit.*

When a new push rod is used or the push rod assembly is transferred to a unit other than the original one, the distance from the end of the adjustment screw to the mounting face of the power cylinder should be rechecked either with a micrometer depth gauge to a dimension of 1.200″ to 1.195″ or with a height gauge J-7723 as shown in Fig. 5-B-22.

If neither a micrometer nor a height gauge is available, the correct adjustment of the push rod can be made as follows: Using an ordinary scale, securely position the adjustment screw so that the distance from the end of the screw to the mounting flange is 1 3/16″ (1.1875″). From this point, turn the screw into the push rod an additional 1/4 turn. This will give an approximate setting to avoid excessive clearance between the adjustment screw and the hydraulic piston.

When push rod adjustment is correct, assemble master cylinder assembly to the vacuum cylinder at four studs. Secure with (4) nuts and lockwashers using 15-30 lb. ft. torque.

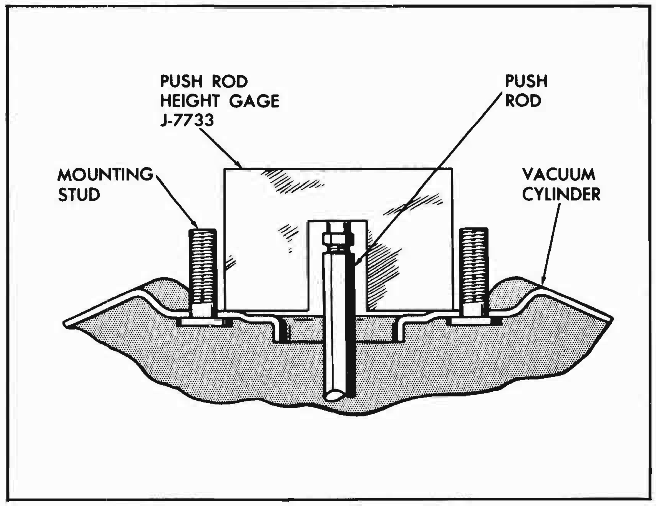


Fig. 5-B-22 Checking Push Rod Adjustment

After assembly of the master cylinder to the power unit, the piston cup of the hydraulic cylinder *must* clear the compensating hole when the unit is in the released position. This can be checked by partially filling the reservoir, and then stroking the power unit. If air bubbles appear, the compensating port is clear. If the primary cup overlaps the compensating port, there will be no flow of air or fluid through the compensating port when stroked. If this condition exists, the adjusting screw should be turned into the pushrod a slight amount, or until the compensating port is open. Failure to clear the compensating port in the released position traps fluid in the hydraulic lines and wheel cylinders and causes brake drag when the fluid warms up.

POWER BRAKE ASSEMBLY—INSTALL

1. Place power brake into position and install four rear housing to dash attaching lock washers and nuts from inside of car. Tighten nuts to 20-35 lb. ft. torque.

2. Attach clevis to brake pedal assembly and adjust to provide 3 1/8″ to 3 3/8″ from floor mat to bottom of pedal pad. Secure clevis lock nut.

3. Adjust stop light switch if necessary to provide 3/16″ of plunger extending from body.

4. Attach vacuum lines.

5. Attach hydraulic line.

6. Bleed brakes as necessary and fill fluid reservoir to provide a distance of 1″ from top of fluid to top of filler hole.

SYSTEM TESTS

1. VACUUM LEAK IN RELEASED POSITION

With transmission in Neutral or Park, and brake released, stop engine and wait one minute. Apply brake several times. Each application should provide less and less pedal travel following normal depletion of reserve vacuum. Number of applications on reserve vacuum will depend on how hard pedal is pressed and how far pedal moves. If vacuum assist is not present, reservoir is plugged or an air leak is indicated. Check external hose and vacuum check valve before opening power unit.

2. UNIT OPERATION

After depleting reserve vacuum put light pressure on pedal and start engine. If power system is functioning properly pedal will fall away slightly.

3. VACUUM LEAK IN HOLDING POSITION

With transmission in Neutral or Park, stop engine while holding a moderately heavy load steadily on pedal. After one minute release and apply pedal several times. If there is no vacuum assist during this test but system was normal during test No. 1 above, there is an air leak within the unit.

NOTE: Some units on this test will leak air internally if pedal load is light. This is a normal condition.

4. HYDRAULIC LEAK

a. Depress brake pedal while engine is running, maintaining constant pressure. If pedal falls noticeably in one minute, the hydraulic system is leaking.

b. If pedal has a spongy feel when applying the brakes, air may be present in the hydraulic system.

Road test brakes by making a brake application at about 40 MPH to determine if vehicle stops evenly and quickly.

If system checks are satisfactory and the brake pedal travels to within 1" of the floor-board, brake shoes require adjustment or replacement.

TROUBLE DIAGNOSIS

The same types of brake trouble may be encountered with power brakes as with standard brakes. Before checking power brake system for source of trouble, refer to trouble diagnosis of standard brakes. After these possible causes have been eliminated, check for cause as outlined below.

HARD PEDAL

a. Vacuum failure due to:

1. Faulty vacuum check valve.
2. Vacuum hose or pipe collapsed, plugged, kinked or disconnected.
3. Internal leaks in power brake unit.

b. Power brake unit trouble.

1. Vacuum
   - (a) Internal vacuum hose off or restricted.
   - (b) Vacuum leaks in unit caused by improper assembly, missing parts, damaged parts and foreign material.
2. Hydraulic
   - (a) Cups swollen by improper fluid.
   - (b) Compensating port not cleared by primary cup.
3. Mechanical
   - (a) Badly dented vacuum cylinder.
   - (b) Bound up pedal linkage.
   - (c) Improperly adjusted stop light switch.
   - (d) Galled valve plunger.
   - (e) Broken or missing springs.

GRABBY BRAKES (APPARENT OFF-AND-ON CONDITION)

a. Faulty pedal linkage.

b. Dented vacuum cylinder.

c. Sticking valve plunger.

d. Defective vacuum check valve.

GRABBY BRAKES (APPARENT OFF-AND-ON CONDITION) Continued

e. Loose vacuum connections.

PEDAL GOES TO FLOOR OR ALMOST TO FLOOR

a. Brake adjustment.

b. Air in hydraulic system.

1. Fluid reservoir empty.

2. Faulty master cylinder check valve.

c. Hydraulic fluid leakage:

1. External:
   (a) Defective filler cap, missing baffle, or filler cap gasket.
   (b) Cracked master cylinder casting.
   (c) Leaks at wheel cylinder, in pipes, hoses or at connections.

2. Internal:
   (a) Defective secondary seal on master cylinder piston.
   (b) Faulty primary cup which causes pedal to sink to the floor under constant load but does not empty reservoir.

SPECIAL TOOL

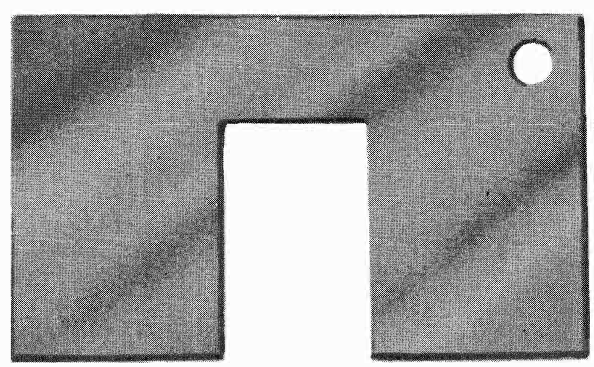


Fig. 5-B-23 Bendix Power Brake—Special Tool

DELCO-MORAINE POWER BRAKE

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

The Delco-Moraine power brake unit can be identified by a grey colored master cylinder and a golden colored vacuum cylinder having a bayonet type fastened cover.

The power brake unit is a combined vacuum and hydraulic unit for power braking and replaces the conventional master brake cylinder. This brake has an overall ratio of 2¾ to 1 (2¾″ of pedal travel moves the power piston 1″). This pedal ratio reduces effort and provides easier brake applications. The wheel brakes are the same, power or manual.

Pedal travel compared to the conventional braking system is greatly reduced. Its height is approximately ⅞ inch above the accelerator pedal, permitting the driver to shift his toe from one pedal to the other without lifting his heel from the floor. Lighter pedal pressures are also required for normal stops.

The power brake unit utilizes engine intake manifold vacuum, and atmospheric pressure for its operation. These units are self-contained, requiring no additional rods or levers. Two external vacuum line connections to this unit are necessary. One is a connection to the carburetor, the other to the vacuum reservoir. A hydraulic connection into the hydraulic brake system is also required.

A vacuum check valve is connected between the brake assembly and the engine intake manifold to prevent loss of vacuum when manifold vacuum falls below that in the power brake system.

In case of engine failure and consequent loss of engine vacuum, several applications of the brakes are possible by using vacuum retained in the vacuum reservoir. In case of complete vacuum loss, brakes can be applied in the conventional manner, although more effort is required due to loss of power assist.

DESIGN

The Moraine power unit is composed of two main sections, a vacuum power cylinder and a hydraulic master cylinder.

The vacuum power cylinder contains the power piston assembly which houses the control valve and reaction mechanism, the power piston return spring and the master cylinder piston which contacts the primary cup in the hydraulic master cylinder. The control valve is made up of the air valve and a floating control valve assembly. The reaction mechanism consists of a hydraulic piston reaction plate, three levers and a valve reaction plate. On the outside of the power cylinder housing is an air filter and a tube for connection to the vacuum source. A push rod which operates the air valve, projects out the end of the power cylinder housing through a boot and attaches to the brake pedal with a clevis.

The master cylinder attaches to the vacuum power cylinder (front housing). A rubber seal between these two units seals against atmospheric pressure leaks. Secondary seals around the master cylinder piston prevent hydraulic fluid in the master cylinder from entering the vacuum area in the power cylinder.

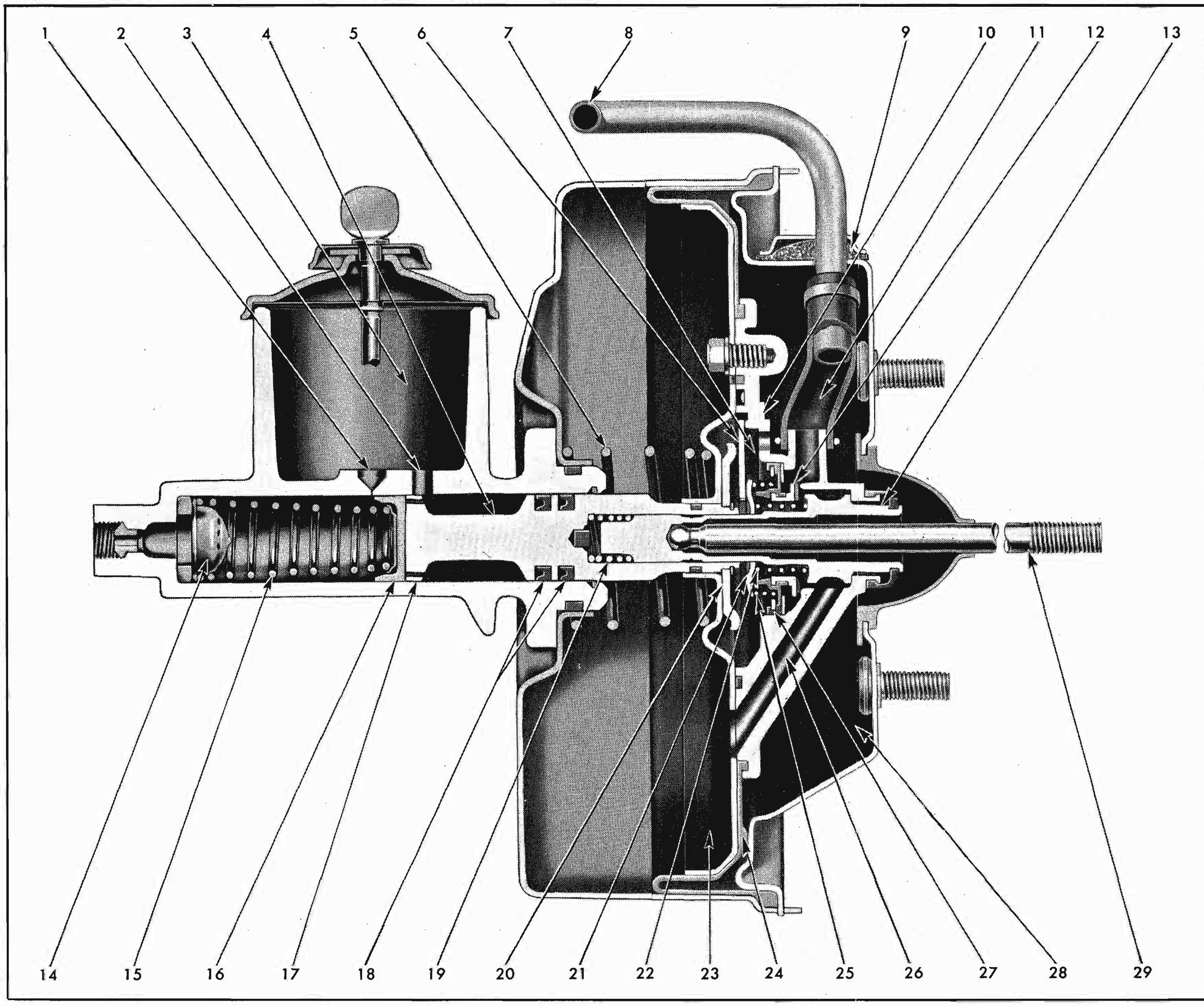


Fig. 5-M-1 Release Position

A fluid reservoir is cast integrally with the master cylinder. Inside the master cylinder are the conventional parts; a primary cup, check valve spring and retainer, check valve, and check valve seat washer.

PRINCIPLES OF OPERATION

RELEASE POSITION (SEE FIG. 5-M-1)

Atmospheric pressure exists on both sides of the air filter (9), in the space (28) between the power piston (10) and the rear housing, in the space (7), between the floating control valve (12) and the air valve (13) through holes to the power piston, around the open annular seat on the air valve (13), and in the power piston passages (26) to the vacuum side (between the power piston and master cylinder) of the power piston at (23). The air valve (13) is held away from the floating control valve (12) by the combination and air valve springs (22) and (19). The combination springs (22) hold the air valve reaction plate (21) against the three reaction levers (6) and forces the hydraulic master cylinder piston reaction plate (20) against its stop and the three reaction levers (6) against the pivot point of the power piston (10). Thus, initial movement of the air valve does not move the reaction mechanism. Under these conditions the power piston is balanced by atmospheric pressure on both sides and is held against the diaphragm stop buttons (24) by the power piston return spring (5).

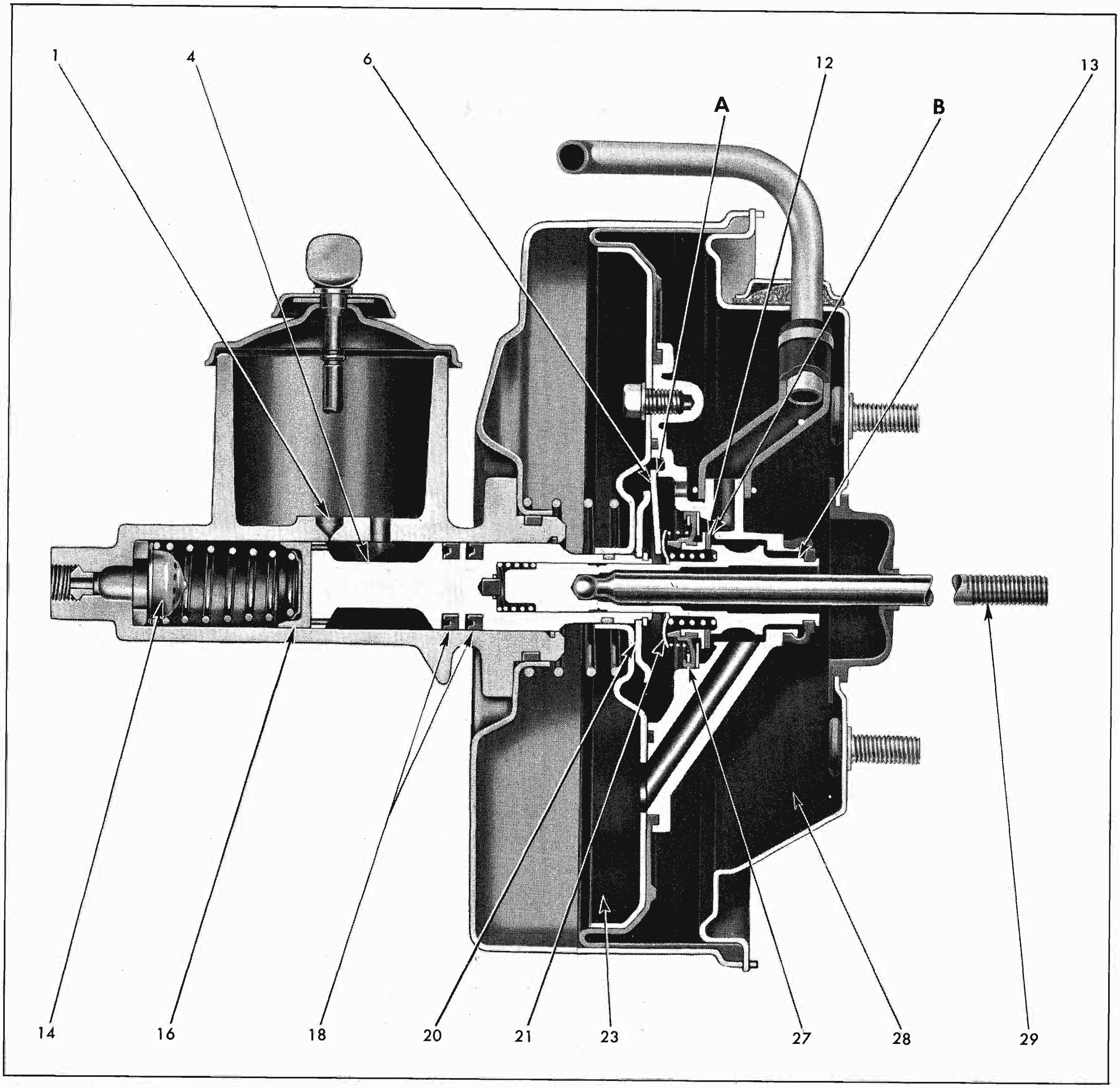


Fig. 5-M-2 Applying

A coiled rubber hose is the vacuum exhaust tube and connects the exhaust manifold assembly (9) to the power piston inside the housing, where a drilled passage communicates with an area around an air valve chamber (11). At this point the vacuum is stopped as the flat rubber face (12) of the floating control valve is pressed against the annular seat of the power piston (10) by the floating control valve return spring (25).

In this position the compensating port (1) in the hydraulic master cylinder is open to the reservoir and fluid can flow freely in either direction between the hydraulic cylinder and the fluid reservoir (3).

A residual pressure is maintained in the brake lines by the check valve (14) and its spring (15).

APPLYING (SEE FIG. 5-M-2)

As the brake pedal is depressed, the push rod (29) carries the air valve (13) forward until its annular seat contacts the flat rubber face (12) of the floating control valve at which point the atmospheric pressure is sealed off and cannot enter the space (23) between the power piston and master cylinder. Further movement carries the floating valve away from the annular seat on the power piston (B) and opens the space (23) to the vacuum source while the air valve (13) remains closed due to annular contact of the air valve on the rubber face of the floating control valve. Thus, as air is exhausted from space (23) by the engine, atmospheric pressure on the air chamber side (28) of the power piston starts moving the piston toward the master cylinder; at the same time it pushes the hydraulic master cylinder piston (4) into the master cylinder.

As the master cylinder primary cup (16) passes the compensating port (1), hydraulic pressure starts to build up in the hydraulic system. The primary cup prevents fluid from returning to the reservoir. Secondary seals (18) around the hydraulic master cylinder piston (4) prevent fluid from entering the vacuum chamber. As this takes place hydraulic fluid is forced through the holes in the check valve (14) and into the hydraulic lines to the wheel cylinders to apply the brakes. The pressure on the end of the master cylinder piston causes the hydraulic master cylinder piston reaction plate (20) to move away from its stop and press against the reaction levers (6). The levers in turn swing around their pivots (A) and push the air valve reaction plate (21) back against the rubber snubbers that are part of the reaction diaphragm (27).

In this manner a fraction of the load on the hydraulic master cylinder piston is transferred through the air valve and the push rod to the brake pedal and gives the operator a feel proportional to the degree of brake application. Thus, part of the load on the hydraulic master cylinder piston (4) is supplied by the operator's foot on the brake pedal, the remainder being supplied by atmospheric pressure on the air (atmospheric pressure) chamber side (28) of the power piston.

HOLDING (SEE FIG. 5-M-3)

During application, hydraulic line pressure build-up ceases when reaction force back through the unit balances the load of the drivers foot. The power piston (10) senses this point when it pulls ahead of the air valve (13) just enough to reseat the floating control valve (12) (at C and D) and seals off supply vacuum. No further movement takes place until the pedal load increases or decreases.

VACUUM FAILURE (SEE FIG. 5-M-3)

When the driver calls for more braking than the available vacuum can supply, the air valve (13) holds the vacuum passage (C) full open and bottoms against the rubber snubber with hydraulic piston (4). Just as when no vacuum is available, braking beyond the point of vacuum runout is "manual" and requires more than usual effort.

RELEASING (SEE FIG. 5-M-4)

As the force on the pedal is released, the combination and air valve return spring (22) and (19) and the three reaction levers (6) force the air valve (13) away from its contact with the floating control valve (12). The floating control valve contacts the power piston (10), shutting off the vacuum to the area between the power piston assembly and the master cylinder space (23). The air valve being away from the floating control valve (12) allows atmospheric pressure to enter into the space (23). Since both sides of the power piston are now open to atmospheric pressure, the power piston return spring (5) forces the piston back against the stop (24).

As the power piston and hydraulic master cylinder piston move back, the fluid from the wheel cylinders flows back into the hydraulic master cylinder by unseating the check valve (14) and into the reservoir.

The fluid reservoir, cast integrally with the master cylinder, supplies fluid to the space between primary cup and secondary seal through a by-pass hole (2) in the casting. When the brake pedal is released quickly, fluid pressure, check valve spring (15) and the power piston return spring (5) force the master cylinder piston (4) to return immediately (to the released position). If hydraulic fluid from the lines cannot return as quickly as the master cylinder piston, compensation is provided for by a flow of fluid from the space between the primary cup and secondary seals through the holes (17) in the master cylinder piston. The excess fluid in the brake system can flow back through the compensating port (1).

CHECKS AND ADJUSTMENTS ON CAR

1. Check for free operation of brake pedal. If binding exists, check pivot points for binding and lubricate as required.

2. Check stop light switch for proper setting and operation.

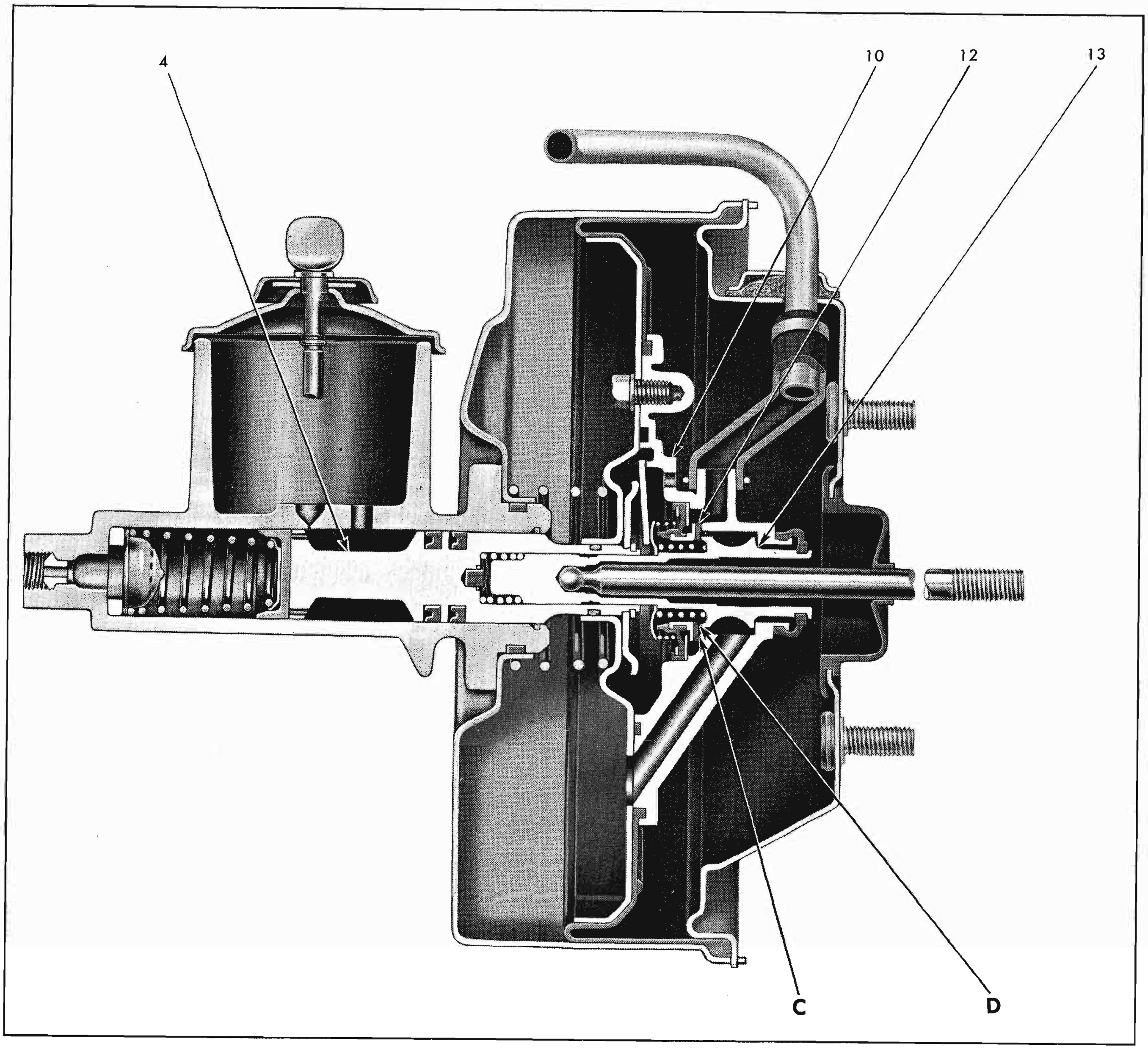


Fig. 5-M-3 Holding Position

3. Check fluid level in hydraulic cylinder reservoir. Fluid level should be 1″ from top of filler plug opening.

4. Check vacuum lines and connections between carburetor, check valve, vacuum reserve tank and vacuum power cylinder for possible vacuum leaks.

5. Check engine for good stall-free idle. Correct as required.

6. Check condition of air cleaner element and insert new element if necessary during overhaul of brake assembly.

MINOR REPAIRS

BLEEDING BRAKES

Brakes should be bled in the same manner as standard brakes.

STOP LIGHT SWITCH—REMOVE AND REPLACE

REMOVE

1. Disconnect wires from switch.

2. Remove nut which retains switch to bracket and remove switch.

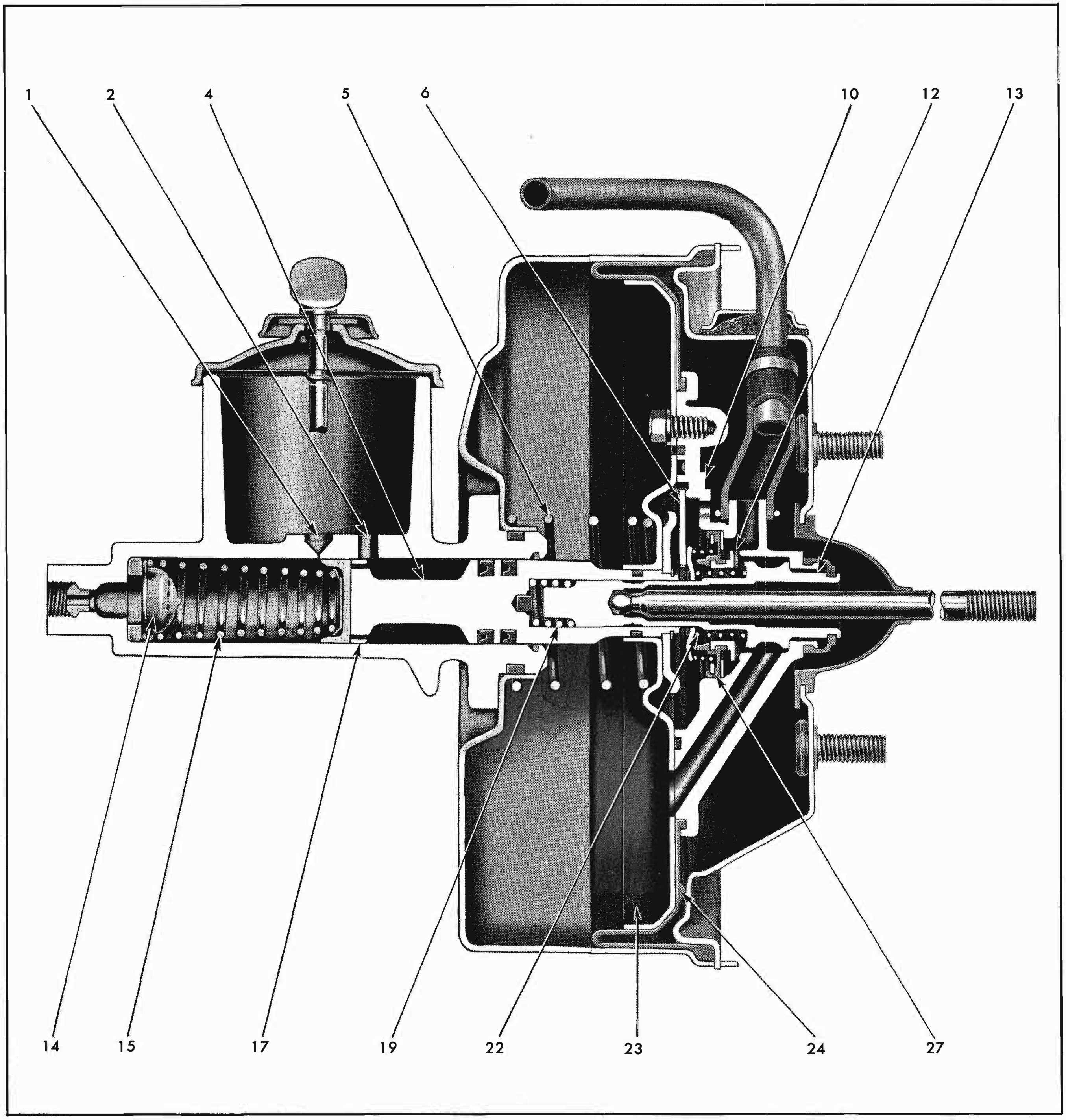


Fig. 5-M-4 Releasing

REPLACE

1. Install first nut on switch assembly.

2. Position switch in stop light switch bracket, install second nut.

3. Connect wires to stop light switch.

4. Ensure that brake pedal is retracted (out) to its fully released position, and position switch so that approximately $3/16''$ of the plunger extends from the switch body.

5. Tighten lock nut to 15-40 lb. in. torque.

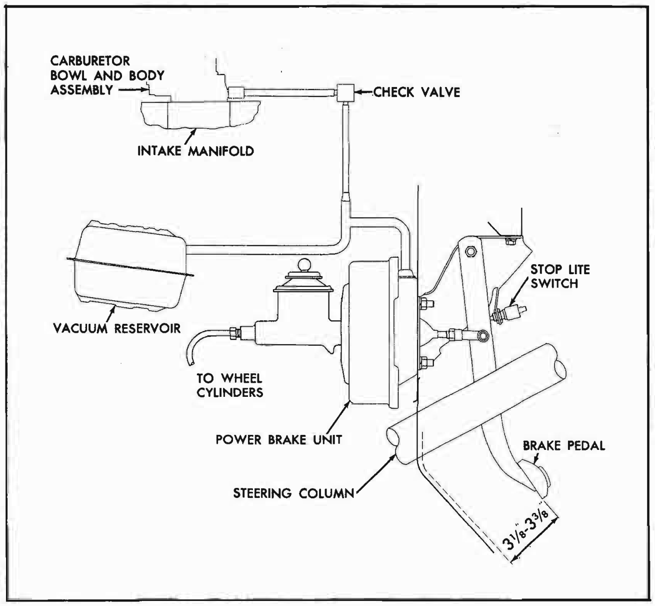


Fig. 5-M-5 Simple Schematic of Power Brake System

OVERHAUL DELCO-MORAINE POWER BRAKE

REMOVE MASTER CYLINDER

Certain repair operations, such as replacement of master cylinder internal parts, permits the master cylinder to be removed by itself, leaving the power cylinder and brackets in the car.

1. Remove hydraulic connection from master cylinder, pump fluid from cylinder, and cover opening and pipe end to exclude dust, dirt, etc.

2. Remove master cylinder attaching nuts and lockwashers from master cylinder attaching studs.

3. Remove master cylinder from vacuum power section so brake to master cylinder selective shims are not damaged. Cover opening in power cylinder to exclude dirt.

NOTE: If the brake to master cylinder selective shims are damaged they must be replaced.

POWER BRAKE ASSEMBLY—REMOVE

1. Disconnect vacuum hoses from reservoir and carburetor pipe at vacuum inlet manifold. Cover hose and pipe openings to exclude dust, dirt, etc. (Fig. 5-M-5).

2. Disconnect pipe from master cylinder hydraulic port and cover opening and pipe end to exclude dust. dirt, etc.

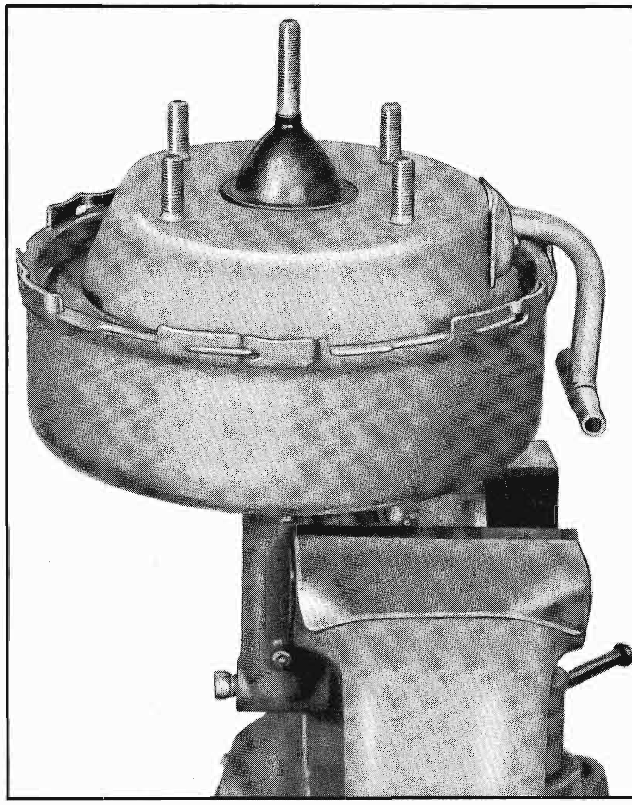


Fig. 5-M-6 Delco-Moraine Brake Mounted in Vise

3. Remove clevis pin from brake pedal inside the car.

4. Remove four (4) nuts and lock washers from rear half housing inside the car and remove power cylinder assembly.

5. Clean exterior of power brake assembly and drain reservoir of hydraulic fluid.

DISASSEMBLE BRAKE ASSEMBLY

DISASSEMBLE OVER-ALL BRAKE UNIT

1. Put power brake unit in a vise, clamping on sides of the master cylinder reservoir with push rod up (Fig. 5-M-6).

2. Remove push rod clevis and clevis lock nut.

3. Remove push rod boot.

4. Using suitable wooden lever against mounting studs rotate rear half housing counterclockwise to unlock rear half housing from front housing.

NOTE: Housing is under 10 lb. spring load.

5. Using pliers, remove hose clamp and pull vacuum hose from fitting at power piston (Fig. 5-M-7).

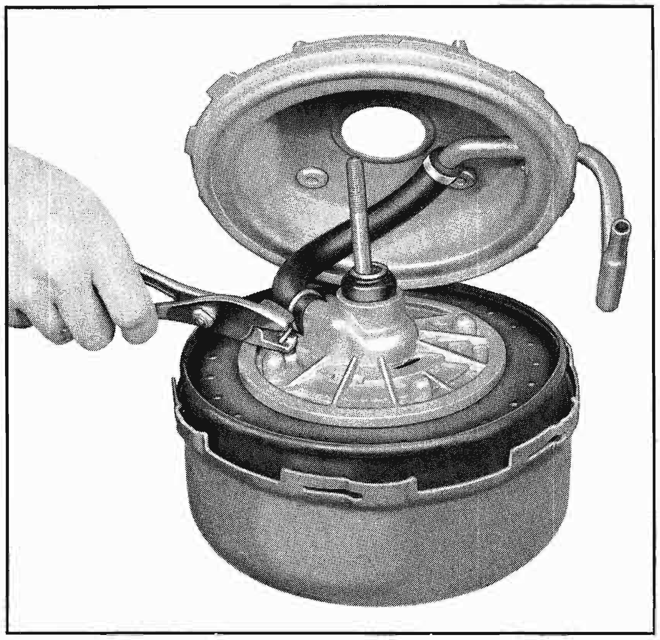


Fig. 5-M-7 Disconnecting Exhaust Hose

6. Remove power piston assembly by lifting straight up slowly and lay it aside on a clean smooth surface.

7. Remove power piston return spring.

8. Reposition master cylinder in vise and remove four (4) nuts and lock washers from studs extending through master cylinder assembly and remove front half housing (Fig. 5-M-8).

DISASSEMBLE REAR HOUSING

1. If underhood area is dusty and on high mileage units, remove exhaust manifold attaching screws from rear half housing.

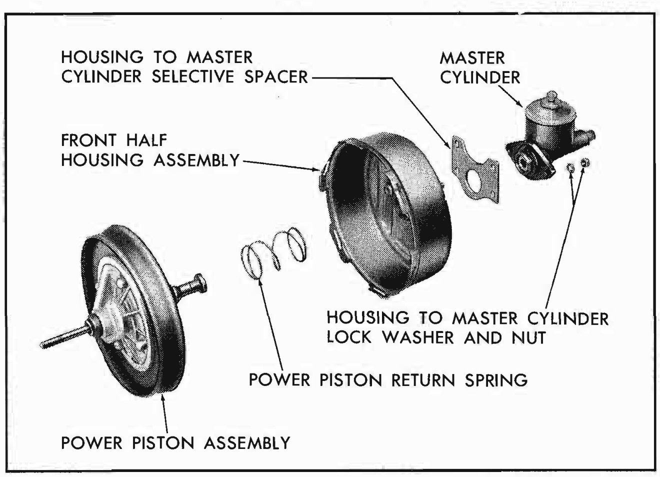


Fig. 5-M-8 Power Brake Units—Exploded View

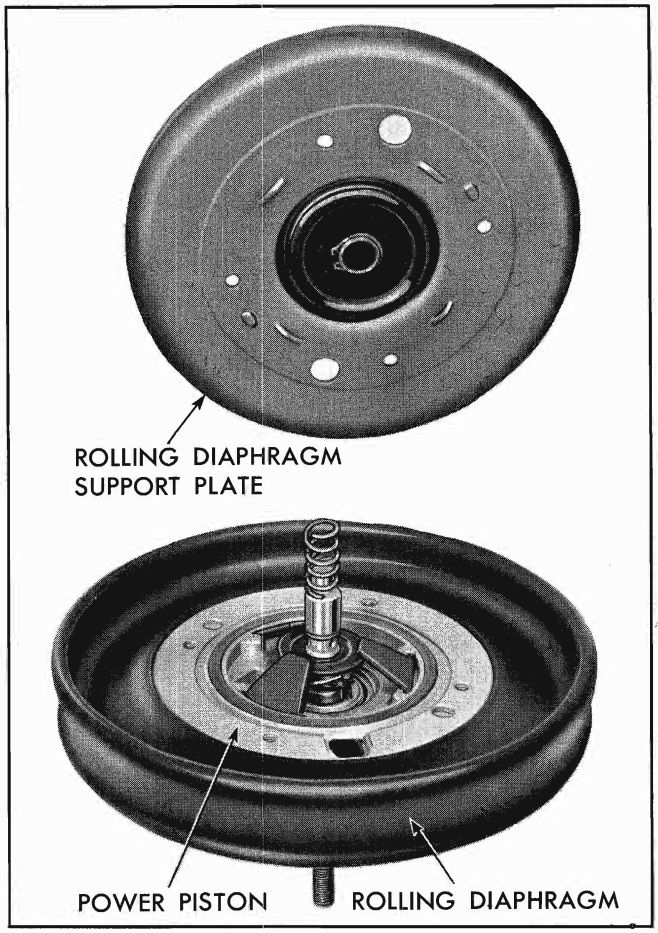


Fig. 5-M-9 Removing Rolling Diaphragm Support Plate from Power Piston

2. Slide off exhaust hose clamp at rear half housing and remove exhaust hose.

DISASSEMBLE POWER PISTON

CAUTION: Exercise extreme care in handling of power piston diaphragm and all rubber surfaces and metal parts in this assembly. The diaphragm should be guarded against grease, oil and foreign matter and must be protected from nicks or cuts that might be caused by rough surfaces, damaged tools, or dropping the piston.

1. Mount power piston in a vise so assembly is held lightly by two diagonally opposite (of the four) retaining screw bosses and so that master cylinder piston is up.

2. Loosen the four (4) screws on the power piston assembly. Remove screws just loosened (parts are spring loaded). Lift the rolling diaphragm support plate from the power piston assembly. Lay these parts aside, on a clean smooth surface (Fig. 5-M-9).

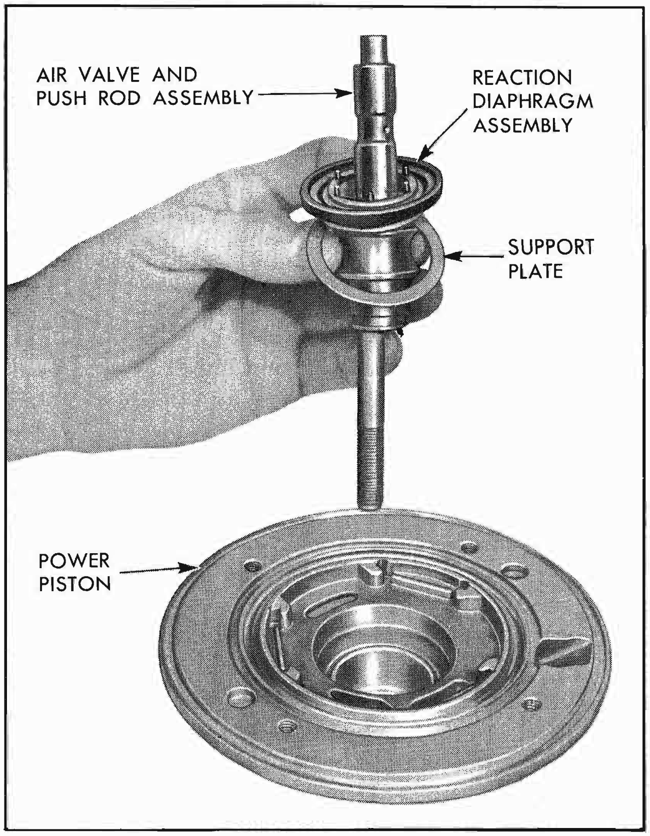


Fig. 5-M-10 Removing Push Rod Assembly

3. Remove the power piston diaphragm and seal ring.

4. Remove three (3) reaction levers, air valve reaction plate, floating control valve return spring, combination spring, and air valve spring.

5. Remove air valve boot from groove in power piston. Pull boot over end of rod.

6. Push the air valve and push rod assembly through the power piston dislodging the floating control valve and reaction diaphragm assembly, (Fig. 5-M-10).

NOTE: The floating control valve assembly can also be removed without removing the air valve by prying up under one side of reaction diaphragm retainer with a thin blade screwdriver.

7. Do not further disassemble the floating control valve assembly unless it is necessary to replace damaged or faulty parts.

8. Remove the reaction plate retaining ring from the master cylinder piston with J-4880 pliers.

9. Remove the reaction plate from the master cylinder piston and press master cylinder piston through rolling diaphragm support plate.

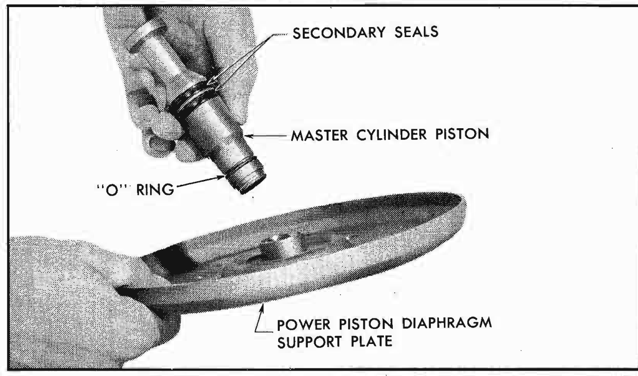


Fig. 5-M-11 Removing Master Cylinder Piston

10. Remove master cylinder piston to rolling diaphragm support plate "O" ring from master cylinder piston (Fig. 5-M-11).

11. Do not remove secondary seals from master cylinder piston unless damaged or worn, but if necessary to remove secondary seals from piston, use thin blade screwdriver or awl to lift the seal out of groove and over end of piston.

DISASSEMBLE MASTER CYLINDER

1. Remove master cylinder to front housing seal from hub on master cylinder.

2. Remove primary cup, check valve spring and retainer assembly, check valve, and check valve seat washer (Fig. 5-M-13).

3. Do not further disassemble the return spring assembly or the check valve assembly.

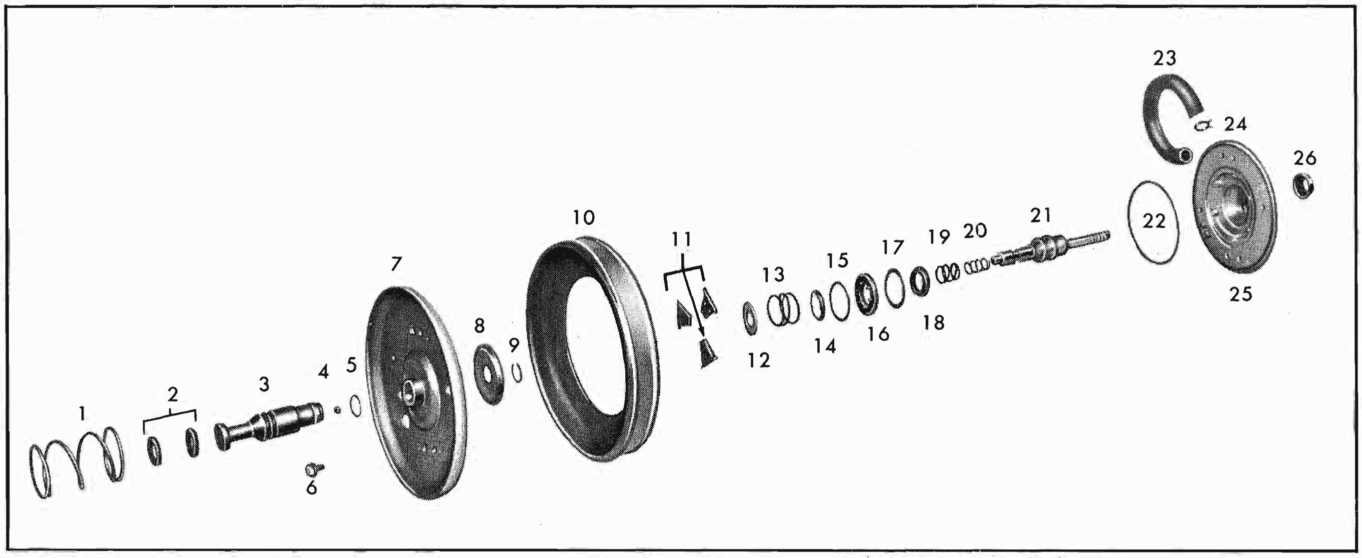
INSPECTION — CLEANING

Thoroughly wash all parts in alcohol and air dry. Blow dust and cleaning fluid out of all internal passages. If inside of front housing is slightly scored or scratched, clean with crocus cloth or fine emery cloth. If scratches in front housing cannot be removed, replace housing.

CAUTION: It is important that all parts be placed on a clean paper or cloth after being cleaned to prevent the possibility of dirt being assembled into unit or grease contacting any rubber parts.

POWER BRAKE ASSEMBLY

Inspect all parts for scoring, pitting, dents or nicks. Small imperfections can be smoothed out with fine emery cloth. Replace if badly nicked, scored or otherwise damaged.



1. Power Piston Return Spring
2. Secondary Seal
3. Master Cylinder Piston
4. Bumper
5. "O" Ring
6. Screw and Lockwasher 1/4-20 x 1/2
7. Rolling Diaphragm Support Plate
8. Hydraulic Master Cylinder Reaction Plate
9. Snap Ring
10. Power Piston Diaphragm
11. Reaction Levers
12. Air Valve Reaction Plate
13. Floating Control Valve Return Spring
14. Floating Control Valve Spring Retainer
15. Reaction Diaphragm Retainer
16. Valve Reaction Diaphragm
17. Reaction Diaphragm Support Plate
18. Floating Control Valve
19. Combination Reaction and Air Valve Return Spring
20. Air Valve Spring
21. Air Valve—Push Rod Assembly
22. Seal Ring
23. Exhaust Hose
24. Exhaust Hose Clamp
25. Power Piston
26. Air Valve Boot

Fig. 5-M-12 Power Piston Assembly—Exploded View

MASTER CYLINDER ASSEMBLY

Inspect bore from the open end. The bore should be free from scores, deep scratches and corrosion. If it appears that corrosive brake fluid has damaged the bore, replace damaged parts and flush out entire brake system including wheel cylinders.

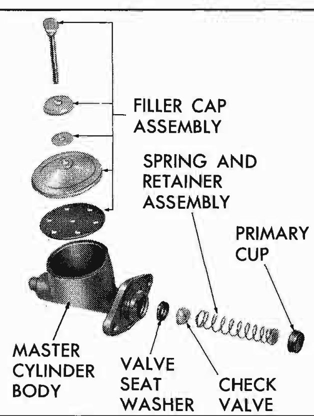


Fig. 5-M-13 Master Cylinder—Exploded View

The sealing surfaces should be clean and smooth. Check for cracks and damaged threads. Be sure that the by-pass and compensating ports to the master cylinder are not restricted.

Check for distortion of all springs and deterioration of all rubber parts. Any evidence of soft or swollen rubber parts indicates contaminated brake fluid requiring flushing of the entire brake system and replacement of wheel cylinder cups, as well as all rubber parts in master cylinder.

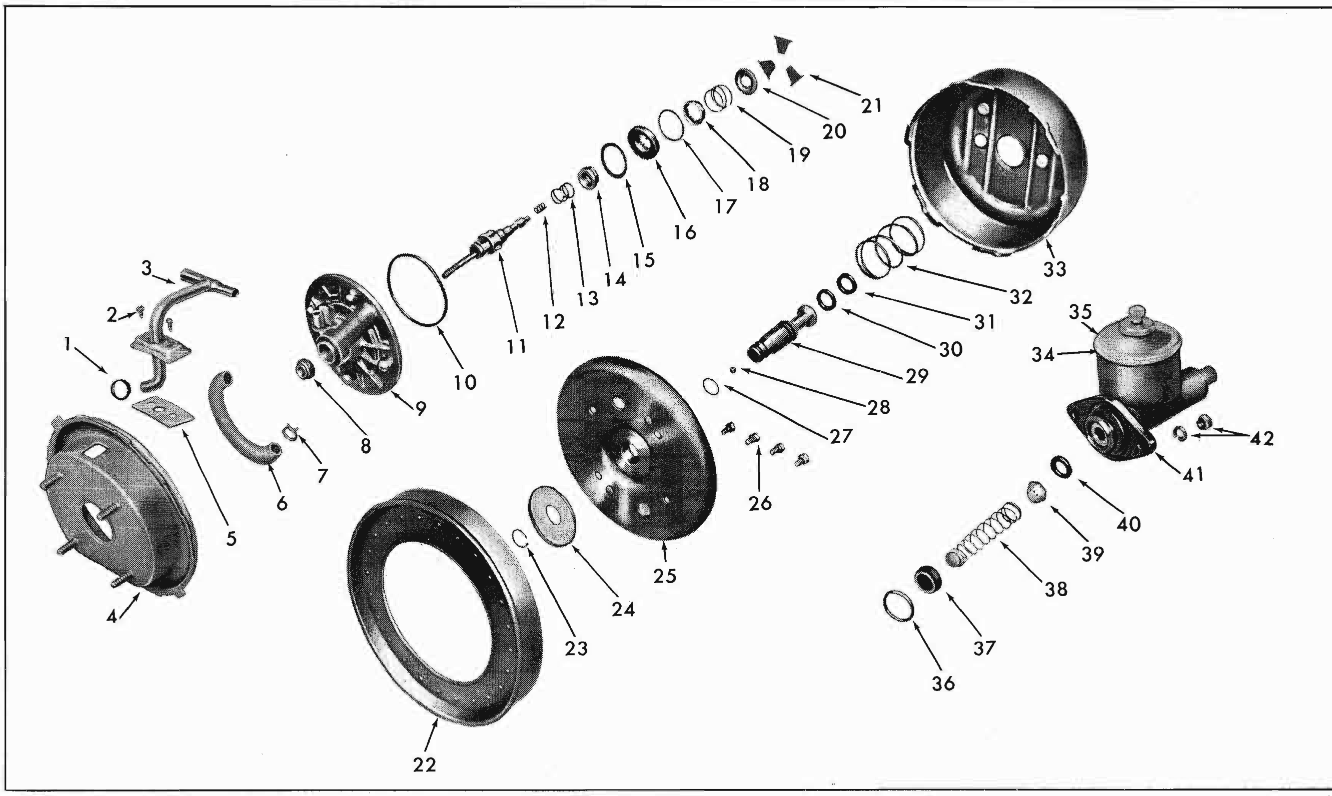
AIR FILTER

Replace air filter element if dirty.

ASSEMBLE BRAKE ASSEMBLY

ASSEMBLE REAR HOUSING

1. Place air filter element and exhaust manifold assembly in position on the rear housing. Install exhaust hose and clamp to exhaust manifold, so hose is parallel with surface of rear housing.



1. Exhaust Hose Clamp
2. Exhaust Manifold Screws
3. Exhaust Manifold Assembly
4. Rear Half Housing
5. Air Filter Element
6. Exhaust Hose
7. Exhaust Hose Clamp
8. Air Valve Boot
9. Power Piston
10. Power Piston Seal Ring
11. Push Rod—Air Valve Assembly
12. Air Valve Spring
13. Combination Reaction and Air Valve Return Spring
14. Floating Control Valve
15. Reaction Diaphragm Support Plate
16. Reaction Diaphragm
17. Reaction Diaphragm Retainer
18. Floating Control Valve Spring Retainer
19. Floating Control Valve Return Spring
20. Air Valve Reaction Plate
21. Reaction Levers
22. Power Piston Rolling Diaphragm
23. Reaction Plate Retaining Ring
24. Hydraulic Master Cylinder Reaction Plate
25. Rolling Diaphragm Support Plate
26. Power Piston Attaching Screws
27. Master Cylinder Piston to Rolling Diaphragm Support Plate "O" Ring
28. Push Rod—Air Valve Assembly Bumper
29. Master Cylinder Piston
30. Secondary Seal
31. Secondary Seal
32. Power Piston Return Spring
33. Front Half Housing Assembly
34. Filler Cap Gasket
35. Filler Cap
36. Master Cylinder to Front Housing Gasket
37. Primary Cup
38. Check Valve Spring and Retainer Assembly
39. Check Valve Assembly
40. Check Valve Seat Washer
41. Master Cylinder Housing
42. Front Housing to Master Cylinder Attaching Nuts and Lock Washers

Fig. 5-M-14 Delco-Moraine Power Brake Assembly—Exploded View

2. Install exhaust manifold to rear housing screws.

3. Install push rod boot.

ASSEMBLE POWER PISTON (FIG. 5-M-15)

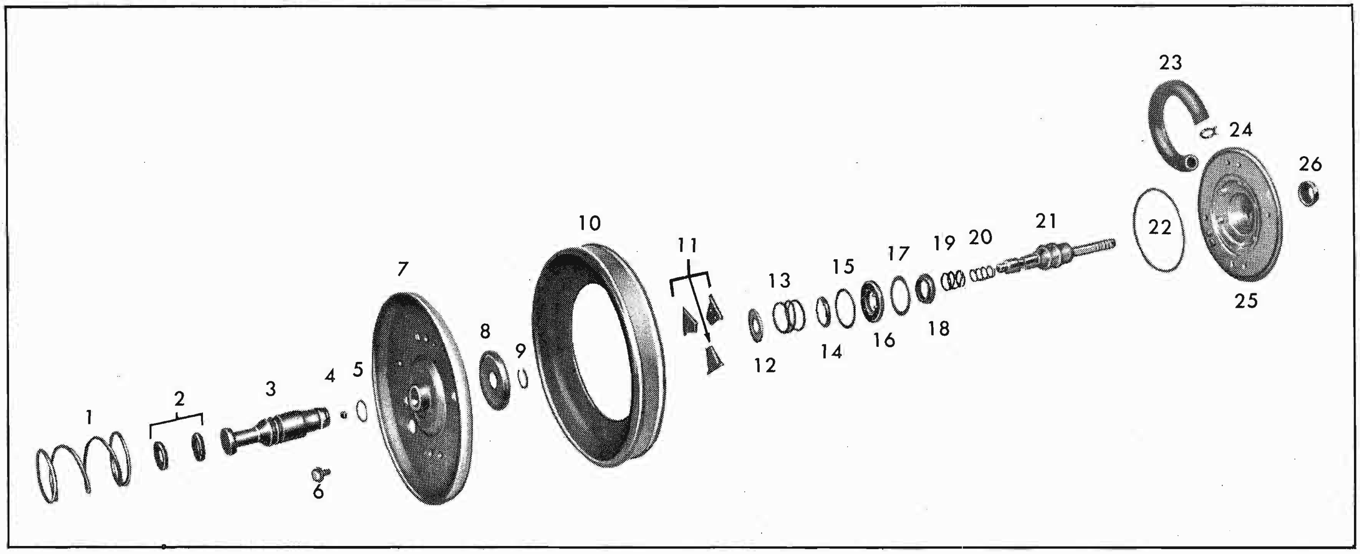
1. Mount power piston in vise with hub end down, lightly holding piston by two of the four screw bosses.

2. Insert air valve and push rod assembly into power piston with threaded end of push rod down.

3. Place reaction diaphragm support plate over the floating control valve.

4. Lubricate outside of metal spool of floating control valve with silicone grease and install into reaction diaphragm as shown in Fig. 5-M-16. Silicone is recommended because it is not injurious to rubber, doesn't dry out, and maintains its body at extreme temperatures.

5. Insert reaction diaphragm retainer under lip of reaction diaphragm. Place the floating control valve spring retainer over the reaction diaphragm so that the six small rubber bumpers are properly positioned in the spring retainer.



1. Power Piston Return Spring
2. Secondary Seal
3. Master Cylinder Piston
4. Bumper
5. "O" Ring
6. Screw and Lockwasher (1/4-20 x 1/2)
7. Rolling Diaphragm Support Plate
8. Hydraulic Master Cylinder Reaction Plate
9. Snap Ring
10. Power Piston Diaphragm
11. Reaction Levers
12. Air Valve Reaction Plate
13. Floating Control Valve Return Spring
14. Floating Control Valve Spring Retainer
15. Reaction Diaphragm Retainer
16. Valve Reaction Diaphragm
17. Reaction Diaphragm Support Plate
18. Floating Control Valve
19. Combination Reaction and Air Valve Return Spring
20. Air Valve Spring
21. Air Valve-Push Rod Assembly
22. Seal Ring
23. Exhaust Hose
24. Exhaust Hose Clamp
25. Power Piston
26. Air Valve Boot

Fig. 5-M-15 Power Brake Piston Assembly—Exploded View

6. Wipe film of silicone grease on outside diameter of reaction diaphragm as a seal. Place the floating control valve and reaction diaphragm assembly over the air valve portion of the air valve and push rod assembly so that the rubber face of the control valve rests on the annular seat of the power piston. Press the outer edge of the reaction diaphragm into position in the power piston.

NOTE: Take care that the reaction diaphragm is not distorted as the assembly is placed into the power piston.

7. Lubricate the $\frac{9}{16}$″ and $\frac{23}{64}$″ diameters of the air valve with silicone grease (Fig. 5-M-17).

8. Lubricate and place the combination spring over the air valve and inside the floating control valve spring retainer to seat on the air valve.

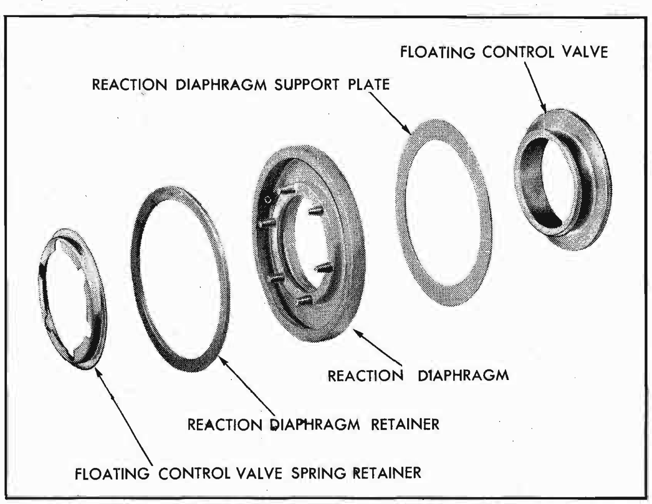


Fig. 5-M-16 Reaction Diaphragm and Related Parts

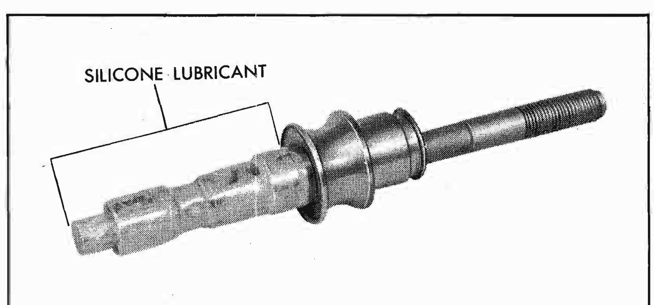


Fig. 5-M-17 Lubricant on Air Valve Assembly

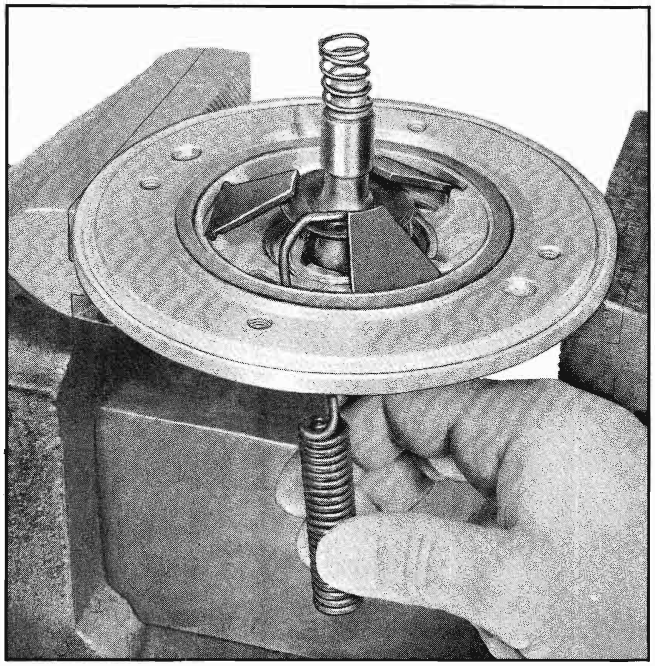


Fig. 5-M-18 Spring Located on End of Air Valve Assembly

9. Install the floating control valve return spring over the air valve to seat on the flange of the floating control valve spring retainer.

10. Position the air valve reaction plate over the air valve with the dished side down.

11. Lubricate the three reaction levers with silicone grease and install the reaction levers in the power piston. Rest the small ends of the levers on the air valve reaction plate.

12. Lubricate and install air valve spring on end of air valve.

13. Insert the power piston seal ring into the inner groove on the flat surface of the power piston face.

14. If master cylinder piston secondary seals were removed, the lips of the seals must face the small holes in the end of the master cylinder piston when reinstalled.

15. Install new master cylinder piston to rolling diaphragm support plate "O" ring on master cylinder piston and lubricate this "O" ring with silicone grease.

16. Insert master cylinder piston into the rolling diaphragm support plate from flange side.

17. Position reaction plate with raised rim away from the rolling diaphragm support plate over the master cylinder piston and secure with reaction plate retaining ring, using J-4880.

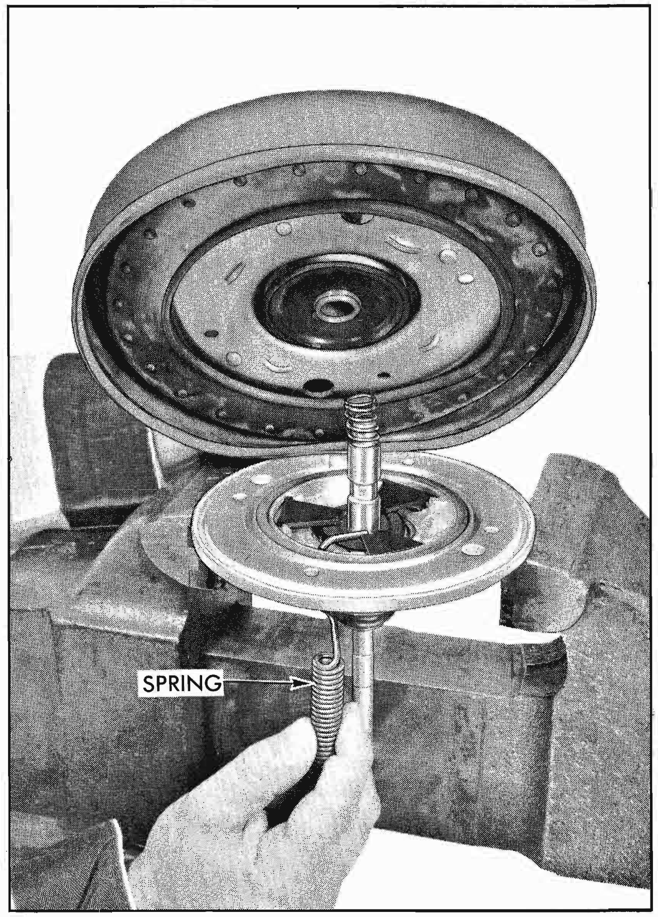


Fig. 5-M-19 Installing Rolling Diaphragm with Aid of Tool

18. Pull skirt of the power piston rolling diaphragm over the rolling diaphragm support plate.

19. Depress air valve reaction plate against spring load, holding it down with a hook up through one of the kidney shaped air passages in the power piston. (See Figs. 5-M-18 and 5-M-19).

20. Pilot the master cylinder piston and diaphragm support plate with diaphragm installed, over the end of the air valve. Align vacuum port in the support plate with the passage in the power piston.

21. Retain support plate to within $\frac{1}{16}''$ of power pistons with two of the four screws before releasing and removing hooks.

22. Check proper installation of rolling diaphragm by shifting its position around support plate.

23. Install two remaining support plate screws and tighten all four to 5-7 lb. ft. torque.

24. Remove power piston assembly from vise and install air valve boot.

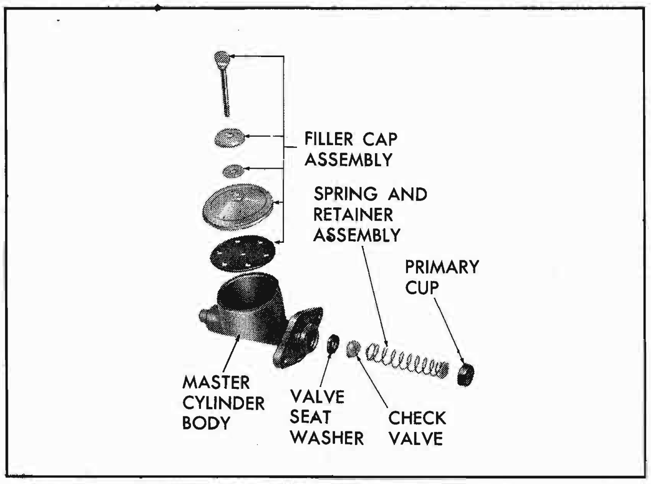


Fig. 5-M-20 Master Cylinder—Exploded View

25. If exhaust hose was removed, slip the exhaust hose securely on the boss so that it is parallel to power piston. Attach clamp so one ear is against power piston, to insure clearance with rear half housing.

ASSEMBLE MASTER CYLINDER (FIG. 5-M-20)

1. Replace check valve seat washer.

2. Press check valve into open end of spring and retainer assembly and position in the bore with the check valve against the check valve seat washer.

3. Dip the primary cup into clean brake fluid and press into bore with lips over retainer.

4. Install master cylinder to front housing seal in groove on master cylinder body. Lubricate outer edge of seal with silicone grease.

5. Install filler cap and gasket.

COMPLETE ASSEMBLY OF POWER BRAKE UNIT

1. Place master cylinder in a vise with filler plug end up.

2. Place housing to master cylinder shims (if any) on master cylinder and install front half housing. Secure with nuts and lock washers using 15-30 lb. ft. torque.

3. Reposition master cylinder in vise with open end of front half housing up.

4. Place the power piston return spring over the flange in the center of the front housing.

Fig. 5-M-21 Connecting Exhaust Hose

5. Guide master cylinder piston through the return spring into the master cylinder bore making sure the piston contacts the back of the primary cup.

6. Attach exhaust hose to exhaust tube manifold (Fig. 5-M-21) so at least ⅝″ of the hose is on the manifold.

7. Insert push rod through the boot on the rear housing.

8. Install rolling diaphragm as follows:

a. Lubricate bead of diaphragm with silicone grease.

b. Start rolling diaphragm into front housing aligned to permit exhaust hose to clear both housing and piston when rear housing is installed.

c. Rest rear housing on front housing.

d. Plug one side of the exhaust manifold assembly and apply a vacuum source to the other side of the exhaust manifold assembly.

e. Push down on push rod to permit the area under the rolling diaphragm to be evacuated and allow atmospheric pressure to force the rolling diaphragm into place.

NOTE: If a vacuum source is not available, then proceed with Step 9.

9. The outer bead of the rolling diaphragm will be properly seated as shown in Fig. 5-M-22 against the front housing while pressing the rear housing down squarely.

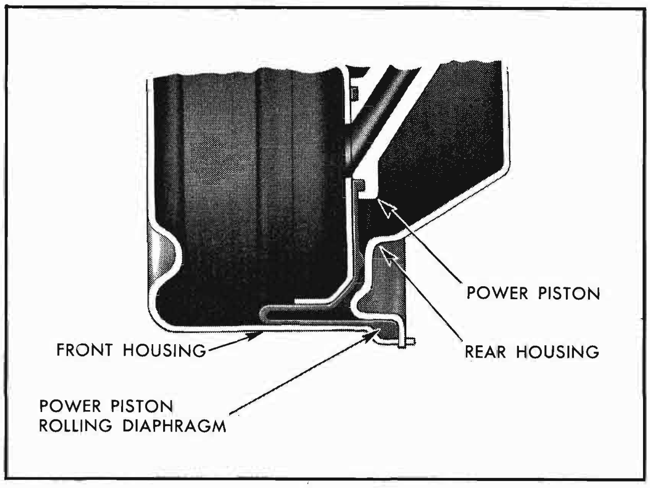


Fig. 5-M-22 Rolling Diaphragm Properly Installed

10. Press the rear housing down aligning the locking lugs. If the rolling diaphragm fails to enter the front housing properly, rotate the rear housing very slightly back and forth while pressing down and guiding the housing to the locking lugs.

11. Rotate the rear housing (with a suitable wooden lever) clockwise to secure the rear housing to the front housing (Fig. 5-M-23). After the rear housing is rotated to the lock position the exhaust manifold assembly should be in line with the master cylinder filler cap.

NOTE: It is important that the bead of the diaphragm is maintained in the recess of the front housing all the way around. This bead *must not* be pinched into the slots as the diaphragm is returned to the locked position nor pushed ahead of the rear housing.

12. Operation of unit *must be* checked full stroke of the piston with vacuum to insure proper positioning of diaphragm. Proper functioning of the vacuum system should also be observed.

NOTE: Manual operation without vacuum may damage a rolling diaphragm not correctly installed.

13. If unit is filled with hydraulic fluid and bled on the bench, it may not be necessary to bleed the hydraulic system on the car.

NOTE: When bleeding the master cylinder on the bench, point front end of cylinder down slightly to allow air to escape through compensating port.

14. Install push rod clevis lock nut end clevis to approximately same position as removed. Leave clevis lock nut loose.

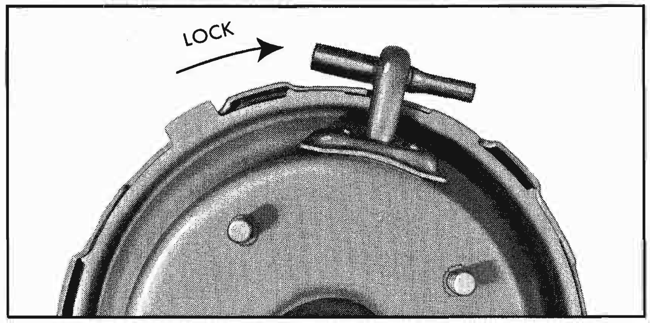


Fig. 5-M-23 Locking Brake Rear Housing

MASTER CYLINDER PISTON ADJUSTMENT

The following gaging operation is necessary whenever any structural parts such as the rear housing, master cylinder piston, front housing, diaphragm support plate, etc., have been replaced with new parts. It is also necessary to gage when the exact number of shims removed at disassembly is not known.

GAGE METHOD

1. Place the master cylinder in a vise or fixture with the master cylinder filler plug up. Remove the nuts and lockwashers.

2. Remove the front housing from the master cylinder. Do not remove the shims from the studs. Be sure no parts are displaced from the bore of the master cylinder.

3. Place master cylinder piston gage J-8531 over the master cylinder piston, and the four housing studs, so that it seats on the housing or shims (Fig 5-M-24).

If the end of the gage and the end of the piston are flush, no additional shimming will be necessary. In cases where the piston end holds the gage above

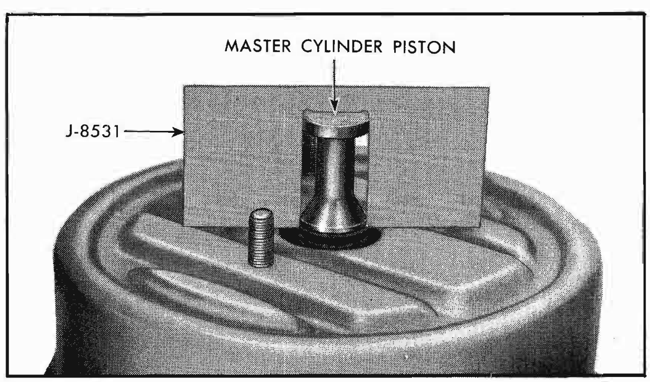


Fig. 5-M-24 Checking Master Cylinder Piston Adjustment

the shims or housing, more shims must be added until the end of the gage and the end of the piston are as close to flush as possible. (The total number of shims is *never* to exceed 5). The piston end should never be more than one shim thickness lower than the end of the gage. If this situation exists, disassemble the power booster and check all parts for deformation and carefully reassemble.

AIR METHOD

(Works best when reservoir is empty of fluid.)

When no gage is available, it is possible to check the correct number of shims by the following method:

1. Tighten the master cylinder nuts to 15-30 lb. ft. torque.

2. Remove the master cylinder filler cap.

3. With the brake released, force air into the hydraulic outlet of the master cylinder.

   A. If air passes freely through the compensating port, which is the smaller of the two holes in the bottom of the master cylinder reservoir, the number of shims is considered satisfactory.

   B. If the air does not flow through the port, the master cylinder must be removed and shims added until it does flow freely. Torque the master cylinder nuts to 15-30 lb. ft.

When the correct number of shims is in position, the master cylinder is assembled to the housing. Care must be taken when inserting the master cylinder piston into the bore. The master cylinder piston cup *must* be in a position so that the master cylinder piston will rest on the flat side of the master cylinder piston cup. When the master cylinder is in position on the studs, the four nuts and lockwashers should be installed and torqued to 15-30 lb. ft.

INSTALL POWER BRAKE ASSEMBLY

1. Place power brake into position and install four rear housing to dash attaching lock washers and nuts from inside of car. Tighten nuts to 20-35 lb. ft. torque.

2. Attach clevis to brake pedal assembly and adjust to provide 3⅛″ to 3⅜″ from floor mat to bottom of pedal pad. Secure clevis lock nut.

3. Adjust stoplight switch as necessary to provide 3⁄16″ of plunger extending from body.

4. Attach vacuum lines.

5. Attach hydraulic line.

6. Bleed brakes as necessary and fill fluid reservoir to provide a distance of 1″ from top of fluid to top of filler hole.

SYSTEM TEST

VACUUM LEAK

1. Vacuum Leak in Released Position

With transmission in Neutral or Park, and brake released, stop engine and wait one minute. Apply brake several times. Each application should provide less and less pedal travel following normal depletion of reserve vacuum. Number of applications on reserve vacuum will depend on how hard pedal is pressed and how far pedal moves. If vacuum assist is not present, reservoir is plugged or an air leak is indicated. Check external hose and vacuum check valve before opening power unit.

2. Unit Operation

After depleting reserve vacuum put light pressure on pedal and start engine. If power system is functioning properly pedal will fall away slightly.

3. Vacuum Leak in Holding Position

With transmission in Neutral or Park stop engine while holding a moderately heavy load steadily on pedal. After one minute release and apply pedal several times, if there is no vacuum assist during this test but system was normal during test No. 1 above, there is an air leak within the unit.

NOTE: Some units on this test will leak air internally if pedal load is light. This is a normal condition.

HYDRAULIC LEAK

a. Depress brake pedal maintaining constant pressure. If pedal falls noticeably in one minute, the hydraulic system is leaking.

b. If pedal has a spongy feel when applying the brakes, air may be present in the hydraulic system.

Road test brakes by making a brake application at about 40 mph to determine if vehicle stops evenly and quickly.

If system checks are satisfactory and the brake pedal travels to within 1″ of the floor-board, brake shoes require adjustment or replacement.

TROUBLE DIAGNOSIS

The same types of brake trouble may be encountered with power brakes as with standard brakes. Before checking power brake system for source of trouble, refer to trouble diagnosis of standard brakes. After these possible causes have been eliminated, check for cause as outlined below.

HARD PEDAL

a. Vacuum failure due to:

1. Faulty vacuum check valve.

2. Vacuum hose or pipe collapsed, plugged, kinked or disconnected.

3. Internal leaks in power brake unit.

b. Power brake unit trouble.

1. Vacuum

(a) Internal vacuum hose off or restricted.

(b) Vacuum leaks in unit caused by improper assembly, missing parts, damaged parts and foreign material.

2. Hydraulic

(a) Cups swollen by improper fluid.

(b) Compensating port not cleared by primary cup.

3. Mechanical

(a) Badly dented front housing.

(b) Bound up pedal linkage.

(c) Improperly adjusted stop light switch.

(d) Broken or missing springs.

GRABBY BRAKES (APPARENT OFF-AND-ON CONDITION)

a. Faulty pedal linkage.

b. Dented front housing.

c. Sticking air valve.

d. Air valve return spring rubbing air valve.

e. Defective vacuum check valve.

f. Loose vacuum connections.

g. Incorrect assembly of reaction levers or springs.

h. Reaction levers and plates not lubricated.

PEDAL GOES TO FLOOR OR ALMOST TO FLOOR

a. Brake adjustment.

b. Air in hydraulic system.

1. Fluid reservoir empty.

2. Faulty master cylinder check valve.

c. Hydraulic fluid leakage:

1. External:

(a) Defective filler cap, missing baffle, or filler cap gasket.

(b) Cracked master cylinder casting.

(c) Leaks at wheel cylinder, in pipes, hoses or at connections.

2. Internal:

(a) Defective secondary seals on master cylinder piston.

d. Faulty primary cup which causes pedal to sink to the floor under constant load, but does not empty reservoir.

ENGINE IDENTIFICATION CHART

Showing Major Components used in 1962 Production Engines.

NOTE: Identification Letter Code stamped immediately below production engine number on front of right hand side of block.

* 3 Speed Borg-Warner S.M. Trans.

** 3 Speed S.M. Trans.

LETTER CODE	TYPE TRANS.	MODEL APPLICATION	10.75:1 Compression Ratio (Cyl. Hd. & Valves)	10.25:1 Compression Ratio (Pistons)	8.6:1 Compression Ratio (Pistons)	7.8:1 Compression Ratio (Pistons)	2 BBL. Carb. (1½ Throttle Bore)	2 BBL. Carb. (1¼ Throttle Bore)	4 BBL. Carburetor	Tri-Power Carburetor	425E and Model 10 H.M. Camshaft (0)	Synchro-Mesh Camshaft (1)	H.M. Camshaft (4) (S.M. Option)	425A Camshaft (6)	Single Valve Spring	Heavy Duty Valve Springs	4 Bolt Main Brg. Caps (3 Center)	Special Valve Lifters	.0022-.0027 Piston Fit	.0007-.0013 Piston Fit	Long Exhaust Manifold	Distributor (Model 1110996)	A/C 45 Spark Plug	A/C 44 Spark Plug	Heavy Duty Starting Motor	Heavy Duty Clutch	Heavy Duty Transmission	Positive Crankcase Ventilation
01A	S/M	Std. - 23			X			X				X			X					X			X					
01A*	S/M	Std. - 26			X			X				X			X					X			X				X	
02B	S/M	Std. - 28 Spl. Equip. - 26			X				X			X			X					X			X				X	
02B**	S/M	Std. - 27 Spl. Equip. - 23			X				X			X			X					X			X					
03B	S/M	Spl. Equip. - 23-26 Std. Pol. & Taxi			X			X				X			X					X			X			X	X	
04B	S/M	Std.-2840-2890;Spl.Equip.27-28			X				X			X			X					X			X			X	X	
05A	S/M	Export - 23				X		X					X							X			X					
05A*	S/M	Export - 26				X		X					X							X			X				X	
06B	S/M	Spl. Police—Std. - 29		X					X				X					X		X		X	X		X	X	X	
08B	S/M	425A - 23-26-27-28-29	X						X					X		X	X	X	X		X	X	X		X	X	X	
10B	S/M	Spl. Equip. - 23-26-27-28-29	X							X			X			X			X			X	X		X	X	X	X
11B	S/M	425A - 23-26-27-28-29	X							X				X		X	X	X	X		X	X	X		X	X	X	X
15H	10 H/M	Std. - 23		X			X				X											X	X		X			
16K	10 H/M	Spl. Equip. - 23		X					X				X									X	X		X			
16KJ	10 H/M	Std. - 29		X					X				X									X	X		X			
17H	10 H/M	Air Cond. - 23		X			X				X											X	X		X			
18K	10 H/M	Air Cond. - 23-29		X					X				X									X	X		X			
20L	10 H/M	425E - 23-29			X			X			X									X			X					
21L	10 H/M	425E - Air Cond. - 23-29			X			X			X									X			X					
23H	10 H/M	Export - 23-29				X	X				X									X			X					
25J	10 H/M	425A - 23-29	X						X					X		X	X	X	X		X	X	X		X			
27J	10 H/M	Spl. Equip. - 23-29	X							X			X						X			X	X		X			X
28J	10 H/M	425A - 23-29	X							X				X		X	X	X	X		X	X	X		X			X
35M	315 H/M	Std. - 26 Taxi & Police		X			X						X									X	X		X			
36P	315 H/M	Std. - 27-28; Spl. Equip. - 26		X					X				X									X	X		X			
37M	315 H/M	Air Cond. - 26 Taxi & Police		X			X						X									X	X		X			
38P	315 H/M	Air Cond. - 26-27-28		X					X				X									X	X		X			
39N	315 H/M	Spl. Police		X					X				X					X				X		X	X			
40R	315 H/M	425E- -26-27-28 & Taxi			X			X			X									X			X					
41R	315 H/M	425E - Air Cond. 26-27-28 & Taxi			X			X			X									X			X					
44M	315 H/M	Export - 26				X	X						X							X			X					
45P	315 H/M	Export - 27-28				X			X				X							X			X					
47N	315 H/M	425A - 26-27-28	X						X					X		X	X	X	X		X	X	X		X			
49N	315 H/M	Spl. Equip. - 26-27-28	X							X			X						X			X	X		X			X
50N	315 H/M	425A - 26-27-28	X							X				X		X	X	X	X		X	X	X		X			X

Fig. 6-1 Engine Identification Chart

ENGINE MECHANICAL

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

Pontiac's 425 V8 engine is used in all models. Displacement is 389 cubic inches provided by $4\frac{1}{16}''$ bore and $3\frac{3}{4}''$ stroke. Three compression ratios are available. A 10.75:1 ratio is available on special order, a 10.25:1 is standard on Hydra-Matic equipped models and an 8:6:1 ratio is standard on synchro-mesh models.

Thirty-five different engine combinations are available; these combinations and the major components of each are shown in Fig. 6-1.

Engine identification is facilitated by a letter-number code stamped below the production engine number. By referring to Fig. 6-1 and using the identification letters, major engine components can be determined.

The economy engine on Hydra-Matic equipped cars can also be identified by an "E" stamped on the snorkel of the carburetor air cleaner.

The engine (Fig. 6-2) features completely machined combustion chambers, overhead valves, ball pivot rocker arm construction, harmonic balancer, hydraulic lifters, aluminum pistons, straight valve guides, superior crankcase ventilation and lubrication systems, and large displacement combined with high

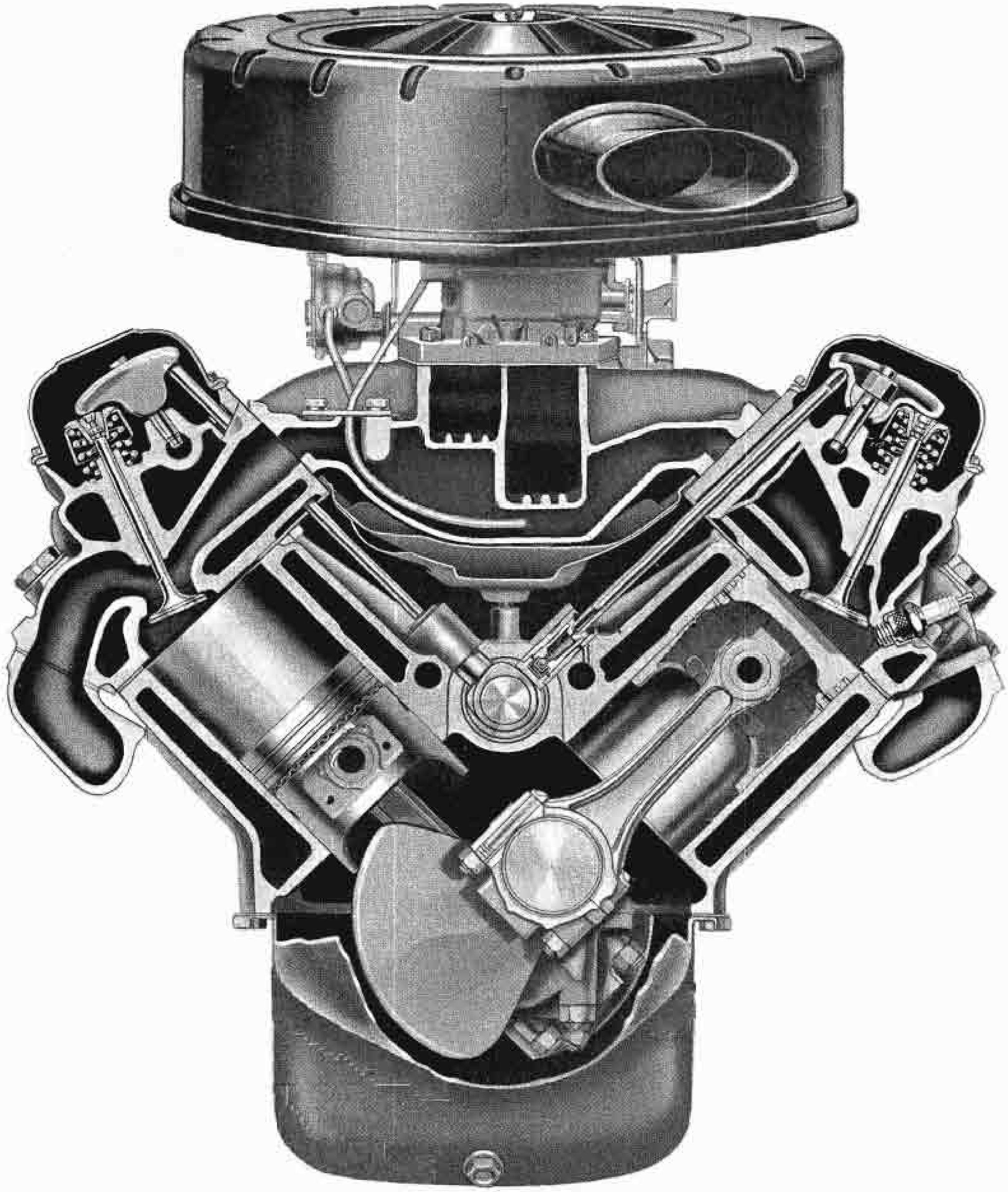


Fig. 6-2 Transverse Cross Section of Engine

compression ratio for utmost performance and economy.

Detailed descriptions of cooling, crankcase ventilation, and the lubrication system are given in ENGINE COOLING AND LUBRICATION. Mechanical details, such as valves, rocker arms, hydraulic valve lifters, etc. are described on the following pages.

Detailed mechanical specifications begin on page 6-55.

CYLINDER BLOCK

The cylinder block has two banks of four cylinders each, cast at 90° to each other. Left bank cylinders are numbered 1-3-5-7 and right bank cylinders are numbered 2-4-6-8.

The left bank is set slightly behind the right bank. This provides room for mounting the fuel pump in front of the engine on the left side where it receives direct cooling from the fan (Fig. 6-3). Also, it permits a shorter fuel line. Both these factors minimize the possibility of vapor lock. This arrangement of cylinders also provides for mounting the generator on the right side. This location is advantageous since it places the most severe turn in the belt on the slack, or lowest tension side, of the belt.

All main bearing caps are doweled to the cylinder block to insure accurate alignment and facilitate assembly.

Engines which are expected to be used for protracted high torque operation have four attaching bolts in the three center main bearing caps as compared to two bolts per cap in other engines. Fig. 6-4 shows the four bolt cap installation.

Cylinders are completely encircled by water jackets. For details of the engine cooling system see ENGINE COOLING AND LUBRICATION.

CYLINDER HEADS

Left and right cylinder heads are identical. The same casting is used for both heads.

The same head is used on 8.6:1 and 10.25:1 compression ratio engines. A special higher compression head is used on the 10.75:1 engine.

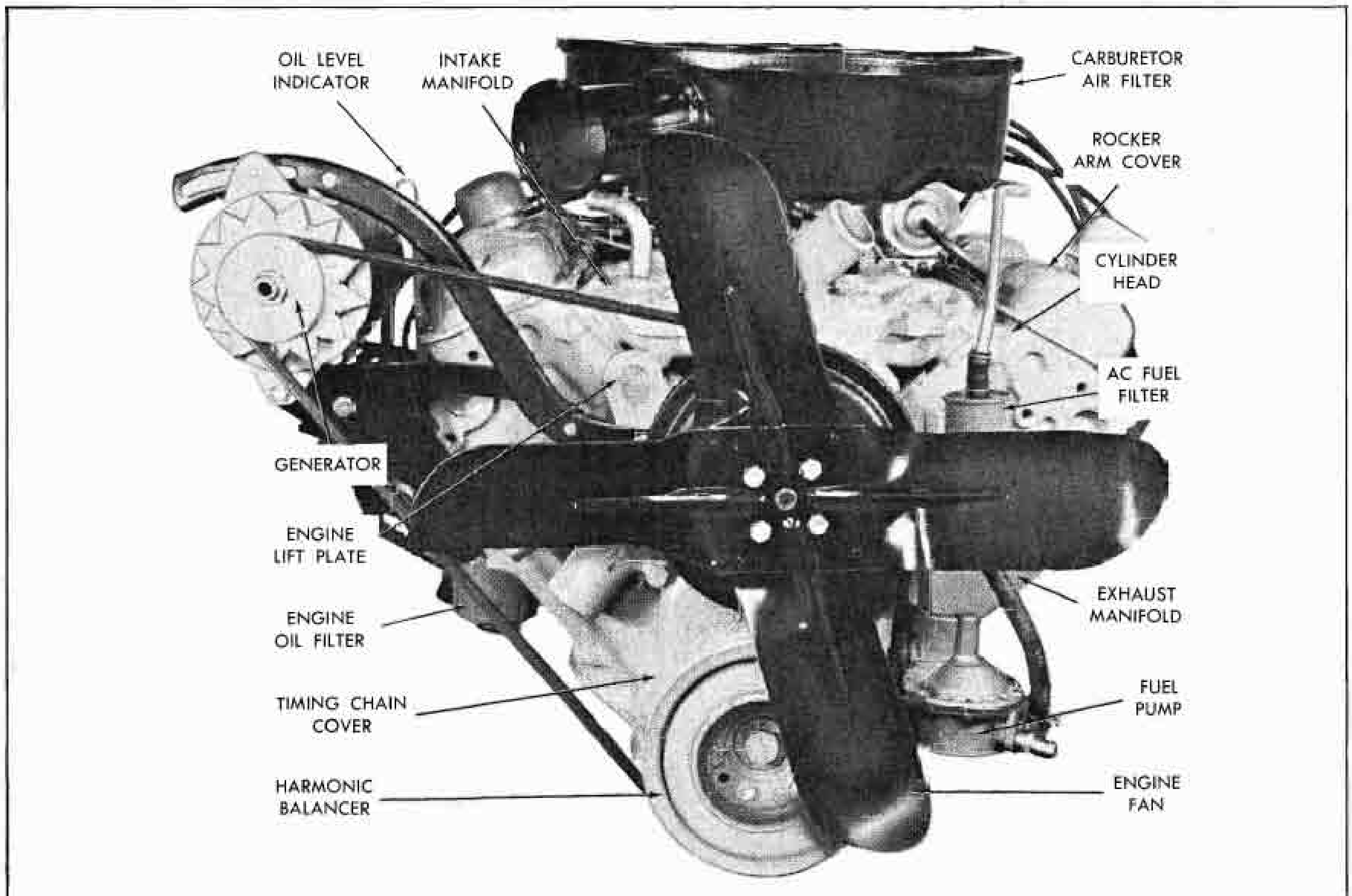


Fig. 6-3 Full Front View of Engine

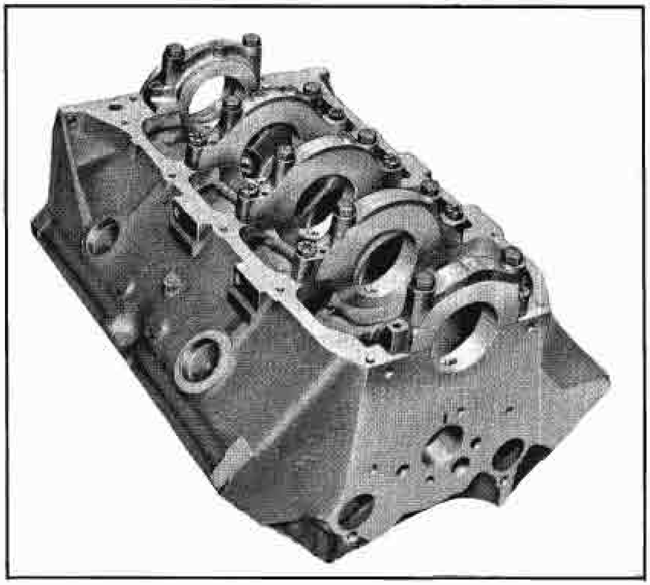


Fig. 6-4 Four Bolt Bearing Cap Installation

Valve seats are completely surrounded by water and each head has an oil gallery which feeds oil to the rocker arm studs to provide lubrication of the upper valve train parts.

Cylinder head casting date is located at the right front corner of the right head and the left rear corner of the left head.

CRANKSHAFT AND BEARINGS

The crankshaft is cast pearlitic malleable iron and is supported by five main bearings. The rear main bearing shells have two oil grooves (Fig. 6-5). The rear oil groove has three oil drain holes evenly spaced. The front four upper and lower shells are not interchangeable, due to omission of oil groove in lower half. Torsional vibration is dampened by the harmonic balancer mounted on the front end of the crankshaft.

The rear main bearing is sealed by a packing seated in a chamfered groove in the block and bearing cap (Fig. 6-5). A slinger on the crankshaft in front of the seal and the drain groove in the rear main bearing prevent an excess of oil from getting to the seal.

Slots are cast in the cylinder block and cap seal groove to prevent seal rotation.

CAMSHAFT AND DRIVE

Four different camshafts are used. The engine chart (Fig. 6-1) shows the application of each. Camshafts can be identified by a digit stamped on the front end of the shaft. Correct identification is as follows:

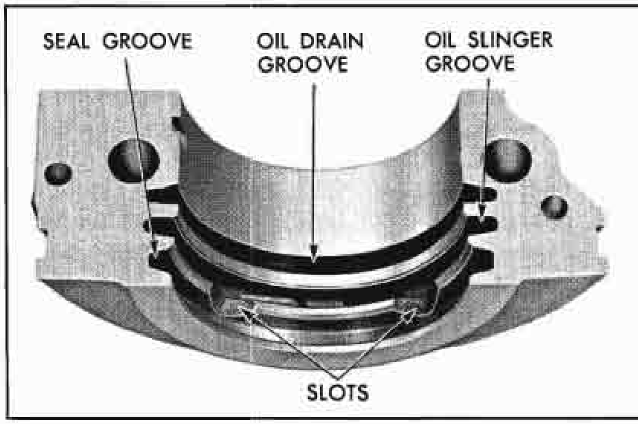


Fig. 6-5 Rear Main Bearing Cap

0=425E and Roto Hydra-Matic Camshaft

1=Synchro-Mesh Camshaft

4=Super Hydra-Matic Camshaft

6=425A Camshaft

The camshafts are cast from alloy iron. Cam lobes are ground, hardened and tapered with the high side toward the rear. This, coupled with a spherical face on the lifter causes valve lifters to rotate. The camshaft is supported by five bearings.

A 7/8" wide, 60 link timing chain is used to drive the camshaft. The 42 tooth camshaft drive sprocket is made from cyanide hardened, cast alloy iron, while the 21 tooth crankshaft sprocket is made from case hardened steel.

PISTONS AND CONNECTING RODS

The pistons are aluminum alloy, tin plated, with steel struts to control expansion and give added strength. Pistons are cam ground so that the diameter across the thrust face is larger than the diameter fore and aft of the engine. The steel struts give assurance that the piston will expand front to rear and that the thrust diameter will not change. Two compression rings and one oil control ring are used, all of which are located above the piston pin.

The pistons used in the 10.25:1 and 10.75:1 compression ratio engines are flat on top as shown in Fig. 6-6. Pistons used in the 8.6:1 compression ratio engine are dished as shown in the illustration and also have an "L" cast on the back side. Dishing provides the larger combustion chamber volume required for the lower compression ratio.

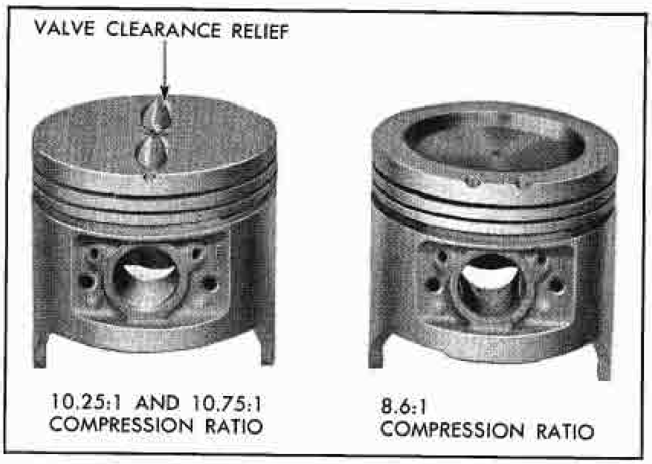


Fig. 6-6 Standard and High Compression Pistons

The high compression piston has a relief machined into the head of the piston for valve clearance.

Piston pins are offset $\frac{1}{16}''$ toward thrust side (right hand side) to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path (Fig. 6-7). This feature provides quieter engine operation. Pins are hardened steel and have a floating fit in the pistons. They are retained in the connecting rods by a press fit.

I-beam forged connecting rods are used. A lubrication groove between the connecting rod and cap directs a jet of oil onto the opposite cylinder wall to lubricate the piston and rings and to provide splash for lubricating the piston pins.

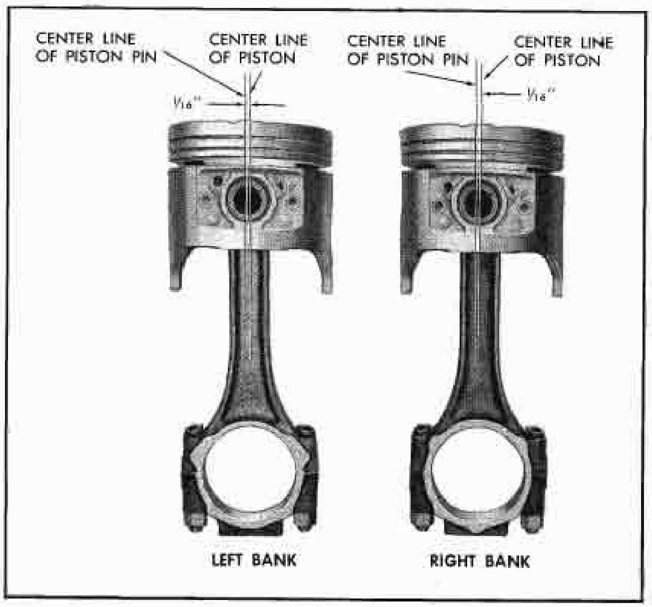


Fig. 6-7 Connecting Rod and Piston Assembly

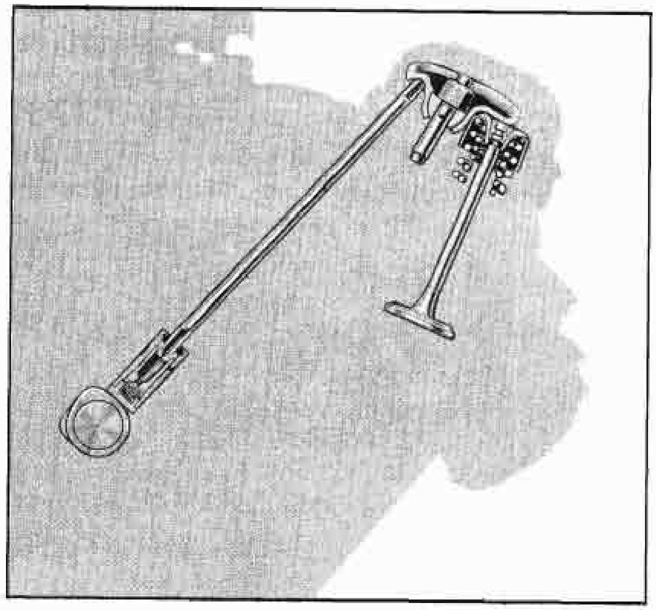


Fig. 6-8 Fixed Setting Rocker Arm Valve Train

VALVE TRAIN

A very simple ball pivot type valve train is used (Fig. 6-8). Motion is transmitted from the camshaft through the hydraulic lifter and push rod to the rocker arm. The rocker arm pivots on its ball and transmits the camshaft motion to the valve. The rocker arm ball is retained by a nut which locks against a chamfer on the stud.

The maximum in durability is assured by the use of cyanide-hardened stamped steel rocker arms. In addition all friction points to the valve train are positively lubricated.

The cylinder head has straight valve guides cast integral (Fig. 6-9). External shields are used on both

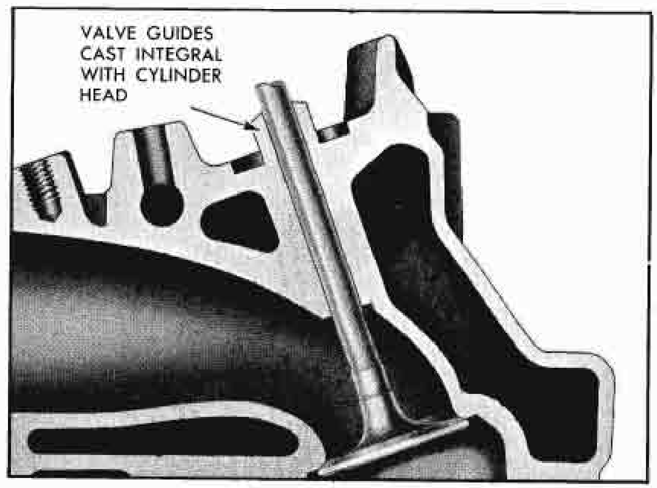


Fig. 6-9 Cross Section View of Intake Valve Guide

intake and exhaust valves to reduce the amount of oil splashed against stems. Valve stem seals are used on exhaust as well as intake valves to prevent oil from entering the valve guides.

Inner and outer valve springs are used on all engines except the standard synchro-mesh transmission which uses a single valve spring.

HYDRAULIC VALVE LIFTERS

Hydraulic lifters are used to keep all parts of the valve train in constant contact. In other words each lifter is an automatic adjuster maintaining zero lash under all conditions. This insures precision valve timing and silent operation, increases valve life, and eliminates the need for tappet adjustment.

The hydraulic lifter assembly (Fig. 6-10) includes: the cast iron body which rides in the cylinder block boss, the plunger, push rod seat, plunger spring, ball check valve, ball check valve retainer, and retainer ring.

The hydraulic valve lifter functions as follows: When the lifter is riding on the low point of the cam, the plunger spring keeps the plunger and push rod seat in contact with the push rod.

When the lifter body begins to ride up the cam lobe, the ball check valve cuts off the transfer of oil from the reservoir below the plunger. The plunger and lifter body then rise as a unit pushing up the push rod and opening the valve.

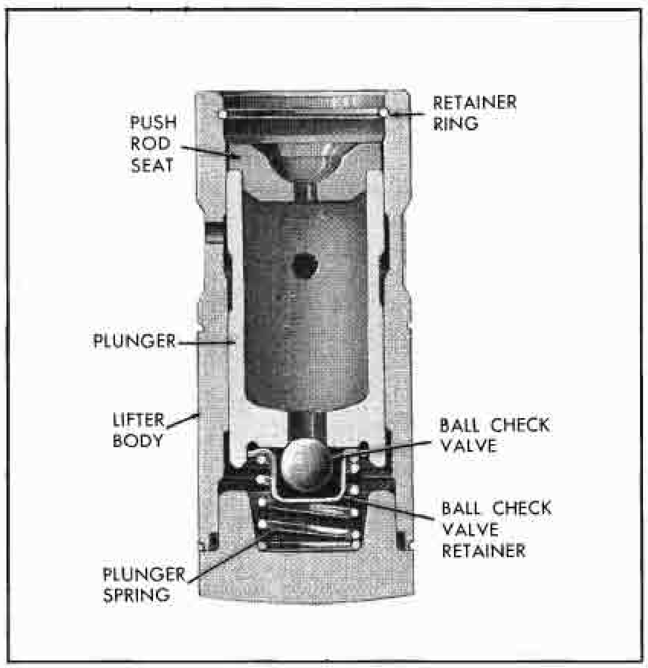


Fig. 6-10 Sectional View of Valve Lifter Assembly

As the lifter body rides down the other side of the cam the plunger follows with it until the valve closes. The lifter body continues to follow the cam to its low point, but the plunger spring keeps the plunger in contact with the push rod. The ball check valve will then move off its seat and the lifter reservoir will remain full.

During operation a small amount of oil leaks out of the lifter between the plunger and body. A controlled amount of leakage is important to provide continuous adjustment of the plunger position within the lifter. This leakage is called "leak down" and must be within certain limits to provide correct operation (see page 6-16).

Oil is supplied to the lifter by the cylinder block oil gallery to replace that lost through leak down. The annular groove around the outside of the lifter body indexes with the passage drilled from the gallery to the lifter boss. Oil then enters the lifter from this groove and passes into the plunger cavity. From the plunger cavity, oil under pressure is also fed up the push rod to lubricate the friction area between the upper end of the push rod and the rocker arm.

FUEL DISTRIBUTION SYSTEM

The intake manifold is designed to provide fuel passages which are short and practically equal in length. With the two barrel carburetor each throat of the carburetor feeds four cylinders as shown in Fig. 6-11. The intake manifold used with the four barrel carburetor is fundamentally the same as with two barrel but has four openings to index with the carburetor throats. With the four barrel carburetor the two throats on the right side feed four cylinders and the two throats on the left side feed four cylinders (Fig. 6-12).

On tri-power equipped units, distribution is the same as two barrel with extra fuel fed to each group

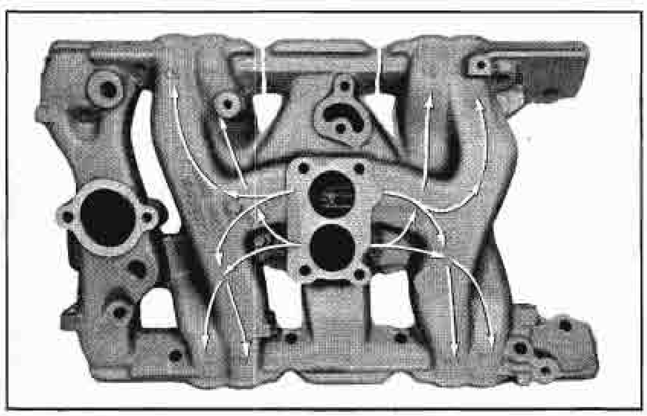


Fig. 6-11 Intake Manifold—Two Barrel Carburetor

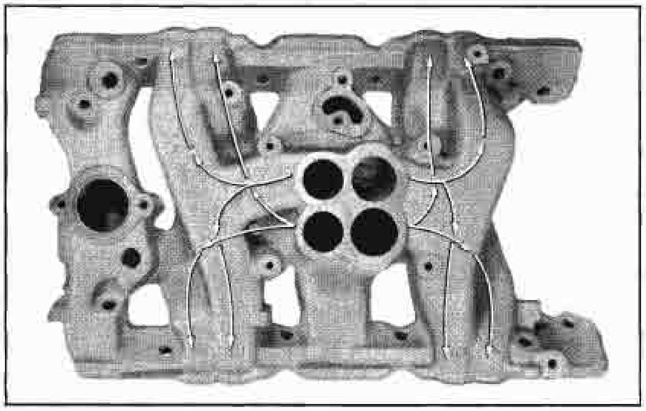


Fig. 6-12 Intake Manifold—Four Barrel Carburetor

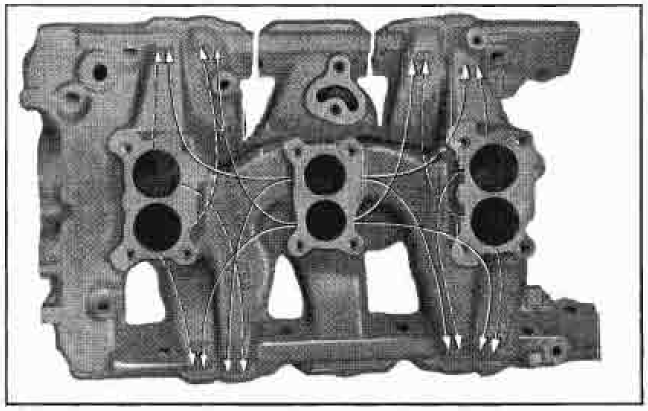


Fig. 6-13 Intake Manifold—Tri-Power Carburetor

of 4 cylinders from the end carburetors on demand (Fig. 6-13).

A stove is included in the intake manifold surrounding the risers which lead to the carburetor. When the engine is cold, exhaust gases from the right bank of cylinders pass through a passage in the intake manifold to circulate around and heat the stove. The fuel-air mixture passing from the carburetor to the cylinders is thereby pre-heated to the desired temperature for proper combustion.

EXHAUST SYSTEM

Two cast iron exhaust manifolds are used, one for each bank of cylinders. Exhaust gases from the left manifold pass through a crossover pipe which passes beneath the engine to the right side. At this point the exhaust pipe from the right manifold joins the crossover pipe and gases are carried rearward to the muffler and tailpipe. A thermostatically controlled valve in the outlet of the right manifold blocks the passage of exhaust out of this manifold when the engine is cold. Exhaust from the cylinders on the right bank will then pass through the intake manifold exhaust crossover passage and out the left cylinder head and exhaust manifold.

In passing through the crossover passage, the hot gases serve to heat the intake manifold stove.

COMBUSTION CHAMBERS

Combustion chambers are completely machined to insure accurate volume control and uniform shape for all cylinders. Spark plugs are located near intake valves for maximum power and to properly fire economically lean mixtures.

The contoured wedge shape of the combustion chamber (Fig. 6-14) minimizes the possibility of detonation, facilitates breathing and provides swirling turbulence for smooth, complete combustion.

Intake valves are large and have 30° seat angles to further provide easy breathing for high combustion efficiency. Exhaust valve seat angle is 45°.

SERIAL NUMBERS

The manufacturers motor vehicle identification number is located on a machined pad on the front of the right-hand bank of the block.

The production engine number will also be found in the same area (Fig. 6-15). This number is used for production control purposes during manufacture. The production engine number should be included on AFAs or P I Reports concerning the engine.

PERIODIC SERVICE

There are no periodic services required on the mechanical portions of the engine. Periodic services connected with the engine consist of tune-up, lubri-

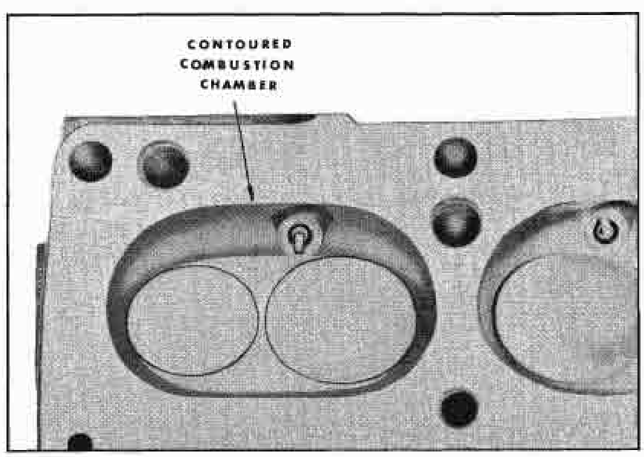


Fig. 6-14 Cylinder Head Viewed from Bottom

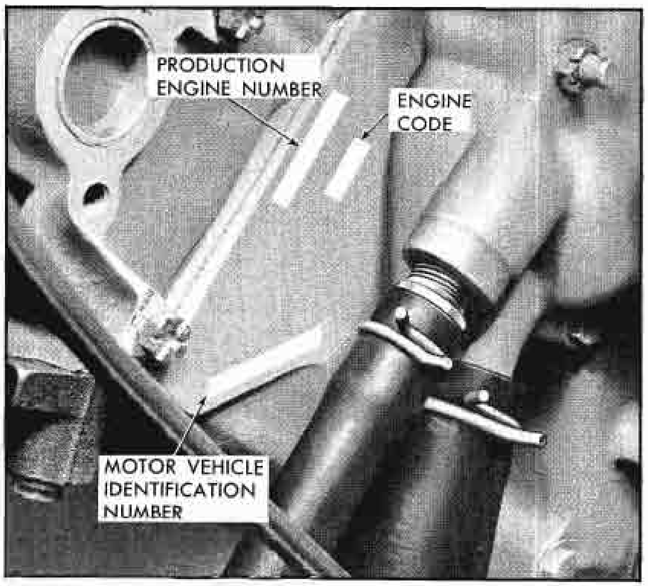


Fig. 6-15 Engine Serial Number Location

cation, replacing oil filter, fuel filter, etc. Procedures and recommendations for these services will be found in appropriate sections of this book.

ADJUSTMENTS ON CAR

ADJUST DRIVE BELTS

Engine fan and accessory drive belts may be adjusted either by the deflection method or by use of the Borroughs Belt Tension gauge. Page 6A-12 gives the correct specifications for both methods.

ADJUST IGNITION TIMING

See ELECTRICAL SECTION.

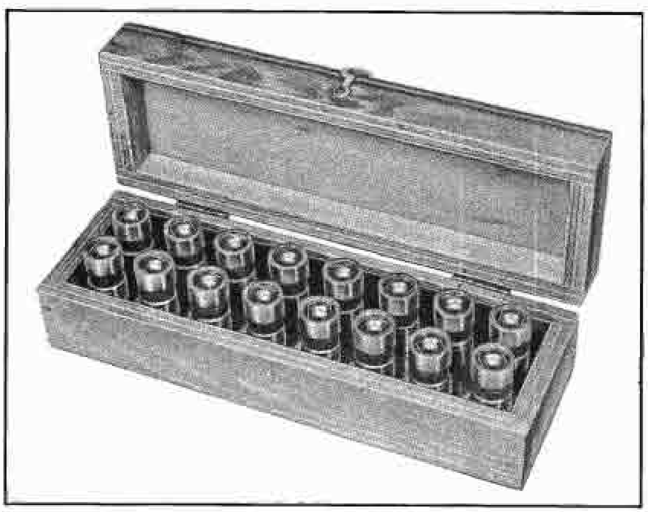


Fig. 6-16 Valve Lifter Storage Box J-5763

ADJUST CARBURETOR

See ENGINE FUEL SECTION.

GENERAL INFORMATION ON ENGINE SERVICE

Cleanliness is a primary factor when servicing the V-8 engine. The slightest particle of dirt that finds its way into a hydraulic lifter may cause a malfunction.

Since any dirt which may enter the oil galleries or passages in the engine could eventually get to a lifter, cleanliness should be exercised when any part of the engine is removed or disassembled. When a cylinder head is removed for any purpose, it is necessary to remove the push rod cover. This exposes the lifters to any dirt which may fall from the upper portion of the block or which may be carried in the air. Thus, it is wise to cover the lifter galleries until ready to reassemble the engine.

When lifters are removed for any reason, they should immediately be placed in order in valve lifter storage box J-5763 (Fig. 6-16). This is important for two reasons. First, it is the easiest way to keep lifters clean. Second, lifters should always be replaced in the same bosses from which they were removed.

Valves, valve lifters, push rods, rocker arms, rocker arm balls, and rocker arm ball nuts should always be kept in sets and returned to their original positions. These parts will tend to mate as the engine operates and will provide more satisfactory operation when kept together. By storing lifters in storage box J-5763 and valves, push rods, rocker arms, balls and nuts in holding stand J-5709 (Fig. 6-17) whenever they are removed, they can easily be kept in sets for identifi-

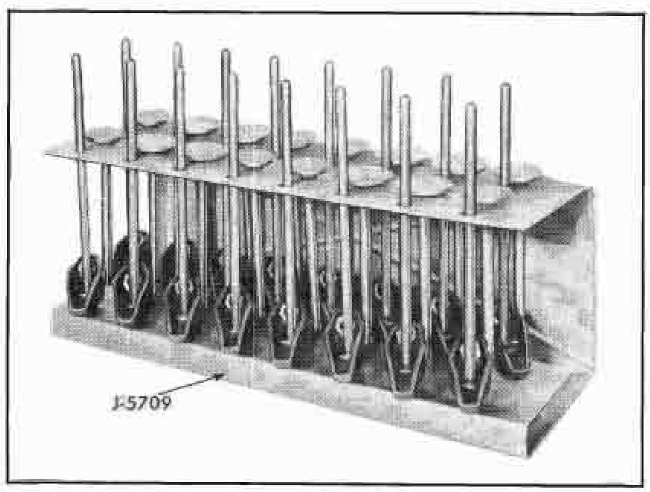


Fig. 6-17 Valve and Valve Train Holding Stand J-5709

cation during assembly. In addition to keeping the parts in sets, the push rods should be replaced with the same end up. In other words, the same end will contact the rocker arm as before the engine was disassembled. The upper end can usually be identified by the polished surface which contacts the rocker arm. Push rods will also be polished somewhat in the area where the rod passes through the head.

When hydraulic valve lifters are disassembled, the various parts of each lifter must be kept together. This is especially important since the lifter body and plunger are selectively fitted. The use of the special tray included with cleaning tank J-5821 will aid in keeping the parts of each lifter together when lifters are being serviced.

Cylinder head screws should be installed without thread sealer of any kind.

When raising or supporting the engine for any reason, do not use a jack under the oil pan or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump, jacking against the oil pan may cause it to be bent against the pump. The result would be a telegraphed noise which would be difficult to trace. The crankshaft pulley is sheet steel and will not support engine weight.

It should be kept in mind, while working on the engine, that the twelve volt electrical system is capable of violent and damaging short circuits. When performing any work where electrical terminals could possibly be grounded, the ground cable of the battery should be disconnected.

Any time the carburetor or air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material which could follow the intake passage in the cylinder and cause extensive damage when the engine is started.

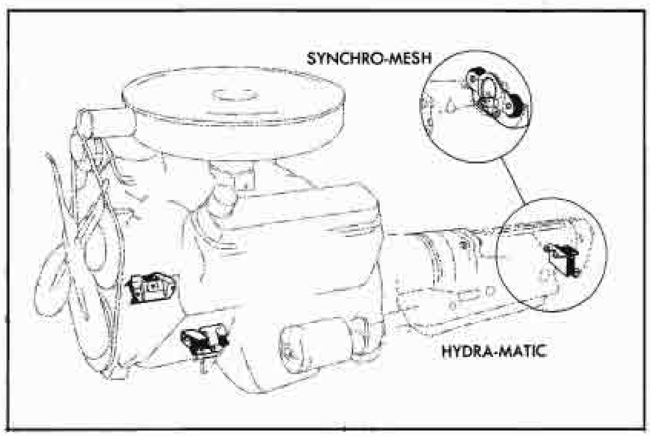


Fig. 6-18 Engine Mount Location

In the mechanical procedures described in this section generally no references will be made to the removal of optional equipment such as power steering pump, air conditioning compressor, etc.

Should it become necessary to remove any such item to perform other service,refer to the appropriate section of the manual for specific information.

SERVICE OPERATIONS ON CAR

ENGINE INSULATORS—REMOVE AND REPLACE (Fig. 6-18)

FRONT INSULATORS

NOTE: If a new rear insulator is also to be installed, it should be installed first since the engine locates from the rear insulator.

1. Raise hood and, using suitable engine lifting equipment, take weight of engine off front insulators.

CAUTION: Disconnect battery ground strap before raising engine. When the engine is raised, the starting motor solenoid terminals may contact the steering gear which could energize the starting motor if the ground cable is not disconnected.

2. Remove bolts fastening engine insulators to engine.

3. Remove bolts which fasten insulators to frame.

4. Raise engine just clear of insulator.

5. Remove insulator.

6. Position new insulator against engine and install attaching screws and washers. Tighten to 40-55 lb. ft. torque.

7. Lower engine.

8. Install frame to insulator bolts with lockwashers and plain washers and tighten securely.

REAR INSULATOR

NOTE: The rear insulator locates the engine. For this reason, any time the rear insulator is replaced the front insulators must be allowed to re-position on the frame as is brought out in the following procedure.

1. Support engine at rear to remove engine weight from rear insulator, using suitable engine lifting equipment.

2. Remove two transmission extension bracket to cross member support nuts (Fig. 6-19) and raise engine until transmission extension bracket studs are disengaged from lower cross member support.

3. Remove extension bracket to insulator retaining nuts (Fig. 6-19) and remove bracket.

4. Remove two front nuts from transmission extension clamp (Fig. 6-19) and remove insulators.

5. Install new insulators between transmission extension bracket and clamp, using flat washers on each end of two studs which hold insulators in place.

6. Install bracket by reversing above steps.

7. Lower engine until transmission extension bracket studs engage lower cross member support. Install nuts and tighten to 35-50 lb. ft. torque.

8. Check front mounts and, if improperly seated, loosen front mount to frame bolts and raise front of engine, letting front mounts seat themselves on frame bracket.

9. Lower engine and tighten front mount to frame bolts 40-55 lb. ft. torque.

CYLINDER BLOCK AND HEAD CORE HOLE AND OIL PASSAGE PLUGS—REMOVE AND REPLACE

All plugs in the block and cylinder head can be replaced with the engine in the car. The rear plugs in the block can be reached by removing the transmission, flywheel, and flywheel housing (synchromesh). In order to remove and replace water jacket plugs, it helps to lower the rear of the engine. When lowering the rear of the engine, the front insulators must be removed or they will be damaged.

REMOVE PLUGS

Rear plugs in left cylinder head can be reached through toe plate hole in floor, but right cylinder head must be removed for replacement of rear plugs. Water jacket plugs in sides of block can be reached by removing engine components which are in the way. Old plugs can be removed by using a punch to knock a hole through the center of the plug and then working the plug out. Punching through the plug also serves to distort and loosen the plug. When removing cylinder head oil gallery plugs, drive punch through plug near bottom so as not to damage rocker arm stud.

Remove small oil passage plug in top of cylinder head as follows:

1. Remove rocker arm cover.

2. Insert easy-out in hole of plug turning counterclockwise and pulling out on easy-out at same time (Fig. 6-20).

PREPARE HOLES AND PLUGS FOR INSTALLATION

After plugs are removed, carefully clean holes, removing all sharp edges to ensure plugs will seal properly and not be damaged in installation. Coat pressed-in plugs and pipe plugs with sealer before installation.

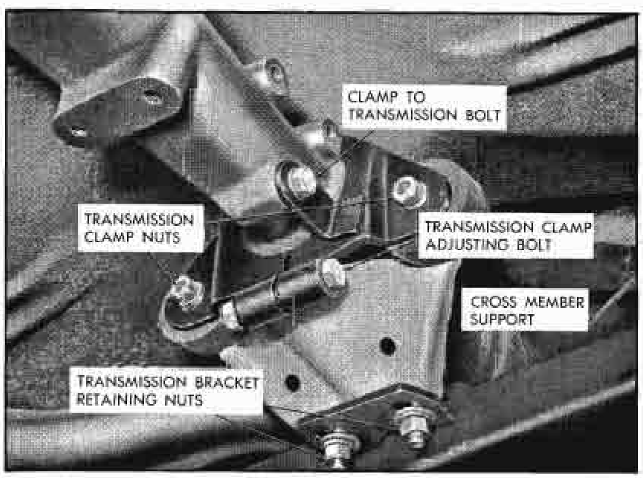


Fig. 6-19 Rear Engine Mount—Synchro-Mesh

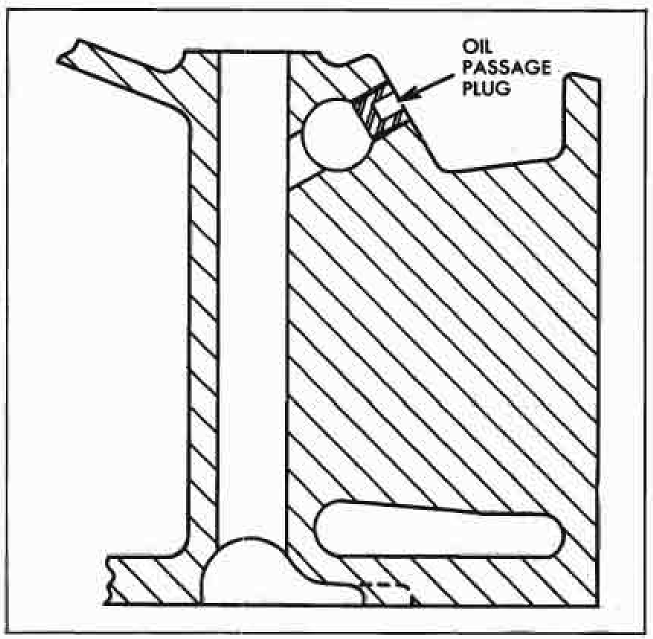


Fig. 6-20 Cylinder Head Small Oil Passage Plug

INSTALL NEW PLUGS

The following plugs can be installed by driving into place using a flat piece of metal or hard wood bearing against the outer surface: Camshaft plug, water jacket plugs, rear oil gallery plug in block, cylinder head core hole plugs, valve spring chamber plug, and the oil hole plug in the top of the cylinder head.

Front oil gallery plugs in the block, and cylinder head oil gallery plugs must be driven into place using a tool which bears against the bottom of the plug. A ½" x 3" bolt will make a satisfactory tool for this purpose.

All plugs should be driven in until the outer edge is flush with the surrounding surface.

MANIFOLD—VALVE TRAINS—CYLINDER HEADS

RIGHT SIDE EXHAUST MANIFOLD OR GASKET—REMOVE AND REPLACE

REMOVE

1. Remove generator and bracket.

2. Remove bolts from exhaust crossover pipe on right side of engine.

3. Straighten tabs on manifold front and rear individual bolt locks and remove manifold attaching bolts, manifold, and gasket.

NOTE: Locks are used on the front and rear pairs of bolts only.

4. Remove old gasket from exhaust crossover pipe.

REPLACE

1. Thoroughly clean gasket surfaces of cylinder head and exhaust manifold. Check condition of heat control valve and related parts.

2. Place new gasket on exhaust crossover pipe connector.

3. Replace exhaust manifold and new gasket. Use new individual manifold bolt locks on front and rear pairs of bolts.

NOTE: Place manifold outlet in position over end of crossover pipe but do not permit weight of manifold to rest on crossover pipe. Since the end holes of the gasket are slotted, installation of gasket may be simplified by first installing the manifold using only the front and rear bolts to retain manifold. Allow clearance of about $^{3}/_{16}$" between cylinder head and exhaust manifold. After inserting the gasket between head and manifold, the remaining bolts may be installed.

4. Tighten all bolts evenly and securely to 20-35 lb. ft. torque. Bend tab of screw locks against bolt heads.

NOTE: Be sure tabs are bent against sides of bolt heads, not on top of bolt heads.

5. Replace generator and bracket.

LEFT SIDE EXHAUST MANIFOLD OR GASKET—REMOVE AND REPLACE

REMOVE

1. Remove exhaust crossover pipe flange bolts on left side of engine.

2. Straighten tabs on manifold individual bolt locks. (Tabs can be straightened from beneath car by using long handled screwdriver.)

NOTE: Locks are used on the front and rear pairs of bolts only.

3. Remove the two front and rear manifold attaching bolts. (Bolts can be removed from beneath car using universal socket and extension.)

4. Remove two center attaching bolts.

5. Move manifold forward and remove from engine.

6. Remove gasket from crossover pipe.

REPLACE

1. Thoroughly clean gasket surfaces of cylinder head and exhaust manifold.

2. Install exhaust crossover pipe gasket using two thin (.075" thick) gaskets or one thick (.135" thick) gasket.

3. Place manifold in position against cylinder head and install two end bolts, finger tightening only.

4. Slide gasket between manifold and cylinder head.

5. Install remaining bolts and new bolt locks.

NOTE: All bolts can be started from beneath car using socket and extension.

6. Tighten all bolts evenly and securely to 20-35 lb. ft. torque. Bend tabs of bolt locks against bolt heads.

INTAKE MANIFOLD OR GASKET– REMOVE AND REPLACE

REMOVE

1. Drain water from radiator and from each side of cylinder block.

NOTE: Most of the water can be drained from the block through the radiator drain by raising rear end of car approximately 15 to 18 inches off the floor.

2. Remove air cleaner.

3. Remove upper radiator hose.

NOTE: If condition of hose does not warrant replacing with new hose, possible damage to hose and clamps can be reduced by leaving hose attached to water outlet. In this case water outlet may be disconnected from manifold and moved out of way.

4. Disconnect heater hose from fitting.

5. Disconnect wire from thermogauge unit.

6. Remove right spark plug wire bracket cap screw from manifold.

7. On cars equipped with power brakes, remove power brake vacuum pipe from carburetor.

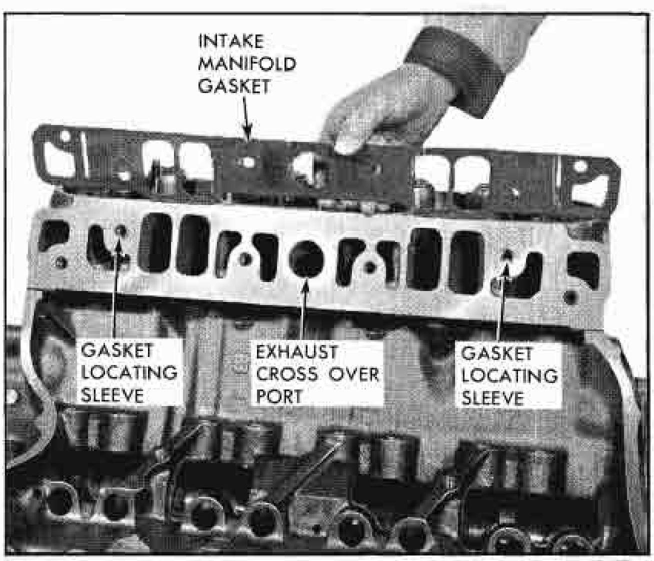


Fig. 6-21 Installing Intake Manifold Gasket

8. Disconnect distributor to carburetor vacuum hose.

9. Disconnect fuel line connecting carburetor and filter.

10. Disconnect throttle rod from carburetor.

11. Remove screws retaining throttle control bracket assembly.

12. Remove intake manifold retaining bolts and nuts, and remove manifold and gaskets.

NOTE: Make certain O-ring seal between intake manifold and timing chain cover is retained and installed during assembly if not damaged.

REPLACE

NOTE: When a new manifold is to be installed, transfer carburetor, water outlet, thermostat, heater hose fitting and thermogauge fitting. Use new gaskets on those units requiring gaskets and new O-ring seal between manifold and timing chain cover.

1. Install new gaskets on cylinder heads, positioning them over locating sleeves (Fig. 6-21).

2. Install intake manifold on engine, exercising caution to prevent bending locating sleeves on heads.

3. Install O-ring seal.

4. Install cap bolts and nuts loosely.

5. Position throttle control bracket assembly on manifold and install cap bolts.

6. Tighten timing chain cover to intake manifold bolt until both units are metal to metal (10-20 lb. ft. torque).

7. Tighten all nuts and bolts evenly to 40-45 lb. ft. torque.

8. Connect throttle rod to carburetor.

9. On cars equipped with power brakes, install vacuum pipe to carburetor.

10. Install fuel pipe connecting carburetor to fuel filter.

11. Connect heater hose to fitting.

12. Install upper radiator hose.

13. Connect wire to thermogauge unit terminal.

14. Install vacuum hose connecting distributor vacuum advance unit to carburetor.

15. Install spark plug wire bracket.

16. Install rear generator brace.

17. Replace air cleaner.

18. Close drain cocks and fill radiator to proper level.

19. Check Hydra-Matic linkage adjustments (see HYDRA-MATIC SHOP MANUAL).

PUSH ROD COVER OR GASKET—REMOVE AND REPLACE

REMOVE

1. Remove intake manifold, retaining O-ring seal.

2. Remove crankcase ventilator outlet pipe brackets from rear of right cylinder head and flywheel housing, and remove ventilator outlet pipe, or remove positive crankcase ventilation valve if car is so equipped.

3. Remove screws from push rod cover and remove cover.

REPLACE

1. Cement new gasket on push rod cover.

2. Replace push rod cover and tighten screws to 5 lb. ft. torque.

3. Replace positive crankcase ventilation valve, if applicable, or replace crankcase ventilator outlet pipe and brackets, slipping pipe into neoprene seal on push rod cover. Neoprene seal should seat on push rod cover. (A light coat of oil will facilitate installation of pipe into seal.)

4. Install intake manifold and O-ring seal.

VALVE SPRING, SHIELD OR SEAL—REMOVE AND REPLACE

REMOVE

1. Remove rocker arm cover, spark plug and distributor cap. (Remove rear generator bracket on right side.)

2. Remove rocker arm.

3. After removing rocker arm, thread valve spring compressor stud J-8929-1 on rocker arm stud and compress valve spring using compressor J-6384-1 and nut J-8929-2 while holding valve up with valve holder J-5961-2 (Fig. 6-22). Remove valve spring retainer cup locks and then remove valve spring compressor, valve spring retainer cup shield and valve stem seal.

REPLACE

1. Install new part or parts, compress springs with valve spring compressor J-6384-1 and nut J-8929-2 (while holding valve up with holder J-5961-2), install valve stem seal and retainer cup locks. Remove spring compressor and valve holder, then test valve stem seal using suction cup end of tool J-5751 (Fig. 6-23).

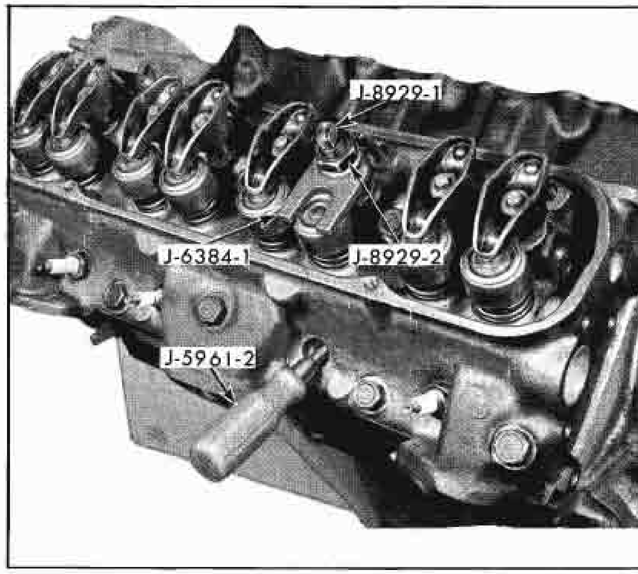


Fig. 6-22 Valve Spring Compressed

2. Install rocker arm, tighten rocker arm ball retaining nut to 15-25 lb. ft. torque.

3. Replace rocker arm cover, spark plug, distributor cap and connect spark plug wire.

PUSH ROD AND VALVE LIFTER—REMOVE AND REPLACE

REMOVE

1. Remove intake manifold, retaining O-ring seal.

2. Remove push rod cover.

3. Remove rocker arm cover.

4. Loosen rocker arm ball nut and move rocker arm off push rod.

5. Remove push rod.

6. Before removing lifter that is suspected of having a stuck plunger, it can be tested using lifter plunger unloader J-5097. To check lifter, insert pin of unloader tool through hole in push rod seat and push down on tool. Pin will unseat ball and tool will move push rod seat and plunger down. If lifter plunger is stuck, it will be impossible to move push rod seat down.

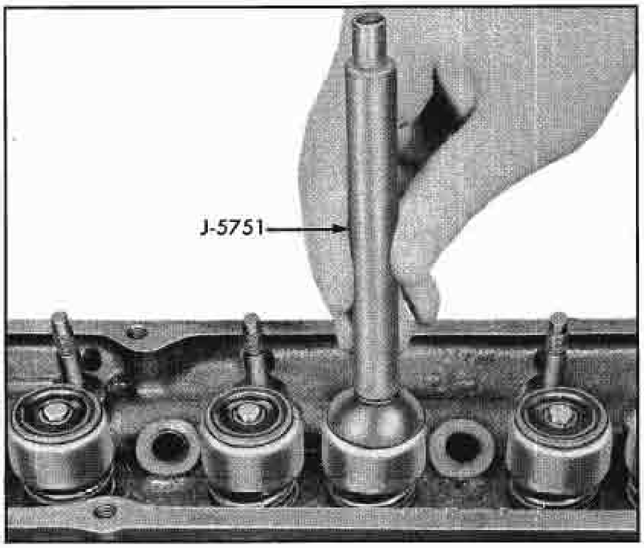


Fig. 6-23 Checking Valve Stem Seal

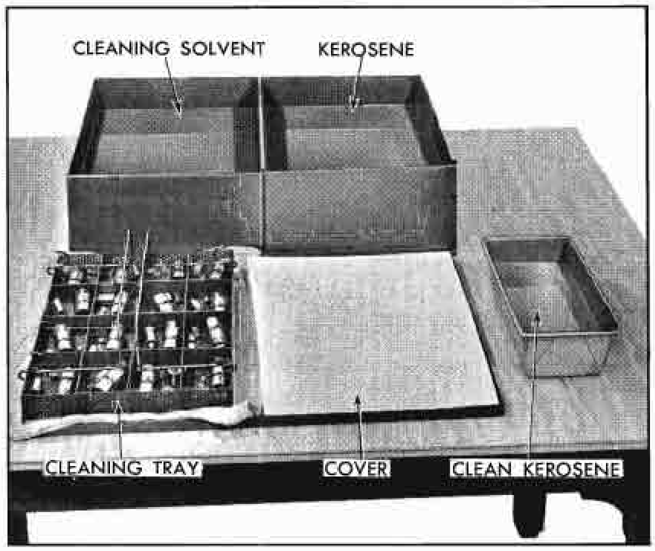


Fig. 6-24 Lifter Wash Tank and Tray J-5821

7. Remove lifter. Hydraulic valve lifter remover J-3049 may facilitate removal of lifter.

NOTE: If more than one lifter is to be replaced, store push rods in stand J-5709 and lifters in lifter box J-5763 so they can be re-installed in exactly the same place and position. See GENERAL INFORMATION ON ENGINE SERVICE.

REPLACE

NOTE: If new lifter is to be installed, be sure to remove all sealer coating from inside of new lifter and check leakdown rate. See page 6-16.

1. Place new lifter in lifter boss.

2. Replace push rod exactly as removed (same end against rocker arm).

3. Position rocker arm on push rod and tighten rocker arm ball retaining nut to 15-25 lb. ft. torque.

4. Replace rocker arm cover.

5. Inspect condition of push rod cover gasket and replace if necessary; replace push rod cover and tighten screws to 2-6 lb. ft. torque.

6. Replace intake manifold using new gaskets and replace O-ring seal.

VALVE LIFTER–RECONDITION

NOTE: Because of the important part hydraulic valve lifters play in the operation of an engine and the close tolerances to which they are manufactured, proper handling, and above all, *cleanliness,* cannot be overstressed when servicing these parts.

New lifters are serviced as individual units packaged with a plastic coating. Leave the coating on until ready to check leakdown rate. It is not necessary to remove the oil from new lifters prior to checking leakdown rate since special leakdown oil is already in new lifters.

Wash tank and tray J-5821 (Fig. 6-24) is recommended for cleaning valve lifters. This tank should be used only for valve lifters and should be kept covered when not in use. All servicing should be done in an area removed from grinders or other sources of dust and foreign material.

Lifters should at all times be stored in a covered box (Fig. 6-16) which will aid in keeping them clean. The lifter box should be kept dry and as free of oil as possible.

VALVE LIFTER–DISASSEMBLE

1. Remove push rod seat retainer ring by holding seat down with push rod while dislodging spring from lifter body with a pointed tool (Fig. 6-25).

NOTE: It may be necessary to unseat lifter ball, using plunger unloader J-5097, before plunger can be pushed down.

2. Invert lifter and allow push rod seat and plunger to slide out of body. If plunger sticks in body, place lifter in large end of hydraulic valve lifter plunger remover J-4160-A, with push rod end of lifter downward. Hold tool firmly in hand with thumb over

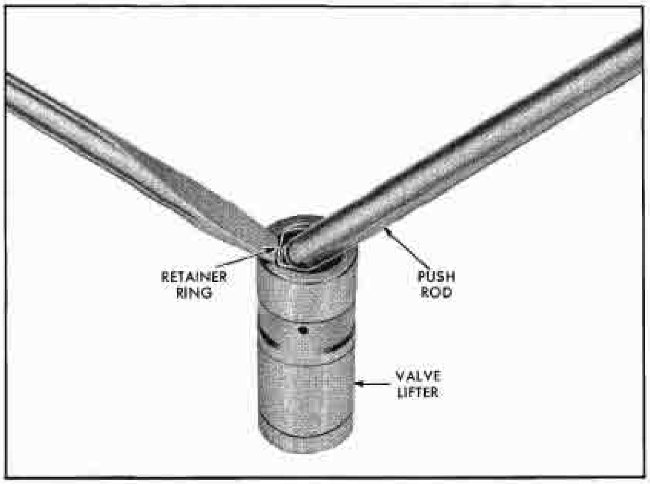


Fig. 6-25 Removing Push Rod Seat Retainer Ring

lifter body and sharply strike the tool against a block of wood (Fig. 6-26) until plunger falls out.

NOTE: It may be necessary to soak a lifter having a stuck plunger in cleaning solvent for several minutes in order to remove the plunger.

3. Drain oil out of lifter body and place all valve lifter parts in separate compartment of tray from wash tank J-5821 (Fig. 6-24).

CAUTION: Valve lifter body and plunger are selectively fitted and must not be interchanged with parts of other lifters. (Keeping all parts of lifters together will also aid in trouble diagnosis.)

VALVE LIFTER–CLEAN AND INSPECT

Wash tank J-5821 is recommended for cleaning valve lifter parts. This tank consists of two chambers, a tray and a cover. One chamber is for cleaning solvent and the other is for kerosene. Whenever the tank is not being used (and when parts are soaking), the cover should be closed.

1. Before placing tray of parts in cleaning solvent, first immerse it in kerosene chamber to remove as much engine oil as possible. (This reduces contamination of solvent, thus prolonging its useful life.)

2. Submerge tray in cleaning solvent and allow to soak for approximately one hour. More time may be required depending on varnish condition and effectiveness of solvent. Light agitation of tray in solvent at 10-15 minute intervals will hasten cleaning action.

3. After varnish has dissolved or has been sufficiently softened to permit removal by wiping, suspend

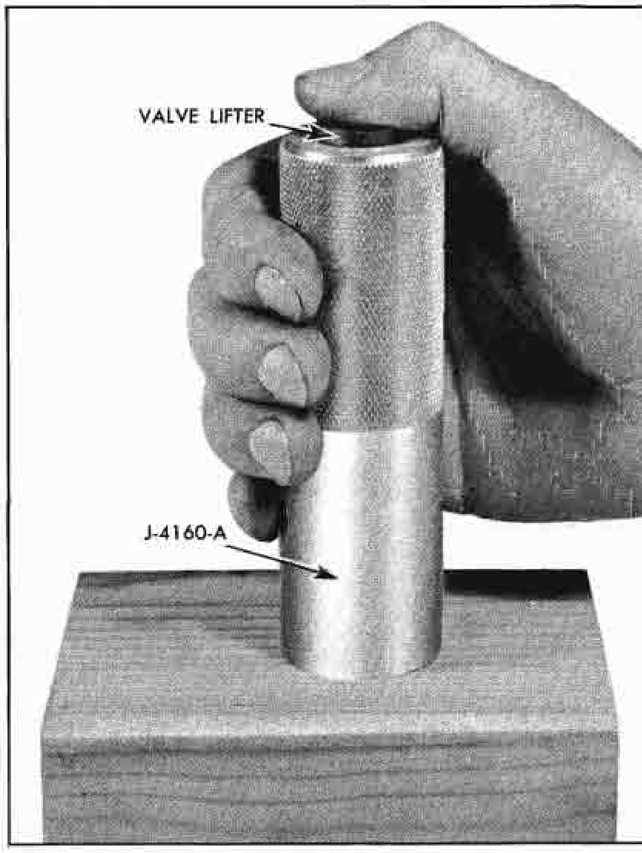


Fig. 6-26 Removing Stuck Plunger with J-4160-A

tray above solvent, utilizing hooks on tray handles. Allow tray and parts to drain for a brief period.

4. Rinse tray of parts in kerosene chamber to cut solvent and to avoid injury to hands (from solvent).

5. Wipe out tank cover and place tray of parts on cover in front of tank (Fig. 6-24). A shop towel under tray and clean paper on remainder of cover will enhance cleanliness.

NOTE: Absolute cleanliness can be assured if each lifter is inspected and assembled after cleaning before proceeding to the next lifter.

6. Working on one lifter at a time and using *clean, lint-free* cloths, thoroughly wipe off lifter parts. Clean plunger and external and internal surfaces of body with a hard wiping action. A bristle brush may be used to clean internal surface of lifter body.

CAUTION: Do not use wire brush or sand paper, since damage to machined surface is likely.

7. Inspect lifter body. Both inner and outer surfaces of lifter body should be inspected for scoring. Lifter assembly should be replaced if body is roughly scored, grooved, or galled. Inspect cam con-

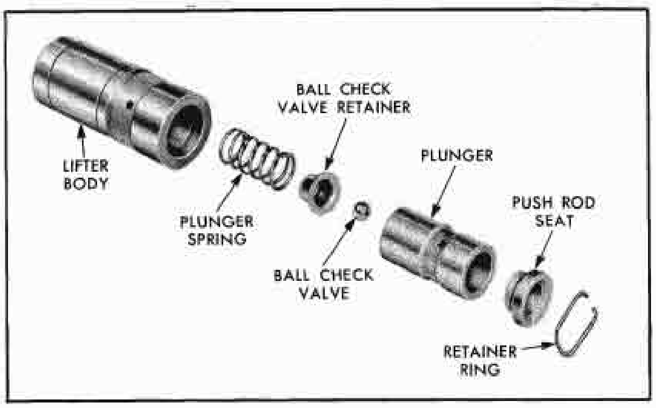


Fig. 6-27 Exploded View of Valve Lifter

tact surface on lower end of lifter body. Replace the lifter assembly if this surface is excessively worn, galled or otherwise damaged.

8. Inspect lifter plunger. Using a magnifying glass, inspect the check ball seat for defects. Inspect outer surface of plunger for scratches or scores. Small score marks with a rough, satiny finish will cause the plunger to seize when hot but operate normally when cool. Defects in check ball seat or scores or scrathes on outer surface of plunger which may be felt with a fingernail are causes for replacing the lifter assembly. This rule does not apply to the slight edge which may sometimes be present where the lower end of plunger extends below the ground inner surface of the body. This edge is not detrimental unless it is sharp or burred.

A blackened appearance is not a malfunctioning condition. Sometimes the discoloration serves to highlight slight grinder chatter marks and give the outer surface of plunger a ridged or fluted appearance. This condition will not cause improper operation, therefore, it may be disregarded.

9. Inspect push rod seat. Inspect push rod seat for roughness and make sure that hole in center is open.

10. Inspect valve lifter ball. Carefully examine ball for nicks, imbedded material or other defects which would prevent proper seating. Such defects may cause intermittently noisy lifter operation. Also inspect plunger face of ball retainer for excessive wear.

VALVE LIFTER–ASSEMBLE

NOTE: All parts must be absolutely clean when assembling a hydraulic lifter. Since lint and dust may adhere to parts they should not be blown off with air or wiped with cloths. All parts should be rinsed in clean kerosene and assembled without drying. A small container with clean kerosene (separate from cleaning tank) should be used for each set of lifters being overhauled.

Figure 6-27 shows the relative position of component parts of valve lifters. The recommended procedure for assembly is given in the following steps.

1. Rinse plunger spring and ball retainer and position retainer in spring.

2. Rinse lifter ball and place in retainer.

3. Rinse plunger and place on retainer so that seat on plunger mates with ball.

4. Invert plunger with parts assembled thus far and, after rinsing lifter body, install body over spring and plunger.

5. Place lifter body on clean paper; rinse and install push rod seat and retainer ring.

6. After lifter has been assembled, place in lifter box and close lid to preserve cleanliness.

TEST VALVE LIFTER LEAKDOWN RATE

After all lifters have been assembled, the leakdown rate must be checked before they are installed in the engine. Valve lifter leakdown tester J-5790 (Fig. 6-28) is designed to test leakdown rate of lifters to determine whether or not they are within specified

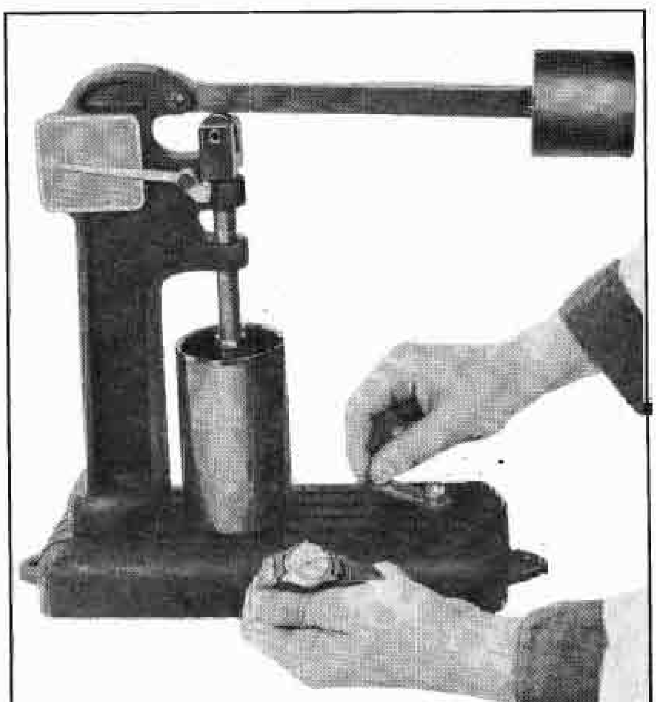


Fig. 6-28 Testing Leak-Down Rate

limits. As with previous service operations concerned with lifters, cleanliness is paramount. The tester cup and ram should be thoroughly cleaned, and testing should be done in an area free of dust and dirt. The testing procedure is described in the following steps:

1. Fill tester cup to approximately one inch from top with special fluid which is available from your lifter tester dealer.

NOTE: No other type fluid is recommended.

2. Swing weight arm up out of the way, raise ram, and position lifter into boss in center of tester cup.

3. Adjust ram (with weight arm clear of ram) so that the pointer is positioned on the set line (marked "S"). Tighten jam nut to maintain setting.

4. Operate lifter through full travel of plunger by pumping weight arm to fill lifter with test fluid and force out air. (Lifter must be completely submerged at all times.) Continue pumping for several strokes after definite resistance is detected.

5. Raise weight arm to allow plunger spring to expand fully; lower arm onto ram and commence turning crank slowly (1 revolution every 2 seconds). Time indicator travel from lower line (first line above set line) to line marked .125 or 1/8", while still rotating cup with crank (Fig. 6-28). Lifter is satisfactory if rate is between 12 and 60 seconds.

A doubtful lifter should be tested three or four times. Disassemble, inspect, and re-test doubtful lifters. If leakdown still is not within specifications, replace lifter.

6. After each lifter is tested, replace in lifter box to ensure cleanliness. Leave lifters in box until ready for installation in cylinder block.

7. When all lifters have been tested, empty cup, clean, and place cover over tester to maintain its cleanliness.

CYLINDER HEAD OR GASKET—REMOVE AND REPLACE

REMOVE

1. Remove intake manifold, push rod cover, and rocker arm cover.

2. Loosen all rocker arm retaining nuts and move rocker arms off push rods.

3. Remove push rods and place in support stand J-5709 so they can be replaced in exact position from which they were removed. See GENERAL INFORMATION ON ENGINE SERVICE.

4. Remove exhaust crossover pipe to manifold attaching bolts.

5. Remove battery ground strap and engine ground strap on left head or engine ground strap and Hydra-Matic oil level indicator tube bracket on right head.

6. Remove cylinder head bolts (dowel pins will hold head in place) and remove head with exhaust manifold attached using lifting hooks J-4266.

CAUTION: Extreme care should be taken when handling or storing cylinder heads as the rocker arm studs are hardened and may crack if struck.

NOTE: If left head is being removed, it will be necessary to raise head off dowel pins, move it forward, and "jockey" the head in order to clear the power steering and power brake equipment if car is so equipped.

7. Remove cylinder head gasket.

REPLACE

NOTE: Right and left cylinder heads are the same. New heads are complete with rocker arm studs, and all plugs.

When installing new head, transfer all serviceable parts to new head using new seals on intake and exhaust manifold valve stems, and new exhaust manifold gasket. Install new intake manifold gasket locating sleeves. Clamp straight edge into position as shown in Fig. 6-29 and check rocker arm position with valve train gauge J-8928.

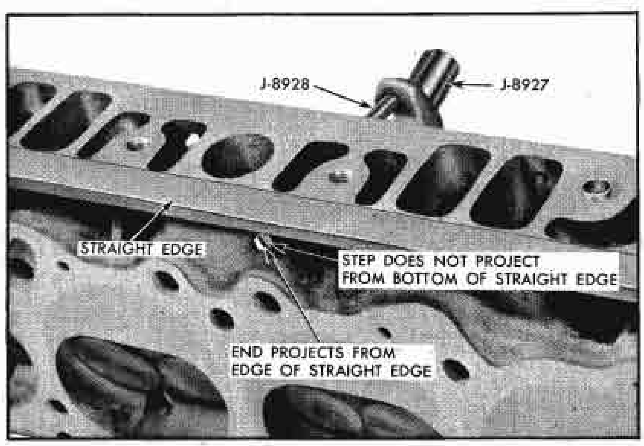


Fig. 6-29 Position of Gauge J-8928 when Stud is Properly Installed

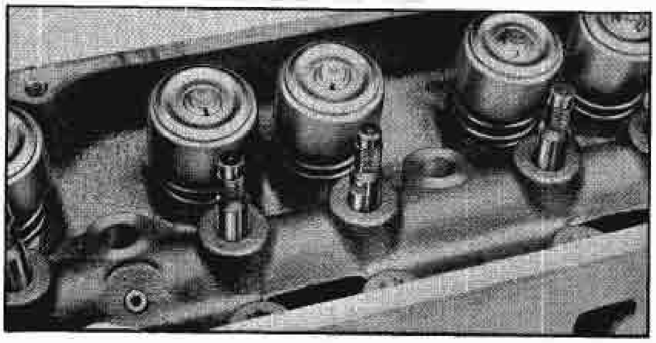


Fig. 6-30 Slots Filed in Rocker Arm Stud

1. Remove straight edge from cylinder head and thoroughly clean gasket surfaces of head and block. Place new gasket on block, and replace cylinder head.

2. Start all bolts in threads.

NOTE: Bolts are three different lengths. When inserted in proper holes all bolts will project an equal distance from head. Do not use sealer of any kind on threads.

3. Tighten bolts evenly to 85-100 lb. ft. torque.

4. Install push rods in same location from which they were removed and with the same end up against rocker arm.

5. Reposition rocker arms and tighten rocker arm ball retaining nuts to 15-25 lb. ft. torque.

6. Replace rocker arm cover and tighten screws to 5 lb. ft. torque.

7. Replace push rod cover and tighten screws to 5 lb. ft. torque.

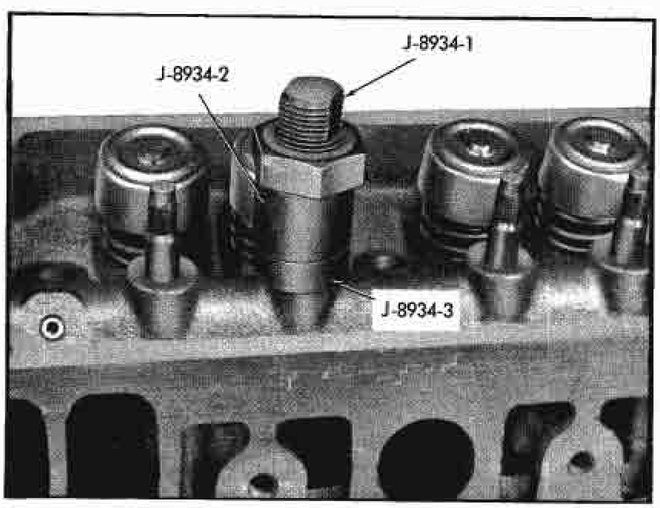


Fig. 6-31 Tool J-8934 Positioned to Remove Rocker Arm Stud

8. Replace battery ground strap and engine ground strap on left head or engine ground strap and Hydra-Matic oil level indicator tube bracket on right head. Also replace the engine oil level indicator on right side.

9. Replace intake manifold using new gaskets.

10. Install new crossover pipe to exhaust manifold gaskets and replace flange bolts.

NOTE: Use two thin (.075") gaskets or one thick (.135") gasket.

ROCKER ARM STUD—REMOVE AND REPLACE

(Rocker arm studs are replaceable providing a press of two tons capacity or more is available.)

NOTE: Both standard and .003" oversize studs are available. If replacing stud which has become loose, use .003" oversize stud and install according to steps 7 through 19. If replacing stud that is broken or because of faulty threads or oil hole, use standard size stud and install according to steps 8 through 19.

1. Remove cylinder head from engine.

2. With rocker arm removed, file two slots 3/32" to 1/8" deep on opposite sides of rocker arm stud (Fig. 6-30). Top of slots should be 1/4" to 3/8" below thread travel.

3. Place washer at bottom of rocker arm stud.

4. Position rocker arm stud remover J-8934 on rocker arm stud and tighten screws securely with 5/32" allen wrench.

5. Place spacer over stud remover J-8934.

6. Thread 7/8" standard nut on stud remover and turn nut until rocker arm stud is out of cylinder head (Fig. 6-31).

7. Remove plugs (Fig. 6-32) from ends of cylinder head oil gallery and thoroughly clean out metal deposits and foreign matter from oil gallery (head must be right side up so foreign material will not lodge in or around studs).

8. Position rocker arm on new rocker arm stud and place rocker arm stud installer J-8927 on stud in place of rocker arm ball.

9. Coat rocker arm stud with white lead and oil and with cylinder head mounted in press on tool J-5712 so studs are vertical, position new stud with rocker arm and rocker arm stud installer over hole in head (Fig. 6-33).

10. Carefully press stud into head until it is in about half way ($\frac{7}{16}''$).

11. Clamp straight edge on cylinder head as shown in Fig. 6-33 and position valve train gauge J-8928 in push rod hole so that it seats properly in the rocker arm.

12. With valve seated, slowly press rocker arm stud into cylinder head (Fig. 6-33) until gauge projects about midway between the end of the gauge and the step with respect to the straight edge as shown in Fig. 6-29.

13. Remove rocker arm stud installer J-8927, rocker arm and ball and straight edge.

14. Blow air through hole in new stud to ensure that the passage is not restricted.

15. Blow air through oil gallery to remove any foreign matter.

16. Replace plugs in ends of oil gallery (Fig. 6-32).

17. Check oil passages from oil gallery to all studs. See CYLINDER HEAD AND VALVES–CLEAN AND INSPECT.

18. Install rocker arm and ball and install nut loosely.

19. Replace cylinder head.

CYLINDER HEAD AND VALVES–RECONDITION

CYLINDER HEAD AND VALVES–DISASSEMBLE

Remove valve spring retainer cup locks (keepers), valve stem oil seals, valve spring retainer cups, valve stem shields, valve springs, and valves, using valve spring compressor J-8929. Valve stem oil seals must be discarded and replaced with new seals any time they are removed.

2. Place valves in valve and valve train holding stand J-5709.

CYLINDER HEAD AND VALVES–CLEAN AND INSPECT

Efficient engine performance depends to a great degree upon the condition of engine valves. Close inspection of intake valves is especially important as excessive clearance of valve stems in guides will permit oil to be pulled into the combustion chamber causing fouled spark plugs and clogged piston rings. Oil deposited on valve heads will carbonize and burn causing valves to leak with resultant loss of engine power. Therefore, valves must operate properly and if inspection discloses any malfunction of valves, the

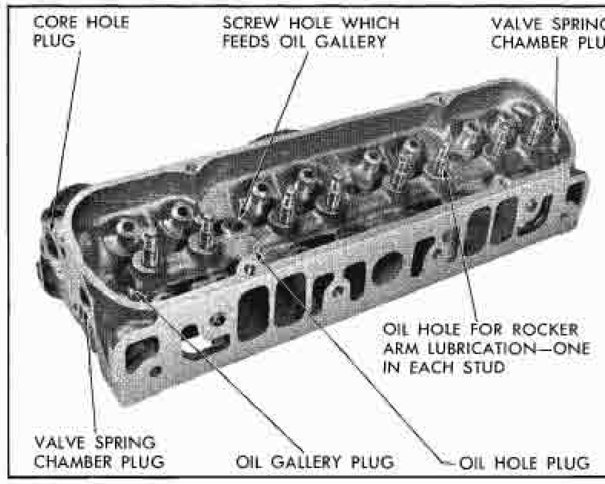


Fig. 6-32 Cylinder Head Passage Identification

trouble must be corrected to avoid future damage to valves or related engine parts.

1. Inspect valves and seats to determine condition before cleaning. Also check oil and water passage plugs for evidence of leakage (Fig. 6-32).

2. Clean valves thoroughly to remove deposits from head and stem.

3. Clean and inspect cylinder head as follows:

a. Clean carbon deposits from combustion chambers and all sludge or foreign matter from other areas of cylinder head. If a scraper or wire brush is used for cleaning, use care to prevent damage to valve seats.

CAUTION: To prevent damage to valve seat it is good practice to keep wire brush well away from seat.

b. Clean cylinder head thoroughly using suitable cleaning equipment.

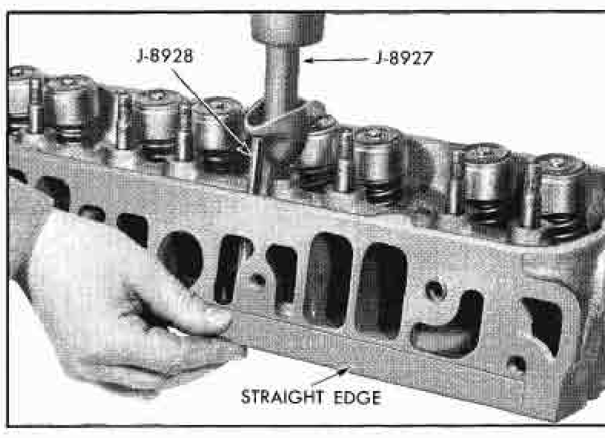


Fig. 6-33 Pressing in New Rocker Arm Stud

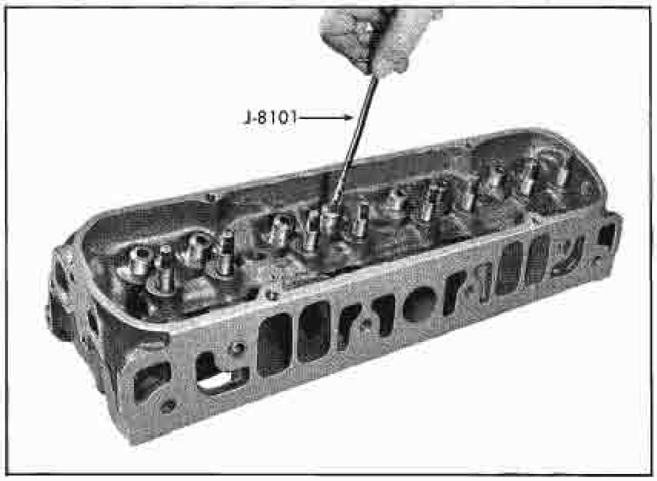


Fig. 6-34 Cleaning Valve Guide with J-8101

c. Check oil passages from oil gallery through rocker arm studs. A simple test can be made using a rubber hose and smoke. Block lower end of cylinder head screw hole which feeds oil gallery (Fig. 6-32) and blow smoke in top end of hole through rubber hose. Smoke should come out hole in each stud.

4. Clean valve guides thoroughly using valve guide cleaner J-8101 (Fig. 6-34).

5. Visually inspect valve guides for evidence of wear, especially the end toward the spring seat. If a guide is scored or galled, install valve with proper oversize stem according to procedure on page 6-21.

6. Clean valve springs and inspect to see that they meet specifications.

7. Clean push rods and thoroughly clean out oil passage through center of rod. Inspect to see that the rod is straight.

8. Clean rocker arms and rocker arm balls, and visually inspect for evidence of wear.

9. Clean spark plugs as outlined in ELECTRICAL SECTION.

10. Clean and inspect valve lifters.

VALVES AND SEATS–RECONDITION

1. Reface valves and seats as follows:

Valves should be ground on a special bench grinder designed specifically for this purpose and built by a reputable manufacturer. Valve seats should be ground with reputable power grinding equipment having stones of the correct seat angle and a suitable pilot which pilots in the valve stem guide. To ensure positive sealing of the valve face to its seat, the grinding stones should be carefully refaced before any grinding is done. Intake valve seat angle is 30°, exhaust valve seat angle is 45°. Intake valve face angle is 29° and exhaust valve face angle is 44°. This will provide hairline contact between valve and seat to provide positive sealing and reduce build-up of deposits on seating surfaces (Fig. 6-35).

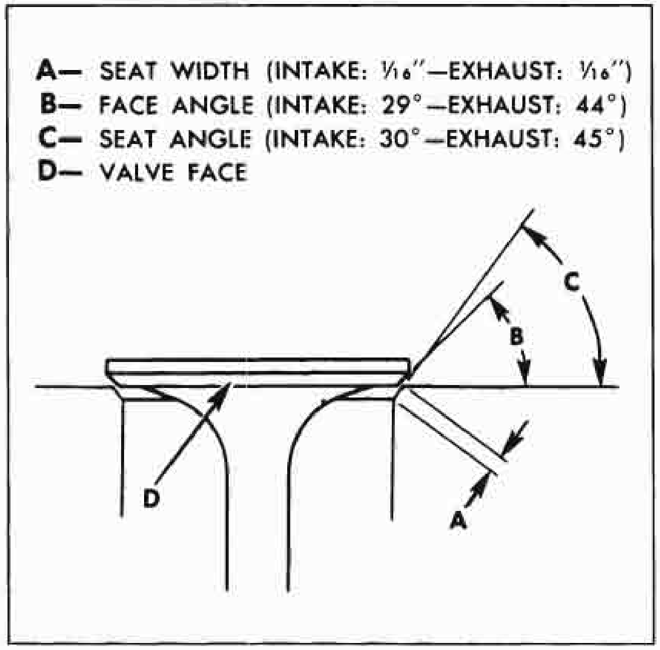


Fig. 6-35 Valve Seat and Face Angles

DO NOT USE REFACING EQUIPMENT EXCESSIVELY; only enough material should be removed to true up surfaces and remove pits. The valve head will run hotter as its thickness is diminished; therefore, if valve face cannot be cleaned up without grinding to point where outside diameter of valve has a sharp edge, the valve should be replaced. Whenever it is necessary to replace a valve, the new valve should be of the same stem diameter as the valve removed (unless the valve guide is reamed to provide proper fit).

Width of exhaust valve seats should be 1/16" (.048"-.070"). Intake valve seat should be between 3/64" and 1/16" (.045"-.071"). If seat width is excessive it should be narrowed by grinding with a flat stone (Fig. 6-36). This is the only method that should be used to narrow the seat.

NOTE: Lapping of valve seats is not required or recommended.

2. Check concentricity of valve seat and valve guide. Concentricity of valve seat and valve guide can be checked by using a suitable dial indicator or

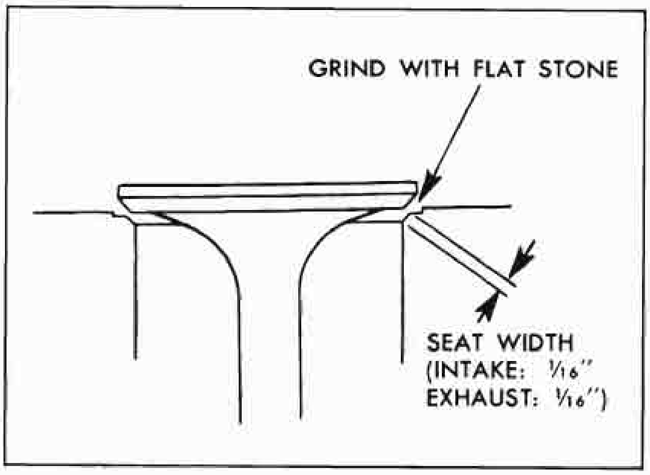


Fig. 6-36 Valve Seat After Grinding with Flat Stone

prussian blue. When using a dial indicator, total runout should not exceed .002".

When prussian blue is used, a light coat should be applied to the face of the valve only and the valve rotated in its seat. If blue appears all the way around the valve seat, the valve seat and the valve guide are concentric with one another.

3. Check concentricity of valve stem and face of valve. After cleaning prussian blue from valve and seat from preceding check, lightly coat valve seat with prussian blue and rotate valve in guide. If blue appears all the way around the valve, the valve stem and valve face are concentric with one another.

NOTE: Both tests in steps 2 and 3 are necessary to insure proper valve seating.

4. Check and correct length of valve stem using valve train gauge J-8928 as follows:

a. Position rocker arm on stud and hold in place using rocker arm stud installer J-8927. Slip valve into place and hold it against valve seat. While holding rocker arm and valve in position securely, insert valve train gauge J-8928 through push rod hole and seat snugly in push rod seat of rocker arm (Fig. 6-37) With all parts seated, step end of gauge should be at least flush with gasket face of head, but should not project past the step on the gauge.

b. If gauge projects too far, indicating that the valve stem is too long, grind the tip of the valve stem as necessary to make the gauge index properly.

CAUTION: When grinding valve stem, be very careful not to overheat it. Overheating will soften the hardened stem causing rapid wear.

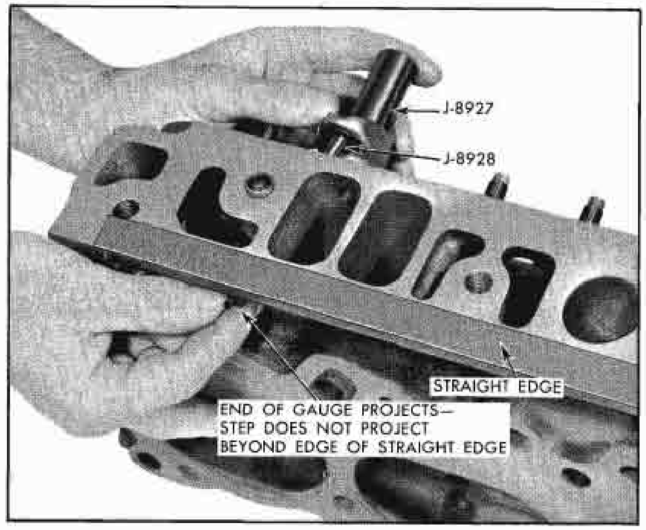


Fig. 6-37 Checking Length of Valve Stem with J-8928

FITTING VALVE STEMS TO GUIDES

Correct valve stem clearance for valve guides is .0021" to .0038" for the intake valve and .0026" to .0043" for the exhaust valve.

Valves with oversize stems are available in .001", .003" and .005" larger than standard. The same valve stem to guide clearance applies for oversize stems.

Oversize reamers are required to enlarge valve guide holes to fit the oversize stems. When the reamer is turned through the valve guide it will size the hole to fit the valve stem according to the above limits.

Carefully ream the valve guide using valve guide reamer J-5830-1 for .003" oversize stems and valve guide reamer J-6621 for .005" oversize stems (Fig. 6-38). For best results when installing .005" oversize

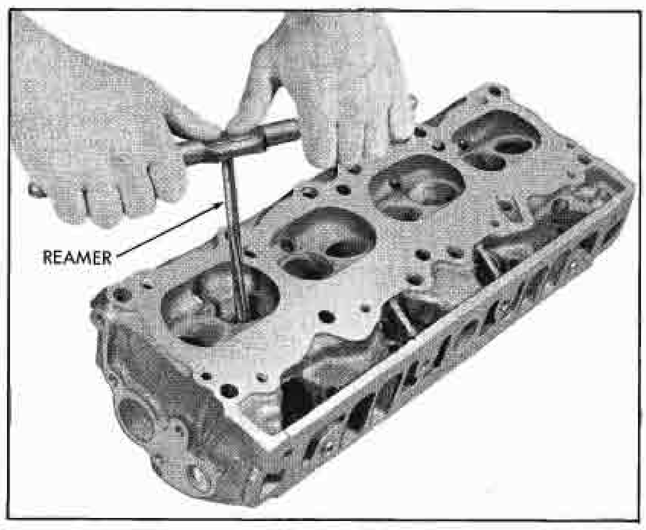


Fig. 6-38 Fitting Valve Stems to Guide

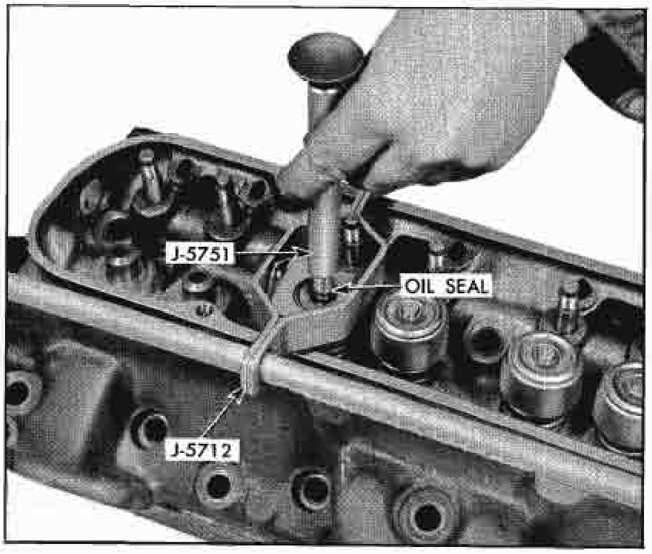


Fig. 6-39 Installing Valve Stem Seal with J-5751

valve stem use the .003" oversize reamer first and then ream to .005" oversize. Always reface the valve seat after reaming valve guide.

NOTE: Valves are marked .001, .003 or .005 with colored ink.

CYLINDER HEAD AND VALVES–ASSEMBLE

1. Install valves, valve springs, valve stem shields, valve spring retainer cups, valve stem seals and retainer cup locks using suitable spring compressor. The valve stem seals must be installed in the second groove (from end of stem). Valve stem seal installer and tester J-5751 can be used to install this seal (Fig. 6-39).

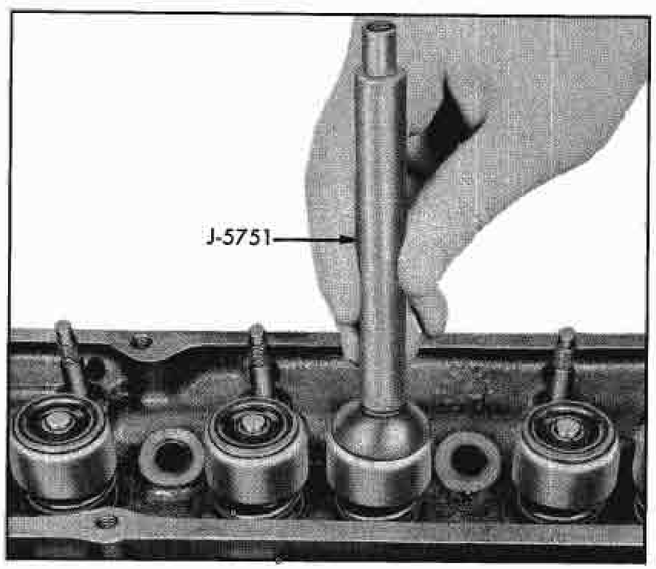


Fig. 6-40 Checking Valve Stem Seal

After the valves have been installed, the suction cup end of special tool J-5751 should be used to test for leaks between the valve spring retainer cup and valve stem seal (Fig. 6-40). The suction cup will tend to be held to the valve spring retainer cup by suction when the seal is satisfactory. If a leak is detected, replace seal or valve spring retainer cup as necessary. It is important to have a positive seal between the valve spring retainer cup and the valve stem seal to prevent excessive amounts of oil from being drawn down the valve stem which will cause exhaust smoke and oil consumption.

2. Install spark plugs.

HARMONIC BALANCER—TIMING CHAIN COVER AND GASKET—TIMING CHAIN AND SPROCKETS—OIL SEAL—FUEL PUMP ECCENTRIC

HARMONIC BALANCER–REMOVE AND REPLACE

1. Loosen generator at adjusting strap and lower pivot bolt and remove fan belt from harmonic balancer. On cars equipped with power steering, also remove power steering pump belt from harmonic balancer.

2. Position fan so wide angles will be at top and bottom allowing access to balancer (Fig. 6-41).

3. Remove harmonic balancer attaching bolt and retainer washer.

4. Remove harmonic balancer by sliding it off end of crankshaft.

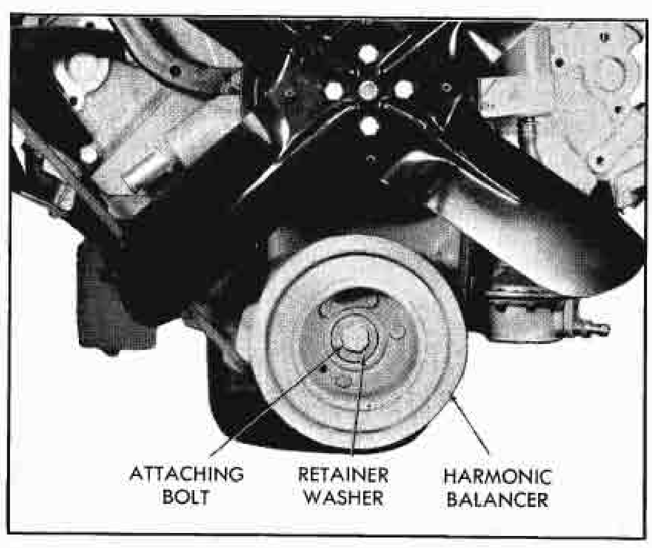


Fig. 6-41 Harmonic Balancer

5. Install new harmonic balancer by reversing above steps, lining up timing mark on balancer with pointer on timing chain cover (Fig. 6-42).

NOTE: Be sure to install key parallel with crankshaft.

6. Tighten harmonic balancer attaching bolt to 130-190 lb. ft. torque.

NOTE: Remove flywheel cover and lock flywheel before tightening balancer bolt.

TIMING CHAIN COVER, GASKET, OIL SEAL, OR FUEL PUMP ECCENTRIC—REMOVE AND REPLACE

1. Drain radiator and cylinder block.
2. Remove generator adjusting strap.
3. Remove fan belt and accessory drive belt.
4. Remove fan and pulley from hub of water pump.
5. Disconnect upper and lower radiator hoses.
6. Remove fuel pump.
7. Remove harmonic balancer.
8. Remove front four oil pan to timing chain cover screws.
9. Remove two timing chain cover to oil cooler line support screws.
10. Remove timing chain cover to block attaching bolts and nuts and timing chain cover to intake manifold bolt.

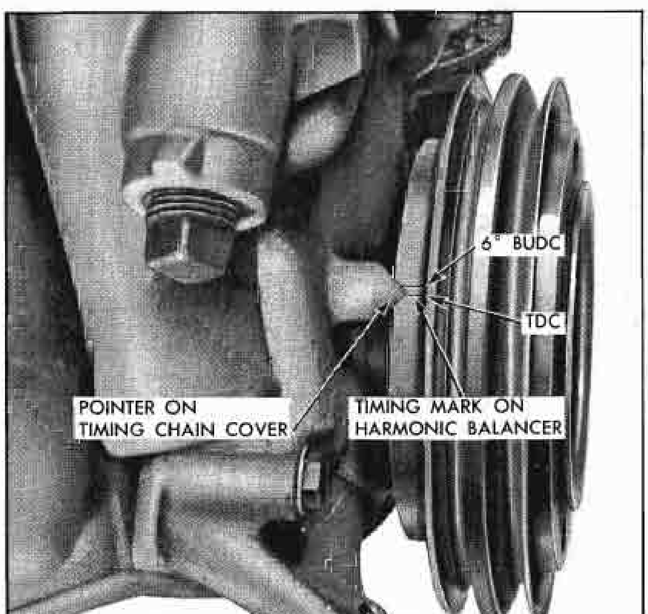


Fig. 6-42 Timing Mark on Harmonic Balancer Aligned with Pointer on Timing Chain Cover

11. Pull timing chain cover forward to clear studs and remove.
12. Remove O-ring seal from recess in intake manifold water recirculation passage.
13. Remove timing chain cover gasket and thoroughly clean gasket surfaces on block and cover. Use care to prevent gasket particles and other foreign material from falling into oil pan.
14. Inspect front oil pan gasket and replace if damaged. If new gasket is installed, it should be cemented to oil pan.
15. Remove timing chain cover oil seal and install new seal. Face of new seal should be coated with special purpose moly grease.
16. If new fuel pump eccentric and bushing is to be installed, remove camshaft sprocket retainer bolt and retainer washer and remove eccentric (Fig. 6-43). Install new eccentric, indexing tang on eccentric with hole in camshaft sprocket. Install bushing over eccentric with flange against sprocket. Insert retainer screw with retainer washer and tighten securely.
17. Position new timing chain cover gasket over studs against block.
18. Transfer water pump to new timing chain cover if new cover is to be installed.
19. Install new O-ring seal in water recirculation passage of intake manifold.
20. Position timing chain cover on engine, install bolts and nuts and tighten securely.
21. Install four oil pan to timing chain cover screws and tighten to 10-15 lb. ft. torque.

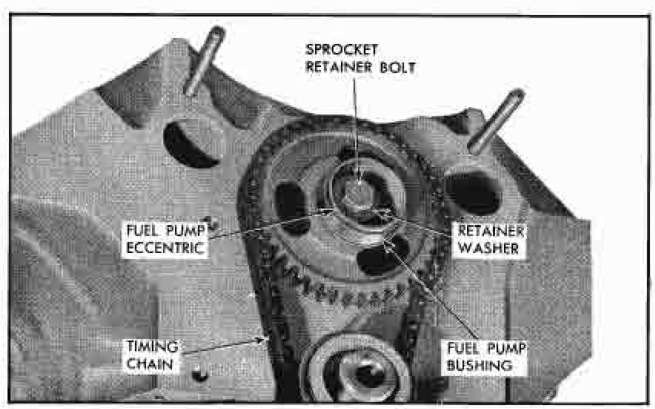


Fig. 6-43 Front of Engine with Timing Chain Cover Removed

22. Install harmonic balancer, retainer bolt with retainer, and tighten to 130-190 lb. ft. torque.

23. Connect lower radiator hose to pump inlet.

24. Position pulley and fan on water pump hub and install attaching bolts. Tighten to 15-25 lb. ft. torque.

25. Install power steering pump and belt on cars so equipped.

26. Install generator adjusting strap.

27. Install fan belt and accessory drive belts. Adjust to proper tension. Refer to page 6A-12.

28. Install fuel pump.

29. Install two oil cooler line supports to timing cover.

30. Refill cooling system and check for leaks.

TIMING CHAIN AND SPROCKETS–REMOVE AND REPLACE

1. Remove timing chain cover, making certain O-ring seal is retained for installation at assembly.

2. Remove fuel pump eccentric, bushing and timing chain cover oil seal.

3. Align timing marks to simplify proper positioning of sprockets during reassembly (Fig. 6-44).

4. Slide timing chain and sprockets off ends of crankshaft and camshaft.

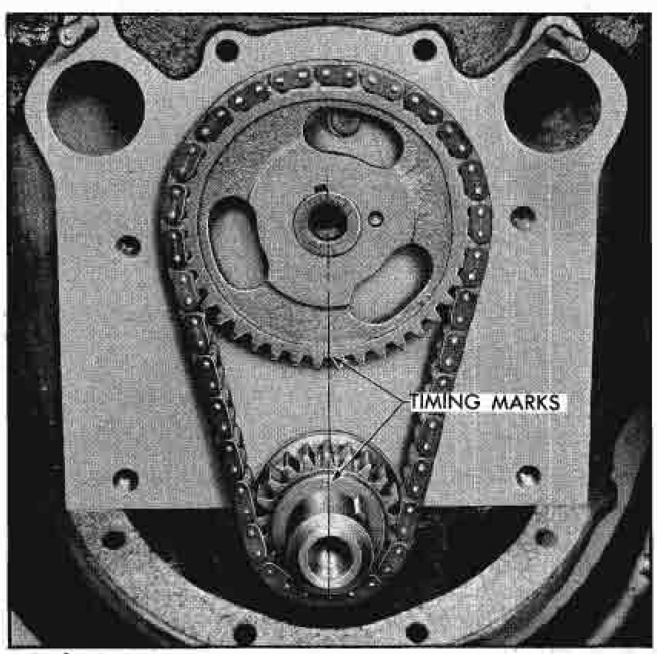


Fig. 6-44 Aligning Timing Marks

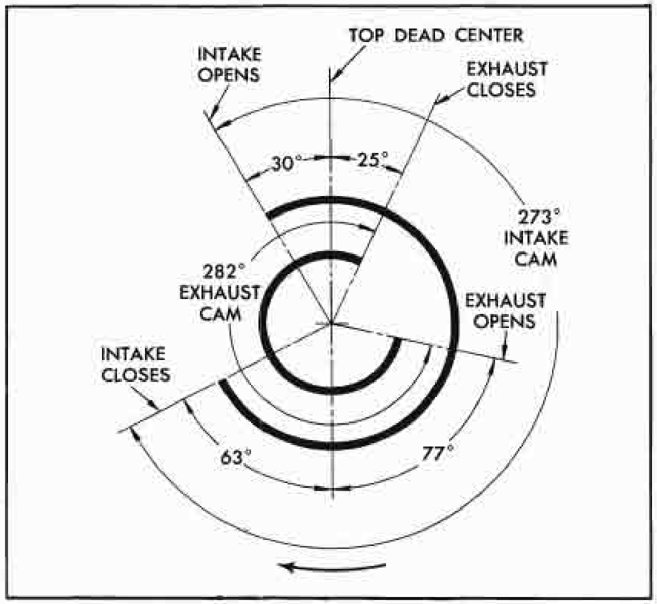


Fig. 6-45 Valve Timing Diagram for Super Hydra-Matic

5. Install new timing chain and/or sprockets making sure marks on timing sprockets are aligned exactly on a straight line passing through the shaft centers (Fig. 6-44). Camshaft should extend through sprocket so that hole in fuel pump eccentric will locate on shaft. Valve timing diagrams for the engine are shown in Fig. 6-45 through Fig. 6-48.

6. Install fuel pump eccentric and bushing, indexing tab on eccentric with hole in sprocket. Install retainer bolt with retainer washer and tighten securely.

7. Coat contact surface of timing chain cover oil seal with special purpose moly grease and install seal.

8. Install timing chain cover, making sure O-ring seal is in place.

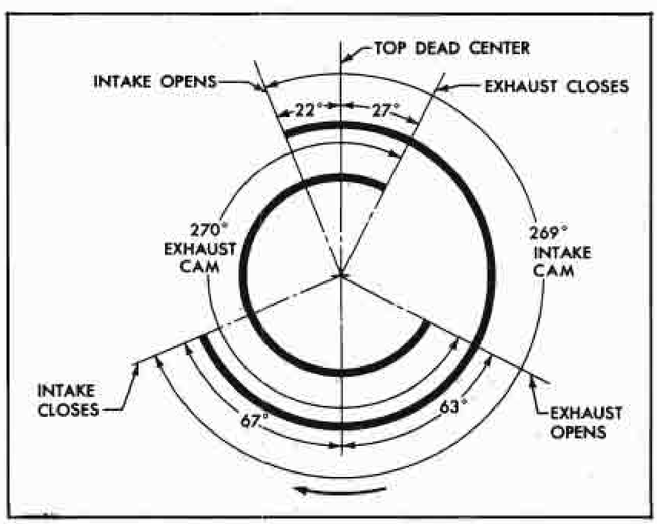


Fig. 6-46 Valve Timing Diagram for 425E Engine and Roto Hydra-Matic

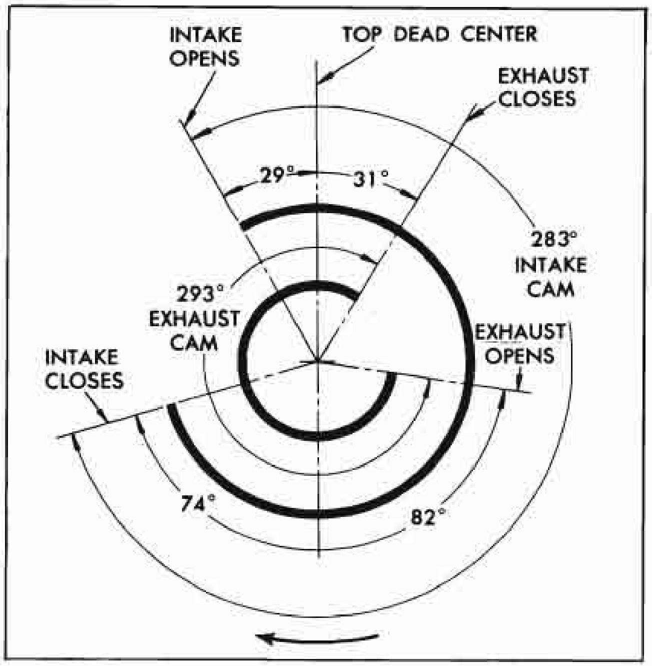


Fig. 6-47 Valve Timing Diagram for 425A Engine

FLYWHEEL OR CLUTCH PILOT BEARING—
REMOVE AND REPLACE

NOTE: See HYDRA-MATIC SHOP MANUAL for replacement of flywheel on Hydra-Matic models.

1. Remove transmission. (See SYNCHRO-MESH SECTION for synchro-mesh transmission or HYDRA-MATIC MANUAL for Hydra-Matic transmission).

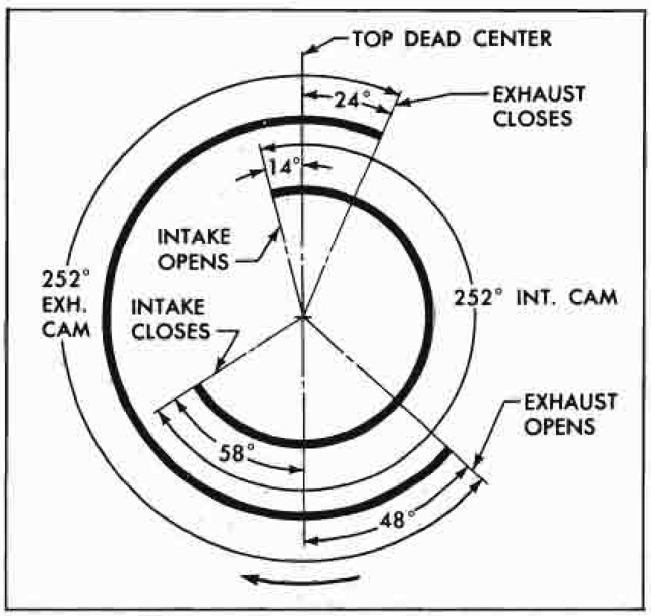


Fig. 6-48 Valve Timing Diagram for 3-Speed Synchro-Mesh

2. Remove clutch assembly.

3. If clutch pilot bearing is to be replaced, use cold chisel to remove staking in end of crankshaft which keeps bearing in place when transmission is removed (Fig. 6-49). Remove clutch pilot bearing from hole in crankshaft.

If bearing is a snug fit in crankshaft, use puller J-4383 and slide hammer J-2619-A or J-942 to remove bearing. When installing new bearing see that hole in crankshaft is thoroughly clean. Install new bearing with shielded side toward transmission. Start bearing into hole and tap into place by using clutch pilot bearing installer J-5736 against outer race. Stake slightly as shown in Fig. 6-49, to keep bearing in place in case transmission is removed in the future.

4. If flywheel is to be removed and reinstalled, scribe marks on flywheel and crankshaft flange, remove flywheel to crankshaft bolts and remove flywheel. When reinstalling clean the mating flanges of flywheel and crankshaft carefully, making sure there are no burrs on either mounting face. Position flywheel on crankshaft flange with scribe marks in alignment and install flywheel to crankshaft bolts and tighten evenly to 85-100 lb. ft. torque.

NOTE: Flywheel bolts do not require lock washers.

5. Install clutch and transmission.

OIL PAN AND/OR OIL PAN GASKETS—
REMOVE AND REPLACE

REMOVE

1. Drain radiator and crankcase.
2. Remove hood and air cleaner.
3. Disconnect negative lead to battery.
4. Disconnect radiator to timing chain cover hose

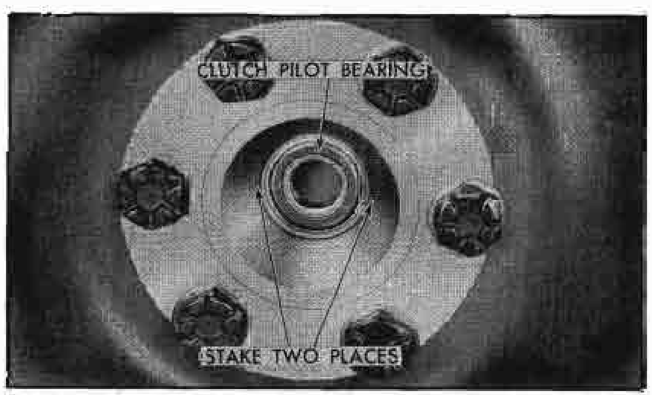


Fig. 6-49 Clutch Pilot Bearing Staked

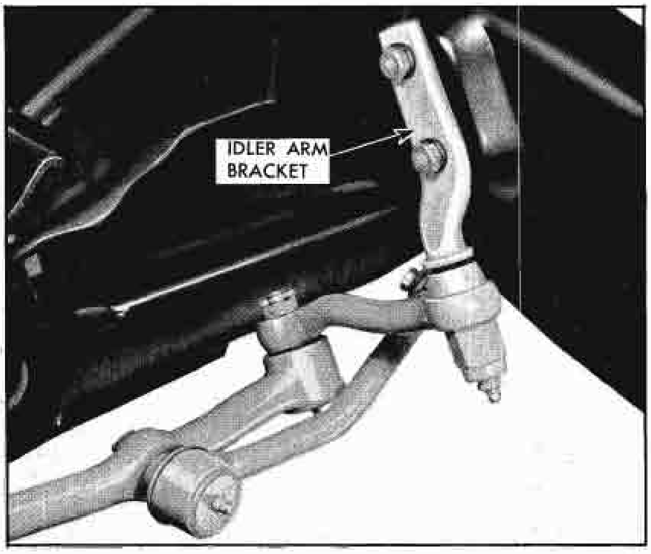


Fig. 6-50 Idler Arm Bracket to Frame Screws

and radiator to intake manifold hose at radiator.

5. Remove upper radiator support and fan guard.

6. Remove two coil to body retaining bolts and move coil away from body.

7. Remove crossover and exhaust pipe to exhaust manifold retaining bolts.

8. Remove two idler arm to frame retaining bolts and lower idler arm and tie rod (Fig. 6-50).

9. Remove bolts from front engine mounts.

10. Remove two starter motor to clutch housing retaining bolts and lower starter motor.

11. Remove oil pan to block retaining bolts and oil pan to timing chain cover retaining bolts.

12. Remove lower cover from clutch housing.

13. Hook chain fall under front of intake manifold and lift front of engine as high as possible.

14. Remove flywheel cover from clutch housing.

15. Remove oil pan from block and let drop.

16. Remove front main bearing cap and move crankshaft to number one position.

17. Holding crossover pipe and tie rod down, remove oil pan.

REPLACE

1. Install new side gaskets on oil pan, using gasket retainers (Fig. 6-51).

2. Install new oil pan gasket in rear main bearing cap (Fig. 6-52).

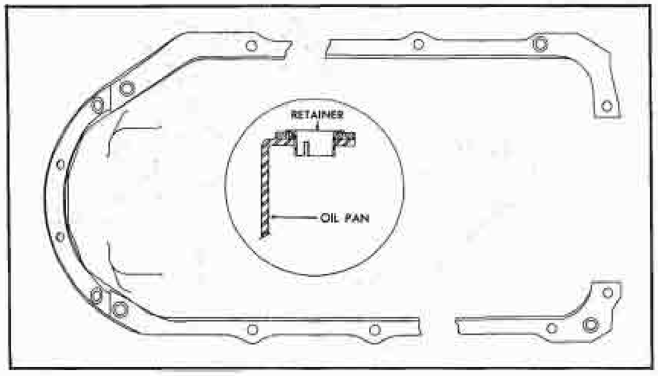


Fig. 6-51 Installing Oil Pan Gasket Retainers

3. Holding crossover pipe and tie rod down, push oil pan into place.

4. Install front main bearing cap, tightening to 95 lb. ft. torque.

NOTE: It is necessary to position jack stand under front frame and lower hoist to torque main bearing cap.

5. Install new oil pan to timing chain cover gasket on pan, using gasket retainers (Fig. 6-53).

6. Install oil pan to block and oil pan to timing chain cover retaining screws and torque 10-15 lb. ft.

7. Install flywheel cover and tighten retaining bolts 10-20 lb. ft. torque.

8. Insert two flywheel cover to cylinder block retaining bolts and tighten 10-20 lb. ft. torque.

9. Install lower clutch housing cover and tighten bolts 10-20 lb. ft. torque.

10. Install starter motor and torque two starter motor to clutch housing retaining bolts 20-45 lb. ft.

11. Install new gaskets on exhaust and crossover

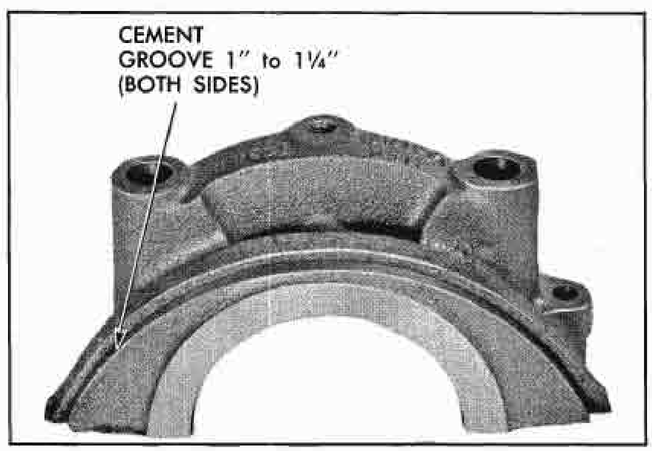


Fig. 6-52 Rear Oil Pan Gasket Positioned in Bearing Cap

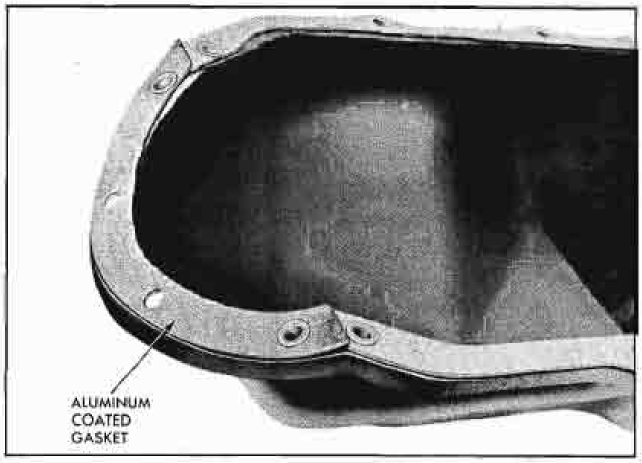


Fig. 6-53 Front Oil Pan Gasket Overlapping Side Gaskets

pipes and raise pipe into position. Insert four retaining bolts and tighten securely.

12. Insert idler arm to frame retaining bolts and tighten securely.

13. Lower engine and insert right and left engine mount bolts. Tighten 40-55 lb. ft. torque.

14. Connect radiator to timing chain cover hose and radiator to intake manifold hose.

15. Install coil and air cleaner.

16. Install upper radiator support and fan guard.

17. Hook up negative lead to battery.

18. Install hood.

19. Fill crankcase and radiator.

CAMSHAFT AND/OR CAMSHAFT BEARING—REMOVE AND REPLACE

The camshaft and camshaft bearings can be replaced with engine installed in car or with engine removed and disassembled for overhaul; however, to replace the rear camshaft bearing without removing and completely disassembling engine, the propeller shaft, transmission and clutch housing must first be removed.

To replace the camshaft and/or the rear center, center, front center or front camshaft bearing without removing and completely disassembling the engine, proceed as follows:

1. Drain radiator.

2. Remove carburetor air filter.

3. Disconnect all water hoses, vacuum hose and spark plug wires.

4. Disconnect carburetor linkage, fuel lines and wires to thermogage unit.

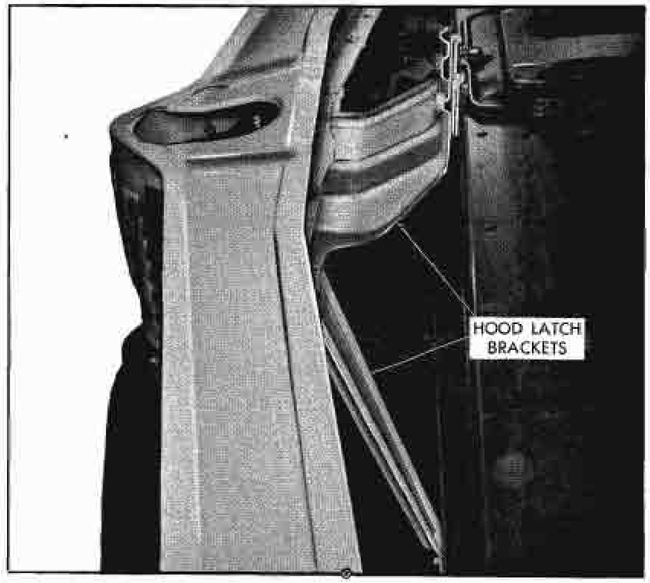


Fig. 6-54 Hood Latch Bracket

5. Remove hood latch bracket (Fig. 6-54).

6. Remove radiator, fan and pulleys.

7. On air conditioned cars, remove generator mounting bracket and generator.

8. Remove crankcase ventilator outlet pipe, if any, and remove both rocker arm covers and gaskets.

9. Remove distributor hold-down clamp and remove distributor.

10. Remove intake manifold and gaskets, making certain gasket locating sleeves remain seated.

NOTE: Make certain O-ring seal between intake manifold and timing chain cover is retained and installed during assembly.

11. Remove push rod cover.

12. Loosen rocker arm ball retaining nuts so that rocker arms can be disengaged from push rods and turned sideways.

13. Remove push rods and hydraulic lifters. Store push rods in stand J-5709 and lifters in lifter box J-5763 so they can be reinstalled in original positions.

14. Remove harmonic balancer.

15. Remove fuel pump.

16. Remove four oil pan to timing chain cover screws.

17. Remove timing chain cover and gasket.

18. Remove timing chain cover oil seal, fuel pump eccentric and fuel pump bushing.

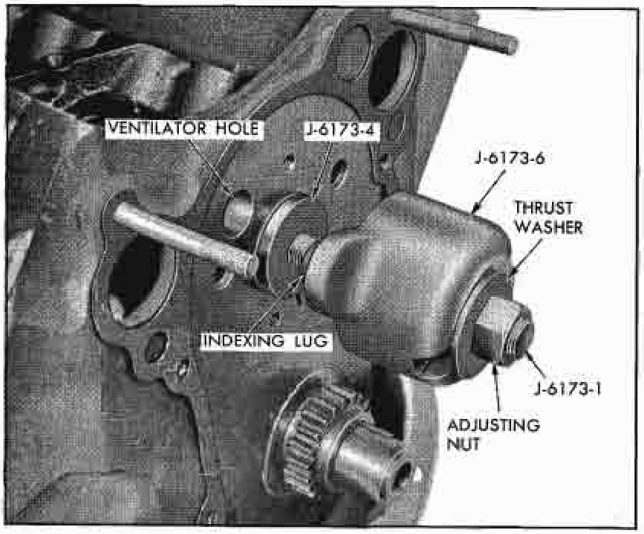


Fig. 6-55 Positioning Index Collar

19. Align timing marks on timing chain sprockets and remove timing chain and sprockets.

20. Remove camshaft thrust plate.

21. Carefully pull camshaft from engine, exercising caution so as not to damage bearings in block.

NOTE: The clearance for camshaft removal is very limited and, in cases where engine mounts are worn excessively, it may be necessary to raise the front of the engine to permit removal.

22. Stuff clean rags through openings in engine block as an aid in preventing foreign material or parts of bearing remover tool from dropping into block.

CAUTION: It is imperative that operator exercise extreme caution when inserting bearing remover adapters or key through openings in engine block to prevent them from dropping into engine.

CAMSHAFT BEARING–REMOVE

1. Insert remover adapter J-6173-4 into front bearing to act as a support for shaft J-6173-1 (Fig. 6-55).

NOTE: If front bearing is to be replaced, insert installer adapter in center bearing to act as support for shaft.

2. Insert replacer adapter J-6173-3 into rear of bearing to be removed so that shoulder on remover bears against rear edge of bearing.

NOTE: If rear bearing is to be removed, it will be necessary to remove camshaft rear plug.

3. Place indexing collar J-6173-6 on threaded end of shaft with open side toward unthreaded end and start thrust washer and nut on shaft (Fig. 6-55).

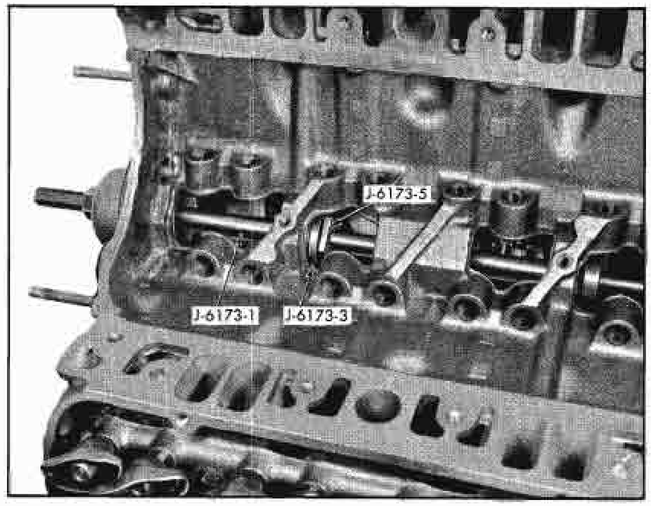


Fig. 6-56 Preparing to Remove Camshaft Bearing

4. Insert shaft and indexing collar through remover and replacer adapters and position lug on indexing collar in ventilator hole in front of block (Fig. 6-55). This indexes the shaft so that it cannot rotate.

5. Slip key J-6173-5 into notches in shaft behind bearing to be removed (Fig. 6-56).

6. Turn nut on front of shaft to pull key against remover adapter J-6173-4, then continue to turn nut until bearing is pulled out of its hole.

CAMSHAFT BEARING–REPLACE

1. Place a clean rag against each side of the transverse member just below the bearing hole to catch any shavings and carefully clean up the hole. All scratches or nicks in the cast iron should be smoothed with a scraper or file, being careful not to get any chips in cylinder head gallery feed hole. Chamfer the rear edge of the hole slightly to reduce the possibility of shaving down the outer diameter of the bearing when it is installed.

2. Insert remover adapter J-6173-4 into front bearing to act as a support for the shaft.

NOTE: If front bearing is being replaced, insert remover adapter in center bearing to act as support for the shaft.

3. Insert pilot J-6173-7 into hole in which bearing is to be installed.

4. Coat outside of new bearing with oil and place it over replacer adapter J-6173-3, indexing notch in edge of bearing with pin on replacer adapter.

NOTE: The notch in the edge of the bearing is used to properly position the bearing, with respect to the oil holes, when it is installed. When bearings are installed in production, the notches all face the front except the one in the rear bearing. In the field it is necessary to install bearings with the notch facing the rear.

5. Position replacer adapter J-6173-3, with bearing in position against shoulder, against rear of hole in which bearing is to be installed (Fig. 6-57). Index mark on shoulder of replacer must point down (toward crankshaft side) to properly position bearing.

6. Insert shaft with indexing collar, thrust washer, and nut through remover, pilot and replacer adapters and index lug on collar with ventilation hole in front of block (Fig. 6-55).

7. Slip key J-6173-5 into notches in shaft behind replacer adapter J-6173-3 and tighten nut to start bearing into hole (Fig. 6-57). Continue to tighten nut until bearing has been pulled completely into its hole. When properly positioned, it will be approximately flush with both sides of the transverse member.

NOTE: Rear bearing should be pulled in until front edge is flush with block. This will leave shoulder at end of counterbore for camshaft rear plug visible behind bearing.

8. Remove remover and replacer set J-6173.

9. Visually observe that holes in bearing line up with drillings in block.

10. Carefully remove rags used to catch particles of metal and use magnet or vacuum cleaner to make sure that all metal particles are removed from block surfaces and oil drillings.

CAMSHAFT—REPLACE

1. Coat inner diameters of all camshaft bearings with oil and carefully install camshaft. Rotate camshaft through several revolutions to make sure it is completely free. If any tight spots are found, remove camshaft and very carefully polish down the center journal slightly. If still not free, polish the front and rear journals slightly. If any particular bearing causes binding of the camshaft, replace that bearing also.

NOTE: Front center and rear center journals should not be polished except to remove slight roughness or scratches. Slight warpage of the camshaft is not harmful provided the journals are polished down until the camshaft rotates freely in its bearings.

2. With camshaft properly seated, install camshaft thrust plate and tighten bolts 10-25 lb. ft. torque.

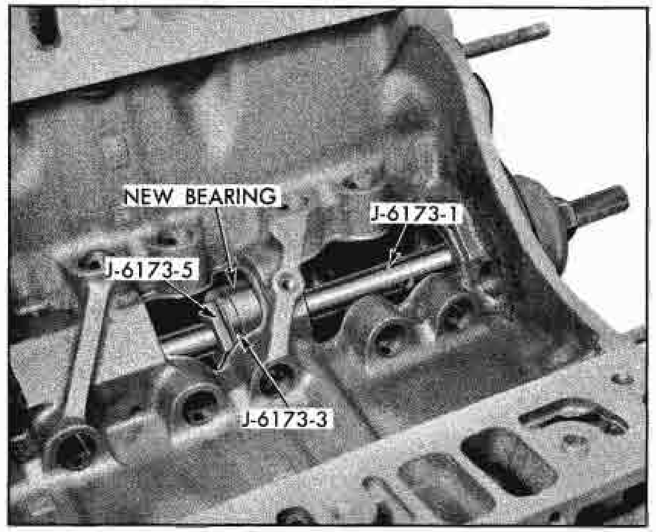


Fig. 6-57 Preparing to Install Camshaft Bearing

3. Install timing chain sprockets and timing chain, making sure marks on sprockets are aligned properly (Fig. 6-44).

4. Coat contact surface of timing chain cover oil seal with special purpose moly grease and install seal, fuel pump eccentric and bushing. Tighten camshaft sprocket retaining bolt 30-45 lb. ft. torque.

5. Install timing chain cover and new gasket and tighten cover to cylinder block bolts and cover to block stud nuts 20-35 lb. ft. torque.

6. Insert four oil pan to timing chain cover screws and tighten 10-15 lb. ft. torque.

7. Install fuel pump and tighten bolts 15-30 lb. ft. torque.

8. Install harmonic balancer. Tighten bolt 130-190 lb. ft. torque.

9. Install hydraulic lifters and push rods, making certain they are replaced in their original positions.

10. Engage rocker arms on push rods and tighten rocker arm ball retaining nuts 15-25 lb. ft. torque.

11. Install push rod cover. Tighten bolts 25-70 lb. in. torque.

12. Install intake manifold and gasket. Tighten bolts 30-45 lb. ft. torque.

NOTE: O-ring seal must be installed between intake manifold and timing chain cover before manifold is securely positioned.

13. Install distributor, positioning rotor pointer to number six cylinder, and install distributor hold-down clamp. Tighten clamp retaining screw 15-25 lb. ft. torque.

14. Install crankcase ventilator outlet pipe and both rocker arm covers and gaskets. Tighten cover bolts 45-80 lb. in. torque.

15. If generator bracket and generator were removed, install and tighten bolts 10-25 lb. ft. torque.

16. Install fan and pulleys.

17. Install radiator, tightening all bolts securely.

18. Install hood latch bracket and tighten bolts 15-20 lb. ft. torque.

19. Connect carburetor linkage, fuel lines and thermogage unit.

20. Connect all water hoses, vacuum hose and spark plug wires.

21. Install carburetor air filter.

22. Refill cooling system and check for leaks.

OIL PUMP—REMOVE AND REPLACE

1. Remove engine oil pan.

2. Remove oil pump attaching bolts while holding oil pump in place. Carefully lower oil pump away from block with one hand while removing oil pump drive shaft with other hand (Fig. 6-58).

3. Position drive shaft in distributor and oil pump drive gears. Place pump against block using new gasket between pump and block. Index drive shaft with pump drive gear shaft. Install two attaching screws with lock washers and tighten securely.

NOTE: Removal and installation of pump does not affect ignition timing, since the oil pump and distributor drive gear is mounted on the distributor shaft.

4. Install oil pan.

OIL PUMP—RECONDITION

DISASSEMBLE

1. Remove cotter pin which retains floating screen to oil pump inlet, and remove screen (Fig. 6-59).

2. Remove pressure regulator spring retainer, spring, and pressure regulator ball.

3. Remove screws retaining cover to oil pump body and remove cover.

4. Remove driven gear and drive gear with shaft.

CLEAN AND INSPECT

1. Clean all parts thoroughly. Screen must be thoroughly cleaned by using a fluid such as used for carburetor cleaning.

2. Inspect pressure regulator spring (Fig. 6-60) for distortion, cracks, and wear on sides.

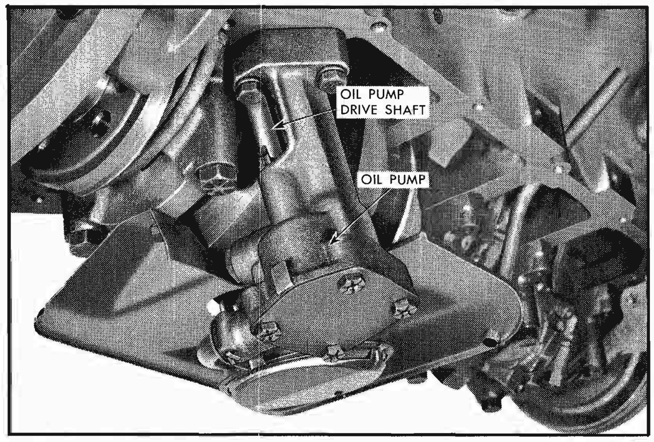


Fig. 6-58 Oil Pump and Oil Pump Drive Shaft

3. Inspect pressure regulator ball to see that it is not nicked or otherwise damaged.

4. Inspect pump body, driven gear shaft and cover for evidence of wear.

5. Inspect pump gears and end of drive gear shaft for wear (Fig. 6-60).

6. Inspect oil pump drive shaft (distributor to pump shaft) for evidence of wear and cracks.

ASSEMBLE

1. Install drive and driven gears.

2. Install cover and turn drive shaft by hand to ensure that it turns freely.

3. Install pressure regulator ball, spring and retainer.

CAUTION: Do not attempt to change oil pressure by varying length of pressure regulator valve spring.

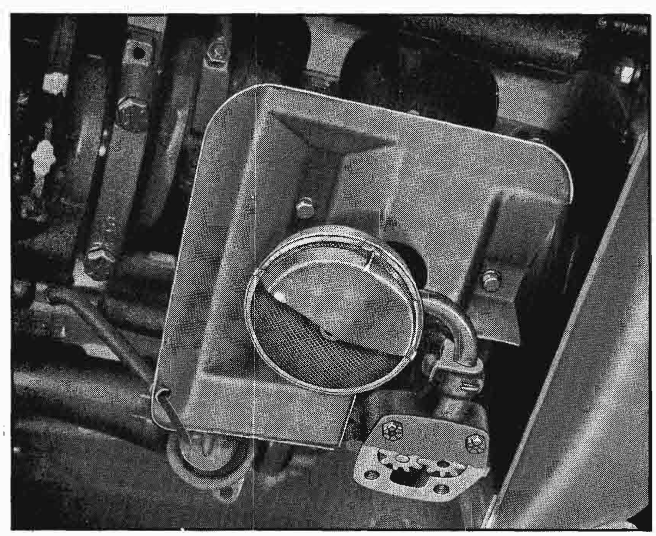


Fig. 6-59 Oil Pump Floating Screen Assembly

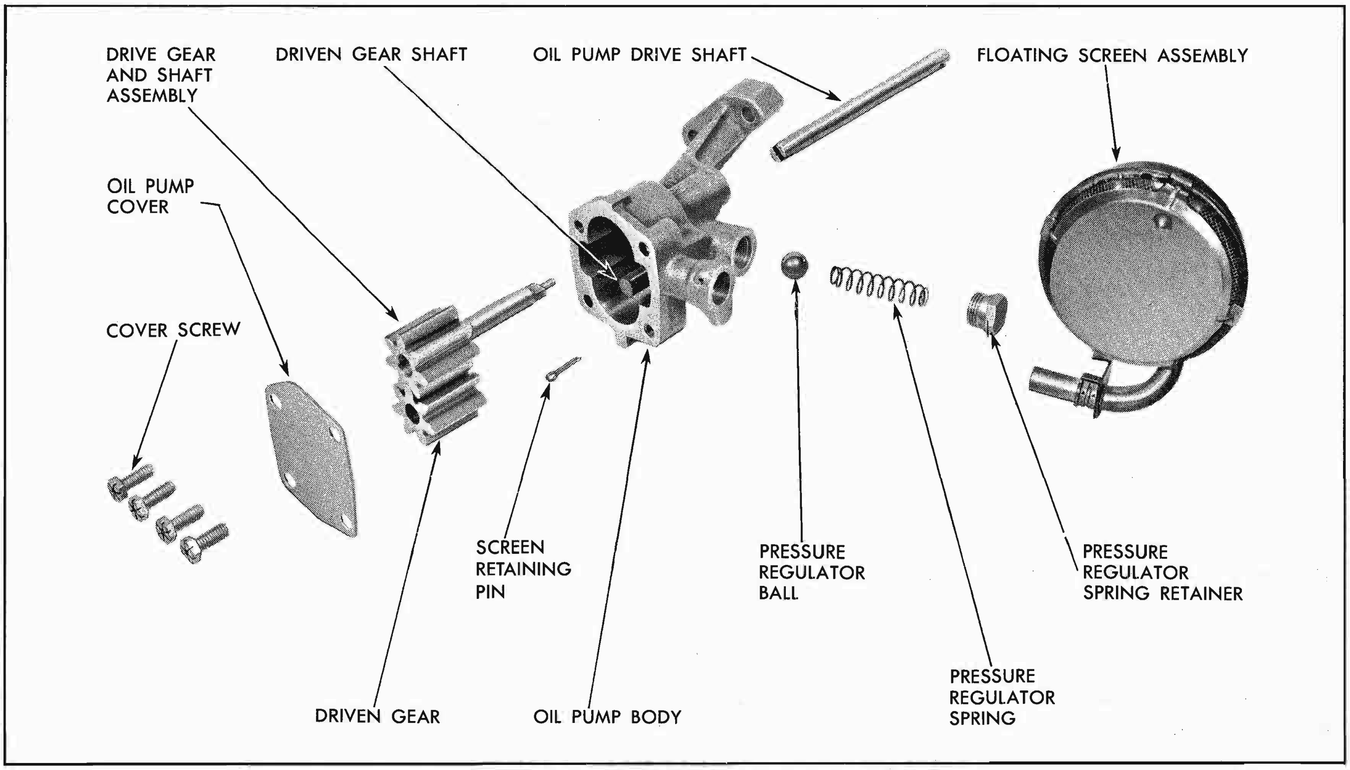


Fig. 6-60 Oil Pump—Exploded View

4. Install screen assembly on oil pump and install new cotter pin retainer, bending both ends of cotter pin 90° to avoid contact with oil pan. See Fig. 6-58.

CONNECTING ROD BEARINGS— REMOVE AND REPLACE

1. Remove oil pan.
2. To gain access to numbers 5, 6, 7 or 8 connecting rod caps it will be necessary to remove oil pump screen and oil baffle.
3. Rotate crankshaft as necessary to bring crank pin carrying bearing to be replaced straight down (Fig. 6-61).
4. Remove bearing cap of bearing to be replaced.
5. Install connecting rod bolt guide set J-5239 on connecting rod bolts (Fig. 6-62).
6. Push piston and rod assembly up far enough to allow removal of bearing shell. Remove bearing shells from rod and cap.

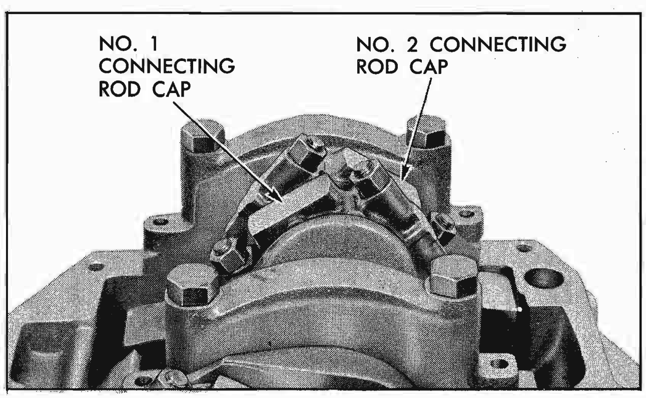


Fig. 6-61 Crankshaft Positioned for Removal of No. 1 and No. 2 Connecting Rod Caps

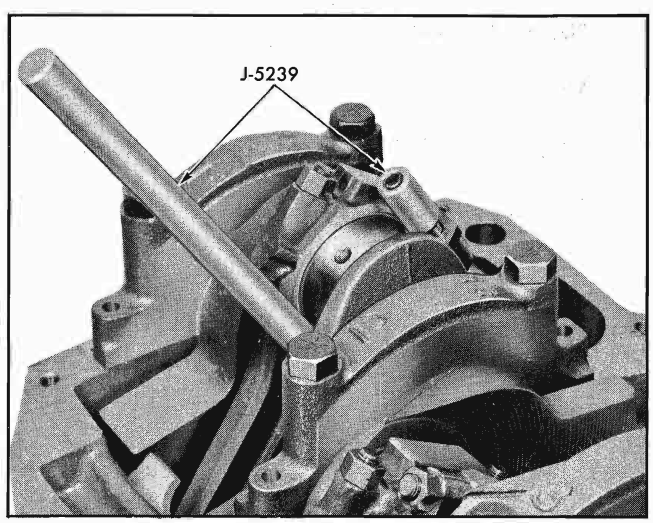


Fig. 6-62 Set J-5239 Positioned for Removal of Connecting Rod Bearing Shell

7. Inspect crank pin for damage, out-of-round, and taper.

8. Reassemble cap and rod with new bearing shells and check fit using plastigage or shim stock as outlined below.

CAUTION: Under no circumstance should a bearing cap be filed or shimmed in an effort to effect a fit.

PLASTIGAGE METHOD FOR DETERMINING CONNECTING ROD BEARING CLEARANCE

a. Place a piece of plastigage plastic the length of bearing in bearing (bearing must be free of oil); install bearing and cap and tighten nuts to 45 lb. ft. torque. DO NOT TURN CRANKSHAFT WITH PLASTIGAGE IN PLACE.

b. Remove bearing cap. Using plastigage scale, measure width of flattened piece of plastic. If reading is not over 2¼, standard size connecting rod bearing should be used; if over 2¼, use .001″ undersize bearing and recheck. Connecting rod bearing inserts .002″ undersize are available for cases where use of the .001″ undersize bearing results in excessive clearance.

SHIM STOCK METHOD FOR DETERMINING CONNECTING ROD BEARING CLEARANCE

a. Place .0015″ brass shim ½″ wide by ⅞″ long in bearing cap with new standard insert and install cap. Tighten nuts to 45 lb. ft. torque.

b. Attempt to move connecting rod endwise on crankpin by hand and then by a light tap of a hammer.

c. Repeat test to move rod endwise by hand with shim removed. If connecting rod did not move by hand, but moved by tap of hammer in step "b" and moved freely in this step, the standard bearing should be used. If rod could be moved by hand in step "b", install .001″ undersize bearing. If necessary, recheck with .002″ undersize bearing.

9. After determining that the correct bearing insert has been fitted, tighten connecting rod cap nuts to final tightness of 40-46 lb. ft. torque. Nuts are self-locking and require no lock washers or cotter pins.

10. Replace oil baffle and oil pump screen if they were removed.

11. Replace oil pan, using new gaskets.

MAIN BEARINGS—REMOVE AND REPLACE

1. Remove oil pan.

2. To gain access to rear center bearing cap, remove oil baffle. To gain access to rear main, remove oil pump in addition to oil baffle.

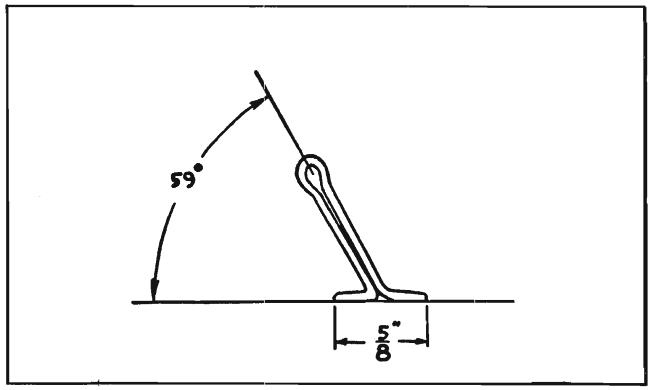


Fig. 6-63 Tool for Removing Upper Half of Main Bearing

3. Remove bearing cap of main bearing to be replaced.

4. Make a tool for removing upper half of bearing shell as shown in Fig. 6-63. KMO 734 can also be used.

5. Insert tool in oil hole of crankshaft and rotate crankshaft in usual direction of rotation. This will cause bearing to be moved from between shaft and bearing seat.

6. Oil bearing surface of shell and install by inserting plain end of bearing shell at indented side of bearing seat and gently rotating shell into place by turning shaft.

7. Install new bearing lower half by inserting in bearing cap so indentation in shell and cap coincide.

8. Install bearing cap and check fit of bearing using plastigage or shim stock as outlined below.

CAUTION: Under no circumstances should bearing caps be filed or shimmed in an effort to effect a fit.

PLASTIGAGE METHOD FOR DETERMINING MAIN BEARING CLEARANCE

a. Place a piece of plastigage plastic the length of bearing in bearing (bearing must be free of oil); install main bearing and cap and tighten rear main bearing to 110-130 lb. ft. torque, all others to 90-110 lb. ft. torque.

NOTE: Do not turn crankshaft with plastigage in place.

When position of engine is such that weight of crankshaft is on bearing caps, all bearing caps must be in place and tightened so crankshaft weight will be properly supported and not give error in reading at bearing being checked. Shim caps on either side of bearing being checked to force crankshaft against upper half of bearing.

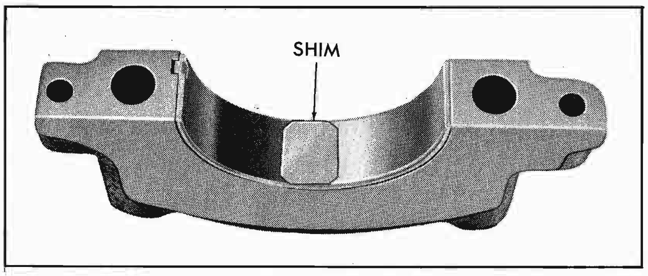


Fig. 6-64 .002 Shim Positioned in Cap for Checking Bearing Clearance

b. Remove bearing cap and using plastigage scale, measure width of flattened piece of plastic. If reading is not over 2½, standard size main bearing should be used; if reading is over 2½, use .001″ undersize bearing and recheck. Main bearing inserts .002″ undersize are available for cases where use of the .001″ undersize bearing results in excessive clearance.

SHIM STOCK METHOD FOR DETERMINING MAIN BEARING CLEARANCE

a. Place .002″ brass shim ½″ wide by 1″ long in main bearing cap with new standard bearing and install cap, pulling up bolts to specified torque. Refer to Fig. 6-64 for position of shim in cap.

b. Attempt to rock crankshaft by hand 1″ in either direction.

CAUTION: Do not attempt to move crankshaft more than 1″ in either direction or shim may damage bearing.

c. Repeat test in step "b" without shim. If crankshaft moves freely without shim in place and locks with .002″ shim, the standard bearing is satisfactory. If it is possible to rock the crankshaft freely with the .002″ shim, the .001″ undersize bearing should be used and the fit rechecked. If necessary, recheck with .002″ undersize bearing.

9. After determining that the correct bearing insert has been fitted, tighten bearing cap to final tightness of 90-110 lb. ft. torque except rear main bearing cap which should be tightened to 110-130 lb. ft. torque.

NOTE: Before installing rear main bearing cap, apply a ¹⁄₁₆″ wide bead of sealer on face of rear main bearing cap from packing groove to external cork groove on both sides. (Use suitable sealer.)

Reinstall cap and tighten to 110-130 lb. ft. torque. Lock washers are not used on main bearing cap screws.

10. Replace oil pump, cylinder block to oil baffle tube, and oil baffle if they were previously removed.

11. Replace oil pan, using new gaskets.

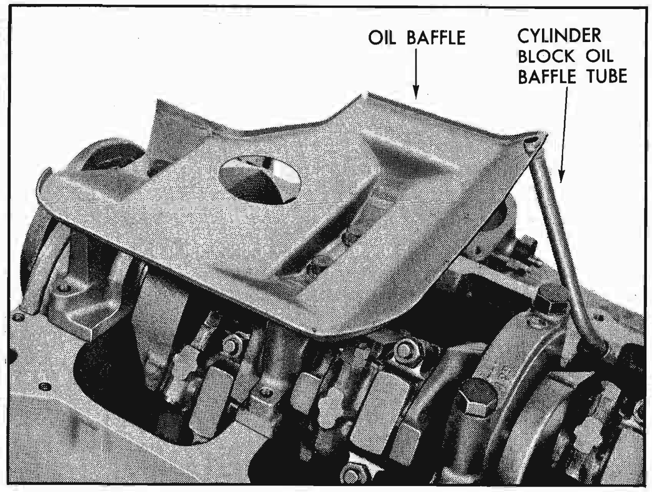


Fig. 6-65 Engine Oil Baffle and Tube Assembly

REAR MAIN BEARING OIL SEAL—REMOVE AND REPLACE

REMOVE

1. Remove oil pan.
2. Remove oil pump and oil pump drive shaft.
3. Remove oil baffle and cylinder block to oil baffle tube (Fig. 6-65).
4. Remove rear main bearing cap.
5. Remove rear center main bearing cap.
6. Loosen remaining bearing caps sufficiently to allow crankshaft to be moved away from block approximately ½″ at the rear.
7. With crankshaft lowered to provide clearance, remove upper half of rear main bearing oil seal.
8. With rear main bearing cap on bench, remove oil seal and bearing shell.

REPLACE

1. Install new seal in block as follows:

a. First install seal in cap and compress seal using hammer and seal compressor J-7588 (Fig. 6-66).

b. Trim one end of seal flush with cap.

c. Rotate seal slightly and recompress to eliminate "bumps" caused by seal retention slots.

d. Remove seal from cap, and install in block by slipping up over crankshaft into seal cavity of block. Insert end which was flush with cap first.

e. Install rear center main bearing cap with bearing shell and tighten to 95 lb. ft. torque to pull crankshaft up into place against seal.

f. Carefully trim both ends of seal flush with block.

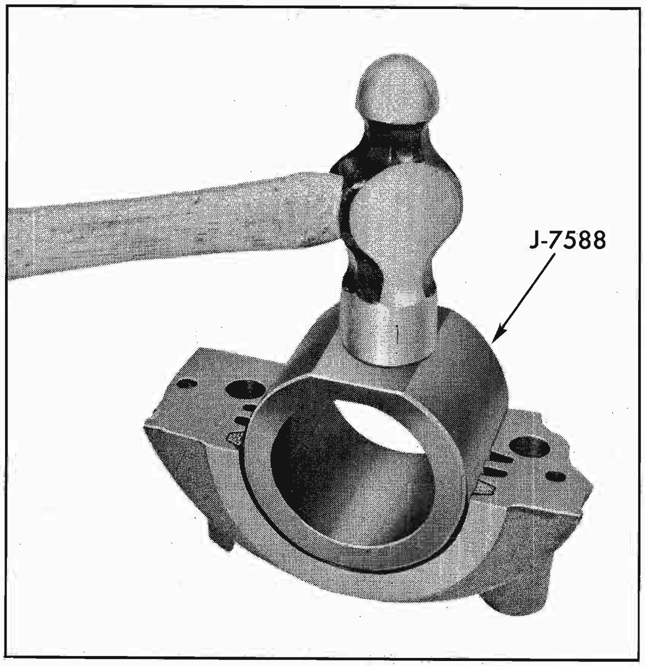


Fig. 6-66 Compressing Upper Seal in Bearing Cap with J-7588

2. Install a new seal in rear main bearing cap, using tool J-7588 to pack seal tightly. Be sure to pack seal tightly into groove and trim flush with cap (Fig. 6-66).

3. Install cap with shell and tighten to 110-130 lb. ft. torque.

4. Remove rear main bearing cap again and inspect split line between cap and block to be certain that none of the seal material has been compressed between the two. If inspection shows material between cap and block surface, scrape it off to insure proper seating of metal surfaces.

5. Clean face of rear main bearing cap with volatile type cleaner to remove all oiliness. Then apply a $\frac{1}{16}''$ diameter bead of sealer on face of the cap from packing groove to external cork groove on both sides. Reinstall cap and tighten to 110-130 lb. ft. torque.

6. Tighten remaining main bearing caps to 90-110 lb. ft. torque.

7. Replace oil baffle and cylinder block to oil baffle tube.

8. Replace oil pump and oil pump drive shaft.

9. Replace oil pan, using new gasket.

CONNECTING ROD AND PISTON ASSEMBLY—REMOVE AND REPLACE

REMOVE

1. Remove intake manifold and cylinder head on bank from which piston is to be removed.

2. Remove oil pan and if number 5, 6, 7, or 8 rod and piston assembly is to be removed, remove oil baffle and oil pump screen.

3. Rotate crankshaft so crank pin carrying assembly to be replaced projects straight downward (Fig. 6-61).

4. Remove bearing cap and install connecting rod bolt guide set J-5239.

5. Carefully remove connecting rod and piston assembly by pushing out with knurled handle of long guide (Fig. 6-67).

REPLACE

1. Install connecting rod bolt guide set on connecting rod bolts with long handle guide on same side as oil groove in rod.

2. Using suitable ring compressor insert piston and connecting rod assembly into cylinder so that "F" on web and notch in top of piston are toward front of engine. This will place the oil groove of the connecting rod so that it will direct oil against the opposite cylinder wall.

3. From beneath engine, pull connecting rod, with bearing shell in place, into position against crank pin.

4. Remove guide set J-5239. Install bearing cap and cap nuts and tighten to 40-46 lb. ft. torque.

5. Replace oil pump screen and oil baffle, if they were removed.

6. Replace oil pan, using new gaskets. Tighten oil pan screws to 10-15 lb. ft. torque.

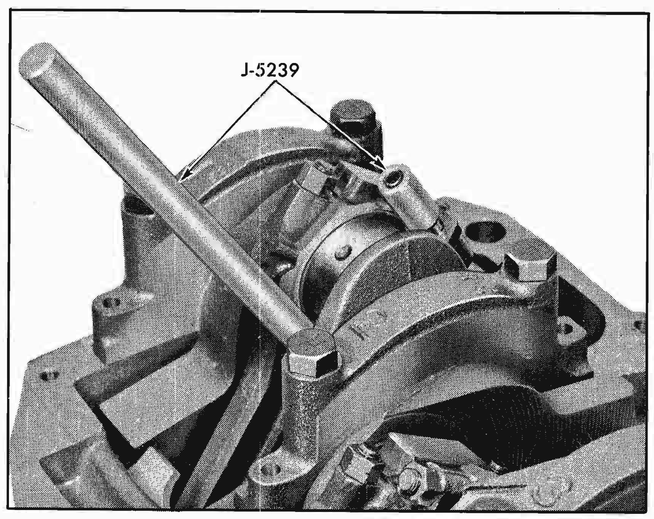


Fig. 6-67 Removing Connecting Rod and Piston Assembly with J-5239

7. Install cylinder head and intake manifold.

CONNECTING ROD AND PISTON ASSEMBLY—RECONDITION

NOTE: Use care at all times when handling and servicing connecting rods and pistons. To prevent possible damage to these units, do not clamp rod or piston in vise since they may become distorted. Do not allow pistons to strike against one another, against hard objects, or bench surfaces, since distortion of piston contour or nicks in the soft aluminum material may result.

CONNECTING ROD AND PISTON—DISASSEMBLE

1. Remove piston rings using suitable piston ring remover.

NOTE: It is important that rings be removed carefully to prevent scratching or burring of ring grooves and lands.

2. Using a suitable arbor press, place plunger of tool J-6901 into piston pin bore and position on arbor press (Fig. 6-68).

3. Place tool J-6901-5 between connecting rod and piston boss (Fig. 6-68).

4. Place tool J-6901-3 (Fig. 6-68) in piston pin and press piston pin down until pin bottoms in tool J.-6901.

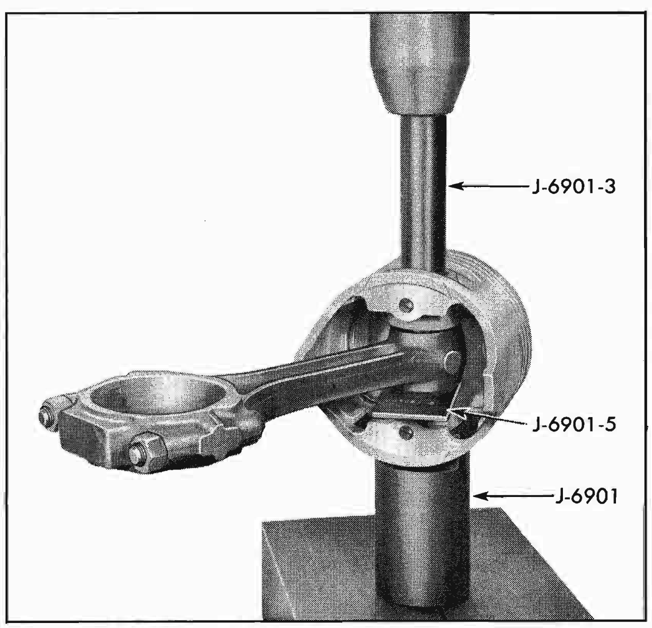


Fig. 6-68 Piston Positioned in Arbor Press for Removal of Pin

5. Remove tool J-6901-5 from between connecting rod and piston boss.

6. Remove plunger and spring from tool J-6901 (Fig. 6-68).

7. Place end of piston pin in tool J-6901 and place on arbor press.

8. Using tool J-6901-3 (Fig. 6-68) press pin out of piston and connecting rod.

9. Remove bearing cap and bearings.

CONNECTING ROD AND PISTON—CLEAN AND INSPECT

1. Clean carbon, varnish, and gum from piston surfaces, including underside of piston head. Clean ring grooves, and oil holes in oil ring groove, using suitable cleaning tools and solvent.

2. Clean piston pin, rod, cap, bolts and nuts in suitable solvent. Reinstall cap on connecting rod to assure against subsequent mixing of caps and connecting rods.

3. Carefully examine piston for rough or scored bearing surfaces; cracks in skirt or head; cracked, broken, or worn ring lands; scored, galled, or worn piston bosses. Damaged or faulty pistons should be replaced.

NOTE: If piston pin bosses are rough or worn out-of-round and the piston is otherwise serviceable, the pin bosses may be honed for oversize pins. Before fitting oversize pins, however, it is advisable to check fit of piston in bore.

4. Inspect piston pin for scoring, roughness, or uneven wear.

5. Inspect bearing shells to see that they are serviceable. Fit of bearings should be checked when engine is being assembled.

CYLINDER BORES—INSPECT

Inspect cylinder bores for out-of-round or excessive taper. If bores show excessive out-of-round or taper, or if cylinder walls are badly scored, scratched or worn beyond specified limits, the cylinder block should be rebored and new pistons and rings installed.

NOTE: Boring operation must be done under close supervision so that specified clearance between pistons, rings, and cylinder bores is maintained.

HONING CYLINDER BORES

Before honing, cylinder bores should be thoroughly cleaned with a suitable solvent to remove all carbon and oil. Crankshaft, bearings and other internal parts must be covered or taped to protect them during operation. Usually one or two strokes with proper hone will remove light scoring, scuffing or scratches from cylinder walls.

If new rings are to be installed and inspection indicates cylinder bores are satisfactory in respect to out-of-round and taper, with no scoring or scratches evident, it is not necessary to de-glaze cylinder bores as new rings will break in properly under normal operation.

CAUTION: Make certain all abrasives are removed from engine parts after honing. It is recommended that a strong soap solution be used to thoroughly clean parts.

FIT AND REPLACE PISTON

Pistons should be fitted in the bores by actually measuring the fit. Clearance between the piston and the cylinder bore should be .0007" to .0013" on standard engines; .0022" to .0027" on 425A, police and synchro-mesh tri-power.

NOTE: In some instances, where driver's habits indicate carelessness in breaking in a newly serviced engine, it is recommended a clearance from .0015" to .002" be used in fitting piston replacements.

If cylinder bores have been reconditioned, or if pistons are being replaced, reconditioning of bores and fitting of pistons should be closely coordinated. If bore has been honed, it should be washed thoroughly with hot, soapy water and a stiff bristle brush.

Using a cylinder checking gauge, measure the cylinder bore crosswise of the block to find the smallest diameter. Record the smallest diameter of each bore.

NOTE: When measuring cylinder bores and pistons it is very important that the block and pistons be at room temperature. If any or all of the parts are hotter or colder than normal room temperature, improper fitting will result.

Measure the piston skirt perpendicular to the piston pin boss (piston pin removed) and 1¼" below the oil ring groove. Make sure the micrometer is in full contact (Fig. 6-69).

As the pistons are measured they should be marked for size identification and the measurements recorded.

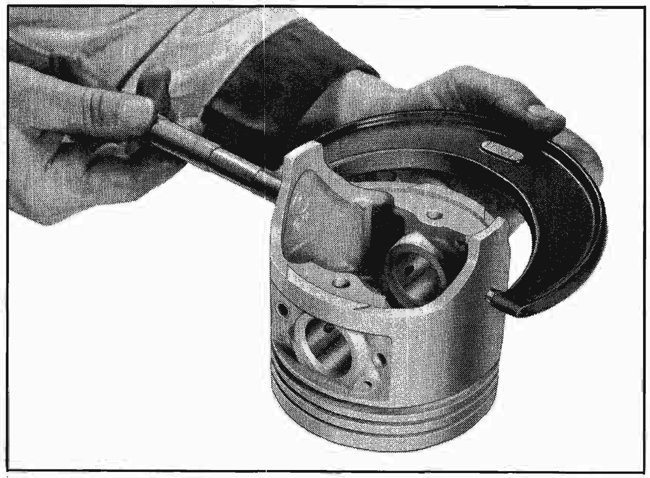


Fig. 6-69 Measuring Piston with Micrometer

If there is excessive clearance between a cylinder bore and the piston which was installed in that bore, a new piston should be used.

New pistons are serviced for both standard and premium fuel engines in standard size and .005", .010", .020" and .030" oversize.

NOTE: Since these are nominal or basic sizes, it is important that new pistons be measured to ensure proper fit. All new pistons are serviced with selectively fitted piston pins.

After all measurements have been made, match the new pistons with the cylinders where they will fit with proper clearance. Honing of cylinder bore may be necessary to effect a proper fit. When properly mated, mark the pistons with the cylinder numbers they fit so they will not become mixed.

FITTING PIN IN PISTON

The piston pin fit in piston is .0003" to .0005" loose with pin and bosses clean and dry.

NOTE: Piston and pin must be at room temperature when checking fit and pin must be able to fall from piston by its own weight.

FITTING OVERSIZE PINS IN PISTONS AND CONNECTING ROD PIN BORES

In case the standard size piston does not fit properly in the piston, an oversize piston pin must be fitted. Piston pins are available in .001" and .003" oversize.

When oversize pins are used, the piston pin bosses must be honed to give the required fit. It will also be necessary to hone the connecting rod pin bore to fit the oversize pin using a Sunnen hone or similar accurate equipment.

NOTE: A special grit hone is used for honing the connecting rod pin bore. The piston pin size should be .0008" to .0016" larger than the connecting rod pin bore for the proper press fit. The piston pin should not show any movement under 1500 lb. minimum load after assembly in rod.

ASSEMBLE CONNECTING ROD TO PISTON

All pistons have an "F" cast on the front side. There is also a notch cast in the top of the high compression piston head and two notches cast in top of the low compression piston head at the front (Fig. 6-70) to facilitate proper installation. The piston assemblies should always be installed with the notch or notches toward the front of the engine.

REPLACE PISTON PIN

1. Place plunger and spring in tool J-6901 (Fig. 6-71) to be used as a pilot and stop.

2. Place plunger of tool J-6901 in piston pin bore and place on arbor press.

3. Coat piston pin and rod lightly with graphite lubricant.

4. Place tool J-6901-3 in piston pin and press pin into piston and connecting rod (Fig. 6-71) until piston pin bottoms against plunger of tool J-6901. Piston must turn freely on pin. If piston binds on pin, disassemble, hone piston pin bosses slightly and reassemble.

The odd numbered piston assemblies will always be installed in the left hand bank of cylinders, while

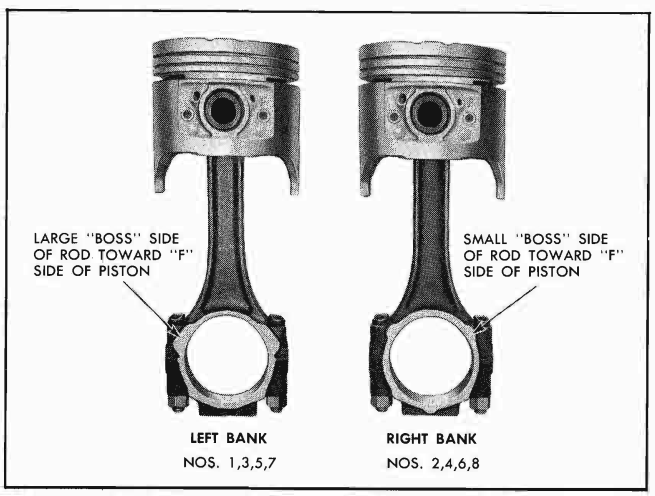


Fig. 6-70 Correct Assembly of Rod to Piston

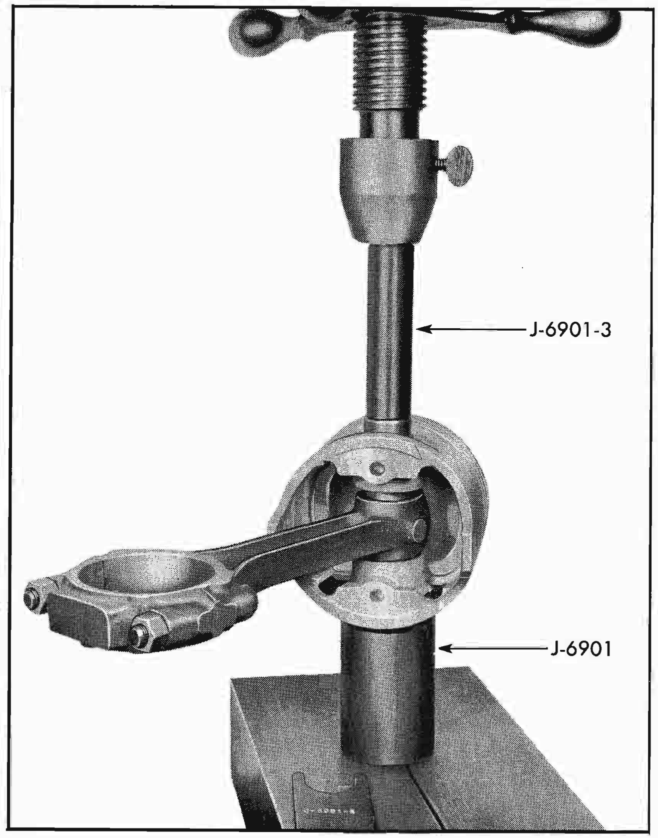


Fig. 6-71 Installation of Piston Pin

the even numbered piston assemblies will always be installed in the right hand bank of cylinders.

One side of the connecting rod will have large machined bosses with cap boss (Fig. 6-70). This side of the connecting rod and cap of the two adjacent rods on each crankpin will always be facing each other.

This means that the large machined bosses on odd numbered rods will always be facing the front of the engine, while the small machined bosses on even numbered rods will also be facing the front of the engine. When the rod and piston are correctly installed, the oil groove between the rod and cap will be on the left side on even numbered rods, and on the right side on odd numbered rods.

INSTALL PISTON RINGS

Two compression rings and one 4-piece oil control ring, all above the piston pin, are used on pistons for both standard and premium fuel engines. The top compression rings are taper faced and also have either a step or a chamfer on the inside diameter of the top side. The top compression ring is chrome plated. The lower compression ring may have a step or chamfer on the inside but **should always be in-**

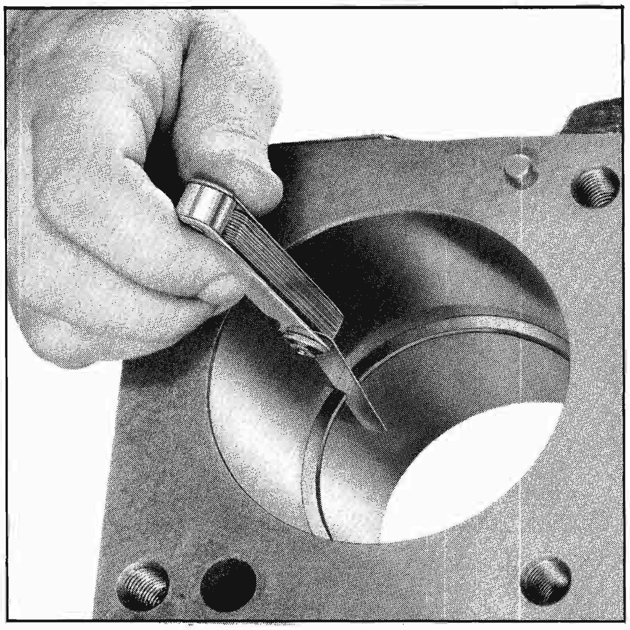


Fig. 6-72 Checking Ring Gap with Feeler Gauge

stalled with the mark (letter "T", dot or word "TOP") toward the top.

New rings are serviced for the standard size pistons, and for .005", .010", .020", and .030" oversize pistons. When selecting rings be sure they match the size of the piston on which they are to be installed, i.e. standard rings for standard pistons, .010" oversize rings for .010" oversize pistons, etc. Ring gap and side clearance should be checked while installing rings as follows:

1. Check pistons to see that ring grooves and oil return holes have been properly cleaned.

2. Place ring down at the bottom of the ring traveled part of the cylinder bore in which it will be used. Square ring in bore by pushing it into position with head of piston.

3. Measure gap between ends of ring with feeler gauge (Fig. 6-72). Gaps should be as follows:

Upper Compression Ring	.016"-.026"
Lower Compression Ring	.013"-.025"
Oil Ring	.015"-.035"

Incorrect ring gap indicates that wrong size rings are being used. If rings are selected according to the size of the bore (standard .005" oversize, etc.) they should have the proper gap. It should not be necessary to alter ring gap by filing.

4. Install rings on piston, using suitable ring installing tool, such as J-7135, to prevent breakage or fracture of rings, or damage to pistons.

5. Measure side clearance of rings in ring groove (Fig. 6-73) as each ring is installed. Clearance with new pistons and rings should be as follows:

Upper Compression Ring	.0015"-.0030"
Lower Compression Ring	.0015"-.0035"
Oil Control Ring	.0015"-.0085"

If side clearance is excessive, piston should be replaced.

ENGINE—REMOVE FROM VEHICLE

NOTE: The engine may be removed from the car with the transmission attached; however, if it is desired to remove the transmission before removing the engine, the following procedure given below will still apply in general.

1. Drain water, engine oil, and transmission lubricant.

2. Remove hood. See CHASSIS SHEET METAL SECTION.

3. Remove engine ground wire.

4. Remove air cleaner and disconnect throttle and transmission linkage.

5. On cars with power steering, remove power steering pump belt and pump with mounting bracket, leaving hoses connected. Place pump in a position where it will not become damaged when engine is removed.

6. Remove upper and lower radiator hose and disconnect heater line from intake manifold and timing chain cover. On Hydra-Matic equipped cars remove inlet and outlet oil lines from radiator. Remove oil pressure warning light wire from switch terminal at filter.

7. Remove fuel pump lines and filter.

8. Remove fuel and vacuum lines.

9. Remove carburetor and gasket.

10. Remove terminal from thermogauge unit on intake manifold. Disconnect coil primary lead at coil. Disconnect generator to regulator wires from generator, release from clips retaining to valve cover and pull clear of engine.

11. Remove battery and cables.

12. Remove radiator and fan.

13. Remove crankcase ventilator outlet pipe.

14. Loosen muffler and tail pipe supports, then disconnect exhaust pipe from exhaust crossover pipe.

15. Disconnect solenoid wire loom from junction block on fender skirt.

16. Remove gearshift manual linkage at transmission.

17. Disconnect linkage from clutch release fork and remove clutch control countershaft bracket from flywheel housing (synchro-mesh equipped cars).

18. Remove propeller shaft drive line assembly.

19. Remove top breather pipe bolt from rear end of right side cylinder head. Thread 3/8" bolts through ends of short, strong chain and insert in top holes at rear of right and left cylinder heads. Loop heavy chain fall through short chain and connect end of chain fall to lift plate on timing chain cover.

CAUTION: Bolts at rear of cylinder heads must be drawn up as tightly as possible to prevent pulling out.

20. Remove bolts holding front and rear insulators to frame.

21. Disconnect Hydra-Matic oil cooler lines at timing cover.

22. On Hydra-Matic equipped cars, support bottom of transmission with special automatic transmission jack and remove frame cross member to which engine rear insulator was fastened.

CAUTION: Use care to prevent transmission swinging down when cross member is removed, as possible damage to transmission or personal injury may result.

23. Carefully hoist engine and transmission out of car checking frequently to see that sufficient clearance exists to prevent bending any parts; this is especially important in the case of Hydra-Matic throttle linkage.

CRANKSHAFT—REMOVE AND REPLACE

The crankshaft can be removed and replaced with cylinder heads, pistons, rods, manifolds and other upper engine components installed, but the flywheel, clutch and transmission assemblies must be removed.

REMOVE

1. Remove spark plugs.

2. Remove engine oil pan.

3. Remove oil pump assembly and oil pump drive shaft (Fig. 6-58).

4. Remove oil baffle and oil baffle tube (Fig. 6-65).

5. Remove harmonic balancer.

6. Remove fuel pump (Fig. 6-74).

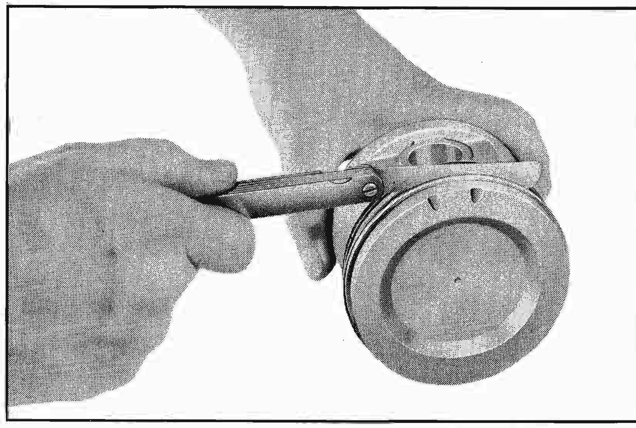


Fig. 6-73 Measuring Side Clearance of Ring in Groove

7. Remove timing chain cover, gasket and O-ring seal.

8. Remove fuel pump eccentric and bushing (Fig. 6-75).

9. Remove timing chain cover oil seal.

10. Remove sprockets and timing chain (Fig. 6-75).

11. Remove connecting rod caps.

12. Remove main bearing caps from block (Fig. 6-75).

NOTE: Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Depress pistons until connecting rods are free of crankshaft.

13. Lift crankshaft from block.

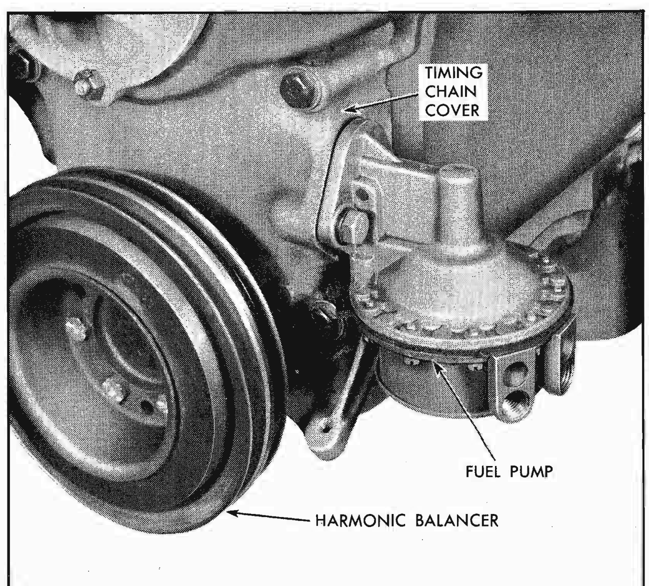


Fig. 6-74 Position of Fuel Pump on Timing Chain Cover

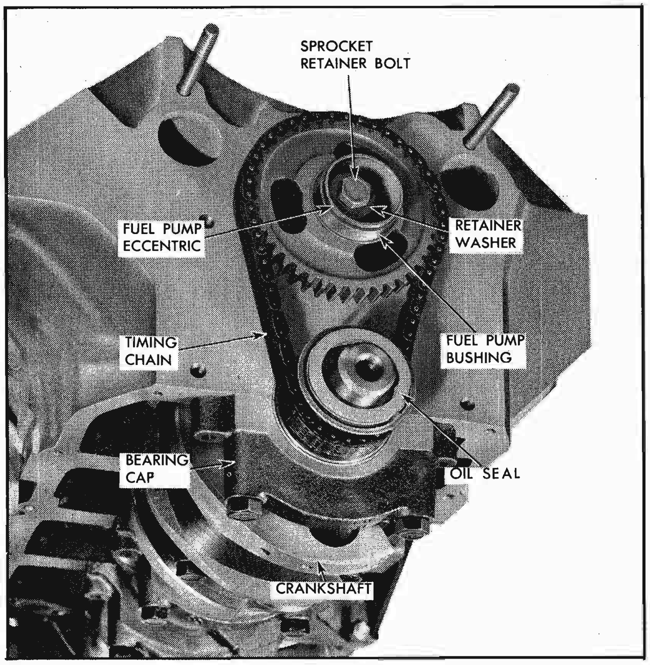


Fig. 6-75 Front View of Engine with Oil Pan and Timing Chain Cover Removed

REPLACE

1. With upper bearings installed position crankshaft in block.

2. Install main bearing caps (with bearing shells in place) but do not tighten retaining bolts.

3. Pull connecting rods and piston assemblies into place, rotating crankshaft as necessary to properly seat rods.

NOTE: Make sure upper bearings remain in proper position.

4. Remove tape from connecting rod threads and install connecting rod caps (with bearings) and retaining nuts, but do not tighten.

5. Tighten rear main bearing cap to 110-130 lb. ft. torque and all remaining bearing caps 90-110 lb. ft. torque.

6. Tighten connecting rod bearing cap retaining nuts 40-46 lb. ft. torque.

7. Install sprockets and timing chain, making sure timing marks on sprockets are aligned properly (Fig. 6-44).

8. Install new timing chain cover oil seal, coating contact surface with special purpose moly grease.

9. Install fuel pump eccentric and bushing and insert sprocket retaining bolt with washer. Tighten securely.

10. Install timing chain cover, new cover gasket and new O-ring seal.

11. Install fuel pump (Fig. 6-74).

12. Install harmonic balancer.

13. Install oil baffle and oil baffle tube.

14. Install oil pump drive shaft and oil pump assembly.

15. Install engine oil pan.

16. Install spark plugs.

ENGINE—DISASSEMBLE FOR OVERHAUL

(With transmission, clutch and flywheel removed and engine mounted in holding stand.)

1. Remove oil level indicator.

2. Remove bolt from rocker arm cover and remove oil level indicator tube.

3. Remove generator, with mounting brackets, and fan belt.

4. Remove fan and pulley.

5. Remove generator adjusting strap.

6. Remove distributor assembly with spark plug wires and spark plug wire supports as follows:

a. Remove wires from spark plugs and remove spark plug wire supports.

b. Disconnect secondary coil wire at center of distributor cap.

c. Disconnect primary coil wire at coil.

d. Disconnect hose at vacuum advance diaphragm on distributor.

e. Remove distributor hold down clamp (Fig. 6-76).

f. Remove distributor (turn lightly to right while pulling out).

7. Remove positive crankcase ventilation valve or remove crankcase ventilator outlet pipe brackets from cylinder head and flywheel housing, if car is so equipped.

8. Pull pipe out of flange on valve push rod cover assembly. (Push neoprene seal up on pipe so it will not be lost.)

9. Remove throttle linkage bracket.

10. Disconnect fuel filter hose at fuel pump and remove pump.

11. Disconnect upper fuel filter connecting hose from carburetor fuel line.

12. Remove carburetor and fuel filter assembly.

13. Remove oil filter and gasket.

14. Remove spark plugs.

15. Remove rocker arm covers.

16. Remove exhaust crossover pipe assembly.

17. Remove right and left side exhaust manifolds.

18. Remove intake manifold and gaskets.

19. Remove valve push rod cover assembly with gaskets.

20. Remove rocker arm nuts and remove rocker arms with balls and place in valve and valve train holding stand J-5709 (Fig. 6-17).

NOTE: Valve lifters, push rods, rocker arms, rocker arm balls, and retaining nuts must be kept in sets when removed and each set must be replaced in the exact locations from which they were removed.

21. Remove push rods and place in support stand J-5709.

22. Remove valve lifters with remover J-3049. Place lifters in valve lifter box J-5763 (Fig. 6-16) so lifters can be installed in the bosses from which they were removed.

23. Remove cylinder head bolts and remove cylinder heads and gaskets.

NOTE: Locating pins in cylinder block will hold cylinder head in position when all bolts have been removed.

24. Scrape carbon from upper edge of bore. This will usually eliminate the ridge making the use of a ridge reamer unnecessary.

25. Turn engine over in holding stand and remove flywheel housing front shield and oil pan.

26. Remove oil pump with floating screen and oil pump drive shaft.

27. Remove engine oil baffle and cylinder block to oil baffle tube.

28. Remove connecting rod and piston assemblies in pairs as follows:

NOTE: Mark each rod and cap with the corresponding cylinder number to ensure that they will be returned to the same place when reinstalled.

a. Turn crankshaft so that two opposite pistons are near bottom of stroke (Fig. 6-61). This will put crankpin on center line of block and expose rod nuts most advantageously.

NOTE: Crankshaft can be turned by using a $15/16''$ socket and handle on harmonic balancer attaching bolt.

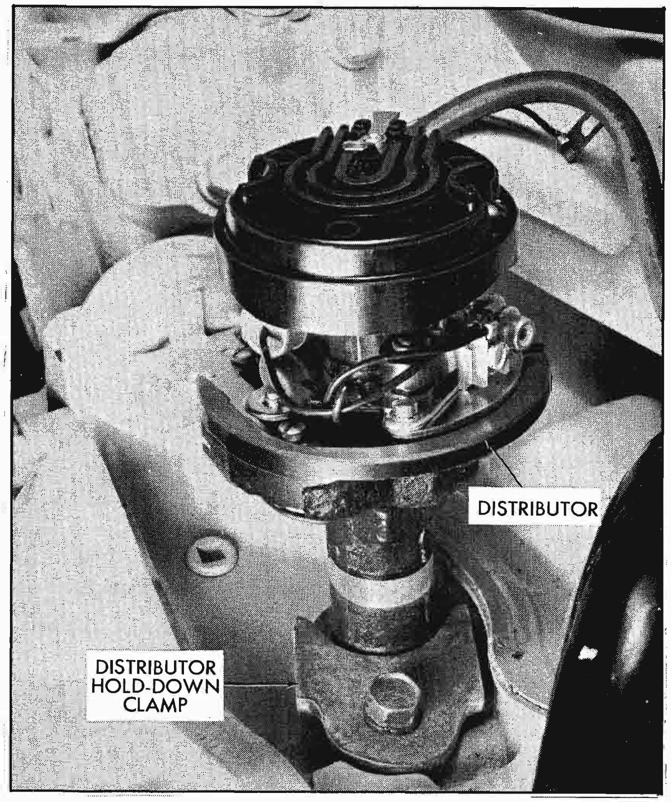


Fig. 6-76 Distributor Hold-Down Clamp

b. Remove rod nuts and bearing cap with bearing shell.

c. Install connecting rod bolt guide set J-5239 on connecting rod bolts (Fig. 6-67).

d. Carefully apply force on tool J-5239 and force piston out of cylinder bore.

e. Reinstall bearing cap on connecting rod to keep mating parts together.

f. Repeat for remaining assemblies.

29. Remove harmonic balancer attaching bolt and washer, and slide balancer off crankshaft.

NOTE: A hammer handle placed between the block and the front counterweight of the crankshaft will hold the crankshaft while attaching bolt is being removed.

30. Remove timing chain cover, timing chain cover oil seal, and timing chain cover to block gasket.

31. Remove fuel pump eccentric from camshaft. Place hammer handle between block and front crankshaft counterweight to hold crankshaft.

32. Slide timing sprockets and timing chain off ends of crankshaft and camshaft.

33. Remove camshaft thrust plate attaching bolts and remove thrust plate.

34. Remove camshaft from block, using care to prevent damage to bearings from cam lobes.

35. Remove all main bearing caps.

NOTE: All caps are held in positive alignment by dowel pins, which also aid in correctly installing the caps. Bearing caps should be kept in order as they are removed to avoid the possibility of interchanging caps when they are replaced.

36. Lift crankshaft from block using care to prevent damage to bearing shells.

37. Remove bearing shells from block.

38. Remove rear main bearing oil seal packing.

39. Remove drain cocks from either side of cylinder block.

ENGINE—CLEAN AND INSPECT

CLEAN AND INSPECT CYLINDER BLOCK

1. Visually inspect all water and oil passage plugs for evidence of leakage and thoroughly clean exterior of block.

2. With block inverted clean out water jacket, using steam or suitable pressure type cleaning equipment, by injecting solution through two large holes in front of block.

3. Remove all oil passage plugs (Fig. 6-77 and 6-78).

4. Flush out all oil passages in the block (refer to OIL CIRCULATION) with suitable pressure type cleaning equipment using tri-sodium phosphate and hot water, steam, or equivalent cleaning solvent.

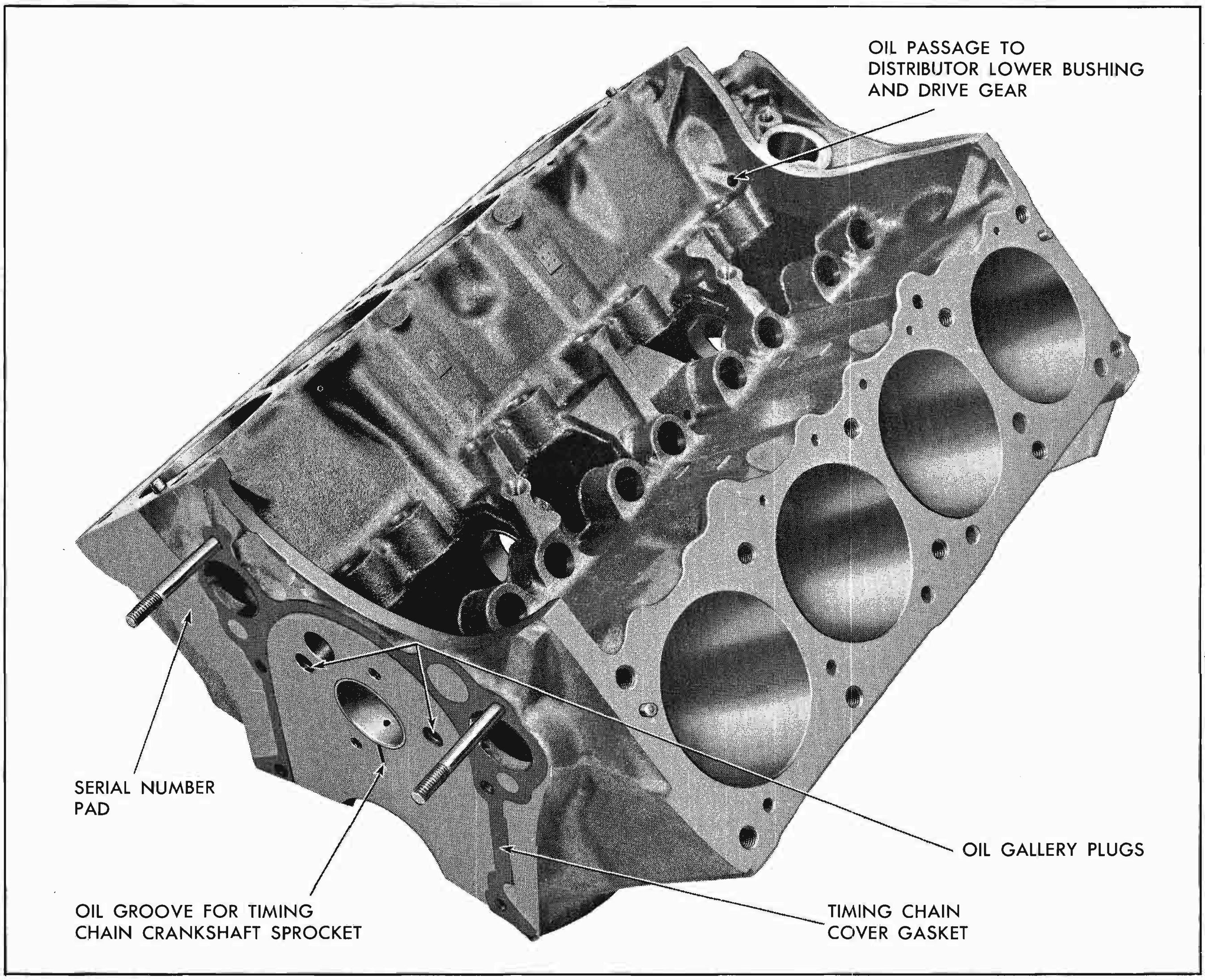


Fig. 6-77 Cylinder Block—View from Left Front

NOTE: The oil passages (Fig. 6-78) in the block which supply oil from the front center and rear center camshaft bearings to the right and left cylinder heads respectively are considerably larger than the oil holes in the camshaft bearings (Fig. 6-79). Due to this fact, sludge may collect in the passages above these bearings and may subsequently be forced into the oil galleries of the cylinder head, causing possible restriction of oil passages in the rocker arm studs. For this reason these passages should be thoroughly cleaned and inspected.

5. Immediately after cylinder bores, valve lifter bores and other machined surfaces have dried, apply oil to prevent rusting.

6. Examine block thoroughly for evidence of cracks. Check all machined surfaces for burrs, scores, and scratches.

7. Visually inspect condition of cylinder bores and check for out-of-round and taper using suitable measuring equipment.

8. Visually inspect camshaft bearings for scoring, galling or evidence of excessive wear.

9. Check fit of each valve lifter in its boss. Lifters should have .0013" to .0028" clearance in boss of block. If clearance is excessive, lifter should be replaced with an oversize lifter. Lifters are serviced .001" and .002" oversize. Reaming of lifter bosses is not recommended.

10. Inspect all oil passages in block to see that they are not obstructed. The following is a suggested procedure.

a. With cylinder block inverted, use pen light to see that passage from oil pump to filter is open (Fig. 6-79).

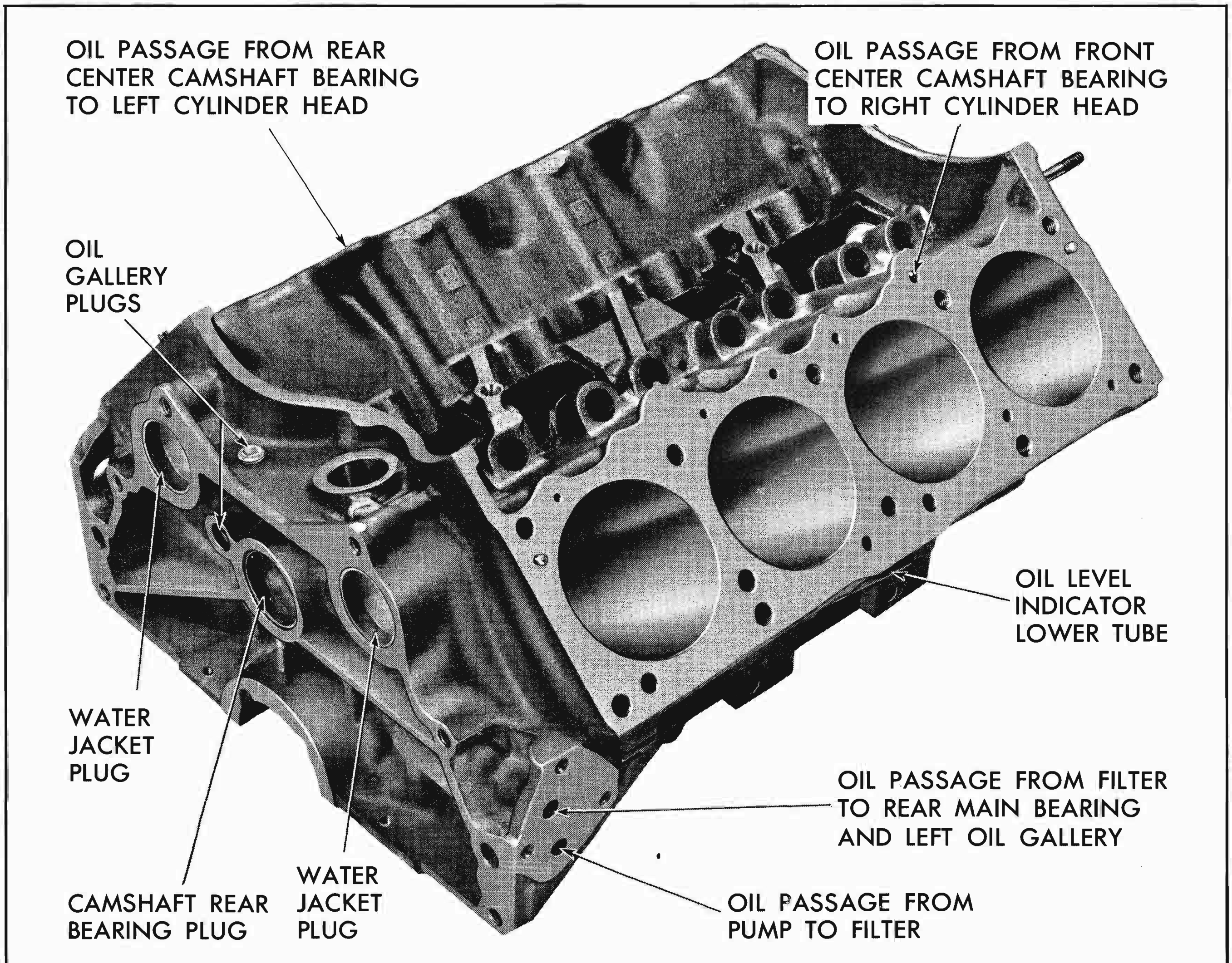


Fig. 6-78 Cylinder Block—View from Right Rear

b. Check passage from filter outlet to rear main bearing by inserting wire in oil filter outlet passage and using pen light to see that wire is visible in passage to rear main bearing (Fig. 6-78).

c. Visually check passage from each main bearing to corresponding camshaft bearing (Fig. 6-79).

d. Check passage from filter outlet (through left oil gallery) to main bearings. Use rubber hose to blow smoke in oil filter outlet while observing to see that smoke passes out passages leading to all main bearings.

e. With cylinder block right side up, check oil passages to left bank lifter bosses. Use rubber hose to blow smoke in oil filter outlet while observing for smoke passing out oil passages from left main oil gallery to lifter bosses.

f. Check oil passages to right bank lifter bosses. Use rubber hose to blow smoke in passage from front main bearing to right main oil gallery while observing for smoke passing out passages from right gallery to lifter bosses.

g. Visually check passage from rear center camshaft bearing to left cylinder head and passage

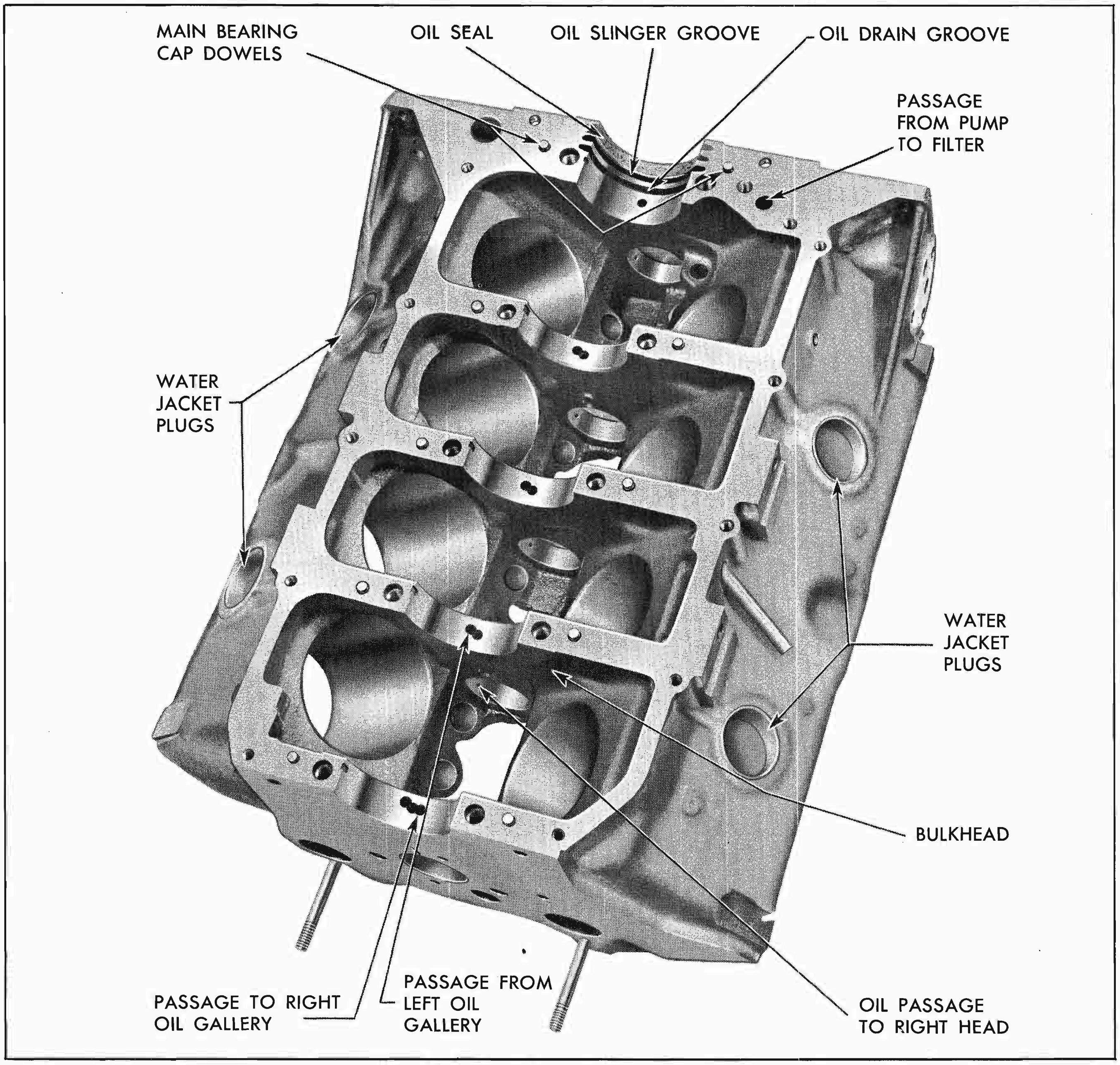


Fig. 6-79 Cylinder Block—View from Bottom

from front center camshaft bearing to right cylinder head (Fig. 6-78).

h. Use wire to check two drain holes in lifter galley (Fig. 6-80).

CLEAN AND INSPECT CRANKSHAFT AND MAIN BEARINGS

1. Inspect main bearing journals and crankpins for scoring or galling. Measure crankpins and bearing journals to see that maximum out-of-round and taper does not exceed .0005".

2. Inspect main bearing shells to be sure that they are serviceable. Fit of bearings should be checked when engine is being assembled.

CLEAN AND INSPECT CAMSHAFT, THRUST PLATE, AND FUEL PUMP ECCENTRIC

1. Check camshaft for general condition. Bearing journals should not be scored or burred. Cam lobes should be smooth and free of burrs and grooves. Oil pump drive gear should not have excessive wear.

2. Inspect camshaft thrust plate to see that no groove or ridge has been worn into bearing side of plate.

3. Inspect fuel pump eccentric and bushing for evidence of excessive wear.

CLEAN AND INSPECT TIMING CHAIN AND SPROCKETS

Clean sprockets and chain and inspect for evidence of excessive wear.

ENGINE—ASSEMBLE

1. Install drain cock in each side of block.

2. Install rear main bearing oil seal in block and cap as follows:

a. Place seal in groove in block and pack tightly with hammer and tool J-7588 (Fig. 6-81).

b. With tool still in place cut seal off flush with block. Remove tool from block.

c. Place seal in groove in bearing cap and pack tightly with hammer and tool J-7588 (Fig. 6-82).

d. With tool still in place carefully cut seal off flush with cap. Remove tool from cap.

3. Position main bearing shells in block.

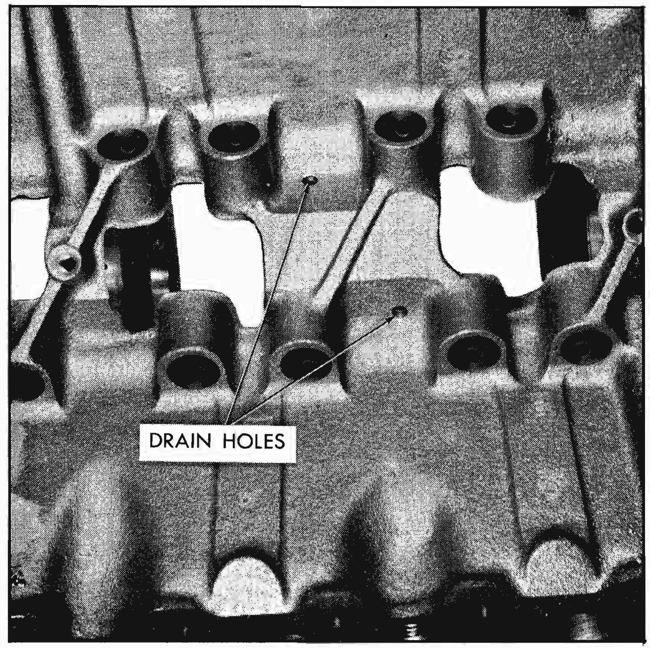


Fig. 6-80 Drain Holes in Lifter Galley

The rear main bearing cap has three grooves, one for oil drain, one for the oil slinger and the other for the seal (Fig. 6-83). The upper bearing shells have two oil grooves. The front oil groove has an oil hole in the center while the rear oil groove has three oil drain holes evenly spaced. The upper and lower shells are not interchangeable due to location of tang slots in block and cap. For the front, front center, center, and rear center bearings install the shells with the oil grooves in the cylinder block (upper) position and install the shells without the oil grooves in the cap (lower) position. There will be no oil supply to the bearings if the shells are reversed.

4. Carefully position crankshaft in place in block.

5. Position main bearing shells in caps and measure bearing clearances as follows:

CAUTION: Under no circumstances should bearing caps be filed or shimmed in an effort to effect a final fit.

PLASTIGAGE METHOD FOR DETERMINING MAIN BEARING CLEARANCE

a. Place a piece of plastigage plastic the length of bearing in bearing to be checked (bearing must be free of oil); install all main bearings and caps and tighten to specified torque given in step 6 below. DO NOT TURN CRANKSHAFT WITH PLASTIGAGE IN PLACE.

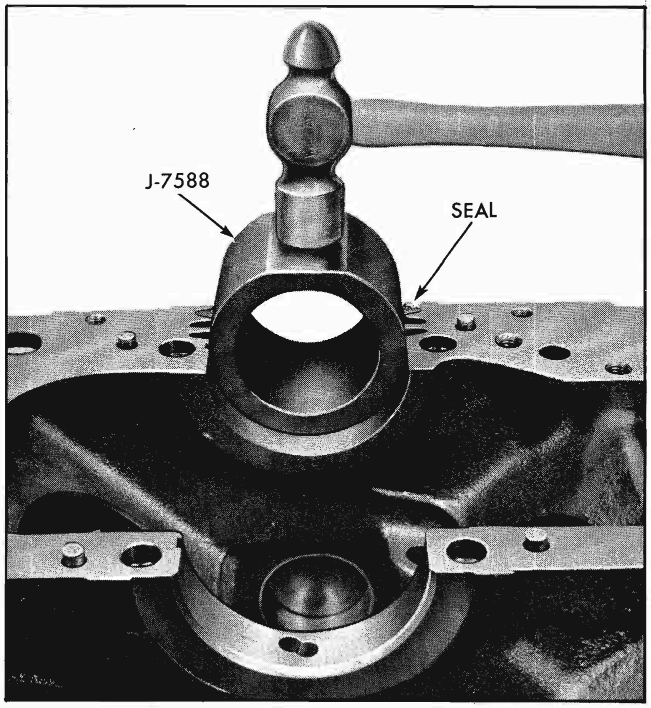


Fig. 6-81 Compressing Seal in Block with J-7588

When position of engine is such that weight of crankshaft is on bearing caps, all bearing caps must be in place and tightened so crankshaft weight will be properly supported and not give error in reading at bearing being checked. Shim caps on either side of

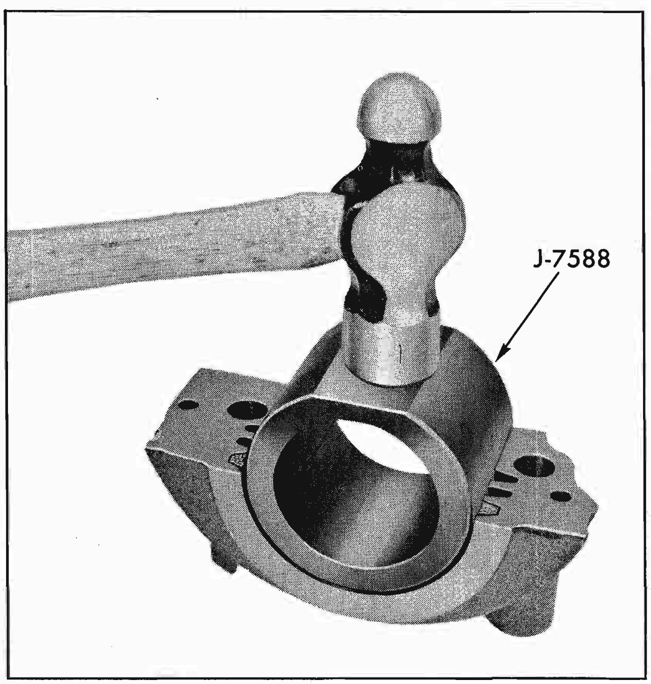


Fig. 6-82 Compressing Upper Seal in Bearing Cap with J-7588

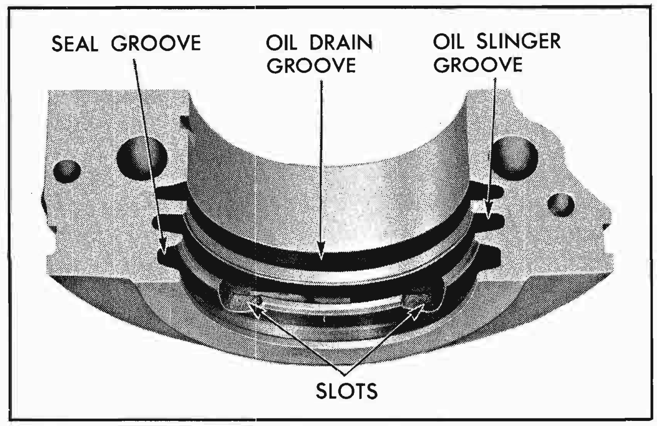


Fig. 6-83 Rear Main Bearing Cap

bearing being checked to force crankshaft against upper half of bearing.

b. Remove bearing cap with plastigage and, using plastigage scale, measure width of flattened piece of plastic. If reading is not over 2½, standard size main bearing should be used; if reading is over 2½, use .001″ undersize bearing and recheck. Main bearing inserts .002″ undersize are available for cases where use of the .001″ undersize bearing results in excessive clearance.

SHIM STOCK METHOD FOR DETERMINING MAIN BEARING CLEARANCE

a. Place .002″ brass shim, ½″ wide by 1″ long in main bearing cap to be checked, using new standard bearing, and install all caps and bearings, pulling up bolts to specified torque given in step 6. Refer to Fig. 6-64 for position of shim in cap.

b. Attempt to rock crankshaft by hand 1″ in either direction.

CAUTION: Do not attempt to move crankshaft more than 1″ in either direction or shim may damage bearing.

c. Repeat test in step "b" without shim. If crankshaft moves freely without shim in place and locks with .002″ shim, the standard bearing is satisfactory. If it is possible to rock the crankshaft freely with the .002″ shim, the .001″ undersize bearing should be used and the fit rechecked. If necessary, recheck with .002″ undersize bearing.

6. After determining that the correct bearing insert has been fitted, tighten all bearing caps to final tightness of 90-110 lb. ft. torque, except rear main bearing cap which should be tightened to 110-130 lb. ft. torque.

NOTE: Before final installation of rear main bearing cap, apply a 1/16" wide bead of sealer on face of rear main bearing cap from packing groove to external cork groove on both sides. (Use suitable crankshaft sealer.) Reinstall cap and tighten to 110-130 lb. ft. torque.

NOTE: Lock washers are not used on main bearing cap bolts.

7. Install camshaft being careful not to damage bearings as camshaft is inserted.

8. Position camshaft thrust plate over camshaft with groove facing block, install attaching bolts with lock washers, and tighten 10-25 lb. ft. torque.

9. Make sure keys are in place in crankshaft and camshaft. Install timing chain and sprockets making sure marks in sprockets are aligned exactly on a straight line passing through the shaft centers (Fig. 6-84).

NOTE: Alignment can be simplified by first installing sprockets without chain to align timing marks. If timing chain is excessively loose, new chain or new chain and sprockets should be used.

10. Position fuel pump eccentric and bushing on camshaft sprocket. Install attaching bolt with retainer and tighten 30-45 lb. ft. torque. Place hammer handle between block and crankshaft counterweight to keep shafts from turning.

11. Coat contact surface of timing chain cover oil seal with special purpose moly grease and install seal on end of crankshaft.

12. Turn engine right side up. Position timing chain cover gasket over studs and against block and install timing chain cover. Insert all but timing chain cover to intake manifold attaching bolts and tighten 20-35 lb. ft. torque. Install nuts on studs but do not tighten.

13. Slide harmonic balancer onto crankshaft, making certain groove in I.D. of balancer is lined up with key on crankshaft, and install harmonic balancer to crankshaft with bolt and washer. With hammer handle in place between block and crankshaft counterweight to keep crankshaft from turning, tighten harmonic balancer to crankshaft bolt 130-190 lb. ft. torque.

14. Remove hammer handle and turn crankshaft so crankpin for rod and piston assemblies to be installed projects straight down.

NOTE: Crankshaft can be turned by means of the harmonic balancer attaching bolt.

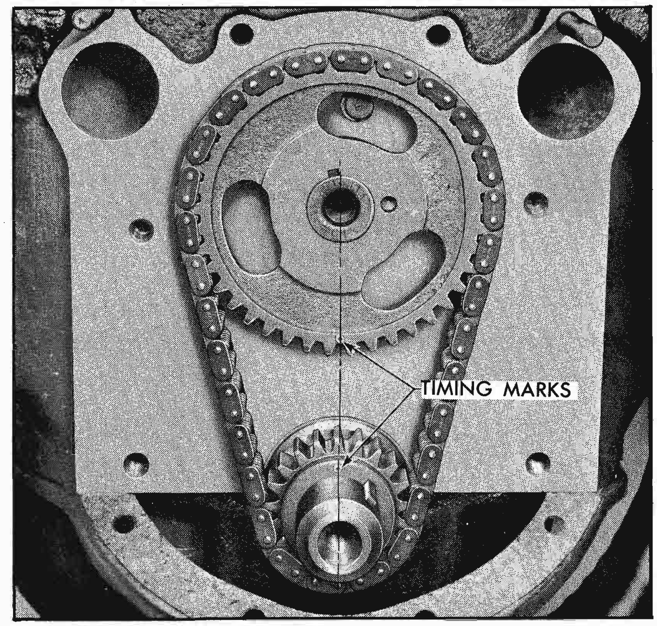


Fig. 6-84 Aligning Valve Timing Marks

15. Install connecting rod bolt guide set J-5239 on connecting rod bolts with long guide on side with oil groove (so it will be toward center of engine when installed.)

16. Install bearing shell in connecting rod.

CAUTION: When installing bearing shells, make sure they are squarely seated in the rod and cap. If care is not used with these relatively narrow bearings, they may be installed slightly askew (bearing not exactly parallel to rod or cap) causing damage or breakage.

17. Using suitable ring compressor, insert connecting rod and piston assembly into bore with "F" on web of piston and notch on top of piston facing front. From beneath engine, use long guide to pull connecting rod into place against crankpin. Remove guide set from connecting rod bolts.

18. Position bearing shell in cap and measure bearing clearance as follows:

CAUTION: Under no circumstances should a bearing cap be filed or shimmed in an effort to effect a fit.

PLASTIGAGE METHOD FOR DETERMINING CONNECTING ROD BEARING CLEARANCE

a. Place a piece of plastigage plastic the length of bearing in bearing (bearing must be free of oil); install bearing and cap and tighten nuts to 40-46 lb. ft. torque. DO NOT TURN CRANKSHAFT WITH PLASTIGAGE IN PLACE.

b. Remove bearing cap. Using plastigage scale, measure width of flattened piece of plastic. If reading is not over 2¼, standard size connecting rod bearing should be used; if over 2¼, use .001″ undersize bearing and recheck. Connecting rod bearing inserts .002″ undersize are available for cases where use of the .001″ undersize bearing results in excessive clearance.

SHIM STOCK METHOD FOR DETERMINING CONNECTING ROD BEARING CLEARANCE

a. Place .0015″ brass shim ½″ wide by ⅞″ long in bearing cap with new standard insert and install cap. Tighten nuts to 40-46 lb. ft. torque.

b. Attempt to move connecting rod endwise on crankpin by hand and then by a light tap of a hammer.

c. Repeat test to move rod endwise by hand with shim removed. If connecting rod did not move by hand, but moved by tap of hammer in step "b" and moved freely in this step, the standard bearing should be used. If rod could be moved by hand in step "b", install .001″ undersize bearing. If necessary, recheck with .002″ undersize bearing.

19. After determining that the correct bearing insert has been fitted, repeat above procedures for remaining piston and rod assemblies and tighten connecting rod cap nuts to final tightness of 40-46 lb. ft. torque. Nuts are self-locking and require no lock washers or cotter pins.

20. Position cylinder block to oil baffle tube and engine oil baffle on engine, install attaching bolts with lock washers and tighten securely (Fig. 6-85).

21. Insert oil pump drive shaft through opening in block and install oil pump assembly, using gasket between pump and block. Use lock washers on attaching bolts and tighten securely.

22. Install new gaskets to oil pan, using retainers and cement rear main bearing cap gasket to cap. Install oil pan and all except the two rear bolts. Position flywheel housing front shield against oil pan and flywheel housing. Install rear two oil pan bolts and four shield to flywheel housing bolts. Tighten oil pan bolts to 10-20 lb. ft. torque.

23. Install each cylinder head as follows:

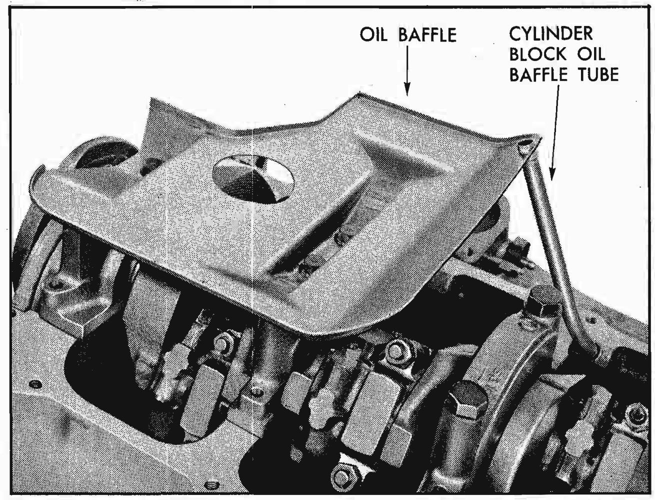


Fig. 6-85 Proper Assembly of Oil Baffle and Tube

a. Position gasket on block, indexing with locating pins (gaskets are interchangeable end for end and side for side).

b. Position cylinder head on gasket, indexing with locating pins.

c. Install cylinder head bolts and tighten evenly to 85-100 lb. ft. torque.

NOTE: Three different length bolts are used. When inserted in the proper holes, all will project the same amount from their respective bosses. Do not use sealer of any kind on threads. Install bolt with integral stud at left front corner of left head (for battery ground cable), and at right rear corner of right head (for radio ground strap).

24. Install lifters in bosses from which they were removed.

25. Install push rods and rocker arms with balls, and start rocker arm nuts.

NOTE: Push rods should be installed in same places they were originally installed and with same end contacting rocker arm.

26. Tighten rocker arm ball retaining nuts to 15-25 lb. ft. torque.

27. Install distributor as follows:

a. Turn crankshaft to firing position of number one cylinder so that number one exhaust and intake valve lifters are both on base circles of their cams (Fig. 6-86) and timing mark on harmonic balancer is indexed with pointer (Fig. 6-87).

NOTE: Number one intake must have just closed.

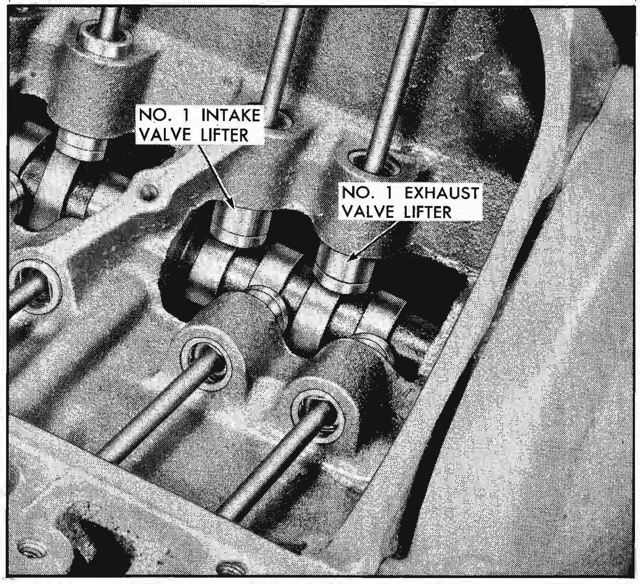


Fig. 6-86 Relationship of Lifters and Cams when Cylinder No. 1 is in Firing Position

b. Position new distributor to block gasket on block.

c. Install distributor (without cap and wires) so that vacuum diaphragm faces the left side of the engine and rotor arm points toward contact in cap for number six cylinder. It will also be necessary to turn the oil pump drive shaft, using a screwdriver, so it will index with distributor shaft. Distributor and rotor will be positioned as shown in Fig. 6-88 when properly installed.

28. Install distributor hold down clamp and special bolt and tighten enough to hold distributor in place.

29. Cement new gasket to push rod cover. Install push rod cover and insert two bolts and flat washers and tighten to 2-7 lb. ft. torque.

30. Cement new gaskets to rocker arm covers and install covers leaving bolts loose. (Some of the bolts will have to be removed later to install wire and pipe clips.)

31. Position new intake manifold gaskets over locating sleeves on cylinder heads and install intake manifold with new O-ring seal, exercising caution to prevent bending locating sleeves.

32. Install intake manifold bolts and nuts using special flat washers under nuts. Install timing chain cover to intake manifold bolt and tighten to 20-35 lb. ft. torque. Tighten remaining intake manifold bolts to 30-45 lb. ft. torque.

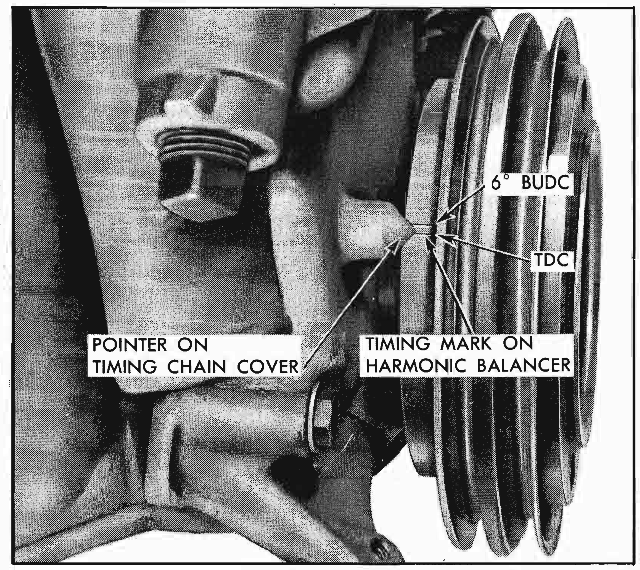


Fig. 6-87 Timing Mark on Harmonic Balancer Aligned with Pointer on Timing Chain Cover

NOTE: On Hydra-Matic models, install throttle control engine bracket under rear screw.

33. Thoroughly clean gasket surfaces of cylinder heads and exhaust manifolds and install both exhaust

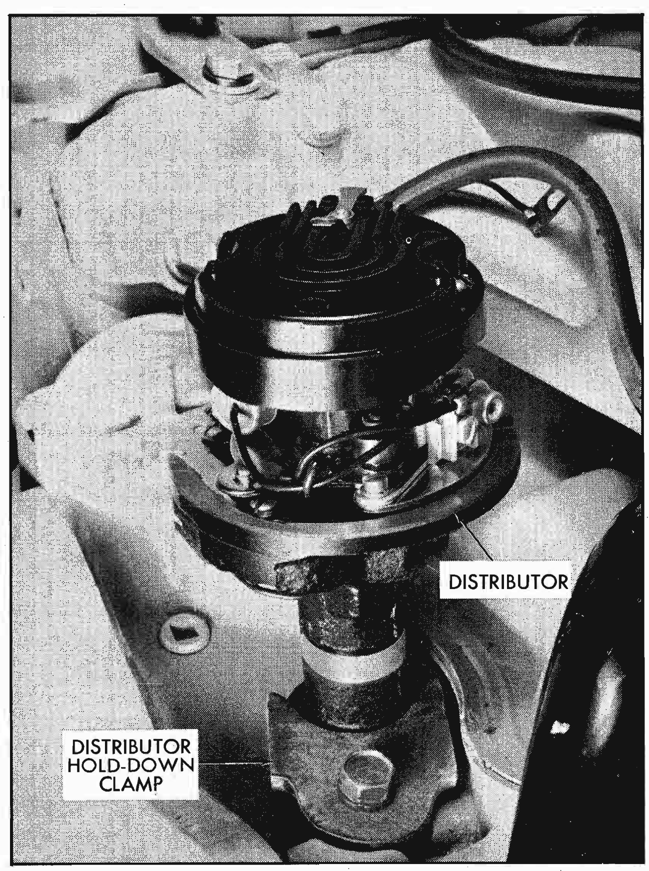


Fig. 6-88 Distributor Properly Installed

manifolds, holding in place loosely with one bolt at each end. Slide new gaskets into place, install remaining bolts and tighten to 20-35 lb. ft. torque.

NOTE: Use new special locks under front and rear pairs of bolts and bend tabs against bolt heads after tightening.

34. Install exhaust crossover pipe using one thick (.135" thick) or two thin (.075" thick) gaskets at each flange. Install flange bolts and tighten securely.

35. Position oil filter on block using new gasket, install attaching bolts using flat washer and lock washer and tighten to 20-35 lb. ft. torque.

36. On engines equipped with crankcase ventilator outlet pipe, oil interior of outlet pipe seal and slide onto pipe. Insert pipe into flange on push rod cover, and slide seal down to cover connection. Slide outlet pipe to cylinder head clamp onto pipe and attach to rear of cylinder head.

37. On engines equipped with positive crankcase ventilation valve, apply soap or rubber lubricant to tapered surface of check valve grommet and install check valve to push rod cover. Install fittings in holes in intake manifold.

38. Attach hoses to fittings, using soap or rubber lubricant, and assemble connector to hoses. Attach retaining bracket with intake manifold bolt and insert hoses.

39. Install carburetor.

40. Install fuel pump on pad on timing chain cover using new gasket (it may be helpful to turn crankshaft to put the fuel pump eccentric at the low point). Install screws with lock washers and tighten securely.

41. Attach fuel filter assembly to left timing chain cover stud and tighten nut 20-35 lb. ft. torque.

42. Attach generator adjusting strap to right timing chain cover stud and tighten nut to 20-35 lb. ft. torque.

43. Install throttle control engine bracket to rear of cylinder head on synchro-mesh models. On cars equipped with Hydra-Matic transmission connect intermediate rod to carburetor throttle rod bracket, and connect cross shaft bracket to flywheel housing.

44. Attach carburetor throttle rod to throttle lever on carburetor.

45. Attach coil and bracket assembly to intake manifold using flat washer and lock washer on each bolt.

46. Connect fuel filter hose to fuel pump.

47. Connect upper fuel filter hose to carburetor fuel line.

48. Tighten rocker arm cover screws to 45-80 lb. in. torque, leaving oil level indicator tube retaining screw loose.

49. Install spark plugs using new gaskets and tighten carefully to 15-25 lb. ft. torque.

50. Install distributor cap with spark plug and coil wires. Connect spark plug wires, coil secondary wire and connect distributor to coil primary wire (connect to negative terminal of coil).

51. Connect hose to vacuum advance diaphragm on distributor.

52. Install pulley and fan on water pump hub. Tighten bolts to 15-25 lb. ft. torque.

53. Install generator.

54. Install drive belts and adjust to proper tension. Refer to page 6A-12. Tighten generator attaching bolts securely.

55. Install oil level indicator tube and tighten remaining rocker arm cover screw 45-80 lb. in. torque.

56. Install oil level indicator.

ENGINE—INSTALL IN VEHICLE

1. Assemble clutch and transmission to engine.

2. Install rear brackets with insulators on transmission extension and install front insulators on engine.

3. Thread ⅜" bolts through ends of short, strong chain and insert in top holes at rear of right and left cylinder heads. Loop heavy chain fall through short chain and connect end of chain fall to lifter plate on timing chain cover.

CAUTION: Bolts at rear of cylinder heads must be drawn up as tightly as possible to prevent pulling out.

4. Very carefully lower engine, clutch and transmission assembly into place in car. Fasten rear extension bracket to frame cross member and fasten front insulator to front cross member.

NOTE: On Hydra-Matic models, it will be necessary to raise the rear of the engine to install the engine support rear cross member. The rear of the engine should be raised by using a special automatic transmission jack under the transmission oil pan.

CAUTION: Do not use jack under engine oil pan.

5. Install propeller shaft.

6. On synchro-mesh models, connect clutch linkage. See ENGINE CLUTCH SECTION.

7. Connect gearshift manual linkage to transmission.

8. Connect exhaust pipe assembly to exhaust manifolds using new gaskets. Use two thin (.075" thick) or one thick (.135" thick) gasket.

9. Connect solenoid wire loom to junction block on left fender skirt, routing loom beneath steering column and around cable guide on cover of power brake unit. Route battery cable in same manner and fasten in clamp on junction block.

10. Install radiator.

11. Connect regulator to generator wires, routing through clips along right rocker arm cover. Connect coil primary lead and install thermogauge unit.

12. Connect power brake vacuum hose to check valve to carburetor pipe, if car is so equipped.

13. Connect flex fuel line to fuel pump. Connect oil pressure warning light wire to switch terminal.

14. Connect upper and lower radiator hoses and heater lines. If Hydra-Matic transmission, connect inlet and outer oil lines to radiator. Connect oil cooler line supports at timing cover.

15. Install carburetor, gasket, fuel and vacuum pipes and hoses.

16. Install power steering pump and belt and adjust belt tension, if car is so equipped.

17. Connect throttle linkage and install carburetor air cleaner.

18. Install battery cable and connect battery cables to battery posts. If new ground cable is installed be sure to connect it to bracket on battery support as well as to the engine.

19. Install radio ground strap.

20. Install hood.

21. Fill cooling system, crankcase, and transmission.

22. Adjust ignition timing, carburetor, and Hydra-Matic linkage.

TROUBLE DIAGNOSIS

ENGINE FAILS TO START

CAUSE:

a. Corroded or loose battery terminal connections and/or weak battery.

b. Broken or loose ignition wires and/or faulty ignition switch.

c. Excessive moisture on plugs, caps or ignition system.

d. Damaged distributor rotor, cracked distributor cap and/or corroded distributor contact points.

e. Fouled spark plugs and/or improper spark plug gap.

f. Weak or faulty coil.

g. Carburetor flooded and/or fuel level in carburetor bowl not correct.

h. Dirt and water in gas line or carburetor.

i. Sticking choke.

j. Faulty fuel pump.

k. Faulty solenoid or starting motor.

l. Park or neutral switch inoperative.

ENGINE MISSES WHILE IDLING

CAUSE:

a. Spark plugs damp or gap incorrectly set.

b. Excessive moisture on ignition wires and caps.

c. Leaks in ignition wiring.

d. Ignition wires making poor contact.

e. Uneven compression.

f. Burned, pitted or incorrectly set contact points.

g. Faulty coil or condenser.

h. Worn distributor cam or cracked distributor cap.

i. Incorrect carburetor idle adjustment and/or dirty jets or plugged passages in carburetor.

j. Foreign matter, such as dirt or water, in gas line or carburetor.

k. Air leak at carburetor mounting gasket.

l. Choke inoperative.

m. Faulty spark advance mechanism.

n. Burned, warped, pitted, or sticking valves.

o. Incorrect valve lifter clearance.

p. Low compression.

ENGINE "LOPES" WHILE IDLING

CAUSE:

a. Air leaks between intake manifold and heads.

b. Blown head gasket.

c. Worn timing chain or sprockets.

d. Worn camshaft lobes.

e. Overheated engine.

ENGINE STALLS

CAUSE:

a. Carburetor idle speed set too low and/or idle mixture too rich or too lean.

b. Carburetor needle valve and seat inoperative.

c. Incorrect carburetor float level and/or carburetor flooding.

d. Dirt or water in gasoline or carburetor.

e. Choke improperly adjusted or sticking.

f. Faulty ignition system.

g. Spark plugs damp or dirty and/or gaps incorrectly set.

h. Faulty coil or condenser.

i. Distributor points burned, pitted, dirty, or incorrectly set.

j. Distributor advance inoperative.

k. Exhaust system restricted.

l. Leaks in carburetor mounting gasket or intake manifold.

m. Incorrect valve lifter clearance.

n. Burned, warped, or sticking valves.

o. Low compression.

p. Engine overheating.

ENGINE HAS NO POWER

CAUSE:

a. Weak coil or condenser.

b. Incorrect ignition timing.

c. Excessive play in distributor shaft or distributor cam worn.

d. Insufficient point dwell.

e. Spark plugs dirty or gaps incorrectly set.

f. Carburetor not functioning properly.

g. Improper carburetor float level.

h. Carburetor fuel mixture too rich or too lean.

i. Foreign matter, such as dirt or water, in gas line or carburetor.

j. Faulty fuel pump.

k. Valve springs weak and/or valves sticking when hot.

l. Burned, warped, or pitted valves.

m. Valve timing incorrect.

n. Incorrect valve lifter clearance.

o. Worn camshaft lobes.

p. Pistons incorrectly fitted in block.

q. Blown cylinder head gasket.

r. Low compression.

s. Flow control valve inoperative (Power Steering).

t. Clutch slipping.

u. Brakes dragging.

v. Engine overheating.

w. Transmission regulator valve sticking (Hydra-Matic).

x. Faulty spark plug wires.

y. Sub-standard fuel.

z. Fuel filter plugged.

ENGINE MISSES AT VARIOUS SPEEDS

CAUSE:

a. Dirt and water in gas line or carburetor.

b. Fouled carburetor jets.

c. Incorrect ignition timing.

d. Points dirty, pitted or incorrectly spaced.

e. Excessive play in distributor shaft.

f. Insufficient spring tension on points.

g. Distributor cam lobe worn.

h. Weak coil or condenser.

i. Spark plugs dirty or damp and/or gaps set too wide.

j. Insufficient point dwell.

k. Detonation or pre-ignition.

l. Heat control valve not functioning properly.

m. Excessively worn fuel pump diaphragm.

n. Weak valve spring.

o. Worn camshaft lobes.

p. Engine overheating.

q. Sub-standard fuel.

EXTERNAL ENGINE OIL LEAKAGE

CAUSE:

a. Improperly seated or broken fuel pump gasket.

b. Improperly seated or broken push rod cover gasket.

c. Improperly seated or broken oil filter gasket.

d. Broken or improperly seated oil pan gasket.

e. Gasket surface of oil pan bent or distorted.

f. Improperly seated or broken timing chain cover gasket.

g. Worn timing chain cover oil seal.

h. Worn or improperly seated rear main bearing oil seal.

i. Loose oil line plugs.

j. Engine oil pan drain plug improperly seated.

k. Rear camshaft bearing drain hole plugged.

l. Loose rocker arm covers, gasket broken, or cover distorted or bent.

OIL BY-PASSING PISTON RINGS

CAUSE:

a. Oil level too high.

b. Excessive main or connecting rod bearing clearance.

c. Piston ring gaps not staggered.

d. Incorrect size rings installed; rings out-of-round, broken, or scored.

e. Insufficient piston ring tension due to engine overheating.

f. Ring grooves or oil return holes clogged.

g. Rings sticking in ring grooves of piston.

h. Compression rings installed upside down.

i. Excessively worn or scored cylinder walls.

OIL PUMPING AT VALVE GUIDES

CAUSE:

a. Intake valve seals damaged or missing.

b. Worn valve stems or guides.

EXCESSIVE OIL CONSUMPTION

CAUSE:

a. Oil pressure too high.

b. Oil level too high.

c. Sludge in engine.

d. Overheated engine.

e. Oil breather caps clogged.

f. Oil too thin.

g. Cylinder head porous between oil gallery and intake ports.

h. Cylinder head gasket leak at oil passage.

i. Intake manifold gaskets leak.

NO OIL PRESSURE WHILE IDLING

CAUSE:

a. Faulty oil gauge.

b. Oil pump not functioning properly. (Regulator ball stuck in position by foreign material).

c. Excessive clearance at main and connecting rod bearings.

d. Loose camshaft bearings.

e. Leakage at internal oil passages.

NO OIL PRESSURE WHILE ACCELERATING

CAUSE:

a. Oil pump not functioning properly.

b. Low oil level in oil pan.

c. Leakage at internal oil passages.

BURNED, STICKING OR BROKEN VALVES

CAUSE:

a. Weak valve springs.

b. Improper valve lifter clearance.

c. Improper valve guide clearance and/or worn valve guides.

d. Out-of-round valve seats or incorrect valve seat width.

e. Deposits on valve seats and/or gum formation on stems or guides.

f. Warped valves or faulty valve forgings.

g. Exhaust back pressure.

h. Improper spark timing.

h. Engine overheating.

i. Fuel of too low octane rating.

NOISY VALVES

CAUSE:

a. Incorrect valve lifter clearance.

b. Excessively worn or faulty valve lifters.

c. Worn valve guides.

d. Excessive run-out of valve seat or valve face.

e. Worn camshaft lobes.

f. Pulled or loose rocker arm studs.

g. Bent push rods.

NOISY PISTONS AND RINGS

CAUSE:

a. Excessive clearance between piston and bore.

b. Improper fit or piston pin.

c. Excessive accumulation of carbon in heads.

d. Connecting rods improperly aligned.

e. Excessive clearance between rings and grooves.

f. Rings broken.

BROKEN PISTONS AND/OR RINGS

CAUSE:

a. Undersize pistons installed.

b. Wrong type and/or size rings installed.

c. Cylinder bores tapered or eccentric.

d. Connecting rods improperly aligned.

e. Excessively worn ring grooves.

f. Rings improperly assembled.

g. Insufficient ring gap clearance.

NOISY CONNECTING RODS

CAUSE:

a. Connecting rods improperly aligned.

b. Excessive bearing clearance.

c. Eccentric or out-of-round crankshaft journals.

d. Insufficient oil supply.

e. Low oil pressure.

f. Connecting rod bolts not tightened correctly.

NOISY MAIN BEARINGS

CAUSE:

a. Low oil pressure and/or insufficient oil supply.

b. Excessive bearing clearance.

c. Excessive crankshaft end play.

d. Eccentric or out-of-round crankshaft journals.

e. Sprung crankshaft.

f. Excessive belt tension.

g. Loose harmonic balancer.

NOISY VALVE LIFTERS

CAUSE:

a. Broken valve springs.

b. Worn or sticking rocker arms.

c. Worn or bent push rods.

d. Valve lifters incorrectly fitted to bore size.

e. Faulty valve lifter plunger or push rod seat.

f. Plungers excessively worn causing fast leak-down under pressure.

g. Excessively worn camshaft lobes.

h. Valve lifter oil feed holes plugged causing internal breakdown.

i. Faulty valve lifter check ball. (Nicked, flat spot, or out of round.)

j. Rocker arm retaining nut installed upside down.

k. End of push rod excessively worn or flaked.

SPECIFICATIONS

Type	90° V-8 O.H. Valve
Bore and Stroke	4 1/16" x 3 3/4"
Piston Displacement	389 cu. in.
Taxable Horsepower	52.8
Compression Ratio—Hydra-Matic Transmission	10.25:1
Compression Ratio—Synchro-Mesh Transmission	8.6:1
Compression Ratio—Special	10.75:1

HORSEPOWER AND TORQUE	S.M.	H.M. (Exc. 425E or 425A) Roto Hydra-Matic	Super Hydra-Matic	425A	425E (with H.M. Only)
Brake Horsepower— 2 Barrel Carb.	215 @ 3600 rpm	267 @ 4200 rpm	—	—	230 @ 4000 rpm
Torque (lb. ft.)— 2 Barrel Carb.	390 @ 2000 rpm	405 @ 2400 rpm	—	—	380 @ 2000 rpm
Brake Horsepower— 4 Barrel Carb.	235 @ 3600 rpm	287 @ 4400 rpm	303 @ 4600 rpm	333 @ 4800 rpm	—
Torque (lb. ft.)— 4 Barrel Carb.	402 @ 2000 rpm	417 @ 2400 rpm	425 @ 2800 rpm	425 @ 2800 rpm	—
Brake Horsepower— 3 x 2 Barrel Carb.	318 @ 4600 rpm	318 @ 4600 rpm	318 @ 4600 rpm	348 @ 4800 rpm	—
Torque (lb. ft.)— 3 x 2 Barrel Carb.	430 @ 3200 rpm	430 @ 3200 rpm	430 @ 3200 rpm	430 @ 3200 rpm	—

Compression Pressure at Cranking Speed .... 140-150 psi @ 155-165 rpm
(8.6:1 Compression Ratio—Regular fuel, economy engine and standard S.M. transmission)

Compression Pressure at Cranking Speed .... 155-165 psi @ 155-165 rpm
(10.25:1 Compression Ratio—premium fuel in H.M. except economy and special engines)
(10.75:1 Compression Ratio—triple two barrel and special high output engines)

Firing Order	1-8-4-3-6-5-7-2
Car-Engine Serial No. Location	Front Face of Right Cylinder Bank
Production Engine No. Location	Front Face of Right Cylinder Bank
Cylinder Nos.—Front to Rear	
Left Bank	1-3-5-7
Right Bank	2-4-6-8

CAMSHAFTS

Material	Alloy Cast Iron
Journal Diameter	1.8987-1.8997
Bearing—Inside Diameter (after line reaming)	1.9012-1.9017
Bearing Length	
Front	1.060
All others	.680
Bearing Clearance	.0015 to .0030
End Play	.003-.007

CONNECTING RODS

Length, center to center	6.63
Lower end bearing, inside diameter and length	2.2507-2.2517 x 7/8"
Bearing clearance on crank pin—limits when new	.0005-.0025
End play of connecting rod on crank pin	.006 to .011

CRANKSHAFTS

Material	Pearlitic Malleable Iron
Journal Diameter	3.000
Bearing Length—bearing shell, including chamfer	
Front	15/16"
Front Center	15/16"
Center	15/16"
Rear Center Including Thrust Flanges	1.133-1.135
Rear	1.590
Thrust Taken On	Rear Center
Crank Pin Diameter	2.2492-2.2502
Journal and Pin Maximum Out of Round and Taper	.00025
Thrust Bearing End Play—Limits When New	.0035-.0085
Main Bearing Clearance—Limits When New	Front .0005-.0025
	Front center, Center, Rear center and Rear .0005-.003

FLYWHEEL

Teeth on ring	176
Teeth on starter pinion	9

PISTONS AND CYLINDERS

Cylinder bore out-of-round and taper when new	.001
Piston material	Aluminum Alloy
Piston clearance in cylinder—Standard	.0007 to .0013
Piston clearance in cylinder 425A, police, synchro-mesh tri-power	.0022 to .0027
Piston fit using 1/2" x .0015 feeler	8-15 lbs. pull
Piston ring gap	
Compression rings	
Upper	.016-.026
Lower	.013-.025
Oil Ring Segments	.015-.035
Piston ring to groove clearance	
Compression rings	
Upper	.0015 to .0030
Lower	.0015 to .0035
Oil Ring Assembly	.0015 to .0085

PISTON PINS

Fit in piston	.0003 to .0005 loose with piston and pin at 70°F.
Fit in rod	.0008 to .0016 press
Diameter (selective)	.9800 to .9804
Length	3.250

TIMING CHAIN

Camshaft sprocket material	Cyanide hardened cast iron (cylinder iron)
Crankshaft sprocket material	Case hardened steel—SAE 1020 or 1022
Number of links in chain	60

VALVES

Material	
Intake	G.M. Manganese Molybdenum Steel
Exhaust	G.M. T-XCR Steel
Head Diameter	
Intake	1.88
Exhaust	1.60
Stem Diameter	
Intake	.3407-.3414″
Exhaust	.3402-.3409″
Seat Angle	
Intake	30°
Exhaust	45°
Fit of stem in guide (new)	Intake .0021 to .0038 Exhaust .0026 to .0043
Valve Lift	Standard Synchro-Mesh—All Series .33 23 and 25 Series Hydra-Matic and 425E Option .37 26, 27 and 28 Series Hydra-Matic and Tri-Power Carb. Option .40 425A Engine Option .40

VALVE LIFTER

Diameter	.8424-.8427
Clearance in boss	.0013 to .0028
Length—overall	2.000
Leak-down rate	12-60 seconds with 50 lb. load
Plunger travel (for gauging purposes)	.125 (1/8″)

VALVE SPRINGS

	Roto and Super HYDRA-MATIC and 425E	HEAVY DUTY	SYNCHRO-MESH
OUTER			
Spring Pressure	60 @ 1.52	62 @ 1.52	
and Length	114 @ 1.12	131 @ 1.12	
			80 @ 1.53
INNER			171 @ 1.20
Spring Pressure	26 @ 1.48	32 @ 1.48	
and Length	64 @ 1.08	96 @ 1.08	

WRENCH TORQUE SPECIFICATIONS

Note: Torque in lb. ft. unless otherwise shown.

TORQUE	SIZE	APPLICATION
		Cylinder Block—Bearing and Caps
90-110	1/2-13	Bolt—Main Brg. Cap to Block (Exc. Rear Main)
110-130	9/16-12	Bolt—Rear Main Brg. Cap to Block
		Cylinder Head
85-100	1/2-13	Bolt—Cylinder Head and Battery Ground
85-100	1/2-13	Bolt—Cylinder Head
		Clutch Housing and Cover
10-20	5/16-18	Bolt—Clutch Housing Bottom Cover
30-45	7/16-20	Bolt—Clutch Fork Bolt to Clutch Housing
10-20	5/16-18	Bolt—Clutch Housing Cover Shield to Housing
		Harmonic Balancer
15-25	5/16-24	Bolt—Harmonic Balancer Weight Assy. to Pulley
130-190	5/16-18	Bolt—Harmonic Balancer Assembly to Crankshaft
		Flywheel
85-100	1/2-20	Bolt—Flywheel Assembly to Crankshaft
40-55	7/16-14	Bolt—Flywheel Housing to Cylinder Block
		Connecting Rods—Pistons—Rings
40-46	3/8-24	Nut—Connecting Rod and Bushng Assy. Cap to Rod
		Oil Pan
10-20	5/16-18	Bolt—Engine Oil Baffle to Bearing Cap
8-15	5/16-18	Bolt—Oil Pan to Cylinder Block
10-20	5/16-18	Bolt—Oil Pan to Cyl. Blk. (Also Att. Clutch Hsg. Cover)
18-25	1/2-20	Screw—Oil Pan Drain (Plug)
		Oil Pump, Pressure Reg. and Oil Screen
10-20	5/16-18	Bolt—Engine Oil Pump Cover to Body
8-18	3/4-16	Retainer—Oil Pump Pressure Reg. Spring
20-35	3/8-16	Bolt—Engine Oil Pump Assembly to Block
		Oil Filter Pad Cover
20-35	3/8-16	Bolt—Oil Filter Assy. to Block
20-35	3/8-16	Bolt—Oil Filter Pad Cover to Block
		Crankcase Ventilator
20-35	3/8-16	Bolt—Crankcase Vent. Outlet Pipe Brkt. to Cyl. Hd.
25-85 Lb.In.	1/4-14	Screw—Crankcase Vent. Outlet Pipe Brkt. to Pipe
25-85 Lb.In.	1/4-14	Screw—Crankcase Vent. Outlet Air Cleaner to Pipe Clamp

Note: Torque in lb. ft. unless otherwise shown.

TORQUE	SIZE	APPLICATION
		Timing Chain Cover
20-35	3/8-16	Bolt—Timing Chain Cover to Cyl. Block
*	3/8-24	Stud—Timing Chain Cover to Block (Block End)
20-35	3/8-16	Nut—Timing Chain Cover to Block (Stud)
10-20	5/16-18	Bolt—Timing Chain Cover to Intake Manifold Seal Clamp
		Engine Fan and Pulley
15-25	5/16-24	Bolt—Fan and Pulley to Water Pump Shaft Flange
		Water Pump
*	5/16-24	Stud—Water Pump to Timing Chain Cover (Cover End)
10-25	5/16-24	Nut—Water Pump to Timing Chain Cover (Stud)
		Thermostat and Water Outlet Fitting
20-35	3/8-16	Bolt—Intake Manifold Water Outlet Fit. to Manifold
		Manifold—Intake and Exhaust
*	3/8 NPSF	Plug—Intake Manifold Heater Hole
30-45	3/8-16	Bolt—Intake Manifold Assy. to Cyl. Head
20-35	3/8-16	Bolt—Exhaust Manifold to Cyl. Head
		Carburetor and Automatic Choke
*	5/16-18	Stud—Carb. to Manifold (Manifold End)
10-25	5/16-24	Nut—Carb. to Manifold (Stud)
10-25	5/16-18	Bolt—Tube and Plate Assy. to Manifold
*	1/4 (Tube)	Nut—Carburetor to Manifold to Tube (To Carb.)
		Carburetor Air Cleaner and Silencer
10-20 Lb. In.	1/4-20	Stud—Air Cleaner and Silencer to Carb.
10-20 Lb. In.	1/4-20	Nut—Air Cleaner and Silencer to Carb.
		Fuel and Vacuum Pump and Pipes
5-15 Lb. In.	No. 10-12	Screw—Fuel Filter to Carb. Pipe Brkt. (To Pipe)
20-35	3/8-16	Bolt—Fuel Filter to Carb. Pipe Brkt. (To Cyl. Head)
*	3/8 (Tube)	Nut—Fuel Filter to Carb.
15-30	3/8-16	Bolt—Fuel Pump to Timing Chain Cover
*	1/4 NPTF	Fitting—Fuel Pump Fuel Hose (Outlet)
		Accelerator Control
60-120 Lb. In.	1/2-28	Bolt—Accelerator Control Lever Housing Cover to Housing
60-120 Lb. In.	1/4-28	Bolt—Accelerator Throttle Cont. Rod Ext. to Carb.
30-60 Lb. In.	1/4-28	Nut—Carb. Throttle Rod Adj. Jam
60-120 Lb. In.	1/4-20	Screw—Accel. Pedal Mounting Ball Stud Bracket

NOTE (*) Torque not a requirement, other means of control and/or specifications are used, checked for alignment, bottoming, height and/or leaks.

Note: Torque in lb. ft. unless otherwise shown.

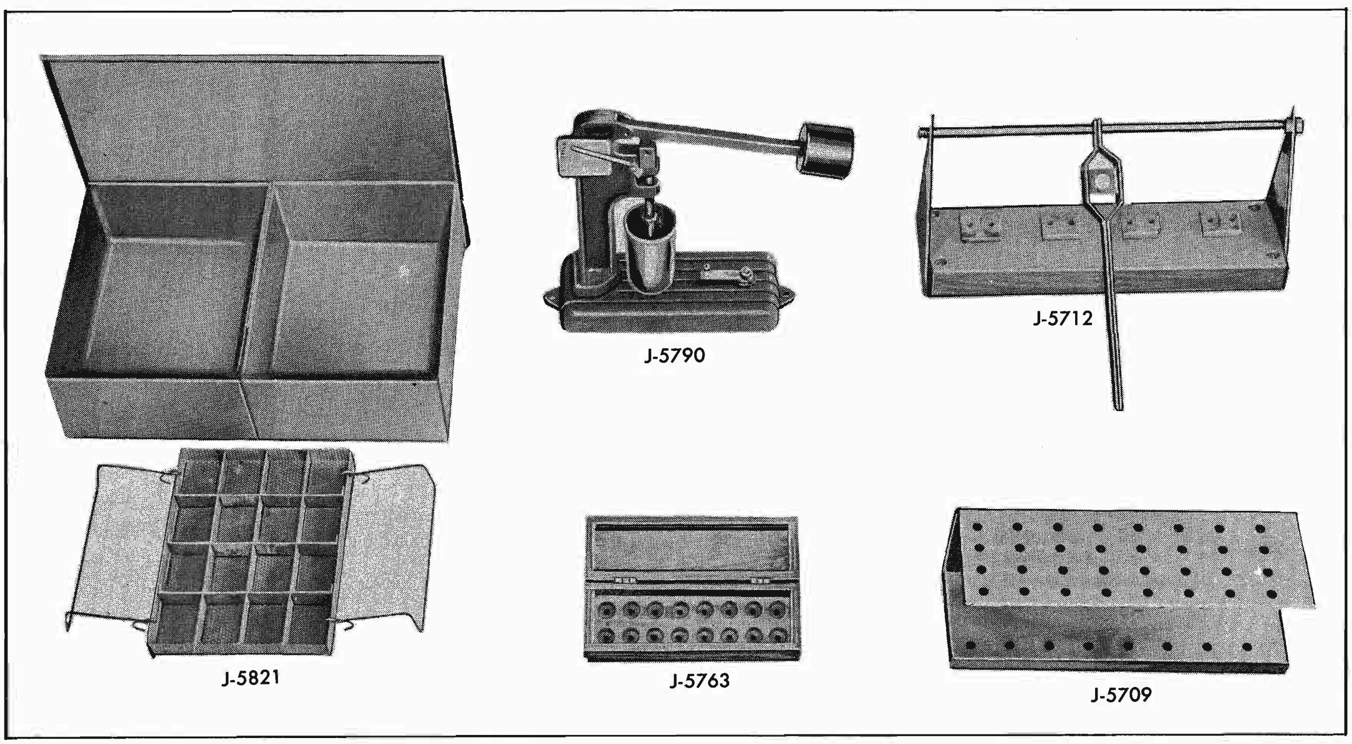
TORQUE	SIZE	APPLICATION
		Engine to Frame Mounting
25-35	3/8-24	Bolt—Rear Bearing Retainer Mounting Bracket Clamping
15-25	3/8-16	Bolt—Engine Rear Cross Member Frame Insulator
40-55	1/2-20	Bolt—Engine Front Insulator Assy. to Support Bracket
15-25	3/8-16	Bolt—Engine Rear Mounting Insulator Assy. to Bearing Retainer
40-55	7/16-14	Bolt—Engine Front Support Insulator to Engine
25-35	3/8-24	Nut—Engine Rear Mount Support Bracket to Cross Member
25-35	3/8-24	Bolt—Engine Rear Insulator Assy. to Mounting Bracket
15-25	3/8-16	Bolt—Rear Bearing Retainer Mounting Bracket to Bearing Retainer
25-35	3/8-24	Nut—Engine Rear Mounting Insulator to Cross Member Bracket
		Clutch Assembly
20-35	3/8-16	Bolt—Clutch Cover and Pressure Plate Assy. to Flywheel (SMT)
		Clutch Control
60-120 Lb. In.	3/8-24	Nut—Clutch Pedal Rod Trunnion Jam
20-35	3/8-16	Bolt—Clutch Control Countershaft Brkt. (To Frame)
*	3/8-24	Nut—Clutch Fork Countershaft Rod Adjusting
60-120 Lb. In.	3/8-24	Nut—Clutch Fork Countershaft Rod Adj. Nut Jam
60-120 Lb. In.	3/8-16	Nut—Clutch Control Silencer Bumper Screw Jam
30-36	1/2-20	Bolt—Clutch Fork Ball to Flywheel Housing
60-120 Lb. In.	No. 10-12	Screw—Clutch Pedal Stop to Body Floor
30-45	7/16-20	Bolt—Clutch Fork Ball to Flywheel Housing
		Camshaft and Drive, Valves and Valve Cover
25-70 Lb. In.	5/16-18	Bolt—Valve Push Rod Cover Assy. to Block
10-25	5/16-18	Bolt—Camshaft Thrust Plate to Block
30-45	1/2-20	Bolt—Camshaft Sprocket to Camshaft
		Valve Rocker Arms and Covers
45-80 Lb. In.	5/16-18	Bolt—Valve Rocker Arm Cover to Head
15-25	3/8-24	Nut—Valve Rocker Arm Ball Retainer
		Generator and Voltage Regulator
15-25 Lb. In.	No. 10-32	Fuse, Screw and Clip Assy.—Reg. To Battery
20-30	5/16-24	Bolt and Nut—Gen. to Support and Brkt.
60-80	1/2-20	Nut—Generator Mounting Brkt. to Cyl. Head Bolts
25-50 Lb. In.	No. 12-24	Nut—Generator Terminal
10-35 Lb. In.	1/4-20	Bolt—Generator Current and Voltage Reg. to Dash
15-25	5/16-18	Bolt—Generator Adj. Strap to Generator
20-35	3/8-24	Bolt and Nut—Generator Frt. Support to Gen. Brkt.
20-35	3/8-16	Bolt—Gen. Front Support to Cylinder Head
20-35	3/8-24	Bolt and Nut—Generator Brace to Gen. Brkt.
20-35	3/8-24	Nut—Gen. Mounting Brkt. Brace to Cyl. Head Bolt
		Starting Motor and Control
20-45	7/16-14	Bolt—Starting Motor to Clutch Housing
10-15 Lb. In.	No. 8-32	Nut—Ignition Switch (Starter Switch) Wire to Solenoid
60-120 Lb. In.	3/8-16	Nut—Battery Cable to Junction Block Terminal

NOTE (*) Torque not a requirement, other means of control and/or specifications are used, checked for alignment, bottoming, height and/or leaks.

Note: Torque in lb. ft. unless otherwise shown.

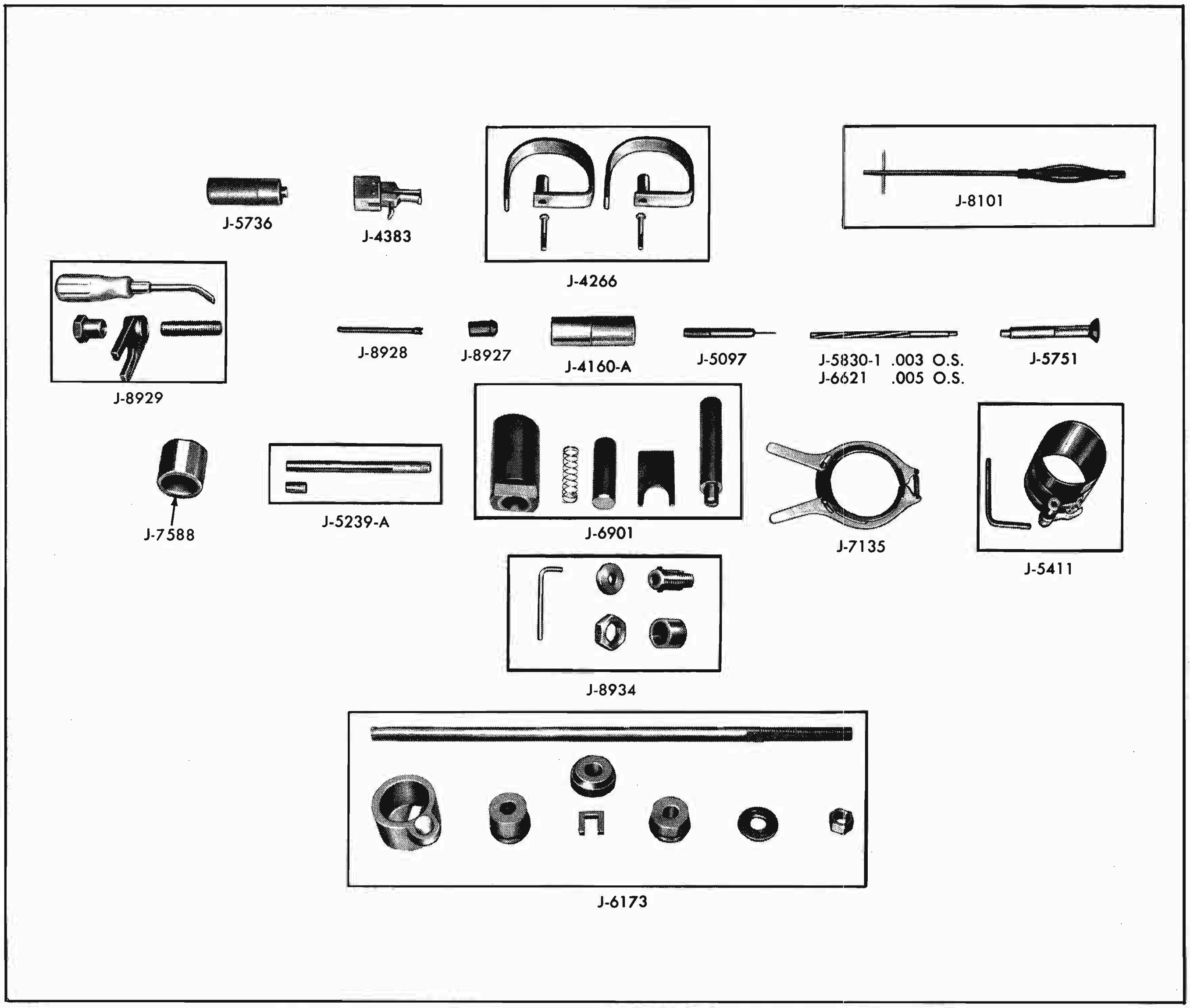
TORQUE	SIZE	APPLICATION
		Distributor
15-25	3/8-16	Screw and L/W Assy.—Dist. Hold-Down Clamp to Cyl. Blk.
		Ignition Switch, Coil Wires and Spark Plugs
10-20	5/16-18	Screw—Spark Plug Wires Brkt.—RH (To Intake Manifold)
20-35	3/8-16	Bolt—Spark Plug Wires Brkt.—LH (To Intake Manifold)
50-80 Lb. In.	No. 14-10	Bolt—Ignition Coil Assy. to Dash
5-15 Lb. In.	1-32	Ferrule—Ignition and Starter Switch to Instrument Panel
15-25	14 MM	Plug Assembly—Spark
		Transmission Gear Set and Case
45-60	1/2-13	Bolt—Transmission Assy. to Clutch Housing
40-60	7/16-14	Bolt—Clutch Housing to Block
		Exhaust Pipe
15-25	3/8-24	Bolt—Crossover Pipe to RH Manifold
10-15	5/16-24	Nut—Exhaust Pipe to Muffler
10-15	5/16-24	Nut—Exhaust Pipe to Conn.

SPECIAL TOOLS



J-5709 Valve and Valve Train Holding Stand
J-5712 Cylinder Head Holder and Valve Spring Compressor
J-5763 Hydraulic Valve Lifter Storage Box
J-5790 Hydraulic Valve Lifter Tester
J-5821 Hydraulic Valve Lifter Solvent Tank and Tray

SPECIAL TOOLS



J-4160-A Hydraulic Valve Lifter Plunger Remover

J-4266 Cylinder Head Lifting Hooks

J-4383 Clutch Pilot Bearing Remover

J-5097 Hydraulic Valve Lifter Plunger Unloading Tool

J-5239-A Connecting Rod Bolt Guide Set

J-5411 Piston Ring Compressor

J-5736 Clutch Pilot Bearing Installer

J-5751 Intake and Exhaust Valve Stem Seal Installer and Tester

J-8101 Valve Guide Cleaner

J-5803-1 Valve Guide Reamer .003 oversize

J-6621 Valve Guide Reamer .005 oversize

J-6173 Camshaft Bearing Remover and Replacer

J-8927 Rocker Arm Stud Installer

J-8928 Valve Train Gauge

J-8929 Valve Spring Compressor Set

J-8934 Rocker Arm Stud Remover

J-6901 Piston Pin Remover and Replacer Set

J-7135 Piston Ring Remover and Replacer

J-7588 Rear Main Bearing Oil Seal Installer

ENGINE COOLING AND LUBRICATION

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

ENGINE COOLING SYSTEM

The cooling system consists of the radiator core, water pump, cooling fan, pellet type thermostat and suitable passages for water circulation through the engine (Fig. 6A-1).

RADIATOR

Four different type radiators are used on all models, with the exception of Grand Prix. These are:

1. Radiator for cars equipped with Hydra-Matic transmission.

2. Radiator equipped with Hydra-Matic heavy duty oil cooler for taxi and police cars, and heavy duty chassis.

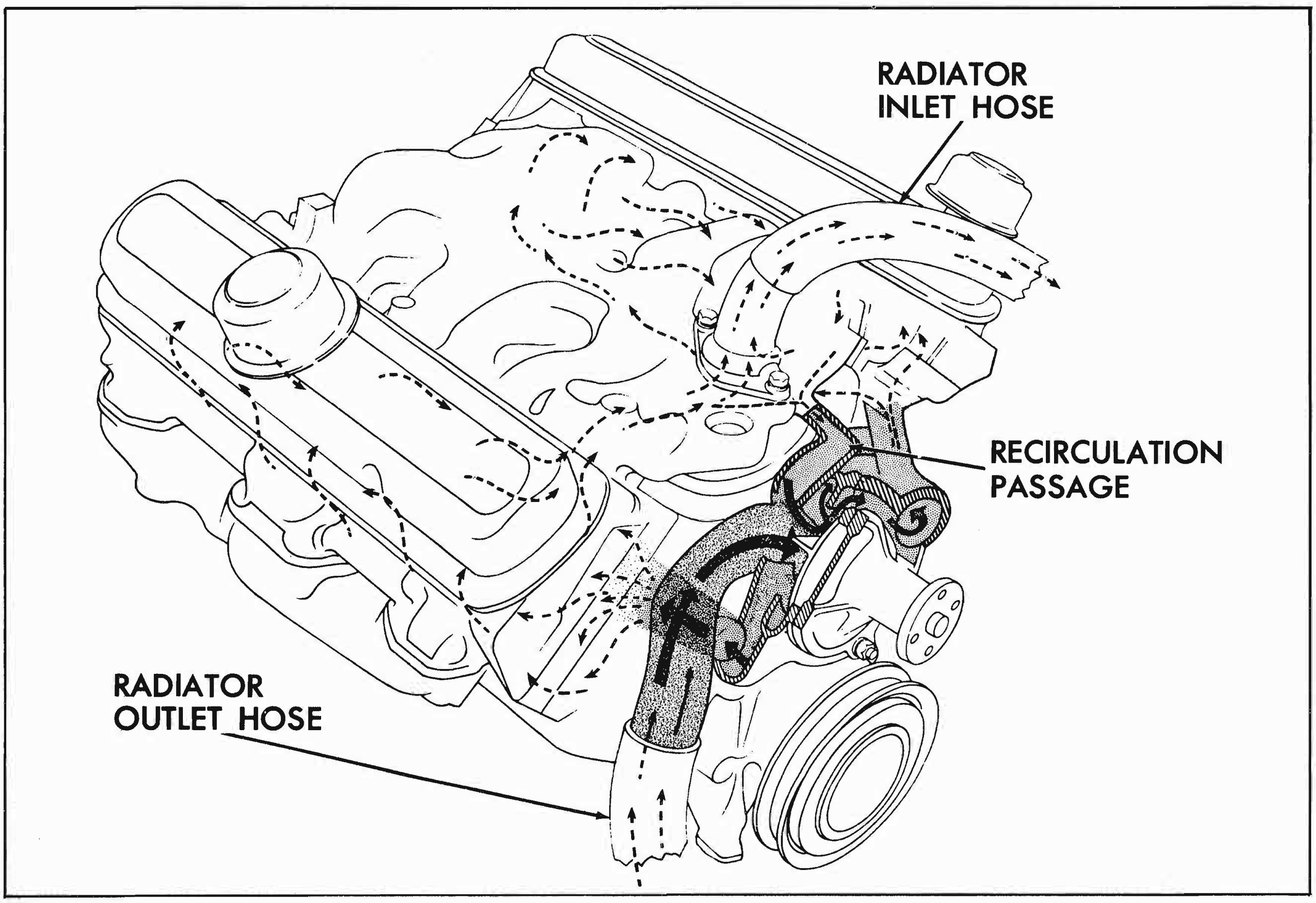


Fig. 6A-1 Engine Cooling System

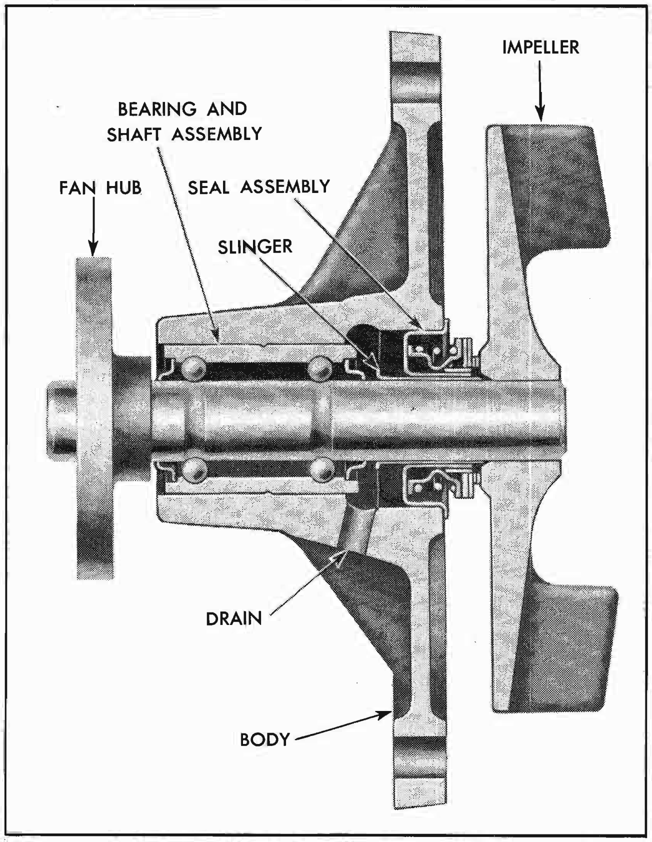


Fig. 6A-2 Cross Section of Water Pump

3. Radiator for synchro-mesh transmission.

4. Radiator for cars equipped with air conditioning.

The Grand Prix utilizes three different radiators. These are:

1. Radiator for models equipped with Hydra-Matic transmission.

2. Radiator for models equipped with synchro-mesh transmission.

3. Radiator for models equipped with air conditioning.

Hydra-Matic transmission radiators have oil coolers built into the lower tank with inlet and outlet fittings for circulation of transmission fluid. The Hydra-Matic transmission radiator equipped with the heavy duty oil cooler is for use on police cars, taxicabs, etc. as optional equipment where extreme cooling conditions must be met.

The radiator used with the synchro-mesh transmission is the conventional type, while cars equipped with air conditioning use a radiator which has more cooling capacity for the greater cooling demands.

The radiators are of the down-flow tube and center type and are constructed of copper. A drain cock is located on the bottom tank of the radiator.

A pressure-vent type cap is used on the radiator to allow a build-up of 13 psi of pressure in the cooling system. This pressure raises the boiling point of water from 212°F. to approximately 245°F. at sea level. Cars equipped with air conditioning, synchro-mesh transmission or 425E engine use a 15 psi vent type cap. This pressure raises the boiling point of water from 212°F. to approximately 250°F. at sea level.

CAUTION: As long as there is pressure in the cooling system, the temperature can be considerably higher than the boiling temperature of the solution in the radiator without causing the solution to boil. Removal of the radiator cap while the engine is hot and the pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over the engine, fenders, and the person removing the cap. If the solution contains inflammable anti-freeze, such as alcohol, there is also the possibility of causing a serious fire. When removing filler cap, rotate cap toward left very slowly; if hissing of vapor is encountered, tighten cap immediately and wait for system to cool sufficiently to allow removal of cap. After pressure in the system has been relieved, turn cap more forcibly to left and remove. Turn cap all the way to the right when installing. It should not be necessary to check coolant level unless temperature gauge shows over-heating, and then not until engine is stopped and allowed to cool to normal.

FAN

The fan is used to increase the air flow through the radiator at low speeds. In addition, it forces air into the cranckcase ventilator inlets on top of the rocker arm covers to provide air flow for crankcase ventilation.

All cars except those equipped with air conditioning have a fan which has four blades which are unevenly spaced and have curled tips to provide minimum noise. A seven bladed fan is used on cars with air conditioners.

A fan shroud is used to prevent recirculation of air around the fan on air conditioned cars.

WATER PUMP

A centrifugal type water pump is used to circulate the water through the system. The water pump impeller turns on a steel shaft mounted on a double-row, permanently lubricated sealed ball bearing (Fig. 6A-2). A bellows type seal is seated in the water pump body between the bearing and the impeller.

The seal surface is a phenolic washer which is held by the spring loaded bellows against a machined surface on the impeller.

The inlet side of the pump is connected to the lower radiator tank by means of a hose. A small recirculation passage connects the water leg of the intake manifold to the timing chain cover (which acts as the pump body) to provide recirculation of water when the thermostat is closed. (See Fig. 6A-1.)

THERMOSTAT

A pellet type thermostat (Fig. 6A-3) is used in the water outlet passage in the intake manifold to control the flow of coolant, providing fast engine warm up and regulating coolant temperatures. A wax pellet, or power element, in the thermostat expands when heated and contracts when cooled. The pellet is connected through a piston to a valve and when the pellet is heated, pressure is exerted against a rubber diaphragm which forces the valve to open. As the pellet is cooled, the contraction allows a spring to close the valve (Fig. 6A-3). Thus, the valve remains closed while the coolant is cold, preventing circulation of coolant through the radiator, but allowing coolant to circulate throughout the engine to warm it quickly and evenly.

As engine becomes warm, the pellet expands and the thermostat valve opens permitting the coolant to flow through the radiator where heat is passed through the radiator walls. This opening and closing of the thermostat valve permits enough coolant to enter the radiator to keep the engine within specified temperature limits.

Engine thermostat control temperatures vary as coolant anti-freeze mixtures vary; therefore, a 170°F thermostat is installed as standard equipment and is used in connection with glycol type anti-freeze; however, if alcohol type anti-freeze is used, a 160°F thermostat must be used.

The chart in Fig. 6A-4, is a typical engine coolant temperature curve for a 180°F. thermostat when the engine is operated at a constant speed of 25 mph and 0°F. air is the ambient temperature. A bench check would show that a 180°F. thermostat would start to open between 177°F. and 182°F. and, if continued to be warmed, it would have a minimum opening of .380" at 202°F.

NOTE: Higher temperature thermostats will not provide faster warm up, since their valves remain tightly closed until the control temperatures are reached.

COOLING SYSTEM CIRCULATION

Water circulation is provided by a single impeller, specially designed water pump which provides a balanced flow of water into each bank of the cylinder block.

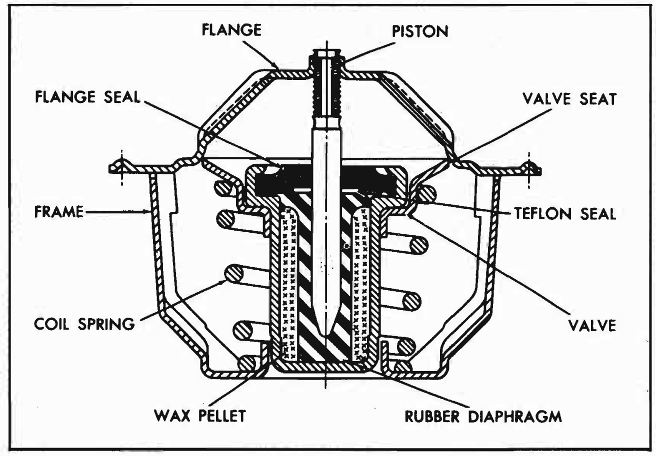


Fig. 6A-3 Pellet Type Thermostat

Water circulation during warm-up (thermostat closed) is from the pump to each bank of the cylinder block, up into the cylinder heads, into the front of the intake manifold, and back to the inlet of the pump via an internal recirculation passage connecting the intake manifold and timing chain cover which acts as pump body (Fig. 6A-1).

Water circulation after normal operating temperatures are reached (thermostat open) takes two courses. Part of the water will always recirculate as outlined above. A major portion of the water, however, will circulate into the intake manifold as outlined above, but will then pass directly into the radiator via the outlet passage and hose above the thermostat and thence back to the pump inlet.

The water pump and the water transfer holes between the block and cylinder heads have been designed to provide an equitable flow of coolant, and

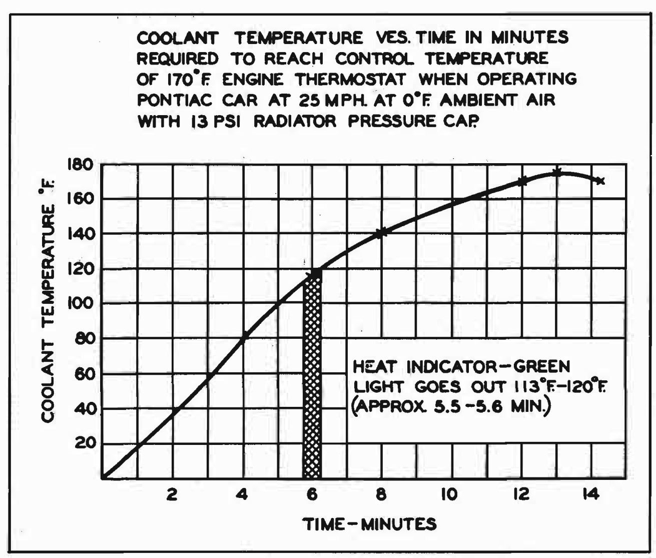


Fig. 6A-4 Thermostat Heat Chart

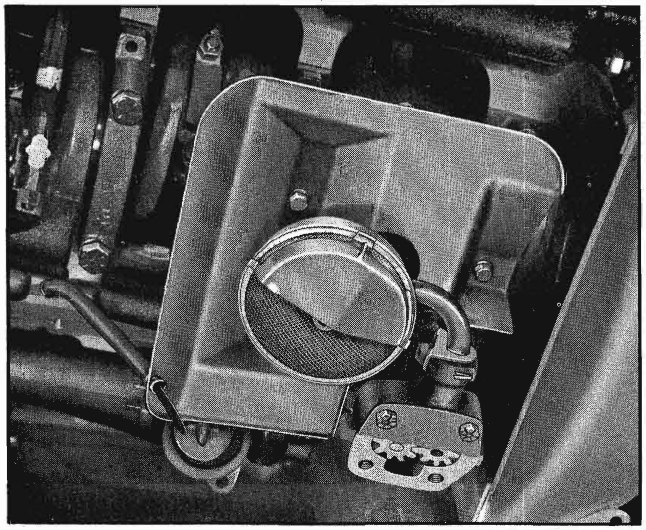


Fig. 6A-5 Oil Pump and Intake

provide temperature balance in both banks of the engine and within each bank and its cylinder head.

ENGINE LUBRICATION SYSTEM

OIL PUMP

Oil is circulated under pressure by a spur gear type pump. The pump is mounted on the right rear bottom of the cylinder block (Fig. 6A-5) and is driven by the distributor drive gear. Maximum oil pressure is regulated by a spring-loaded, ball type, pressure regulator valve. No adjustment of the pressure regulator valve is provided.

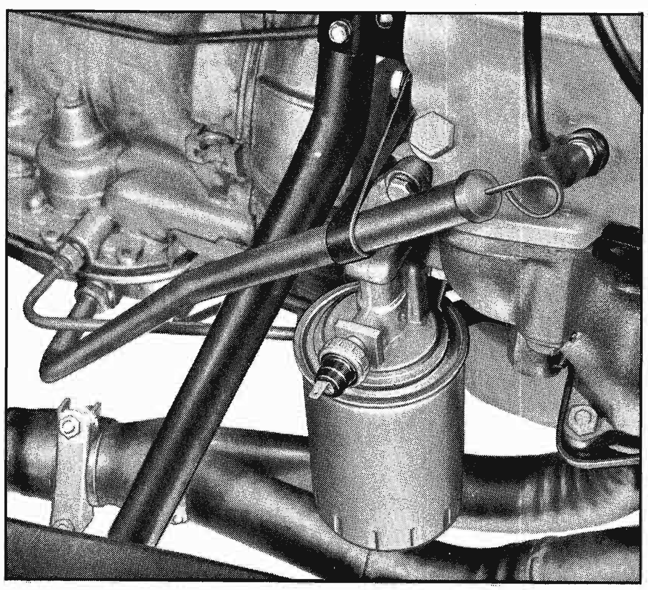


Fig. 6A-6 Oil Filter

Oil is taken into the pump through a floating type oil intake. By allowing the intake to float, only the cleanest oil, which lays near the surface is pumped through the engine. All oil entering the floating intake passes through a screen. As a safety precaution a large hole is provided in the middle of the screen. During normal operation no oil can pass through this hole since the grommet around the hole is seated against the baffle. If the screen should become plugged, however, pump suction will cause the screen to move away from the baffle, and oil will flow through the large center hole.

OIL FILTER

A full flow oil filter is used on the engine (Fig. 6A-6). The filter is mounted on a machined boss on the right rear side of the engine block.

All oil from the pump passes through the filter before going to the engine oil galleries. In the filter the oil passes through a filtering element where all dirt and foreign particles are removed.

A by-pass valve is located in the filter base casting to insure ample lubrication in case the filter element becomes restricted. Thus, if required, oil will flow directly from the inlet through the spring loaded by-pass valve to the outlet without any possibility of washing accumulated dirt off the filter element.

OIL CIRCULATION

The positive pressure system delivers oil under pressure to the crankshaft, connecting rods, and camshaft bearings and to the valve train parts. Each cylinder wall is lubricated by a metered jet from the groove in the opposite connecting rod. Splash from the jet and off the crankshaft lubricates piston pins and bushings. Timing chain and sprockets receive metered jet lubrication as do the fuel pump eccentric and rocker arms. A hole in the block from the push rod gallery through the distributor boss lubricates the distributor shaft and bushings.

Oil flow through the engine is as follows (Fig. 6A-7): Oil is first supplied by the pump and filter to two parallel oil galleries drilled in the block on each side of the camshaft. Oil travels from rear to front in the left gallery and from front to rear in the right gallery. The rear crankshaft and camshaft bearings receive oil from a hole drilled through the passage connecting the filter to the left gallery. All other crankshaft bearings receive oil from holes drilled to the left hand gallery. The remaining four camshaft bearings are supplied by a hole drilled vertically from each crankshaft bearing journal to camshaft bearing journal.

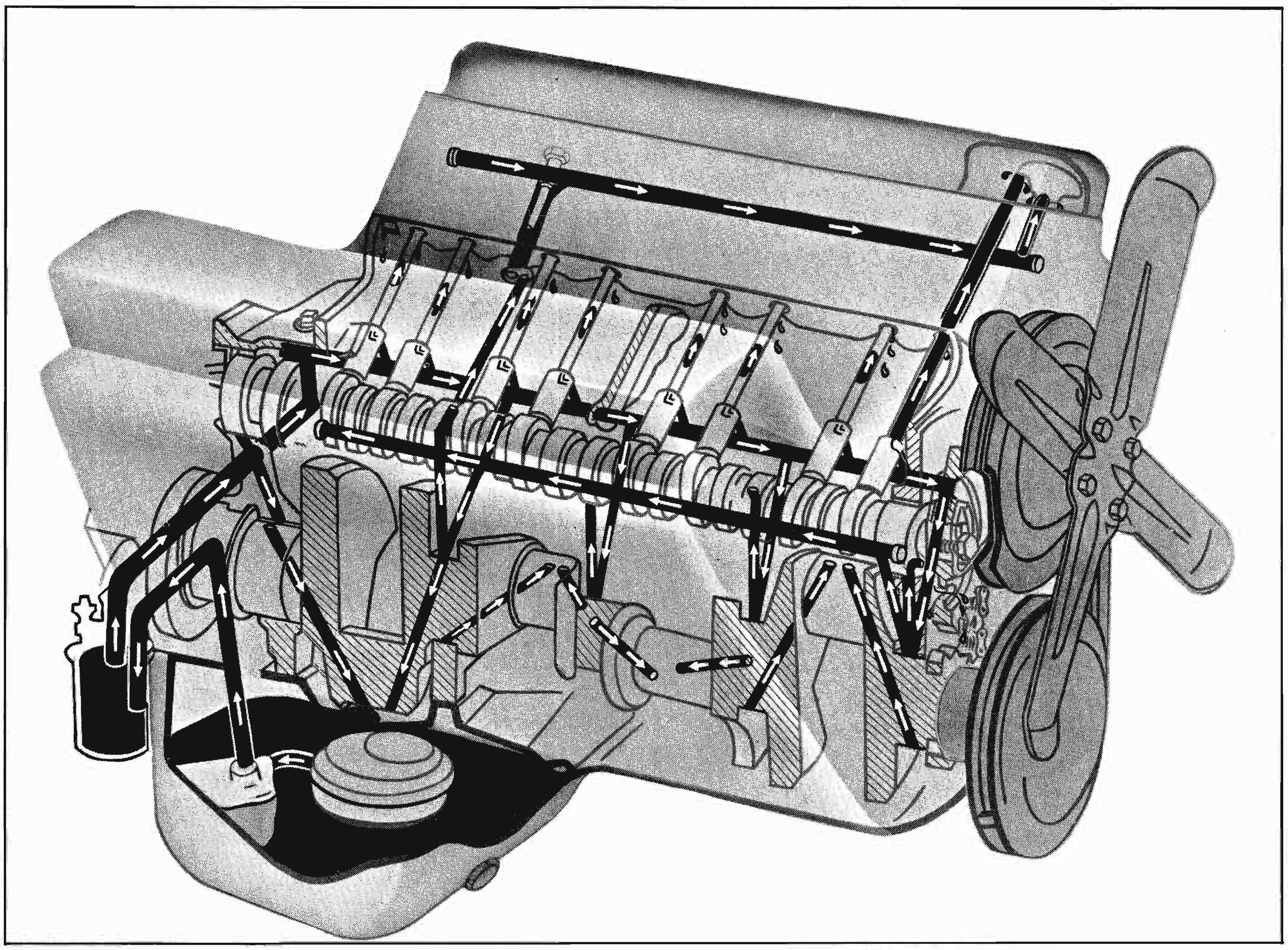


Fig. 6A-7 Engine Lubrication

Hydraulic valve lifters are fed by holes drilled from each lifter boss to the oil galleries (Fig. 6A-7). Oil is fed under pressure from a hole in the push rod seat of the valve lifter up through the hollow push rod to provide pressure lubrication of both ends of the push rod.

Oil is also positively fed to the cylinder heads to lubricate all valve train surfaces. An oil gallery in the right hand cylinder head is fed intermittently by a line leading from the front center camshaft bearing journal, while the gallery in the left hand head is fed from the rear center camshaft journal. Oil from cylinder head galleries flows up holes in each rocker arm ball stud and out through a $1/16''$ hole drilled into the side of the stud to index with the ball. This oil lubricates the ball seat and also flows out through grooves in the top of the ball to fill the rocker arm with oil. Overflow from the rocker arm passes over the end onto the valve stem to lubricate the contact area between the rocker arm and the end of the valve stem.

Lubrication of the camshaft thrust plate, timing chain and sprockets, fuel pump eccentric and rocker arm is provided for by a passage in the front of the camshaft. A lateral hole in the front bearing journal indexes with the camshaft bearing oil supply hole in the block once each revolution. An oil jet then squirts out of the horizontal hole in the end of the camshaft toward the front of the engine. Part of this oil is projected straight forward, against the camshaft thrust plate. Another part of the oil is projected downward through the grooves in the block and thrust plate to the crankshaft timing chain sprocket (Fig. 6A-8). Oil passing down the groove also is forced out the hole in the thrust plate. The jet of oil from this hole is timed to pass through one of the openings in the camshaft sprocket and strike the fuel pump eccentric and rocker arm.

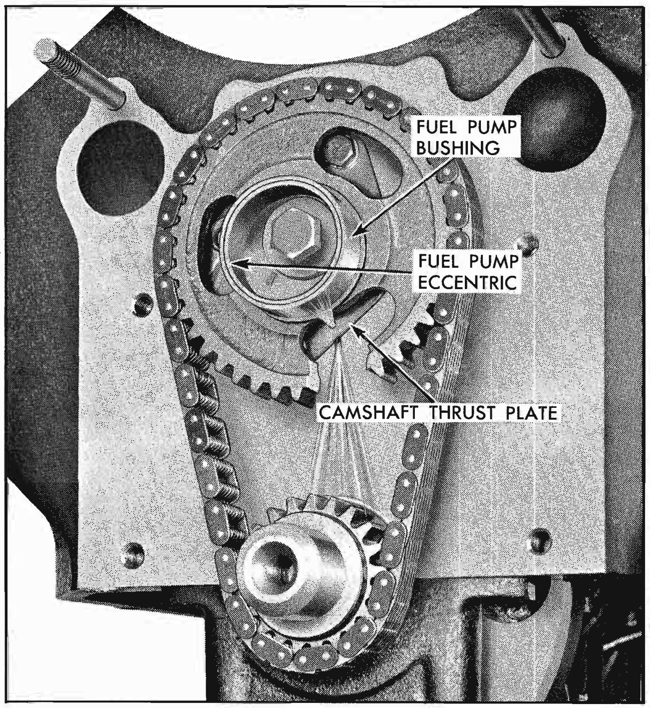


Fig. 6A-8 Timing Chain, Sprocket, Camshaft Thrust Plate, Fuel Pump Eccentric and Rocker Arm Lubrication

The oil pan has been made as deep as possible to provide the maximum depth of oil. This minimizes splashing and foaming which would be detrimental to the operation of hydraulic lifters. It also insures a constant supply of oil during rapid acceleration and sharp turns. Additional protection against splashing and foaming is provided by the oil pan baffle. The baffle extends across the entire sump area of the oil pan preventing oil which is thrown off the crankshaft from churning that in the sump.

CRANKCASE VENTILATION

When gasoline is burned in the cylinders of any internal combustion engine, one of the by-products is water vapor. Actually, more than one gallon of water is produced for every gallon of gasoline burned. Most of this water vapor is blown out through the exhaust system. Some of it, however, leaks down into the crankcase where it can have very destructive effects through the formation of sludge and acid. The acid is formed when the water combines with sulphur dioxide which is another by-product of combustion.

Adequate crankcase ventilation evaporates the moisture and carries it, as well as the combustion gases, out of the engine. Pontiac's crankcase ventilation system provides complete ventilation of the engine. This system functions as follows (Fig. 6A-9):

Air is forced into the engine through an air inlet in each rocker arm cover. The inlets, which also serve as oil filler caps, are located at the front (left side) and middle (right side) of the rocker arm covers where they receive direct blasts of air from the fan. Filter elements in the air inlet ensure the circulation of clean air through the engine.

The flow of air through the crankcase is aided by the suction type air outlet which exhausts vapors and fumes beneath the car.

Air entering the inlets circulates along the top of the cylinder heads inside the rocker arm covers. Cast openings at the front and rear of each cylinder head allow air to be forced down into the area of the block below the push rod cover.

Air passing down into the block at the front circulates into the timing chain cover through a hole near the top of the block. The ventilating air then circulates down around the timing chain and sprockets and into the crankcase.

An oil separator, or baffle chamber, inside the push rod cover insures against excessive oil being carried out of the engine with the ventilating air.

PERIODIC SERVICE

ENGINE OIL

See GENERAL LUBRICATION SECTION.

OIL FILTER

The disposable cartridge should be replaced at initial 4,000 mile oil change, then every 8,000 miles to insure best filter performance. To replace filter, raise car and proceed as follows:

1. Turn hex nut on bottom of filter counterclockwise to unscrew filter from base.

2. Wipe filter base with clean cloth and make sure filter base attaching screws are tight.

3. Apply light grease or oil on new gasket furnished in filter package and place gasket firmly in groove at open end of filter.

4. Hand tighten filter on hollow center stud until gasket contacts filter base (Fig. 6A-10) then complete tightening with additional ⅔ turn of filter but DO NOT OVER TIGHTEN. Use care when tightening to prevent "bunching" of gasket. DO NOT USE WRENCH TO TIGHTEN CARTRIDGE.

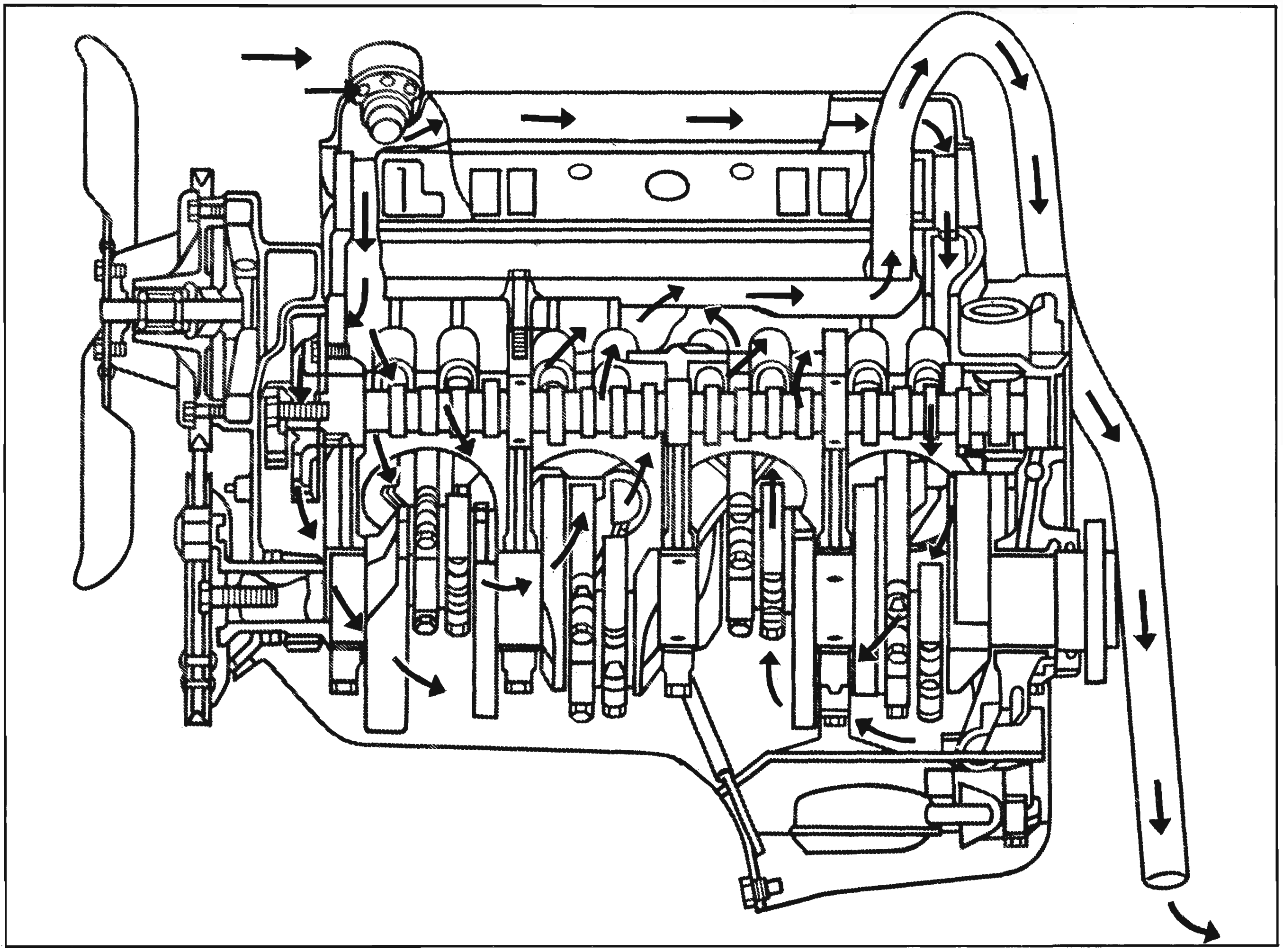


Fig. 6A-9 Crankcase Ventilation System

5. Add oil to bring to "FULL" mark on dipstick. Run engine and check for leaks at filter to base gasket.

6. Recheck crankcase oil level. If necessary, add oil to bring to "FULL" mark on dipstick.

CRANKCASE VENTILATOR INLETS

See GENERAL LUBRICATION SECTION.

CHECKING AND FILLING COOLING SYSTEM

No periodic check of coolant level is necessary or desirable. The coolant level should be considered correct as long the the temperature gauge does not indicate overheating.

Always allow the cooling system to cool to normal before removing the cap. When removing filler cap, rotate cap toward left very slowly; if there is pressure in the system, tighten cap immediately and wait for system to cool sufficiently to allow removal of cap.

When filling radiator, do not bring level more than one inch above radiator core. This air space is required for expansion and contraction and if the space is not left, coolant will be lost out the overflow.

FLUSHING COOLING SYSTEM

It is especially important to flush and check the cooling system for leaks when anti-freeze is used, because of the possibility of damage to engine parts should it reach the interior of the engine.

1. Drain radiator and block by opening drain cock on radiator lower tank and removing plugs on both sides of engine block.

2. After the system is empty and with drains open, run water into radiator. Engine should be running

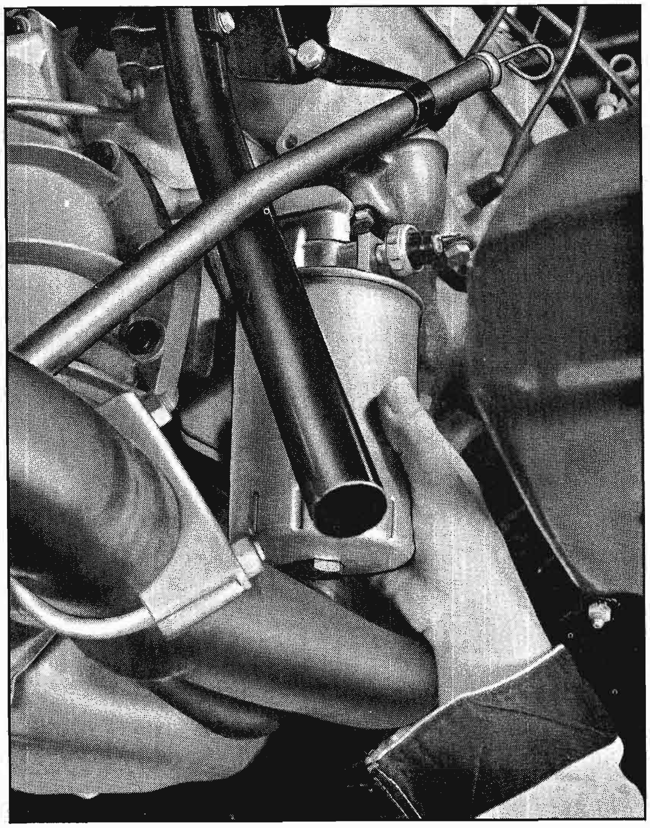


Fig. 6A-10 Installing Filter Cartridge

and should be occasionally accelerated as this will aid in circulating water and dislodging rust and scale.

CAUTION: Do not introduce cold water into a hot engine or block may be cracked. Allow engine to cool, then add water with engine running.

3. Where there is difficulty in getting water to run clear or there is an excessive amount of rust and scale, the cooling system should be cleaned with a cleanser supplied for that purpose by a reputable source. If force flushing equipment is used, it should be used on the RADIATOR ONLY (engine to radiator inlet and outlet hoses removed) as any reverse flushing of the block with the water pump in place may cause the water pump seal to leak, if flushing pressure is excessive.

PREPARING COOLING SYSTEM FOR ANTI-FREEZE

The cooling system should be properly prepared for the addition of anti-freeze each fall.

To properly prepare cooling system:

1. Bring engine up to operating temperature.

2. Flush out cooling system as instructed previously.

3. Tighten all hose connections on radiator, heater and defroster. Replace any deteriorated hose. Check to see that radiator hold down bolts are tightened properly.

4. Fill system with water and operate engine, checking for water leaks at radiator core, hose connections, water pump seal and gaskets, heater and defroster connections, and head to block joint.

5. Drain sufficient water to allow addition of proper quantity of anti-freeze.

CAUTION: Do not overfill. Allow for expansion of coolant.

ADDING ANTI-FREEZE TO COOLING SYSTEM

CAUTION: Salt solutions, such as calcium or magnesium chloride, sodium silicate, etc.; honey, glucose, sugar solutions; and oils or kerosene are not satisfactory for use as anti-freeze compounds in automotive cooling systems.

In selecting anti-freeze for winter operation, the local conditions and type of service should be considered. Pontiac recommends the use of glycol type anti-freeze in its cooling system.

Glycol type anti-freeze is non-evaporating. For this reason it will not be boiled away by the higher temperatures resulting from hard drives on warm days or from use of the high opening thermostat.

Glycol type anti-freeze, although not subject to loss by evaporation, should not be left in the cooling system indefinitely, since the rust inhibitor in the anti-freeze will become exhausted and rusting in the cooling system will result.

TESTING ANTI-FREEZE

In using a hydrometer to determine the freezing point of radiator solution, make sure the correct hydrometer markings are read. Unless hydrometer is provided with means for temperature correction, test should be made at the temperature at which hydrometer is calibrated, for if the solution is warmer or colder large errors may result (in some cases as much as 30°F.). Most good hydrometers are equipped with a thermometer and temperature correction scale which allows an accurate test of freezing point over a range of temperatures.

MINOR REPAIRS

THERMOSTAT—REMOVE AND REPLACE

1. Drain radiator, disconnect upper hose and remove water outlet fitting from intake manifold.

2. Remove thermostat. Unless obviously inoperative, test the thermostat before replacing with new one.

3. Install thermostat with pellet or cartridge projecting down into water passage in intake manifold.

4. Using new gasket, install water outlet fitting.

5. Connect upper radiator hose.

6. Refill radiator to approximately three inches from top and check for leaks.

OIL FILTER—REMOVE AND REPLACE

1. Remove oil pressure warning light wire from terminal on filter base, remove three attaching screws with lock washers and flat washers, and remove filter assembly and gasket.

2. If new filter base is to be installed, transfer fittings from old to new base.

3. Position gasket and filter assembly on engine. (Replace gasket if damaged.)

4. Install three attaching screws with flat washers and lock washers, and tighten securely.

5. Attach oil pressure warning light wire.

RADIATOR—REMOVE AND REPLACE

1. Drain water from radiator.

2. Remove attaching screws which fasten fan shroud to radiator support and move fan shroud out of way (air conditioning only).

3. Disconnect upper and lower radiator hose, using tool J-8404.

4. Remove radiator upper hold down screws.

5. Remove radiator by pulling up and out of radiator support.

NOTE: If removing Hydra-Matic transmission radiator, disconnect the inlet and outlet oil hose and plug openings with tape, plastic, or similar plug.

6. Install radiator by reversing above steps and, after refilling radiator, run engine for a short period of time and check for leaks. If Hydra-Matic transmission radiator, recheck transmission oil level.

If installing new radiator, transfer fittings from old radiator to new radiator.

WATER PUMP—REMOVE AND REPLACE

NOTE: Water pump is serviced only as an assembly.

1. Drain radiator.

2. Loosen generator at adjusting strap and remove fan belt from fan pulley.

3. Remove fan and pulley.

4. Remove water pump retaining nuts and remove pump.

5. Install pump by reversing above steps. When pump is installed on engine, drain hole will be at bottom. Tighten water pump attaching nuts to 15 lb. ft. torque.

OIL PUMP—REMOVE AND REPLACE

1. Remove engine oil pan. See OIL PAN AND/OR OIL PAN GASKETS—REMOVE AND REPLACE ENGINE MECHANICAL Section.

2. Remove oil pump attaching screws while holding oil pump in place. Carefully lower oil pump away from block with one hand while removing oil pump drive shaft with other hand.

3. Recondition oil pump if necessary (see below).

4. Position drive shaft in distributor and oil pump drive gears. Place pump against block using new gasket between pump and block. Index drive shaft with pump drive gear shaft. Install two attaching screws with lock washers and tighten securely.

NOTE: Removal and installation of pump does not affect ignition timing, since the oil pump and distributor drive gear is mounted on the distributor shaft.

5. Install oil pan.

OIL PUMP—OVERHAUL

DISASSEMBLE PUMP

1. Remove cotter pin which retains floating screen to oil pump inlet, and remove screen (Fig. 6A-11).

2. Remove pressure regulator spring retainer, spring, and pressure regulator ball.

3. Remove screws retaining cover to oil pump body and remove cover.

4. Remove driven gear and drive gear with shaft.

CLEAN AND INSPECT PUMP

1. Clean all parts thoroughly. Screen must be thoroughly cleaned by using a fluid such as used for carburetor cleaning.

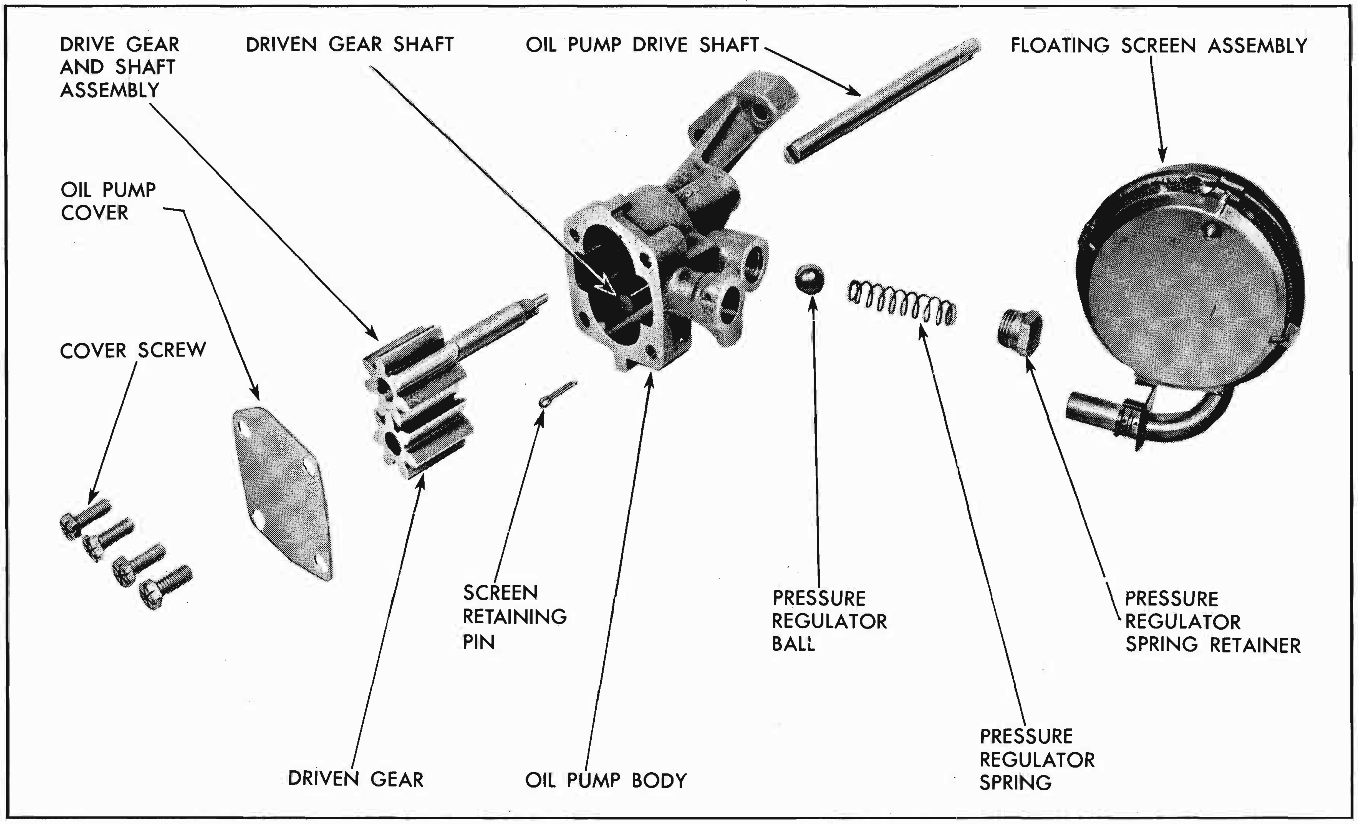


Fig. 6A-11 Exploded View of Oil Pump

2. Inspect pressure regulator spring (Fig. 6A-11) for distortion, cracks, and wear on sides.

3. Inspect pressure regulator ball to see that it is not nicked or otherwise damaged.

4. Inspect pump body, driven gear shaft and cover for evidence of wear.

5. Inspect pump gears and end of drive gear shaft for wear.

6. Inspect oil pump drive shaft (distributor to pump shaft) for evidence of wear and cracks.

ASSEMBLE PUMP

1. Install drive and driven gears.
2. Install cover and turn drive shaft by hand to insure that it turns freely and has a slight amount of end play.
3. Install pressure regulator ball, spring and retainer.

CAUTION. Do not attempt to change oil pressure by varying length of pressure regulator valve spring.

4. Install screen assembly on oil pump and install new cotter pin retainer, bending both ends of pin 90° to outer side to avoid contact with oil pan.

TROUBLE DIAGNOSIS

SYMPTOM	CAUSE
Cooling system loses water.	1. Make sure owner is not trying to keep radiator filled to top, and is not filling while cold. The expansion and contraction of water during operation will cause level to drop to several inches below the top of the filler neck. Once the level

SYMPTOM	CAUSE
Cooling system loses water (Continued).	becomes stabilized it will not change appreciably during operation. 2. Check for leaks from radiator or hose connections, including heater. 3. Check for crack in block. Pull engine oil dipstick to check for water in crankcase. 4. Remove rocker arm covers and check for cracked cylinder head. 5. Remove cylinder heads and check gaskets. While heads are off, check for cracks in heads or block.
Buzzing noise from radiator cap.	This is caused by the relieving of excessive pressure when radiator boils. Check causes of overheating.
Overheating (coolant actually boils).	1. Check engine thermostat. An operational check can be made by hanging thermostat on a hook in a can of water. Do not let the thermostat touch the sides or bottom of the can. Suspend a thermometer in the can and stir water while applying heat. The thermostat should start to open at the temperature stamped on it, $\pm$ 10°F and be fully open (approximately ¼" minimum) at 22°F above the specified temperature. 2. Check for punctures in radiator, ruptured or disconnected hoses, loose pressure cap or use of low boiling point anti-freeze. These conditions prevent cooling system from maintaining proper pressure. 3. Check to see that the radiator cap seats in radiator filler neck and holds pressure. 4. Check for driving conditions which may cause overheating. Prolonged idling, start and stop driving in long lines of traffic on hot days, climbing steep grades on hot days, etc. will occasionally cause coolant to boil. 5. Check engine operation to make sure tune-up is not needed. Timing retarded past TDC (top dead center) may cause overheating. NOTE: Timing must be set with vacuum advance line disconnected. 6. Check fan belt for excessive looseness. 7. Clean debris from radiator. 8. Clean cooling system. 9. Remove cylinder heads and check water passages in heads and block for obstructions.

SYMPTOM	CAUSE
Over cooling (cold engine operation).	1. Check engine thermostat.
Green heat indicator light on.	1. Engine coolant temperature is below 113-120°F. Allow engine to warm up and if light remains on check thermostat and/or heat indicator switch.
Red heat indicator light on.	1. Engine coolant temperature is above 236-240°F. (car without air conditioning) or 242-246°F. (cars with air conditioning or 425E engine). Check thermostat and/or heat indicator switch.

SPECIFICATIONS

COOLING SYSTEM

Type .... Pressure with Vent
Operating Pressure (Except all Synchro-Mesh Transmission, 425E Engine and Air Conditioning) .... 12 to 15 psi
All with Synchro-Mesh Transmission, 425E Engine or Air Conditioning .... 14 to 17 psi
Pump Type .... Centrifugal
Pump and Fan Drive .... V-Belt
Pump Bearings .... Sealed Ball Bearings
Radiator Type .... Tube and Center
Core Area—Standard .... 439 sq. in.
Core Area—w/Air Conditioning .... 439 sq. in.
Core Thickness .... 2″
Thermostat .... 180° F.
Fan Diameter—Standard .... 19″
Fan Diameter—w/Air Conditioning .... 19½″
Number of Blades—Standard 4
Number of Blades—w/Air Conditioning Fan Clutch .. 7
Belt Adjustment .... Generator Link
Cooling System Capacity—Quarts:
Without Heater 18½
With Heater 19½
Anti-Freeze Recommendation:
5 Quarts .... Protects to +8°F.
9 Quarts .... Protects to −20°F.

LUBRICATION SYSTEM

Type .... Pressure
Oil Pressure at 2600 rpm .... 30-40 psi
Engine Lubricant Capacity When Refilling
.... 4-qts. (5 qts. if filter element is changed)
Oil Pump Type .... Spur Gear

DRIVE BELTS FOR 1962 PONTIAC ENGINE AND ACCESSORY DRIVE COMBINATIONS

Belt Width	Belt Name	Borroughs Gauge
3/8″	Power Steering Pump Belt—Power Steering except Air Conditioning	70-75
15/32″	Power Steering Pump Belt—Power Steering with Air Conditioning	100-105
3/8″	Water Pump and Fan Belt	70-75
15/32″	Air Conditioning Comp. Drive Belt	100-105
3/8″	Water Pump, Fan and Idler Pulley Belt — with Air Conditioning except Power Steering	70-75

TORQUE SPECIFICATIONS

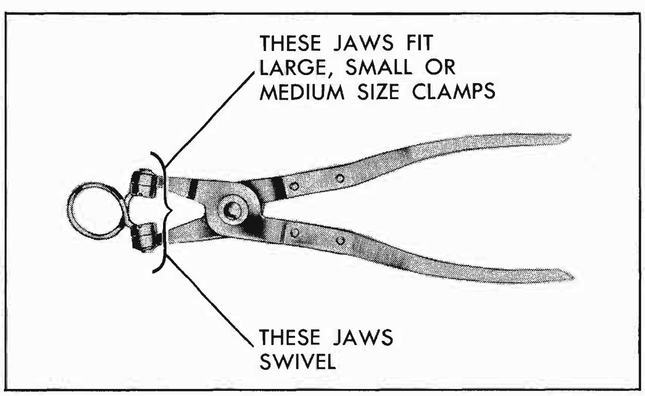
(Torque in lb. ft. unless otherwise specified.)

TORQUE	SIZE	APPLICATION
		Oil Pan
10-20	5/16-18	Bolt—Engine Oil Baffle to Bearing Cap
8-15	5/16-18	Bolt—Oil Pan to Cylinder Block
10-20	5/16-18	Bolt—Oil Pan to Cyl. Blk. (Also Att. Clutch Hsg. Cover Shield)
18-25	1/2-20	Screw—Oil Pan Drain (Plug)

TORQUE	SIZE	APPLICATION
		Oil Pump, Pressure Reg. and Oil Screen
10-20	5/16-18	Bolt—Engine Oil Pump Cover to Body
8-18	3/4-16	Retainer—Oil Pump Pressure Reg. Spring
20-35	3/8-16	Bolt—Engine Oil Pump Assembly to Block
		Oil Filter Pad Cover
20-35	3/8-16	Bolt—Oil Filter Assy. to Block
20-35	3/8-16	Bolt—Oil Filter Pad Cover to Block
		Crankcase Ventilator
20-35	3/8-16	Bolt—Crankcase Vent. Outlet Pipe Brkt. to Cyl. Hd.
25-85 lb. in.	1/4-14	Screw—Crankcase Vent. Outlet Pipe Brkt. to Pipe
25-85 lb. in.	1/4-14	Screw—Crankcase Vent. Outlet Air Cleaner to Pipe Clamp
		Timing Chain Cover
20-35	3/8-16	Bolt—Timing Chain Cover to Cyl. Block
*	3/8-24	Stud—Timing Chain Cover to Block (Block End)
20-35	3/8-16	Nut—Timing Chain Cover to Block (Stud)
		Engine Fan and Pulley
15-25	5/16-24	Bolt—Fan and Pulley to Water Pump Shaft Flange
		Water Pump
*	5/16-24	Stud—Water Pump to Timing Chain Cover (Cover End)
10-25	5/16-24	Nut—Water Pump to Timing Chain Cover (Stud)
		Thermostat and Water Outlet Fitting
20-35	3/8-16	Bolt—Intake Manifold Water Outlet Fit. to Manifold

NOTE: (*) Torque not a requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.

SPECIAL TOOLS



J-8404 Universal Hose Clamp Pliers

ENGINE FUEL

CONTENTS OF THIS SECTION

HEAT CONTROL

All models have an automatically operated heat control valve mounted in the right bank manifold, which utilizes the exhaust gases of the engine to heat the incoming fuel air charge during warm-up so as to improve vaporization and distribution. The heat control valve is regulated by a coiled thermostatic spring (Fig. 6B-1). A counterweight is mounted on the other end of the heat control valve shaft and this counterweight, in conjunction with the thermostatic spring, operates to close and open the heat control valve. The assembly is kept from rattling by an anti-rattle spring mounted next to the thermostatic spring.

A detailed description of the operation of the heat control valve will be found in the ENGINE MECHANICAL Section.

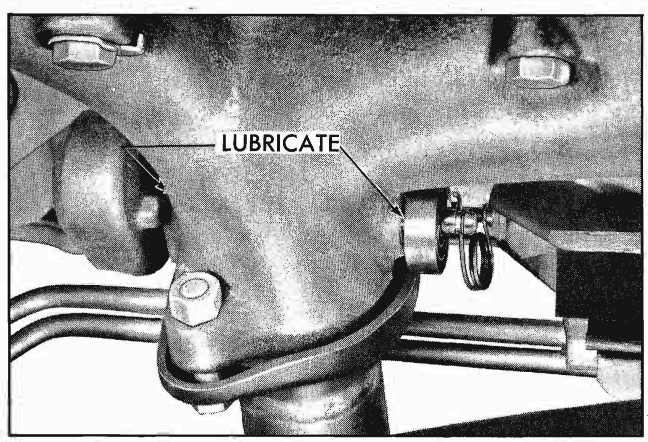


Fig. 6B-1 Heat Control Valve Thermostatic Spring and Counterweight

CARBURETOR AIR CLEANER AND SILENCER

A combined air cleaner-silencer is used on all models. These units filter air entering the carburetor to keep abrasive dust from being carried into the engine, and reduce air and induction noises.

Two types of air cleaners are available: standard and heavy duty. The heavy duty model is intended for territories where the standard air cleaner is inadequate.

The heavy duty air cleaner contains an oil moistened sponge-like material (polyurethane) which removes the dust particles as the air passes through (on all carburetor combinations except triple two barrel installations). Triple two barrel carburetors will use an air cleaner made of folded paper.

The standard air cleaner contains an oil moistened wire screen filter element which "catches" dust particles as the air passes through.

Service instructions for both type cleaners are covered in the GENERAL LUBRICATION Section.

THROTTLE RETURN CHECK

DESCRIPTION

All Hydra-Matic four barrel and Roto Hydra-Matic two barrel, except triple two barrel carburetor models, are equipped with a throttle return check device which is mounted on the intake manifold. The return check is designed to open the throttle valve to increase engine speed slightly and prevent stalling when engine vacuum drops. It also acts to retard throttle closing when the driver suddenly takes his foot off the accelerator pedal.

ADJUSTMENT

1. Be sure fast idle adjustment on the four barrel carburetors has been made then shut off engine. There is no separate fast idle adjustment on the two barrel carburetors.

2. a. On four barrel carburetors, rotate the fast idle cam so that the fast idle speed screw rests on the highest step of the fast idle cam.

b. On the two barrel carburetors, rotate the fast idle cam so that the speed screw rests on next to the highest step of the fast idle cam.

3. Measure the clearance between the contact screw and the contact on the throttle lever. The clearance should be as follows (Fig. 6B-3):

4 barrel carburetors .....090-.095 inch (Hi Step)
2 barrel ($1^{11}/_{16}''$ throttle bore) ....062-.067 inch (Second Step)
2 barrel ($1^{7}/_{16}''$ throttle bore) ....090-.095 inch (Second Step)

4. If adjustment is necessary, adjust the contact screw. Hold sleeve next to diaphragm bracket from turning while turning contact screw.

NOTE: On four barrel carburetors, this adjustment must be performed when fast idle speed is set according to specifications. If for any reason the fast idle speed is changed, recheck the throttle return check adjustment.

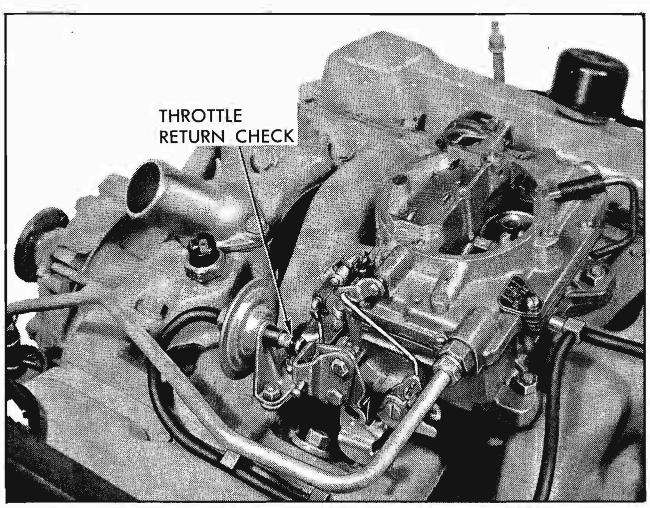


Fig. 6B-2 Throttle Return Check Hook-up for Roto Hydra-Matic Four Barrel Carburetor (Same Hook-up for Two Barrel)

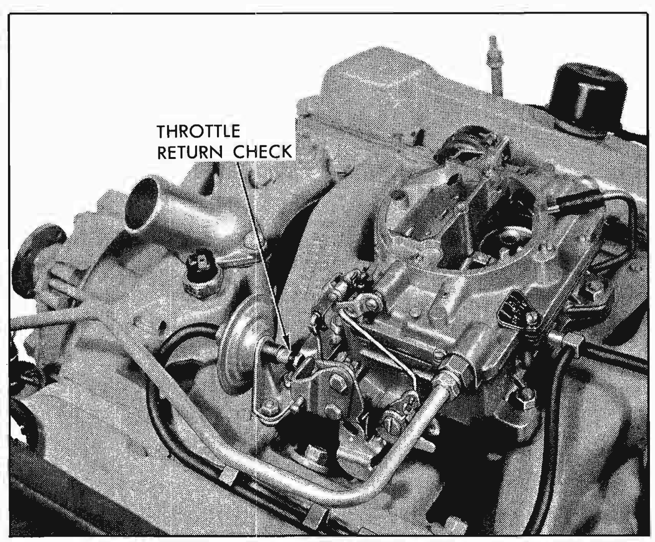


Fig. 6B-3 Throttle Return Check Hook-up for Super Hydra-Matic Four Barrel Carburetor

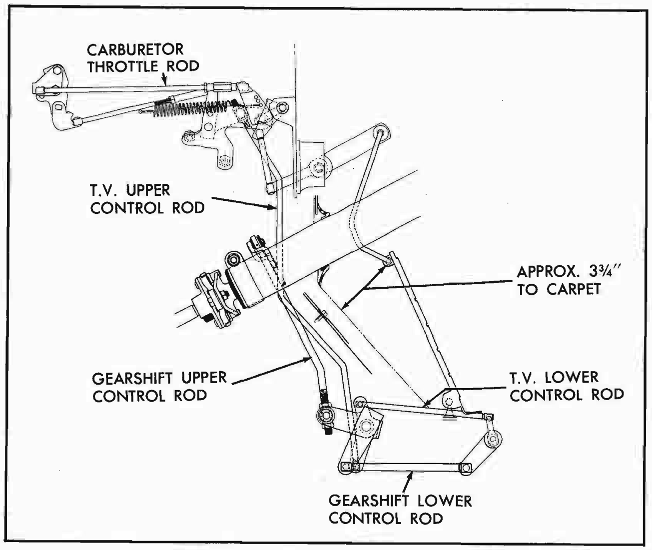


Fig. 6B-4 Throttle Control Linkage—Super Hydra-Matic

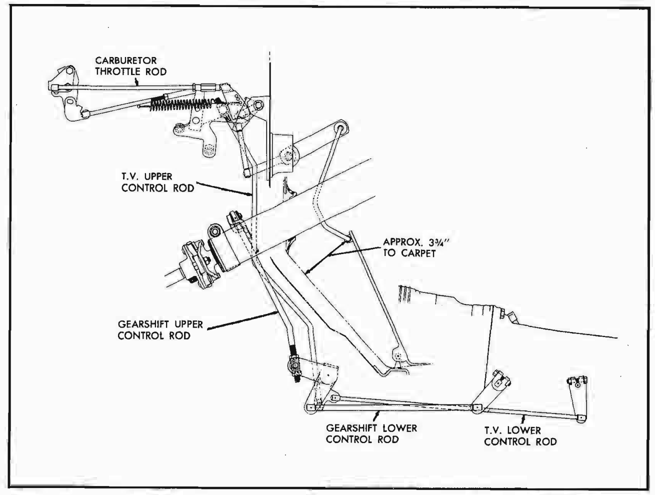


Fig. 6B-5 Throttle Control Linkage—Roto Hydra-Matic

ADJUST THROTTLE CONTROL LINKAGE

Linkage operation will not be satisfactory if binding or excessive wear exists. See Figs. 6B-4 and 6B-5.

1. Remove air cleaner.

2. Loosen both nuts at transmission throttle control rod trunnion (Fig. 6B-6).

3. Adjust engine idle speed to 480-500 rpm *in drive range* (540-560 with air conditioning).

4. Shut off engine and install linkage adjustment pin J-7687 through holes in throttle control lever and bracket (Fig. 6B-7).

NOTE: On carburetors equipped with a throttle return check, before installing pin, it will be necessary to either remove throttle return check or install tool J-6342-01 over return check so that it will not interfere with linkage adjustment.

5. With throttle valves fully closed, loosen lock nut and adjust length of transmission throttle control rod to carburetor (Fig. 6B-7) so that gauge pin is free in hole. Leave pin installed and tighten lock nut securely. Recheck freeness of gauge pin in holes.

6. Push throttle control rod to transmission (T.V. upper rod) downward lightly until the outer throttle lever is felt to touch end of travel (Fig. 6B-8).

CAUTION: Make sure that, when lever is in this position, the upper lock nut is not touching trunnion.

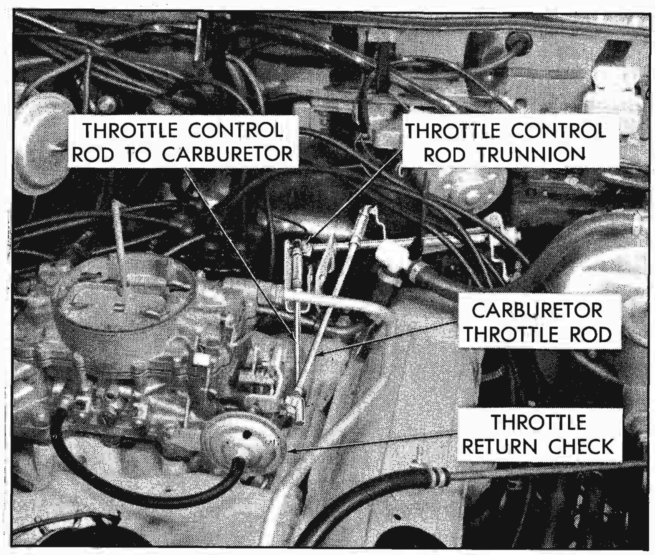


Fig. 6B-6 Location of Throttle Trunnion

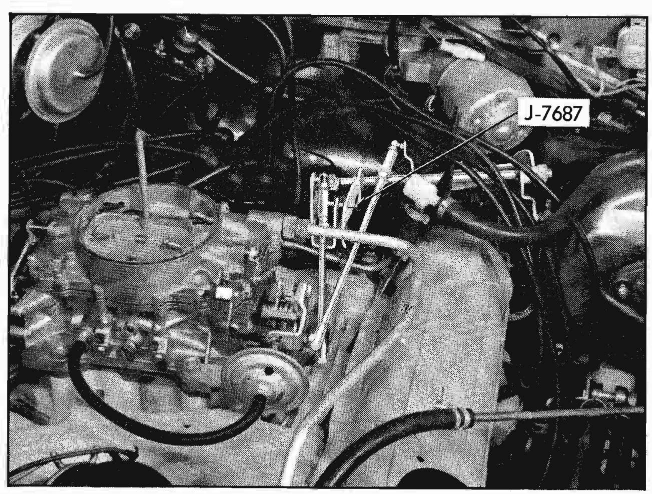


Fig. 6B-7 J-7687 in Position

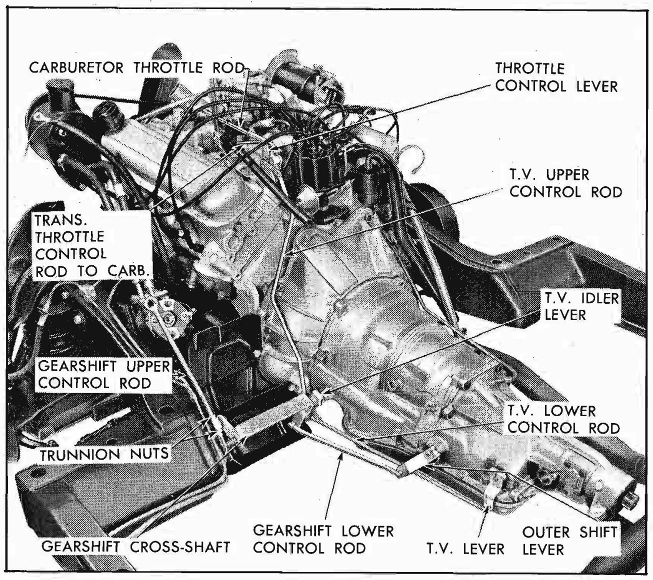


Fig. 6B-8 Identification of Throttle Linkage—Roto Hydra-Matic

7. While holding throttle control rod to transmission in this position, tighten upper and lower trunnion lock nuts finger tight. Shorten throttle control rod to transmission by backing off lower trunnion nut 2½ turns and tighten upper nut securely. Remove gauge pin.

8. Loosen lock nut on carburetor throttle rod.

9. Adjust carburetor throttle rod to obtain 4 35/64″ clearance from under side of attaching boss on pedal to body toe pan as shown in Fig. 6B-5 (approximately 3¾″ to carpet).

10. Tighten lock nut on carburetor throttle rod securely.

11. Install air cleaner.

12. After throttle linkage adjustment has been made, road test car and tailor adjustment as required by shortening or lengthening the T.V. upper rod one half turn at a time to obtain the best shift feel.

ROCHESTER 2GC CARBURETOR
(1-11/16″ Throttle Bore Diameter)

Two basic models of 2GC carburetors are used. The first model (large) incorporates 1 11/16″ throttle bores and has the choke housing located on the throttle flange. This model is used as standard equipment on all Hydra-Matic models except the Bonneville Series.

The second model (small) uses 1 7/16″ throttle bores and has the choke housing attached to the bowl cover. This type is used as standard equipment on all synchro-mesh except the Bonneville, in the tri-power installation and as the economy option on Hydra-Matic models.

Carburetor model number can be used to identify specific 2GC carburetors. The model number is found on a tag attached to a bowl cover screw. The chart below gives model number and usage information.

Carburetor Model No.	Carburetor Usage	Throttle Bore Diameter
7020070	Super Hydra-Matic, except Bonneville	1 11/16″
7020071	Roto Hydra-Matic, except Bonneville	1 11/16″
7020072	Super HM with Circ-L-Aire Conditioning, except Bonneville	1 11/16″
7020073	Roto HM with Circ-L-Aire Conditioning, except Bonneville	1 11/16″
7020060	Synchro-mesh, except Bonneville	1 7/16″
7020074	Super Hydra-Matic—economy option	1 7/16″
7020075	Roto Hydra-Matic—economy option	1 7/16″
7020076	Super HM—economy option, with Circ-L-Aire Conditioning	1 7/16″
7020077	Roto HM—economy option, with Circ-L-Aire Conditioning	1 7/16″
7013063	Tri-power—front carburetor	1 11/16″
7013065	Tri-power—rear carburetor	1 11/16″
7020064	Tri-power—center carburetor—synchro-mesh	1 7/16″
7020067	Tri-power—center carburetor—Super Hydra-Matic	1 7/16″
7020069	Tri-power—center carburetor—Roto Hydra-Matic	1 7/16″

The following circuit descriptions and overhaul procedures apply specifically to the 7020070 carburetor and, with the exception of the choke housing relocation, apply to all other 2GC carburetors.

GENERAL DESCRIPTION

The cluster casting is the heart of the carburetor; it embodies the small or secondary venturi, the high speed passages, the main well tubes and nozzles, the idle tubes, and the calibrated air bleeds for both the low and high speed metering system, as well as the accelerating pump jets.

When the cluster is removed, all of these vital parts can be readily seen, cleaned and examined because the main well tubes and idle tubes are permanently installed in the cluster body by means of a precision press fit.

The cluster fits on a platform provided in the body casting of the carburetor so that the main well and idle tubes are suspended in the fuel.

A gasket is used between the cluster casting and the body platform.

This method of design and assembly serves to insulate the main well tubes and idle tubes from engine heat thus preventing heat expansion and percolation spill-over during hot idle periods of operation and during the time the hot engine is not operating.

An external idle vent valve is located on the bowl cover which vents any fuel vapors which may form in the fuel bowl during periods of "hot" idle to the atmosphere. The fuel bowl is also internally vented to give a completely balanced carburetor.

The model 2GC carburetor is of side bowl construction. It is designed, however, with fuel supply jets and passages submerged below the liquid level to provide efficient engine operation under all driving conditions.

A carburetor choke housing is located on the throttle body assembly and is connected to the choke valve through an intermediate choke rod.

A center stud mounting provides for secure attachment of the carburetor air cleaner assembly.

All engines with the Super Hydra-Matic transmissions have full manifold vacuum spark advance at idle. The carburetor for cars equipped with the Roto Hydra-Matic transmission will have the vacuum advance hooked to the spark port. Synchro-mesh carburetors are not drilled for spark port.

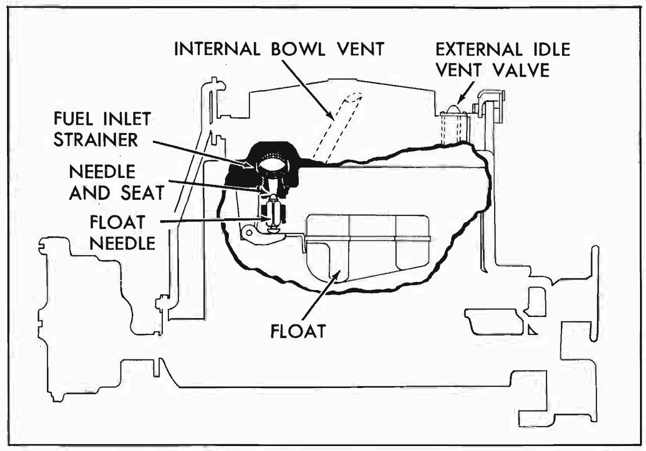


Fig. 6B-9 Float System

Six "systems" are utilized in the Rochester 2GC carburetor. They are: Float System, Idle System, Part Throttle System, Power System, Pump System, and Choke System.

These systems are described and illustrated schematically in the following text.

FLOAT SYSTEM (Fig. 6B-9)

The float system controls the level of fuel in the carburetor bowl.

Entering fuel first travels through the inlet strainer to remove particles which might block jets or passages. Then the fuel passes through the needle and seat into the carburetor bowl; flow continues until the rising liquid level raises the float to a position where the valve is closed. Thus the fuel level can be regulated by setting the float to close the valve when the proper level is reached.

A tang located at the rear of the float hanger prevents the float from traveling too far downward.

The carburetor is internally vented. The vent transmits the air pressure from beneath the air cleaner to the fuel in the float bowl. The amount of fuel metered by the carburetor is dependent upon the pressure in the float bowl causing fuel to flow. By locating the vents below the air cleaner, or internally, the carburetor automatically compensates for air cleaner restriction, since the same pressure causing air to flow will also be causing fuel to flow.

An external idle vent, located in the top of the float bowl, vents the bowl to atmosphere during idle operation. In this way any fuel vapors which may form in the bowl during hot idle or when parked will be vented to the outside. The idle vent automa-

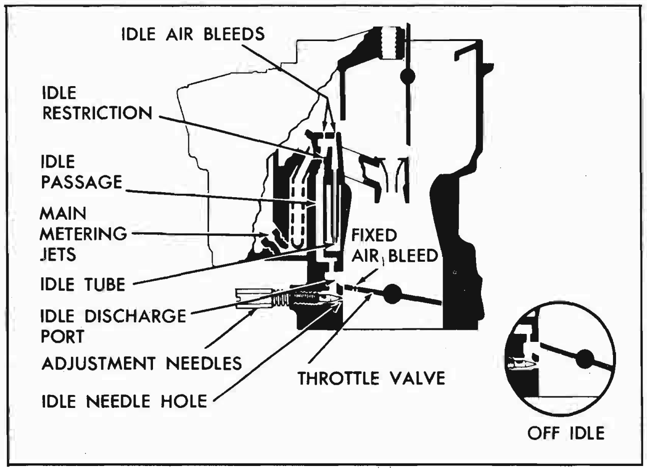


Fig. 6B-10 Idle System

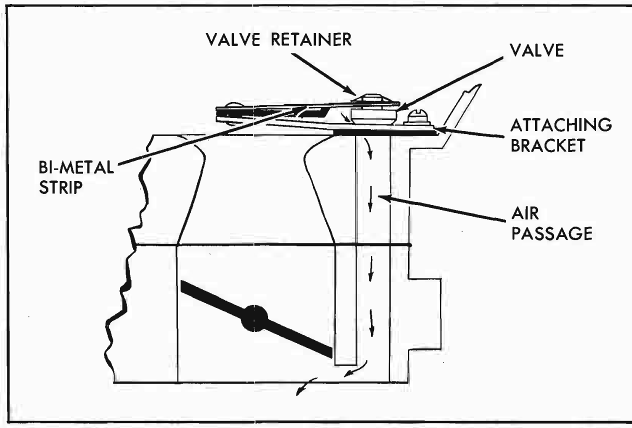


Fig. 6B-11 Idle Compensator (Cars with Circ-L-Air Conditioner)

tically closes after the throttle valve has moved from the idle position into the part throttle range, returning the carburetor to internal balance.

IDLE SYSTEM (Figs. 6B-6, 6B-10)

The idle system consists of the idle tubes, idle passages, idle air bleeds, idle mixture adjustment needles, idle discharge slot and an idle air adjustment screw.

In the curb idle speed position, the throttle valves are held open by the speed adjusting screw.

In order to obtain sufficient idle air for stable idle speed adjustment, a fixed air bleed is necessary; this is accomplished by a drilled hole in each throttle valve. The fixed idle air bleeds maintain a constant idle air flow for part of the idle air requirements, while the idle speed adjustment screw regulates the remainder of the idle air. Thus, the engine idle speed can be adjusted by the idle speed adjustment screw.

The idle mixture needle hole is in the high vacuum area below the throttle valve while the fuel bowl is vented to atmospheric pressure. Vacuum can be called a lack of pressure, so a high vacuum area can be spoken of as an area of low pressure. Thus it can be said that there is considerable pressure difference between the normal atmospheric pressure on the fuel in the bowl and the low pressure (or high vacuum) at the idle mixture needle hole.

The fuel and fuel/air mixture will be forced by atmospheric pressure to occupy any low pressure area. It will flow from the fuel bowl to the manifold in the following manner:

The atmospheric pressure acting on the fuel in the bowl forces fuel through the main metering jets into the main well. It is metered by the idle fuel metering orifice at the lower tip of the idle tube and travels up the idle tube. When the fuel reaches the top of the idle tube, it mixes with air entering through the primary idle air bleed. The mixture moves through the horizontal idle passage where more air is added at a second idle air bleed and then down through a restriction in the vertical passage which serves to further break up the fuel. More air is picked up at a third idle air bleed just below the idle restriction.

The fuel/air mixture next moves down the vertical idle passage to the idle discharge slot located just above the throttle valve. Through this slot further air is added to the mixture, which then passes through the idle mixture needle hole.

In addition to this mixture of fuel and air, there is air entering the carburetor bore through the fixed idle air bleeds. For smooth operation, the air from the idle needle hole must combine to form the correct final mixture for curb idle engine speed.

The position of the idle adjustment needle governs the amount of fuel/air mixture admitted to the carburetor bore.

Except for this variable at the idle adjustment needle, the idle system is specifically calibrated for low engine speeds.

A hot idle compensator is incorporated in all carburetors on cars equipped with factory installed air conditioning and all Hydra-Matic equipped tri-power engines. The function of the idle compensator is to prevent rough idle and stalling during prolonged hot idle conditions. It functions as follows (Figs. 6B-11 and 6B-12):

It consists of a bi-metal strip, a valve and mounting bracket. The idle compensator is mounted between the venturi on the large bore carburetors and on the

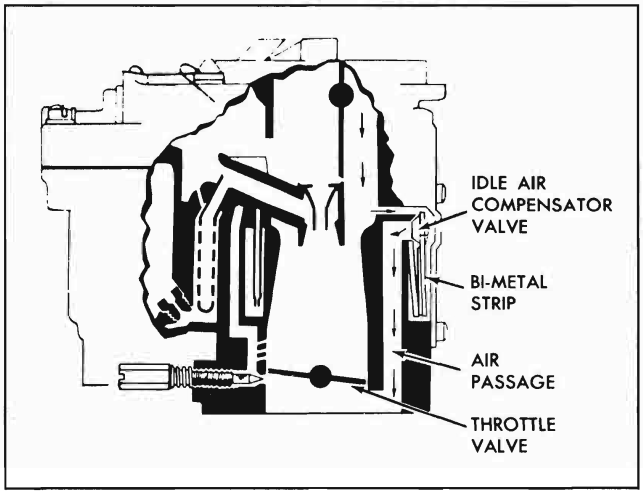


Fig. 6B-12 Idle Compensator (Cars with Hydra-Matic and Triple Two Barrel Carburetor—Center Carburetor)

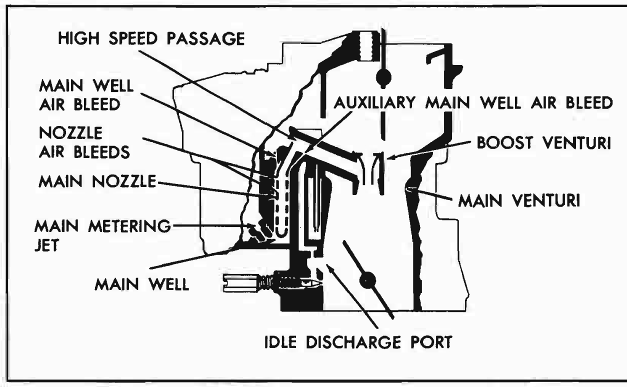


Fig. 6B-13 Part Throttle System

back of the carburetor on the bowl casting on small bore carburetors. Below the compensator is a passage leading to manifold vacuum below the throttle blades.

As engine and underhood temperatures rise to a predetermined value, the bi-metal strip lifts the valve off its seat. This allows fresh air to enter the manifold below the throttle valves and off-set rich mixtures due to fuel vapors that are causing the rough idle and stalling.

When underhood temperatures return to normal, the bi-metal strip will lower and the compensator valve will close and normal idle operation will resume.

NOTE: No adjustments are necessary on the idle compensator. The compensator valve must be closed while adjusting engine idle.

PART THROTTLE SYSTEM (Fig. 6B-13)

As the throttle valve is opened, there is a change in pressure differential points.

Opening of the valve progressively exposes the idle discharge slot to manifold vacuum and the air stream with the result that they deliver additional fuel/air mixture for fast idle engine requirements.

Further opening of the throttle valve increases the speed of the air stream passing through the venturi, thus lowering the pressure (or raising the vacuum) in the small venturi area of the carburetor bore. At the same time, the edge of the throttle valve is moved away from the wall of the bore, progressively reducing the vacuum and thus the mixture flow at the idle discharge slot.

Since the low pressure point is now in the small venturi area, fuel and fuel/air mixture will be forced from the fuel bowl through the main metering system to the venturi as follows:

The fuel passes through the main metering jet into the main well, where it rises in the main well tube. Air entering through the main well air bleeds in the cluster is mixed with the fuel through the main well tube vents. The mixture continues up the main well tube through the nozzle, where more air is added. The mixture flows through the high speed passage to the small venturi, mixes with additional air and moves on to the bore of the carburetor, through the intake manifold, and into the cylinder as a final mixture for part throttle operation.

A second high speed bleed is incorporated in the cluster of large bore 2GC carburetors only. This bleed is drilled from the main well to the high speed passage and serves two purposes. It transmits low pressure from the secondary venturi and high speed passage to the main well, thereby, helping to raise fuel level. This raising of the level assists the initial feeding of fuel at low speed and also helps control the mixture during high speed operation.

As the throttle opening is increased and more fuel is drawn through the main well tubes the fuel level in the main well drops. More holes in the main well tubes are then exposed to the air in the upper well area and become air bleeds. This maintains the proper fuel/air mixture to the engine throughout the part throttle range.

Permanent jets and air bleeds calibrate the main metering system for efficient part throttle operation.

POWER SYSTEM (Fig. 6B-14)

As was pointed out under part throttle operation, the fuel level in the main well area drops as the throttle valves are opened. This is due to the fact

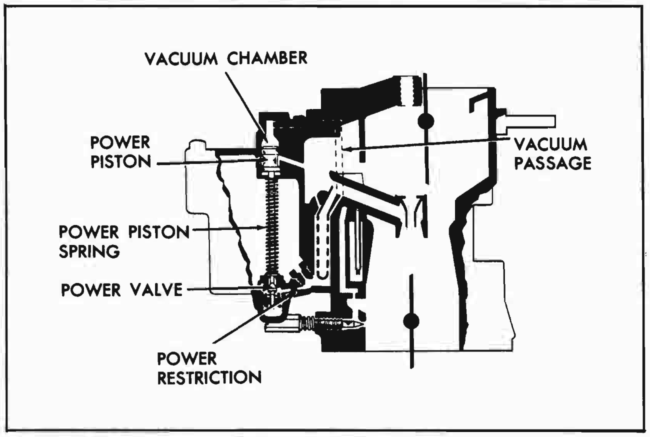


Fig. 6B-14 Power System

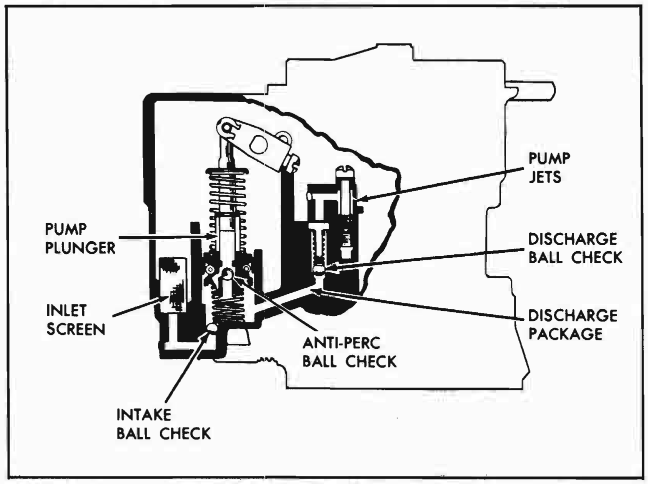


Fig. 6B-15 Pump System

that more fuel is drawn through the main well tubes, but the supply to the main well is held constant by the opening in the main metering jet. For high speed and/or heavy load conditions an additional source of fuel for the main well area is required. The power system accomplishes this purpose.

A spring loaded power piston, controlled by vacuum, regulates the power valve to supply the additional fuel.

The power piston vacuum channel is open to manifold vacuum in the carburetor bore beneath the throttle valves; thus the vacuum in the channel rises and falls with manifold vacuum.

During idle and part throttle operation, manifold vacuum in the channel is high. Therefore, air pressure in the passage beneath the power piston holds the piston in the fully raised position against the tension of the spring. As the load or speed is increased the throttle valves open wider and manifold vacuum drops. The calibrated spring forces the power piston down against the power valve to open it and allow fuel to flow through the power restrictions into the main wells. The amount of fuel is controlled by the main metering jet and the power restriction.

A two-step valve allows a gradual increase in fuel flow as the power valve is opened; at full throttle position, the power valve is fully opened to permit maximum calibrated fuel flow from the power system.

When the load is decreased the throttle valves close and manifold vacuum is increased. Therefore, air pressure below the power piston gradually overcomes the piston spring tension and forces the piston upward to its original position with the power valve fully closed.

PUMP SYSTEM (Fig. 6B-15)

Extra fuel for smooth, quick acceleration is supplied by a double spring pump plunger. A rapid opening of the throttle valves, as is the case when accelerating from low speeds, causes an immediate increase in air velocity. Since fuel is heavier than air it requires a short period of time for it to "catch" up with the air flow. To avoid a leanness during this momentary lag, the accelerator pump furnishes a quantity of liquid fuel sprayed into the air stream to mix with incoming air and maintain the proper fuel/air mixture.

The pump is operated by the combined action of two springs which are calibrated to move the plunger in such a manner that a sustained charge of fuel is delivered for smooth acceleration.

The pump is attached by linkage to the accelerator so that when the throttle valves are closed the pump plunger moves upward in its cylinder creating a low pressure area (partial vacuum) in the cylinder below the plunger. Atmospheric pressure acting on the fuel in the bowl forces fuel into the cylinder through the intake ball check. The discharge ball is seated at this time to prevent air being forced into the cylinder.

When the plunger is moved downward for acceleration, the force of the stroke seats the intake ball check to prevent flow to the fuel bowl, and the fuel is forced up the pump discharge passage. The pressure of the fuel lifts the pump outlet ball check from its seat and the fuel passes on through the pump jets in the cluster, where it is sprayed into the venturi and delivered to the engine.

At higher speeds pump discharge is no longer necessary to insure smooth acceleration. When the throttle valves are opened a predetermined amount the pump plunger bottoms in the cylinder eliminating pump discharge.

An "anti-percolator" check valve, contained inside the plunger, provides relief for any vapors which might form during hot idle or when a hot engine is not operating. The ball check is designed so that it can move up and down in its passage. Throughout the above periods it is seated by gravity and vapors in the pump well rise and by-pass the ball check through small holes in the plunger head.

The "anti-perc" ball check also acts as an extra inlet during the upstroke of the pump plunger, but is seated by fuel when the plunger moves downward.

CHOKE SYSTEM (Fig. 6B-16)

The purpose of the choke system is to provide a rich mixture for cold engine operation. It is necessary to have an extra rich mixture because fuel vapor has a tendency to condense on the cold engine parts; thus decreasing the amount of combustible mixture available at the combustion chamber.

The choke system subjects all fuel outlets in the bore of the carburetor to manifold vacuum while restricting the intake of air.

The choke system includes a thermostatic coil, housing, choke piston, choke valve, and fast idle cam and linkage. It is controlled by a combination of manifold vacuum, air velocity against the offset choke valve, and tension of the thermostatic spring.

When the engine is cold, tension of the thermostatic coil holds the choke valve closed. Starting the engine causes air velocity to strike the offset choke valve. This tends to open it along with the action of intake manifold vacuum on the choke piston. After a slight opening of the choke valve, the tension of the thermostatic coil spring balances the force of air on the valve and the pull of vacuum at the piston.

As the engine warms up manifold vacuum exists in the choke housing. Clean hot air from the choke stove is forced into this low pressure area through a passage in the side of the choke housing to heat the thermostatic coil.

The clean air is supplied to the choke stove in the manifold from the air horn, above the choke valve (just below the air cleaner). Here filtered air from the air cleaner is picked up and carried to the stove by a metal pipe.

A secondary baffle plate serves to distribute the heat from its entering point at the side of the coil throughout the choke housing, to prevent a "hot

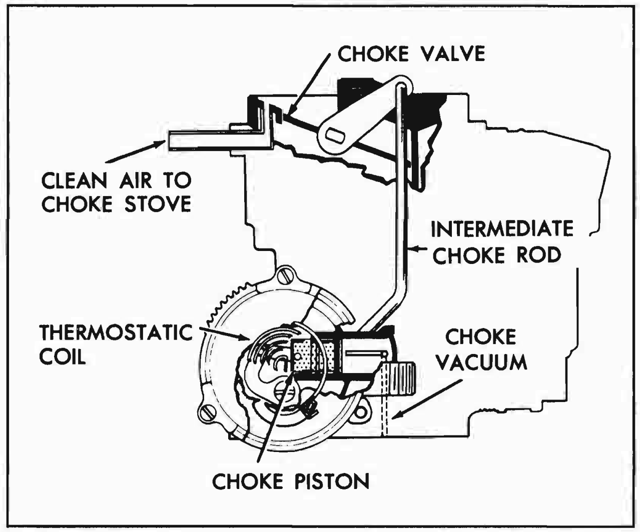


Fig. 6B-16 Choke System

spot" in the coil center, which would cause a rapid opening of the choke valve. The choke baffle is designed in some models with a hole or holes drilled in it. These holes are used to further control heat to the choke coil and, thereby, finely tailors the choke to the particular engine model. The thermostatic coil "relaxes" gradually until the choke is fully open.

If the engine is accelerated during warm-up, the corresponding drop in manifold vacuum on the choke piston allows the thermostatic coil to momentarily close the choke, providing a richer mixture.

During warm-up it is necessary to provide a fast idle to prevent engine stalling. This is accomplished by a fast idle cam connected to the choke shaft. The idle speed screw on the throttle lever contacts the fast idle cam and prevents the throttle valves from returning to the idle position until the choke valve is fully open.

If the engine becomes flooded during the starting period, the choke valve can be partially opened manually to allow increased air flow through the carburetor. This is accomplished by depressing the accelerator pedal to the floor. The unloader projection on the throttle lever contacts the unloader lug on the fast idle cam and in turn partially opens the choke valve.

ADJUSTMENTS ON CAR ROCHESTER 2GC CARBURETOR

All Rochester 2GC adjustments can be performed on the car. With the exception of the idle speed and mixture adjustment and the unloader adjustment, all adjustments are included in the OVERHAUL

AND ADJUSTMENTS procedure. Following are the idle speed and mixture adjustments and the unloader adjustment.

Whenever idle speed screw is turned, the throttle should be opened slightly then closed to seat screw properly on cam.

IDLE SPEED AND MIXTURE ADJUSTMENT

With the engine at operating temperature adjust idle speed to the following specifications.

Synchro-mesh, exc. Air Conditioning . . 480-500 rpm
Hydra-Matic, exc. Air Conditioning . . 480-500 rpm
(in drive range)
Air Conditioning . . . . 540-560 rpm
(H/M drive range, air conditioning off)
(S/M neutral, air conditioning off)

The idle mixture should be adjusted to give a smooth idle at the specified idle speed. Missing is a sign of too lean an idle mixture while "rolling" or "loping" indicates too rich a mixture. Turning the idle mixture screw in, leans out the mixture; one and one-half turns out from the lightly seated position may be used as a preliminary setting of the mixture screws.

NOTE: All two barrel carburetors with Hydra-Matic cars equipped with Circ-L-Aire conditioning have a hot idle compensator. During idle adjustment, make sure the hot idle compensator is closed by depressing the spring loaded button.

UNLOADER ADJUSTMENT

NOTE: Unloader adjustment cannot be made correctly unless linkage is properly adjusted.

1. Remove carburetor air cleaner assembly.

2. Depress accelerator pedal forcibly to floor. (This should be done by person sitting in driver's seat of car to simulate driving conditions.) Check to see that accelerator pedal is not hitting "hump" over transmission.

3. With accelerator pedal depressed as in Step 2, bend tang on throttle lever to give a clearance of .143" to .183" (gauge set J-8556) between the top of the choke valve and the inside of the air horn.

4. Replace air cleaner assembly.

The above procedure will eliminate variance in linkage, floor mat, pedal location, etc., and should ensure correct unloader action.

PERIODIC SERVICE ROCHESTER 2GC CARBURETOR

There are no periodic services required on the Rochester 2GC carburetor; however, choke linkage, choke valve and levers and pump linkage should be kept free of dirt and gum so that they will operate freely. DO NOT OIL LINKAGE.

OVERHAUL AND ADJUSTMENT

Flooding, stumble on acceleration and other performance complaints are, in many instances, caused by the presence of dirt, water or other foreign matter in the carburetor. To aid in diagnosing the cause of the complaint, the carburetor should be carefully removed from the engine without draining the fuel from the bowl. The contents of the fuel bowl may then be examined for contamination as the carburetor is disassembled.

The following is a step-by-step sequence by which the Rochester 2GC carburetor may be completely disassembled and reassembled. Adjustments may be made and various parts of the carburetor may be serviced without completely disassembling the entire unit.

DISASSEMBLY

DISASSEMBLY OF BOWL COVER

1. Remove fuel inlet screen retainer nut and gasket with ¾" wrench and remove the screen (Fig. 6B-17).

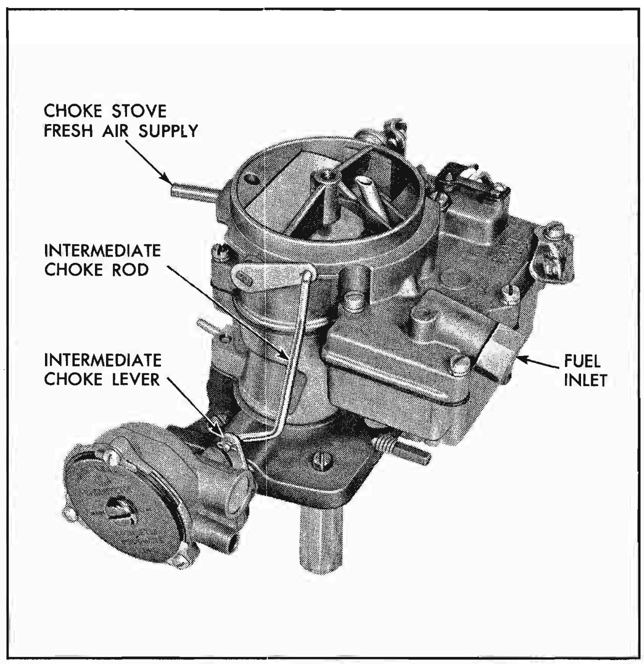


Fig. 6B-17 Rochester 2GC Carburetor

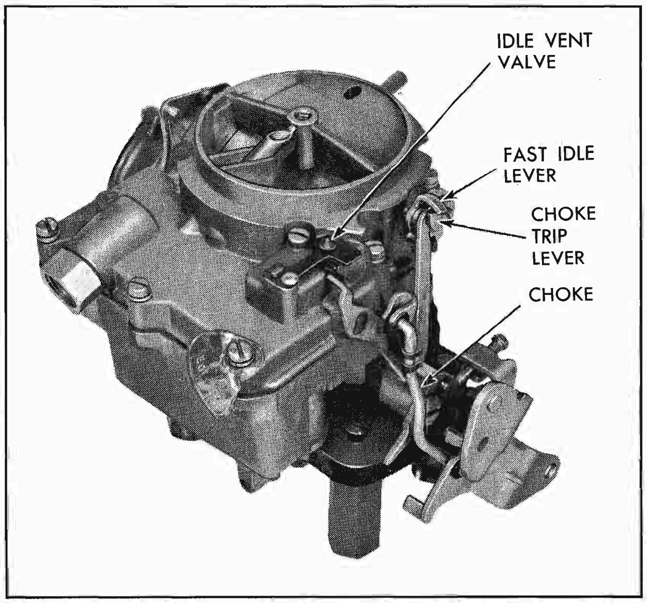


Fig. 6B-18 Rochester 2GC Carburetor

2. Disconnect the pump link (Fig. 6B-18) from the pump lever by removing spring clip. Remove lower end of pump rod from throttle lever by removing clip.

3. Detach choke intermediate rod (Fig. 6B-17) at lower end by removing clip, then detach choke intermediate rod from choke shaft by rotating until the tang on rod clears the slot in lever.

4. Remove retaining screw at the end of the choke shaft and remove choke trip lever and fast idle link and lever (Fig. 6B-18). Lever can be removed from link by turning until slot in lever will pass over tang on link. The link and fast idle cam are retained by a Truarc washer. Disassembly of these pieces will destroy the Truarc washer.

5. Remove eight cover screws (Fig. 6B-19) and lift cover from bowl (Fig. 6B-20).

6. Place upended cover on flat surface. Remove float hinge pin and lift float assembly from cover (Fig. 6B-20). Float needle may now be removed from seat.

7. Remove float needle seat, screen (Fig. 6B-21) and gasket with wide blade screwdriver.

8. Remove power piston (Fig. 6B-21) by depressing piston stem and allowing it to snap free or by holding stem and tapping lightly on air horn with a non-metallic object. Use care not to bend piston stem.

9. Remove retainer on pump plunger shaft, remove plunger assembly from pump arm (Fig. 6B-21). The pump lever and shaft may be removed by loosening set screw on inner arm and removing outer lever and shaft.

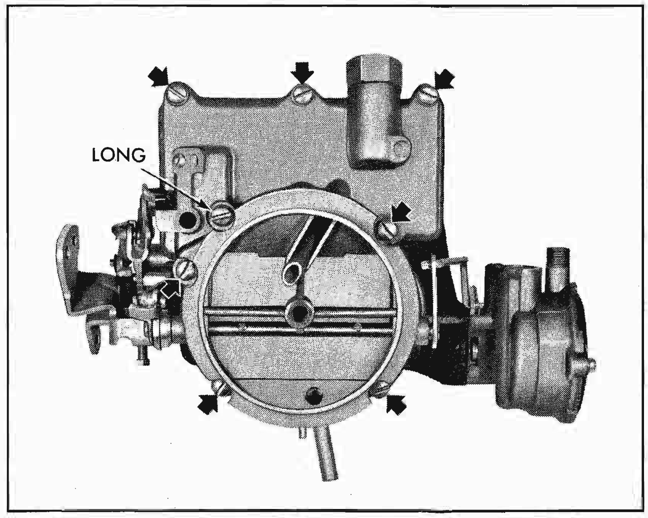


Fig. 6B-19 Location of Cover Attaching Screws

10. The cover gasket may now be removed.

11. Remove idle vent valve.

12. Remove two choke valve attaching screws, then remove choke valve.

13. Remove choke valve shaft from bowl cover.

DISASSEMBLY OF BOWL

1. Remove pump inlet filter screen and pump plunger return spring, and remove aluminum check ball from bottom of pump well (Fig. 6B-22).

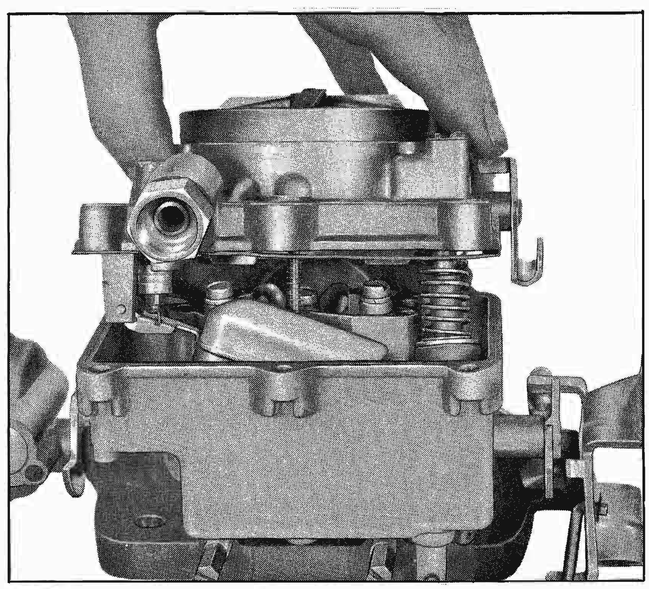


Fig. 6B-20 Removing Bowl Cover Assembly

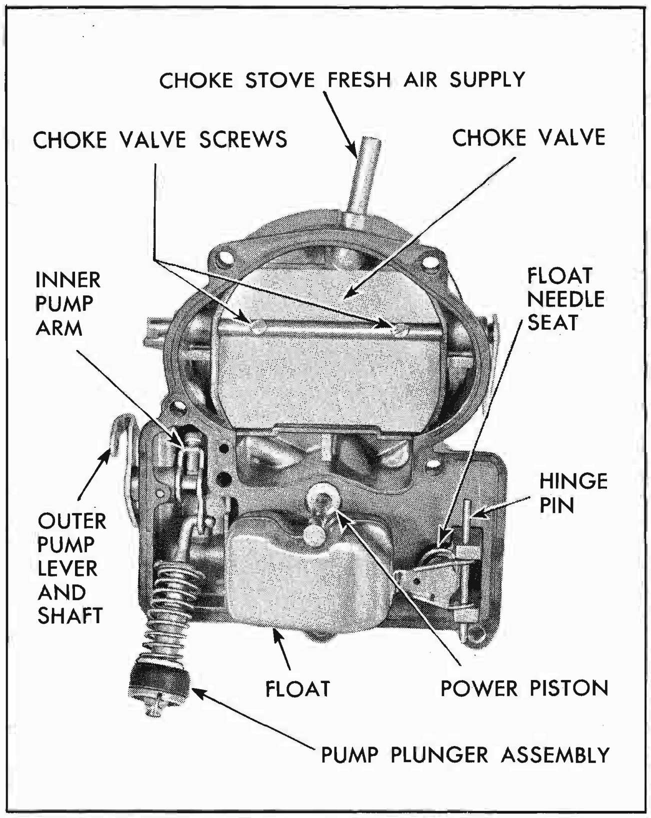


Fig. 6B-21 Bowl Cover Attaching Parts

2. Remove main metering jets and power valve (Fig. 6B-22).

3. Remove three screws on top of cluster, after which cluster and gasket may be removed (Fig. 6B-22).

4. Using a pair of long nose pliers, remove the pump discharge spring retainer (Fig. 6B-23). Then the spring and check ball may also be removed.

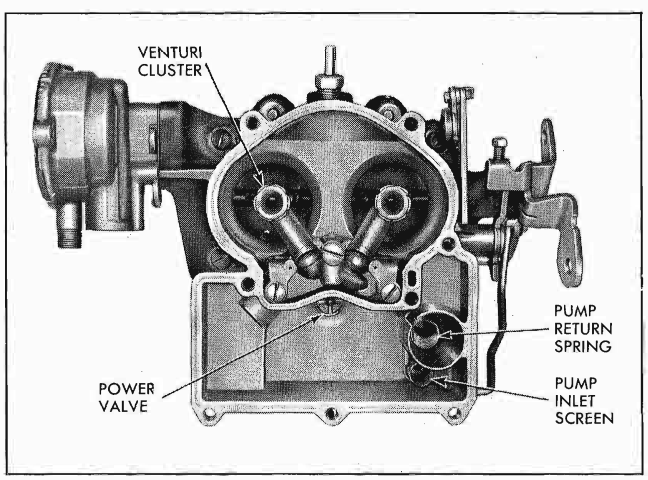


Fig. 6B-22 Carburetor Body Assembly Details

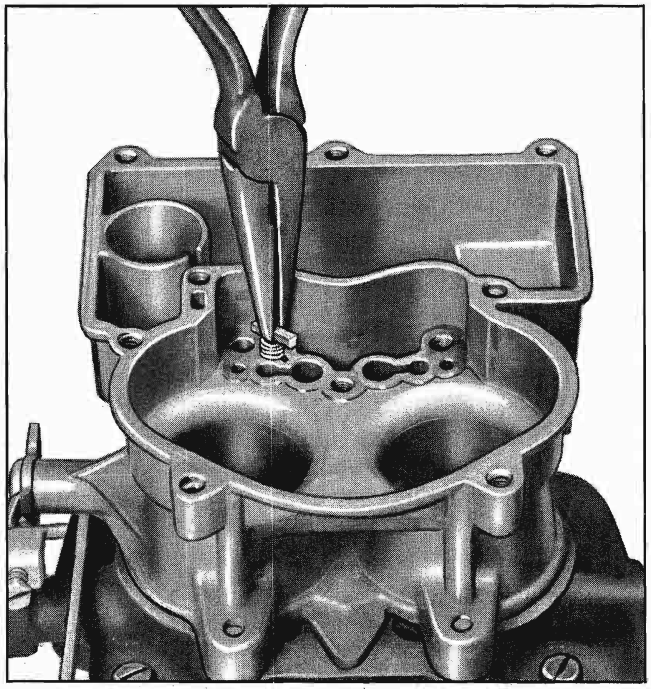


Fig. 6B-23 Removing Pump Discharge Spring Retainer

5. Invert carburetor and remove three large bowl to throttle body attaching screws. Throttle body and gasket may now be removed.

6. Remove fast idle cam and fast idle link as an assembly. DO NOT disassemble.

7. Remove idle compensator bracket and compensator if present.

DISASSEMBLY OF THROTTLE BODY

1. Remove idle adjusting needles and springs.

2. Remove fast idle screw from throttle lever if necessary to replace.

3. Remove the three choke cover attaching screws and retainers, then remove choke cover and coil assembly from choke housing.

4. Remove choke cover gasket and baffle plate.

5. Remove choke piston lever attaching screw (Fig. 6B-24).

6. Remove piston link and lever assembly from carburetor.

NOTE: Piston can be removed from link by dropping out piston pin.

7. Remove the two choke housing attaching screws and detach choke housing from throttle body.

8. Remove intermediate choke shaft and lever from choke housing.

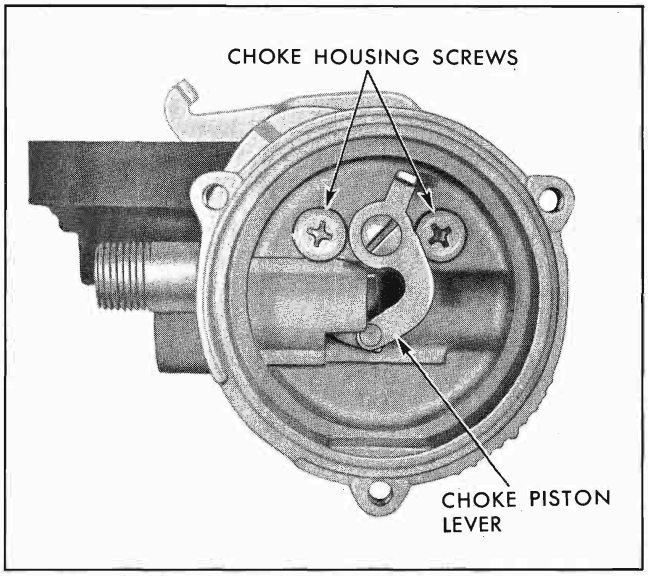


Fig. 6B-24 Choke Housing Screws

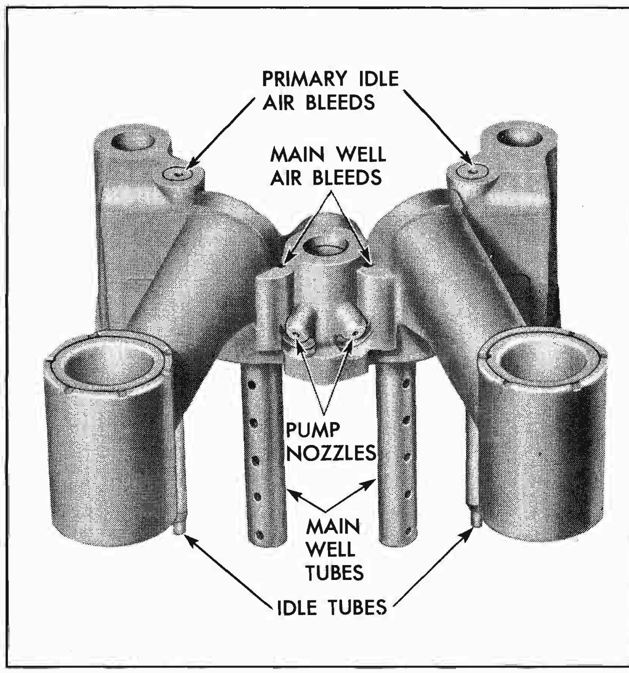


Fig. 6B-25 Passage Identification—Venturi Cluster

CLEANING AND INSPECTION OF PARTS

Dirt, gum, water or carbon contamination in or on the exterior moving parts of a carburetor are often responsible for unsatisfactory performance. For this reason, efficient carburetion depends upon careful cleaning and inspection while servicing.

1. Thoroughly clean carburetor castings and metal parts in clean cleaning solvent.

CAUTION: Choke cover and coil, idle compensator, rubber vent valve, gaskets, and pump plunger should not be immersed in solvent. Clean pump plunger in clean gasoline only.

To avoid damage to gasket between choke housing and throttle body do not soak the throttle body assembly in cleaner or solvent if choke piston housing has not been removed.

2. Blow all passages in castings (Figs. 6B-25 through 6B-29) dry with compressed air and blow off all parts until they are dry.

CAUTION: Do not pass drills or wires through calibrated jets or passages as they may enlarge orifices and seriously affect carburetor calibration.

3. Check all parts for wear. If wear is noted, defective parts must be replaced. Note especially the following:

a. Check float needle and seat for wear. If wear is noted the assembly must be replaced.

b. Check float lip for wear and float for dents. Check floats for gasoline leaks by shaking.

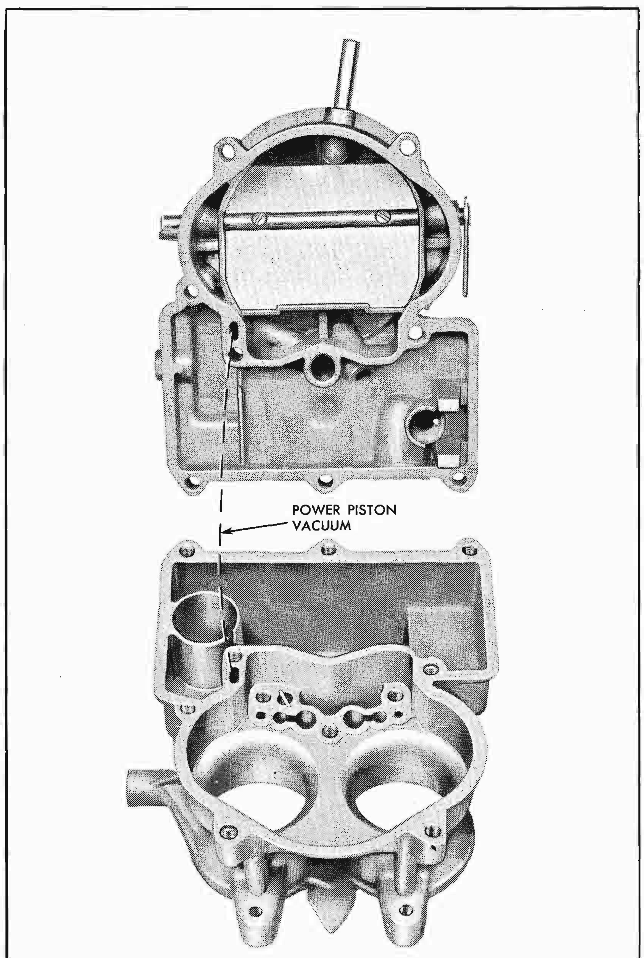


Fig. 6B-26 Passage Identification—Body to Bowl Cover

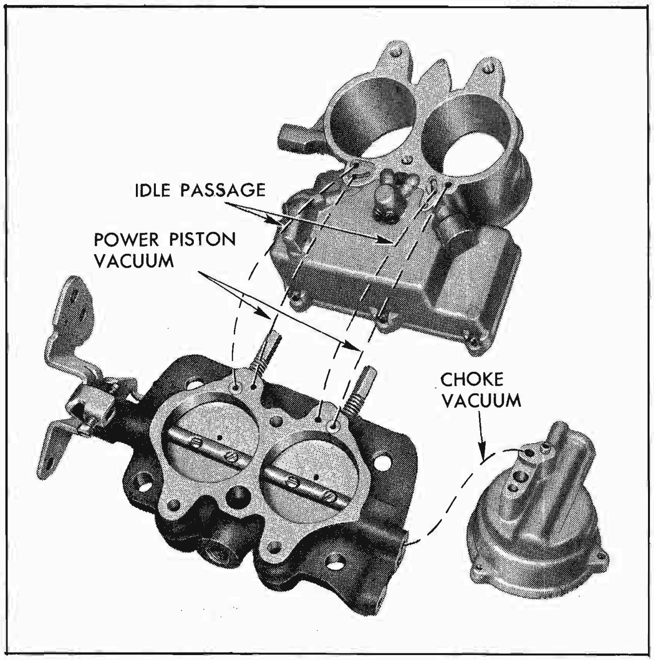


Fig. 6B-27 Passage Identification—Flange—Bowl—Choke Housing

c. Check throttle and choke shaft bores in throttle body and cover castings for wear or out of round.

d. Inspect idle adjusting needle for burrs or ridges. Such a condition requires replacement.

e. Inspect fast idle cam—if wear is noted on steps of cam it should be replaced as it may upset engine idle speed during the warm-up period.

f. Inspect pump plunger leather. Replace plunger if cup is damaged.

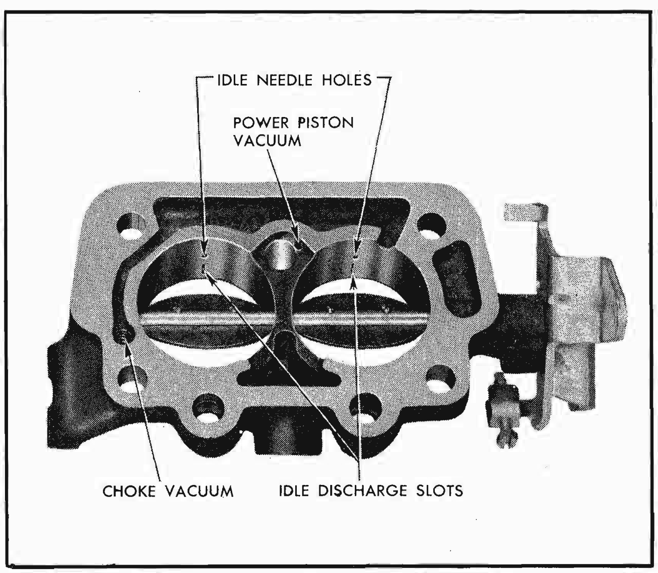


Fig. 6B-28 Passage Identification—Throttle Flange

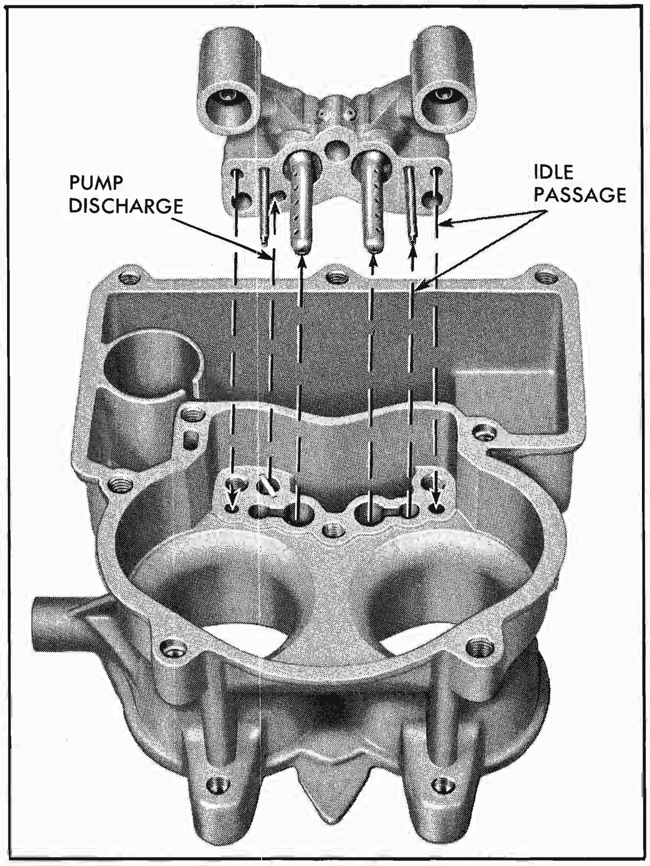


Fig. 6B-29 Passage Identification—Body to Cluster

g. Inspect power piston and spring for burrs or distortion. Replace if necessary.

4. Check all filter screens for dirt or lint. Clean and if they are distorted or plugged, replace with new parts.

5. Inspect cluster casting. If any parts in castings are loose or damaged, cluster assembly must be replaced.

6. Use new gaskets in reassembly.

ASSEMBLY AND ADJUSTMENT

ASSEMBLY OF THROTTLE BODY

1. Install fast idle screw in throttle lever if removed.

2. Screw idle mixture and adjusting needles and springs into throttle body until finger tight. Back out screw 1½ turns as a preliminary idle adjustment.

3. Upend bowl, place new throttle body gasket in position and attach throttle body. Tighten screws evenly and securely.

NOTE: Choke housing should be reassembled to throttle body after installing air horn.

ASSEMBLY OF BOWL

1. Install hot idle compensator on bowl section between venturi.

2. Drop steel pump discharge check ball into pump discharge hole. Ball is $^3/_{16}''$ diameter (do not confuse with aluminum intake ball). Install pump discharge spring and retainer.

3. Replace cluster and gasket, tighten screws evenly and securely. Make certain center screw is fitted with gasket to prevent pump discharge leakage.

4. Replace main metering jets and power valve.

5. Drop aluminum pump intake ball check into hole in pump well. Install pump return spring, pressing with finger to center it in pump well.

6. Replace pump inlet strainer, pressing carefully into position.

ASSEMBLY OF BOWL COVER

1. Install choke shaft in air horn, then install choke valve on choke shaft using two attaching screws. Letters RP on choke valve should face towards top of air horn (Fig. 6B-30). Center choke valve before tightening screws, by installing the fast idle lever and choke trip lever. Maintain approximately .020″ clearance between the fast idle lever and air horn casting. Then tighten choke valve screws and "stake" lightly. Then install choke trip lever and fast idle lever. Choke valve should move freely in housing.

2. Replace pump outer lever and shaft assembly and inner lever, tighten retaining screw on inner lever (Fig. 6B-31).

3. Install small fuel screen on needle seat.

4. Install float needle seat screen and gasket, using wide blade screwdriver.

5. Attach pump plunger shaft with retainer, with shaft end pointing inward towards center of air horn casting.

6. Install cover gasket.

7. Insert needle in seat, carefully position float and insert hinge pin.

8. Adjust float.

(a) Float Level Adjustment

With air horn inverted and gasket in place and needle seated, there should be $5/8'' \pm 1/16''$ clearance between the lower edge of float seam (sharp edge) at the toe end and air horn gasket (Fig. 6B-32). Use

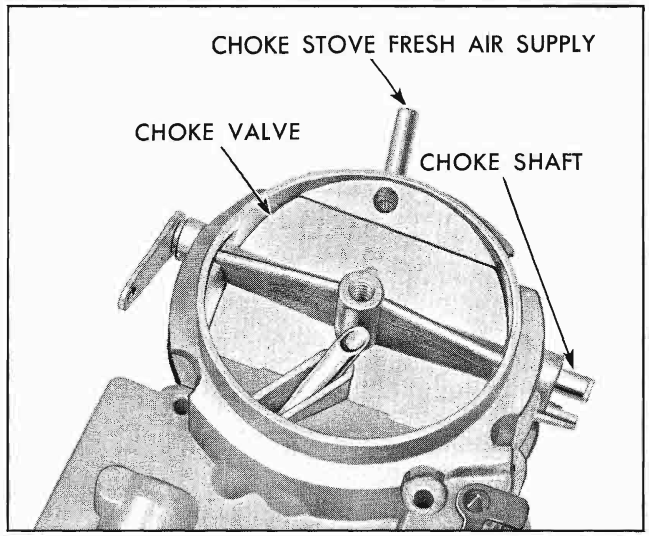


Fig. 6B-30 Choke Valve and Shaft Installed

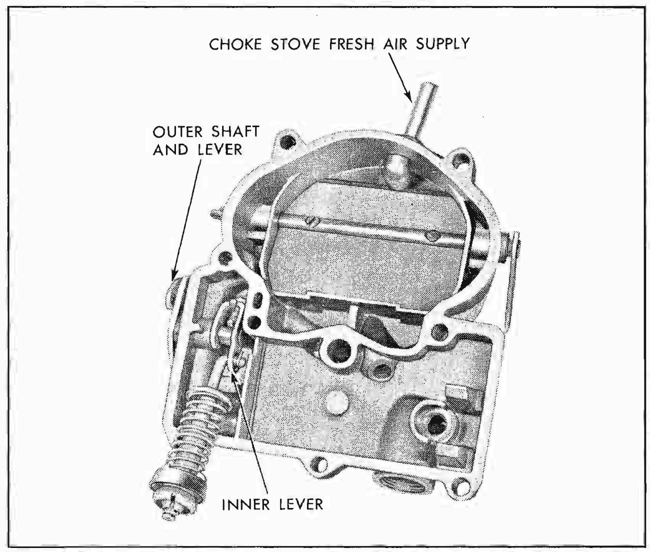


Fig. 6B-31 Pump Plunger Installed on Bowl Cover

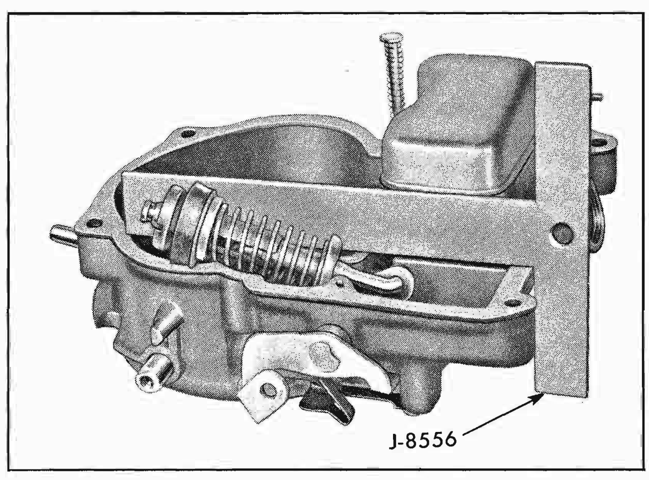


Fig. 6B-32 Checking Float Level

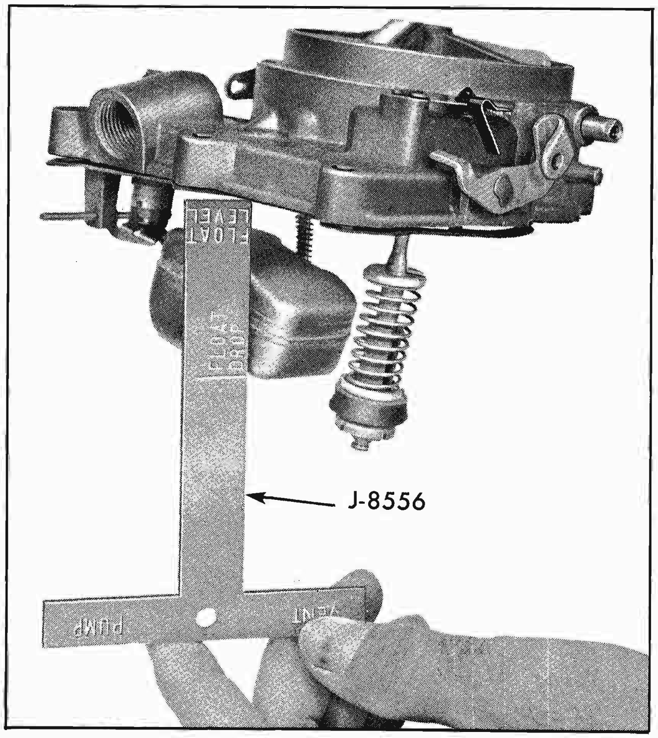


Fig. 6B-33 Checking Float Drop

gauge set J-8556. To adjust, bend float arm at rear of float. Visually check float alignment after adjusting float.

(b) Float Drop Adjustment

With air horn right side up so that float can hang free, the distance from the gasket surface to the lowest point of the float should be a minimum of 1¾" and can be measured using the float gauge (Fig. 6B-33). Maximum drop can be any amount that will retain needle for installation. Needle must not wedge at maximum drop. To adjust, bend tang at rear of float towards needle seat to decrease float drop and away from needle seat to increase float drop.

9. Install power piston in vacuum cavity; piston should travel freely in cavity. Stake vacuum piston retainer washer.

10. Place cover on bowl, making certain that accelerator pump plunger is correctly positioned and will move freely.

11. Install and tighten eight cover screws evenly and securely.

12. Install filter screen, with closed end toward air horn. Install strainer nut and gasket assembly in cover.

13. Install pump link and retainer.

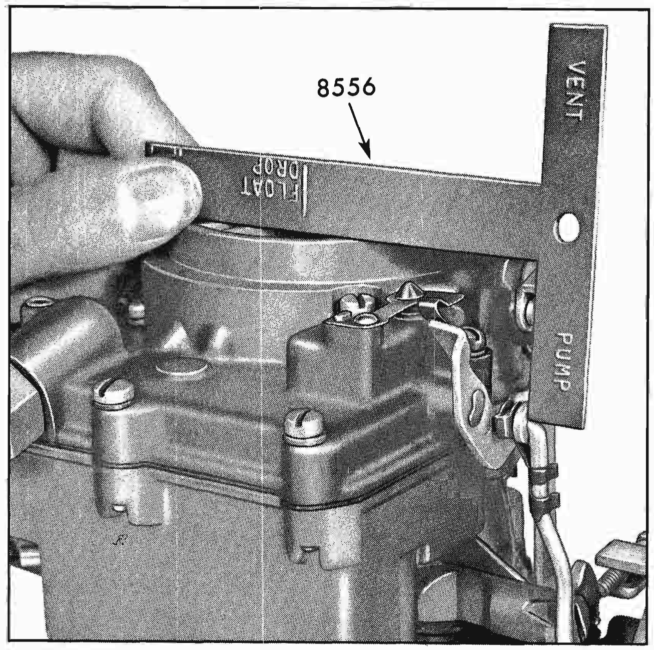


Fig. 6B-34 Pump Link Adjustment

14. Install idle vent valve.

15. To adjust pump link, place tool on top of cleaner mounting ring as shown in Fig. 6B-34. Then with throttle valves fully closed the top surface of the pump rod should just touch the end of the gauge. Measurement should be $1\frac{21}{64}'' \pm \frac{1}{32}''$. Bend pump link to adjust.

16. Install fast idle link and fast idle cam as an assembly and install fast idle lever on other end of fast idle link. Place fast idle lever on choke shaft with the tang facing outward and toward the pump lever. Install trip lever so that tang of trip lever is under tang of choke lever, and install retaining screw (Fig. 6B-35 and 6B-36).

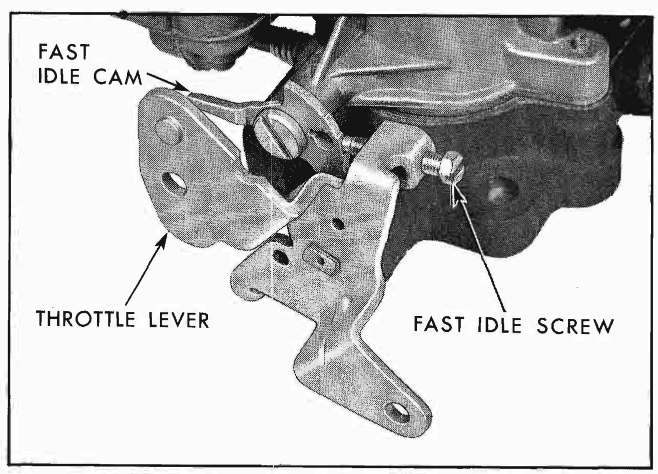


Fig. 6B-35 Fast Idle Cam Installed

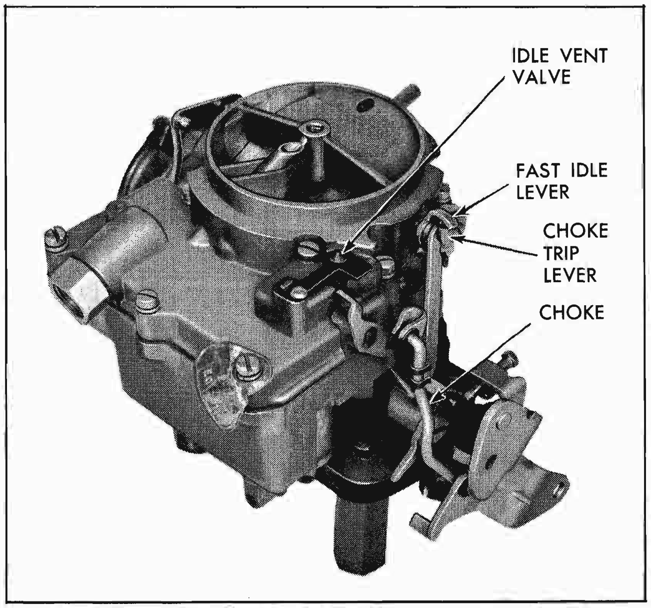


Fig. 6B-36 Carburetor Linkage Installed

17. Assemble intermediate choke shaft and lever and new gasket to choke housing. Attach to throttle body with two attaching screws.

18. Assemble choke piston and linkage to choke housing and attach to intermediate choke shaft. Insert intermediate choke rod into lever on air horn and attach to intermediate choke lever with horseshoe clip.

19. Hold choke valve completely closed and adjust intermediate choke rod as necessary so that choke piston is flush with end of choke housing bore.

20. Install choke baffle plate.

21. Install choke coil and cover and rotate cover counterclockwise until the index marks on cover and housing are aligned. Attach the three retainers and screws to choke housing, tighten securely.

NOTE: Choke valve should be lightly closed at room temperature (75°F.) when index marks on cover and housing are aligned.

FINAL ADJUSTMENTS

CHOKE ROD ADJUSTMENT

1. With the thermostat cover set at index and the choke trip lever in contact with the fast idle lever, locate the fast idle screw on the second step of the fast idle cam, next to the shoulder of the high step.

2. Bend the tang on the fast idle lever so that the small end of .080" wire gauge or drill just fits between the inner side of the air horn and the upper edge of the choke valve (Fig. 6B-37).

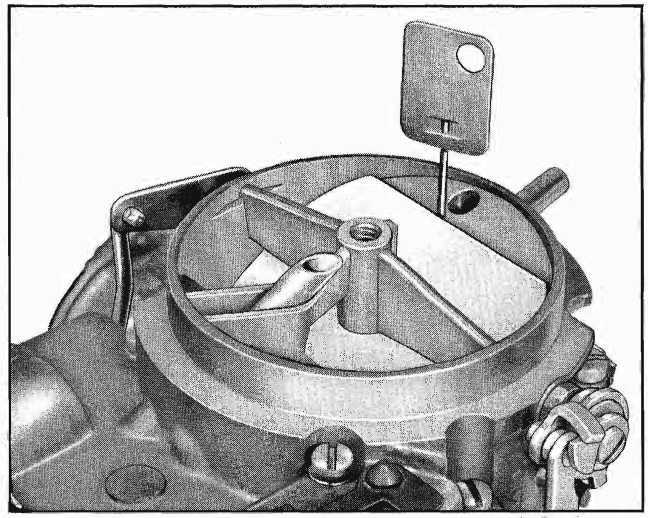


Fig. 6B-37 Choke Rod Adjustment

IDLE VENT ADJUSTMENT

NOTE: Pump rod setting must always be made before making the idle vent adjustment.

With the idle vent valve just closed, bend the tang on the pump lever as necessary to obtain a dimension of $1\frac{17}{64}" \pm \frac{1}{64}"$ between top of pump rod and top of air cleaner ring (Fig. 6B-38). Use tool J-8556 to check.

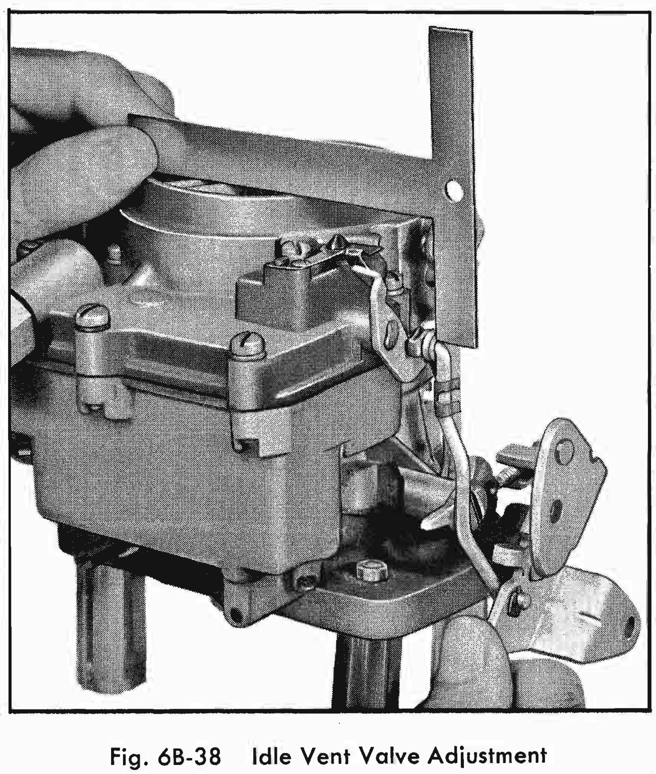
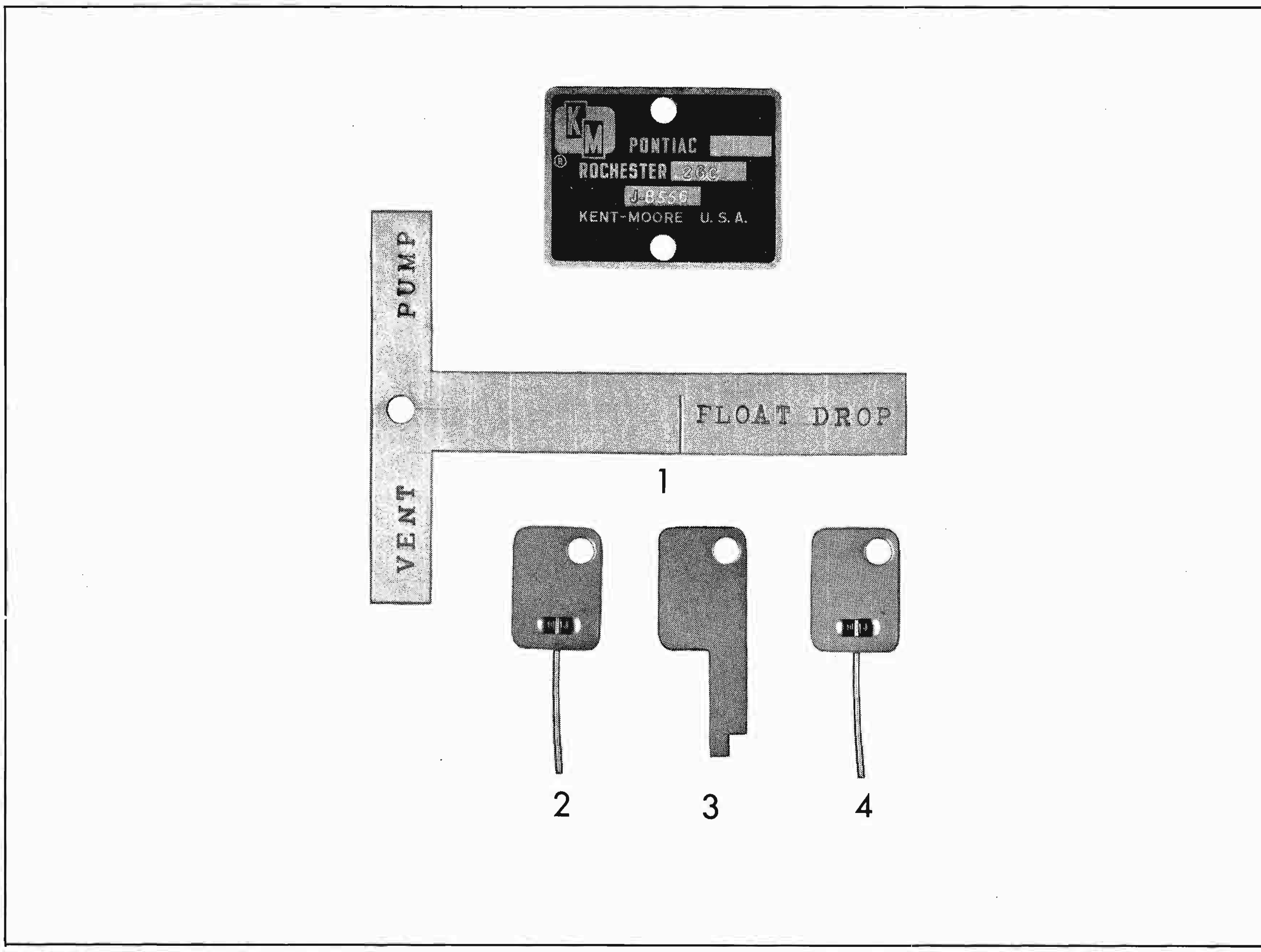


Fig. 6B-38 Idle Vent Valve Adjustment



1. "T" Gauge .... Pump, Idle Vent, Float Level and Float Drop
2. .070″ Gauge .... Choke Rod
3. .163″ Gauge .... Unloader
4. .080″ Gauge .... Choke Setting

Fig. 6B-39 Rochester 2GC (1-11/16″ Throttle Bore)
Special Tools—J-8556-01

ROCHESTER 2GC CARBURETOR (1-7/16" Throttle Bore Diameter)
(MODELS 7020060, 7020064, 7020067, 7020069 AND 7020074 THROUGH 7020077)

DESCRIPTION

The 7020060 carburetor is standard equipment on synchro-mesh models except the Bonneville and the 7020074 and 77 are the economy option carburetors on Hydra-Matic models.

These carburetors are essentially a smaller version of the Hydra-Matic carburetor previously described. The primary differences are in the smaller throttle bore, the location of the choke housing on the bowl cover instead of on the throttle body. The overhaul procedures remain basically the same except for those areas connected directly with choke housing location. Each carburetor is calibrated for its specific application.

Following are adjustment procedures and specifications for the 70020074 - 77 carburetors:

ADJUSTMENTS

FLOAT LEVEL ADJUSTMENT

With air horn inverted, gasket in place and needle seated, there should be $\frac{11}{16}$"$\pm\frac{1}{16}$" clearance between bottom of float seam at toe end and the air horn gasket (Fig. 6B-40). Use gauge set J-8557. To adjust, bend float arm. Recheck float alignment after adjusting float.

FLOAT DROP

With air horn right side up and float hanging free the distance from the gasket surface to the lowest point of the float should be a minimum of 1$\frac{3}{4}$". Use gauge set J-8557 to check (Fig. 6B-41). To adjust, bend float tang. Maximum drop can be any amount that will retain needle for installation. Needle must not wedge at maximum drop.

PUMP ADJUSTMENT

Place end of "T" gauge (J-8557) marked pump, in position on top of air cleaner mounting ring as shown in Fig. 6B-42. With throttle valves fully closed, adjust pump rod to obtain a dimension of 1$\frac{1}{8}$"$\pm\frac{1}{32}$" from air cleaner mounting ring to top of pump rod.

CHOKE ROD ADJUSTMENT

With thermostatic cover set at index and choke trip lever in contact with fast idle lever, locate the fast idle adjusting screw on the second step of the fast idle cam and against the shoulder of the high step. Bend the tang so that the .056" wire gauge (J-8557) just fits between the inner side of the air horn and the upper end of the choke valve (Fig. 6B-43).

IDLE VENT VALVE ADJUSTMENT

NOTE: Pump adjustment must always be made before making the idle vent adjustment.

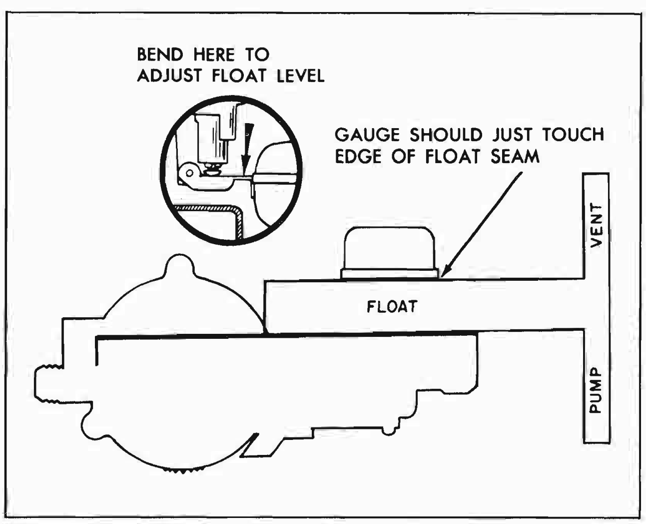


Fig. 6B-40 Checking Float Level

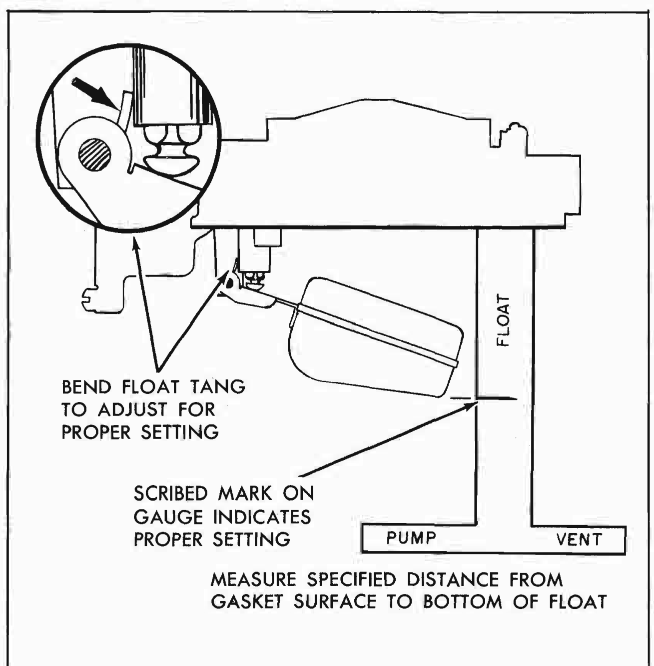


Fig. 6B-41 Checking Float Drop

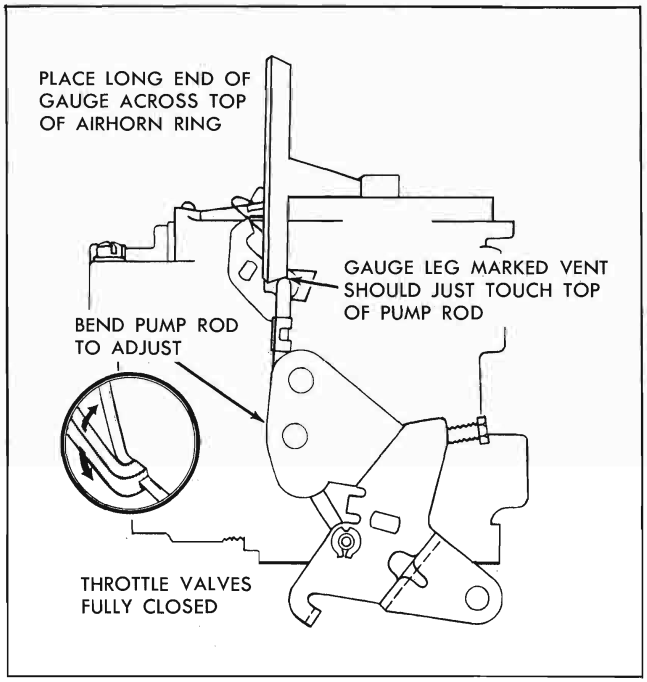


Fig. 6B-42 Checking Pump Adjustment

With the idle vent valve just closed, bend the tang on the pump lever as necessary to obtain a dimension of 1⅝₄″ ± ¹⁄₆₄″ between top of pump rod and top of air cleaner ring (Fig. 6B-44). Use vent leg of "T" gauge J-8557 to check.

IDLE SPEED AND MIXTURE ADJUSTMENT

With the engine at operating temperature, adjust idle speed to the following specifications:

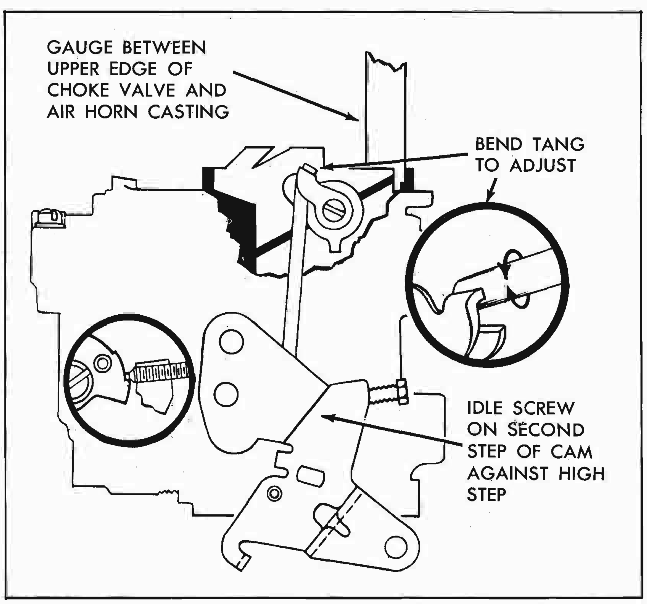


Fig. 6B-43 Choke Rod Adjustment

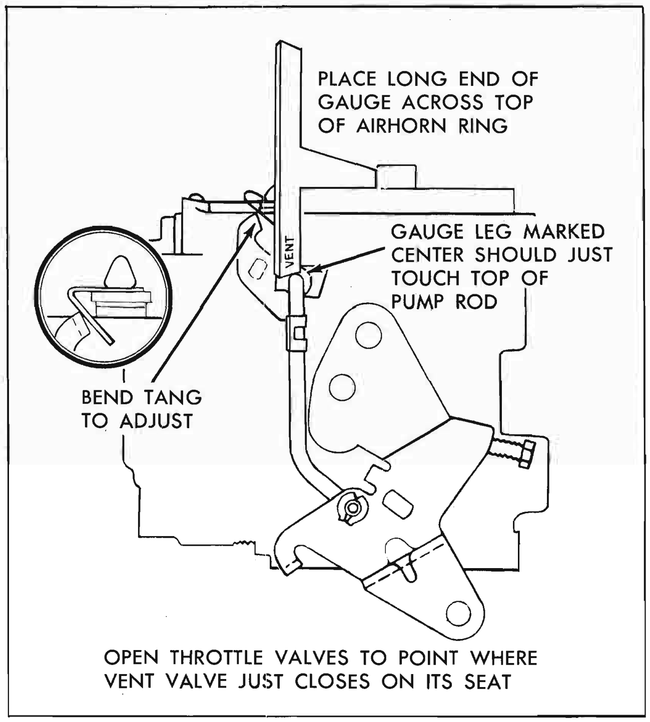


Fig. 6B-44 Idle Vent Valve Adjustment

Whenever idle speed screw is turned, the throttle should be opened slightly then closed to seat screw properly on cam.

Synchro-mesh, exc. Air Conditioning . . 480-500 rpm
Hydra-Matic, exc. Air Conditioning . . 480-500 rpm (in Drive Range)
Air Conditioning . . . . 540-560 rpm
(H/M drive range—air conditioning off)
(S/M neutral, air conditioning off.)

The idle mixture should be adjusted to give a smooth idle at the specified idle speed. Missing is a sign of too lean an idle mixture while "rolling" or "loping" indicates too rich a mixture. Turning the idle mixture screw in, leans out the mixture; one and one-half turns out from the lightly seated position may be used as a preliminary setting of the mixture screws.

NOTE: All triple two barrel carburetors with Hydra-Matic and cars equipped with Circ-L-Aire Conditioning have a hot idle compensator. During idle adjustment, make sure the hot idle compensator is closed by depressing the spring loaded button.

UNLOADER ADJUSTMENT

(NOTE: Unloader adjustment cannot be made correctly unless linkage is properly adjusted.)

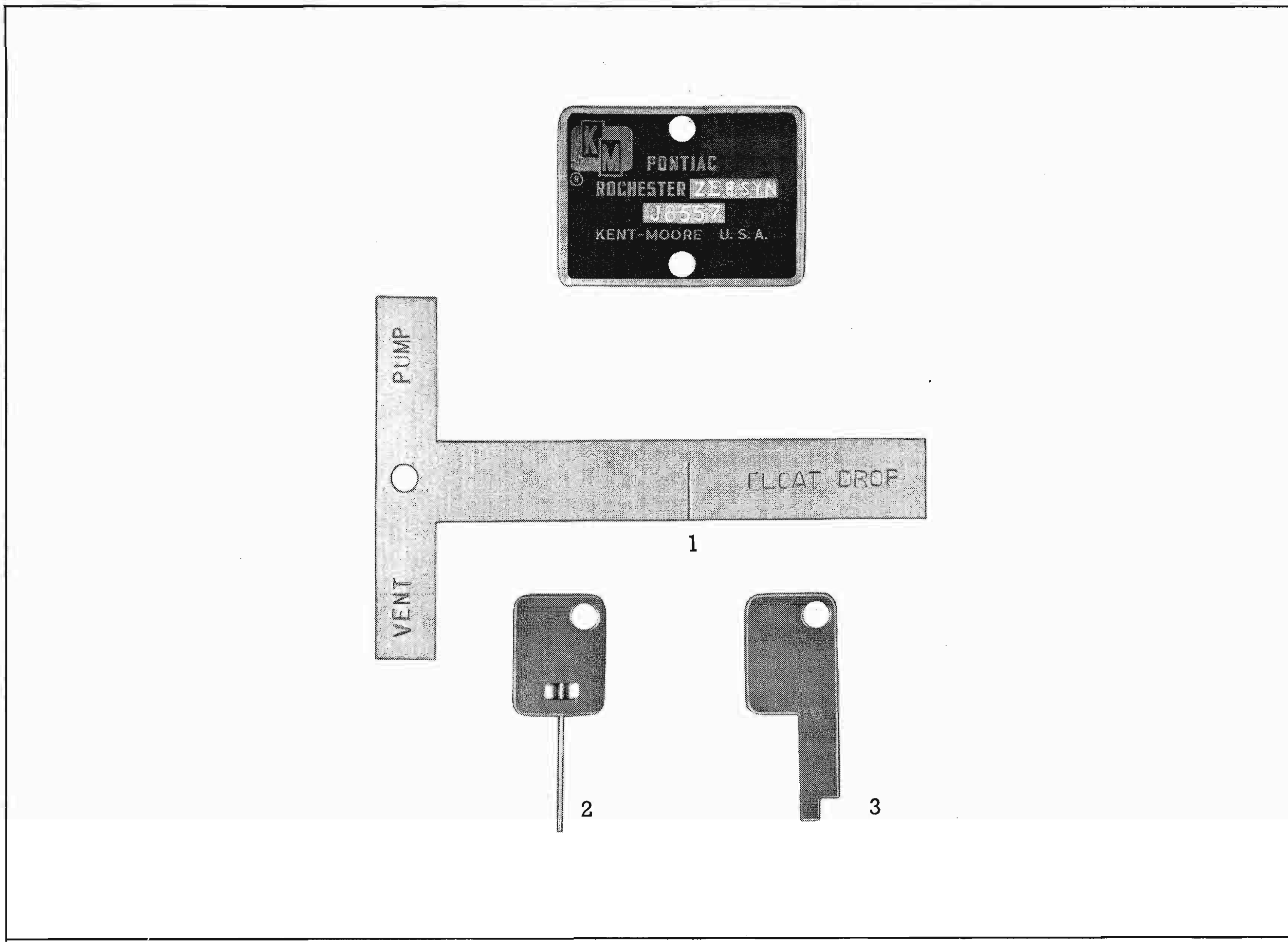
1. Remove carburetor air cleaner assembly.

2. Depress accelerator pedal forcibly to floor. (This should be done by person sitting in driver's seat of car to simulate driving conditions.) Check to see that accelerator pedal is not hitting "hump" over transmission.

3. With accelerator pedal depressed as in Step 2, bend tang on throttle lever to give a clearance of .143" to .183" (gauge set J-8557) between the top of the choke valve and the inside of the air horn.

4. Replace air cleaner assembly.

The above procedure will eliminate variance in linkage, floor mat, pedal location, etc., and should ensure correct unloader action.



1. "T" Gauge..........Pump, Idle Vent, Float Level, Float Drop
2. .056" Gauge.........Choke Rod
3. .163" Gauge.........Unloader

Fig. 6B-45 Rochester 2GC "E" Carburetor (1-7/16" Throttle Bore) Special Tools—J-8557

ROCHESTER 2GC TRIPLE TWO BARREL CARBURETORS

DESCRIPTION

In the triple two barrel installation three Rochester 2 jet carburetors are mounted in tandem. The center carburetor of the trio, called the primary carburetor, contains all the conventional systems of carburetion. These are the float, idle, part throttle, power, pump and choke systems. The front and rear carburetors, called the secondary carburetors, contain only the float, pump and main metering systems.

The center carburetor also incorporates a hot idle air by-pass circuit to avoid over rich idle mixtures on hot idle. When under hood temperatures are high, the hot idle air valve, mounted vertically on the front of the carburetor, opens allowing additional air to enter the manifold below the throttle valves. To ensure that only filtered air enters the manifold this valve is sealed off by a cover and gasket, and can, therefore, only draw air from the air horn area.

When adjusting idle, it is necessary that the valve be in the closed position. To accomplish this, a spring loaded plunger is located in the valve cover. Depressing this plunger holds the valve closed.

The primary carburetor is the only one used during idle, warm-up, and part throttle operation. During cold engine operation, the secondary carburetors are locked out of operation by shutting off the vacuum supply. This is accomplished in the following manner:

A temperature controlled vacuum valve (Fig. 6B-46) mounted at the front of the engine manifold in the water jacket, is controlled by water temperature. The thermo-controlled vacuum valve shuts off all vacuum supplied to the vacuum switch on the center carburetor, until the engine is thoroughly warmed up. When engine temperature reaches approximately 155°F. the temperature controlled vacuum valve opens allowing vacuum to be supplied to the vacuum switch.

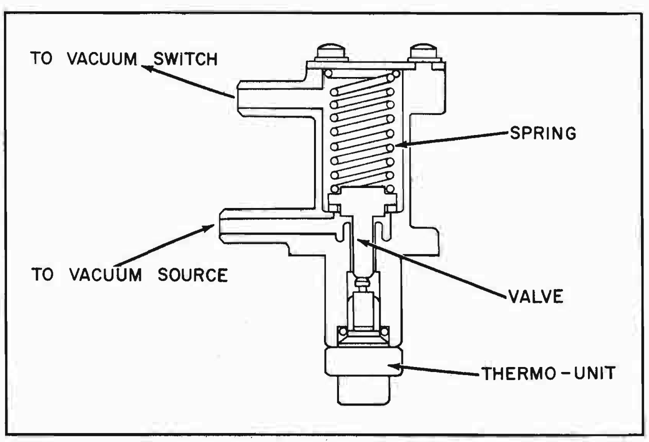


Fig. 6B-46 Thermostatic Lockout Valve

When the primary throttle valves are opened approximately 70°, a lever on the pump arm actuates a vacuum switch which opens a vacuum line to a vacuum diaphragm mounted on the front carburetor. The vacuum diaphragm is connected mechanically by a link to the front carburetor throttle shaft and when the diaphragm moves the throttle valves open fully. The throttle shaft on the rear carburetor is connected mechanically to the shaft on the front carburetor. Therefore movement of the front throttle shaft is transmitted directly to the rear carburetor.

On deceleration the vacuum switch closes shutting off all vacuum at the diaphragm. Air is then bled from inside the carburetor air horn at the front carburetor, through another line through the vacuum switch, allowing the diaphragm to return to its normal position under spring tension. This closes the throttle valves on the front and rear carburetors.

OVERHAUL

The three Rochester carburetors used in this installation can be overhauled using essentially the same procedure as that followed on a standard Rochester 2GC carburetor. Operations concerning the choke, idle and part throttle systems would, of course, be omitted on the front and rear carburetors. When replacing jets and other parts use the Master Parts Catalog for correct parts information.

ADJUSTMENTS

FLOAT LEVEL ADJUSTMENT
(ALL THREE CARBURETORS—FIG. 6B-47)

NOTE: All float adjustments should be made with bowl cover gasket in place.

1. Remove air horn with gasket from carburetor bowl.

2. With bowl cover inverted on a flat surface, place float level gauge on bowl cover as shown.

3. With one edge of the float gauge lying flat across the air horn gasket, the other edge should just touch the "sharp" edge of the float seam. See Fig. 6B-47, dimension 21/32" all carburetors.

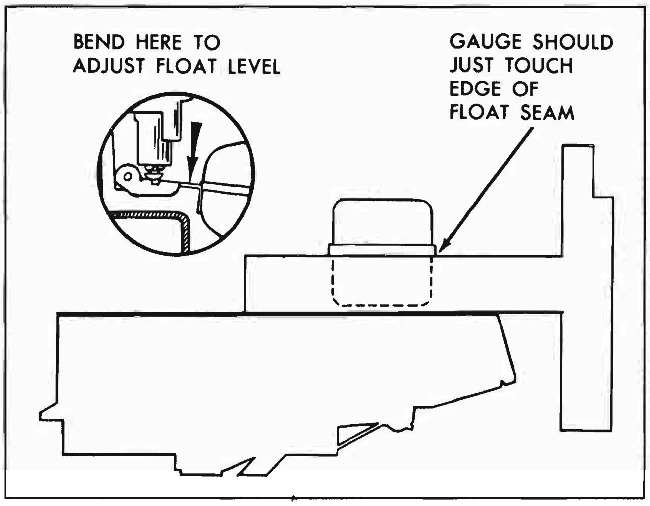


Fig. 6B-47 Float Level Adjustment

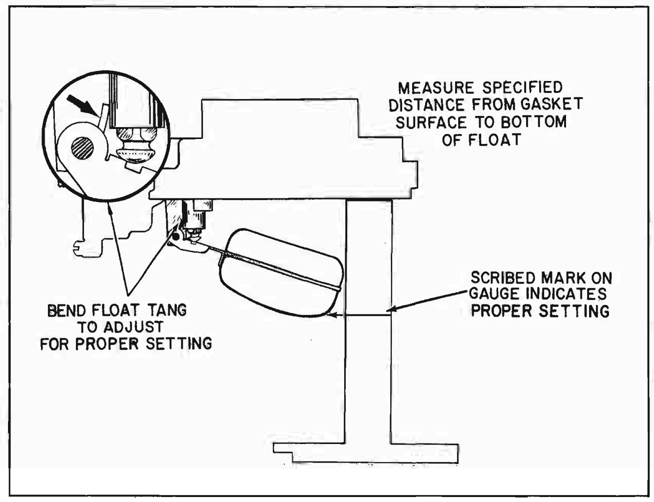


Fig. 6B-48 Float Drop Adjustment

FLOAT DROP ADJUSTMENT
(ALL THREE CARBURETORS—FIG. 6B-48)

1. Hold bowl cover in an upright and level position, place float gauge in position as shown in Fig. 6B-48. This dimension should be a minimum of 1¾". Bounce float lightly with finger before checking measurement to make sure float is settled.

NOTE: Maximum drop can be any amount that will retain needle for installation. Needle must not wedge at maximum drop.

2. If the float drop is incorrect, bend float tang toward float needle seat to decrease drop or away from seat to increase drop.

PUMP ROD ADJUSTMENT
(FIGS. 6B-49 & 6B-50)

1. On the center carburetor, back off idle speed adjustment screw until throttle valves are completely closed.

NOTE: When checking the pump rod adjustment, make sure that the throttle valves are completely closed.

2. Place gauge across top of air horn ring with leg marked "pump" next to top of pump rod (See Fig. 6B-49).

3. With the throttle valves closed, check the distance from top of air horn ring to top of pump rod. Leg of gauge marked "pump" should just touch top of pump rod. This scale dimension should be 55/64" on the end carburetors and 1⅛" on center carburetor.

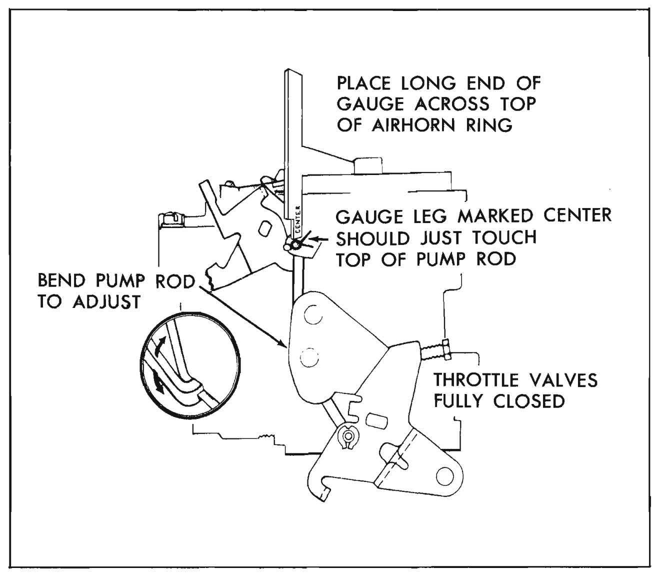


Fig. 6B-49 Pump Rod Adjustment—Center Carburetor

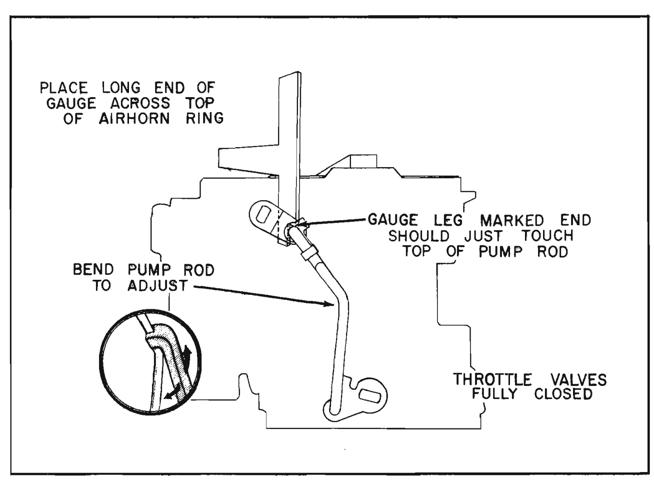


Fig. 6B-50 Pump Rod Adjustment—End Carburetor

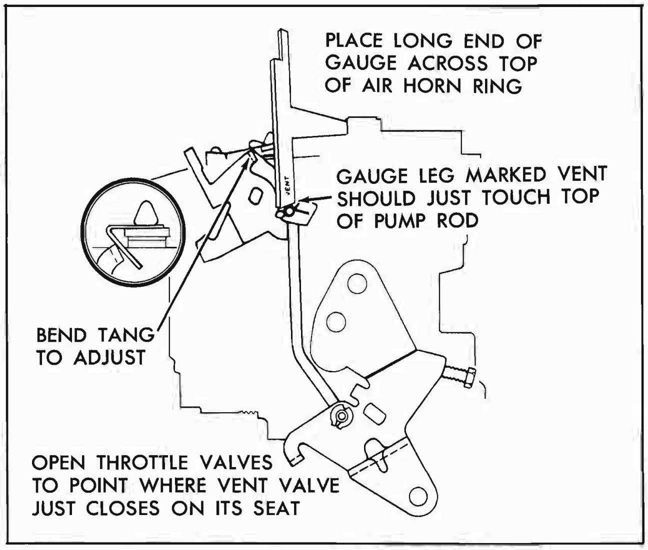


Fig. 6B-51 Idle Vent Valve Adjustment

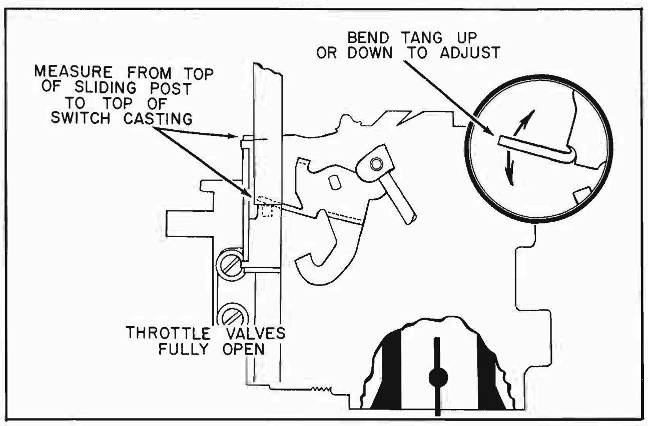


Fig. 6B-52 Vacuum Switch Adjustment

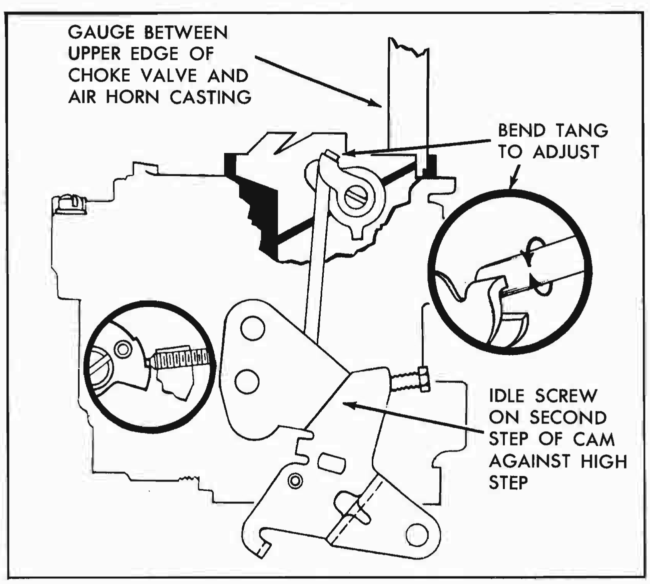


Fig. 6B-53 Choke Rod Adjustment

4. If adjustment is required, bend lower section of pump rod to obtain proper adjustment.

NOTE: Both "center" and "end" carburetor pump rod settings can be made with the combination float, pump and vent gauge. Use side of leg marked "center" for center pump rod setting and side of gauge leg marked "end" for end carburetor pump setting.

IDLE VENT VALVE ADJUSTMENT (CENTER CARBURETOR)

1. To check and adjust the atmospheric idle vent valve, always make the accelerator pump rod adjustment first.

2. Slowly open the throttle valves to the point where the idle vent valve just closes.

3. With the throttle held in this position, place gauge on the top of the air horn ring as shown in Fig. 6B-51. The bottom of the gauge leg marked "vent" should just touch the top of the pump rod. The scale dimension should be $1\frac{1}{32}''$.

4. To adjust, bend vent valve actuating tang on pump lever up or down to obtain specified dimension.

VACUUM SWITCH ALIGNMENT AND ADJUSTMENT (CENTER CARBURETOR)

1. Open throttle to the wide open position and measure the distance from the top of the post to the top of the vacuum switch, Fig. 6B-52. This distance should be $1\frac{5}{32}''$.

2. If adjustment is required, loosen switch attaching screws and move switch up or down to correct.

CAUTION: Be careful not to bump or bend lever after adjustment has been made.

3. Open and close throttle to make sure that arm on pump lever does not bind the post on the vacuum switch.

ADJUST CHOKE ROD (CENTER CARBURETOR ONLY)

Place the idle screw on the second step of the fast idle cam and against the shoulder of the high step as shown in Fig. 6B-53. Make sure that choke trip lever is in contact with the choke counterweight lever. Bend counterweight tang so that wire gauge just fits between the upper edge of the choke valve and the air horn wall. The adjustment specification is .056".

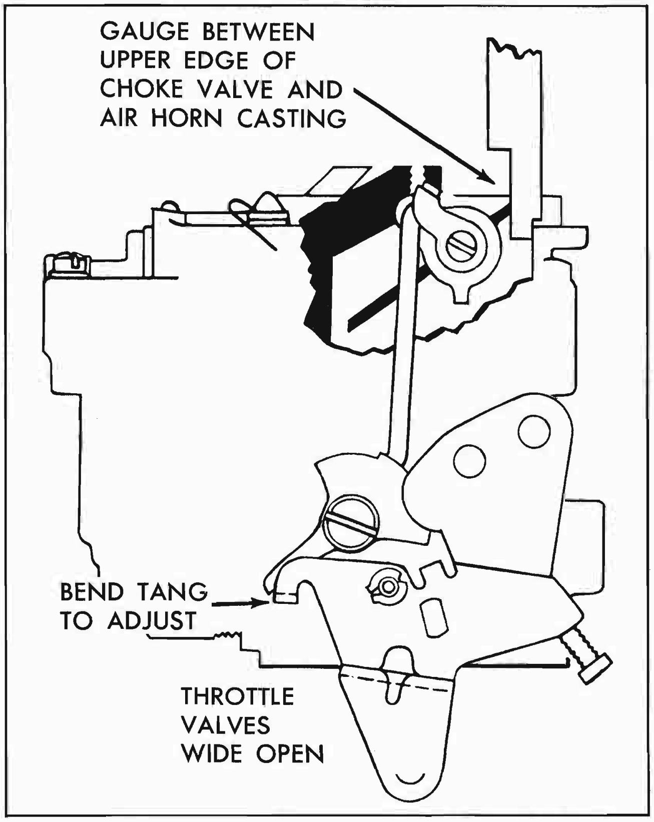


Fig. 6B-54 Unloader Adjustment

ADJUST UNLOADER (CENTER CARBURETOR ONLY)

With the throttle valves held wide open (preferably by person sitting in driver's seat and depressing accelerator pedal) the choke valve should be open enough so that gauge will fit freely between wall of air horn and choke valve (Fig. 6B-54). Bend the unloader tang on the throttle lever to adjust. The adjustment specification is .143"-.183".

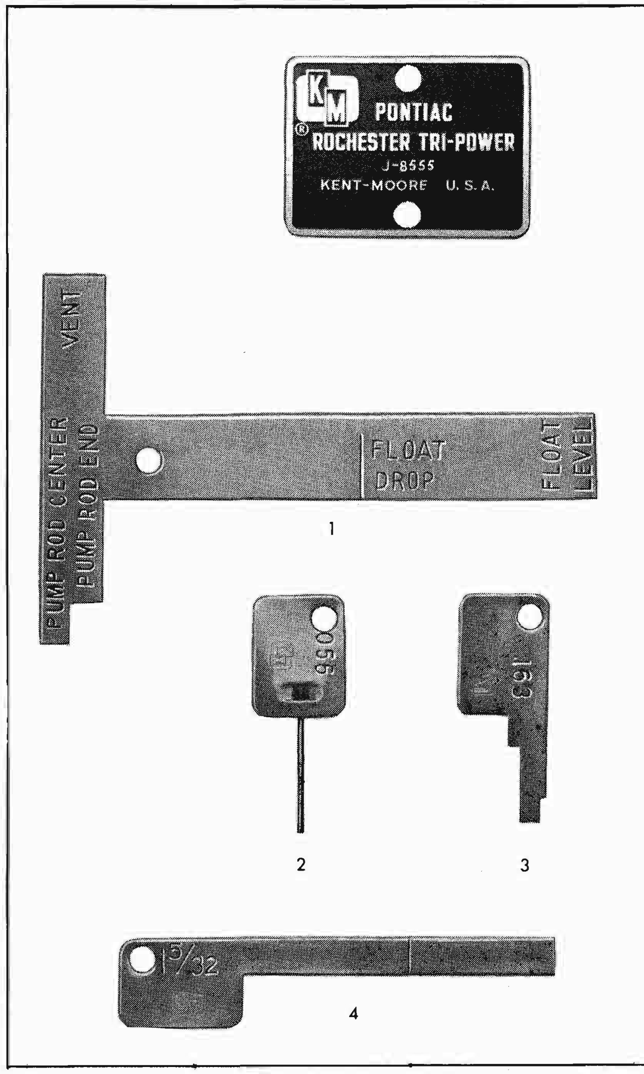
ADJUST THROTTLE ACTUATING ROD

Disconnect the end of throttle actuating rod which connects the throttle levers on the front and rear carburetors. With both throttle valves closed on the front and rear carburetors the rod should center in the slot in the throttle lever. Bend the throttle rod to adjust. Connect throttle rod after adjustment.

ADJUST IDLE SPEED AND MIXTURE

With the engine at operating temperature adjust the idle speed on the center carburetor only to the following specification.

NOTE: Depress hot idle compensator (spring loaded valve) while making idle adjustment.



1. "T" Gauge . . . . Pump, Idle Vent, Float Level and Float Drop
2. .056" Gauge . . . . Choke Rod
3. .163" Gauge . . . . Unloader
4. $1\frac{5}{32}$" Gauge . . . . Vacuum Switch

Fig. 6B-55 Triple Two Barrel Carburetor Special Tools—J-8555

Synchro-mesh, exc. Air Conditioning . .	480-500 rpm
Hydra-Matic, exc. Air Conditioning . . .	480-500 rpm in drive range
Air Conditioning	540-560 rpm

(H/M drive range, air conditioning off.)
(S/M neutral, air conditioning off.)

Adjust mixture on center carburetor to give smoothest possible idle at specified idle speed.

COMPARISON OF TWO BARREL CARBURETORS

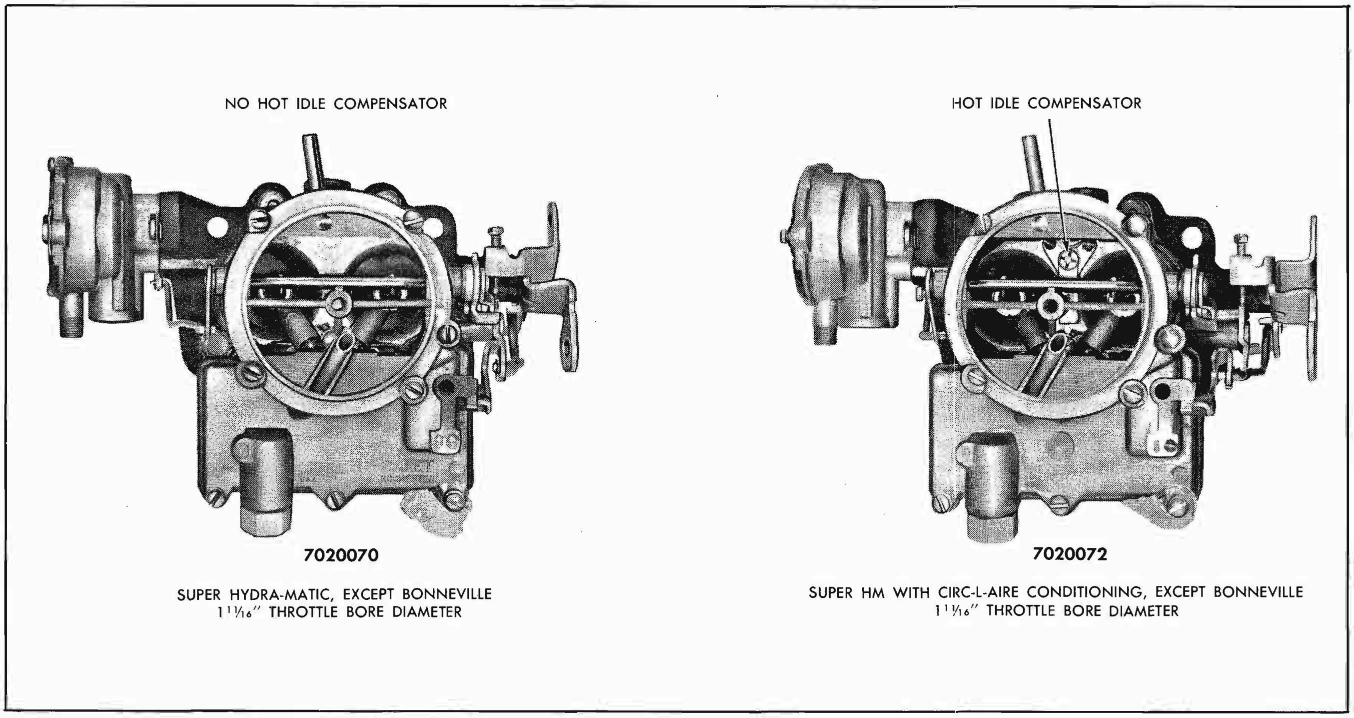


Fig. 6B-56 Comparison of 7020070 and 7020072 Carburetors Showing Hot Idle Compensator Which is Internal. Calibration Specifications Same for Both Carburetors

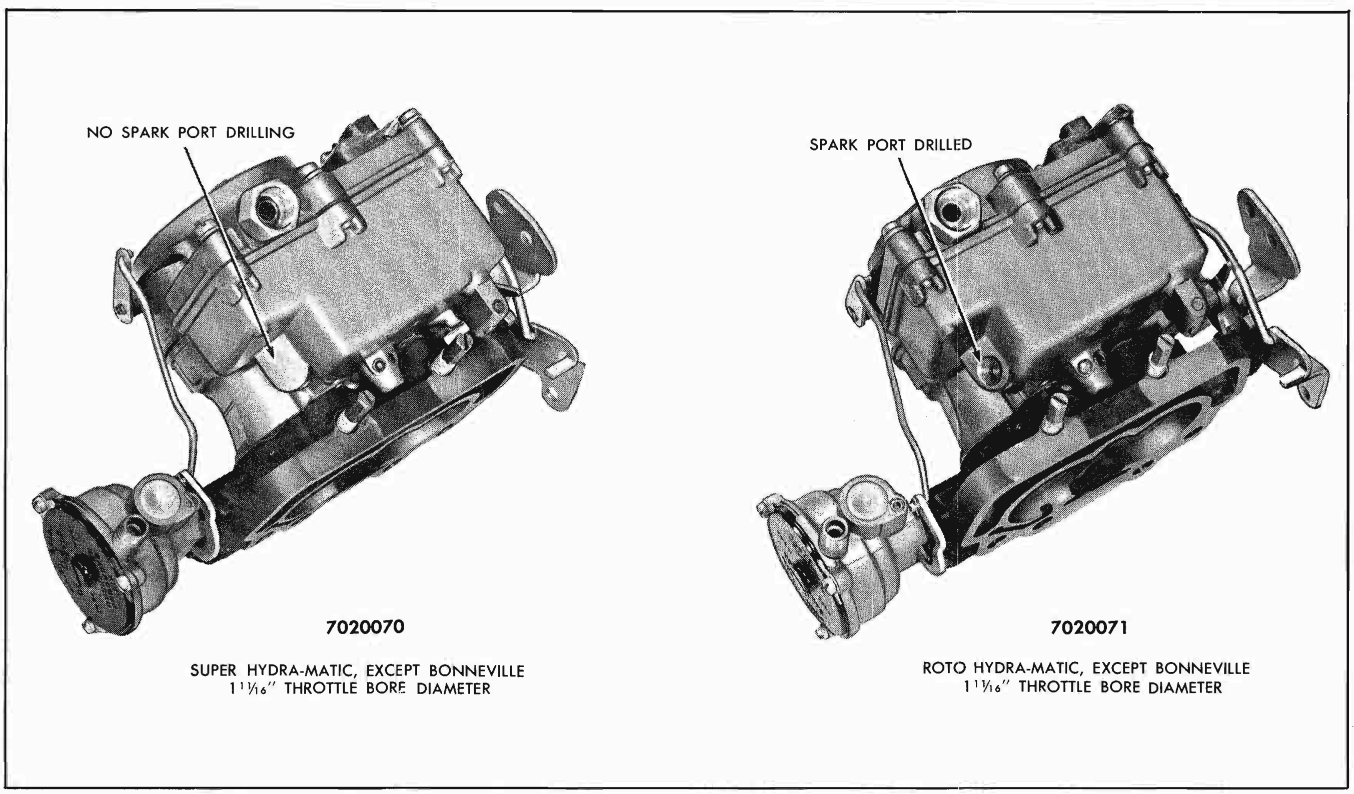
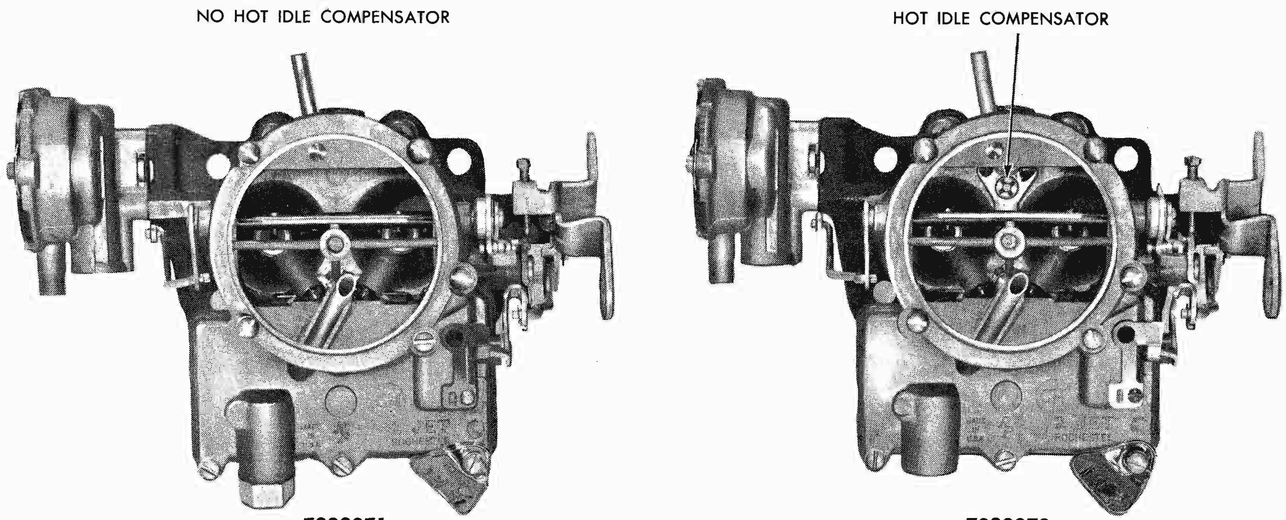


Fig. 6B-57 Comparison of 7020070 and 7020071 Carburetors Showing Spark Port Drilling No Throttle Return Check on 7020070—7020071 Has Throttle Return Check



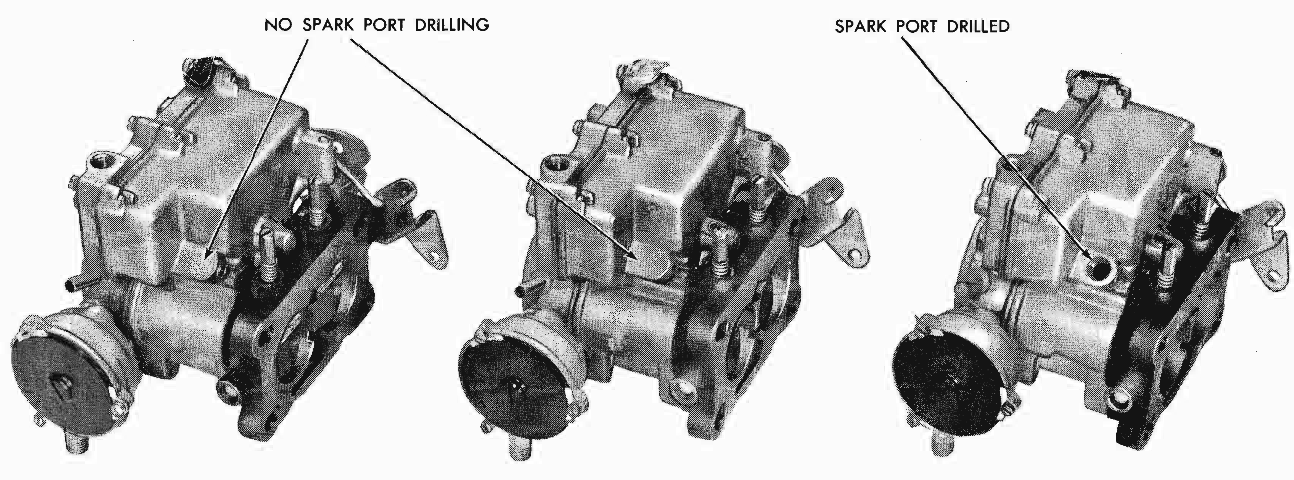
7020071

ROTO HYDRA-MATIC, EXCEPT BONNEVILLE
1 11/16" THROTTLE BORE DIAMETER

7020073

ROTO HM WITH CIRC-L-AIRE CONDITIONING, EXCEPT BONNEVILLE
1 11/16" THROTTLE BORE DIAMETER

Fig. 6B-58 Comparison of 7020071 and 7020073 Carburetors Showing Hot Idle Compensator Which is Internal. Calibration Specifications Same for Both Carburetors



7020060

SYNCHRO-MESH, EXCEPT BONNEVILLE
1 7/16" THROTTLE BORE DIAMETER

7020074

SUPER HYDRA-MATIC ECONOMY OPTION
1 7/16" THROTTLE BORE DIAMETER

7020075

ROTO HYDRA-MATIC ECONOMY OPTION
1 7/16" THROTTLE BORE DIAMETER

Fig. 6B-59 Comparison of 7020060, 7020074 and 7020075 Carburetors Showing Spark Port Drilling. 7020075 is Equipped with Throttle Return Check

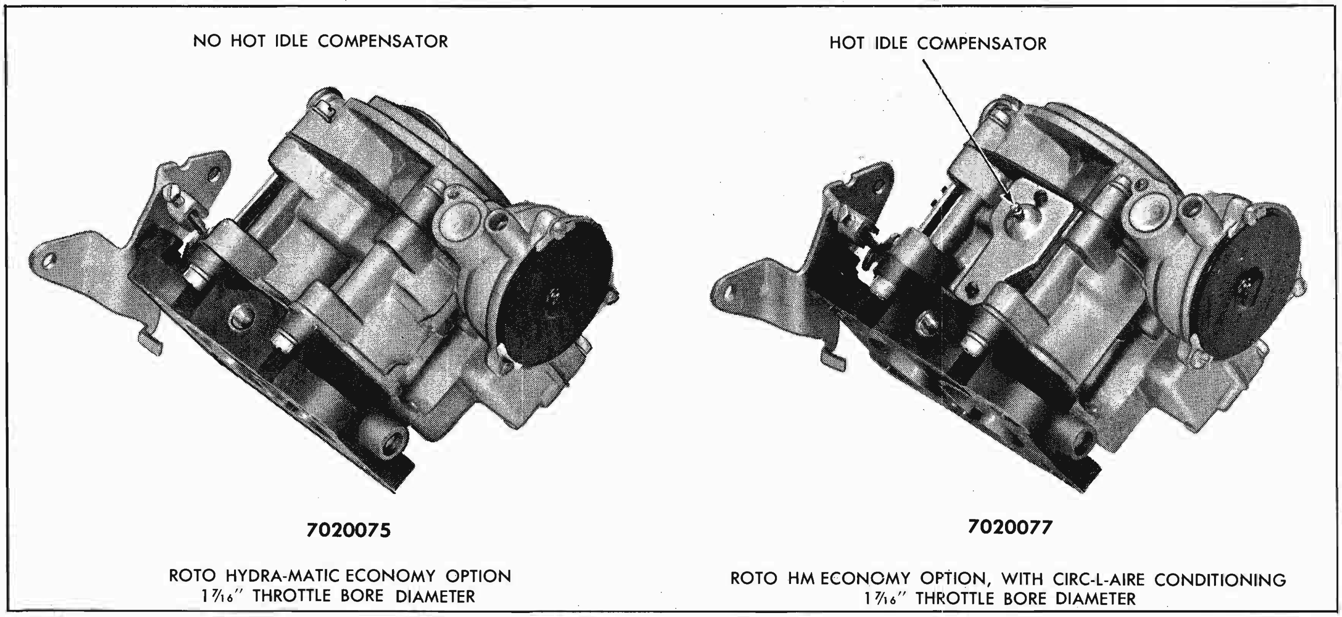


Fig. 6B-60 Comparison of 7020075 and 7020077 Carburetors Showing Hot Idle Compensator Calibration Specifications Same for Both Carburetors

Carburetor Model		Float Level	Float Drop	Choke Rod	Unloader	Stat Setting	Pump Rod	Idle Vent	Throttle Return Check Setting
7013063 7013065 7020070	7020071 7020072 7020073	5/8" ± 1/16"	1 3/4" Min.	.080"	.143"-.183"	Index	1 21/64" ± 1/32"	1 17/64" ± 1/64"	.062"-.067"*
7020060 7020064 7020067 7020069	7020074 through 7020077	11/16" ± 1/16"	1 3/4" Min.	.056"	.143"-.183"	Index	1 1/8" ± 1/32"	1 5/64" ± 1/64"	.090"-.095"*

*With screw on next to high step on cam.

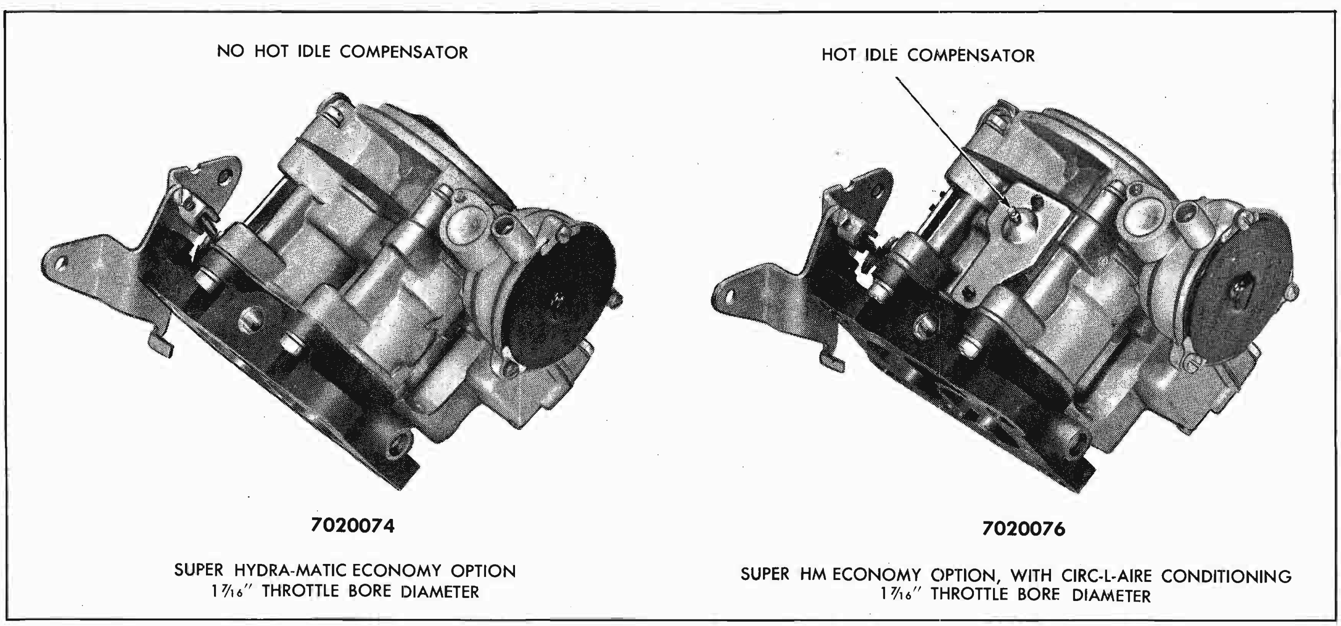


Fig. 6B-61 Comparison of 7020074 and 7020076 Carburetors Showing Hot Idle Compensator Calibration Specifications Same for Both Carburetors

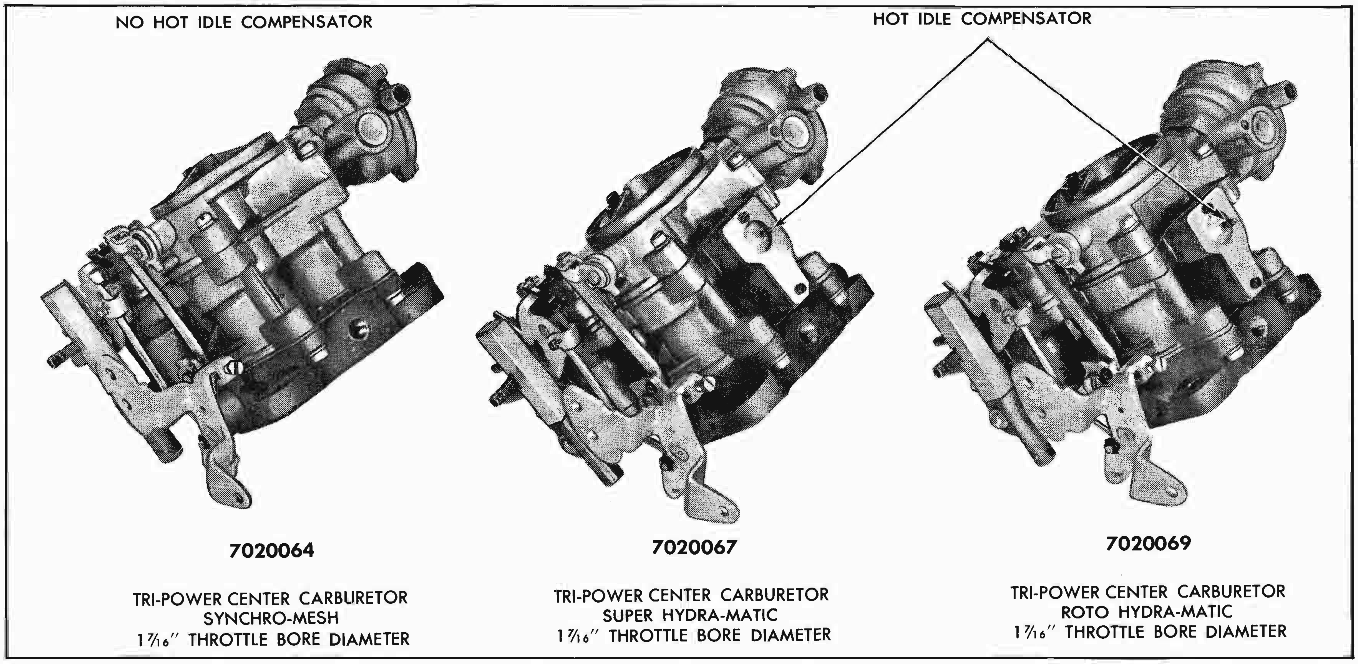


Fig. 6B-62 Comparison of 7020064, 7020067 and 7020069 Carburetors Showing Hot Idle Compensator
None Are Equipped With Throttle Return Check

Carburetor Model	Float Level	Float Drop	Choke Rod	Unloader	Stat Setting	Pump Rod	Idle Vent	Vacuum Switch
Tri-Power Center Carb.	23/32″ ± 1/16″	1 3/4″ Min.	.056″	.143″-.183″	Index	1 1/8″ ± 1/32″	1 1/32″ ± 1/64″	1 5/32″
Tri-Power End Carb.	23/32″ ± 1/16″	1 3/4″ Min.	—	—	—	55/64″ ± 1/32″	—	—

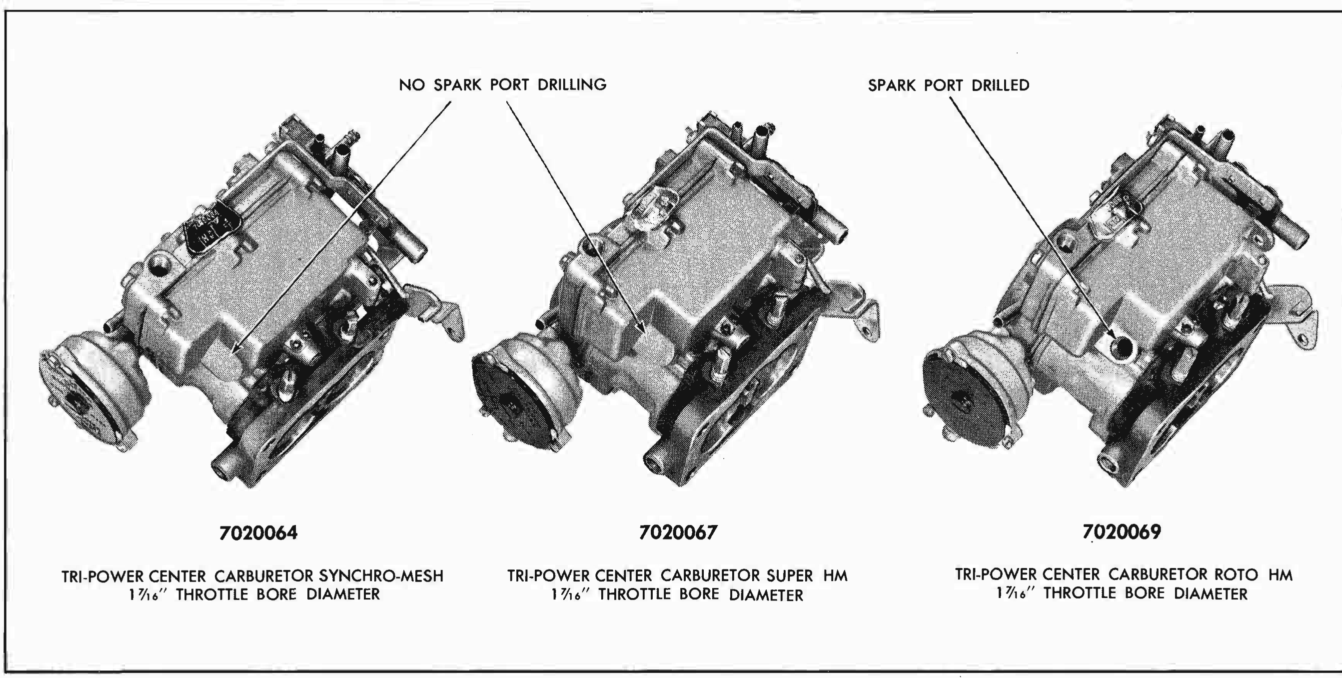


Fig. 6B-63 Comparison of 7020064, 7020067 and 7020069 Carburetors Showing Spark Port Drilling
None Are Equipped With Throttle Return Check

CARTER AFB FOUR BARREL CARBURETOR

DESCRIPTION

The Carter AFB (aluminum four barrel) carburetor is composed of two major assemblies, an air horn assembly and a combined throttle body and bowl called the body assembly. The air horn and body are made of cast aluminum.

The carburetor is basically two dual carburetors in one assembly. The half of the carburetor containing the step up rods, pump assembly and idle system is called the primary side of the carburetor. The other half is called the secondary side.

The carburetor contains the conventional carburetor circuits:

Float Circuits

Low Speed Circuits

High Speed Circuits

Pump Circuit

Choke Circuit

FLOAT CIRCUIT (FIG. 6B-64)

The purpose of the float circuit is to maintain the correct fuel level in the carburetor bowl at all times. The Carter AFB carburetor has two separate float circuits. Each float operates in its own float bowl and each bowl supplies fuel to a primary low speed circuit and to a primary and secondary high speed circuit. The two circuits operate identically.

When the fuel level in the bowl drops the float also drops allowing the needle to fall away from its seat.

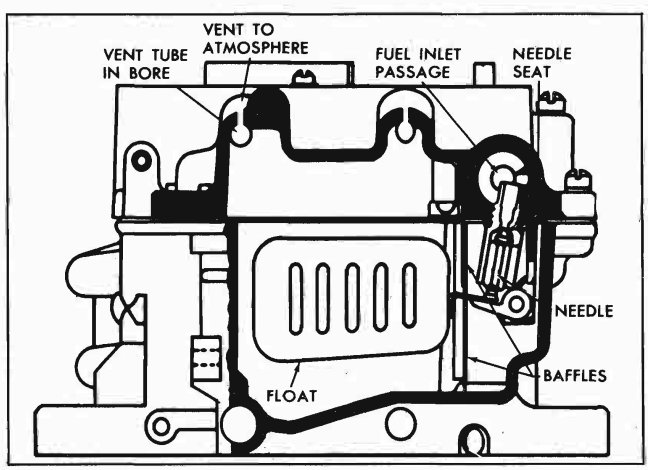


Fig. 6B-64 Float Circuit

Fuel at the fuel inlet under fuel pump pressure will then enter through the strainer screen past the needle and seat and into the float bowl. As the fuel level rises in the bowl the needle valve is seated cutting off the flow of fuel.

The intake needle seats are installed at an angle to give positive seating action of the intake needles. Intake needles and seats are carefully matched in manufacture and tested to ensure against fuel leakage. They should therefore always be used in pairs and not intermixed.

The bowl areas are vented to the inside of the air horn, to atmosphere and to each other to ensure equal pressure on the surface of the fuel at all times and to allow the escape of fuel vapors. Baffles are used in the bowl area to minimize fuel turbulence.

LOW SPEED CIRCUITS (FIG. 6B-65)

Fuel for idle and early part throttle operation is metered through the low speed circuits on the primary side of the carburetor. With the throttle valves closed, manifold vacuum exists at the idle needle port and idle discharge port. Atmospheric pressure will then force fuel through the primary metering jet and up through the low speed jet. The fuel picks up air at the bypass and is metered and broken up in the economizer passage. The fuel mixture then passes by another air bleed, down the idle passage and is discharged at the idle discharge port and the idle needle port.

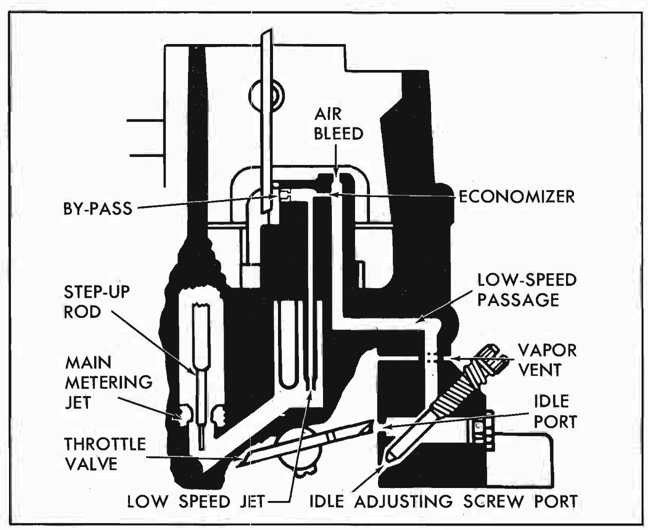


Fig. 6B-65 Low Speed Circuit

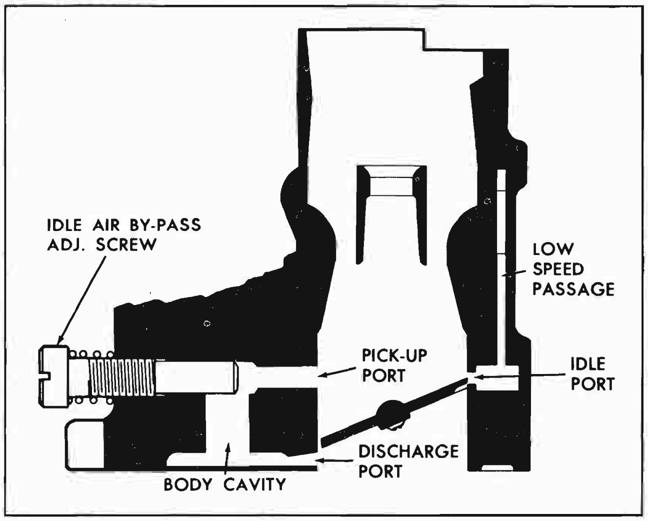


Fig. 6B-66 Idle Air By-Pass Circuit

The idle ports are slot-shaped. As the throttle valves are opened, more of the idle ports are uncovered allowing a greater quantity of fuel mixture to enter the carburetor bores. The secondary throttle valves remain closed at idle.

To aid in hot starting, vapor vents are provided in the throttle bores.

During hot idle the throttle valves are completely closed with the by-passable type carburetor. Idle air is directed around the throttle valves through the passage shown in Fig. 6B-66. The amount of air going through the passage is controlled by the air adjusting screw, thereby also controlling idle speed.

During long periods of idling with an extremely hot engine the fuel in the carburetor bowl becomes hot enough to form vapors. These vapors enter the carburetor bores by way of the inside bowl vents. The vapors mix with the idle air and are drawn into the engine causing an excessively rich mixture and a loss in rpm or engine stalling. Also, the decrease in the density of the air caused by extreme high under-hood temperatures reduces the idle speed.

The hot idle compensator (Fig. 6B-67) is calibrated to open under these temperature conditions, permitting additional air to enter the manifold below the secondary throttle valves (Fig. 6B-68) and mix with the fuel vapors providing a more combustible mixture. The engine rpm may still vary slightly, however, extreme rough idle operation and engine stalling are avoided.

The device is especially beneficial during traffic operation in very hot weather when the car is allowed

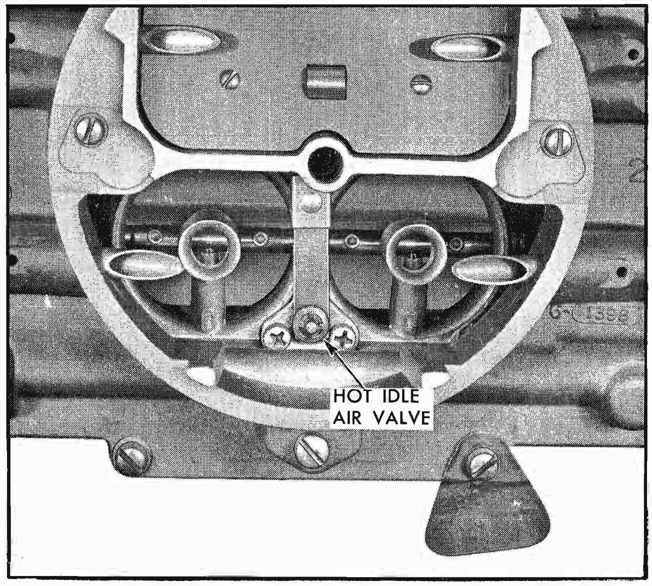


Fig. 6B-67 Hot Idle Air Valve

to idle for a long period of time, particularly on air conditioned equipped automobiles. One of the other more common driving conditions that will bring the thermostatic valve into operation is when the car has been driven at highway speeds during a very hot day and then a line of traffic causes a delay where the engine must be run at idle speed, moving the car only a few feet at a time.

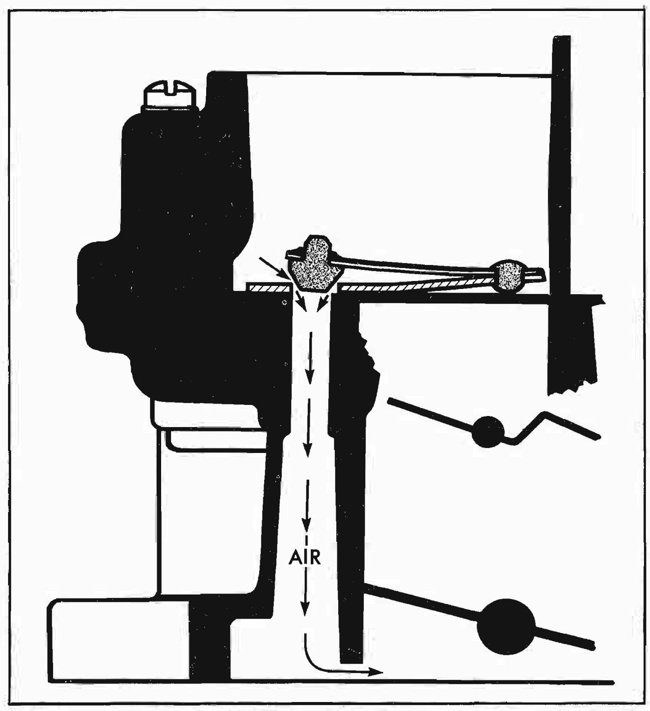


Fig. 6B-68 Hot Idle Air Valve Air Passage (Compensator)

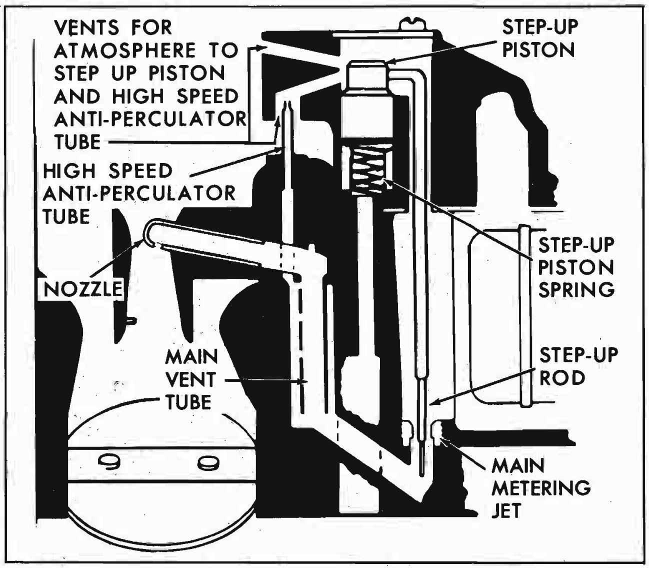


Fig. 6B-69 High Speed Circuit—Primary Side

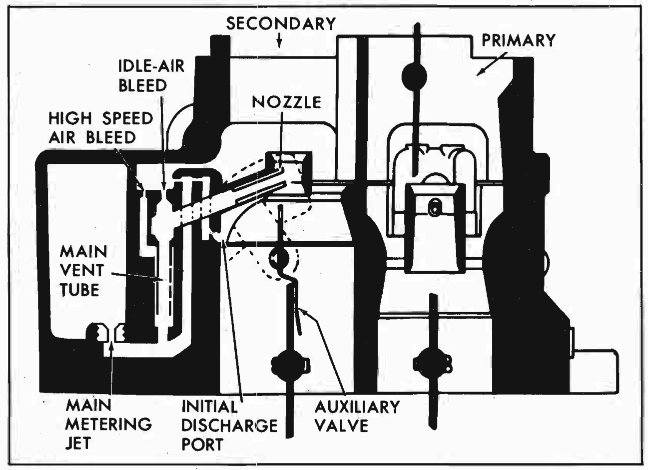


Fig. 6B-70 High Speed Circuit—Secondary Side

The valve is calibrated to open when the air temperature in the bore of the carburetor is between 125 and 135 degrees Fahrenheit with 15″ vacuum applied to the valve seat. The operation of this valve cannot be checked accurately in field service, because of the difficulty of obtaining and measuring an accurate air temperature in the bore of the carburetor and the specified 15″ of vacuum at the seat of the valve. In service, if any doubt exists concerning the operation of the valve, it should be replaced.

A small hole through each primary throttle valve supplies idle air to supplement the air supplied through the by-pass idle air circuit. These supplementary air supply holes provide better adjustability and increase the idle air volume to provide sufficient idle speed on new engines.

HIGH SPEED CIRCUIT—PRIMARY SIDE (FIG. 6B-69)

Fuel for late part throttle and full throttle operation is supplied through the high speed circuit.

As the throttle valves are opened air flow through the carburetor increases to the point that fuel is picked up at the discharge nozzles located in the main venturi. The pressure differential caused by the rapid flow of air through the venturi forces fuel through the primary metering jet up through the main vent tube. After picking up air at the air bleed the mixture is forced out through the main discharge nozzle. The air bleed in the high speed circuit also serves as an anti-percolator passage.

The amount of fuel delivered through the primary high speed circuit is dependent upon air flow or throttle valve opening and by the position of the step-up rods in the primary main metering jets. The step-up rods are controlled entirely by manifold vacuum. When manifold vacuum is high the step-up rod piston and step-up rod are held downward, restricting the flow of fuel through the primary main metering jet. Under any operating condition that reduces manifold vacuum such as acceleration or hill-climbing the step-up rod piston spring raises the step-up rod positioning the smaller diameter or power step in the jet. This allows additional fuel to be metered through the jet. The step-up rods are not adjustable.

HIGH SPEED CIRCUIT— SECONDARY SIDE (FIG. 6B-70)

The throttle valves in the secondary side remain closed until the primary throttle valves open a predetermined amount (approximately 50° of throttle opening). They arrive at the wide open position at the same time as the primary throttle valves.

Mounted above the secondary throttle valves are the auxiliary throttle valves. These valves are opened by air flow and closed by counterweights. When the secondary throttle valves open, only the primary high speed circuit will function until there is sufficient air velocity to open the auxiliary throttle valves. When the auxiliary valves open, fuel will be supplied through the secondary high speed circuit.

Fuel for the secondary side is metered through the secondary main metering jets. No step-up rods are used.

To supplement the starting of the secondary high speed circuit an initial discharge system is used. Initial discharge ports are located next to the venturi struts. When the auxiliary valves start to open, a low pressure area results at these ports and atmospheric pressure forces fuel into the initial discharge passage. Air is picked up at the air bleed and the mixture enters the air stream at the initial discharge ports. As the auxiliary valves continue to open and the secondary nozzles begin to function, pressure increases at the discharge ports and their operation diminishes. An acceleration tube is used to smooth the transition from two to four barrel operation on acceleration.

PUMP CIRCUIT (FIG. 6B-71)

The accelerating pump circuit located in the primary side provides for a measured amount of fuel to be discharged into the carburetor throat during acceleration from low car speeds. A rapid opening of the throttle valves, as is the case when accelerating from low speeds, causes an immediate increase in air velocity. Since fuel is heavier than air it requires a short period of time for it to "catch up" with the air flow. To avoid a leanness during this momentary lag, the accelerator pump furnishes a quantity of liquid fuel, sprayed into the air stream to mix with incoming air and maintain the proper fuel-air mixture. The pump is operated by the combined action of two springs which are calibrated to move the plunger in such a manner that a sustained charge of fuel is delivered for smooth acceleration.

The pump is attached by linkage to the accelerator so that when the throttle valves are closed the pump plunger moves upward in its cylinder creating a low pressure area (partial vacuum) in the cylinder below the plunger. Atmospheric pressure acting on the fuel in the bowl forces fuel into this cylinder through the intake ball check. The discharge needle is seated at this time to prevent air being drawn into the cylinder.

When the throttle is opened, the friction of the plunger in the cylinder and the tension of the lower plunger spring resists the downward movement of the pump plunger causing the plunger shaft to telescope. This compresses the upper spring. The upper spring then overcomes the resistance and pushes the plunger down. However, the speed of the plunger is retarded by the lower spring so that a sustained charge of fuel is released into the system. The movement of the plunger exerts a pressure in the cylinder which seats the intake ball check preventing fuel from being forced back into the bowl. The same pressure also forces fuel up the discharge passage, unseating the pump discharge needle, and on through the pump jets in the cluster where it is sprayed into the carburetor throat.

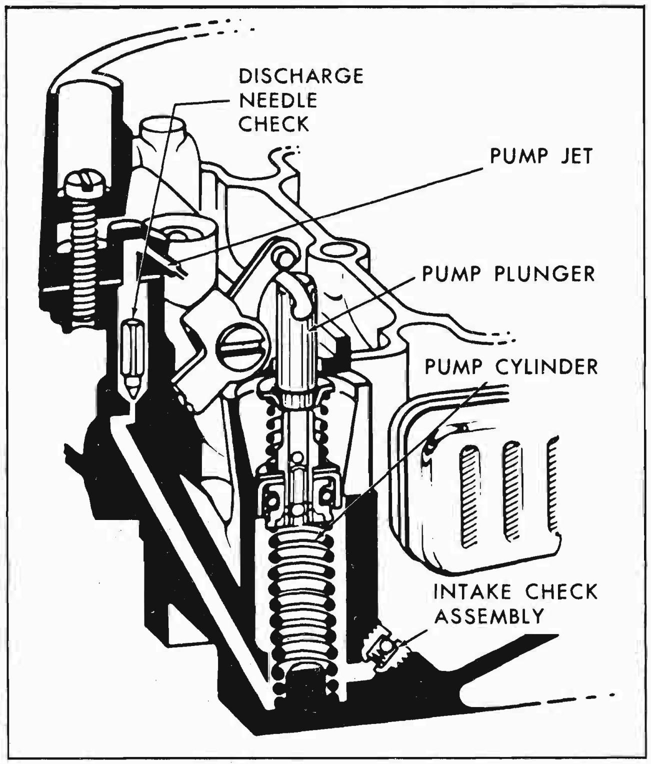


Fig. 6B-71 Pump Circuit

At higher speeds, pump discharge is no longer necessary to insure smooth acceleration. When the throttle valves are opened a predetermined amount, the pump plunger bottoms in the cylinder eliminating pump discharge.

During high speed operation, a vacuum exists at the pump discharge ports. To prevent atmospheric pressure from forcing fuel to these ports and into the system, the pump jets are vented. This allows air instead of fuel to be forced through the pump discharge ports.

An "anti-percolator" check valve, contained inside the plunger, provides relief for any vapors which might form during hot idle or when a hot engine is not operating. The ball check is designed so that it can move up and down in its passage. Throughout the above periods it is unseated by gravity and vapors in the pump well rise and by-pass the ball check through small holes in the plunger head.

The "anti-perc" ball check also acts as an extra inlet during the upstroke of the plunger, but is seated by fuel when the plunger moves down.

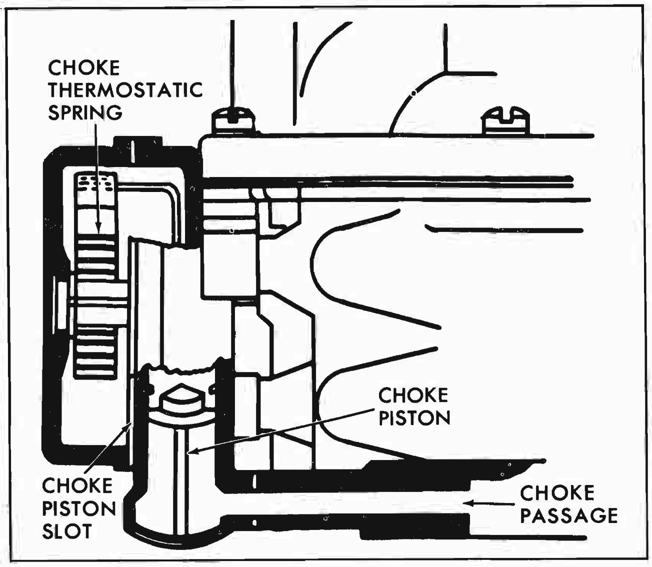


Fig. 6B-72 Choke Circuit

CHOKE CIRCUIT (FIG. 6B-72)

The purpose of the choke system is to provide a very rich mixture for cold engine operation.

The choke system subjects all fuel outlets in the bore of the carburetor to manifold vacuum while restricting the intake of air.

The choke system includes a thermostatic coil, housing, choke piston, choke valve, a source of fresh air supply to the choke stove, and fast idle cam and linkage. It is controlled by a combination of intake manifold vacuum, air velocity against the offset choke valve, atmospheric temperature and hot air from the intake manifold.

When the engine is cold, tension of the thermostatic coil holds the choke valve closed. Starting the engine causes air velocity to strike the offset choke valve. This tends to open it along with the action of intake manifold vacuum on the choke piston. Thus, after a slight opening of the choke valve, the tension of the thermostatic coil spring balances the force of air on the valve and the pull of vacuum at the piston.

At the cold idle position, slots located in the sides of the choke piston cylinder are uncovered, exposing them to intake manifold vacuum. Air, heated in a tube running through the exhaust cross-over passage in the intake manifold, then fills this low pressure area in the choke housing. The flow of warm air heats the thermostatic coil and causes it to lose its tension until full choke valve opening is accomplished. The clean air is supplied to the choke in the manifold from the air horn, just below the air cleaner. Here filtered air from the air cleaner is picked up and carried to the choke by a metal pipe.

A secondary baffle plate is located in the choke housing to distribute the warm air evenly over the thermostatic coil thereby insuring gradual relaxation of the coil. The baffle revolves with the choke valve and prevents the warm air from striking the thermostatic coil until the choke valve opens a predetermined amount. This delays choke opening.

If the engine is accelerated during the warm-up period, the corresponding drop in manifold vacuum allows the thermostatic coil to momentarily close the choke, providing a richer mixture.

To combat engine stalling during warm-up on cool, humid days, caused by "carburetor icing", heated air from the choke housing is circulated through a passage in the base of the carburetor flange.

During the warm-up period, it is necessary to provide a fast idle to prevent engine stalling. This is accomplished by a fast idle cam connected to the choke shaft. The fast idle adjusting screw on the throttle lever contacts the fast idle cam and prevents the throttle valves from returning to a normal warm engine idle position until the choke is open.

If, during the starting period, the engine becomes flooded the choke valve can be partially opened manually to allow increased air flow through the carburetor. This is accomplished by depressing the accelerator pedal forcibly to the floor and engaging the starter. The unloader projection on the throttle lever contacts the unloader lug on the fast idle cam and in turn partially opens the choke valve.

ADJUSTMENTS ON CAR

All Carter adjustments can be performed on the car. All adjustments are included in the "Overhaul and Adjustments" procedure, with the exception of the idle speed and mixture adjustment, fast idle adjustment, and the unloader adjustment. Following are the idle speed, mixture, and the unloader adjustments.

IDLE SPEED AND MIXTURE ADJUSTMENT

1. As a preliminary setting turn air screw out 1½ turns from lightly seated position and mixture screws out 1 turn.

2. Set hand brake securely, place transmission in neutral and connect tachometer to engine.

3. Start engine and warm up thoroughly. Make sure choke is fully open and carburetor is completely off fast idle.

***CAUTION:** When adjusting idle make sure hot idle compensator is held manually closed during adjustment.*

4. Adjust the air screw to obtain correct idle rpm. (Use drive range on Hydra-Matic equipped cars.)

5. Turn mixture screws to best quality (highest rpm) idle.

6. Reset air screw to correct rpm if mixture adjustment changed setting.

7. Recheck mixture adjustment to insure smoothest possible idle.

NOTE: Always recheck idle mixture setting *after* making idle rpm adjustment with air screw.

IDLE SPECIFICATIONS

Synchro-Mesh, exc. air conditioner	480-500 rpm
Hydra-Matic, exc. air conditioning	480-500 rpm in drive range
Air Conditioning (H/M drive range, air conditioning off.) (S/M neutral, air conditioning off.)	540-560 rpm

FAST IDLE ADJUSTMENT

The fast idle setting must be made *after* the idle speed and mixture adjustment has been made. With the engine completely warmed up and the fast idle screw on highest step of fast idle cam, set fast idle screw to give an engine speed of 2200 rpm.

UNLOADER ADJUSTMENT

1. Remove carburetor air cleaner assembly.

2. Depress accelerator pedal forcibly to floor. (This should be done by person sitting in driver's seat of car to simulate actual driving conditions.)

3. With accelerator pedal depressed as in step 2, bend tang on throttle lever to give a clearance of $\frac{5}{32}'' \pm \frac{1}{64}''$ between the top of the choke valve and the inside of the air horn.

4. Replace air cleaner assembly.

The above procedure will eliminate variance in linkage, floor mat, pedal location, etc. and should ensure correct unloader action.

OVERHAUL AND ADJUSTMENT

DISASSEMBLY

DISASSEMBLE AIR HORN

1. Place carburetor on stand J-5923 or J-8328 and remove gasoline inlet strainer nut, gasket and inlet screen (Fig. 6B-73).

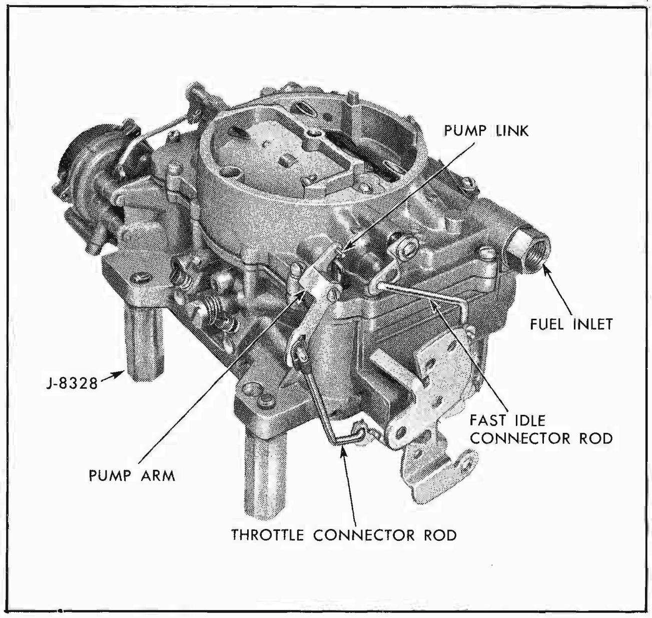


Fig. 6B-73 Carter AFB Carburetor

2. Remove throttle connector rod and anti-rattle spring (Fig. 6B-73).

3. Remove fast idle connector rod at upper end.

4. Remove choke connector rod (Fig. 6B-74).

5. Remove two step-up piston cover plate attaching screws and cover plates (Fig. 6B-74).

6. Remove two step-up rods and step-up pistons. If desired, step-up rod may be separated from piston by

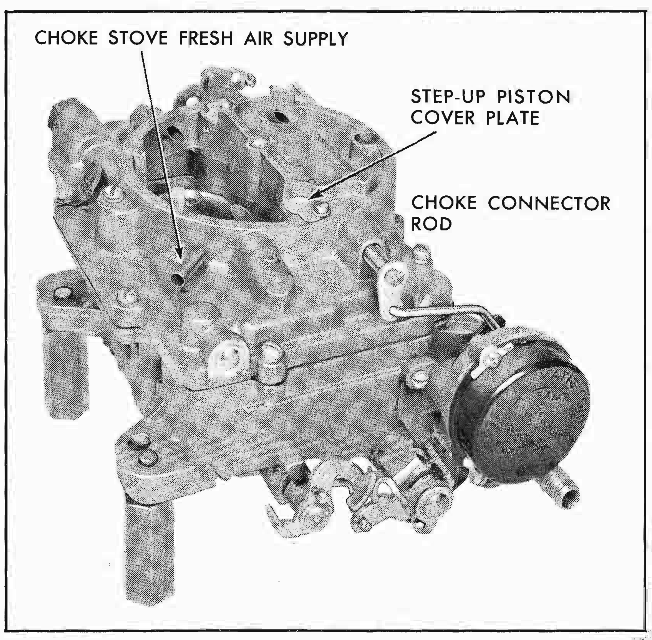


Fig. 6B-74 Carter AFB Carburetor

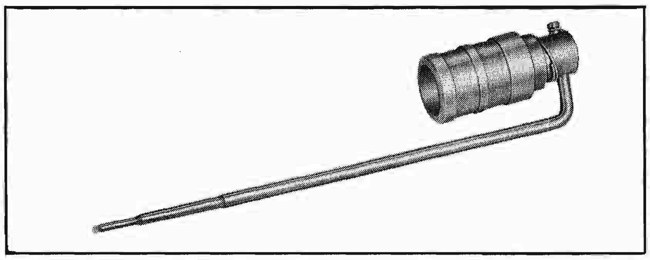


Fig. 6B-75 Step Up Rod and Piston Assembly

unhooking step-up rod retaining spring from end of rod (Fig. 6B-75). Remove two step-up rod piston springs.

7. Remove choke shaft lever retainer screw, choke shaft lever and washer from end of choke shaft.

8. Remove two choke valve attaching screws and choke valve.

9. Remove ten air horn attaching screws and lift off air horn assembly.

10. Slide choke shaft from air horn.

11. Remove pump arm and link and pump plunger assembly.

12. Remove float hinge pin, float and float needle assembly on inlet side of carburetor (Fig. 6B-76).

13. Remove float needle seat and gasket using wide blade screwdriver.

NOTE: Keep individual float parts grouped so that same needle and seat are used together.

14. Remove remaining float hinge pin, float, float needle, float needle seat and gasket.

15. Remove air horn gasket.

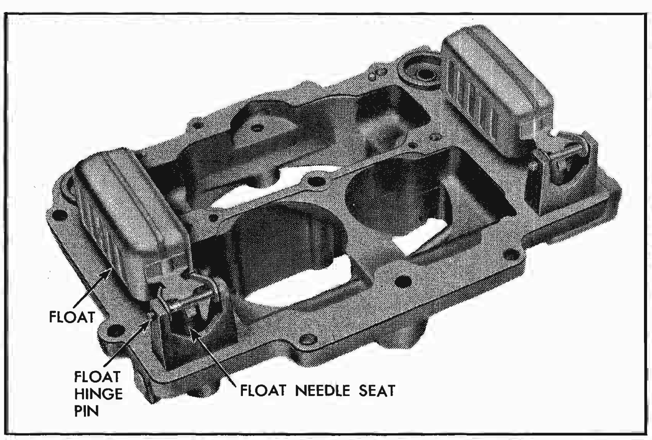


Fig. 6B-76 Air Horn Assembly

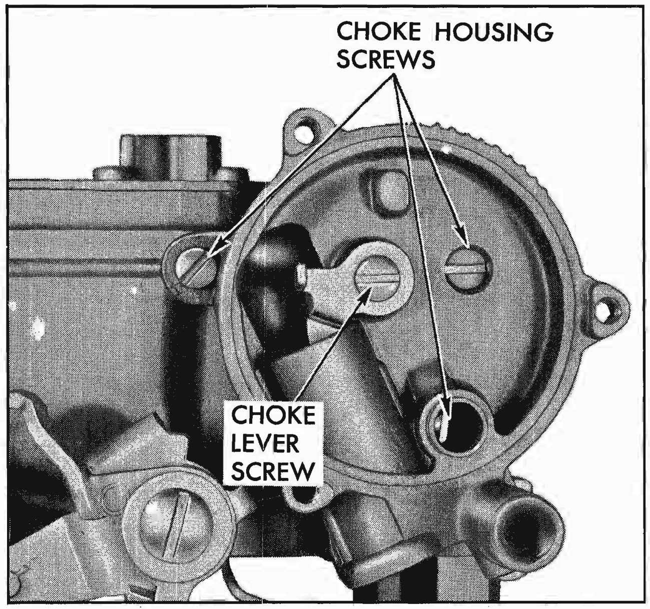


Fig. 6B-77 Location of Choke Housing Screws

DISASSEMBLE BODY

1. Remove three choke coil housing attaching screws and choke coil housing and thermostatic coil.

2. Remove coil housing gasket and baffle plate.

3. Remove choke lever attaching screw. (Fig. 6B-77). Remove choke piston, lever and link assembly by rotating piston from bore.

4. Remove three choke housing to body attaching screws (Fig. 6B-77) and remove choke housing and gasket.

5. Remove lower choke lever and shaft from choke housing.

6. Remove pump jet cluster and gasket. (Fig. 6B-78).

7. Remove two screws and primary venturi and gasket on pump side (Fig. 6B-78).

8. Remove two screws and primary venturi and gasket on choke side.

NOTE: The venturi assemblies are not interchangeable.

9. Remove hot idle air valve and gasket.

10. Remove secondary venturi on pump and choke sides (Fig. 6B-78).

11. Lift out auxiliary throttle valve, shaft and weight assembly (Fig. 6B-79).

12. Remove two primary metering jets.

13. Remove two secondary metering jets.

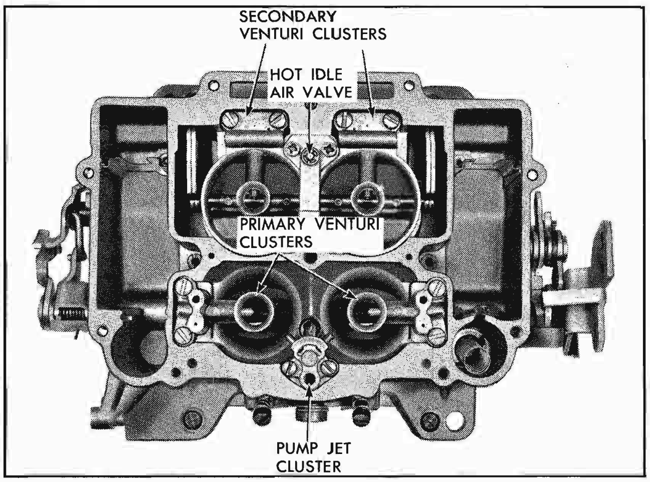


Fig. 6B-78 Top View of Carburetor Body Assembly

14. Remove pump return spring.

15. Remove pump intake check.

16. Remove idle mixture screws.

17. Remove air screw.

18. Carefully invert carburetor body and remove pump discharge check needle.

19. Remove throttle lever adjusting screw and spring.

20. Remove fast idle cam attaching screw, fast idle cam, trip lever and lockout lever (Fig. 6B-80).

21. Remove primary to secondary throttle operating rod (Fig. 6B-81).

22. Remove screw, secondary throttle shaft washer and secondary throttle operating lever and spring.

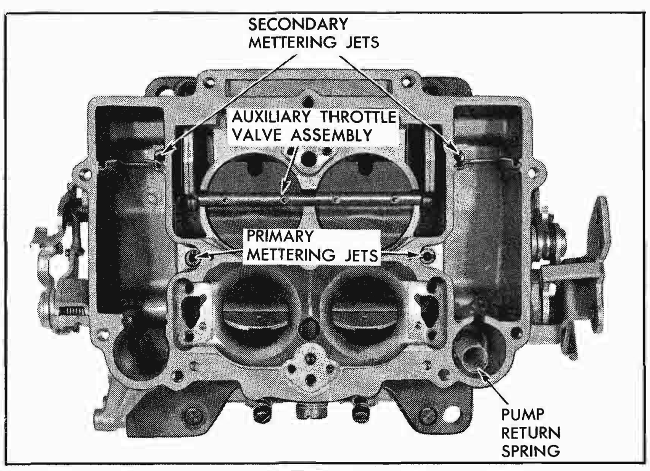


Fig. 6B-79 Body Assembly with Cluster Removed

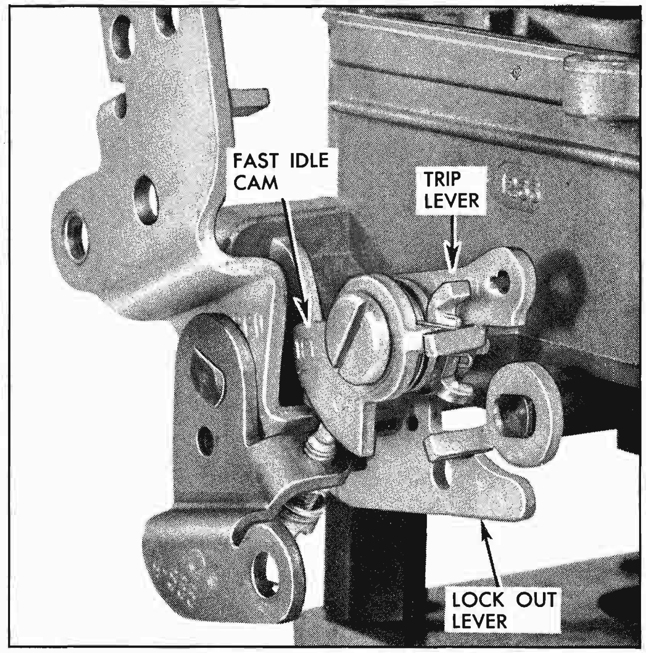


Fig. 6B-80 Location of Fast Idle Cam and Lockout Lever

23. Unhook throttle flex spring from primary outer throttle shaft arm.

24. Remove primary throttle shaft lever attaching screw and washer from primary throttle shaft.

25. Remove outer throttle shaft arm and throttle shaft dog (Fig. 6B-81).

26. Remove inner throttle shaft arm and flex spring.

27. If necessary to remove throttle shafts remove throttle valve attaching screws, throttle valves and slide shaft from carburetor body.

28. Remove fast idle adjusting screw if necessary to replace.

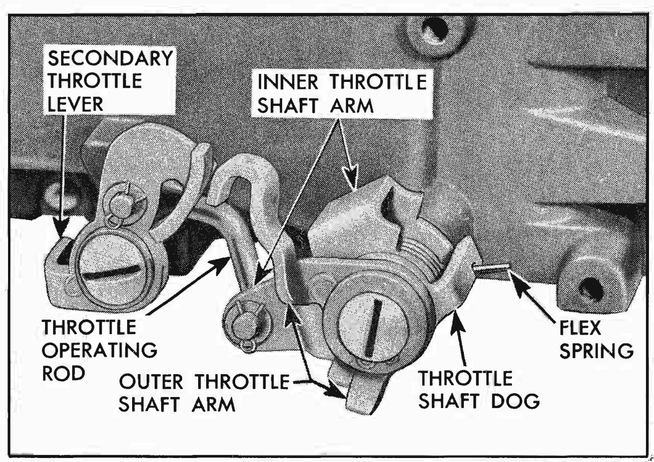


Fig. 6B-81 Primary and Secondary Throttle Linkage

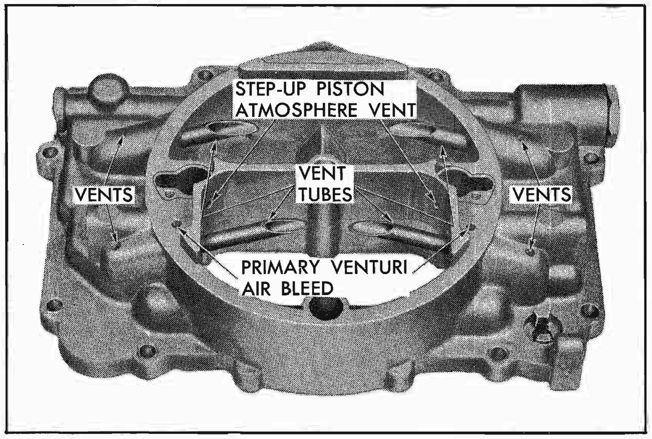


Fig. 6B-82 Passage Identification—Air Horn

CLEANING AND INSPECTION

Dirt, gum, water or carbon contamination in the carburetor or on the exterior moving parts of a carburetor are often responsible for unsatisfactory performance. For this reason, efficient carburetion depends upon careful cleaning and inspection while servicing.

1. Thoroughly clean carburetor castings and all metal parts in clean carburetor cleaning solution.

CAUTION: Composition and plastic parts such as pump plunger and gaskets should not be immersed in cleaner.

2. Blow out all passages (Figs. 6B-82, 83, 84, 85, and 87) in casting with compressed air and blow off all parts to ensure they are free of cleaner.

NOTE: Follow instructions furnished with cleaning solution container.

CAUTION: Do not use drills or wire to clean out jets or ports as this may enlarge the opening and affect carburetor operation.

3. Carefully inspect parts for wear and replace those which are worn, checking the following specific points:

A. Inspect choke piston and choke piston housing for carbon and gum. If necessary to clean choke piston housing, remove Welch plug in the bottom of housing. Plug can be removed by piercing center with a small pointed instrument and prying outward. Care should be exercised so that damage will not result to the casting when removing this plug. Before installing new plug, carbon present in piston cylinder slots should be removed and the Welch plug seat should be carefully cleaned.

B. Remove carbon from bores of throttle flange.

C. Inspect float needles, and seats for wear; if leaking, both needle and seat must be replaced.

D. Inspect float pins for excessive wear.

E. Inspect floats for dents and excessive wear on lip. Check for fluid inside floats by shaking. Replace float if any of above are present.

F. Inspect throttle shafts for excessive wear (looseness or rattle in body flange casting).

G. Inspect idle mixture adjusting screws for burrs. Replace if burred or scored.

H. Inspect pump plunger assembly. If leather is not in good condition, replace plunger.

I. Inspect gasketed surfaces between body and air horn, and between body and flange. Small nicks or burrs should be smoothed down to eliminate air or fuel leakage. Be especially particular when inspecting choke vacuum passage and the top surface of the inner wall of the bowl.

J. Inspect holes in pump rocker arm, fast idle cam and throttle shaft lever. If holes are worn excessively or out of round to the extent of causing improper carburetor operation, the part should be replaced.

K. If excessive wear is noted on fast idle cam, it should be replaced to ensure proper engine operation during warm up.

L. Check all filter screens for lint or dirt. Clean or replace as necessary.

M. Check venturi clusters for loose or damaged parts. If damage or looseness exists, replace cluster assembly.

ASSEMBLY AND ADJUSTMENTS

ASSEMBLE THROTTLE BODY

1. If throttle shafts were removed during disassembly insert shafts through body with lever ends on pump side of body.

2. Using new screws install primary and secondary throttle valves so that trade mark (c in circle) is visible from the bottom of body with throttle valves closed.

3. Install fast idle adjusting screw.

4. Place carburetor body on stand.

5. Install pump intake check.

6. Install inner throttle shaft arm and flex spring on primary throttle shaft (Fig. 6B-86).

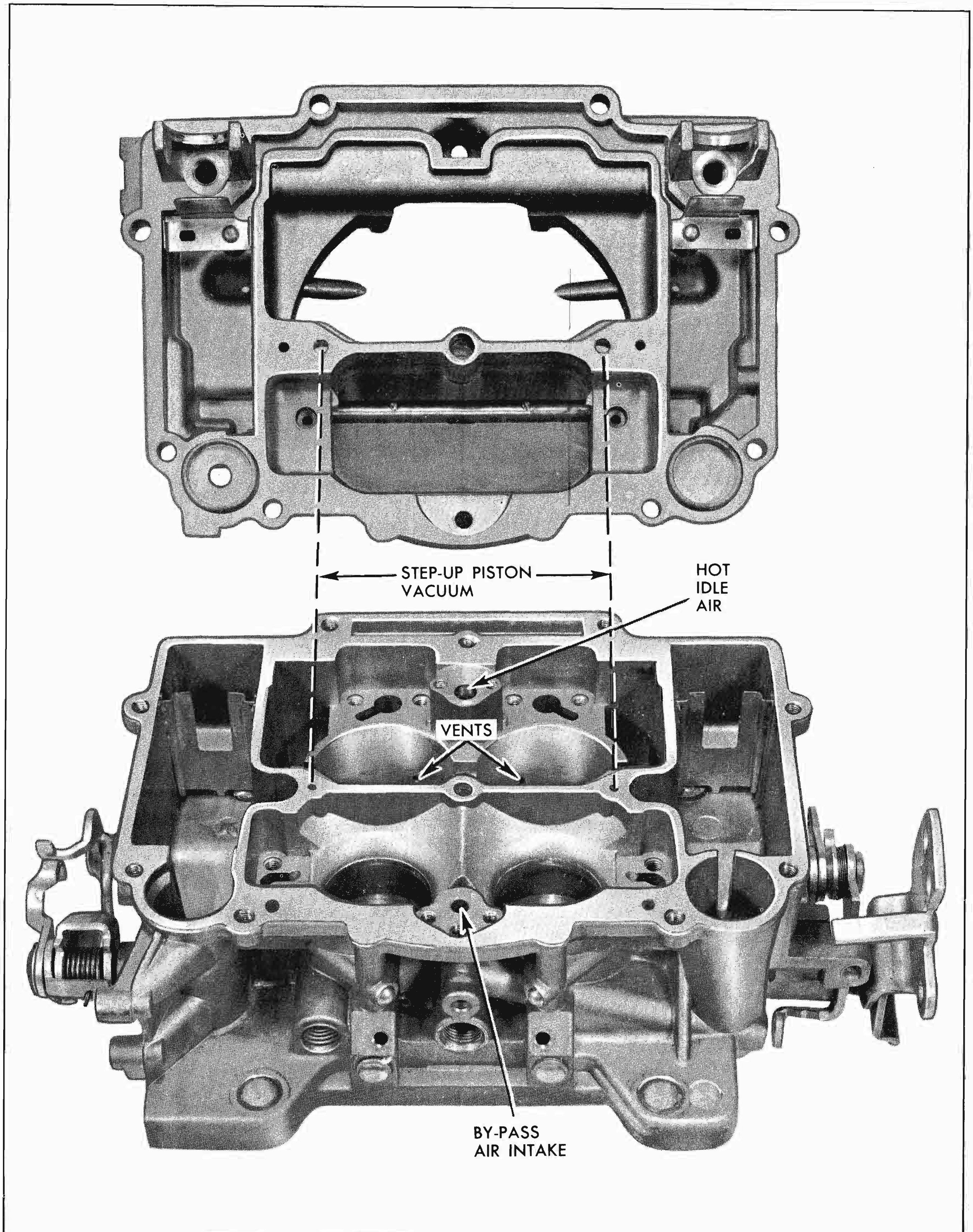


Fig. 6B-83 Passage Identification—Air Horn to Body

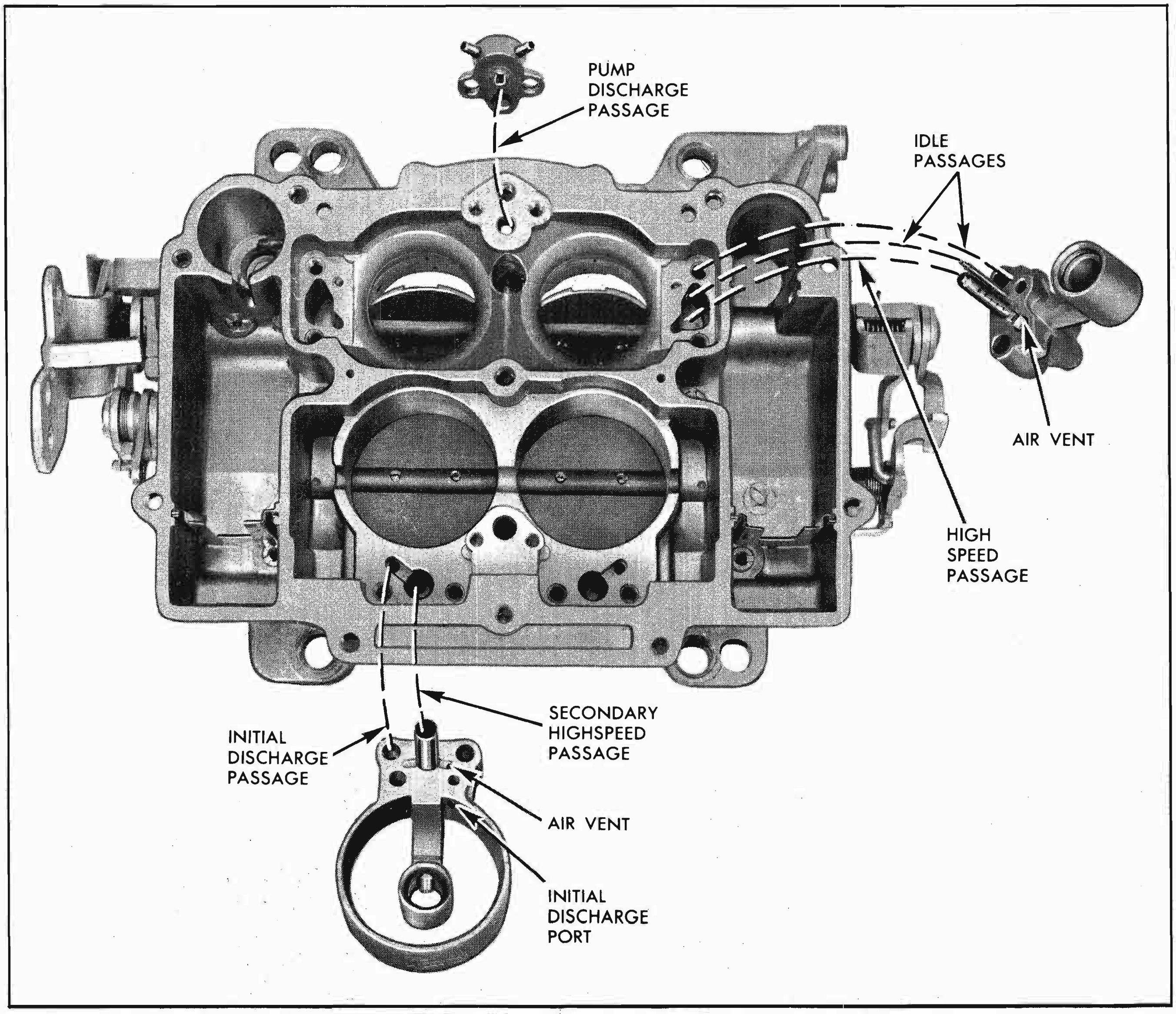


Fig. 6B-84 Passage Identification—Clusters to Body

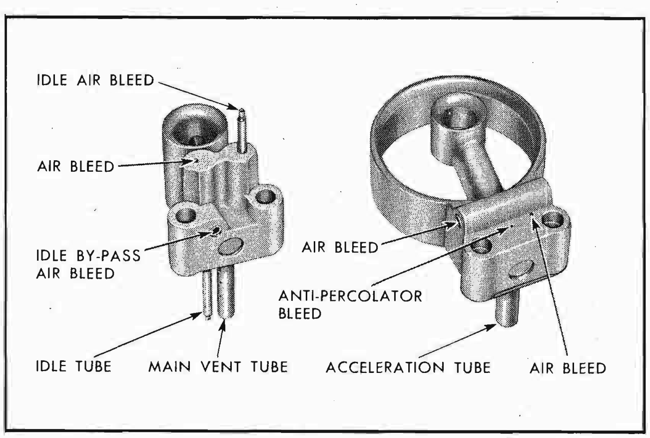


Fig. 6B-85 Passage Identification—Primary and Secondary Venturi Clusters

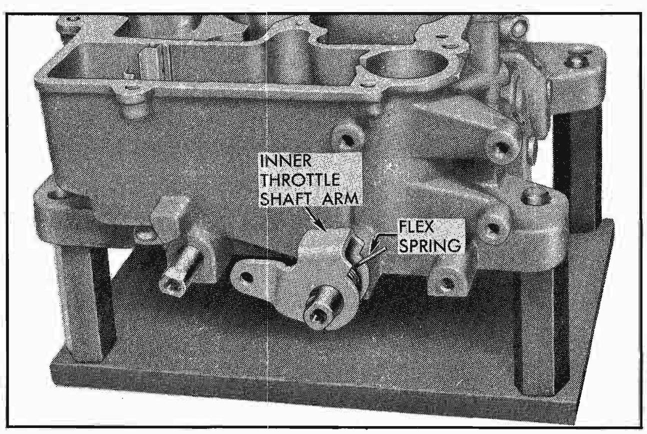


Fig. 6B-86 Inner Throttle Shaft Arm and Flex Spring Installed

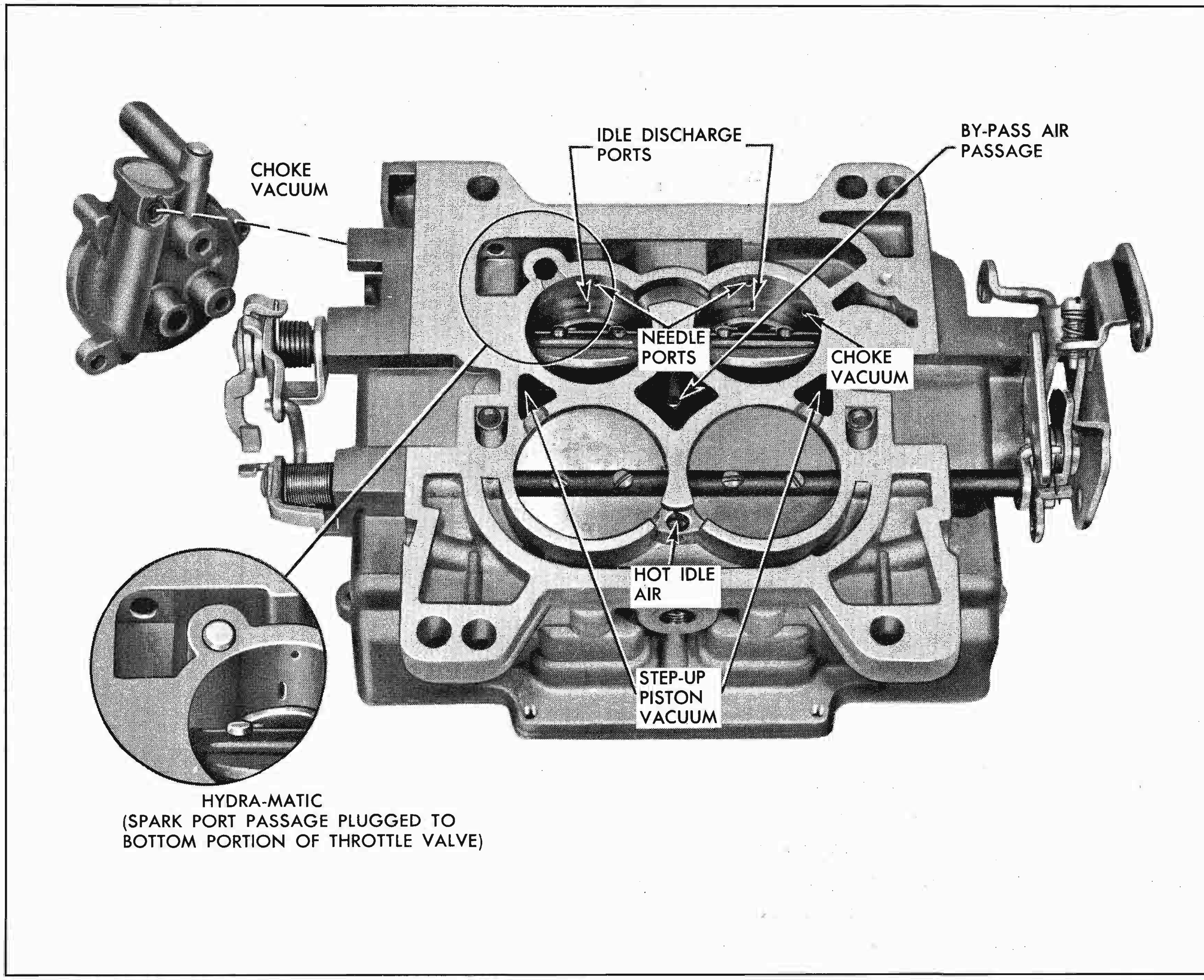


Fig. 6B-87 Passage Identification—Flange Area of Body (Super Hydra-Matic Shown) (Difference in Carburetor for Roto Hydra-Matic Shown in Insert)

7. Install throttle shaft dog on primary throttle shaft (Fig. 6B-88).

8. Install outer throttle shaft arm, washer and retaining screw on primary throttle shaft (Fig. 6B-89).

9. Hook end of flex spring into notch on outer throttle shaft arm.

10. Install secondary throttle operating spring, lever, washer and screw (Fig. 6B-89). Wind spring two turns tight.

11. Install throttle operating rod, washers and spring clips.

12. Install lockout dog, trip lever, fast idle cam and screw (Fig. 6B-90).

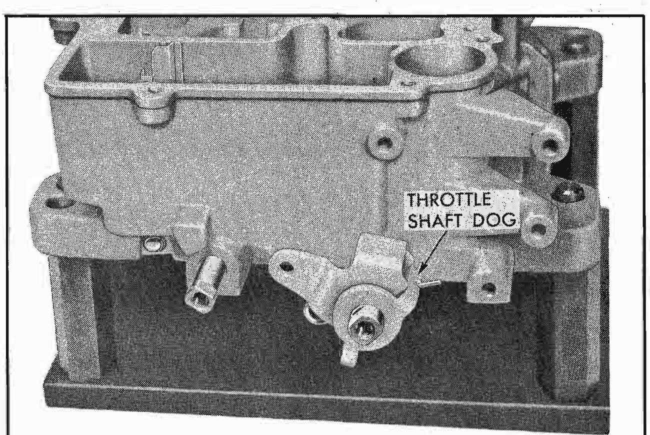


Fig. 6B-88 Throttle Shaft Dog Installed

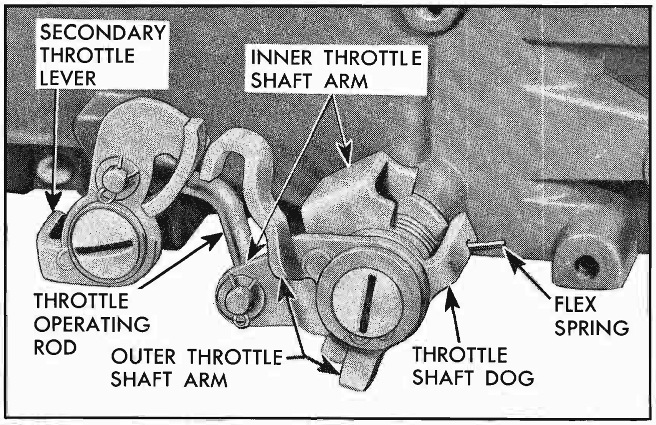


Fig. 6B-89 Primary and Secondary Throttle Linkage Installed

13. Install throttle lever screw and spring.

14. Install idle mixture screws. Turn in finger tight and back out one turn for approximate adjustment.

15. Install air screw. Turn in finger tight and back out 1½ turns for approximate adjustment.

16. Install primary metering jets and secondary metering jets in their respective bores.

17. Set auxiliary throttle valves in place.

18. Install secondary venturi and gaskets on choke and pump sides.

19. Install hot idle air valve and gasket.

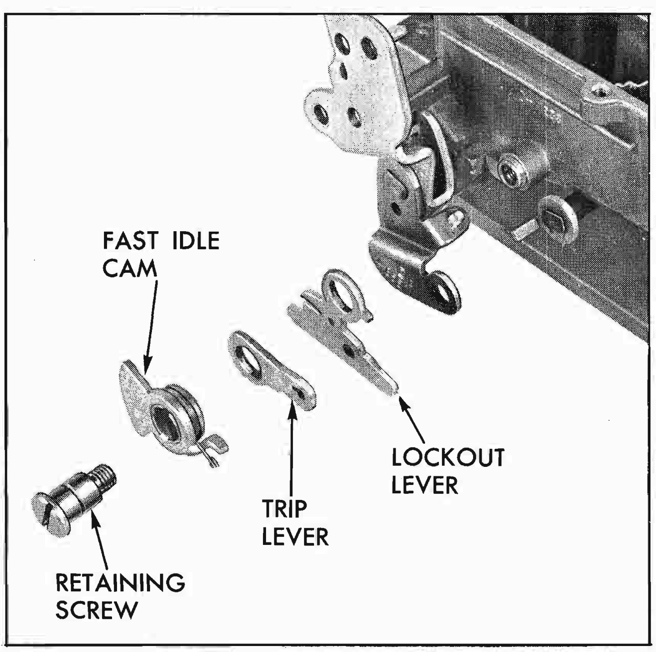


Fig. 6B-90 Lockout Lever and Fast Idle Cam

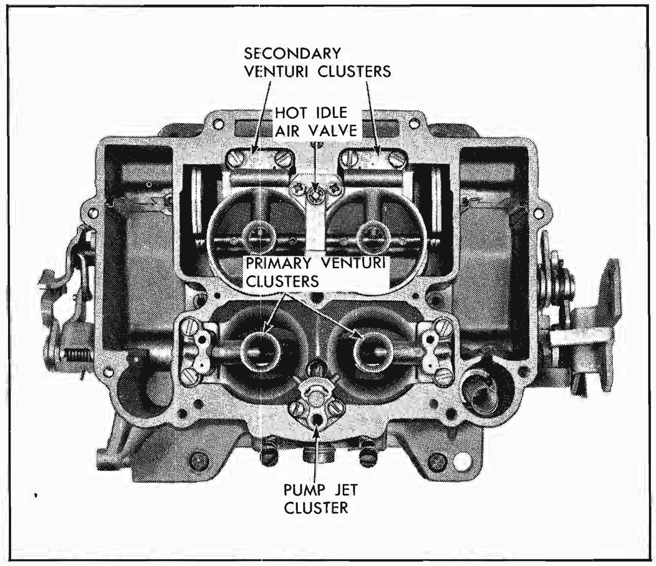


Fig. 6B-91 Venturi Clusters Installed

20. Install primary venturi and gaskets on choke and pump side of carburetor (Fig. 6B-91).

21. Install pump discharge check needle, point down and pump jet cluster and gasket with two screws.

22. Install pump plunger return spring in pump bore.

23. Install lower choke shaft and lever in choke housing and attach choke housing and gasket to carburetor body and three self-tapping screws.

24. Install choke piston and link assembly in choke housing.

25. Attach choke piston linkage to lower choke shaft with screw and spacer washer.

NOTE: Before proceeding with next step perform choke piston lever adjustment.

26. Install choke baffle plate, cover gasket, and choke cover and spring assembly. Set choke at one notch rich.

ASSEMBLE AIR HORN

1. Slide choke shaft into air horn.

2. Install air horn gasket.

3. Install float needle seat and gasket, float needle and float assembly on pump side of air horn.

4. Install float needle seat and gasket, float needle, and float assembly on choke side of air horn.

5. Adjust float:

A. Alignment—

a. Sight down the side of the float shell to determine if the side of the float is parallel to the outer edge of the air horn casting. Adjust by bending float lever by applying pressure to the end of the float shell with the fingers while supporting the float lever with the thumb.

CAUTION: To avoid damaging the float, apply only enough pressure to bend float lever.

b. After aligning float remove as much clearance as possible between arms of float lever and lugs on air horn by bending the float lever. Arms of float lever should be as parallel to the inner surfaces of lugs on air horn as possible. Floats must operate freely without excess clearance on hinge pin.

B. Level (Fig. 6B-92)

With air horn inverted, gasket in place and needle seated, there should be $^{21}\!/_{64}$" ± $^{1}\!/_{32}$" clearance between float at point below first indentation on side of float from toe end and air horn gasket. Fig. 6B-92 illustrates point where $^{21}\!/_{64}$" dimension should be checked. Bend float arm to adjust. Adjust both floats and recheck float alignment.

C. Drop (Fig. 6B-93)

With bowl cover held in upright position and measuring from outer end of each float, the distance between top of floats and bowl cover gasket should be a minimum of $^{23}\!/_{32}$" ± $^{1}\!/_{32}$". To adjust, bend stop tabs on float brackets.

NOTE: Maximum float drop can be any amount which will retain needle for installation. Needle must not wedge at maximum drop.

6. Insert pump plunger shaft through air horn and retain with pump link.

7. Install air horn attaching screws (Fig. 6B-94).

8. Install two step-up rod piston springs in their respective bores.

9. Install step-up rod and piston on pump side of carburetor.

10. Install step-up rod and piston on choke side of carburetor.

11. Install two step-up piston cover plates and screws.

12. Install pump arm lever to air horn casting and connect pump link. Link must be installed as shown in Fig. 6B-95.

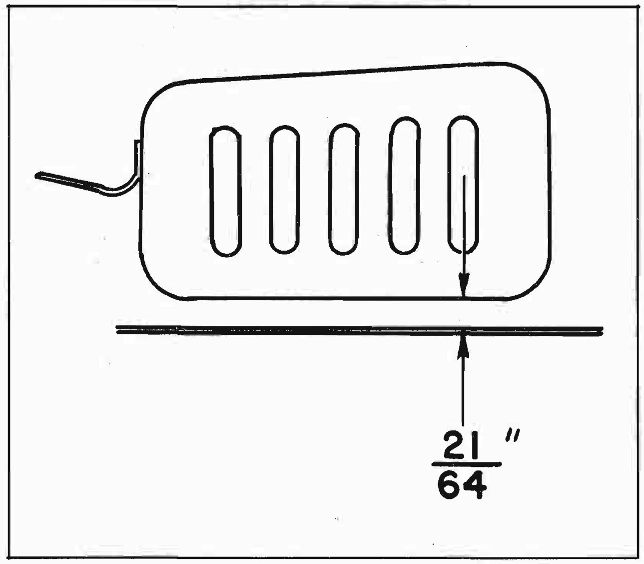


Fig. 6B-92 Float Level Check

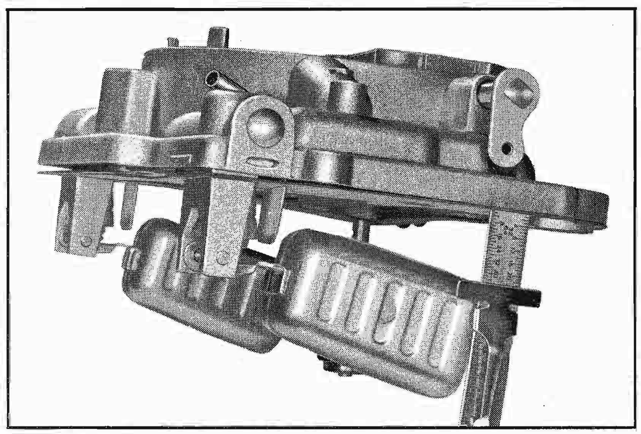


Fig. 6B-93 Checking Float Drop

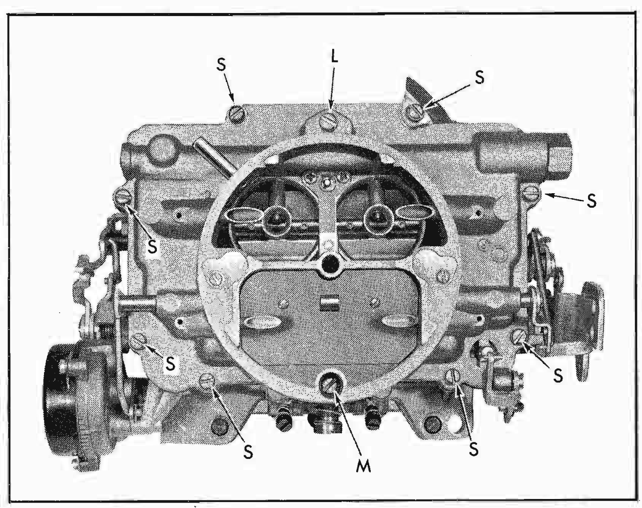


Fig. 6B-94 Location of Air Horn Attaching Screws
L=long, M=medium, S=short

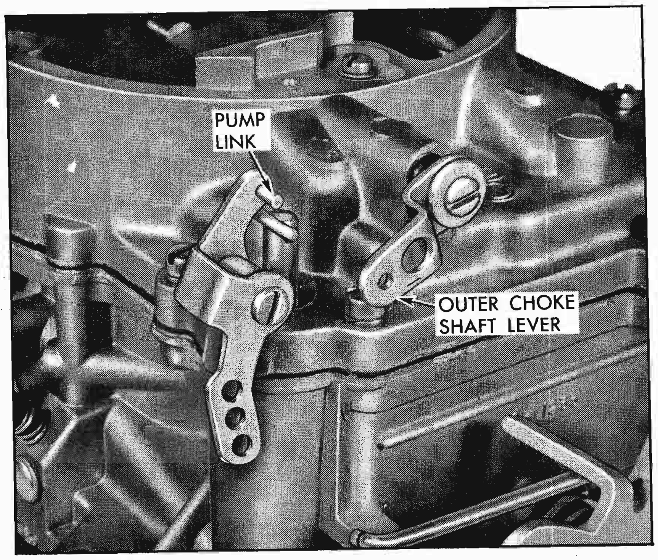


Fig. 6B-95 Pump Link Installed

13. Install pump connector rod in center hole in pump arm lever retaining with spring clip. Fasten lower end with clip to throttle lever.

14. Install choke valve with circle c in trademark visible with the choke valve closed.

15. Install choke connector rod between upper and lower choke lever.

16. Install choke shaft lever, washer, and screw on end of choke shaft (Fig. 6B-95).

17. Install fast idle connector rod between fast idle cam and inner choke shaft lever.

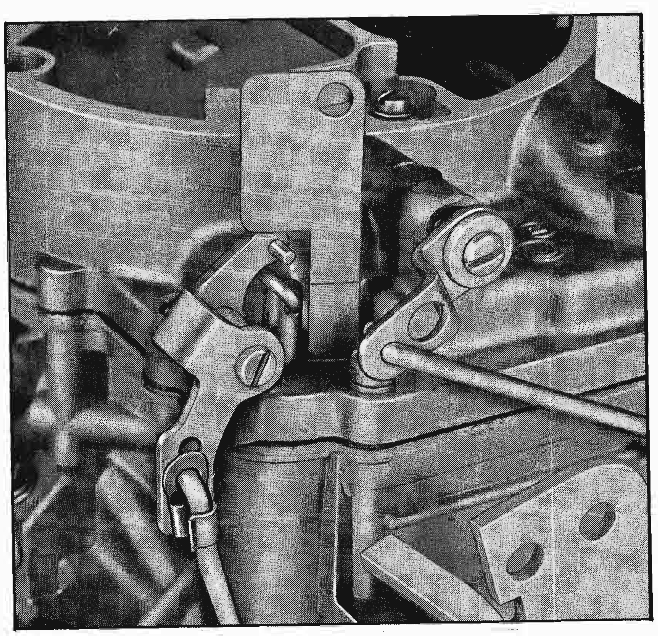


Fig. 6B-96 Checking Pump Adjustment

18. Install throttle connector rod, and washers.

19. Install inlet screen plug and gasket.

ADJUSTMENTS

ADJUST PUMP

1. Be sure choke is wide open so fast idle cam does not hold throttle valves open.

2. The distance from the top of the bowl cover to bottom of "S" pump link should be $5/16'' \pm 1/32''$ (Fig. 6B-96). Adjust pump linkage so that all play is removed at closed throttle position and full throttle lever travel is still obtainable.

NOTE: The three-speed Hydra-Matic carburetor is drilled for distributor vacuum spark advance but plugged with a pipe plug. In no case should the throttle return check diaphragm be connected to this passage. However, in the four-speed Hydra-Matic carburetor, this hole is drilled for the throttle return check and the throttle return check hose is connected at this point.

3. To adjust, bend throttle connector rod at lower angle

ADJUST CHOKE PISTON LEVER

1. Remove three choke coil housing screws and choke coil housing and thermostatic coil.

2. Remove coil housing gasket and baffle plate.

3. Completely close choke valve.

4. Choke piston should be flush to $1/64''$ below outer lip of cylinder.

5. To adjust, bend choke connector rod.

ADJUST CHOKE SHAFT LEVER

With choke valve fully closed and choke lever and arm in contact, bend choke connector rod to align cam index mark on fast idle cam with fast idle screw (Fig. 6B-97).

ADJUST SECONDARY THROTTLE LEVER

1. Open fully both sets of throttle valves. (In this position the stop lugs on primary and secondary throttle levers should contact the boss on the flange.)

2. To adjust, bend secondary throttle operation rod at angle.

NOTE: Primary throttle valves will be a few degrees past vertical and secondary throttle valve will be a few degrees from vertical at wide open throttle.

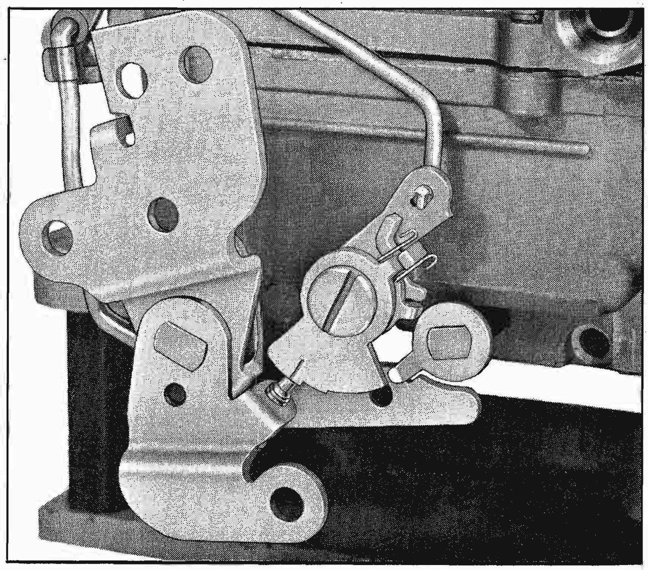


Fig. 6B-97 Checking Choke Shaft Lever

3. Now close primary and secondary throttle valves.

4. There should be .020″ clearance between positive closing shoes on primary and secondary throttle levers (Fig. 6B-98) at their closest position.

5. To adjust, bend shoe on primary lever.

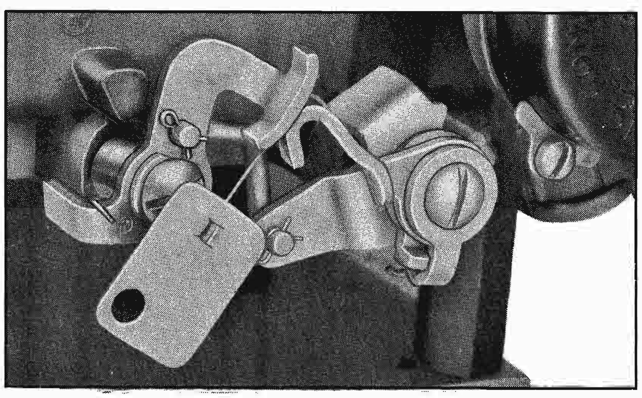
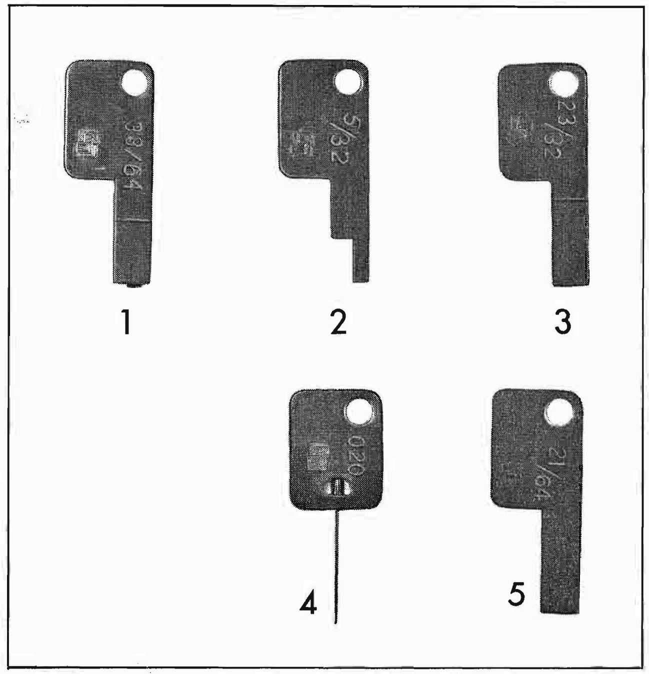


Fig. 6B-98 Checking Secondary Throttle Lever Adjustment



1. $\frac{5}{16}$″ Gauge .... Pump Rod
2. .125″ Gauge ...... Unloader
3. $\frac{23}{32}$″ Gauge ..... Float Drop
4. .020″ Gauge .... Secondary Throttle Lever
5. $\frac{21}{64}$″ Gauge ...... Float Level

Fig. 6B-99 Carter AFB Special Tools—J-7691-01

ADJUST SECONDARY THROTTLE LOCKOUT

1. Crack throttle valves and manually open and close the choke valve.

2. Tang on secondary throttle lever should freely engage in notch of lockout dog.

3. If necessary to adjust, bend tang on secondary throttle lever.

DIFFERENCES IN CALIBRATION SPECIFICATIONS

	Carburetor Model 3300S and 3326S	Carburetor Model 3123S
Primary Cluster	Right 58-603S Left 58-604S	Right 58-548S* Left 58-549S*
Choke Piston	160-250	160-235†
Sec. Metering Jet	120-194 (.0785″)	120-233 (.081″)
Primary Throttle Valves	2-237 (Hole in Valve)	2-195 (No Hole in Valve)
Length of Idle Port (Information Only—no service)	.162″ long	.235″ long

*Calibration and cluster designed to provide approximately 6% more richer mixture due to "abruptness" of torque applications with synchro-mesh transmission.

†Greater vacuum pull down on initial start — approximately 8°-9° more than 3124S and 3125S model carburetors.

Carburetor Model	Usage	Features
3326S (Red Tag)	Roto Hydra-Matic	Spark port in throttle body plugged to area below throttle valve but drilled in area opposite throttle valve as it is seated in bore so that when valve is closed, so is hole. External hole at left of idle mixture screws tapped for distributor vacuum (blank in 3300S). Throttle return check vacuum taken from back of carburetor (Fig. 6B-101). Calibration specification same as 3300S.
3300S (Yellow Tag)	Super Hydra-Matic	Distributor vacuum and throttle return check vacuum taken from back of carburetor. No tapped hole or spark port at left of idle mixture screws.
3123S (Black Tag)	Synchro-Mesh	Full vacuum advance and no throttle return check.

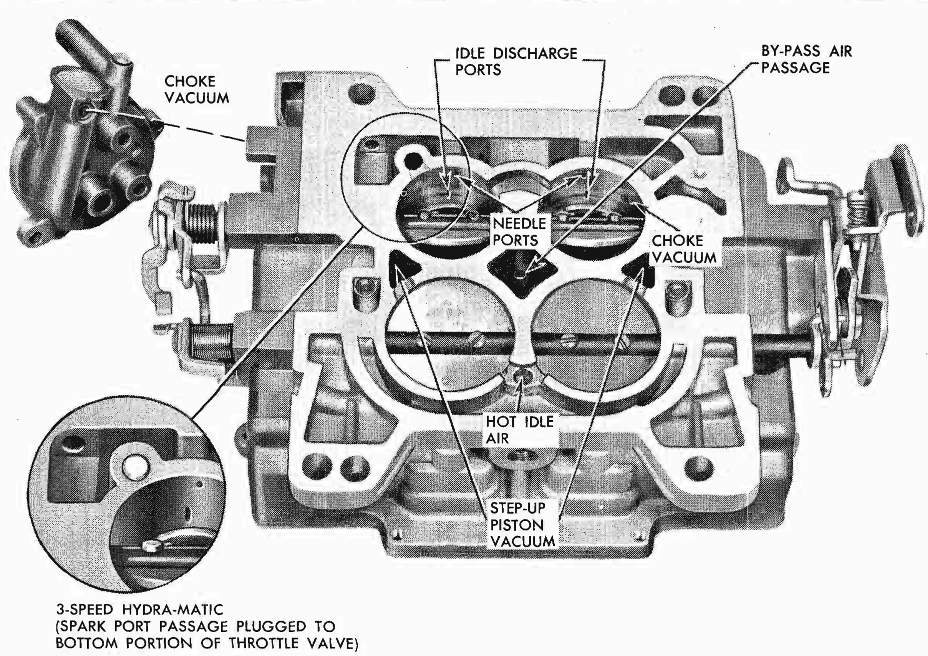


Fig. 6B-100 Comparison of Carburetors for Roto and Super Hydra-Matic

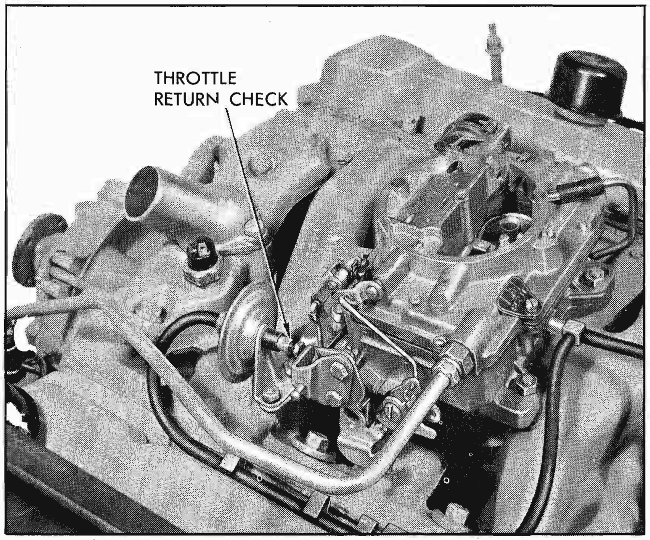


Fig. 6B-101 Throttle Return Check Hook-up for Hydra-Matic Four Barrel Carburetor (Same Hook-up for Two Barrel)

CARBURETOR—GENERAL

TROUBLE DIAGNOSIS AND TESTING

When carburetor troubles are encountered they can usually be corrected by making the adjustments outlined under ADJUSTMENTS ON CAR. The following list of common troubles and their causes will frequently save considerable time in locating the cause of the difficulty.

NOTE: Before any work is performed on the carburetor, make sure trouble is not due to poor compression, or in the ignition system due to improper timing, defective spark plugs, burned ignition points, etc. Always diagnose performance trouble before adjusting or repairing the carburetor.

When the cause of trouble is not located check for trouble in the carburetor system as follows:

POOR FUEL ECONOMY

NOTE: Before any attempt is made to improve fuel economy the actual gasoline mileage should be determined using a tenth of a gallon tester. If the mileage obtained during this test compares favorably with that found on other normal cars, the poor mileage must be attributed to the driving conditions or driving habits of the owner. Also consider factors such as dragging brakes, soft tires, improper tire size, and improper speedometer driven gear.

1. Check automatic choke to see that it operates properly and that it is correctly indexed.
2. Inspect manifold heat valve to see that it operates freely and thermostat is installed properly.
3. Check for leaks in fuel line fittings, at fuel tank, or at fuel pump bowl.
4. Check for dirty or restricted air cleaner.
5. Test for high fuel pump pressure.
6. Disassemble carburetor and check for evidence of vacuum leaks.
7. Check float level.

SURGING CONDITION WITH HOT ENGINE

1. Lean carburetor adjustment. Check mixture setting.
2. Check fuel pump pressure and output.
3. Check needle and seat on leak down tester.
4. Check float adjustment.
5. Check for dirty or obstructed jets or fuel passages.
6. Check for loose cluster or jets.

FLAT SPOT OR POOR ACCELERATION

1. Check manifold heat control valve thermostat for correct operation.
2. Check accelerator pump output visually to see if operating.
3. Check accelerator pump adjustment.
4. Check accelerator pump inlet and outlet valves for leakage.
5. Check for seating of accelerator pump plunger vent ball.
6. Check accelerator pump passages for dirt or obstructions.
7. Check float setting.

ROUGH IDLE

1. Check speed and mixture adjustment.
2. Check mixture screws for wear or burrs.
3. Check for manifold gasket leaks.
4. Check vacuum and heat connection.
5. Check operation and setting of choke system.

6. Check idle passage and throttle bore for carbon and dirt.

7. Check float adjustment.

8. Check for secondary throttle sticking (four barrel and triple two).

9. Check engine compression.

10. Check spark plug gaps.

11. Hot stalling on cars with air conditioning when installed in field from field packing package, install carburetor having hot idle compensator (two barrel only).

IMPROPER HIGH SPEED PERFORMANCE

1. Check spark plugs for correct gap and condition.

2. Check distributor points.

3. Check fuel pump output and pressure.

4. Check filter for restriction or plugging.

5. Check carburetor for evidence of internal vacuum leaks.

6. Check float level adjustment.

7. Check high speed passages for dirt or obstruction.

FLOODING OR LEAKING

1. Check for foreign material in needle and seat area.

2. Check needle and seat on leak down tester.

3. Check float adjustment (make sure float is not binding or rubbing).

4. Check for leaking or collapsed float.

5. Check for cracked bowl or loose passage plugs.

CARBURETOR SERVICE SPECIFICATIONS

Carburetor Model	Float Level	Float Drop	Choke Rod	Unloader	Stat Setting	Pump Rod	Idle Vent	Vacuum Switch	Secondary Throttle Lever	Fast Idle Speed	Throttle Return Check Setting
Rochester 2GC 7013063 7013065 7020070 7020071 7020072 7020073	5/8″ ± 1/16″	1 3/4″ Min.	.080″	.143″-.183″	Index	1 21/64″ ± 1/32″	1 17/64″ ± 1/64″	—	—	—	.062″-.067″*
Rochester 2GC 7020060 7020064 7020067 7020069 7020074 through 7020077	11/16″ ± 1/16″	1 3/4″ Min.	.056″	.143″-.183″	Index	1 1/8″ ± 1/32″	1 5/64″ ± 1/64″	—	—	—	.090″-.095″*
Rochester Tri-Power Center Carb.	23/32″ ± 1/16″	1 3/4″ Min.	.056″	.143″-.183″	Index	1 1/8″ ± 1/32″	1 1/32″ ± 1/64″	1 5/32″	—	—	—
Rochester Tri-Power End Carb.	23/32″ ± 1/16″	1 3/4″ Min.	—	—	—	55/64″ ± 1/32″	—	—	—	—	—
Carter AFB	21/64″ ± 1/32″	23/32″ Min.	—	5/32″ ± 1/32″	1 Notch Rich	In Center Hole 5/16″ ± 1/32″ See Note	—	—	.020″	2200 rpm.	.090″-.095″†

*With screw on next to high step on cam.
†With screw on high step of cam.
NOTE—Carter pump link must be adjusted to remove all lash from accelerating pump train and still maintain full throttle lever travel.

ENGINE POSITIVE CRANKCASE VENT

GENERAL DESCRIPTION

The engine positive crankcase ventilator is designed to redirect any crankcase fumes back into the intake manifold. This system replaces the conventional crankcase ventilator outlet and has a check valve control (Fig. 6B-102) at the push rod cover.

The check valve is designed to operate as follows:

During high manifold vacuum conditions the check valve is pulled towards the intake manifold against spring pressure. This gives us metered flow through the drilled passage in the check valve. Metered flow prevents idle interference from excessive air flow to the carburetor air/fuel mixture just below the throttle body.

Under driving conditions of average operating vacuum, the closing effect of the intake vacuum is counteracted by the calibrated spring pressure, thereby positioning the valve in an intermediate position to allow more air flow consisting of a combination of metered orifice flow and "by-pass" flow. This condition allows maximum crankcase ventilation.

When operating the engine under "0" vacuum or a manifold pressure condition such as a backfire, the check valve is closed by spring tension to prevent fuel vapor from entering the crankcase. The valve is also closed under wide open throttle condition but since this is for a very short duration of time, no irregularity will exist.

INSTALLING AN ENGINE POSITIVE CRANKCASE VENT SYSTEM

TWO AND FOUR BARREL CARBURETORS (FIGS. 6B-103 AND 6B-104)

1. Remove entire existing crankcase vent outlet.

2. Remove air cleaner and two plugs on the intake manifold.

3. Assemble check valve and grommet (soap or rubber lubricant will assist in this assembly).

4. Apply soap or rubber lubricant to the tapered surface of the grommet and valve assembly and assemble to the valve cover at the same opening at which the old outlet pipe and seal were removed.

5. Assemble fittings into holes in the manifold.

6. Assemble hoses to fittings using a coat of soap or rubber lubricant as necessary.

7. Assemble connector to hoses.

8. Attach bracket with manifold bolt and insert hoses.

9. Readjust carburetor idle speed and mixture setting.

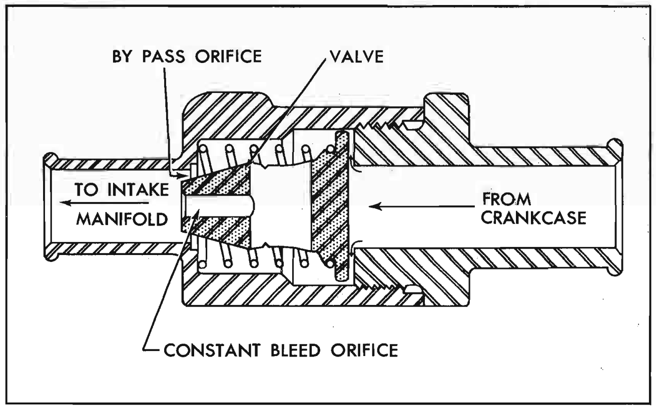


Fig. 6B-102 Cross Section of Vent Check Valve

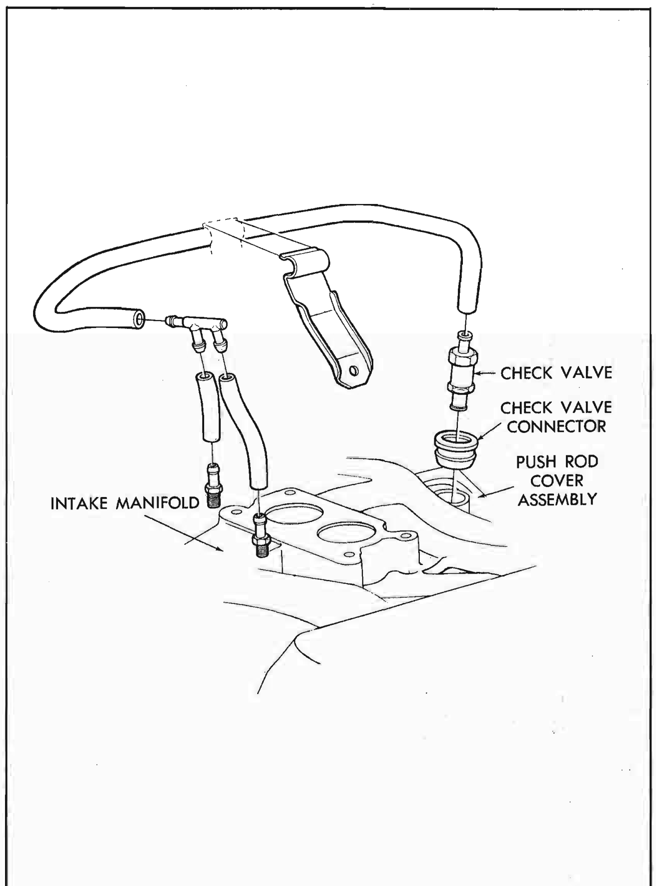


Fig. 6B-103 Engine Positive Crankcase Vent Two Barrel Carburetor Installation

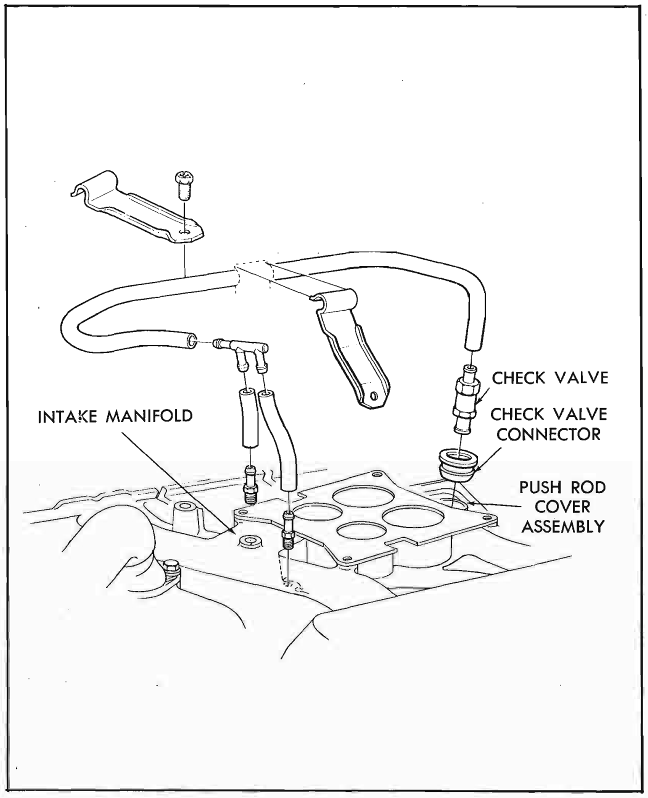


Fig. 6B-104 Engine Positive Crankcase Vent Four Barrel Carburetor Installation

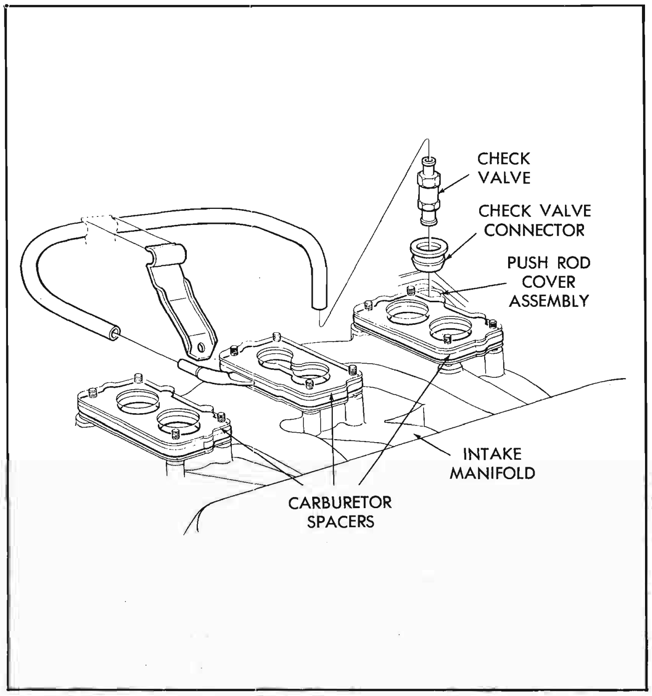


Fig. 6B-105 Engine Positive Crankcase Vent Triple Two Barrel Carburetor Installation

TRIPLE TWO BARREL CARBURETOR (FIG. 6B-105)

1. Remove entire existing crankcase vent outlet.
2. Remove air cleaner, carburetors, gaskets, and twelve studs from intake manifold pads.
3. Assemble check valve and grommet (soap or rubber lubricant will assist in assembly of these parts).
4. Apply soap or rubber lubricant to tapered surface of grommets and assemble to valve cover at same opening at which old outlet pipe and seal were removed.
5. Assemble twelve studs to manifold pads.
6. Assemble six gaskets and spacer assemblies to spacers, carburetors and air cleaner.
7. Assemble hose to both fittings using soap or rubber lubricant.
8. Attach bracket with intake manifold bolt and insert hose.
9. Bend existing choke heat tube as required to fit securely into intake manifold to depth of ½".
10. Loosen fuel filter bracket and raise filter approximately ¼".
11. Readjust carburetor idle speed and mixture setting.
12. Check carburetor and transmission throttle control linkage adjustments.

FUEL PUMP

DESCRIPTION (FIG. 6B-106)

The fuel pump transfers gasoline from the tank to the carburetor in sufficient quantity to meet engine requirements at any speed or load.

The rocker arm spring keeps the rocker arm in constant engagement with the eccentric on the engine camshaft so that the rocker arm moves downward and upward as the camshaft rotates. As the rocker arm is moved downward it bears against a link which is also pivoted on the rocker arm pin. The link is hooked to the diaphragm pull rod so that the diaphragm is moved away from the fuel chamber and the diaphragm spring is compressed. The enlarging fuel chamber moves gasoline from the tank through the tubing and inlet valve and into the space below the diaphragm.

As the rotating eccentric permits the rocker arm to move away from contact with the link, the compressed diaphragm spring is free to move the diaphragm downward to expel the fuel through the outlet valve to the carburetor bowl.

Because the diaphragm is moved downward only by the diaphragm spring, the pump delivers fuel to the carburetor only when the pressure in the outlet line is less than the pressure maintained by the diaphragm spring. Fuel is delivered to the carburetor only when the needle valve is open. When the needle valve is closed by pressure of fuel on the float, the pump builds up pressure in the space below the diaphragm and in the outlet tube until the diaphragm spring is compressed. The diaphragm then remains stationary until more fuel is required.

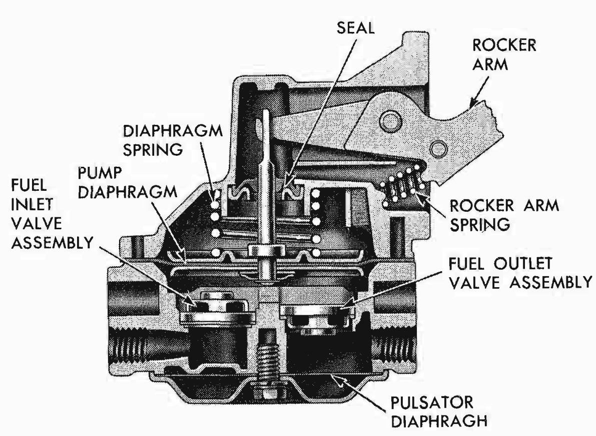


Fig. 6B-106 Schematic View of Fuel Pump

OVERHAUL

DISASSEMBLY

1. Scratch locating marks on fuel cover and pump body so that inlets and outlets will be properly located when pump is reassembled.

2. Place pump rocker arm in soft jawed vise with pump cover facing up.

3. Remove pulsator cover plate, bolt and washer; remove plate, and pulsator diaphragm.

4. Remove pump cover screws except any two that are diametrically opposite.

5. If pump is fairly new, press down firmly on the cover to hold the heavy diaphragm spring compressed and remove the remaining two screws. Release the cover slowly and remove cover assembly, diaphragm spring and spring retainer.

   NOTE: If desired, two 10-32NF x 1½" screws may be screwed diametrically opposite each other to aid in relieving the diaphragm spring pressure when removing the cover.

6. Drive out rocker arm pin with a tapered drift after removing sufficient staked metal from the pin. Be sure to leave sufficient metal for restaking. Remove rocker arm, rocker arm spring, and link.

7. Remove diaphragm, diaphragm spring, and retainer.

8. Using a small chisel, round file or small grinding wheel, remove metal around oil seal which was displaced by staking during assembly. Pull out seal with hook shaped tool. Use care not to damage seal seats.

9. Remove metal displaced by staking around inlet and outlet valves in the same manner. Pry valves and cages out with screwdriver blade. Lift out gaskets.

CLEAN AND INSPECT

1. Clean and rinse all metal parts in solvent. Blow out all passages with air hose.

2. Inspect pump body and fuel cover for cracks, breakage and distorted flanges. Examine all screw holes for stripped or crossed threads. If any of these three parts are damaged the pump should be replaced.

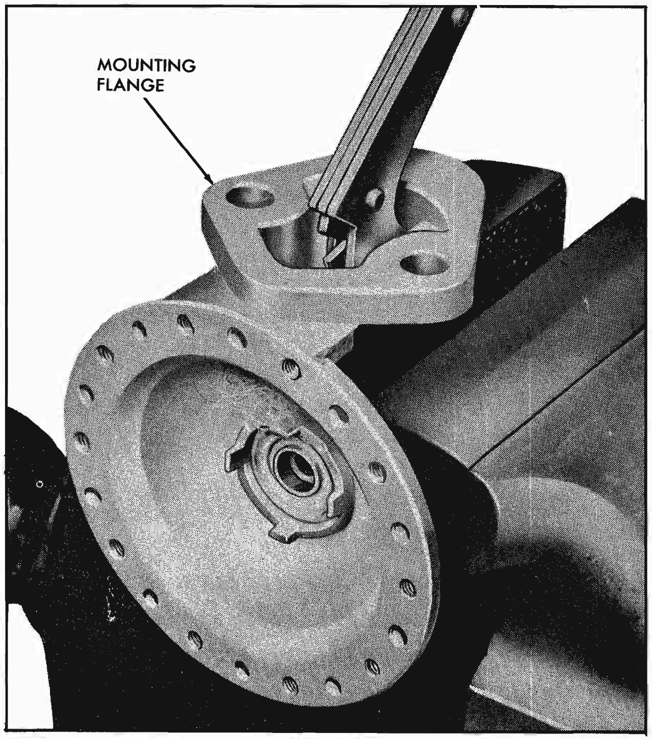


Fig. 6B-107 Correct Position of Pump Body in Vise

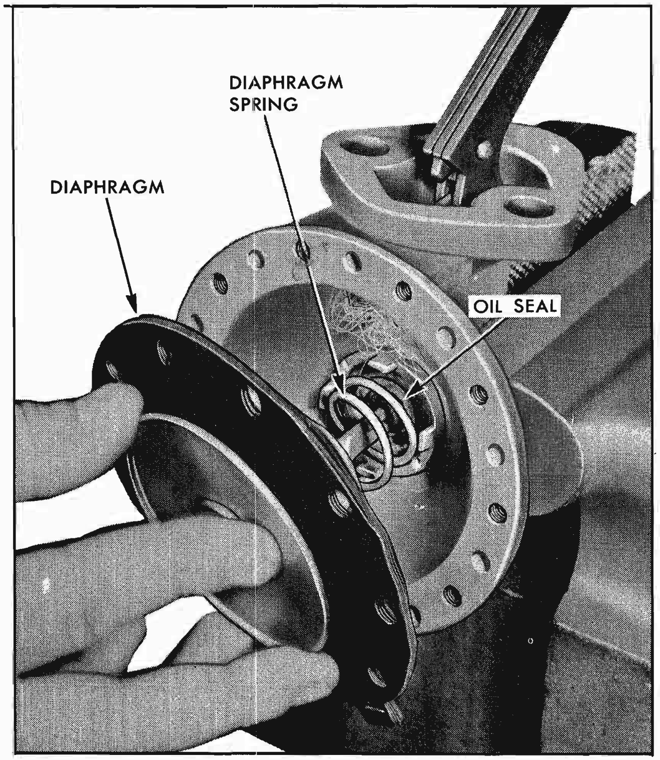


Fig. 6B-108 Sealing Diaphragm Spring in Seal Well

3. Inspect rocker arm for wear or scoring at camshaft pad, at point of contact with links, and at pivot hole. Inspect bushing for wear.

ASSEMBLY

1. Install seal by placing seal and retainer in pull rod recess of pump body with rubber end down toward links and press down firmly with flat end of ⅞" diameter round bar.

2. Stake die cast lip in four places to retain seals.

3. Position link and rocker arm in pump body with hook of link pointing toward top of pump.

4. Align all holes.

5. Drive rocker arm pin through rocker arm and link.

6. Install small washer and restake pin securely.

7. Install inlet and outlet gaskets and valves in pump cover. After pressing down to seal valve against gasket, stake valves in position.

8. Soak pump diaphragm in clean kerosene. Fuel oil may be used, but do not use shellac or sealing compound.

9. Place pump body in vise with mounting flange up (Fig. 6B-107).

10. Set diaphragm on bench with pull rod pointing up. Position the spring retainer and spring over pull rod.

11. Pick up diaphragm, retainer and spring as an assembly and push pull rod through oil seal into body. Be sure diaphragm spring is seated in seal well (Fig. 6B-108).

Have flat of pull rod parallel to flat of link with the diaphragm flush with the body cover flange. With palm of hand turn the diaphragm 90°, or until flat of pull rod is perpendicular to pump link. This motion should engage the pull rod "eye" with the link hook. If not, repeat this procedure until the connection is made.

CAUTION: Be extremely careful when performing this operation to avoid damaging seal.

12. Position rocker arm spring between projection on rocker arm and conical projection on body.

13. Install pump cover on body making sure that scratch marks on cover and body line up. Push on

rocker arm until diaphragm is flat across body flange. Install cover screws and lock washers loosely until screws just engage lock washers. Push rocker arm through its full stroke and hold in that position while tightening cover screws securely.

NOTE: Diaphragm must be flexed before tightening cover screws or pump will deliver too much pressure.

14. Place new pulsator diaphragm on pump body. Install pulsator cover with bolt and lock washer.

TROUBLE DIAGNOSIS AND TESTING

FUEL PUMP INSPECTION AND TEST

NOTE: These procedures may be used for both the combination and single type fuel pumps.

Always check pump while it is mounted on the engine and be sure there is gasoline in the tank.

The line from the tank to the pump is the suction side of the system and the line from the pump to the carburetor is the pressure side of the system. A leak on the pressure side, therefore, would be made apparent by dripping fuel, but a leak on the suction would not be apparent except for its effect of reducing volume of fuel on the pressure side.

1. Tighten any loose line connections and look for bends or kinks in lines which would reduce fuel flow.

2. Tighten diaphragm flange screws.

3. Disconnect fuel pipe at carburetor. Disconnect distributor to coil primary wire so that engine can be cranked without firing. Place suitable container at end of pipe and crank engine a few revolutions. If little or no gasoline flows from open end of pipe then fuel pipe is clogged or pump is inoperative. Before removing pump disconnect fuel pipe at inlet of pump and at gas tank and outlet pipe and blow through them with an air hose to make sure they are clear. Reconnect pipes to pump and retest while cranking engine.

4. If fuel flows from pump in good volume from pipe at carburetor, check fuel delivery pressure to be certain that pump is operating within specified limits as follows:

a. Attach a fuel pump pressure test gauge to disconnected end of pump to carburetor pipe.

b. Run engine at approximately 500 and 1,000 rpm on gasoline in carburetor bowl and note reading on pressure gauge.

c. If pump is operating properly the pressure will be 5¼ to 6½ pounds and will remain constant at speeds between 500 and 1,000 rpm. If pressure is too low or too high, or varies materially at different speeds, the pump should be removed for repair.

ENGINE TUNE UP

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

A minor tune and test consists of testing battery, cleaning, regapping or replacing, if required, spark plugs and distributor points; adjusting distributor dwell angle, ignition timing, carburetor idle mixture, hot idle speed and fast idle speed, and checking manifold heat control valve.

The complete or major tune and test procedure consists of these basic items plus other ignition, compression, electrical and carburetor checks, and a final road test to ensure continued trouble free operation.

BASIC PROCEDURE

CONNECT TUNE-UP EQUIPMENT

Follow manufacturer recommendations for the use of testing equipment. Fig. 6C-1 shows a basic schematic for instrumentation which will apply to many types of test equipment and may be used as a rough guide if equipment manufacturers' instructions are not available.

Connections shown in Fig. 6C-1 are made as follows:

1. Voltmeter.
   a. Positive lead to resistor side of coil.
   b. Negative lead to ground.
2. Timing light.
   a. Positive lead to positive battery terminal.
   b. Negative lead to ground.
   c. Trigger lead to number 1 spark plug.
3. Tachometer.
   a. Positive lead to distributor side of coil.
   b. Negative lead to ground.
4. Dwell Meter.
   a. Positive lead to distributor side of coil.
   b. Negative lead to ground.

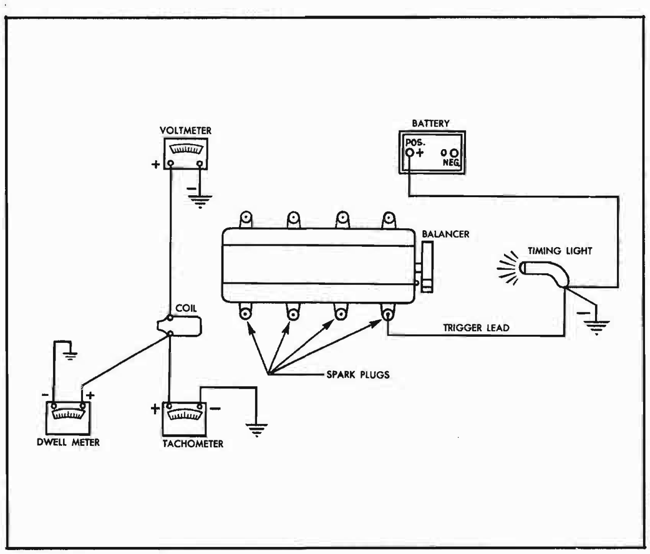


Fig. 6C-1 Simple Schematic of Tune-Up Instrumentations

BATTERY VOLTAGE—TEST WHILE CRANKING ENGINE

NOTE: Disconnect distributor to coil primary wire during this test to prevent engine from firing.

Terminal voltage while cranking must not be less than 9.0 volts on a 12-volt battery. Engine cranking speed (approximately 180 rpm) should also be observed during this check to see that it is satisfactory. If cranking speed is low, check starting circuit to locate cause of low speed. If battery voltage is low while cranking, further tests of battery and/or starting motor circuit should be made to locate trouble.

CAUTION: When installing self locking battery terminals, push the terminal as far down on the battery post as possible, before releasing spring fingers. If this is not done, it may result in cranking failures due to loose terminals. The battery post should be above the cable terminal approximately 1/8".

To insure proper electrical operation, the battery should be in good condition and be adequately charged. Check cell to cell voltage as outlined in the ELECTRICAL SECTION and recharge or replace as necessary.

SPARK PLUGS—REMOVE AND RECONDITION

Check to see that correct spark plugs are being used. Spark plug upper insulators should be thoroughly cleaned to prevent possible flash-out. Thoroughly clean lower insulator and cavity by sand blasting. File both electrodes flat (rounded surfaces increase voltage required to fire plugs) and set gap (.033" to .038"). Leave plugs out for compression check. When plugs are installed, use new gaskets and tighten plugs to 25 lb. ft. torque.

DISTRIBUTOR POINTS—CLEAN AND ADJUST

Remove distributor cap and inspect points for excessive burning or pitting. Replace points if necessary. Use a point file to clean contact area and remove scale from points. Filing is for cleaning purposes only. Do not attempt to remove all roughness. Apply a trace of bearing lubricant to the breaker cam. Adjust distributor dwell to 30° (28°-32°) following procedure outlined in the ELECTRICAL SECTION.

SET IGNITION TIMING

With distributor vacuum line disconnected and car operating at normal idle speed or below, set ignition timing. Follow procedure outlined in the ELECTRICAL SECTION. Correct setting is 6° BTDC.

HOT IDLE SPEED AND MIXTURE—ADJUST

Following adjustment procedure outlined in the ENGINE FUEL SECTION, adjust carburetor idle speed and mixture to give the smoothest idle at the following specifications:

NOTE: Depress hot idle air valve plunger while making adjustment on triple-two barrel carburetors.

Synchro-Mesh (In Neutral) .... 480-500 r.p.m.
Hydra-Matic, Exc. Air Conditioning
(In Drive Range) .... 480-500 r.p.m.
Air Conditioning (AC Off)
Hydra-Matic (Drive Range) ...... 540-560 r.p.m.
Synchro-Mesh (In Neutral) .... 540-560 r.p.m.

FAST IDLE SPEED—ADJUST

Following procedures outlined in the ENGINE FUEL SECTION, adjust fast idle speed to the following (with fast idle screw at highest step of fast idle cam):

Carter 4-Barrel
Carburetor ....H.M. and S.M. Trans.—2200 r.p.m.

ANTI-STALL DIAPHRAGM SETTING

NOTE: Before attempting to set the anti-stall diaphragm, the hot idle speed must be adjusted on the 1 and 2-bbl. carburetors, and the hot idle speed and fast idle speed both must be set on the 4-bbl. carburetor. All adjustments are made with engine shut off.

ROTO HYDRA-MATIC

Standard 2-bbl. (Next to High Step) ...062"-.067"
Economy 2-bbl. (Next to High Step) ...090"-.095"

SUPER HYDRA-MATIC

4-bbl. (On High Step) ....090"-095"

CAUTION: The anti-stall diaphragm plunger must be restrained from turning while adjusting plunger screw to prevent injury to the diaphragm.

SEE THAT EXHAUST MANIFOLD HEAT VALVE OPERATES FREELY

Manifold heat valve must operate freely. If stuck open, it can cause sluggish operation of the engine, especially during warm-up. If stuck closed, engine performance when hot will be unsatisfactory.

ADDITIONAL PROCEDURES

For diagnosis purposes, it is sometimes necessary to proceed further than the basic tune-up procedure. The following steps plus a road test are included in a complete or major tune and test procedure.

BATTERY—CLEAN TOP, TIGHTEN TERMINALS AND HOLD DOWN CLAMP

Clean and neutralize the top of the battery with a solution of baking soda and water. The top of the battery must be clean to prevent current leakage between the terminals and from the positive terminal to the hold down clamp.

In addition to current leakage, prolonged accumulation of acid and dirt on top of the 12-volt battery may cause blistering of the material covering the connector straps and corrosion of the straps. After connecting terminals, coat them with petrolatum to protect them from corrosion. Hold down clamp should be tightened to 22-27 lb. in. torque.

CAUTION: Excessive tightening of the hold down clamp can crack the battery case.

COMPRESSION PRESSURE—TEST EACH CYLINDER

NOTE: If this test is to be performed, it should be done when spark plugs are removed for service during the basic tune-up procedure.

Unless checking for worn rings or for the cause of low speed miss, compression check should not be necessary.

Test compression with engine warm, all spark plugs removed and throttle and choke wide open. No cylinder should be less than 80% of the highest cylinder (see examples). Excessive variation between cylinders, accompanied by low speed missing of the cylinder or cylinders which are low, usually indicates a valve not properly seating, a burned valve or a broken piston ring. Low pressures, even though uniform, may indicate worn rings. This will usually be accompanied by excessive oil consumption.

Example 1

Cyl.	1	2	3	4	5	6	7	8
Press.	136	138	135	144	102	137	140	141

80% of 144 (highest) is 115. Thus cylinder No. 5 is less than 80% of No. 4. This condition, accompanied by low speed missing, indicates a burned valve or broken piston ring.

Example 2

Cyl.	1	2	3	4	5	6	7	8
Press.	85	91	90	87	96	93	87	89

80% of 96 is 77. While all cylinders are well above 77, they are all excessively low. This indicates all poor valves or, if accompanied by oil consumption, worn rings. If compression is subnormal, the tune-up will probably not be satisfactory.

CARBURETOR—CLEAN AIR CLEANER AND CRANKCASE VENTILATOR AIR CLEANERS

The entire air cleaner should be removed from the car for cleaning. The metal cover and shell of the air cleaner should be cleaned on the inside surfaces.

Remove filter element from standard carburetor air cleaner. Wash dirt from filter element and from crankcase ventilator inlets by plunging up and down several times in suitable solvent. Drain dry and re-oil.

POLYURETHANE HEAVY DUTY CLEANER

After each occasion of driving during dust storms or at most every 16,000 miles, remove the cleaner from the engine, remove the cleaner element from the cleaner, and remove the screen from the cleaning element. Wash the element in suitable solvent such as kerosene at room temperature to remove oil and dirt. Squeeze element (do not wring) dry. Dip in SAE 10W-30 oil and squeeze to remove excess oil.

Replace screen in cleaner element with element sealing edges evenly overlapping screen. Clean all dirt from inside air cleaner body, install cleaner element, and reinstall entire cleaner on engine.

HIGH TENSION WIRES, DISTRIBUTOR CAP AND ROTOR—CLEAN AND INSPECT

NOTE: This operation is to be performed while checking distributor points during the basic tune-up procedure. Inspect distributor cap for cracks and flash over.

External surfaces of all parts of the secondary system must be cleaned to reduce the possibility of voltage loss. All high tension wires should be removed from the distributor cap and coil so that terminals can be inspected and cleaned. Burned or corroded terminals indicate that wires were not fully seated, causing arcing between the end of the wire and the terminal. When replacing wires in terminal, be sure they are fully seated before pushing rubber nipple down over tower. Check distributor rotor for damage and distributor cap for cracks.

DISTRIBUTOR—LUBRICATE

Wipe a very small amount of special cam and ball bearing lubricant on cam lobes when servicing.

CARBURETOR CHOKE AND UNLOADER—CHECK OPERATION AND ADJUSTMENT

The specified choke setting provides ideal choke operation in all climates. No seasonal changes are necessary.

Settings are as follows:

Carter 4BBL	Set 1 notch rich
Rochester (all models)	Set at index mark

The choke should *just* close at 75°F. when set at index. In rare cases, it may be necessary to change slightly (never more than two notches) from the standard setting to properly calibrate the choke.

Choke linkage must operate freely. *Do not lubricate linkage since this will collect dust and cause sticking.*

Check unloader action. Inoperative unloader can cause complaints of difficult hot starting. Adjust as outlined in the ENGINE FUEL SECTION.

INTAKE MANIFOLD AND CARBURETOR ATTACHING NUTS—TIGHTEN

Intake manifold attaching screws and nuts on engines should be tightened to 40 lb. ft. torque. Carburetor attaching nuts should be tightened securely. Leaks at these areas can cause rough idle, surging, deceleration popping, or deceleration whistle.

INSPECTION

Inspect for oil and/or coolant leaks. Check radiator hoses. Check and adjust engine fan and accessory drive belt tension. Check steering wheel.

ROAD TEST

TEST PERFORMANCE OF CAR

Observe performance of engine at low speed, during acceleration, and at constant speed. Check for missing, stalling, surging, poor acceleration or flat spots on acceleration. If any irregularity is found, tests listed under diagnosis should be conducted to find and correct trouble.

TEST OPERATION OF:

BRAKES—Pedal should not go closer than 2" from floor mat (1" with power brakes). Fluid level in master cylinder should be one inch below top of master cylinder housing filler plug opening.

PARKING BRAKE—Should hold the car without excessive movement of parking brake pedal.

HYDRA-MATIC—Observe shift pattern at minimum and full throttle and test forced downshifts. Watch for any indications of slipping or unusual shift characteristics that may indicate need for adjustment.

STEERING GEAR—See that steering operates normally and that steering wheel does not have excessive play. Also observe for alignment of steering wheel, pull, wander, or other irregularity that might indicate need for front end alignment.

WINDSHIELD WIPER—Wiper operation should be tested with windshield wet in order to properly judge the action.

CLUTCH—See that clutch engages smoothly and that lash is correct. Follow procedure for adjusting clutch pedal height and lash in the ENGINE CLUTCH section. "Hard" pedal or lack of pedal return may indicate need for overcenter spring adjustment.

LIGHTS AND HORNS—Test operation of headlights, tail lights, stop lights, parking lights, direction signals, and all other lights, as well as the horns.

INSTRUMENTS—Observe operation of all instruments. Observe especially for possible abnormal readings which may indicate trouble.

ACCESSORIES—Test operation of radio, heater, defroster, cigar lighter, other accessories.

ENGINE CLUTCH

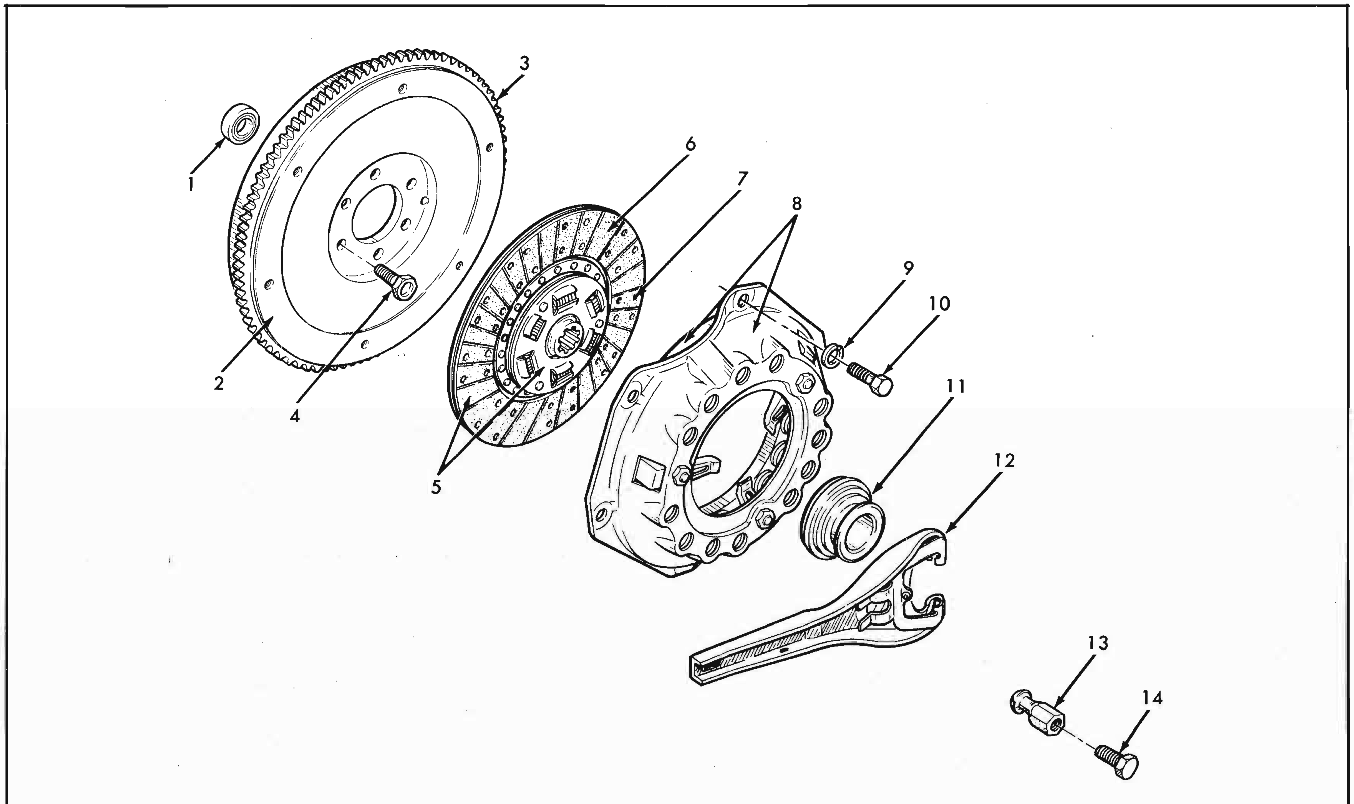
CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

A single plate, dry disc type 10½" clutch is used on all cars with synchro-mesh transmission. The clutch assembly consists of the clutch driven plate assembly, the clutch cover and pressure plate assembly, and the clutch release mechanism (Fig. 6D-1).

The clutch incorporates semi-centrifugal action to guard against clutch slippage at high engine speeds. Twelve coil springs supply the initial clutch plate load (9 plain and 3 yellow springs on standard clutch; 6 black and 6 orange springs on heavy duty clutch).

Three centrifugal rollers (6 rollers on heavy duty clutch) are installed between the clutch plate and cover so that, as engine speed is increased, centrifugal force exerts pressure between clutch cover and the clutch pressure plate.



1. Crankshaft Clutch Pilot Bearing
2. Engine Flywheel
3. Flywheel Ring Gear
4. Flywheel to Crankshaft Bolt
5. Clutch Driven Plate (with facings)
6. Clutch Driven Plate (Facings)
7. Clutch Facing Rivet
8. Clutch Cover and Pressure Plate Assembly
9. Clutch Cover to Flywheel Bolt Washer
10. Clutch Cover to Flywheel Bolt
11. Clutch Release Bearing
12. Clutch Release Fork
13. Clutch Release Fork Ball
14. Clutch Fork Ball Support Bolt

Fig. 6D-1 Engine Clutch and Flywheel Assembly—Exploded View

Eight vibration damper coil springs encircle the driven plate hub to prevent the transmitting of vibration from the engine to the transmission. The grooves on both sides of the clutch driven plate lining prevent the sticking of the plate to the flywheel and pressure plate due to vacuum between the members.

The clutch cover and pressure plate assembly (Fig. 6D-1) is made up of the cover, pressure plate, twelve clutch thrust springs, three clutch release levers, three eyebolts, three anti-rattle springs, three struts and three special adjusting nuts. The clutch thrust springs act on the pressure plate and force the driven plate against the flywheel, thereby coupling the engine to the transmission. The clutch eyebolts connect the pressure plate to the clutch cover and the release levers disengage the pressure plate when force is applied against the clutch release bearing.

The clutch release mechanism consists of a ball thrust bearing, appropriate levers and linkage to manually control the action of the bearing. The ball thrust bearing is piloted on a tubular support (retainer) concentric with and enclosing the transmission main drive (clutch) gear. When pressure is applied to the clutch pedal to release the clutch, the clutch fork pivots on its ball socket. The inner end then pushes the release bearing forward so that it presses against the inner ends of the clutch release levers, releasing the clutch (Fig. 6D-1). Pedal effort is transmitted through the pedal to the countershaft and lever assembly and thence to the clutch fork.

The countershaft is equipped with an overcenter spring (Fig. 6D-2) so that when the clutch pedal is depressed beyond a certain point, the overcenter spring partially balances the clutch springs, thus reducing the pedal effort exerted by the driver in disengaging the clutch.

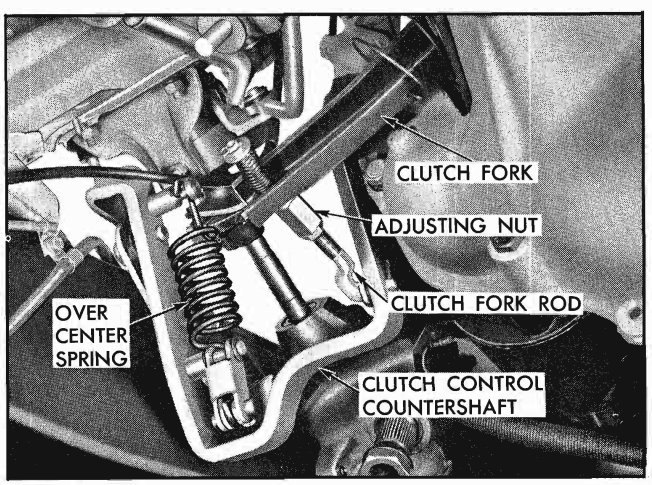


Fig. 6D-2 Engine Clutch Linkage

PERIODIC SERVICE

Every 4,000 miles, lubricate all pivot points with engine oil. Use light grease at pushrod to clutch fork ball joint and chassis grease at high pressure lubrication fitting. The ball type release bearing is lubricated and sealed for life and requires no lubrication.

CLUTCH PEDAL ADJUSTMENT

CAUTION: Do not attempt to adjust pressure plate release levers as they are adjusted at the factory with a special fixture, and cannot be adjusted correctly unless a fixture is used.

Wear on the clutch parts necessitates occasional adjustment. Adjustment should be made so as to maintain clutch pedal free movement (movement until pressure due to contacting bearing is felt at pedal, approximately 3/4", Fig. 6D-3).

NOTE: If pedal is left with too little free movement, frequent readjustment will be necessary. If left with two much free movement, disengagement of clutch may be incomplete.

1. Loosen clutch fork rod adjusting lock nut (Fig. 6D-2).

2. Adjust silencer bumper so that countershaft is lifted .015" to .020" off stop (Fig. 6D-4).

3. Remove clutch fork lash (release bearing touching clutch pressure plate levers) with adjusting nut, then back off adjusting nut 4½ turns on new clutch

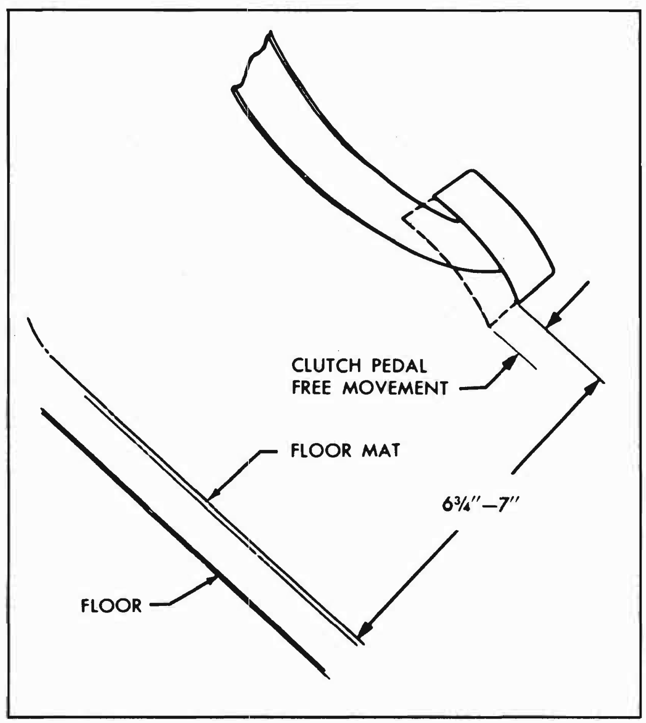


Fig. 6D-3 Proper Clutch Pedal Height and Clearance

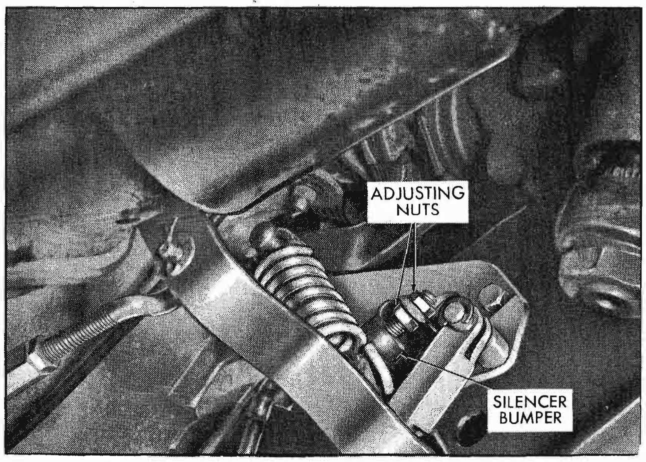


Fig. 6D-4 Adjustment of Silencer Bumper

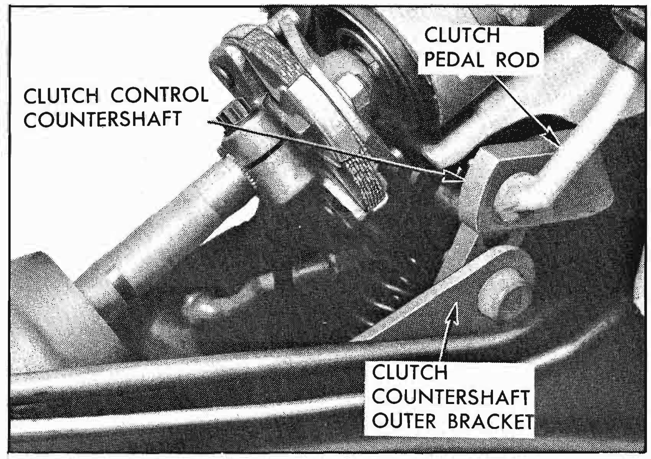


Fig. 6D-5 Location of Clutch Rod and Countershaft

driven plate installation or 3½ turns when worn or old clutch driven plate is re-installed.

4. Tighten lock nut to 60-120 lb. in. torque.

5. Check pedal height. Pedal should be 6¾"-7" above floor mat (Fig. 6D-3). If adjustment is required, loosen pedal rod upper trunnion jam nuts and adjust. Tighten jam nuts after pedal adjustment to 60-120 lb. in. torque.

SERVICES AND REPAIRS

OVERCENTER SPRING—REMOVE AND REPLACE

1. Disconnect clutch fork from rod.

2. Rotate the clutch countershaft to a position that would result from a fully depressed pedal, unhook the spring from the overcenter lever.

3. Install new spring.

4. Rotate countershaft to its stop.

5. Connect clutch fork rod to fork.

CLUTCH—REMOVE AND REPLACE

REMOVE

1. Disconnect battery to starter lead at battery.

2. Remove propeller shaft and transmission. See TRANSMISSION SECTION. Exercise care to avoid damaging transmission front retainer (release bearing support) when transmission is pulled back to free main drive (clutch) gear from flywheel housing.

3. Remove release bearing through rear opening in clutch housing. Do not place bearing in any degreasing solvent, etc.

4. Remove cotter pin, washer and spring at rear end of fork push rod; remove cotter pin and plain washer at front end of rod and remove rod.

5. Remove cotter pin and washer from clutch pedal push rod at countershaft and disengage rod from countershaft (Fig. 6D-5).

6. Rotate countershaft assembly to remove overcenter spring.

7. Remove left hand pivot pin (threaded into countershaft) from countershaft. Move left end of countershaft rearward withdrawing right end of countershaft out of bushing in flywheel housing.

8. Remove starter.

9. Remove front flywheel housing shield.

10. Remove flywheel housing bolts and pull housing off of dowels.

11. Remove flywheel housing.

12. Mark clutch pressure plate cover and flywheel to insure reassembly in the same position as balanced at factory.

13. Loosen bolts holding clutch cover to flywheel one turn at a time until tension is relieved.

14. Remove all but top bolt and move clutch assembly away from flywheel at bottom so as to permit removal of clutch driven plate.

15. Remove remaining bolt to remove clutch cover plate assembly.

INSPECT

1. Inspect clutch driven plate for broken or distorted torsion springs, worn or loose facings, oil on facings, and damaged spline which could cause binding. If any of the above defects are present, replace driven plate with new assembly.

NOTE: Servicing of clutch driven plate must be by replacement of plate assembly only.

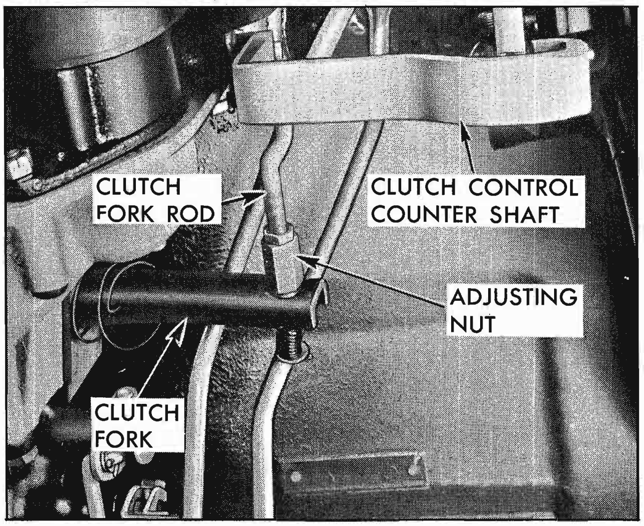


Fig. 6D-6 Clutch Linkage Properly Installed

2. Inspect pressure plate and cover assembly to see that it is free of oil and grease. Check pressure plate for scores or cracked surface.

NOTE: Servicing of clutch driven plate or pressure plate and cover assembly must be made by replacement of assemblies only.

3. Examine transmission retainer carefully to be certain there are no burrs on outer surface which pilots clutch release bearing.

4. Try release bearing on transmission retainer to make sure no binding exists.

5. Check release bearing by placing thrust load on bearing by hand and turning bearing race. Replace if bearing feels rough or seems noisy when turning.

6. Clean flywheel face with carbon tetrachloride, sandpaper or steel wool. Inspect pilot bearing in crankshaft for roughness.

REPLACE

1. Position clutch driven plate so long end of hub is in flywheel and install clutch driven plate and cover assembly on flywheel but do not tighten bolts (install lock washer under each cover to flywheel bolt).

NOTE: Align marks placed on flywheel and on cover during disassembly.

2. Use a spare transmission main drive gear inserted in spline of clutch driven disc to move disc into correct alignment so pilot on end of drive gear will enter clutch pilot bearing. Tighten clutch cover and pressure plate to flywheel bolts one turn at a time until tight, then tighten to 25-35 lb. ft. torque. Remove spare main drive gear used to align clutch disc.

3. Lubricate surface of release fork fingers, which contact release bearing, sides of pressure plate lugs protruding through cover plate stamping, and the release fork ball fulcrum with high melting point wheel bearing lubricant and install release fork.

4. Apply a light coat of grease to inner diameter of clutch release bearing and fill recess in inner diameter of bearing.

5. Install clutch release bearing to fork in flywheel housing.

6. Apply a light coat of high melting point wheel bearing lubricant to full length of outer diameter of transmission release bearing support (retainer).

CAUTION: Do not overlubricate.

7. Install flywheel housing and tighten bolts to 50-70 lb. ft. torque.

8. Install transmission. See TRANSMISSION SECTION.

CAUTION: Use two transmission guide pins in upper holes in clutch housing.

9. Connect clutch linkage to release fork (Fig. 6D-6).

10. Adjust pedal lash (3½ to 4½ turns of adjustment nut from zero lash).

SPECIFICATIONS

Clearance between pedal and floor mat . . . . 6¾"-7"

Clearance between pedal and pan
(under floor mat) . . . . 7⅝"-7⅞"

Pedal Lash—3½ to 4½ turns of adjustment nut (depending on clutch driven plate installation).

Disc Facings

Type	Single Plate Dry
Diameter of Disc	10½"
Facing Size	10½" O.D. x 6½" I.D. x ⅛" Thick
Release Bearing	Sealed Ball Bearing
Number of Thrust Springs	12
Number of Torsion Springs	8

TORQUE SPECIFICATIONS

	Lb. Ft.
Clutch Pressure Plate to Flywheel Bolts	20-30
Flywheel Housing to Engine Block Bolts	50-70
	Lb. In.
Clutch Fork Rod Adjusting Lock Nut	60-120
Clutch Pedal Rod Adjusting Nuts	60-120

STANDARD TRANSMISSION AND GEARSHIFT CONTROL

CONTENTS OF THIS SECTION

DESCRIPTION

The three-speed synchro-mesh transmission is used as standard equipment on Catalina and Safari models (Fig. 7-1).

It consists of two basic sections; the transmission case, or foward section, and the case extension, or rear section. The forward section contains the main gear assemblies, clutch assembly and synchronizing mechanism, while the rear section acts as a supporting member for the entire unit.

Gearshifting is manual through a concentric steering column gearshift mechanism which activates two rods connected to the shifter levers at the transmission case side cover. Shifting of gears is accomplished by

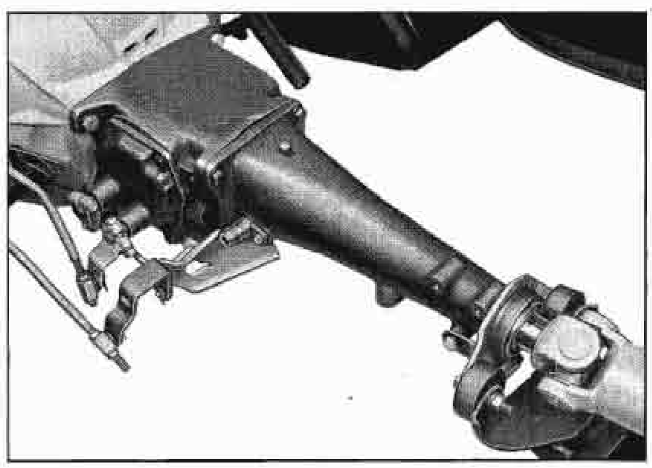
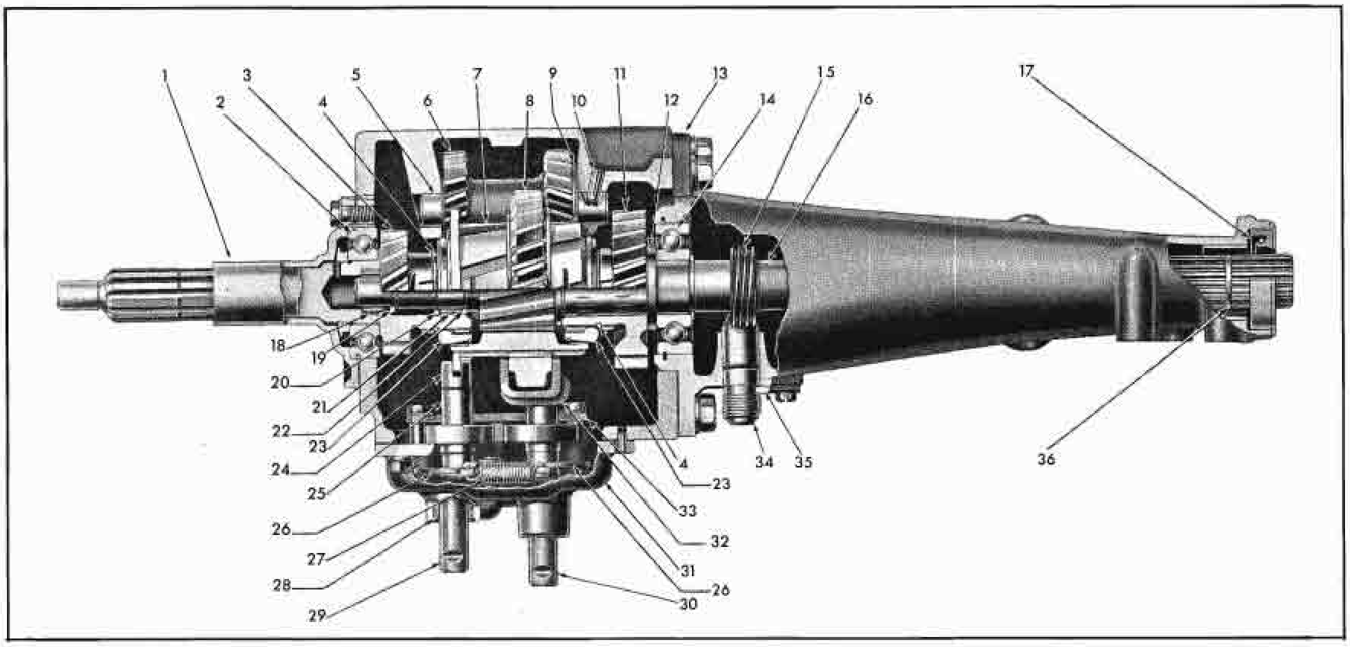


Fig. 7-1 Three-Speed Synchro-Mesh Transmission



1. Main Drive (Clutch) Gear Bearing Retainer
2. Main Drive (Clutch) Gear Bearing
3. Main Drive (Clutch) Gear
4. Energizing Spring
5. Reverse Idler Shaft
6. Reverse Idler Gear
7. Second and Third Speed Clutch
8. First and Reverse Sliding Gear
9. Thrust Bearing and Washer
10. Reverse Idler Shaft Lock Pin
11. Second Speed Gear
12. Thrust Washer
13. Case Extension
14. Mainshaft Rear Bearing
15. Speedometer Drive Gear
16. Mainshaft
17. Oil Seal
18. Front Pilot Bearing Rollers
19. Thrust Washer
20. Thrust Washer
21. Rear Pilot Bearing Rollers
22. Thrust Washer
23. Synchronizer Ring
24. Second and Third Shifter Fork
25. Second and Third Shifter Shaft (Inner)
26. Detent Cam
27. Detent Cam Spring
28. Oil Seal
29. Second and Third Shifter Shaft (Outer)
30. First and Reverse Shifter Shaft
31. Side Cover
32. First and Reverse Shifter Fork
33. Interlock Retainer
34. Speedometer Shaft Fitting
35. Lock Plate
36. Special Snap Ring

Fig. 7-2 Cross Section of Three-Speed Synchro-Mesh Transmission—Top View

the movement of two shift forks which directly engage the gears to be shifted.

DESIGN

The transmission incorporates all helical gears which are machined from drop-forged steel gear blanks, heat-treated and shot peened for strength and long life. The shafts are machined from high grade steel, heat-treated and ground to close limits.

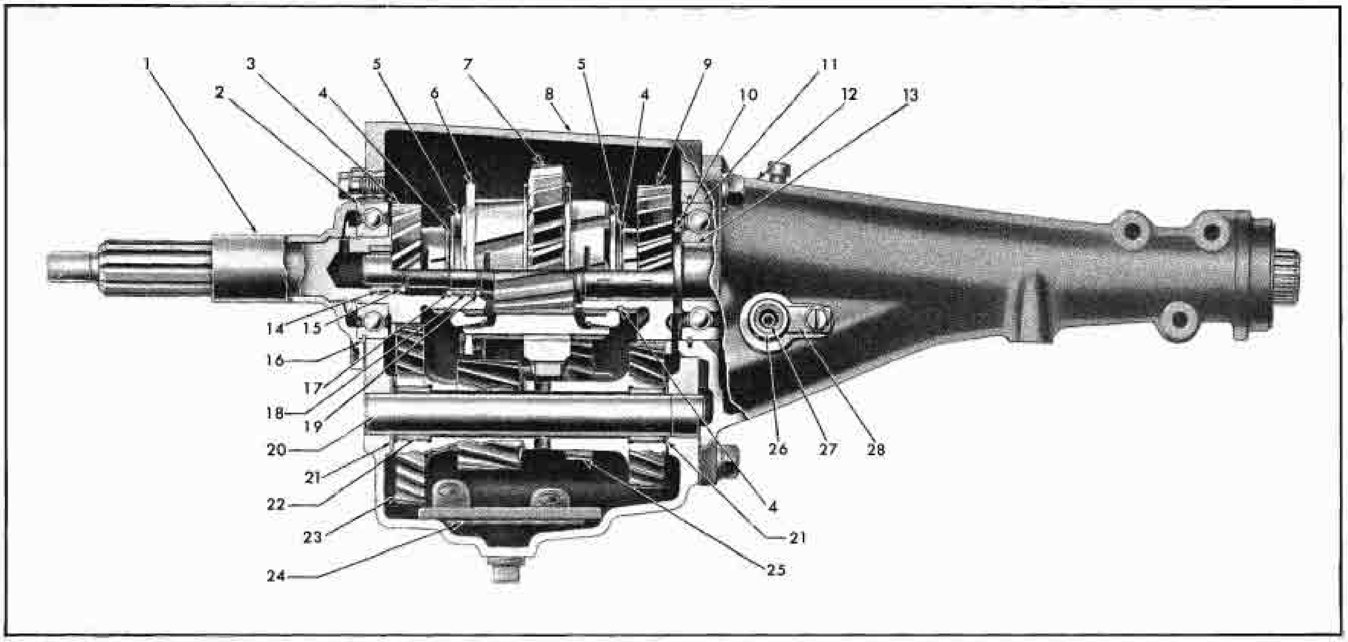
The transmission assembly consists of five basic gears of varying size and design. These gears are so positioned that, when one gear is brought into mesh with another, proper ratios are attained for first, second, third and reverse speeds.

A synchronizing mechanism, consisting of two cone-type synchronizing rings, is incorporated in the 2nd and 3rd speed clutch. It is this mechanism which allows the gears to be meshed properly while in motion.

The main drive (clutch) gear is supported by a heavy duty ball bearing located at the front end of the transmission case (Fig. 7-2). It is piloted at its front end in a single row, prepacked and shielded ball bearing mounted in the engine crankshaft.

The front end of the mainshaft is piloted in a double row of needle bearing rollers set into the hollow end of the main drive (clutch) gear and the rear end of the mainshaft is carried by a heavy duty ball bearing located in the face of the rear extension (Fig. 7-2).

The countergear is carried on needle bearing rollers positioned at both ends of the countershaft and thrust is taken on bronze thrust washers located between each end of the gear and the case. Retaining washers



1. Main Drive (Clutch) Gear Bearing Retainer
2. Main Drive (Clutch) Gear Bearing
3. Main Drive (Clutch) Gear
4. Energizing Spring
5. Synchronizing Ring
6. Second and Third Speed Clutch
7. First and Reverse Sliding Gear
8. Transmission Case
9. Second Speed Gear
10. Thrust Washer
11. Mainshaft Rear Bearing
12. Case Extension
13. Mainshaft
14. Front Pilot Bearing Rollers
15. Thrust Washer
16. Snap Ring
17. Thrust Washer
18. Rear Pilot Bearing Rollers
19. Thrust Washer
20. Countershaft
21. Thrust Washer
22. Roller Bearing
23. Countergear
24. Oil Baffle Plate
25. Reverse Idler Gear
26. Speedometer Shaft Fitting
27. Speedometer Driven Gear Shaft
28. Lock Plate

Fig. 7-3 Cross Section of Three-Speed Synchro-Mesh Transmission—Side View

are installed between the thrust washers and the roller bearings (Fig. 7-3).

The reverse idler gear is carried on ball-indented bronze bushings pressed into front and rear ends of the gear. Forward thrust of the gear is taken on a washer located between the front of the gear and the case, and rearward thrust is taken on a radial roller thrust bearing and washer positioned between gear and case (Fig. 7-2).

The second speed gear floats on the mainshaft, while the first and reverse sliding gear is positioned so that it rides on the 2nd and 3rd speed clutch assembly (Figs. 7-2 and 7-3).

OPERATION

The main drive (clutch) gear is in constant mesh with the countergear, which in turn is in constant mesh with the reverse idler gear and second speed gear. Therefore, with the engine running and the engine clutch engaged, torque is imparted to the main drive (clutch) gear, countergear, second speed gear, and reverse gear at all times.

OPERATION IN NEUTRAL (Fig. 7-4)

In neutral, the first and reverse sliding gear is positioned so that it does not mesh with the countergear or the reverse idler gear. The 2nd and 3rd speed clutch is positioned so that it does not engage the second speed gear or the main drive clutch gear. Therefore, with engine clutch engaged, the main drive (clutch) gear, countergear, second speed gear, and reverse idler gear are turning, but no power is being transmitted through the mainshaft.

OPERATION IN FIRST (Fig. 7-5)

In first speed, the first and reverse sliding gear is moved forward to engage the countergear, which is being turned by the main drive (clutch) gear. This

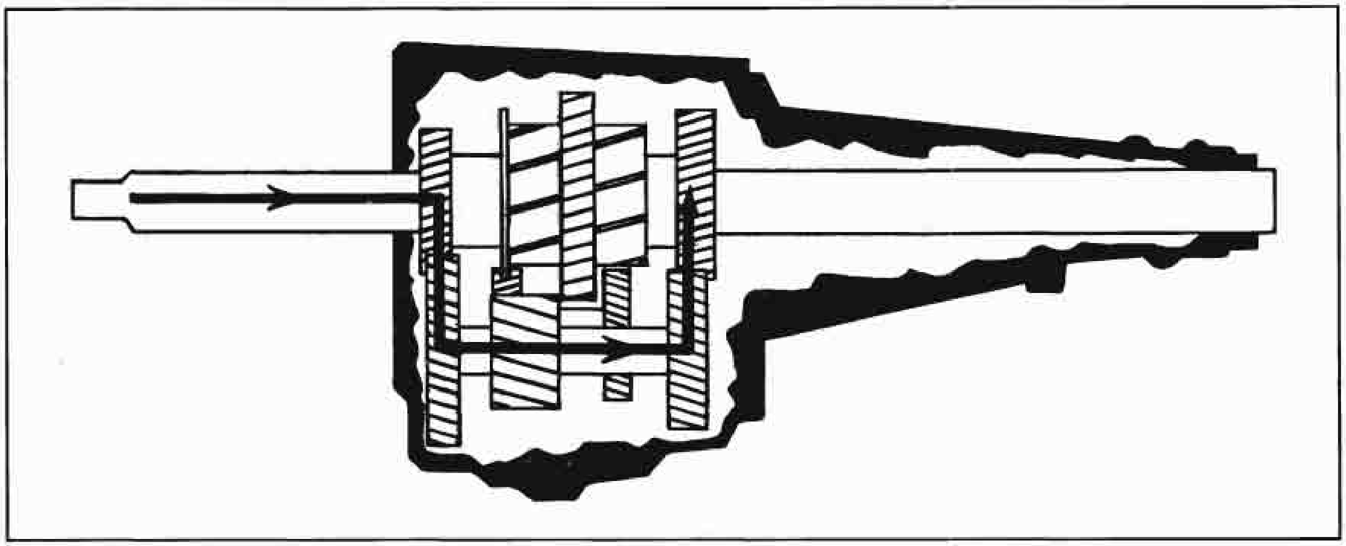


Fig. 7-4 Three-Speed Synchro-Mesh—Power Flow in Neutral

engagement activates the first and reverse sliding gear which rides on, and is splined to, the 2nd and 3rd speed clutch (sleeve). Because the 2nd and 3rd speed clutch is splined to the mainshaft, torque applied to the clutch through the first and reverse sliding gear is imparted directly to the mainshaft.

OPERATION IN SECOND (Fig. 7-6)

In second speed, the first and reverse sliding gear is moved to a neutral position. The 2nd and 3rd speed clutch, which is splined to the mainshaft, is moved toward the rear of the transmission to engage the second speed gear, which floats on the mainshaft. Since the main drive (clutch) gear and second speed gear are always in mesh with the countergear, and since the 2nd and 3rd speed clutch is splined to the mainshaft, engaging the 2nd and 3rd speed clutch with the second speed gear will cause the mainshaft to turn.

OPERATION IN THIRD (Fig. 7-7)

In third speed, or direct drive, the 2nd and 3rd speed clutch is disengaged from the second speed gear and moved forward until it engages the main drive (clutch) gear. Since the 2nd and 3rd speed clutch is splined to the mainshaft, torque is applied directly to the mainshaft in the direction of engine rotation at engine speed.

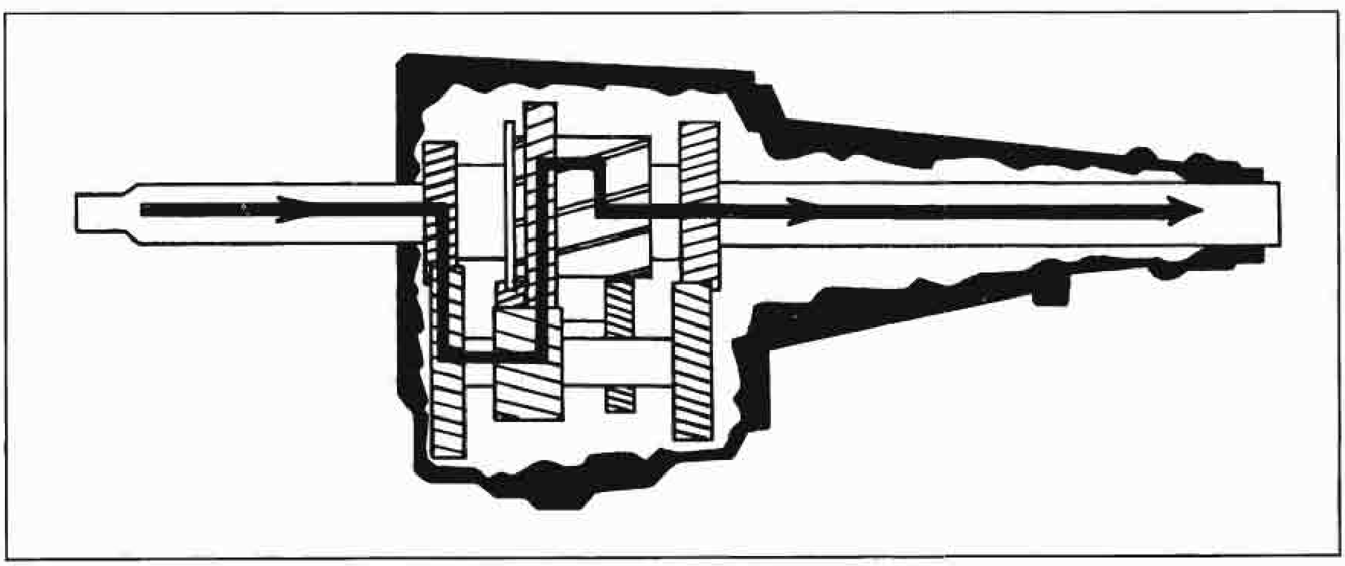


Fig. 7-5 Three-Speed Synchro-Mesh—Power Flow in First Speed

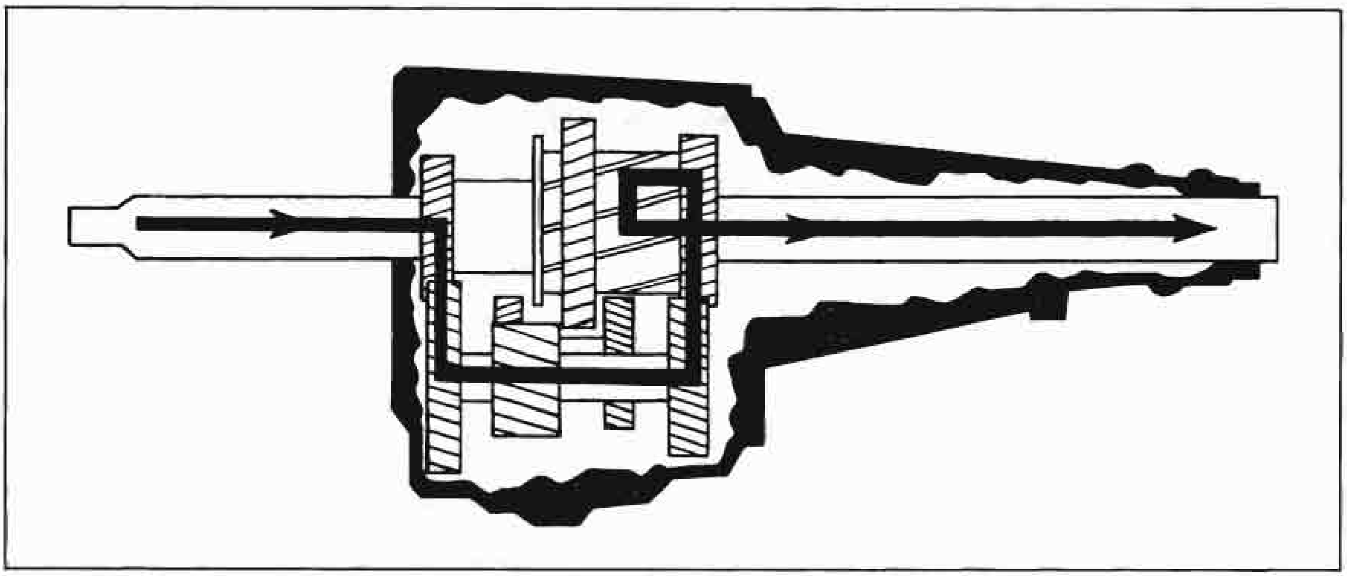


Fig. 7-6 Three-Speed Synchro-Mesh—Power Flow in Second Speed

OPERATION IN REVERSE (Fig. 7-8)

In reverse speed, the 2nd and 3rd speed clutch assumes a neutral position and the first and reverse sliding gear is moved rearward to engage the reverse idler gear. Since the first and reverse sliding gear rides on, and is splined to, the 2nd and 3rd speed clutch (sleeve), which is splined to the mainshaft, the power flow is directed through the main drive (clutch) gear, countergear, reverse idler gear, and first and reverse sliding gear to the mainshaft. As power flows from reverse idler gear to first and reverse sliding gear, the direction of rotation is reversed, making it opposite that of the engine.

PERIODIC SERVICE

TRANSMISSION

No periodic service of the transmission is required except checking for leaks and proper lubricant level at each 4,000-mile inspection period.

If there is evidence of leakage, the leak should be corrected and lubricant added, if needed. Refill capacity is 1.8 pints.

Use SAE 80 "Multi-purpose Gear Lubricant". No special additive to this lubricant is required or recommended.

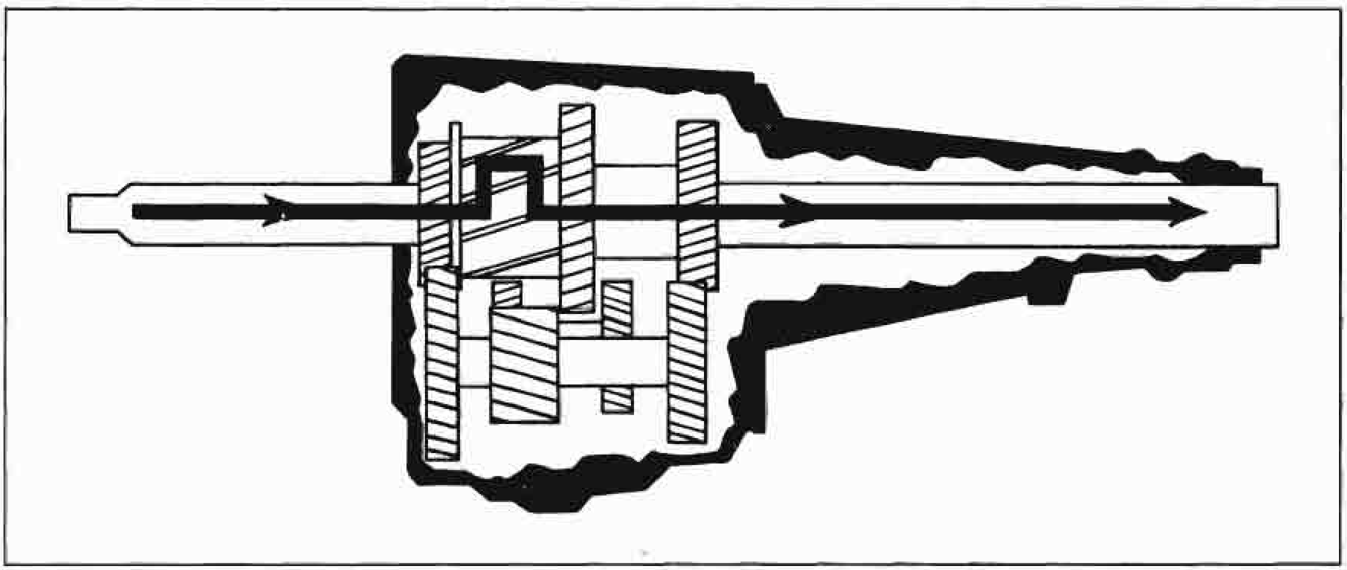


Fig. 7-7 Three-Speed Synchro-Mesh—Power Flow in Third Speed

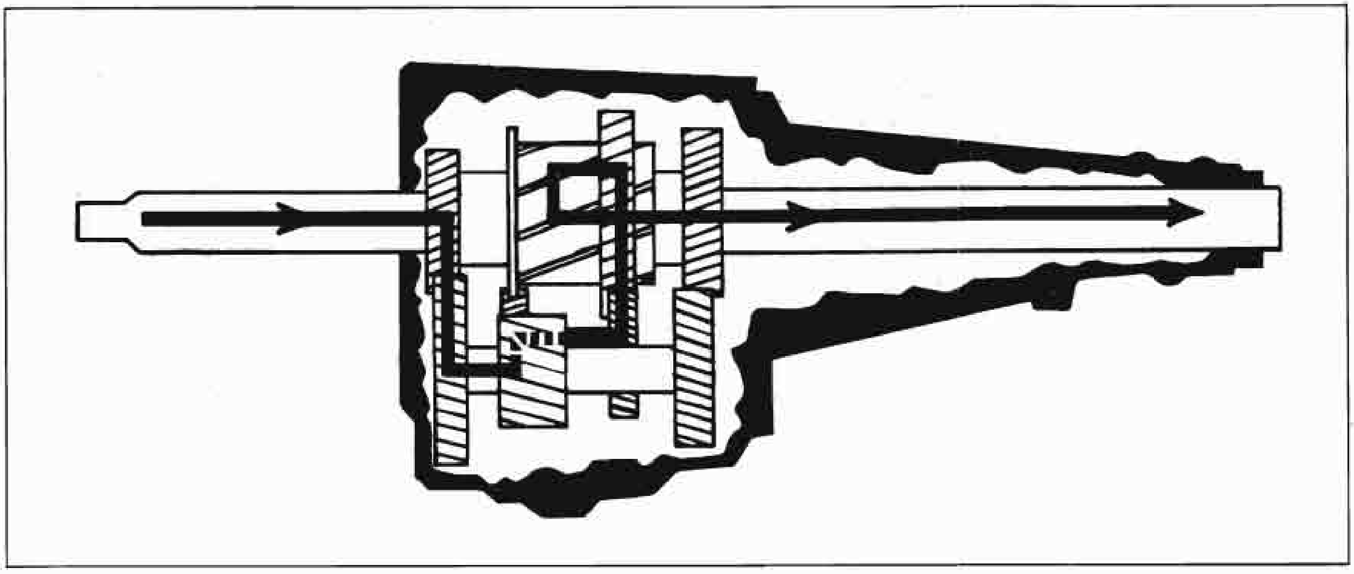


Fig. 7-8 Three-Speed Synchro-Mesh—Power Flow in Reverse

SHIFT CONTROL

No periodic service of the shift control is required. Certain parts are lubricated on assembly and require further lubrication only when parts become dry and sticky.

ADJUSTMENTS ON CAR

GEARSHIFT ROD ADJUSTMENT

1. Position selector lever at upper end of steering column in neutral position.

2. Disconnect shift rods at transmission.

3. Line up 2nd and 3rd and first and reverse levers at lower end of steering column (Fig. 7-9) so they move freely back and forth. (This is the neutral position with slots lined up.)

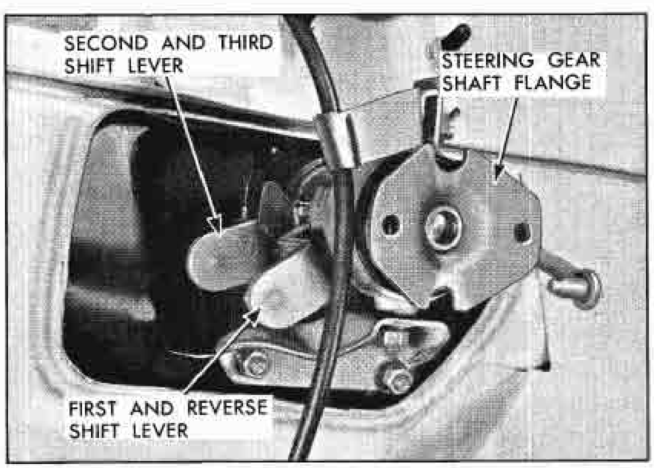


Fig. 7-9 Lining Up 2nd and 3rd and First and Reverse Shift Levers in Neutral Position

4. Attach 2nd and 3rd and first and reverse shift rods to shift levers at transmission and, with transmission levers in full neutral detent, adjust 2nd and 3rd shifter rod trunnion at idler lever and first and reverse trunnion at transmission lever (Fig. 7-10). Tighten trunnion lock nuts to 60-120 lb. in. torque.

5. Move selector lever at upper end of steering column to first speed position and check key at first and reverse shift lever at lower end of steering column. Key should just clear lower side of opening in steering column.

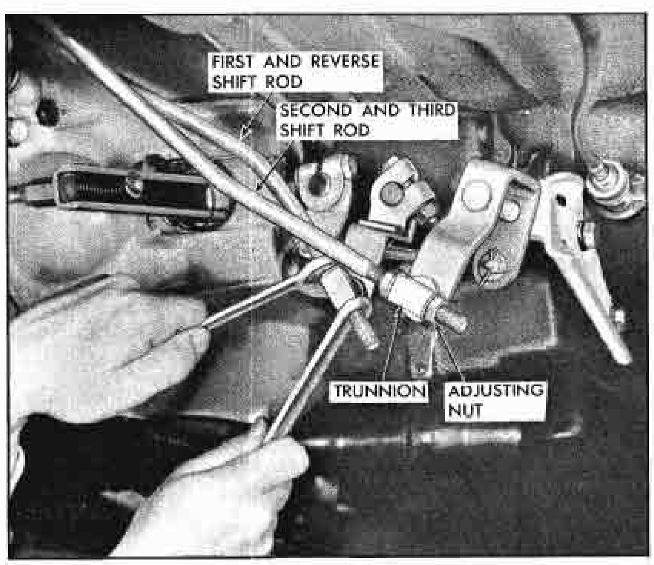


Fig. 7-10 Adjusting Shift Rod Trunnions

6. Move selector lever at upper end of steering column to third speed position and check key at 2nd and 3rd shift lever at lower end of column. Key should again just clear lower side of opening in steering column.

7. Apply wheel bearing grease to all gearshift linkage joints.

8. Check complete shift pattern movement with engine off; then start engine and perform shift pattern.

NOTE: If shifter rod adjustments are made as outlined above and clutch pedal height and lash are correct (see page 7-13), shifting should be smooth in and out of any gear with proper movement of selector lever by the operator.

MINOR REPAIRS

SHIFT LINKAGE AND STEERING COLUMN—REMOVE

1. Disconnect 2nd and 3rd and first and reverse shifter rods from upper levers at base of steering column (Fig. 7-11).

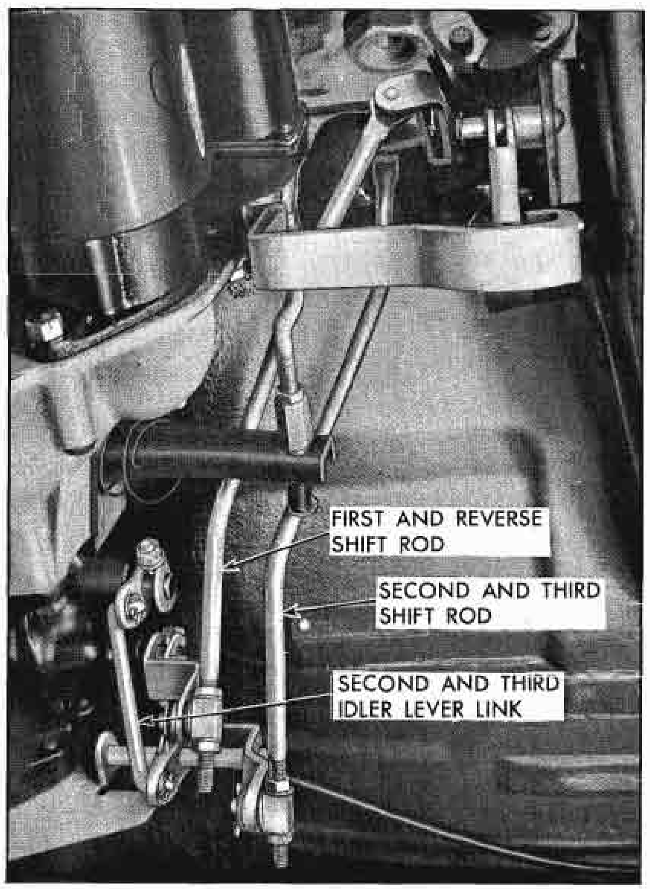


Fig. 7-11 Gearshift Linkage

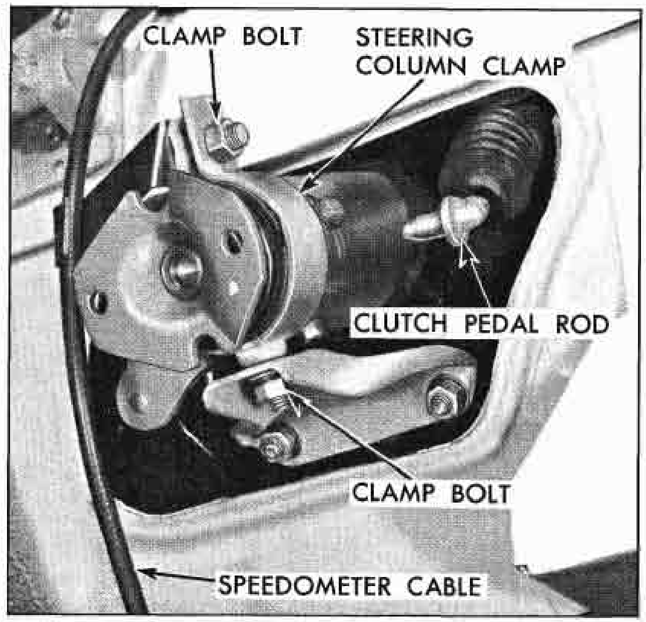


Fig. 7-12 Steering Column Lower Retaining Clamp

2. If shifter rods or second and third idler link (Fig. 7-11), are to be replaced, disconnect them from idler lever and transmission as required.

3. Remove speedometer cable from retainer and remove nut from lower clamp stud (Fig. 7-12).

4. Loosen two nuts holding clamp bracket to floor pan and tilt bracket down to disengage clamp stud from bracket.

5. Remove two steering shaft to steering gear retaining bolts (Fig. 7-13).

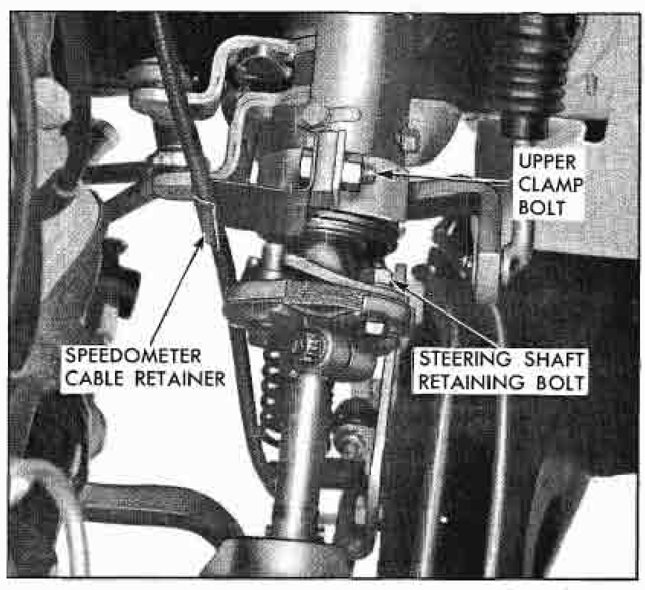


Fig. 7-13 Steering Shaft to Steering Gear Retaining Bolts

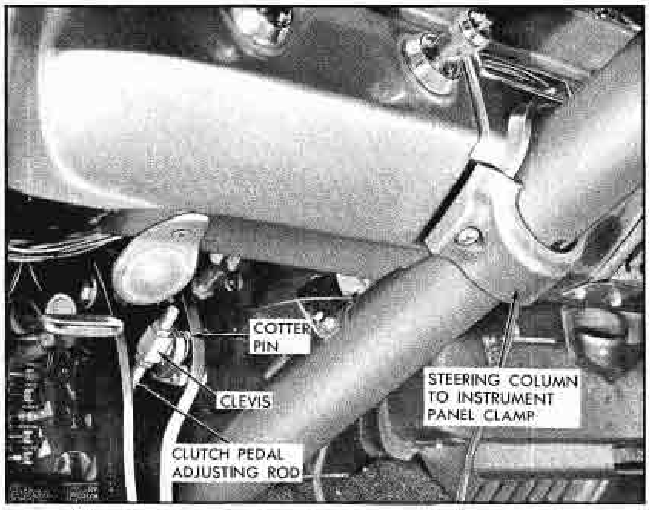


Fig. 7-14 Steering Column to Instrument Panel Clamp

6. Remove steering wheel as outlined under STANDARD STEERING WHEEL–REMOVE AND DISASSEMBLE, or DELUXE STEERING WHEEL–REMOVE AND DISASSEMBLE (Covered in Section 9 of this manual).

7. Remove two steering column bracket to instrument panel attaching screws and washers and remove bracket and insulator (Fig. 7-14).

8. Remove six screws securing toe pan to floor pan.

9. Remove two steering column seal retainer to cover plate screws.

10. Disengage clutch rod at clutch pedal by removing cotter pin (Fig. 7-14).

NOTE: It is not necessary to loosen clutch rod clevis adjusting nuts to disconnect clutch rod from clutch pedal.

11. Push clutch rod insulator through hole in toe pan.

12. Lift toe pan over end of clutch rod and remove.

13. Disconnect horn cable from terminal.

14. Remove wiring connectors from back-up light and direction indicator switch terminals.

15. Rotate steering column so that back-up light and turn indicator switch assemblies will clear instrument panel and withdraw entire steering column and shaft assembly.

STEERING COLUMN—DISASSEMBLE

1. Remove steering gear shaft from lower end of steering column housing.

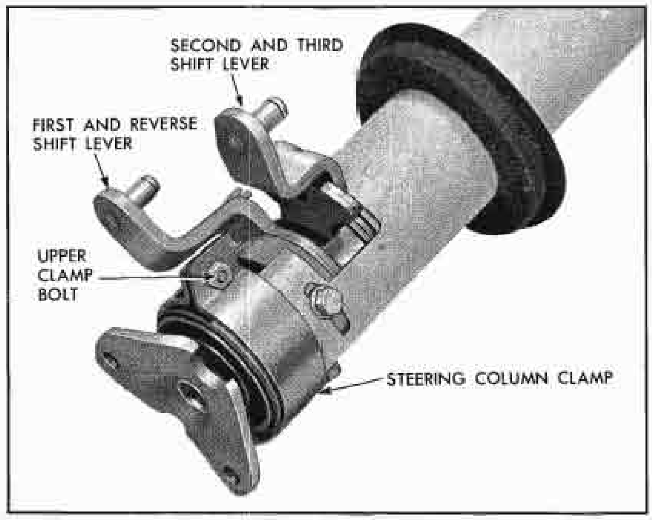


Fig. 7-15 Steering Column Removed from Car

2. Loosen upper bolt on steering column clamp and slip clamp over lower end of column (Fig. 7-15).

3. Remove screw and star washer securing back-up light switch assembly and remove switch from steering column housing.

4. Remove shifter tube back-up light trip lever retaining screw and washer and remove lever through opening in steering column housing (Fig. 7-16).

5. Remove two screws and star washers and remove direction signal switch assembly and horn wire retainer from steering column housing.

6. Hold actuator rod anti-rattle coil spring and bearing plate and remove hair-pin type spring actuator lever from actuator rod.

NOTE: A rag or steering column insulator felt stuffed into the opening below the actuator rod will prevent loss of coil spring.

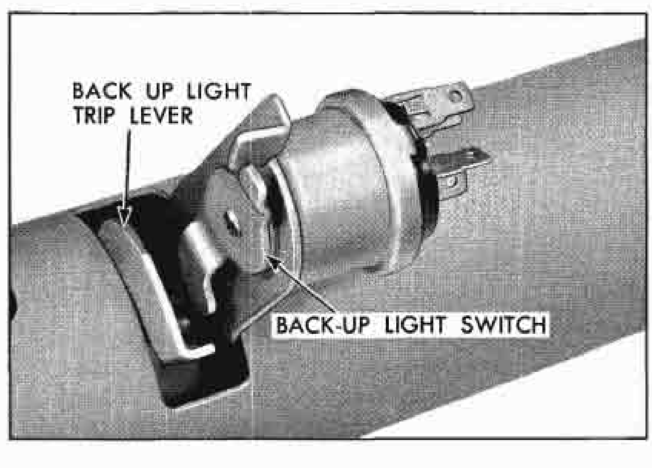


Fig. 7-16 Back-Up Light Switch Assembly

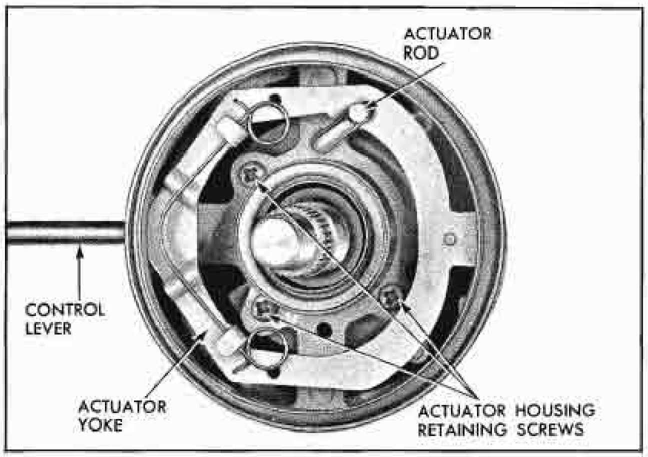


Fig. 7-17 Actuator Yoke Assembly

7. Remove anti-rattle spring and bearing plate.

8. Pull actuator rod out from top end of steering column.

9. Remove horn contact assembly and horn wire from end of upper bearing support assembly.

10. Remove three screws which retain actuator housing and remove housing (Fig. 7-17).

11. Actuator yoke can be removed from housing by removing control lever and pressing out shield.

12. Remove upper bearing support assembly from top end of shifter tube (Fig. 7-18).

13. Remove bearing sleeve from I. D. of bearing.

14. Remove flat washer and wave washer from shifter tube (Fig. 7-19).

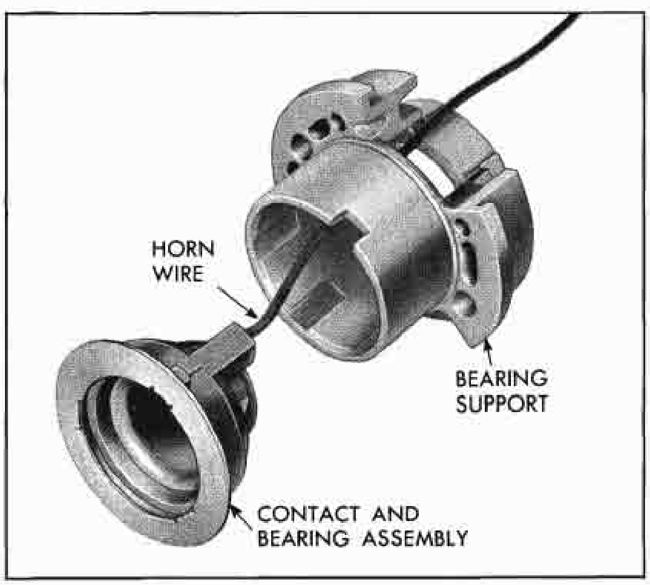


Fig. 7-18 Contact and Bearing Support Assembly

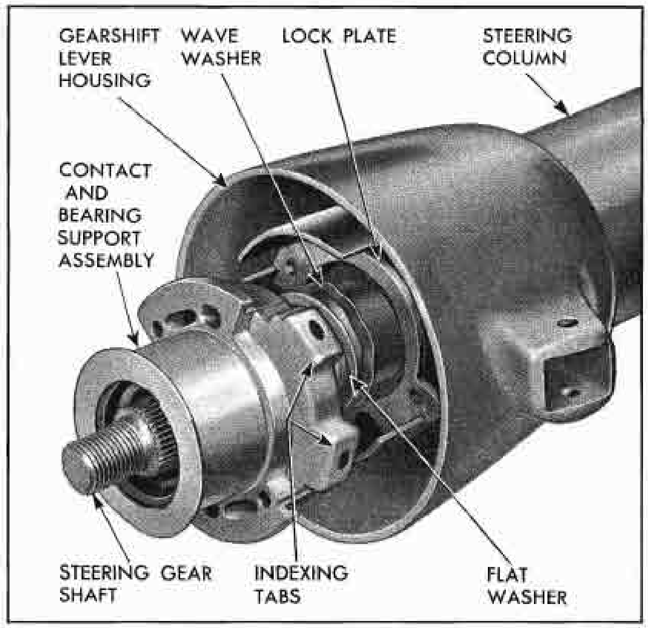


Fig. 7-19 Bearing Support Assembly and Gearshift Lever Housing

15. Disengage and remove bearing support lock plate (Fig. 7-20).

16. Tap out gearshift lever pivot pin, using punch.

17. Remove gearshift lever and, using needle nose pliers, remove anti-rattle spring (Fig. 7-21).

18. Slide gearshift lever housing off end of steering column (Fig. 7-19).

19. Remove rear retainer plate from shifter tube (Fig. 7-22).

20. Using screwdriver or other suitable tool, remove tube support bearing from lower end of steering column housing (Fig. 7-23).

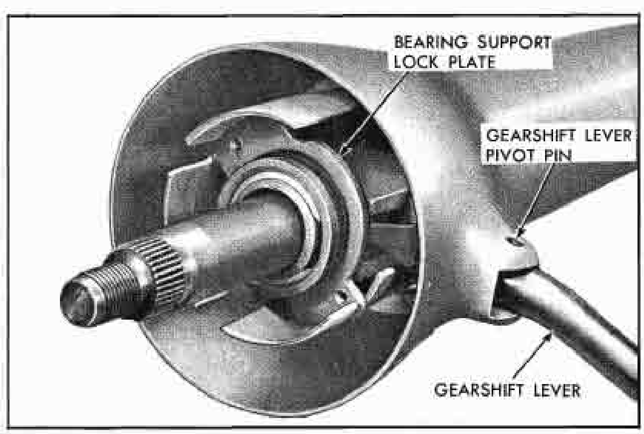


Fig. 7-20 Bearing Support Lock Plate

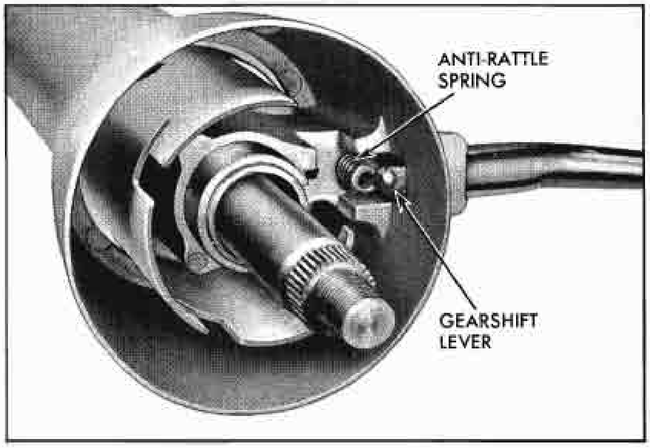


Fig. 7-21 Gearshift Lever Assembly

21. Remove three lower bearing adjusting bolts and remove lower bearing and first and reverse shift lever assembly from shifter tube (Fig. 7-23).

22. Using soft hammer, tap upper end of shifter tube until tube, with second-third shift lever assembly and upper bearing, is free, and remove entire assembly from lower end of steering column (Fig. 7-24).

23. Remove felt insulators from inside of steering column.

24. Remove rubber grommet from steering column.

STEERING COLUMN—ASSEMBLE

1. Install new rubber grommet over steering column, positioning grommet toward upper end of column.

2. Install new felt insulators over shifter tube, positioning them just above spring, upper bearing and second-third shift lever assembly.

3. Insert shifter tube, with bearing and second-third shift lever assembly, into lower end of steering column, making certain felt insulators remain in position.

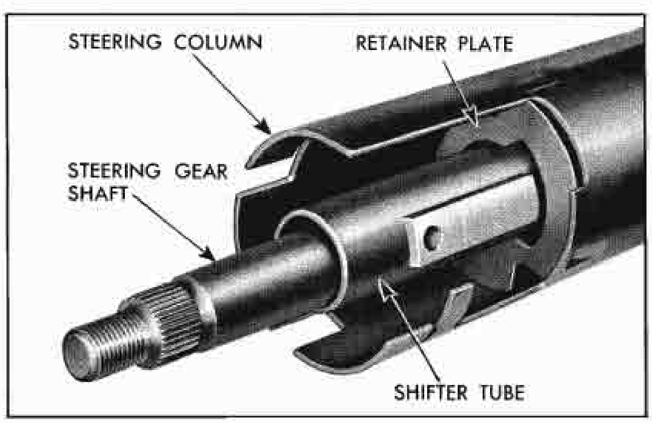


Fig. 7-22 Rear Retainer Plate

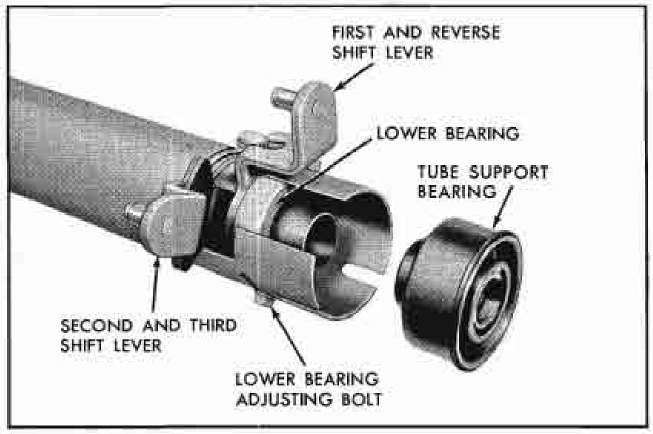


Fig. 7-23 Lower Steering Column Assembly

4. Using soft hammer, tap lower end of shifter tube until upper bearing is firmly seated against flanges in steering column.

5. Assemble first and reverse shift lever assembly in lower bearing and check for free rotation of lever in bearing.

NOTE: Clean bearing surfaces with emery cloth, if necessary, to insure freedom of rotation.

6. Install spacer, first-reverse shift lever assembly and lower bearing over end of shifter tube, seating firmly against spacer.

7. Line up three adjusting bolt holes in lower bearing with three slots in column housing and insert three adjusting bolts and finger tighten.

8. Rotate lower bearing and adjust to obtain .012" maximum end play (Fig. 7-25).

NOTE: Shift levers must rotate freely after adjustment.

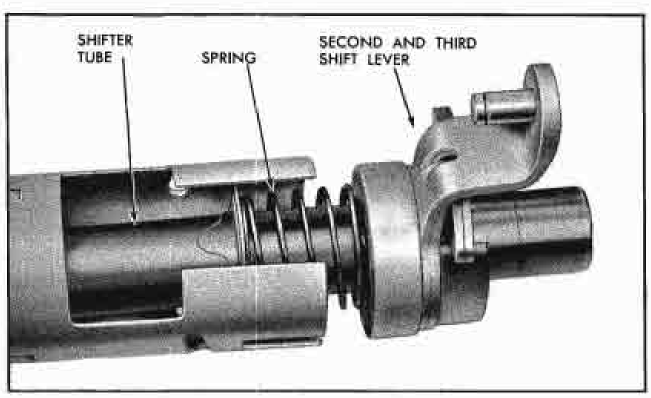


Fig. 7-24 2nd and 3rd Shift Lever Assembly

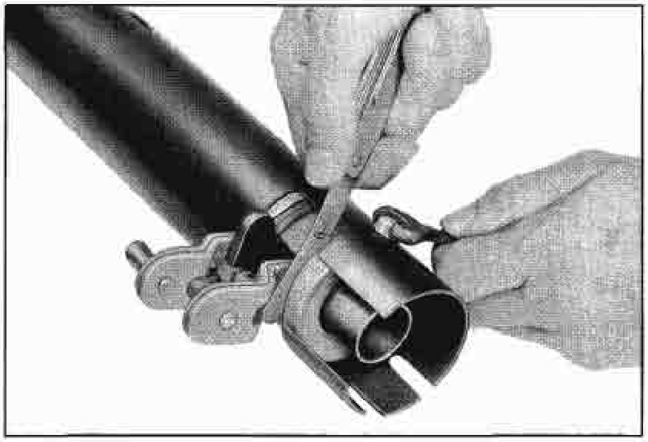


Fig. 7-25 Adjusting Lower Bearing

9. Torque three lower bearing adjusting bolts to 85-125 lb. in.

10. Install new tube support bearing in lower end of steering column and seat firmly, using soft hammer (Fig. 7-23).

11. Install steering column clamp over lower end of steering column.

NOTE: Upper clamp bolt should be finger-tightened only.

12. Install rear retainer plate over upper end of shifter tube (Fig. 7-22).

13. Install gearshift lever housing over end of steering column (Fig. 7-19).

14. Using needle nose pliers, insert gearshift lever anti-rattle spring in depression located in housing (Fig. 7-21).

NOTE: A small amount of grease applied to anti-rattle spring will aid in preventing squeak.

15. Install gearshift lever, depressing anti-rattle spring as lever is inserted (Fig. 7-21). Shim stock placed over spring will aid in assembly of gearshift lever.

16. Install new pivot pin through housing and gearshift lever, tapping pin in until flush with surface of gearshift lever boss on housing.

17. Install bearing support lock plate, engaging flanges on plate in notches of steering column (Fig. 7-20).

18. Install wave washer and flat washer over end of shifter tube, positioning wave washer toward lock plate.

19. Install new sleeve in I. D. of upper bearing, flanged side out, and position upper bearing support over shifter tube, indexing two tabs of support in cutouts at upper end of steering column (Fig. 7-19). The bearing support will properly center shifter tube at upper end of column.

20. Install horn wire and contact assembly in end of bearing support (Fig. 7-18), snaking wire through outer slots of bearing support lock plate and retainer plate and between steering column housing and shifter tube.

NOTE: Attaching a suitably firm wire to end of horn wire will simplify installation of horn wire in steering column.

21. Pull end of horn wire out appropriate opening in steering column (Fig. 7-26).

22. Install actuator housing over upper bearing support and insert three retaining screws. Torque 10-35 lb. in.

23. Install actuator rod bearing plate, direction signal switch and horn wire retainer in appropriate position on housing (Fig. 7-26).

24. Insert two screws and star washers and finger tighten.

25. Insert actuator rod through opening in actuator housing (Fig. 7-17), and engage lower end or rod in retaining hole of bearing plate.

26. Engage top end of actuator rod in slot of actuator housing (Fig. 7-17).

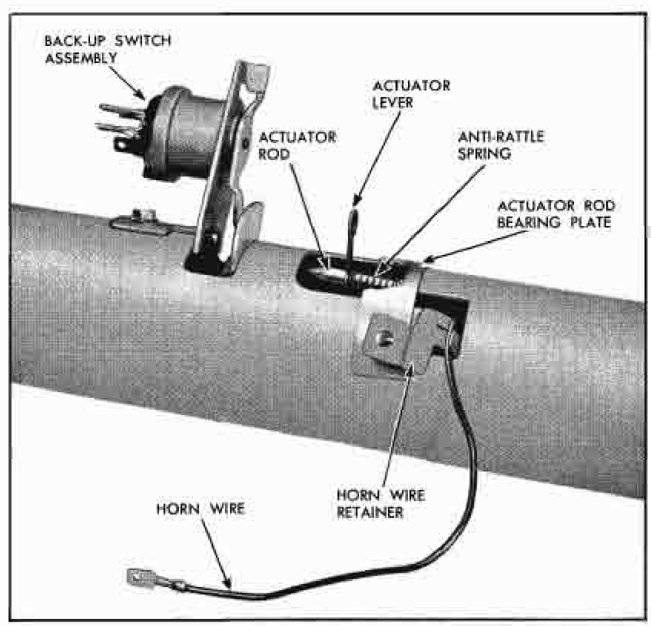


Fig. 7-26 Actuator Assembly and Back-Up Switch

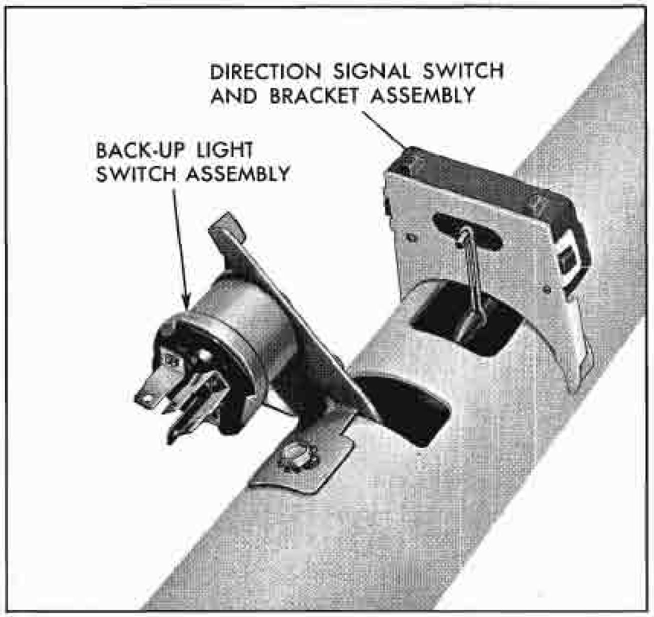


Fig. 7-27 Actuator Lever Engaging Direction Signal Switch

27. Install anti-rattle spring on lower end of actuator rod, exercising extreme care to prevent spring from falling inside steering column.

28. With carrier in neutral, insert .090"-.093" diameter gauge into two holes in switch bracket and install actuator lever, engaging lever on prong of switch (Fig. 7-27).

29. Torque two direction signal switch retaining screws 10-35 lb in.

NOTE: There should be no tension on actuator rod when screws are tightened.

30. Insert horn wire through wire retainer.

31. Install back-up light trip lever through lower opening in steering column and position on shifter tube. Insert retaining screw and star washer and tighten 10-35 lb. in. torque.

32. Install back-up light switch assembly on steering column and insert retaining screw and star washer. Tighten 10-35 lb. in. torque (Fig. 7-27).

NOTE: When upper shift lever is placed in "reverse" position and released, trip lever must hold back-up light switch lever in "on" position. If necessary, bend trip lever to obtain this condition, making certain the movement of upper shift lever to "second" position does not actuate switch.

33. Insert steering gear shaft at lower end of steering column, being extremely careful not to damage seal.

SHIFT LINKAGE AND STEERING COLUMN—INSTALL

1. Insert lower end of steering column assembly through opening in floor of vehicle, lowering column until steering shaft flange and steering gear housing flange meet.

2. Position steering column clamp so that lower clamp stud can be inserted through hole in bracket and install stud retaining nut and washer, but do not tighten.

3. Install two bracket to floor pan retaining nuts and tighten to 10-20 lb. ft. torque and tighten clamp stud retaining nut 10-20 lb. ft. torque.

4. Insert two steering shaft to steering gear retaining bolts, but do not tighten.

5. Install instrument panel bracket and insulator around steering column and insert attaching screws and washers, but do not tighten.

6. Tighten steering shaft to steering gear retaining bolts 10-20 lb. ft. torque.

7. Tighten steering column bracket to instrument panel screws 10-35 lb. in. torque.

8. Attach steering column seal retainer to cover plate with two screws.

9. Insert clutch rod through hole in toe pan and position toe pan around steering column.

10. Install clutch rod insulator through hole in toe pan so that clutch rod is held firmly.

11. Insert six toe pan retaining screws and tighten securely.

12. Position rubber grommet against toe pan.

13. Engage clutch rod with clutch pedal and insert cotter pin.

NOTE: If clutch rod clevis adjusting nuts were not loosened during disassembly, clutch pedal height will probably be correct.

14. Connect horn cable to horn terminal.

15. Plug in wiring connectors at back-up light and direction indicator switch terminals.

16. Install steering wheel as outlined under STANDARD STEERING WHEEL – ASSEMBLE AND REPLACE or DELUXE STEERING WHEEL –ASSEMBLE AND REPLACE (covered in Section 9 of this manual).

17. When steering wheel is drawn down to within .090"-.120" of actuator assembly, tighten top steering column clamp bolt 10-20 lb. ft. torque.

18. Connect first and reverse and 2nd and 3rd shifter rods to shift levers at base of steering column (Fig. 7-11).

19. Adjust shift linkage by referring to steps 1 through 8 under GEARSHIFT ROD ADJUSTMENT.

NOTE: If shifter rods or 2nd and 3rd idler link were replaced, connect them to idler lever and transmission as required.

If pedal lash or clutch pedal height is incorrect, proceed as follows:

20. Adjust pedal lash by loosening clutch fork rod adjusting lock nut.

21. Adjust silencer bumper so that countershaft is lifted .015" to .020" off stop.

22. Remove lash (release bearing touching clutch pressure plate levers) with adjusting nut, then back off adjusting nut 3½ turns.

23. Tighten lock nut to 60-120 lb. in. torque.

24. If clutch pedal height is incorrect (6¾"-7" above floor mat of vehicle) adjust clevis at end of clutch rod until proper height is attained.

25. Check shift pattern movement with engine off; then start engine and perform shift pattern.

SPEEDOMETER DRIVEN GEAR—REMOVE

1. Disconnect speedometer cable.

2. Remove lock plate to extension bolt and lock washer and remove lock plate.

3. Insert screwdriver in lock plate slot in fitting and pry fitting, gear and shaft from extension.

4. Pry O-ring from groove in fitting.

5. Check gear, shaft and fitting for wear and replace if necessary.

SPEEDOMETER DRIVEN GEAR—REPLACE

1. Install new O-ring in groove of fitting and insert shaft.

2. Hold the assembly so slot in fitting is toward lock plate boss on extension and insert assembly in extension.

3. Push fitting into extension until lock plate can be inserted in groove.

4. Install lock plate to extension bolt and lock washer and tighten securely.

5. Connect speedometer cable to speedometer driven gear.

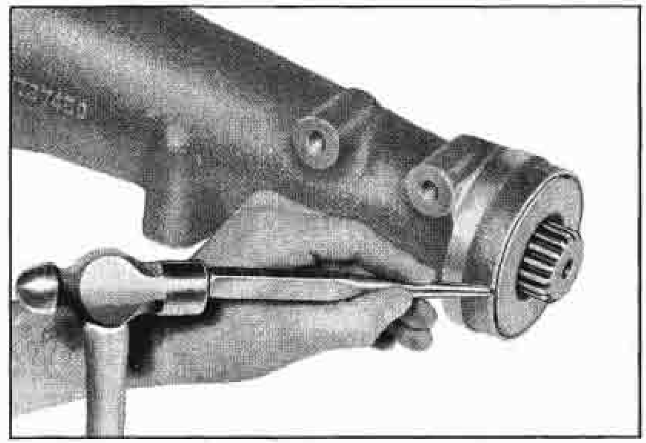


Fig. 7-28 Removing Extension Oil Seal

TRANSMISSION EXTENSION OIL SEAL—REMOVE

To inspect or replace the rear extension oil seal, it is necessary to remove the propeller shaft drive line assembly from the vehicle.

1. Remove "U" bolt nuts, lock plates and "U" bolts from rear axle drive pinion flange.

2. Use suitable rubber band to hold bearings onto journals, if tie wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

3. Slide propeller shaft assembly rearward to disengage yoke from splines on transmission mainshaft and remove.

4. Using punch or other suitable tool (Fig. 7-28), loosen seal from extension and remove.

5. Wash counterbore with cleaning solvent and inspect for damage.

6. Inspect propeller shaft yoke hub for nicks, burrs or scratches which would cut new seal or cause seal to leak or damage bushing.

TRANSMISSION EXTENSION OIL SEAL—REPLACE

1. Coat new seal with sealing compound and start straight in bore of case extension. Using installer J-5154-A, tap seal into counterbore.

2. Install propeller shaft assembly by reversing steps 1 through 3 above.

TRANSMISSION SIDE COVER—REMOVE

It is not necessary to remove transmission from vehicle for inspection or replacement of parts in transmission side cover assembly, but the side cover assembly itself must be removed from transmission case.

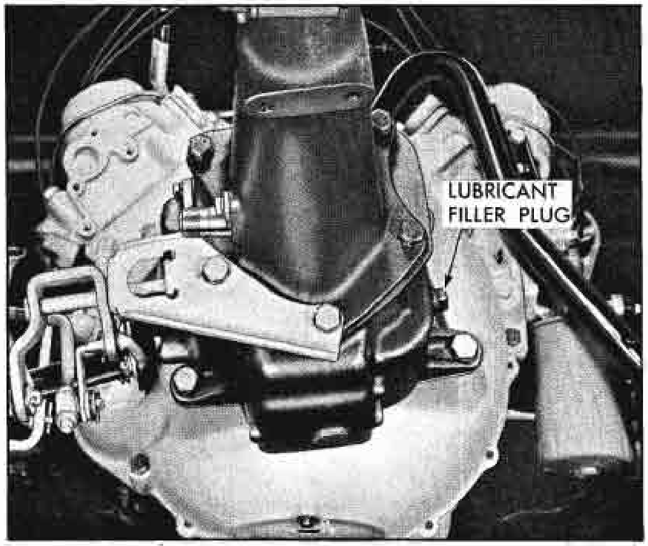


Fig. 7-29 Synchro-Mesh Transmission Filler Plug

1. Remove drain plug at bottom of transmission (Fig. 7-29) and drain lubricant.

2. Disconnect shifter rods from shifter levers at transmission.

3. Remove four transmission cover retaining bolts and lock washers.

4. Remove outer shifter lever clamp bolts and pull levers from shafts.

5. Remove side cover and gasket.

TRANSMISSION SIDE COVER—DISASSEMBLE

1. Remove nuts and locks from shifter interlock retainer and remove retainer (Fig. 7-30).

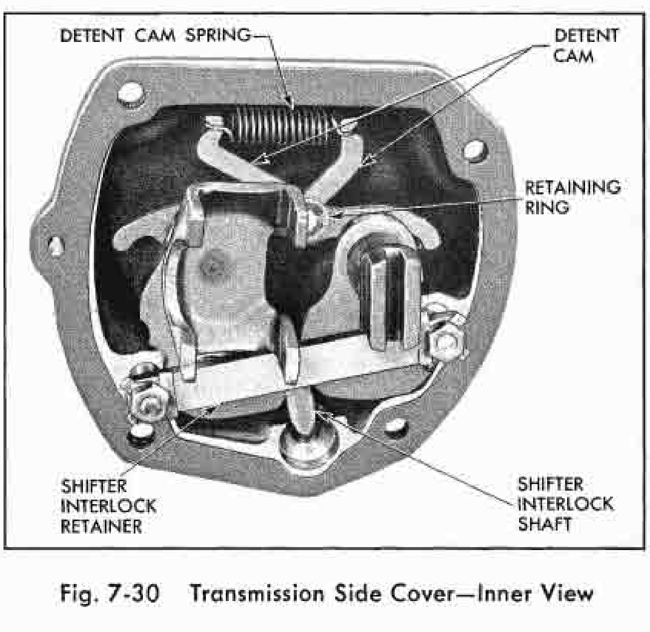


Fig. 7-30 Transmission Side Cover—Inner View

2. Remove detent cam spring to release detent cam (Fig. 7-30).

3. Remove both shifter shafts and shift fork assemblies.

4. Remove retaining ring and remove detent cam (Fig. 7-30).

5. Remove shifter interlock shaft.

6. Inspect and replace necessary parts.

TRANSMISSION SIDE COVER—ASSEMBLE AND REPLACE

1. Install shifter interlock shaft.

2. Install detent cam and retaining ring.

3. Install shifter shafts and shift fork assemblies.

4. Install detent cam spring.

5. Install shifter interlock retainer and locks, and install interlock retainer nuts, tightening securely.

6. Install outer shifter levers on shifter shafts and secure with clamp bolts.

7. Install side cover gasket.

8. Place transmission gears and shifter forks in neutral position and install cover.

NOTE: Flanged side on first and reverse shifter fork must face rear of transmission as shown in Fig. 7-31.

9. Apply special sealer compound to threads of four cover retaining bolts and install bolts and lock

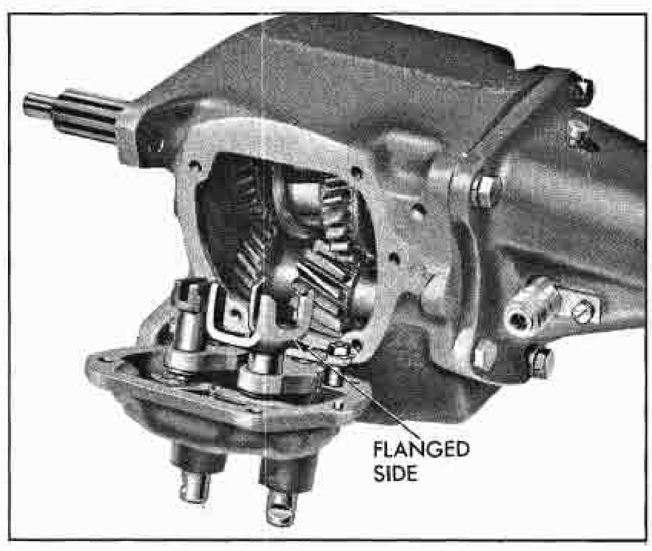


Fig. 7-31 Positioning First and Reverse Shifter Fork in Transmission Side Cover

washers, tightening evenly to prevent cover distortion. Torque to 15 to 18 lb. ft.

10. Connect three shifter rods to shifter levers.

11. Remove filler plug at side of transmission and add 1.8 pints of SAE 80 "Multi-purpose Gear Lubricant." Lubricant level should be approximately level with bottom of filler plug hole.

MAJOR REPAIRS

TRANSMISSION—REMOVE AND OVERHAUL

1. Remove propeller shaft drive line assembly as follows:

   a. Remove "U" bolt nuts, lock plates and "U" bolts from rear axle drive pinion flange.

   b. Use a suitable rubber band to hold bearing onto journals, if tie wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

   c. Remove complete drive line assembly by sliding rearward to disengage yoke from splines on transmission mainshaft.

2. Disconnect speedometer cable from speedometer driven gear.

3. Disconnect shifter rods from shifter levers.

4. Support rear of engine with floor jack.

5. Remove two transmission brackets to cross member retaining nuts (Fig. 7-32).

6. Remove upper transmission to clutch housing bolts and insert transmission aligning studs J-1126.

CAUTION: Aligning studs must be used since they support transmission and prevent distortion of clutch driven plate hub when lower transmission bolts are removed.

7. Remove lower transmission to clutch housing bolts, tilt rear of extension upward to disengage bracket studs from cross member support and withdraw transmission from clutch housing.

8. When transmission is free of clutch housing, tilt front downward and remove.

TRANSMISSION—DISASSEMBLE

1. Remove four cover to transmission retaining bolts and remove cover and gasket.

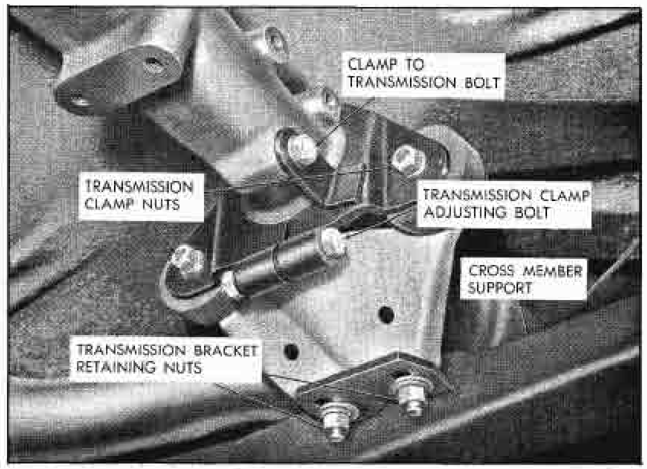


Fig. 7-32 Transmission Rear Extension Support

NOTE: If cover is to be disassembled for inspection and replacement of worn parts, follow procedures 1 through 6 under TRANSMISSION SIDE COVER–DISASSEMBLE.

2. Remove clamp, bracket and insulator assembly from rear extension.

3. Remove extension to transmission case bolts and lock washers.

4. Carefully pull extension and mainshaft assembly out of transmission case, leaving 2nd and 3rd speed clutch assembly and first and reverse sliding gear in case (Fig. 7-33). Do not force mainshaft. Slowly rotate mainshaft and second speed gear to obtain alignment of synchronizing clutch teeth and splines on mainshaft.

NOTE: Care must be taken when pulling mainshaft from rear of case to prevent needle bearings in main drive (clutch) gear from dropping into case.

5. Slide first and reverse gear from 2nd and 3rd speed clutch and remove through side opening in transmission case.

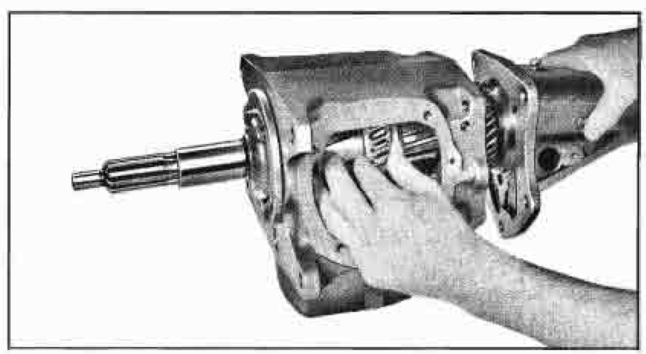
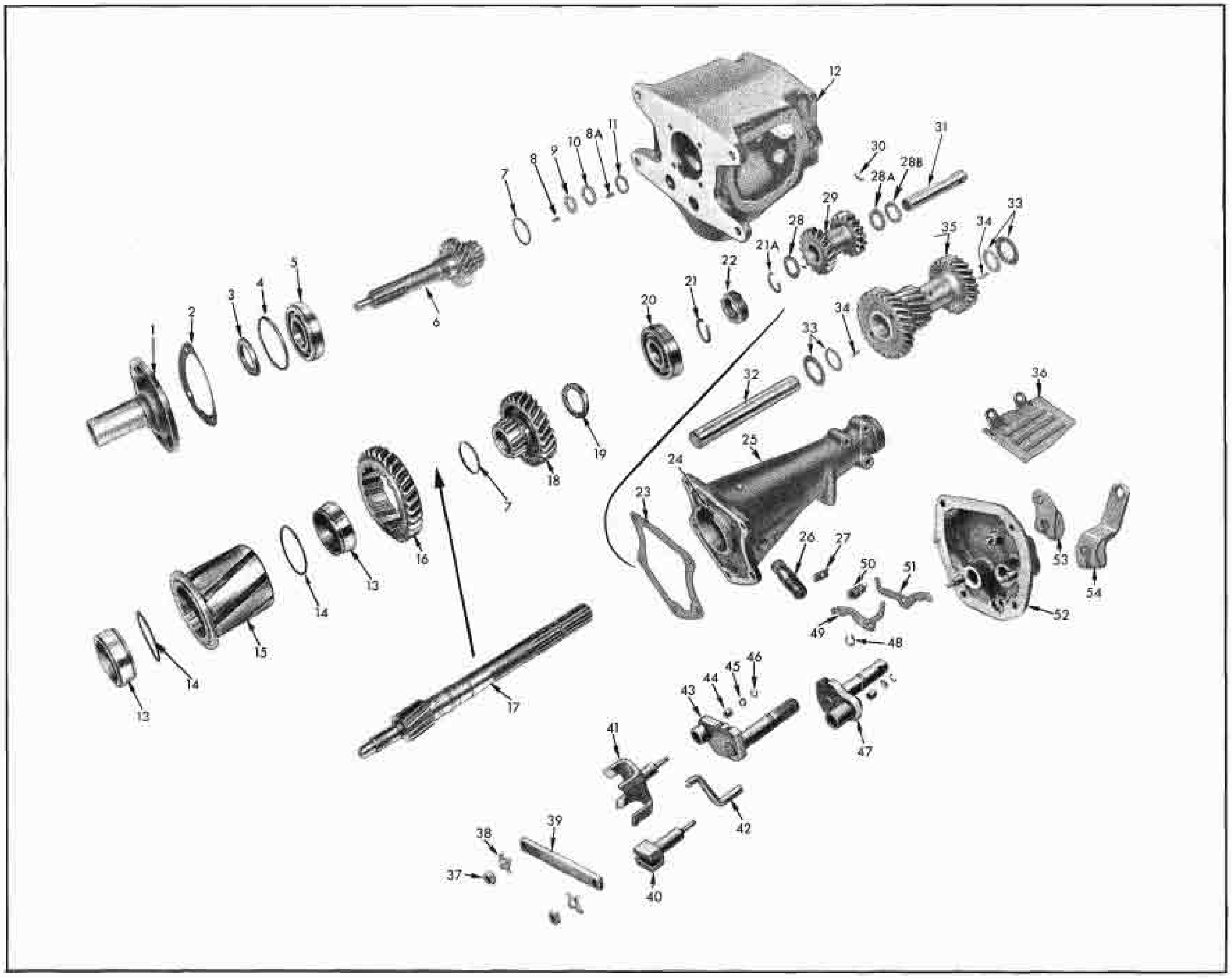


Fig. 7-33 Removal of Mainshaft



1. Main Drive (Clutch) Gear Bearing Retainer
2. Bearing Retainer Gasket
3. Bearing Nut and Oil Slinger
4. Bearing Snap Ring
5. Main Drive (Clutch) Gear Bearing
6. Main Drive (Clutch) Gear
7. Energizing Spring
8. Front Pilot Bearing Roller
8a. Rear Pilot Bearing Roller
9. Thrust Washer
10. Thrust Washer
11. Thrust Washer
12. Transmission Case
13. Synchronizer Ring
14. Snap Ring (Retainer)
15. Second and Third Speed Clutch
16. First and Reverse Sliding Gear
17. Mainshaft
18. Second Speed Gear
19. Thrust Washer
20. Mainshaft Rear Bearing
21. Snap Ring
21a. Special Snap Ring
22. Speedometer Drive Gear
23. Case Extension Gasket
24. Rear Bearing Snap Ring
25. Case Extension
26. Speedometer Drive Gear and Fitting
27. Lock Plate
28. Thrust Washer
28a. Roller Thrust Bearing
28b. Thrust Bearing Washer
29. Reverse Idler Gear
30. Reverse Idler Shaft Lock Pin
31. Reverse Idler Shaft
32. Countershaft
33. Countergear and Roller Thrust Washers
34. Bearing Roller
35. Countergear
36. Oil Baffle Plate
37. Shifter Interlock Retainer Stud Nut
38. Nut Lock
39. Shifter Interlock Retainer
40. Second and Third Shifter Fork
41. First and Reverse Shifter Fork
42. Shifter Interlock Shaft
43. First and Reverse Shifter Lever (Inner)
44. Shifter Fork Spacer
45. Shifter Fork Washer
46. Shifter Fork Retainer
47. Second and Third Shifter Lever (Inner)
48. Detent Cam Retainer
49. First and Reverse Detent Cam
50. Detent Cam Spring
51. Second and Third Detent Cam
52. Side Cover
53. First and Reverse Shifter Lever (Outer)
54. Second and Third Shifter Lever (Outer)

Fig. 7-34 Three-Speed Synchro-Mesh Transmission—Exploded View

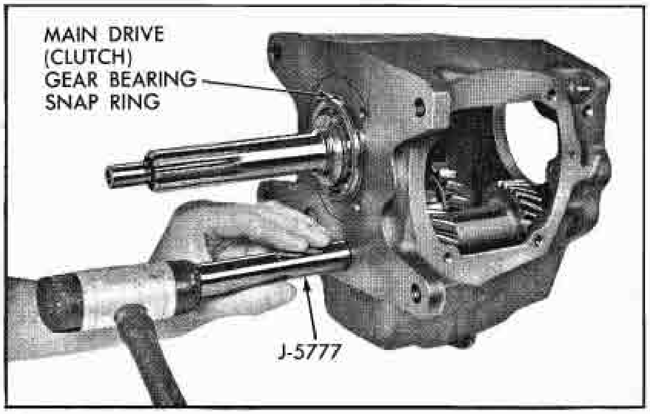


Fig. 7-35 Driving Countershaft Out of Transmission Case

6. Remove 2nd and 3rd speed clutch from main drive (clutch) gear.

7. Remove 24 rear and 14 larger front pilot bearing rollers and thrust washers from inside the main drive (clutch) gear pilot hole (Fig. 7-34).

8. Remove the four main drive (clutch) gear bearing retainer bolts and shakeproof washers and remove the retainer.

9. Remove bearing retainer gasket.

10. Remove the countershaft by tapping it from front to rear of case, using loader J-5777 (Fig. 7-35). Lower the countergear, with loader J-5777 intact, to bottom of case.

NOTE: Countergear must be lowered before removing main drive (clutch) gear to prevent clutch gear bearing from striking countergear.

11. Remove main drive (clutch) gear bearing snap ring (Fig. 7-35).

12. Using soft hammer, tap front end of shaft, moving gear and bearing assembly into case. Remove through side opening (Fig. 7-36).

13. Remove the countergear from case and remove loader J-5777 from countergear.

14. Remove thrust washers and 25 needle bearing rollers from each end of countergear.

15. Tap the reverse idler shaft lock pin into the shaft (Fig. 7-37). The pin is shorter than the diameter of the shaft so the shaft may be removed when the pin is driven in.

16. Using a drift pin, tap rear of reverse idler shaft, driving out case plug ahead of shaft.

NOTE: Do not turn shaft while removing as lock pin may drop down between the idler gear bushings.

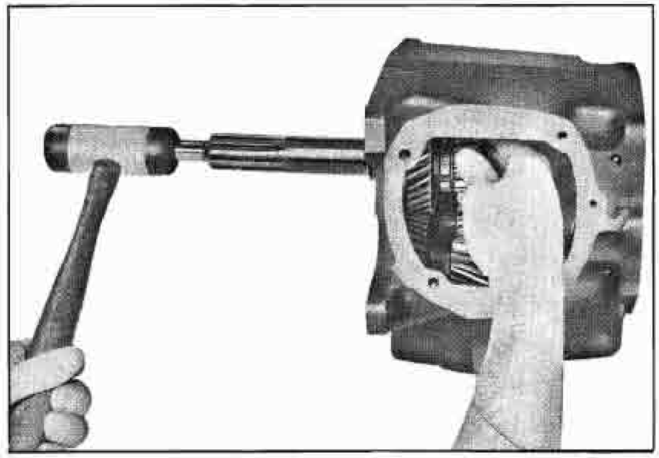


Fig. 7-36 Removing Clutch Gear and Bearing Assembly

17. Remove reverse idler gear, front thrust washer, radial roller thrust bearing and rear thrust bearing washer.

18. To remove mainshaft from rear extension, remove speedometer driven gear assembly as described under SPEEDOMETER DRIVEN GEAR – REMOVE, steps 1 through 5.

19. Remove rear extension to housing gasket.

20. Expand rear bearing snap ring, using tool J-932 (Fig. 7-38), and, while snap ring is expanded, tap rear of shaft with soft hammer to bring mainshaft assembly forward and out of extension.

MAINSHAFT ASSEMBLY–DISASSEMBLE

1. Remove special snap ring from end of mainshaft.

2. Press speedometer drive gear off mainshaft, using suitable split plates in an arbor press (Fig. 7-39).

NOTE: If speedometer drive gear is too tight, remove rear bearing to mainshaft snap ring. Place

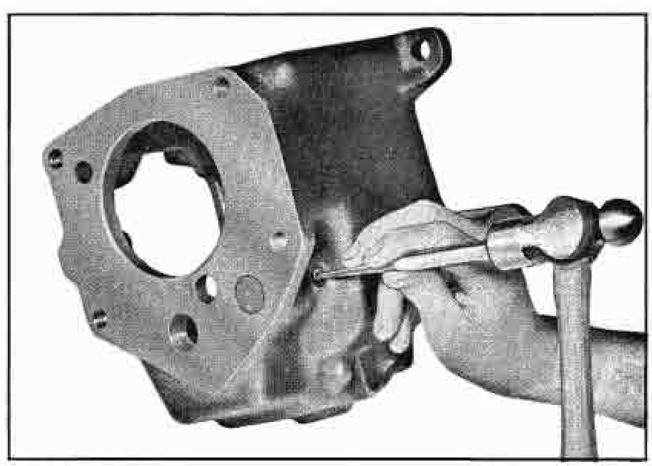


Fig. 7-37 Driving Reverse Idler Shaft Lock Pin Into Shaft

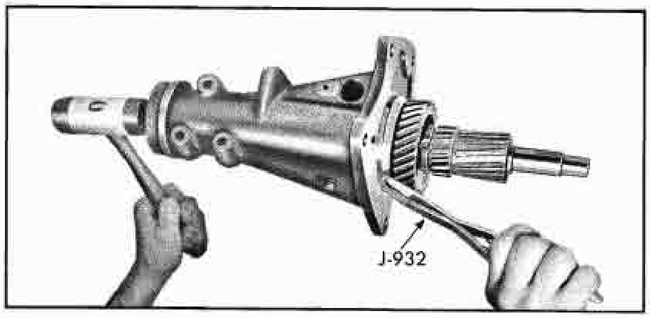


Fig. 7-38 Removal of Mainshaft from Extension Housing

split plates under bearing and press bearing and drive gear off at the same time.

3. Remove rear bearing to mainshaft snap ring and press bearing off shaft.

4. Remove second speed gear thrust washer and second speed gear.

MAIN DRIVE (CLUTCH) GEAR–DISASSEMBLE

1. Place the main drive (clutch) gear in a vise with soft jaws and, using tool J-933, remove the bearing retainer nut and oil slinger (Fig. 7-40).

NOTE: The retaining nut and oil slinger is a one-piece steel casting machined with a left-handed thread and locked in place on the main drive (clutch) gear shaft by being staked into a hole provided for that purpose.

2. Install main drive (clutch) gear and bearing in transmission case and install snap ring on bearing.

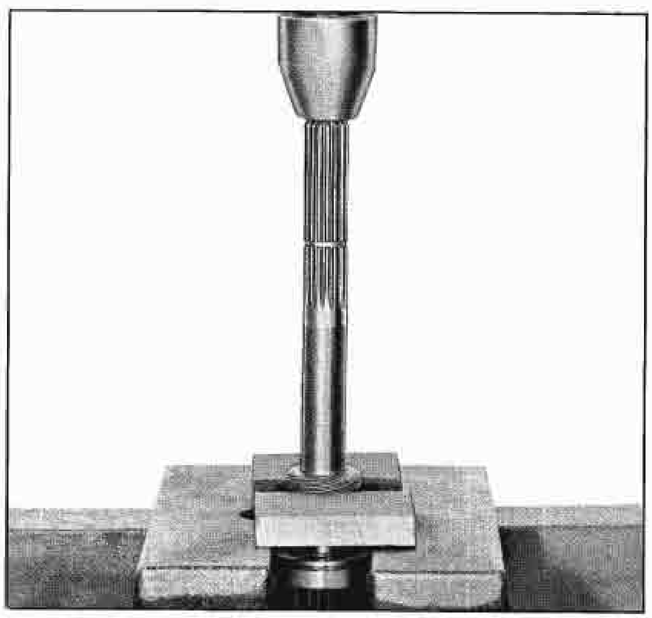


Fig. 7-39 Removing Speedometer Drive Gear

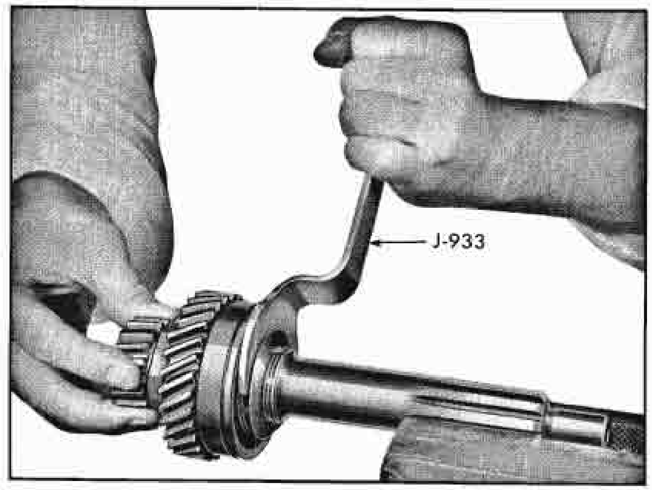


Fig. 7-40 Removing or Installing Oil Slinger

3. Support rear of case in arbor press and press main drive (clutch) gear shaft from bearing (Fig. 7-41). Tap bearing from case.

CLUTCH (SLEEVE) AND SYNCHRONIZER RINGS–DISASSEMBLE

1. Turn one synchronizer ring in the clutch (sleeve) until the ends of the ring retainer (snap ring) can be seen through the slot in clutch sleeve.

2. Using tool J-932, expand ring retainer in the counterbore in clutch sleeve (Fig. 7-42), and withdraw synchronizer ring.

3. Remove other synchronizer ring in same manner.

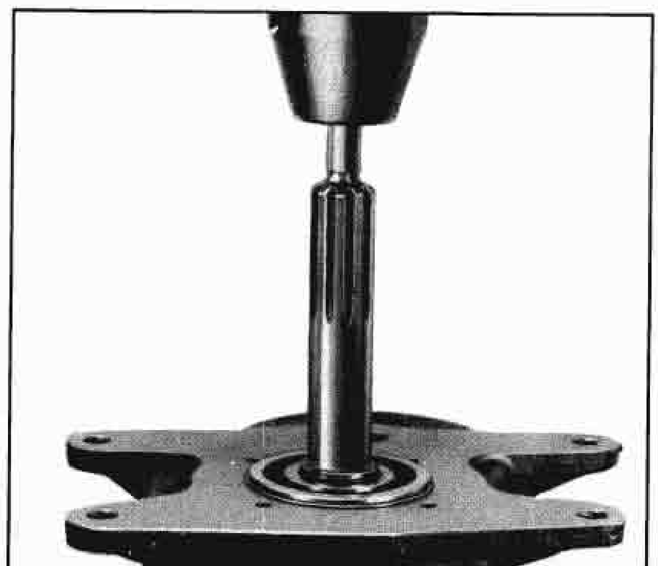


Fig. 7-41 Removal of Clutch Gear Bearing

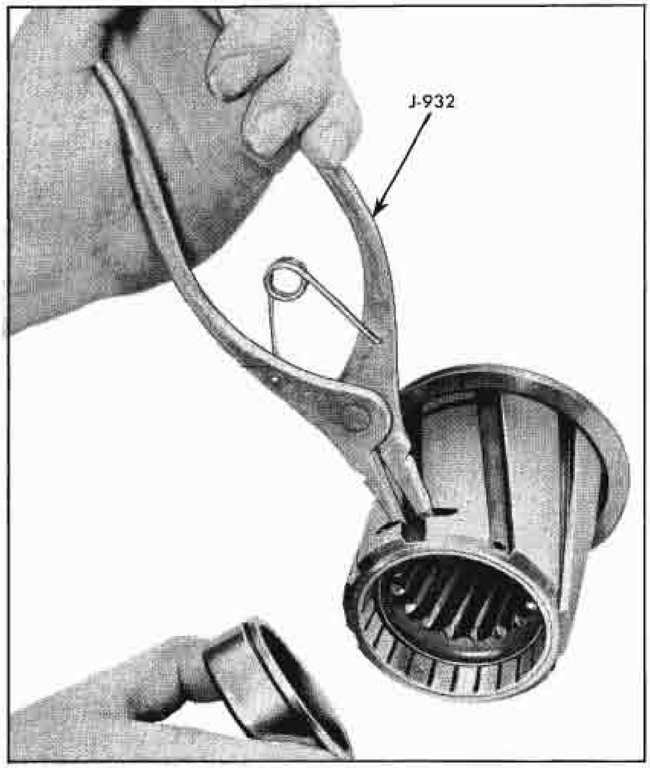


Fig. 7-42 Removing or Installing Synchronizer Ring

SYNCHRONIZER ENERGIZING SPRINGS–REMOVE

1. Under normal operation, it should never be necessary to replace the energizing springs, however, should an energizing spring be removed for any reason, a new spring should be installed.

2. The synchronizer energizing spring may be removed by slipping a thin blade under the spring and raising it sufficiently to slide it over the clutch teeth.

TRANSMISSION CASE EXTENSION OIL SEAL AND BUSHING–REMOVE

1. Using punch or other suitable tool (Fig. 7-43), loosen oil seal from rear extension and remove.

NOTE: Old oil seal should always be discarded after removal from extension.

2. Using tool J-6399, drive bushing, from rear, into case extension (Fig. 7-44).

CLEANING AND INSPECTION

TRANSMISSION CASE AND EXTENSION

1. Wash transmission case and extension outside and inside with a cleaning solvent and closely inspect for cracks.

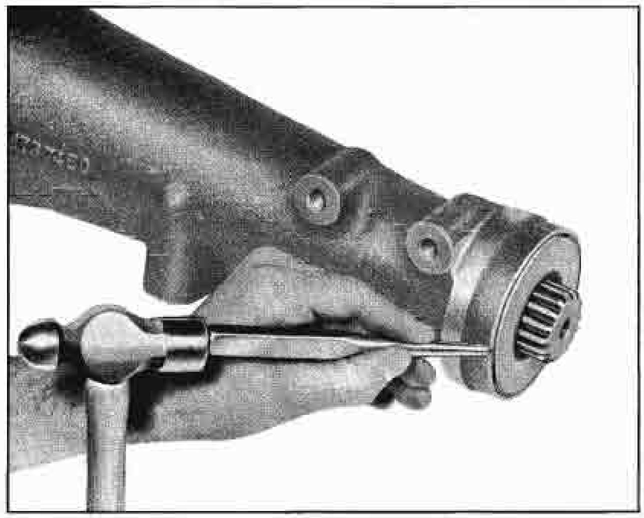


Fig. 7-43 Removing Extension Oil Seal

2. Inspect the faces for burrs or nicks and, if any are present, dress them off with a fine cut mill file.

3. Inspect transmission case extension bushing for excessive wear and replace if necessary.

BALL BEARINGS

1. Wash the bearings throughly in a cleaning solvent.

2. Blow out the bearings with compressed air.

CAUTION: Do not allow the bearings to spin, but turn them slowly by hand. Allowing bearings to spin will damage the race and balls.

3. After cleaning bearings, lubricate them with light engine oil and check for roughness. Roughness may be determined by turning the outer race by hand.

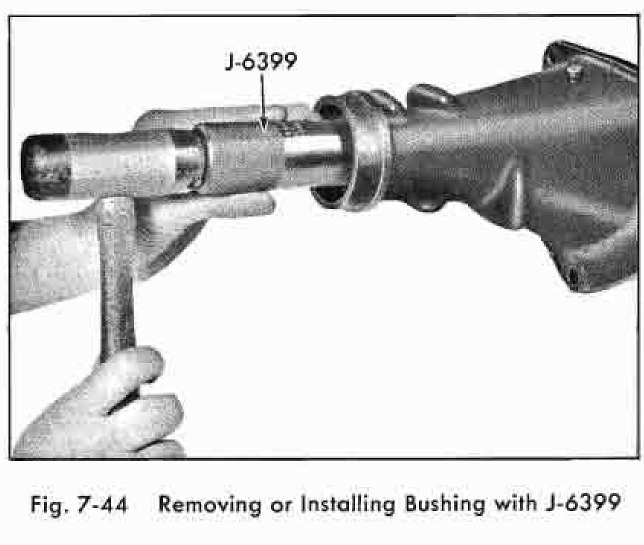


Fig. 7-44 Removing or Installing Bushing with J-6399

GEARS

1. Inspect teeth of all gears for nicks or wear and, if necessary, replace any that are worn or damaged.

2. Check the first and reverse sliding gear, making certain it slides freely on 2nd and 3rd speed clutch.

3. Check the 2nd and 3rd speed clutch, making certain it slides freely on mainshaft.

REVERSE IDLER GEAR SHAFT, BUSHINGS, THRUST WASHERS AND BEARING; AND NEEDLE BEARING ROLLERS

1. Check reverse idler gear shaft for excessive wear and, if wear or damage is indicated, it should be replaced.

2. The bushings used in the reverse idler gear are pressed into the gear, then peened into holes in the bores to lock them in place. They are accurately bored with special diamond boring tools to insure positive alignment of the bushings and the shaft, as well as to insure proper meshing of the gears. Because of the high degree of accuracy to which these parts are machined, the bushings are never serviced separately.

3. Check bushings for excessive wear by inserting a narrow feeler gauge between the shaft and the bushing. The proper clearance is from .002" to .004".

4. The thrust washers and radial roller thrust bearing should be closely examined for wear or damage and replaced if wear or damage is indicated.

5. The fifty countergear needle bearing rollers should be closely inspected for excessive wear and replaced if worn.

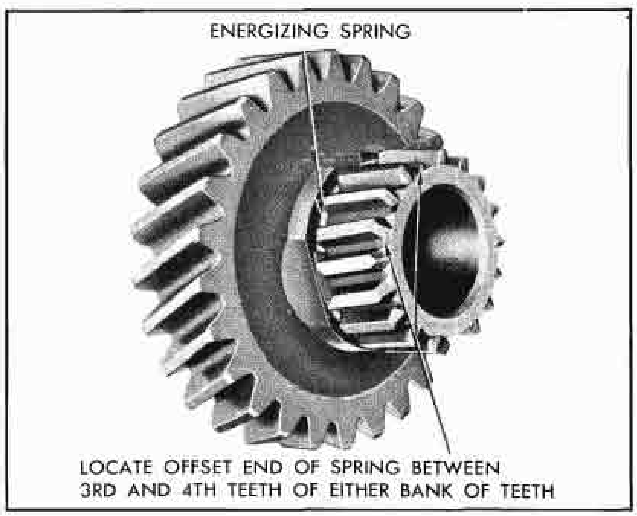


Fig. 7-45 Position of Synchronizer Ring Energizing Springs

6. Closely inspect the 14 front and 24 rear mainshaft pilot needle bearing rollers and replace if worn.

CLUTCH (SLEEVE), SYNCHRONIZER RINGS AND CONES

1. Check the synchronizer cones for wear or for looseness in the clutch sleeve. If cones are damaged in any way, it will be necessary to replace the entire clutch assembly and both synchronizer rings.

2. Inspect the synchronizer rings for smoothness.

3. Place the synchronizer rings in the synchronizer cones and apply pressure with thumbs to see that rings do not rock. Excessive rocking indicates a poor fit between the rings and cones and prevents proper synchronizing of gears during shifting.

INTERNAL COMPONENTS—ASSEMBLE

TRANSMISSION CASE EXTENSION BUSHING AND OIL SEAL–REPLACE

1. Using tool J-6399, drive bushing, from rear of transmission, until end of bushing is slightly below counterbore for oil seal (Fig. 7-44).

2. To replace oil seal, coat new seal with sealing compound and start straight in bore of case extension. Using installer J-5154-A, tap seal into counterbore.

SYNCHRONIZER ENERGIZING SPRINGS–REPLACE

1. It will be noticed, upon examining these springs, that one end is slightly offset. Each spring must be assembled in its grooves in the main drive (clutch) gear and the second speed gear with the offset, or locking end, between the third and fourth teeth of either of the two banks of teeth on these gears. This prevents the spring from turning in its groove (Fig. 7-45).

NOTE: In replacing energizing springs, be careful not to distort the springs by expanding them too much when sliding them over the clutch teeth of main drive (clutch) gear and second speed gear.

CLUTCH (SLEEVE) AND SYNCHRONIZER RINGS–ASSEMBLE

1. Lubricate both synchronizer rings with light grease as an aid in preventing synchronizer ring "lock-up".

2. Install a synchronizer ring retainer (snap ring) in counterbore at one end of clutch sleeve.

3. Insert tool J-932 through slot in clutch sleeve (Fig. 7-42), and expand retainer in counterbore. Install ring in clutch sleeve.

4. Install other synchronizer ring in same manner.

NOTE: Make certain retainers seat fully in their grooves around the rings so rings will turn freely.

MAIN DRIVE (CLUTCH) GEAR—ASSEMBLE

1. Using an arbor press, press the main drive (clutch) gear bearing on main drive (clutch) gear shaft, making certain locating ring groove is toward the front of the shaft.

2. Install the combination clutch bearing retaining nut and oil slinger on the main drive (clutch) gear shaft (Fig. 7-40), drawing it up tightly with tool J-933.

3. Lock the retaining nut and oil slinger in place by staking it into flat on shaft with center punch. Use extreme care so as not to damage threads on shaft.

CAUTION: The main drive (clutch) gear bearing must turn as freely after installation on shaft as it turned before being installed.

MAINSHAFT ASSEMBLY–ASSEMBLE

1. Slide second speed gear on mainshaft, clutch hub to front.

2. Install thrust washer with oil grooves toward gear.

3. Press rear bearing on mainshaft, making certain groove in O.D. of bearing is toward second speed gear.

NOTE: Check position of bearing snap ring groove before installing bearing on mainshaft. Bearing must seat forward of this groove with minimum amount of end play.

4. Select one of four available snap rings so end play of bearing on shaft does not exceed .004". This may be easily determined by trying successively larger rings and selecting the thickest ring that will enter snap ring groove on shaft.

5. Start speedometer drive gear on shaft with chamfered I.D. of gear toward bearing. Press gear on shaft until forward face of gear is 53/64" from rear face of bearing (Fig. 7-46).

6. Install special snap ring on end of mainshaft.

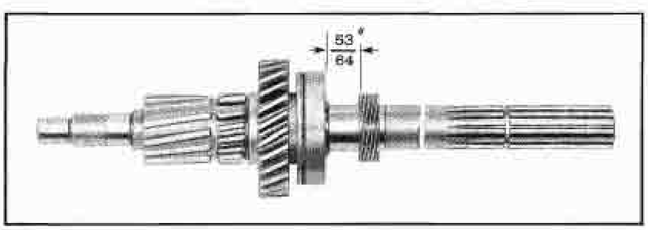


Fig. 7-46 Mainshaft Assembly

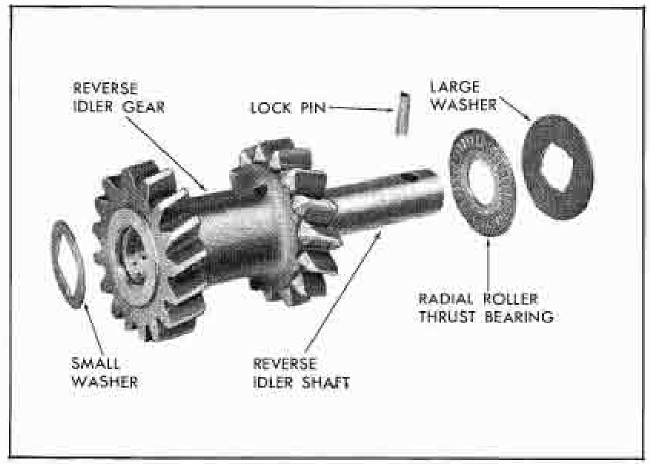


Fig. 7-47 Reverse Idler Gear, Shaft and Thrust Washers

TRANSMISSION—ASSEMBLE

REVERSE IDLER GEAR

1. Coat thrust washers and radial roller thrust bearing with grease.

2. Position radial roller thrust bearing against rear of gear, or end with chamfered gear teeth, and position large thrust washer against bearing. Position small thrust washer at opposite, or front end, of gear (Fig. 7-47).

3. From rear of case, install the idler shaft, aligning lock pin hole in shaft with hole in case (Fig. 7-37), and tap shaft in until front of shaft is flush with inner side of rear boss.

4. Position reverse idler gear assembly in case so radial roller thrust bearing is toward rear of case and gear is lined up with shaft. With soft hammer, tap shaft from rear until lock pin holes are lined up.

5. Coat new idler shaft lock pin with sealer and drive it in approximately 1/16" beyond flush with case. Peen hole slightly to ensure lock pin is secure and to prevent oil leak.

6. Install new idler shaft expansion plug in front of case.

COUNTERGEAR AND MAIN DRIVE (CLUTCH) GEAR

1. Apply cup grease in roller bearing area at each end of countergear and insert tool J-5777 in countergear.

2. Install 25 roller bearings, over tool J-5777, at each end of countergear. The grease will hold the bearings in place while installing countergear assembly in case.

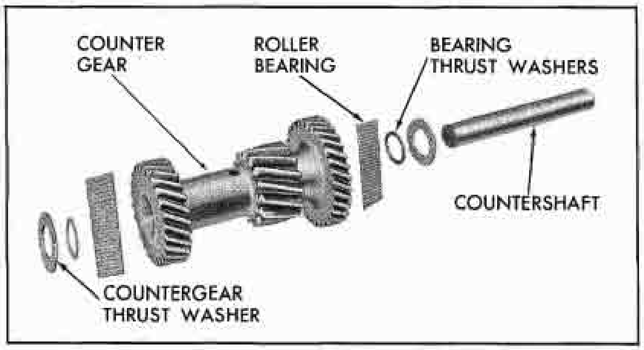


Fig. 7-48 Countergear Assembly

3. Apply grease to bearing thrust washers and countergear thrust washers and place bearing thrust washers, followed by countergear thrust washers, at both ends of countergear (Fig. 7-48), making certain tangs on countergear thrust washers face out.

4. With tool J-5777 in position, place countergear in transmission case and rest it on botttom of case.

5. From inside case, push main drive (clutch) gear assembly through opening in front face of case and, using a brass drift, tap the clutch gear assembly until the clutch gear bearing locating ring groove is outside the front of case. Assembly must be driven straight to prevent damage to bearing (Fig. 7-49).

6. Install snap ring in bearing groove and tap main drive (clutch) gear toward the rear until snap ring rests firmly against face of case.

7. Install the main drive (clutch) gear bearing retainer and new retainer gasket. Gasket must not protrude beyond edge of retainer.

NOTE: The holes in the retainer are unevenly spaced so that retainer can be assembled to the case in only one position, matching up the oil return slot with the oil outlet hole in case.

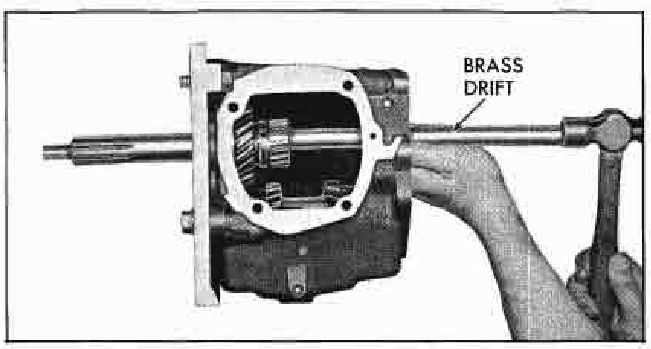


Fig. 7-49 Installation of Main Drive (Clutch) Gear Assembly

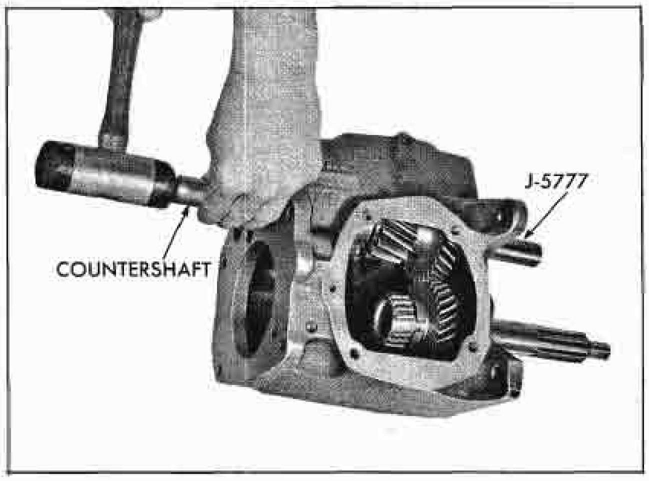


Fig. 7-50 Installation of Countershaft

8. Apply sealing compound to threads of four retainer to case bolts and install bolts and special shakeproof lock washers. Torque 12 to 15 lb. ft.

9. Turn transmission case on flat, or top side.

10. Drop countergear so that idler gear, main drive (clutch) gear and countergears mesh properly. Be careful that thrust washers at end of countergear are not dislodged.

11. Lubricate and start countershaft in case from rear, making certain that flat on end of shaft is horizontal and toward bottom of case.

NOTE: The flat on shaft must be horizontal and at bottom to permit installation of case extension.

12. Align countergear with shaft and, using soft hammer, tap shaft through, pushing bearing loader J-5777 out the front of case (Fig. 7-50).

13. Continue to tap shaft until flat on end is flush with rear face of case.

14. Apply cup grease to pilot hole in main drive (clutch) gear to retain pilot needle bearing rollers (Fig. 7-51).

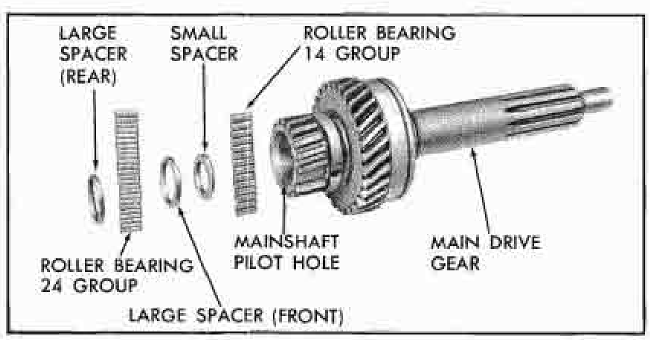


Fig. 7-51 Main Drive (Clutch) Gear Assembly

15. Install the 14 group (larger bearings) and then insert small I.D. spacer.

16. Insert the large I.D. front spacer, followed by the 24 group (smaller bearings).

17. Insert the large I.D. rear spacer with chamfered side out.

SYNCHRONIZING CLUTCH SLEEVE–FIRST AND REVERSE SLIDING GEAR

1. Insert synchronizing clutch assembly, shoulder to front, through rear opening of case.

2. Line up two inner lugs of clutch sleeve synchronizing ring with two wide grooves in main drive (clutch) gear and slide clutch assembly onto main drive (clutch) gear.

3. Through side opening of case, insert first and reverse sliding gear, positioning wide inner bevel and small round depression toward rear. Pilot first and reverse sliding gear onto clutch.

4. Position transmission case to receive mainshaft (Fig. 7-52).

MAINSHAFT AND EXTENSION

1. Carefully insert mainshaft assembly in transmission case extension and, using tool J-932, spread mainshaft bearing snap ring and tap front end of mainshaft, using soft hammer, until snap ring seats firmly in mainshaft bearing groove.

2. Affix new extension housing gasket to transmission case.

3. Align the clutch splines on mainshaft with the clutch splines on second speed gear so as to receive the two inner lugs of the synchronizing ring of 2nd and 3rd speed clutch. Mark with red lead for identification (Fig. 7-53).

4. Lower mainshaft assembly through opening at rear of transmission case, making certain two inner lugs of synchronizing ring engage previously marked grooves of mainshaft and second speed gear (Fig. 7-54).

CAUTION: Use extreme care when lowering mainshaft assembly into transmission case to prevent needle roller bearings from falling into mainshaft pilot hole. Sudden weight exerted on synchronizing rings may cause them to lock up.

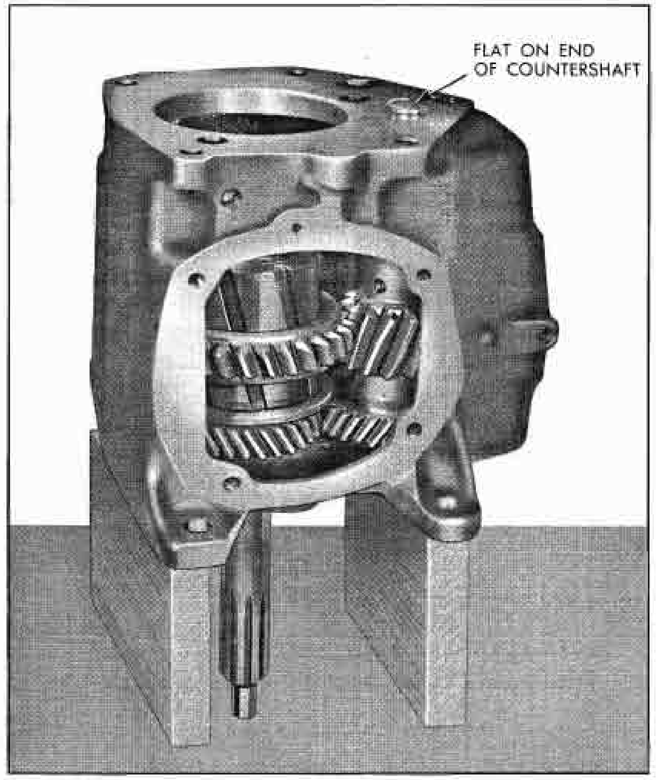


Fig. 7-52 Position of Transmission Case Assembly for Installation of Mainshaft Assembly

5. Rotate extension housing to line up with case, insert the five extension housing to case bolts and washers, applying special sealing compound to threads of attaching bolts, and finger tighten.

6. Set transmission assembly, top side up, on bench. Maneuver 2nd and 3rd speed clutch until ex-

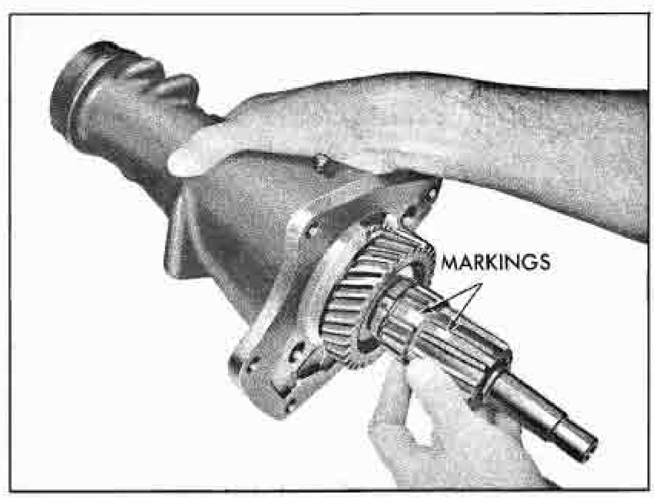


Fig. 7-53 Alignment of Synchronizer Clutch Splines on Mainshaft and Second Speed Gear

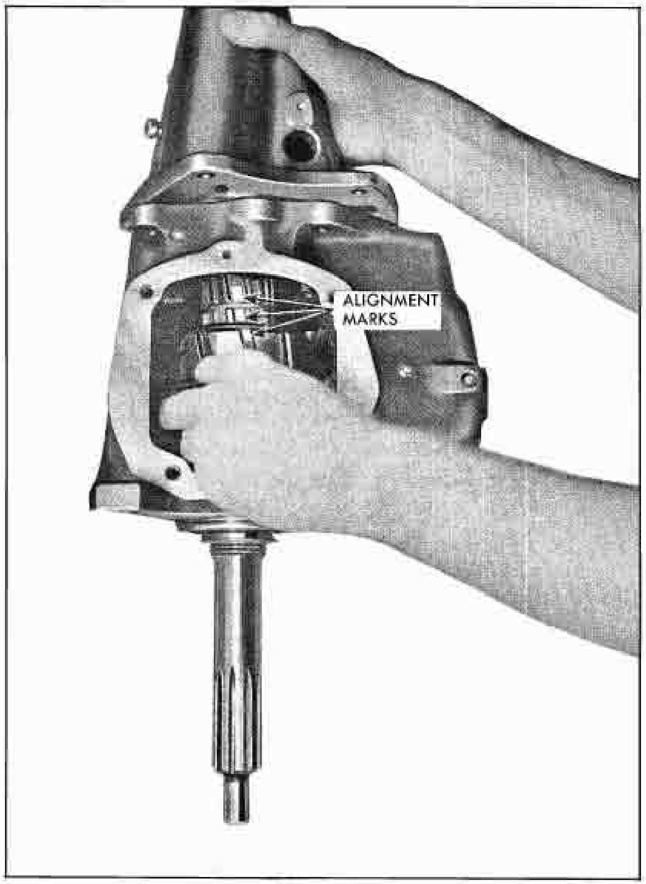


Fig. 7-54 Installing Mainshaft in Transmission Case

tension housing fits flush against transmission case. Tighten bolts 40 to 45 lb. ft. torque.

7. Install speedometer driven gear and fitting in extension housing as outlined under SPEEDOMETER DRIVEN GEAR–REPLACE, steps 1 through 5.

8. Install side cover as outlined under TRANSMISSION SIDE COVER–ASSEMBLE AND INSTALL.

9. Install clamp, bracket and insulator assembly on rear extension.

TRANSMISSION—INSTALL IN VEHICLE

1. Raise transmission until rear extension can be moved rearwards over center cross member.

2. Move transmission forward, aligning with rear of clutch housing and lower rear extension until bracket studs engage holes in cross member support.

3. Insert aligning studs J-1126 in upper transmission to clutch housing bolt holes.

4. Install two lower transmission to clutch housing bolts and tighten 45-60 lb. ft. torque.

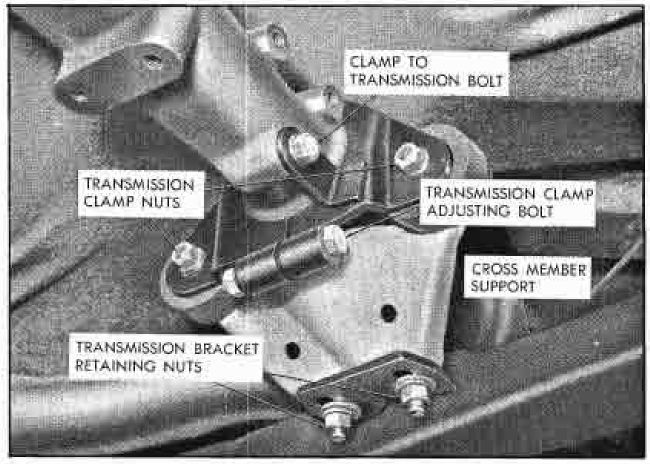


Fig. 7-55 Installing Rear Extension Mount

5. Remove aligning studs and install two upper transmission to clutch housing bolts and tighten 45-60 lb. ft. torque.

6. Install two transmission extension bracket to cross member retaining nuts. Tighten to 25-35 lb. ft. torque (Fig. 7-55).

7. Connect shifter rods to shifter levers (Fig. 7-56).

8. Connect speedometer cable to speedometer driven gear fitting.

9. Install propeller shaft drive line assembly by reversing steps a. through c. under TRANSMISSION –REMOVE FROM VEHICLE.

10. Remove filler plug at side of transmission and add 1.8 pints of SAE 80 "Multi-purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole.

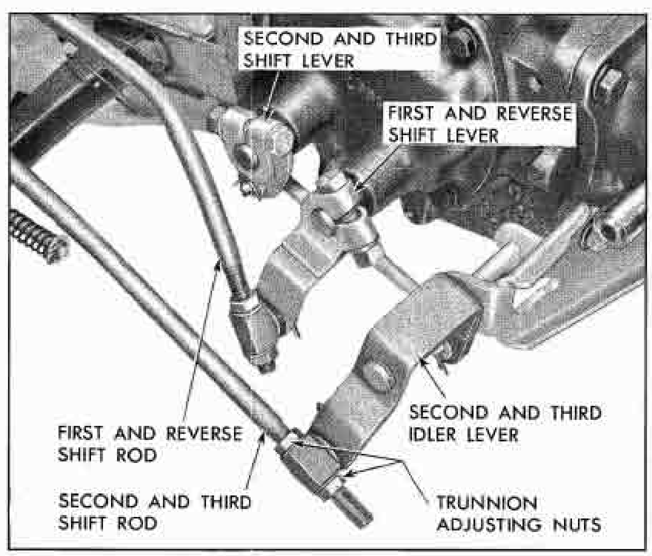


Fig. 7-56 Gearshift Linkage Connected at Transmission

TROUBLE DIAGNOSIS AND TESTING

TROUBLE	REMEDY
SLIPS OUT OF HIGH GEAR	
a. Transmission loose on clutch housing.	a. Tighten mounting bolts.
b. Shifter rods interfere with engine mounts or clutch throw-out lever.	b. Replace or bend levers and rods to eliminate interference.
c. Shifter linkage does not work freely, binds.	c. Adjust and free up shift linkage. Torque reactions of engine should not cause the lever on transmission to move. The movement of transmission with respect to body and frame should be transferred to the control linkage.
d. Does not fully engage.	d. Measure length of engagement pattern on clutching teeth. If less than $\frac{7}{64}''$, check for bent levers, shifter shafts, detent cam plates, control rods and other shift linkage. Replace or straighten defective parts.
e. Damaged mainshaft pilot bearing.	e. Replace pilot bearing.
f. Main drive (clutch) gear bearing retainer broken or loose.	f. Tighten or replace main drive (clutch) gear bearing retainer.
g. Dirt between transmission case and clutch housing.	g. Clean mating surfaces.
h. Misalignment of transmission.	h. Shim between transmission case and clutch housing.
SLIPS OUT OF LOW AND/OR REVERSE	
a. First and/or reverse gears damaged from operating at part engagement.	a. Determine cause. For example, worn shift fork and control lever or rod interference. Replace worn or bent parts.
b. Improper mated splines on inside of first and reverse sliding gear and/or external splines on 2nd and 3rd speed clutch.	b. Replace 2nd and 3rd speed clutch and/or first and reverse sliding gear. Possible correction is to change index of gear on clutch approximately 180° and/or turning the rear side of first and reverse gear to the front of the transmission.
c. Improperly adjusted linkage.	c. Adjust linkage.
NOISY IN ALL GEARS	
a. Insufficient lubricant.	a. Fill to correct level.
b. Worn countergear bearings.	b. Replace countergear bearings and shaft.
c. Worn or damaged main drive (clutch) gear and countergear.	c. Replace worn or damaged gears.
d. Damaged main drive (clutch) gear or mainshaft ball bearings.	d. Replace damaged bearings.
e. Damaged speedometer gears.	e. Replace damaged gears.

TROUBLE	REMEDY
NOISY IN HIGH GEAR	
a. Damaged main drive (clutch) gear bearing.	a. Replace damaged bearing.
b. Damaged mainshaft bearing.	b. Replace damaged bearing.
c. Damaged speedometer gears.	c. Replace speedometer gears.
NOISY IN NEUTRAL WITH ENGINE RUNNING	
a. Damaged main drive (clutch) gear bearing.	a. Replace damaged bearing.
b. Damaged mainshaft bearing.	b. Replace damaged bearing.
NOISY IN ALL REDUCTION GEARS	
a. Insufficient lubricant.	a. Fill to correct level.
b. Worn or damaged clutch gear or countergear.	b. Replace faulty or damaged gears.
NOISY IN SECOND ONLY	
a. Damaged or worn second speed constant mesh gears.	a. Replace damaged gears.
b. Worn or damaged countergear rear bearings.	b. Replace countergear bearings and shaft.
NOISY IN LOW AND REVERSE ONLY	
a. Worn or damaged first and reverse sliding gear.	a. Replace worn gear.
b. Damaged or worn low and reverse countergear.	b. Replace countergear assembly.
NOISY IN REVERSE ONLY	
a. Worn or damaged reverse idler gear.	a. Replace reverse idler gear assembly.
b. Worn reverse idler bushings.	b. Replace reverse idler gear assembly.
c. Damaged or worn reverse countergear.	c. Replace countergear assembly.
EXCESSIVE BACKLASH IN SECOND ONLY	
a. Second speed gear thrust washer worn.	a. Replace thrust washer.
b. Mainshaft rear bearing not properly installed in case.	b. Replace bearing, lock or case as necessary.
c. Universal joint retaining bolt loose.	c. Tighten bolt.
d. Worn countergear rear bearing.	d. Replace countergear bearings and shaft.
EXCESSIVE BACKLASH IN ALL REDUCTION GEARS	
a. Worn countergear bushings.	a. Replace countergear.
b. Excessive end play in countergear.	b. Replace countergear thrust washers.

TROUBLE	REMEDY
LEAKS LUBRICANT	
a. Excessive amount of lubricant in transmission.	a. Drain to correct level.
b. Loose or broken main drive (clutch) gear bearing retainer.	b. Tighten or replace retainer.
c. Main drive (clutch) gear bearing retainer gasket damaged.	c. Replace gasket.
d. Cover loose or gasket damaged.	d. Tighten cover or replace gasket.
e. Operating shaft seal leaks.	e. Replace operating shaft seal.
f. Idler shaft expansion plugs loose.	f. Replace expansion plugs.
g. Countershaft loose in case.	g. Replace case.

TRANSMISSION SPECIFICATIONS

The transmission face, clutch housing and block are accurately squared in production so that each unit may be interchanged as necessary. Special alignment of these assemblies is not necessary if they are installed properly.

Shift Positions	Gear Ratios
Low	2.47:1
Second	1.53:1
Third	1.00:1
Reverse	2.63:1
Lubricant Capacity	1.8 Pints

SPEEDOMETER GEAR USAGE CHART
STANDARD 3-SPEED SYNCHRO-MESH TRANSMISSION WITH 8.00 X 14 TIRES

Rear Axle Ratio	Speedometer Sleeve Ass'y. Ratio	Speedometer Sleeve Ass'y. Color	Speedometer Drive Joint (Adapter) Ratio
41:9 (4.55)	19:8	Lt. Green	.6944
43:10 (4.30)	19:8	Lt. Green	.7333
41:10 (4.10)	19:8	Lt. Green	.7692
39:10 (3.90)	19:8	Lt. Green	.8095
40:11 (3.64)	21:8	Red	Not Required
41:12 (3.42)	20:8	Blue	Not Required
42:13 (3.23)	19:8	Lt. Green	Not Required
40:13 (3.08)	18:8	Brown	Not Required

Fig. 7-57 Speedometer Gear Usage Chart

TORQUE SPECIFICATIONS

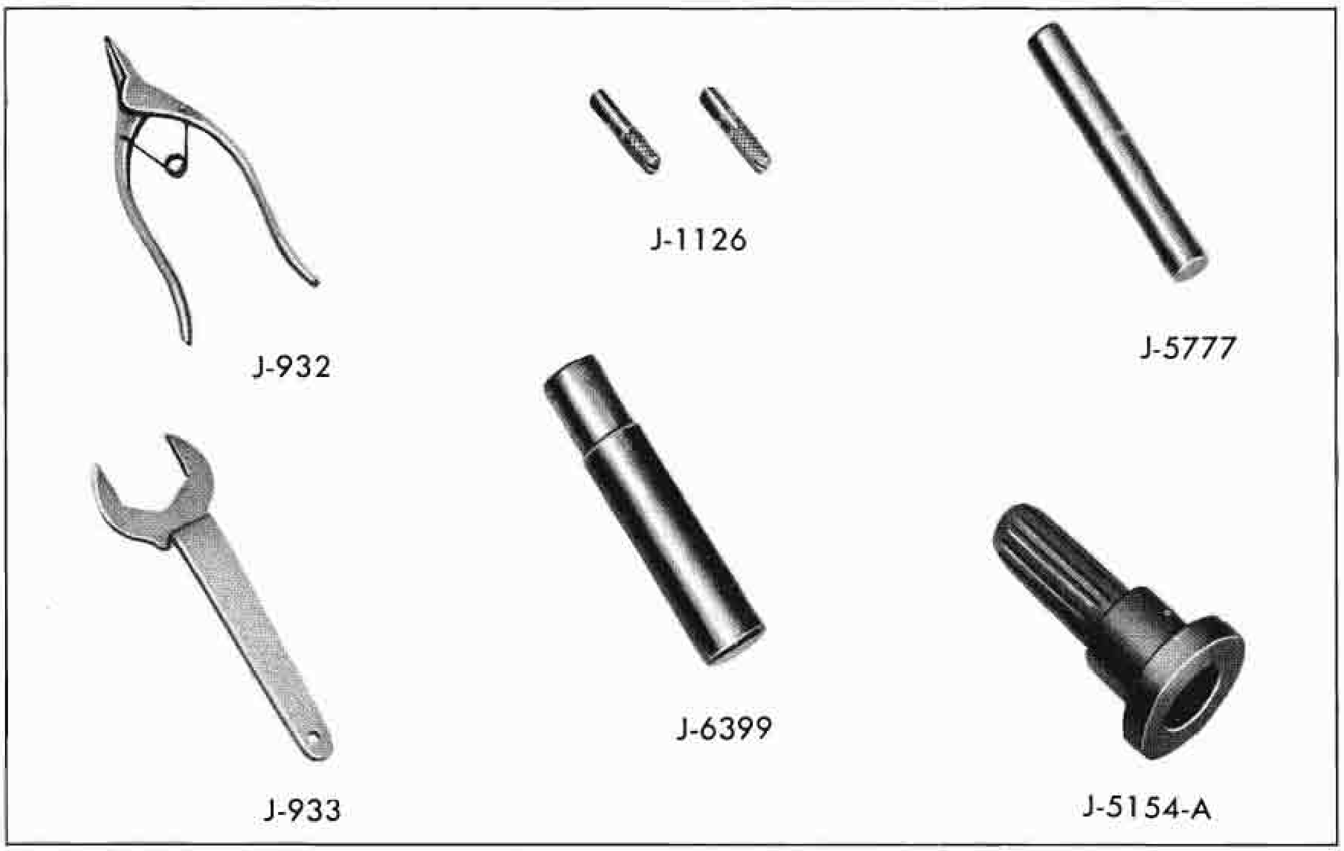
	Lb. Ft.
Screw Assembly (Speedometer Clamp)	3-5
Shifter Interlock Retainer Stud	3-5
Shifter Interlock Retainer Nut	3-5
Screw Assembly (Chip Collector)	3-5
Clutch Gear Bearing Retainer Bolts	12-15
Side Cover Bolts	15-18
Rear Extension Bolts	40-45
Transmission Drain Plug	25-35
Transmission Filler Plug	25-35
Shift Lever Bolts	12-15

TORQUE SPECIFICATIONS

	Lb. Ft.
Rear Clamp Support to Transmission Bolt	20-30
Rear Bracket Support to Cross Member Nuts	25-35
Insulator Assembly to Support Bracket	25-35
Gear Shift Intermediate Bracket to Transmission Extension Bolt	40-55
Steering Column Clamp Support Bracket to Floor Pan Nuts	10-20
Steering Column Clamp Upper Bolt	10-20
Steering Column Clamp Lower Stud Nut	10-20

	Lb. In.
Gear Shift Control Rod Trunnion Jam Nut	60-120
Clutch Pedal Trunnion Jam Nut	60-120
Steering Column Lower Bearing Adjusting Bolts	85-125
Actuator Housing Retaining Screws	10-35
Direction Signal Switch Retaining Screws	10-35
Back-Up Light Trip Lever Retaining Screw	10-35
Back-Up Light Switch Assembly Screw	10-35
Steering Column Bracket to Instrument Panel Screws	10-35

SPECIAL TOOLS



J-932 Snap Ring Pliers
J-933 Clutch Gear Retainer Nut Wrench
J-1126 Aligning Studs
J-5154-A Transmission Extension Oil Seal Installer
J-5777 Countershaft Needle Bearing Loader
J-6399 Rear Bearing Extension Bushing—Remove and Replace

Fig. 7-58 Synchro-Mesh Transmission Special Tools

HEAVY DUTY TRANSMISSION AND GEARSHIFT CONTROL

CONTENTS OF THIS SECTION

DESCRIPTION

The heavy duty three-speed synchro-mesh transmission (Fig. 7A-1), is used as standard equipment on the Star Chief, Bonneville (except Safari), and Grand Prix models. It is also used on heavy duty chassis, taxi cabs and police cars, and as optional equipment on tri-power and 425A engines. In design, it resembles the standard synchro-mesh transmission, but the mainshaft and case extension are considerably longer.

Gears are shifted manually through a concentric steering column gearshift mehanism which activates two rods connected to the shifter levers at the transmission case side cover. Two shift forks inside the transmission directly engage the gears to be shifted.

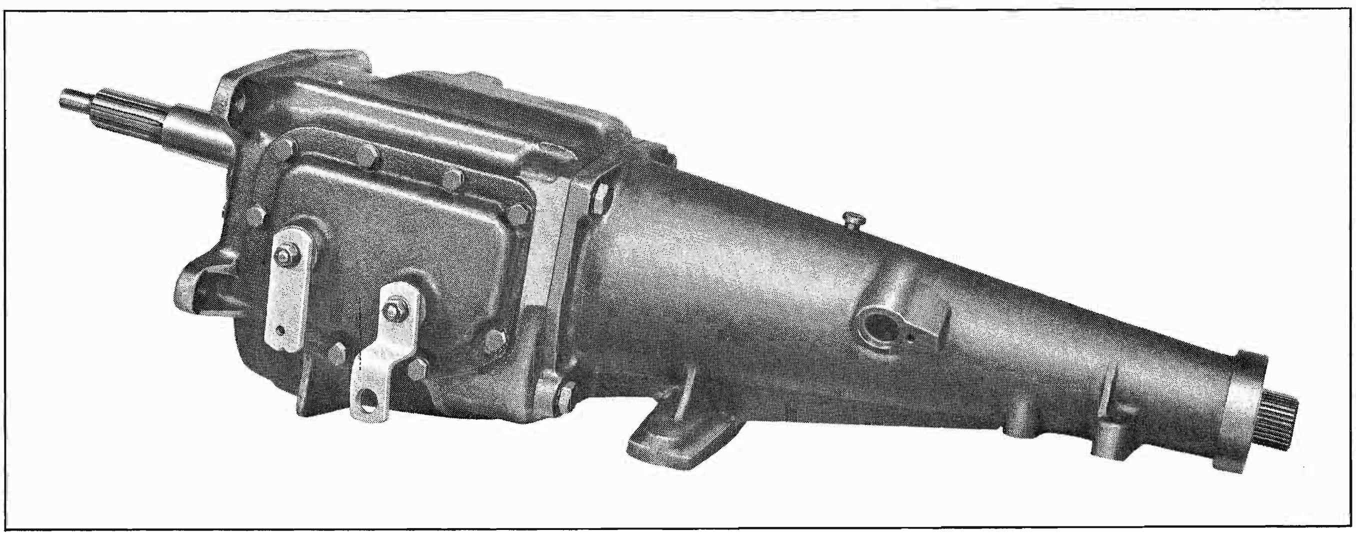
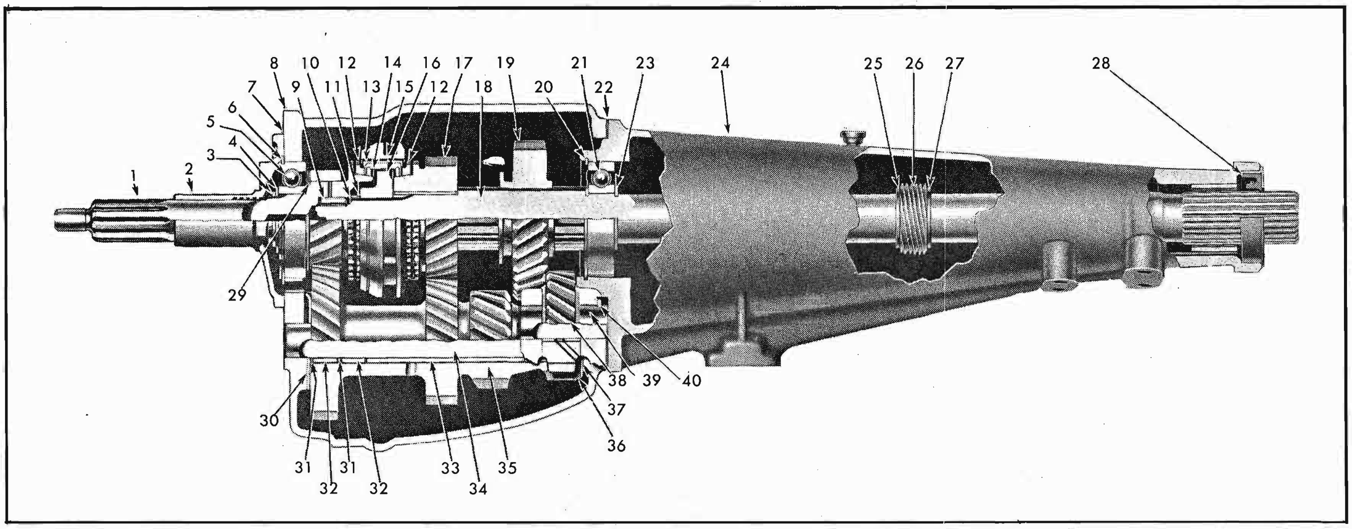


Fig. 7A-1 Three Speed Heavy Duty Synchro-Mesh Transmission



1. Main Drive Gear
2. Main Drive Gear Bearing Retainer
3. Main Drive Gear Snap Ring
4. Main Drive Gear Washer
5. Main Drive Gear Bearing
6. Main Drive Gear Bearing Snap Ring
7. Bearing Retainer Gaskets
8. Transmission Case
9. Mainshaft Front Roller Bearings
10. Bearing Spacing Washer
11. Clutch Hub Retaining Snap Ring
12. Synchronizing Rings
13. Clutch Key
14. Clutch Key Springs
15. 2nd and 3rd Speed Clutch Sleeve
16. 2nd and 3rd Speed Clutch Hub
17. Second Speed Gear
18. Mainshaft
19. First and Reverse Sliding Gear
20. Mainshaft Rear Bearing Front Snap Ring
21. Mainshaft Rear Bearing
22. Retainer Extension Gasket
23. Mainshaft Rear Bearing Rear Snap Ring
24. Rear Bearing Retainer Extension
25. Speedometer Drive Gear Front Snap Ring
26. Speedometer Drive Gear
27. Speedometer Drive Gear Rear Snap Ring
28. Retainer Extension Oil Seal
29. Oil Retaining Washer
30. Countergear Front Thrust Washer (Bronze)
31. Countershaft Bearing Retainer Washers
32. Countershaft Roller Bearings
33. Countershaft Bearing Spacer
34. Countershaft
35. Countergear
36. Countergear Rear Thrust Washer (Bronze)
37. Countergear Rear Thrust Washer (Steel)
38. Reverse Idler Gear
39. Reverse Idler Gear Shaft
40. Reverse Idler Gear Shaft Lock Key

Fig. 7A-2 Cross Section of Three-Speed Heavy Duty Synchro-Mesh Transmission

DESIGN

All gears are of helical design, heat-treated and shot-peened for strength and long life. The shafts are machined from high grade steel, heat-treated and ground to close limits.

There are five basic gears in the transmission: main drive gear, second speed gear, first and reverse sliding gear, reverse idler gear and countergear. These gears vary in size and design and are so positioned that, when one gear is brought into mesh with another, proper ratios are attained for first, second, third and reverse speeds (Fig. 7A-2).

A synchronizing assembly, consisting of a 2nd and 3rd speed clutch hub and sleeve, two synchronizing rings and three energizer clutch keys, is retained on the front end of the mainshaft to synchronize the meshing of gears in all forward speeds.

The main drive gear is piloted at its front end in a single row, prepacked and shielded ball bearing mounted in the engine crankshaft. It is supported at

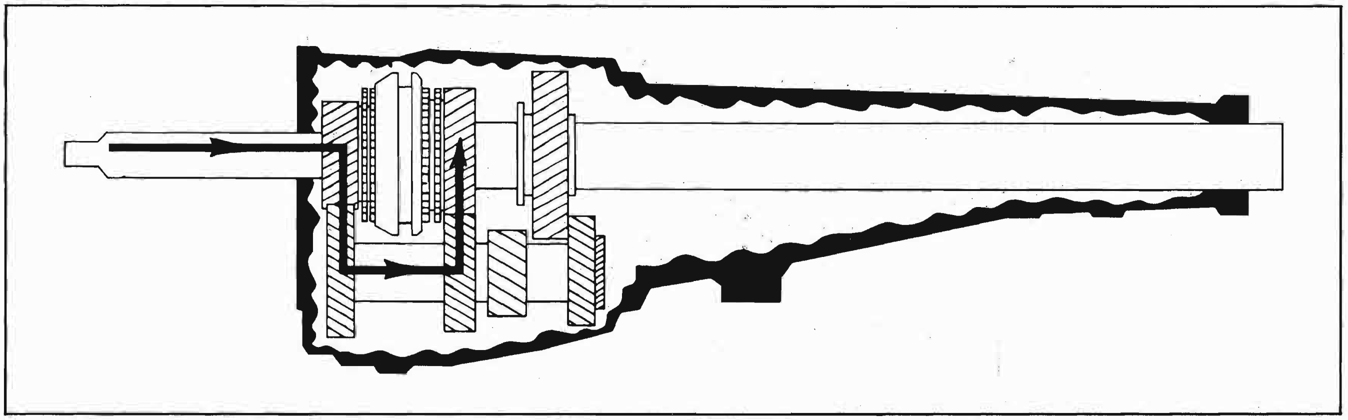


Fig. 7A-3 Three-Speed Heavy Duty Synchro-Mesh—Power Flow in Neutral

its rear by a heavy duty ball bearing located at the front end of the transmission case.

The front end of the mainshaft is piloted in a single row of needle roller bearings set into the pilot hole of the main drive gear and the mainshaft proper is carried by a heavy duty ball bearing located in the face of the rear extension.

The countergear is supported by a double row of needle roller bearings positioned at each end of the countershaft. Thrust on the countergear is taken by a bronze thrust washer at the front and a bronze and steel washer at the rear.

The second speed gear and reverse idler gear are carried on press-fit, ball-indented and steel-backed bronz bushings which line the inner bore of these two gears.

The 2nd and 3rd speed clutch hub is splined to the mainshaft, while the second speed gear floats on the mainshaft. The first and reverse sliding gear has six inner splines which engage six outer grooves in the mainshaft, allowing forward and rearward movement of gear, but prohibiting rotation of gear on mainshaft.

OPERATION

The main drive gear, second speed gear and reverse idler gear are in constant mesh with the countergear; therefore, with the engine running and the engine clutch engaged, the main drive gear, second speed gear, reverse idler gear and countergear will rotate at all times. The main drive gear and second speed gear are used in conjunction with the synchronizing assembly to reduce the possibility of clashing gears while shifting.

OPERATION IN NEUTRAL (Fig. 7A-3)

In neutral, the first and reverse sliding gear is positioned so that it does not mesh with the countergear or reverse idler gear. The 2nd and 3rd speed clutch is positioned so that it does not engage the main drive gear or second speed gear. Therefore, with engine clutch engaged, the main drive gear, second speed gear, reverse idler gear and countergear are turning, but no power is being transmitted through the mainshaft.

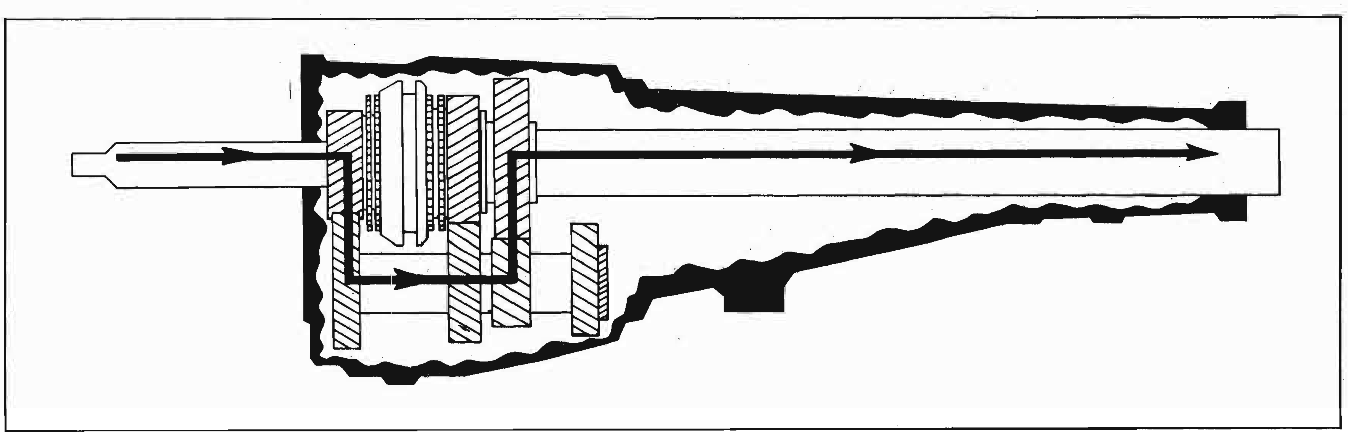


Fig. 7A-4 Three-Speed Heavy Duty Synchro-Mesh—Power Flow in First

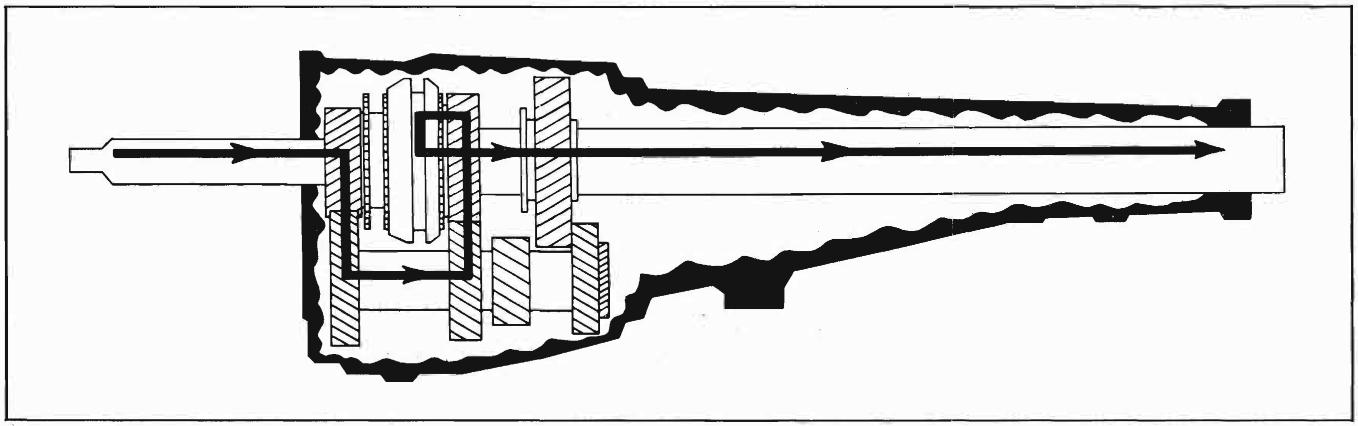


Fig. 7A-5 Three-Speed Heavy Duty Synchro-Mesh—Power Flow in Second

OPERATION IN FIRST (Fig. 7A-4)

In first speed, the first and reverse sliding gear is moved forward to mesh with the countergear, which is being turned by the main drive gear. The first and reverse sliding gear is now activated by the countergear and, because the six inner splines of the first and reverse sliding gear are seated in the outside diameter grooves of the mainshaft, torque is applied directly to the mainshaft through the first and reverse sliding gear.

OPERATION IN SECOND (Fig. 7A-5)

In second speed, the first and reverse sliding gear is moved toward the rear, assuming a neutral position. The 2nd and 3rd speed clutch (sleeve) is moved rearwards to engage the second speed gear, which is being turned by the countergear. Since the 2nd and 3rd speed clutch (hub) is splined to the mainshaft, this engagement of the 2nd and 3rd speed clutch with the second speed gear imparts torque from the second speed gear through the clutch assembly to the mainshaft.

OPERATION IN THIRD (Fig. 7A-6)

In third speed, or direct drive, the first and reverse sliding gear remains in a neutral position. The 2nd and 3rd speed clutch (sleeve) is disengaged from the second speed gear and moved forward to engage the main drive gear. Since the 2nd and 3rd speed clutch (hub) is splined to the mainshaft, torque is applied directly to the mainshaft through the 2nd and 3rd speed clutch.

OPERATION IN REVERSE (Fig. 7A-7)

In reverse speed, the 2nd and 3rd speed clutch assumes a neutral position. The first and reverse sliding gear is moved rearward to mesh with the reverse idler gear, which is being turned by the countergear. Since the first and reverse sliding gear is splined to the mainshaft, engagement with the reverse idler gear will impart torque to the mainshaft; however, because the power flows from countergear to reverse idler gear and then to the first and reverse sliding gear, the direction of rotation is reversed, making it opposite that of the engine.

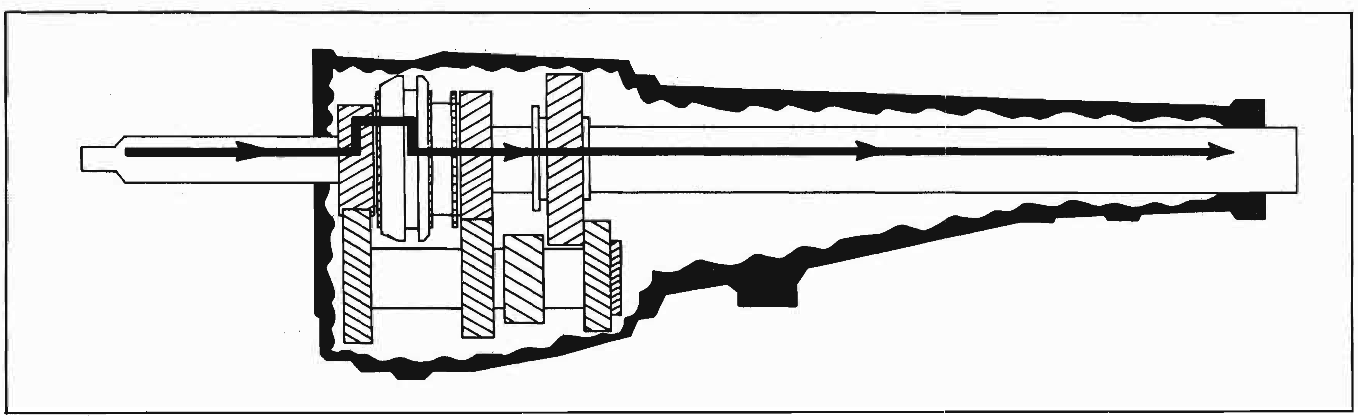


Fig. 7A-6 Three-Speed Heavy Duty Synchro-Mesh—Power Flow in Third

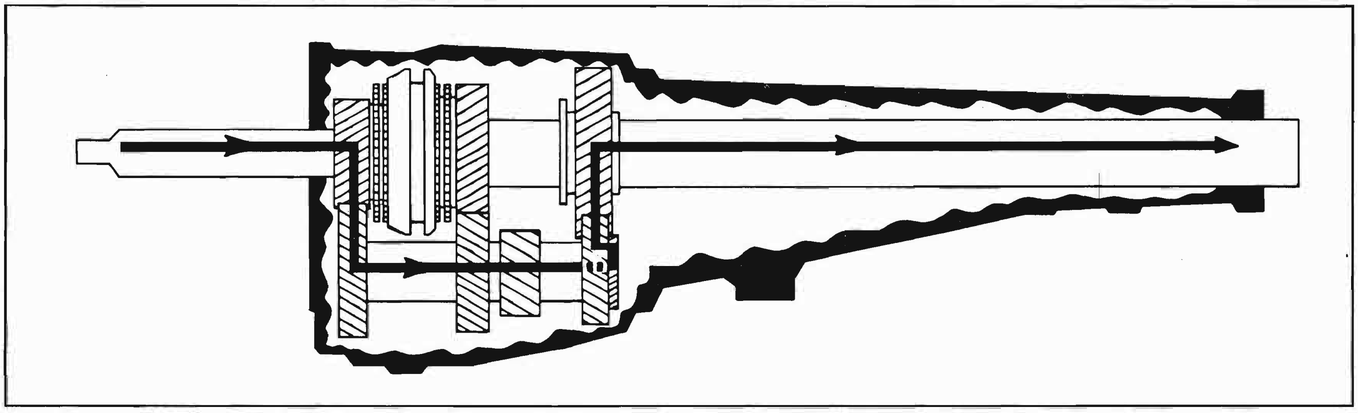


Fig. 7A-7 Three-Speed Heavy Duty Synchro-Mesh—Power Flow in Reverse

PERIODIC SERVICE

TRANSMISSION

No periodic service of the transmission is required except checking for leaks and proper lubricant level at each 4,000-mile inspection period.

If there is evidence of leakage, the leak should be corrected and lubricant added, if needed. Refill capacity is 2.8 pints.

Use SAE 80 "Multi-purpose Gear Lubricant" when refilling. No special additive to this lubricant is required or recommended.

SHIFT CONTROL

No periodic service of the shift control is required. Certain parts are lubricated on assembly and require further lubrication only when parts become dry and sticky.

ADJUSTMENTS ON CAR

GEARSHIFT ROD ADJUSTMENT

For gearshift rod adjustment of the 3-speed heavy duty synchro-mesh transmission, refer to GEARSHIFT ROD ADJUSTMENT in SECTION 7.

MINOR REPAIRS

SHIFT LINKAGE AND STEERING COLUMN—REMOVE AND REPLACE

For removal and replacement procedures of shift linkage and steering column, refer to SECTION 7.

SPEEDOMETER DRIVEN GEAR—REMOVE

1. Disconnect speedometer cable.

2. Remove lock plate to extension bolt and lock washer and remove lock plate.

3. Insert screwdriver in lock plate slot in fitting and pry fitting, gear and shaft from extension.

4. Remove "O" ring from groove in fitting.

5. Check gear, shaft and fitting for wear and replace, if necessary.

SPEEDOMETER DRIVEN GEAR—REPLACE

1. Install new "O" ring in groove of fitting and insert shaft.

2. Hold the assembly so slot in fitting is toward lock plate boss on extension and insert assembly in extension.

3. Push fitting into extension until lock plate can be inserted in groove.

4. Install lock plate to extension bolt and lock washer and tighten securely.

5. Connect speedometer cable to speedometer driven gear.

TRANSMISSION EXTENSION OIL SEAL—REMOVE AND REPLACE

To inspect or replace the rear extension oil seal, it is necessary to remove the propeller shaft drive line assembly from the vehicle.

1. Remove "U" bolt nuts, lock plates and "U" bolts from rear axle drive pinion flange.

2. Use suitable rubber band to hold bearings onto journals, if tie wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

3. Slide propeller shaft assembly rearward to disengage yoke from splines on transmission mainshaft and remove.

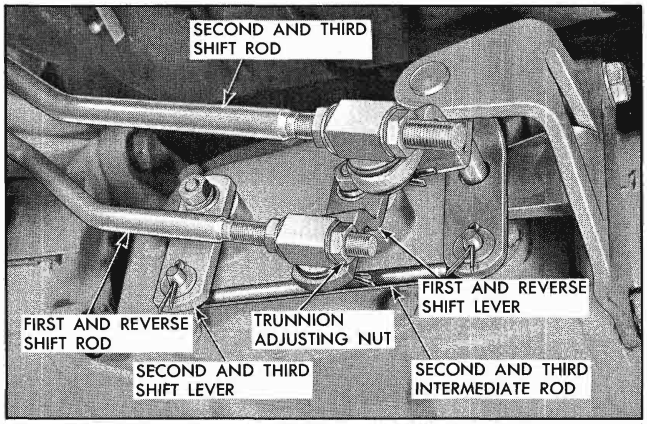


Fig. 7A-8 Gearshift Linkage

4. Using punch or other suitable tool, loosen seal from extension and remove.

5. Wash counterbore with cleaning solvent and inspect for damage.

6. Inspect propeller shaft yoke for nicks, burrs or scratches which would cut new seal or cause seal to leak or damage bushing.

7. Coat new seal with sealing compound and start straight in bore of case extension. Using installer J-5154-A, tap seal into counterbore.

8. Install propeller shaft assembly by reversing steps 1 through 3 above.

TRANSMISSION SIDE COVER—REMOVE AND REPLACE

The transmission side cover can be removed, overhauled and installed without removing the transmission from chassis.

REMOVE

1. Remove drain plug at bottom of case and drain lubricant from transmission.

2. Disconnect shifter rods from shifter levers at transmission side cover (Fig. 7A-8).

3. Remove nine cap screws and lock washers securing cover to side of case and withdraw side cover assembly and gasket from case.

DISASSEMBLE

1. Remove nuts, lock washers and flat washers and withdraw outer shifter control levers from shifter lever shafts.

2. Remove shift forks from shifter levers (Fig. 7A-9).

3. Remove inner shifter levers, two steel poppet balls, poppet spring, interlock pin, and interlock sleeve from cover.

4. Remove "O" ring seals from shifter lever shafts.

ASSEMBLE

1. Install new "O" ring seals in grooves of shifter lever shafts.

2. Install first and reverse shifter lever in cover.

3. Assemble interlock sleeve, poppet ball, poppet spring, and interlock pin in cover with ball engaging center detent in first and reverse shifter lever cam. Place other poppet ball against spring and, depressing ball with screwdriver, install 2nd and 3rd shifter lever in cover (Fig. 7A-9).

4. Check clearance between end of interlock sleeve and shifter lever cams when one lever is in neutral (center detent) and the other lever is shifted into gear position. Clearance should be 0.001″ to 0.007″. Interlock sleeves are available in lengths of 1.0235″, 1.0185″, 1.0135″, and 1.0085″ to provide selection for proper clearance.

5. Install outer shifter control levers on shifter lever shafts and secure with flat washers, lock washers and nuts. Tighten nuts securely.

6. Assemble shift forks to shift levers.

REPLACE

1. Remove all particles of old gasket and affix new gasket on case.

2. Place transmission gears in neutral. Position shift forks on cover in neutral (center detent).

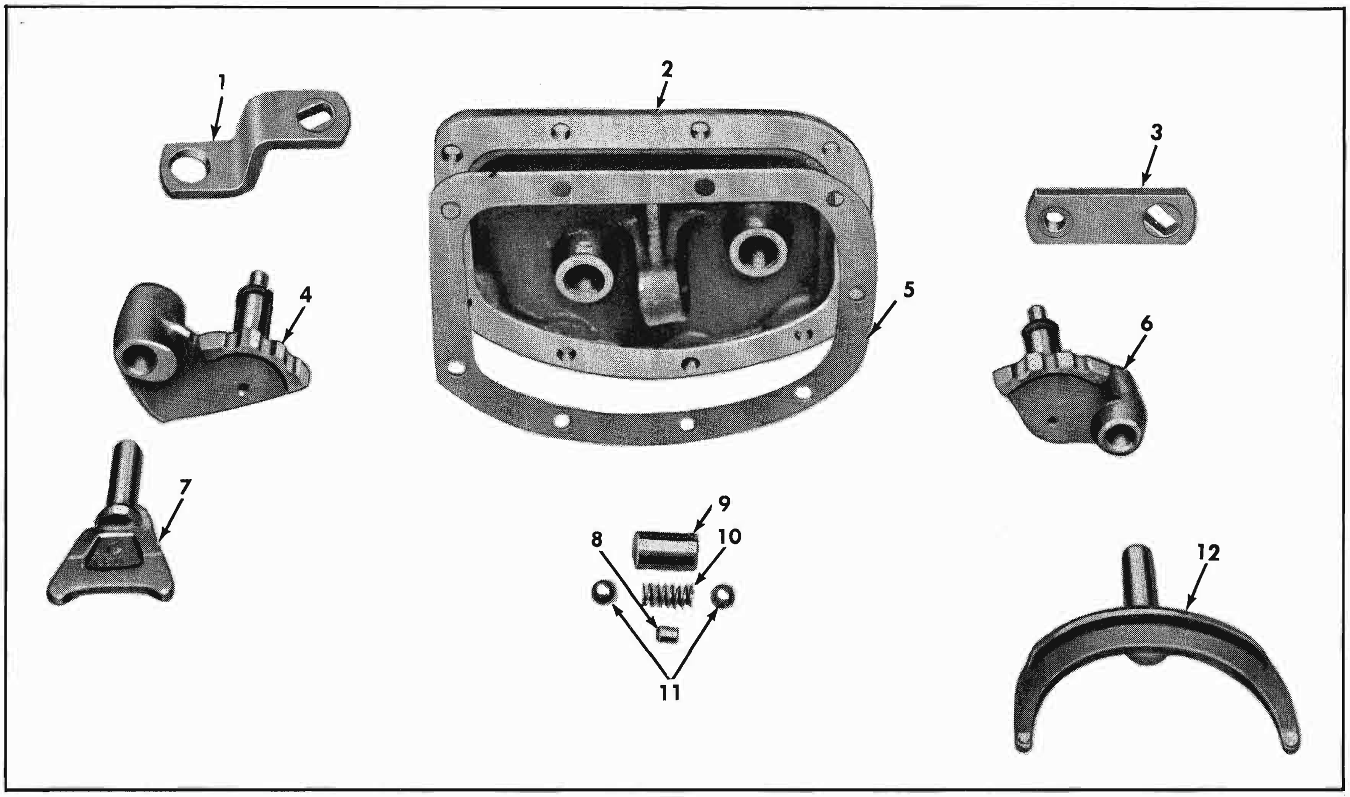
3. Assemble cover to transmission case making sure shift forks engage grooves in 2nd and 3rd speed clutch sleeve and in first and reverse sliding gear (Fig. 7A-2).

4. Apply suitable sealing compound to threads of nine cover to case cap screws and install cap screws and lock washers. Torque 12 to 15 lb. ft.

5. Connect shifter rods to levers.

6. Install drain plug in bottom of transmission case.

7. Remove filler plug at side of transmission case and add 2.8 pints of SAE 80 "Multi-purpose Gear Lubricant." Lubricant should be approximately level with bottom of filler plug hole.



1. First and Reverse Control Lever
2. Side Cover
3. 2nd and 3rd Control Lever
4. First and Reverse Shifter Lever
5. Gasket
6. 2nd and 3rd Shifter Lever
7. First and Reverse Shift Fork
8. Interlock Pin
9. Interlock Sleeve
10. Poppet Spring
11. Poppet Balls
12. 2nd and 3rd Shift Fork

Fig. 7A-9 Side Cover—Exploded View

MAJOR REPAIRS

TRANSMISSION—REMOVE AND OVERHAUL

1. Remove drain plug at bottom of transmission case and drain lubricant.

2. Remove propeller shaft drive line assembly as follows:

a. Remove "U" bolt nuts, lock plates and "U" bolts from rear axle drive pinion flange.

b. Use a suitable rubber band to hold bearing onto journals, if tie wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

c. Remove complete drive line assembly by sliding rearward to disengage yoke from splines on transmission mainshaft.

3. Disconnect speedometer cable.

4. Disconnect shifter rods from shifter levers at side cover (Fig. 7A-8).

5. Support rear of engine with floor jack.

6. Remove two transmission bracket to cross member retaining nuts.

7. Remove upper transmission to clutch housing bolts and install transmission aligning studs J-1126.

CAUTION: Aligning studs must be used since they support transmission and prevent distortion of clutch driven plate hub when lower transmission bolts are removed.

8. Remove lower transmission to clutch housing bolts.

9. Support transmission and remove frame cross member support.

10. Withdraw transmission from clutch housing and remove.

TRANSMISSION—DISASSEMBLE

1. Remove nine cap screws and lock washers securing side cover to transmission case.

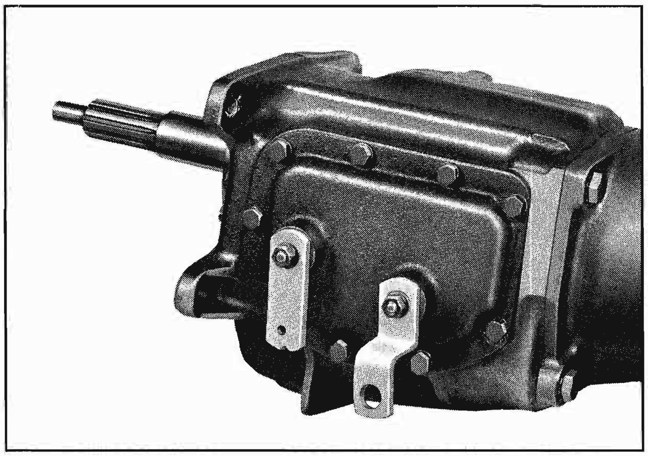


Fig. 7A-10 Transmission Side Cover

2. Remove side cover assembly and gasket (Fig. 7A-10).

NOTE: If cover is to be disassembled for inspection and replacement of worn parts, follow procedures 1 through 4 under TRANSMISSION SIDE COVER—DISASSEMBLE.

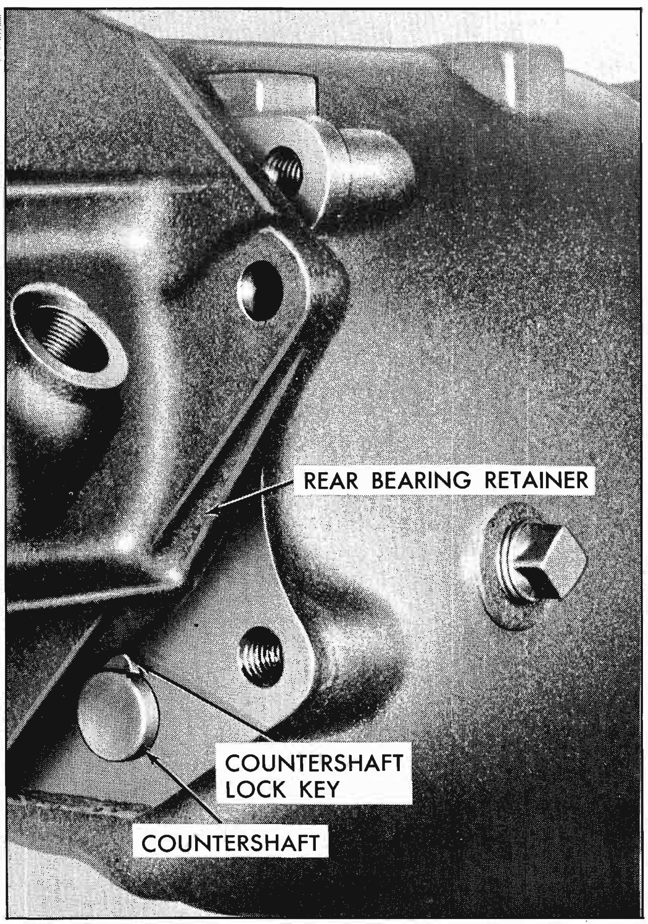


Fig. 7A-11 Rear Bearing Retainer Rotated

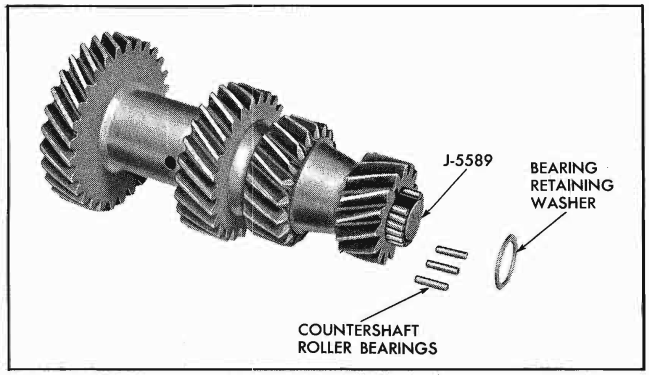


Fig. 7A-12 Bearing Loader Positioned in Countergear

3. Remove clamp, bracket and insulator assembly from rear extension.

4. Remove four cap screws and lock washers securing mainshaft rear bearing retainer extension to case and move extension away from case approximately one-half inch, then rotate retainer to expose countershaft and lock key (Fig. 7A-11).

5. From front of transmission case, drive countershaft to rear, using countershaft bearing loader tool J-5589.

NOTE: When lock key in countershaft clears transmission case (Fig. 7A-11), remove lock key to permit countershaft to clear rear bearing retainer extension.

6. Drive countershaft all the way out and leave tool J-5589 in the countergear to retain the roller bearings (Fig. 7A-12).

7. Drop countergear down in transmission case, then remove rear bearing retainer extension, gasket, and mainshaft assembly from transmission case as shown in Fig. 7A-13.

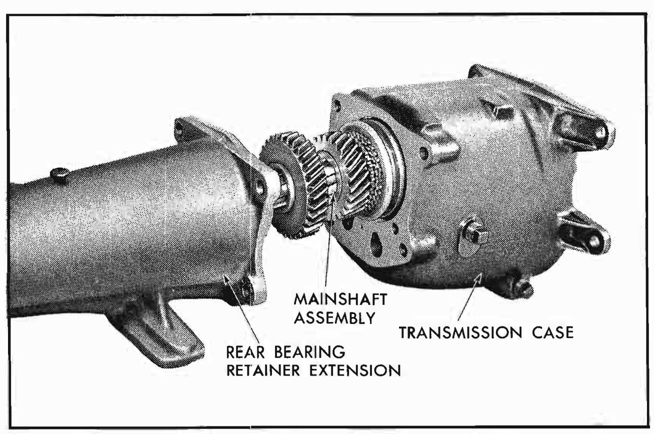
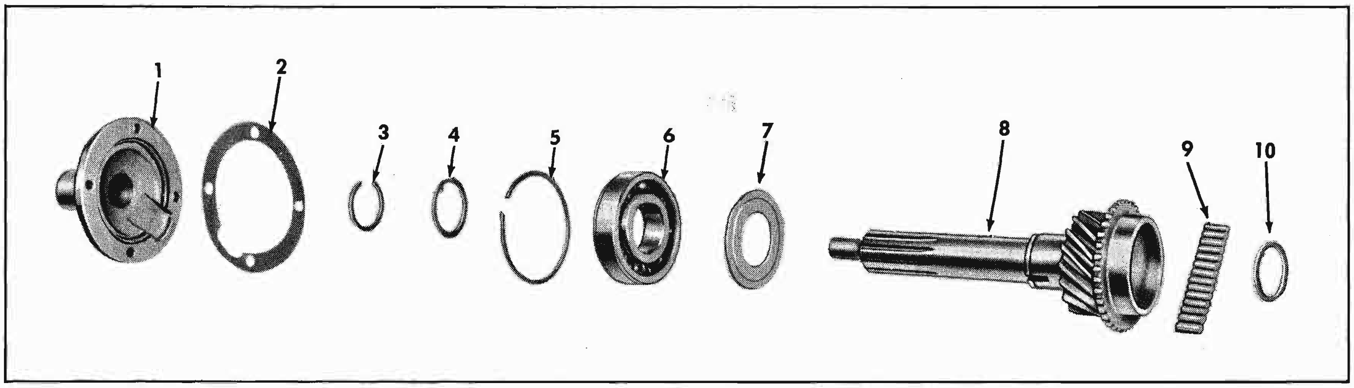


Fig. 7A-13 Removing or Replacing Rear Bearing Retainer and Mainshaft Assembly



1. Main Drive Gear Bearing Retainer
2. Bearing Retainer Gasket
3. Main Drive Gear Snap Ring
4. Main Drive Gear Washer
5. Main Drive Gear Bearing Snap Ring
6. Main Drive Gear Bearing
7. Oil Retaining Washer
8. Main Drive Gear
9. Mainshaft Front Roller Bearings
10. Bearing Spacing Washer

Fig. 7A-14 Exploded View of Main Drive Gear with Retainer and Gasket

8. Remove 14 mainshaft front roller bearings from inside the main drive gear (Fig. 7A-14).

9. Remove bearing spacing washer from front end of mainshaft (Fig. 7A-14).

10. Remove four cap screws and lock washers securing main drive gear bearing retainer to case. Remove bearing retainer and gasket (Fig. 7A-15).

11. Remove main drive gear snap ring and washer from main drive gear at front side of main drive gear bearing, using snap ring pliers. Place transmission case on end on arbor press bed and press main drive gear out of bearing.

12. Remove oil retaining washer from main drive gear.

13. Tap the main drive gear bearing out through front of case and remove main drive gear bearing snap ring from outside diameter of shaft.

14. Using ½″ brass drift, drive reverse idler gear shaft to rear of case until lock key can be removed.

15. Remove lock key and, from rear of case, drive idler gear shaft into case.

16. Remove reverse idler gear and shaft from transmission case.

17. Remove countergear assembly and thrust washers from transmission case.

18. Remove tool J-5589 from countergear and remove the 80 roller bearings, four bearing retaining washers and bearing spacer from inside the countergear (Fig. 7A-16).

19. Remove synchronizing ring from front side of 2nd and 3rd speed clutch sleeve. Remove clutch hub retaining snap ring from front end of mainshaft, using snap ring pliers as shown in Fig. 7A-17.

NOTE: If relationship of 2nd and 3rd speed clutch sleeve and 2nd and 3rd speed clutch hub are not marked, mark them for assembly purposes.

20. Remove 2nd and 3rd speed clutch sleeve from clutch hub and remove clutch hub from mainshaft (Fig. 7A-18).

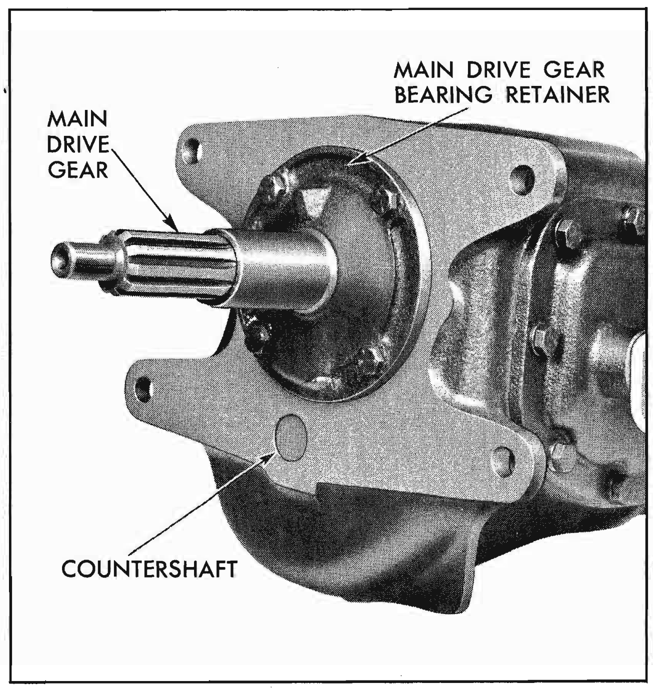
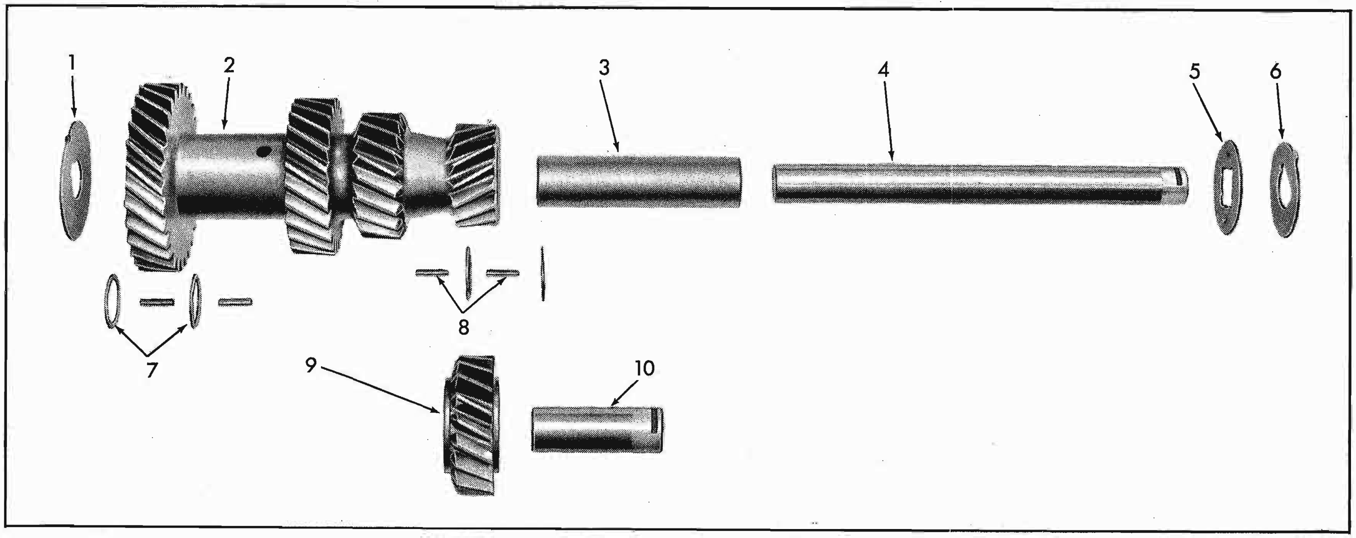


Fig. 7A-15 Main Drive Gear and Bearing Retainer



1. Front Thrust Washer (Bronze)
2. Countergear
3. Countershaft Bearing Spacer
4. Countershaft
5. Rear Thrust Washer (Bronze)
6. Rear Thrust Washer (Steel)
7. Countershaft Bearing Retainer Washers
8. Countershaft Roller Bearings
9. Reverse Idler Gear
10. Reverse Idler Gear Shaft

Fig. 7A-16 Exploded View of Countergear Assembly with Reverse Idler Gear and Shaft

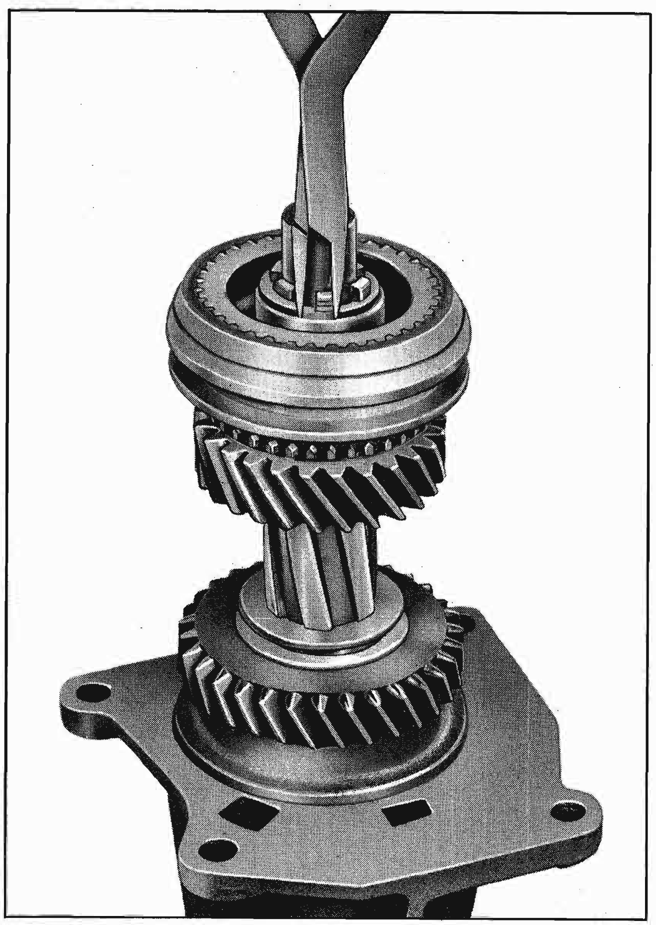


Fig. 7A-17 Removing or Replacing Mainshaft Snap Ring

21. Remove two clutch key springs and three clutch keys from clutch hub (Fig. 7A-19).

22. Remove rear synchronizing ring and second speed gear from mainshaft.

23. Remove first and reverse sliding gear from mainshaft.

24. Remove speedometer driven gear lock plate to extension bolt and lock washer and remove lock plate.

25. Insert screwdriver in lock plate slot in fitting and pry fitting, gear and shaft from extension.

26. Remove mainshaft rear bearing front snap ring from rear bearing retainer extension and, using soft hammer, tap mainshaft and rear bearing out of retainer extension.

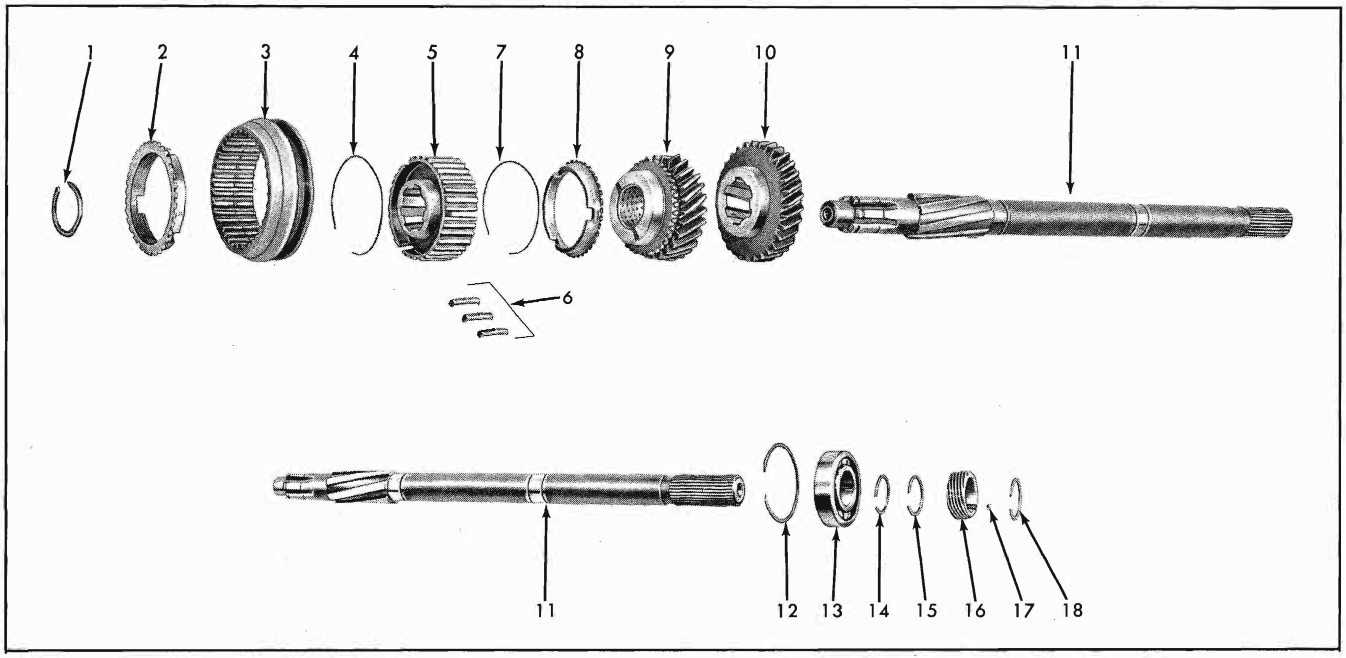
27. Remove snap ring from rear of speedometer drive gear.

28. Remove speedometer drive gear, detent ball and front speedometer drive gear snap ring.

29. Remove mainshaft rear bearing rear snap ring.

30. Using arbor press, press mainshaft rear bearing toward rear of shaft until loose and remove.

31. Using punch or other suitable tool, loosen oil seal from rear bearing retainer extension and remove.



1. Snap Ring
2. Front Synchronizer Ring
3. 2nd and 3rd Speed Clutch Sleeve
4. Clutch Key Spring
5. Clutch Hub
6. Clutch Keys
7. Clutch Key Spring
8. Rear Synchronizer Ring
9. Second Speed Gear
10. First and Reverse Sliding Gear
11. Mainshaft
12. Mainshaft Rear Bearing Front Snap Ring
13. Mainshaft Rear Bearing
14. Mainshaft Rear Bearing Rear Snap Ring
15. Speedometer Drive Gear Front Snap Ring
16. Speedometer Drive Gear
17. Detent Ball
18 Speedometer Drive Gear Rear Snap Ring

Fig. 7A-18 Mainshaft and Gears—Exploded View

CLEANING AND INSPECTION

TRANSMISSION CASE AND REAR BEARING RETAINER EXTENSION

1. Wash the transmission case and rear extension thoroughly inside and out with cleaning solvent, then inspect them for cracks.

2. Check the front and rear faces for burrs or nicks and, if any are evident, dress them off with a fine cut mill file.

3. Check bearing and shaft bores in case and, if damaged, replace case.

BALL BEARINGS

1. Wash all bearings thoroughly in cleaning solvent, then blow bearings dry with compressed air.

CAUTION: Do not allow bearings to spin, but turn them slowly by hand. Allowing bearings to spin may damage the race and balls.

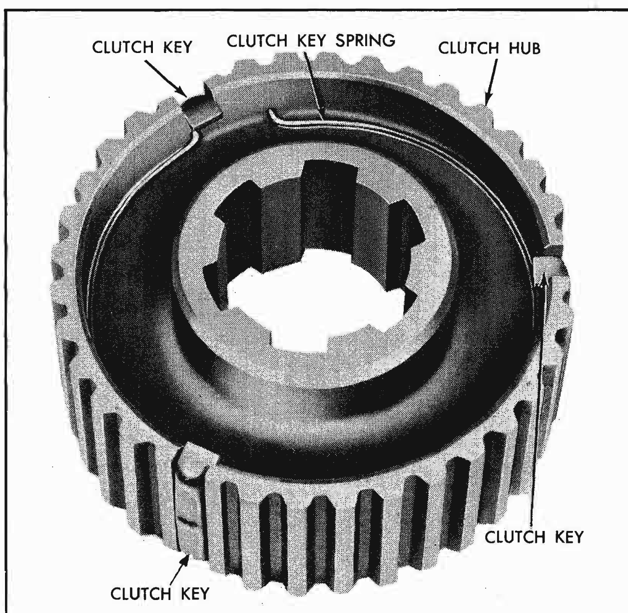


Fig. 7A-19 Clutch Keys and Synchronizer Springs Installed in Clutch Hub

2. After cleaning bearings, lubricate them with light engine oil and check for roughness by slowly turning the outer race by hand.

GEARS

1. Inspect teeth of all gears for excessive wear, chips, or cracks, and replace any that are not in good condition.

2. Inspect bushings in second speed gear and reverse idler gear for wear or damage. If either bushing is worn or damaged, replace the complete gear assembly. Bushings are never serviced separately.

3. Check first and reverse sliding gear for freedom of movement on the mainshaft.

4. Check the 2nd and 3rd speed clutch sleeve to see that it slides freely on the clutch hub.

NEEDLE ROLLER BEARINGS AND THRUST WASHERS

1. Closely inspect the 14 mainshaft front roller bearings and 80 countergear roller bearings for excessive wear and, if wear is indicated, replace.

2. Check bronze and steel countergear thrust washers to see that tangs are not bent or distorted.

SYNCHRONIZER RINGS

1. Check 2nd and 3rd speed clutch synchronizer rings for wear, roughness, or damage and replace if necessary.

TRANSMISSION—ASSEMBLE

MAINSHAFT ASSEMBLY—ASSEMBLE AND INSTALL

1. From rear of mainshaft, slide rear bearing on shaft and press into place, using suitable split plates in an arbor press.

2. Install mainshaft rear bearing rear snap ring in groove in mainshaft.

3. Install speedometer drive gear front snap ring in groove in mainshaft.

4. Slide speedometer drive gear on shaft from rear, positioning detent ball in detent hole in shaft. Line up inner groove of speedometer drive gear with detent ball and position gear over ball.

5. Install speedometer drive gear rear snap ring in groove in mainshaft.

6. Install mainshaft through front opening of rear bearing retainer extension and, with soft hammer, tap front end of mainshaft until rear bearing clears front snap ring groove in retainer extension.

7. Secure mainshaft and rear bearing in place by installing rear bearing front snap ring in groove of retainer extension.

8. Coat new oil seal with sealing compound and start straight in bore of rear extension. Using installer J-5154-A, tap seal into counterbore.

9. Install first and reverse sliding gear, shift hub forward, over front end of mainshaft.

10. Install second speed gear, hub forward, over front end of mainshaft.

11. Assemble clutch key springs in 2nd and 3rd speed clutch hub, with one end of each spring positioned in the same slot and the other end free, and place the three clutch keys in their respective slots in hub (Fig. 7A-19).

12. Install 2nd and 3rd speed clutch sleeve on clutch hub, aligning marks made during disassembly.

13. Place synchronizing ring on rear, or shoulder side, of the sleeve and hub assembly, making certain slots in ring are aligned with clutch keys.

NOTE: A light lubricant applied to inner surface of synchronizing rings will help prevent rings from locking up during final assembly.

14. Install sleeve, hub, and synchronizing ring assembly on mainshaft, clutch sleeve shoulder to rear, and secure with clutch hub retaining snap ring (Fig. 7A-17).

15. Install bearing spacing washer on pilot at front end of mainshaft.

COUNTERGEAR—ASSEMBLE AND INSTALL

1. Place countergear bearing spacer and countergear bearing loader J-5589 inside the countergear.

2. At one end of countergear, install one row of 20 roller bearings, laying them over bearing loader J-5589 and seating them against bearing spacer (Fig. 7A-20).

3. Install bearing retainer washer.

4. Install second row of 20 roller bearings over bearing loader J-5589.

5. Install bearing retainer washer on outer end of countergear.

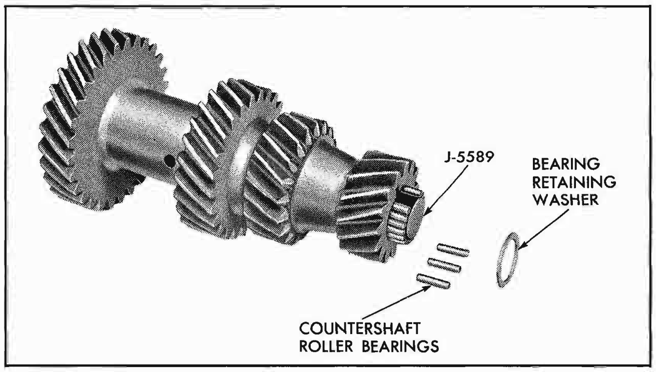


Fig. 7A-20 Installing Roller Bearings in Countergear

6. At other end of countergear, repeat installation procedures 2 through 5 above, being careful not to dislodge bearings from their respective position.

7. Place large bronze thrust washer at front end of countergear, tang facing out so that it will seat in groove at front of case. Retain with heavy grease.

8. Place smaller bronze thrust washer against rear of countergear, tangs facing gear and seated in grooves. Retain with grease (Fig. 7A-16).

9. Through side cover opening in transmission case, insert countergear assembly, large gear end toward front of case. Rest countergear assembly on bottom of case.

10. Place steel thrust washer at rear of countergear between bronze thrust washer and case, positioning tang on steel thrust washer in groove in case.

MAIN DRIVE GEAR—ASSEMBLE AND INSTALL

1. Install oil retaining washer (Fig. 7A-14), on main drive gear, depressed side up.

2. Tap main drive gear bearing on shaft, snap ring groove to front, using tool J-6133-A.

3. Install main drive gear washer against bearing inner race and secure in place by installing main drive gear snap ring in groove provided in drive gear.

4. From inside case, push main drive gear assembly through opening in front face of case. Using soft hammer, tap assembly from rear until bearing attains proper position for installation of snap ring.

CAUTION: Make certain assembly is driven straight to prevent damage to bearing.

5. Install snap ring in groove of bearing and tap front end of shaft until snap ring rests firmly against face of case.

6. Position main drive gear bearing retainer over main drive gear and flush against drive gear bearing outer race. Using feeler gauge, check clearance between bearing retainer bolting flange and transmission case to determine thickness of gaskets required to form a seal.

NOTE: Gaskets are available in thicknesses of .010" and .015".

7. Remove bearing retainer, select gasket combination of proper thickness, and install gaskets and bearing retainer, making certain oil groove in retainer is lined up with oil outlet hole in case.

8. Apply suitable sealing compound to threads of four retainer to case cap screws and insert cap screws and lock washers. Tighten 12-15 lb. ft. torque.

9. Position reverse idler gear in rear of case, chamfer on teeth toward front and, from rear, start idler gear shaft through case and gear.

10. Place lock key in notch at rear of idler gear shaft, then drive shaft into case until lock key seats against cutout in case and shaft is flush with rear of case.

11. Coat bore at rear end of main drive gear with heavy lubricant and insert the 14 roller bearings in bore (Fig. 7A-14).

12. Place new rear bearing retainer extension gasket on front end of extension.

13. Lightly lubricate inner surface of front synchronizing ring and install on hub of main drive gear, positioning one clutch key slot so that it is visible from side opening in case.

14. On top of 2nd and 3rd speed clutch sleeve, mark position of one clutch key with red lead, and align mark with clutch key slot in synchronizing ring.

15. Carefully install mainshaft and extension assembly through opening in rear of case (Fig. 7A-13), making certain front end of mainshaft enters roller bearings at rear of main drive gear and mark on clutch sleeve lines up with slot in synchronizing ring.

CAUTION: Extreme care should be taken when installing mainshaft to prevent roller bearings from being forced into lubricant opening in drive gear.

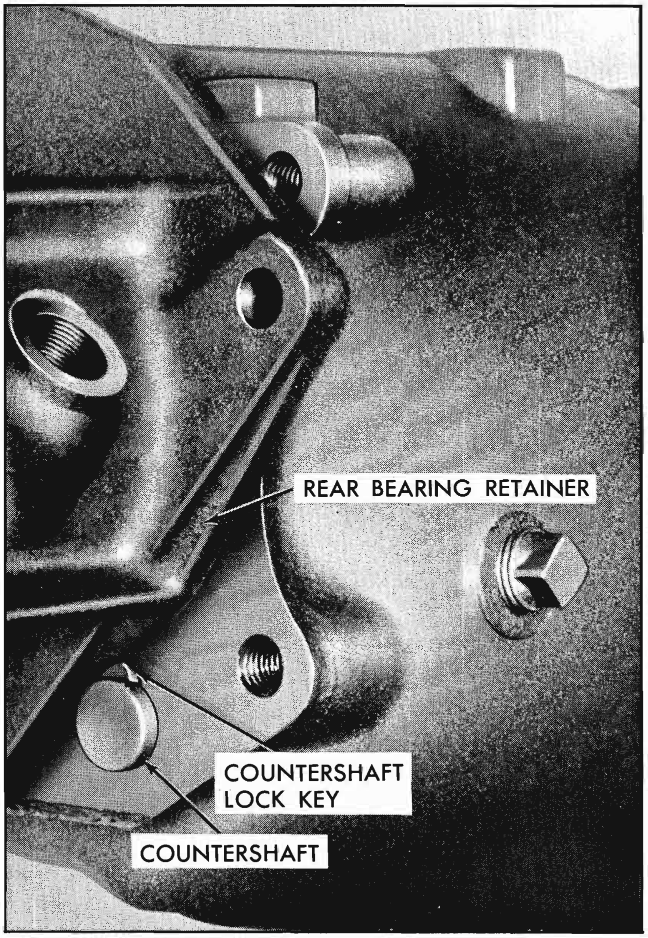


Fig. 7A-21 Rear Bearing Retainer Rotated

16. Sit transmission on its top side to assist in correctly positioning countergear and to help align countergear with shaft opening in case.

NOTE: Rotating main drive gear back and forth will help in aligning countergear thrust washers with shaft opening in case.

17. With rear bearing retainer extension rotated as shown in Fig. 7A-21, insert countershaft through exposed shaft opening in rear of case, making certain the shaft passes through both thrust washers before it enters countergear.

18. Using soft hammer, tap countershaft through countergear, forcing tool J-5589 out opening at front of case.

19. Before countershaft is driven fully into place, install lock key in notch at rear of shaft, then drive shaft in until lock key seats against cutout in case.

20. Align mainshaft rear bearing retainer extension and gasket with transmission case.

21. Apply suitable sealer to threads of four extension to case cap screws and install cap screws and lock washers and finger tighten.

22. Check both synchronizing rings through side opening in case, to insure freedom of movement, and then tighten cap screws 55-60 lb. ft. torque.

23. Install speedometer driven gear and fitting in extension housing as outlined under SPEEDOMETER DRIVEN GEAR–REPLACE, steps 1 through 4.

24. If transmission side cover is disassembled, assemble as outlined under TRANSMISSION SIDE COVER–ASSEMBLE, steps 1 through 6.

25. Install side cover assembly on transmission as outlined under TRANSMISSION SIDE COVER–REPLACE, steps 1 through 4.

26. Install clamp, bracket and insulator assembly on rear extension.

TRANSMISSION—INSTALL IN VEHICLE

1. Raise transmission, aligning with rear of clutch housing and insert aligning studs J-1126 in upper transmission to clutch housing bolt holes.

2. Support transmission and install frame cross member support.

3. Install two lower transmission to clutch housing bolts and tighten 45-60 lb. ft. torque.

4. Remove aligning studs and install two upper transmission to clutch housing bolts and tighten 45-60 lb. ft. torque.

5. Install two transmission extension bracket to cross member retaining nuts. Tighten to 25-35 lb. ft. torque.

6. Connect shifter rods to shifter levers (Fig. 7A-22).

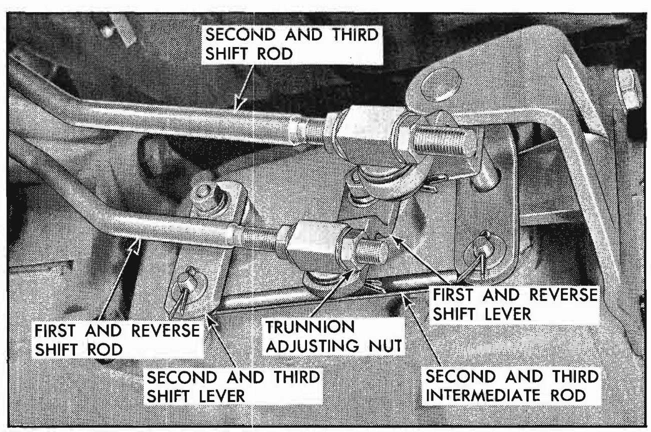


Fig. 7A-22 Proper Assembly of Shift Rods to Shift Levers

7. Connect speedometer cable to speedometer driven gear fitting.

8. Install propeller shaft drive line assembly by reversing steps a. through c. under TRANSMISSION —REMOVE FROM VEHICLE.

9. Remove filler plug at side of transmission and add 2.8 pints of SAE 80 "Multi-purpose Gear Lubricant." Lubricant level should be approximately level with bottom of filler plug hole.

TROUBLE DIAGNOSIS AND TESTING

TROUBLE	REMEDY
SLIPS OUT OF HIGH GEAR	
a. Transmission loose on clutch housing.	a. Tighten mounting bolts.
b. Shifter rods interfere with engine mounts or clutch throw-out lever.	b. Replace or bend levers and rods to eliminate interference.
c. Shifter linkage does not work freely, binds.	c. Adjust and free up shift linkage. Torque reactions of engine should not cause the lever on transmission to move. The movement of transmission with respect to body and frame should be transferred to the control linkage.
d. Does not fully engage.	d. Measure length of engagement pattern on clutching teeth. If less than $7/64''$, check for bent levers, shifter shafts, detent cam plates, control rods and other shift linkage. Replace or straighten parts.
e. Damaged mainshaft pilot bearing.	e. Replace pilot bearing.
f. Main drive gear bearing retainer broken or loose.	f. Tighten or replace main drive gear bearing retainer.
g. Dirt between transmission case and clutch housing.	g. Clean mating surfaces.
h. Misalignment of transmission.	h. Shim between transmission case and clutch housing.
SLIPS OUT OF LOW AND/OR REVERSE	
a. First and/or reverse gears damaged from operating at part engagement.	a. Determine cause, for example, worn shift fork and control lever or rod interference. Replace worn or bent parts.
b. Improper mated splines on inside of first and reverse sliding gear and/or external splines on 2nd and 3rd speed clutch.	b. Replace 2nd and 3rd speed clutch and/or first and reverse sliding gear. Possible correction is to change index of gear on clutch approximately 180° and/or turning the rear side of first and reverse gear to the front of the transmission.
c. Improperly adjusted linkage.	c. Adjust linkage.
NOISY IN ALL GEARS	
a. Insufficient lubricant.	a. Fill to correct level.
b. Worn countergear bearings.	b. Replace countergear bearings and shaft.

TROUBLE	REMEDY
NOISY IN ALL GEARS (Continued)	
c. Worn or damaged main drive gear and countergear.	c. Replace worn or damaged gears.
d. Damaged main drive gear or mainshaft ball bearings.	d. Replace damaged bearings or main drive gear.
e. Damaged speedometer gears.	e. Replace damaged gears.
NOISY IN HIGH GEAR	
a. Damaged main drive gear bearing.	a. Replace damaged bearing.
b. Damaged mainshaft bearing.	b. Replace damaged bearing.
c. Damaged speedometer gears.	c. Replace speedometer gears.
NOISY IN NEUTRAL WITH ENGINE RUNNING	
a. Damaged main drive gear bearing.	a. Replace damaged bearing.
b. Damaged mainshaft bearing.	b. Replace damaged bearing.
NOISY IN ALL REDUCTION GEARS	
a. Insufficient lubricant.	a. Fill to correct level.
b. Worn or damaged main drive gear or countergear.	b. Replace faulty or damaged gears.
NOISY IN SECOND ONLY	
a. Damaged or worn second speed constant mesh gears.	a. Replace damaged gears.
b. Worn or damaged countergear rear bearings.	b. Replace countergear bearings and shaft.
NOISY IN LOW AND REVERSE ONLY	
a. Worn or damaged first and reverse sliding gear.	a. Replace worn gear.
b. Damaged or worn low and reverse countergear.	b. Replace countergear assembly.
NOISY IN REVERSE ONLY	
a. Worn or damaged reverse idler gear.	a. Replace reverse idler gear assembly.
b. Worn reverse idler bushings.	b. Replace reverse idler gear assembly.
c. Damaged or worn reverse countergear.	c. Replace countergear assembly.
EXCESSIVE BACKLASH IN SECOND ONLY	
a. Second speed gear thrust washer worn.	a. Replace thrust washer.
b. Mainshaft rear bearing not properly installed in case.	b. Replace bearing, lock or case as necessary.
c. Worn countergear rear bearing.	c. Replace countergear bearings and shaft.

TROUBLE	REMEDY
EXCESSIVE BACKLASH IN ALL REDUCTION GEARS	
a. Worn countergear bushings.	a. Replace countergear.
b. Excessive end play in countergear.	b. Replace countergear thrust washers.
LEAKS LUBRICANT	
a. Excessive amount of lubricant in transmission.	a. Drain to correct level.
b. Loose or broken main drive gear bearing retainer.	b. Tighten or replace retainer.
c. Main drive gear bearing retainer gasket damaged.	c. Replace gasket.
d. Cover loose or gasket damaged.	d. Tighten cover or replace gasket.
e. Operating shaft seal leaks.	e. Replace operating shaft seal.
f. Idler shaft expansion plugs loose.	f. Replace expansion plugs.
g. Countershaft loose in case.	g. Replace case.

TRANSMISSION SPECIFICATIONS

The transmission face, clutch housing and block are accurately squared in production so that each unit may be interchanged as necessary. Special alignment of these assemblies is not necessary if they are installed properly.

Shift Positions	Gear Ratios
Low	2.49 to 1
Second	1.59 to 1
Third	1.00 to 1
Reverse	3.15 to 1
Lubricant Capacity	2.8 pints

TORQUE SPECIFICATIONS

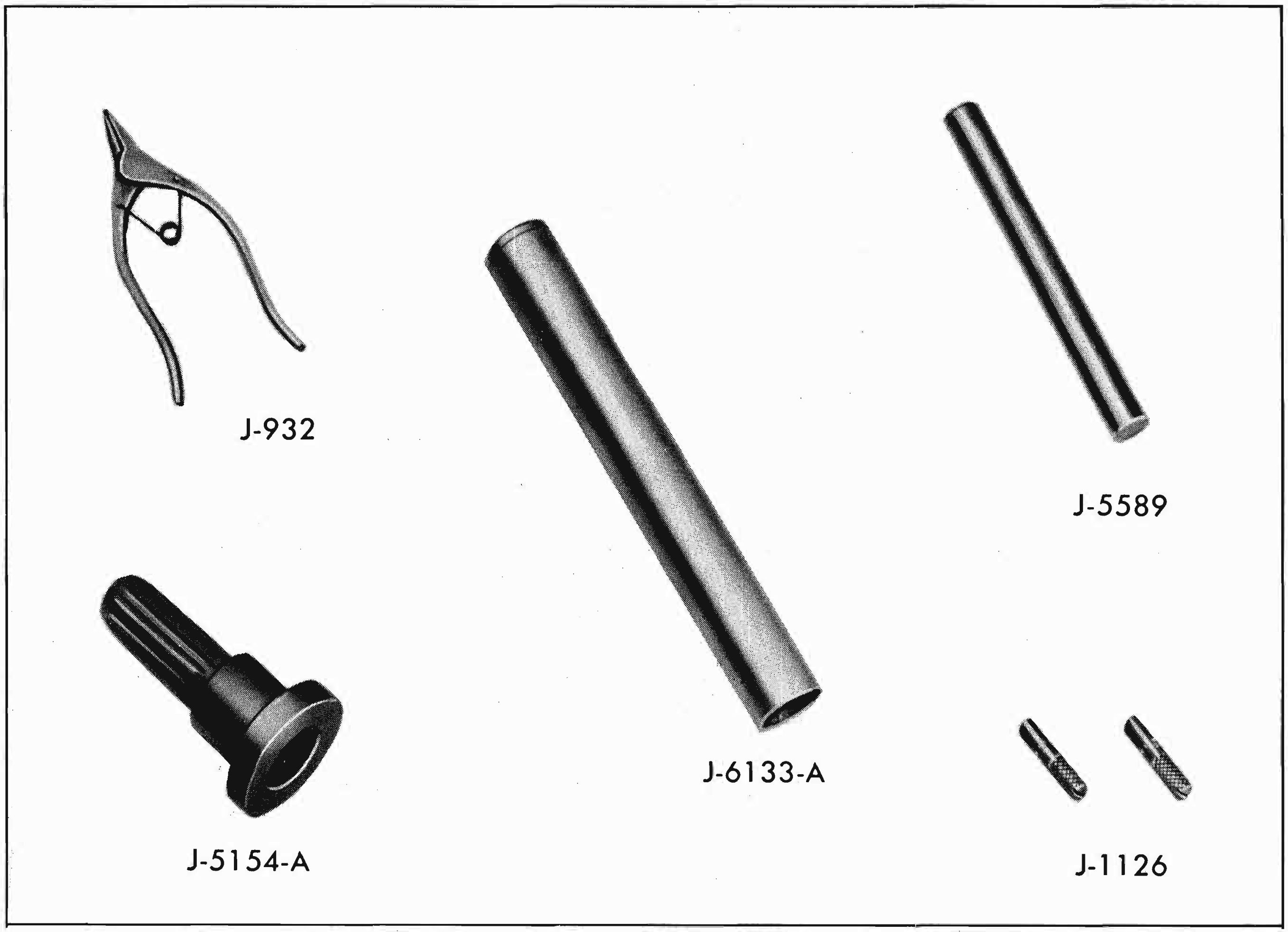
	Lb. Ft.
Screw Assembly (Speedometer clamp)	3-5
Main Drive Gear Bearing Retainer Bolts	12-15
Side Cover Bolts	12-15
Rear Bearing Retainer Extension Bolts	55-60
Drain Plug	25-35
Filler Plug	25-35
Rear Clamp Support to Transmission Bolt	20-30
Rear Bracket Support to Cross Member Nuts	25-35
Insulator Assembly to Support Bracket	25-35

SPEEDOMETER GEAR USAGE CHART
HEAVY DUTY 3 SPEED SYNCHRO-MESH TRANSMISSION WITH 8.00 x 14 TIRES

	Speedometer Sleeve Assy.		Speedometer Drive Joint (Adapter)
Rear Axle Ratio	Ratio	Color	Ratio
41:9 (4.55)	19:8	Lt. Green	.6944
43:10 (4.30)	19:8	Lt. Green	.7333
41:10 (4.10)	19:8	Lt. Green	.7692
39:10 (3.90)	22:8	Yellow	Not Required
40:11 (3.64)	21:8	Red	Not Required
41:12 (3.42)	20:8	Blue	Not Required
42:13 (3.23)	19:8	Lt. Green	Not Required
40:13 (3.08)	18:8	Brown	Not Required

Fig. 7A-23 Speedometer Gear Usage Chart

SPECIAL TOOLS



J-932	Snap Ring Pliers
J-1126	Aligning Studs
J-5154-A	Transmission Extension Oil Seal Installer
J-5589	Countershaft Needle Bearing Loader
J-6133-A	Main Drive Gear Bearing Installer

Fig. 7A-24 Three-Speed Heavy Duty Transmission Special Tools

FOUR-SPEED TRANSMISSION AND SHIFT LINKAGE

CONTENTS OF THIS SECTION

DESCRIPTION

The four-speed synchro-mesh transmission (Fig. 7B-1) is available only on special order and is engineered to operate on all Pontiac models. It consists of two basic sections; the transmission case, or forward section, and the case extension, or rear section. The forward section contains the four forward speed gear assemblies, clutch assemblies and synchronizing mechanisms, while the rear section contains the reverse gear assembly.

Gearshifting is manual through a floor-type gearshift lever which activates shift control rods connected to the transmission cover shifter levers for first through fourth gears, and to the reverse lever located in the case extension. The shifter lever to the rear of the transmission cover controls the first and second speed gears, while the lever to the front controls the third and fourth speed gears.

All four forward gears are provided with synchronizing clutches which can be engaged while the car is in motion (Fig. 7B-1). Closely spaced gear ratios of 2.54 (first), 1.92 (second), 1.51 (third) and 1.00 (fourth) provide excellent ratio matching with minimum loss of engine speed at the shift points. Reverse gear (2.61 ratio) is not synchronized; therefore, vehicle should be brought to a complete stop before engaging reverse gear.

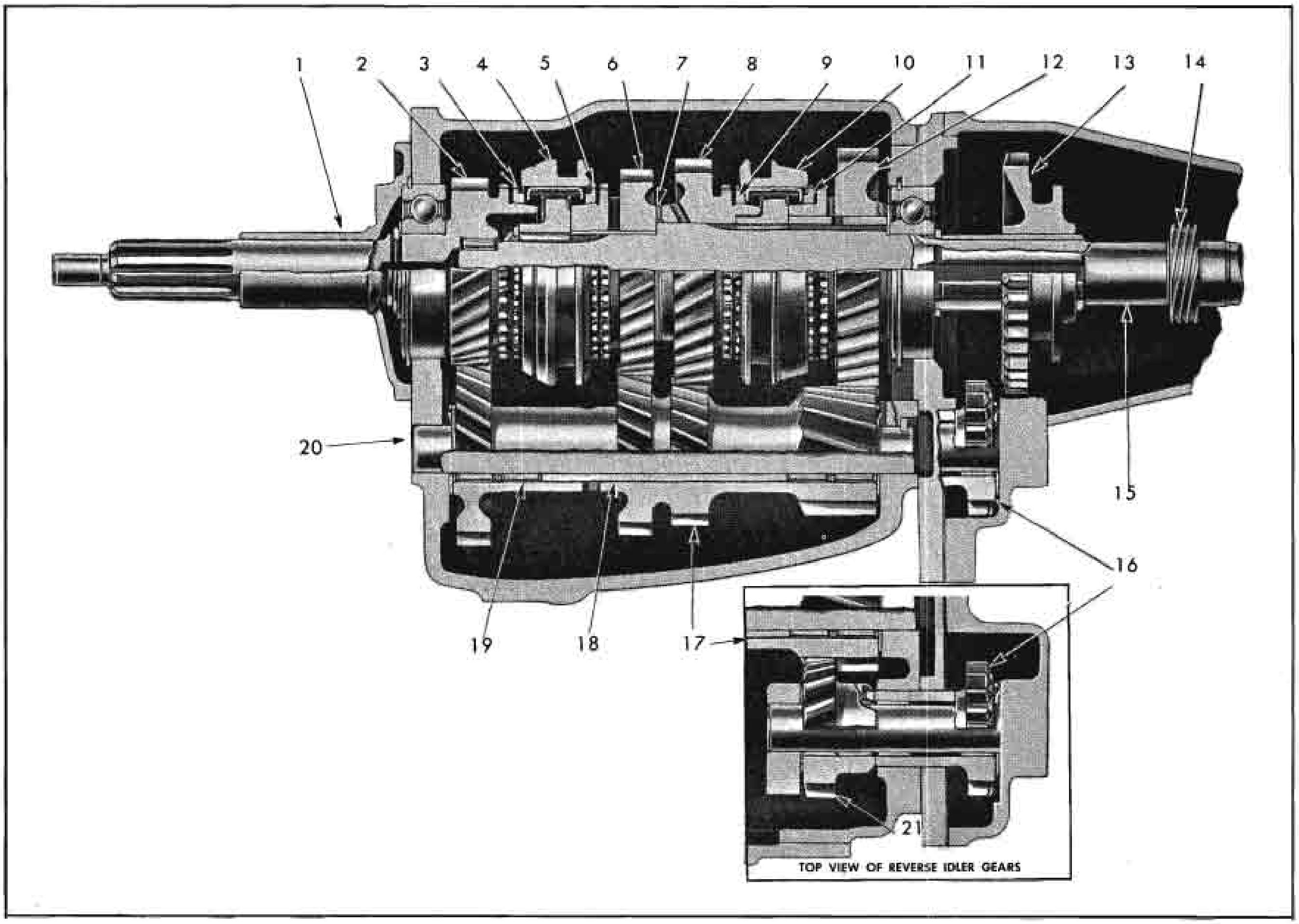
The transmission may be used as an aid in decelerating by downshifting in sequence without double shifting or gear clashing due to all forward speeds being synchronized.

DESIGN

The four-speed transmission incorporates helical gears specially designed to provide high torque capacity without additional weight, and gear teeth proportioned to operate at high speeds with neither excessive heat generation nor excessive frictional losses. Shafts, bearings, high capacity clutches and other precision parts are held to close limits, providing proper clearances necessary for durability during extended heavy usage.

Seven basic gears are utilized in this transmission. They are: main drive gear, third speed gear, second speed gear, first speed gear, reverse gear, countergear and reverse idler gear (front and rear). See Fig. 7B-1.

The front end of the main drive gear is piloted in a single row, prepacked and shielded ball bearing mounted in the engine crankcase, while the rear end



1. Bearing Retainer
2. Main Drive Gear
3. Fourth Speed Synchronizing Ring
4. Third and Fourth Speed Clutch Assembly
5. Third Speed Synchronizing Ring
6. Third Speed Gear
7. Thrust Bearing
8. Second Speed Gear
9. Second Speed Synchronizing Ring
10. First and Second Speed Clutch Assembly
11. First Speed Synchronizing Ring
12. First Speed Gear
13. Reverse Gear
14. Speedometer Drive Gear
15. Mainshaft
16. Reverse Idler Gear (Rear)
17. Countergear
18. Countergear Bearing Roller Spacer
19. Countergear Bearing Roller
20. Countershaft
21. Reverse Idler (Gear) (Front)

Fig. 7B-1 Cross Section of Four-Speed Synchro-Mesh Transmission

is supported by a heavy duty ball bearing located at the front end of the transmission case.

The front end of the mainshaft is piloted in a row of roller bearings set into the hollow end of the main drive gear and the rear end is carried by a heavy duty ball bearing located at the rear end of the transmission case.

The countergear is carried on a double row of roller bearings positioned at both ends of the gear, while thrust is taken on thrust washers located at front and rear of gear.

The two-piece reverse idler gear is carried on press-fit bronze bushings and thrust is taken on thrust washers located between the front of the gear and the back of the reverse idler thrust boss and the rear of the gear and the reverse idler shaft boss in the case extension.

The first, second and third speed gears have press-fit bushings lining their inner bores which enable these gears to float freely on the mainshaft, while the reverse speed gear has splines on its inner bore to prevent the gear from rotating on the mainshaft but allow forward and rearward movement of this gear.

The two clutch assemblies are splined to the mainshaft so that they can impart torque to the mainshaft whenever they engage a rotating gear.

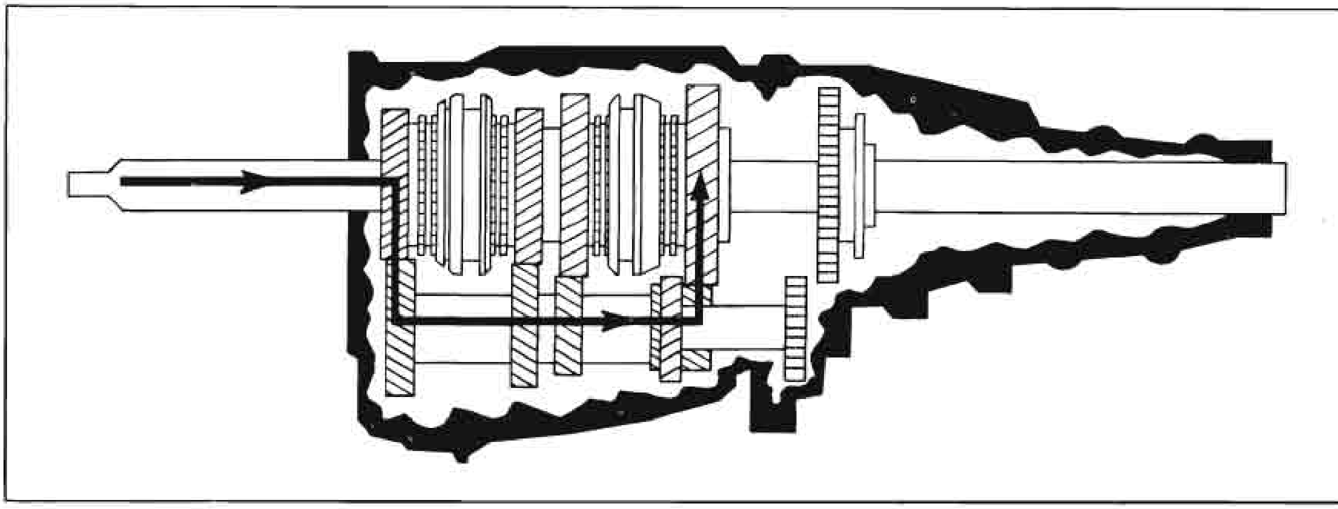


Fig. 7B-2 Four-Speed Synchro-Mesh—Power Flow in Neutral

OPERATION

The main drive gear, third speed gear, second speed gear, first speed gear and reverse idler gears are in constant mesh with the countergear; therefore, with the engine running and the engine clutch engaged, torque is imparted to the main drive gear and through the countergear to the third, second, first, and reverse idler gears at all times.

OPERATION IN NEUTRAL (Fig. 7B-2)

In neutral, with engine clutch engaged, the main drive gear turns the countergear. The countergear then turns the third, second, first, and reverse idler gears. But, because the third and fourth and first and second speed clutch (sleeves) are neutrally positioned, and the reverse speed gear is positioned at the rear, away from the reverse idler gear, power will not flow through the mainshaft.

OPERATION IN FIRST (Fig. 7B-3)

In first speed, the first and second speed clutch (sleeve) is moved rearwards to engage the first speed gear, which is being turned by the countergear. Because the first and second speed clutch (hub) is splined to the mainshaft, torque is imparted to the mainshaft from the first speed gear through the clutch assembly.

OPERATION IN SECOND (Fig. 7B-4)

In second speed, the first and second speed clutch (sleeve) is moved forward to engage the second speed gear, which is being turned by the countergear. This engagement of the clutch (sleeve) with the second speed gear imparts torque to the mainshaft because the first and second speed clutch (hub) is splined to the mainshaft.

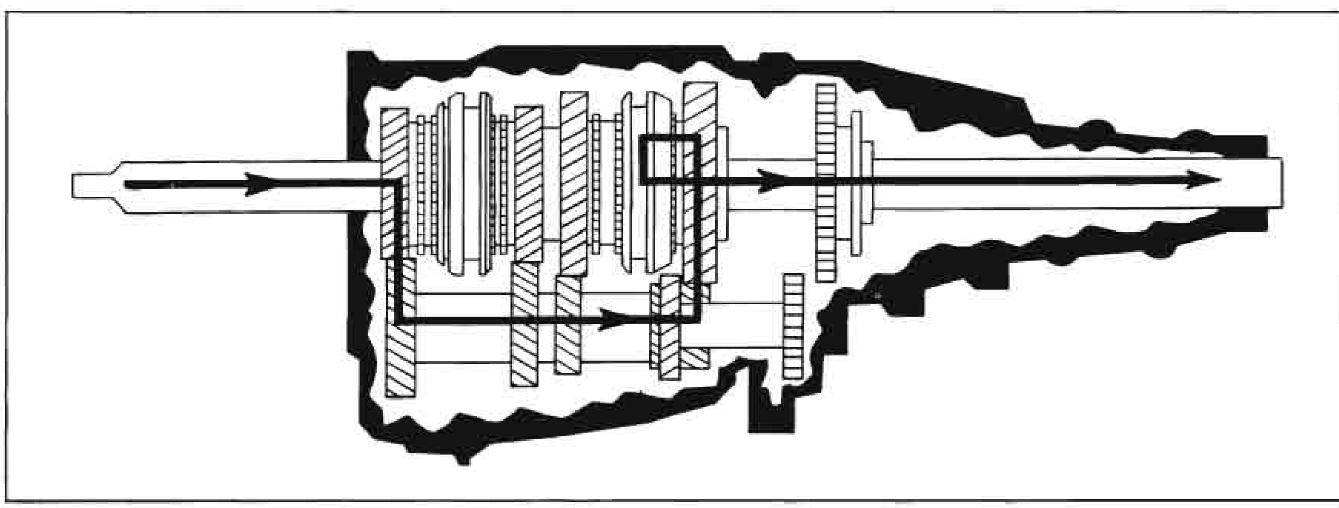


Fig. 7B-3 Four-Speed Synchro-Mesh—Power Flow in First Speed

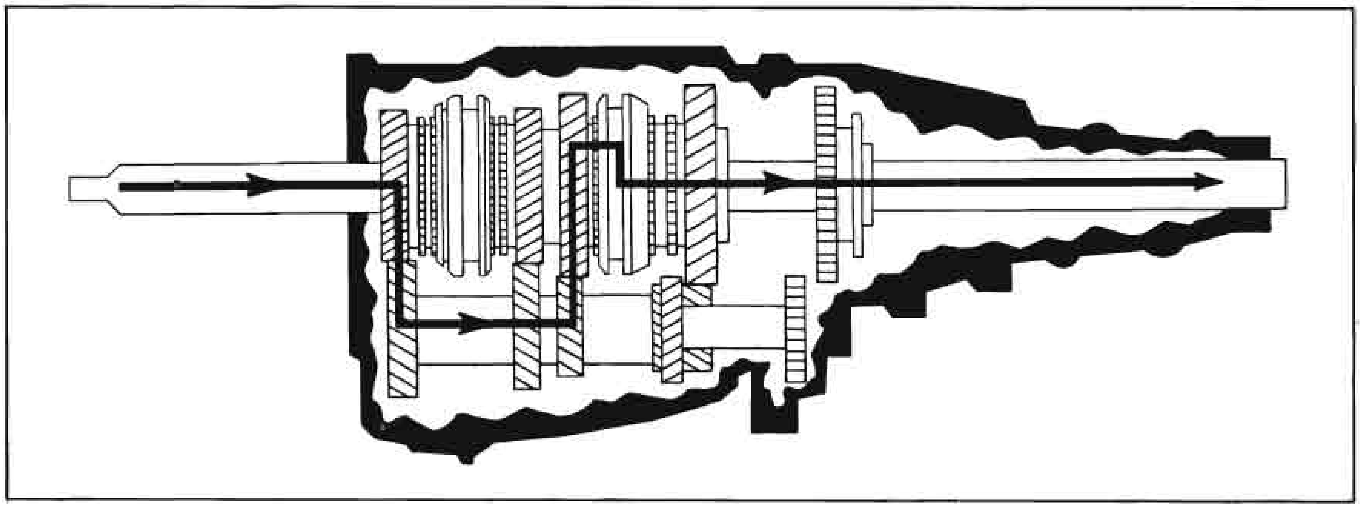


Fig. 7B-4 Four-Speed Synchro-Mesh—Power Flow in Second Speed

OPERATION IN THIRD (Fig. 7B-5)

In third speed, the first and second speed clutch assumes a neutral position. The third and fourth speed clutch (sleeve) moves rearward to engage the third speed gear, which is being turned by the countergear. Because the third and fourth speed clutch (hub) is splined to the mainshaft, torque is imparted to the mainshaft from the third speed gear through the clutch assembly.

OPERATION IN FOURTH (Fig. 7B-6)

In fourth speed, or direct drive, the third and fourth speed clutch (sleeve) is moved forward to engage the main drive gear and the first and second speed clutch remains in a neutral position. This engagement of the main drive gear with the third and fourth speed clutch assembly imparts torque directly to the mainshaft.

OPERATION IN REVERSE (Fig. 7B-7)

In reverse speed, both clutch assemblies assume a neutral position. The reverse speed gear is moved forward to engage the rear reverse idler gear, which is being turned by the countergear. Because the reverse speed gear is splined to the mainshaft, this engagement causes the mainshaft to turn; however, because power flows from main drive gear to countergear and through reverse idler gear to reverse speed gear, the direction of rotation will be opposite that of the engine.

PERIODIC SERVICE

TRANSMISSION

No periodic service of the transmission is required except checking for leaks and proper lubricant level at each 4,000-mile inspection period.

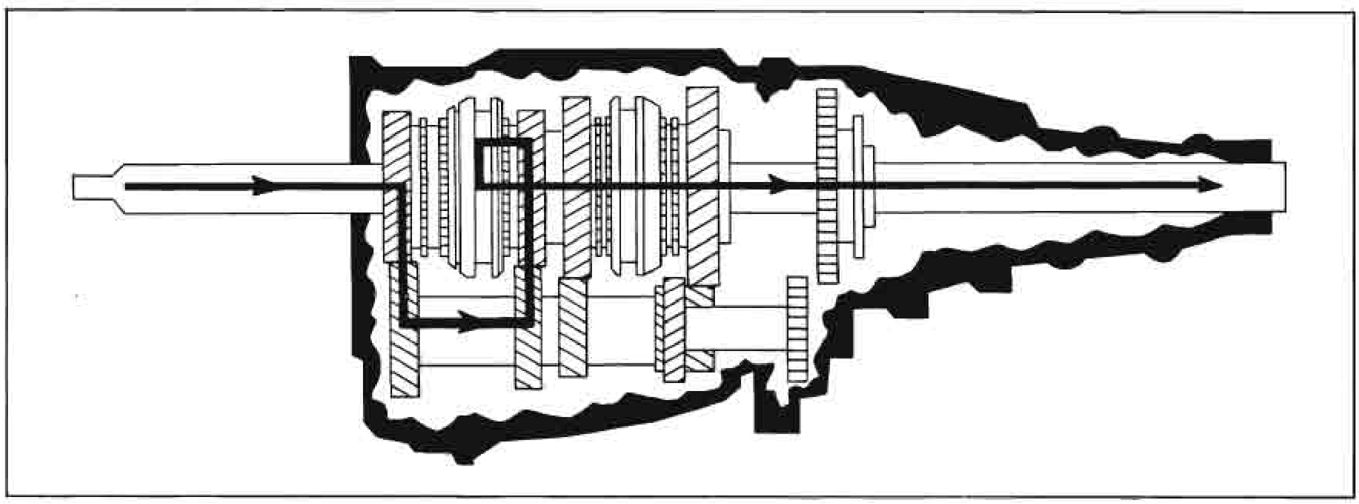


Fig. 7B-5 Four-Speed Synchro-Mesh—Power Flow in Third Speed

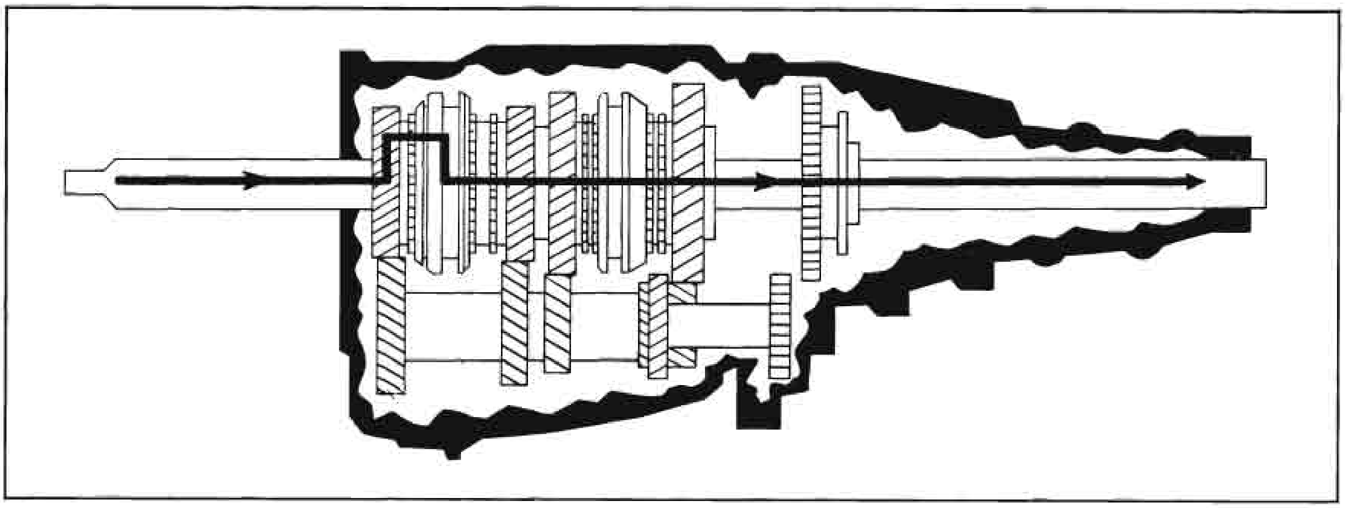


Fig. 7B-6 Four-Speed Synchro-Mesh—Power Flow in Fourth Speed

If there is evidence of leakage, the leak should be corrected and lubricant added, if needed. Refill capacity is 2.5 pints.

Remove filler plug at side of case and add **SAE 80** "Multi-purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole.

SHIFT CONTROL

No periodic service of the shift control is required. Certain parts are lubricated on assembly and require further lubrication only when parts become dry and sticky.

ADJUSTMENTS ON CAR

SHIFT LINKAGE ADJUSTMENT

The four-speed transmission gear shift linkage (Fig. 7B-8) utilizes three shift rods and levers. A simple gauge block, shown in Fig. 7B-9, will aid in making the proper adjustments. The adjustments can be made without the gauge block by having an assistant hold the manual shift lever in the neutral position.

1. Remove transmission gearshift lever seal from floor pan.

2. Place transmission in neutral and, if gauge block is used, position in slot.

3. Remove cotter pin, anti-rattle washer and clevis pin at each shift lever.

4. On each shift rod, adjust the threaded clevis to permit free entry of the clevis pin into the hole in the transmission shift lever.

5. Reconnect the clevises to the shift levers.

6. Remove the gauge block and check the shifts. If any roughness still exists, one of the clevises may

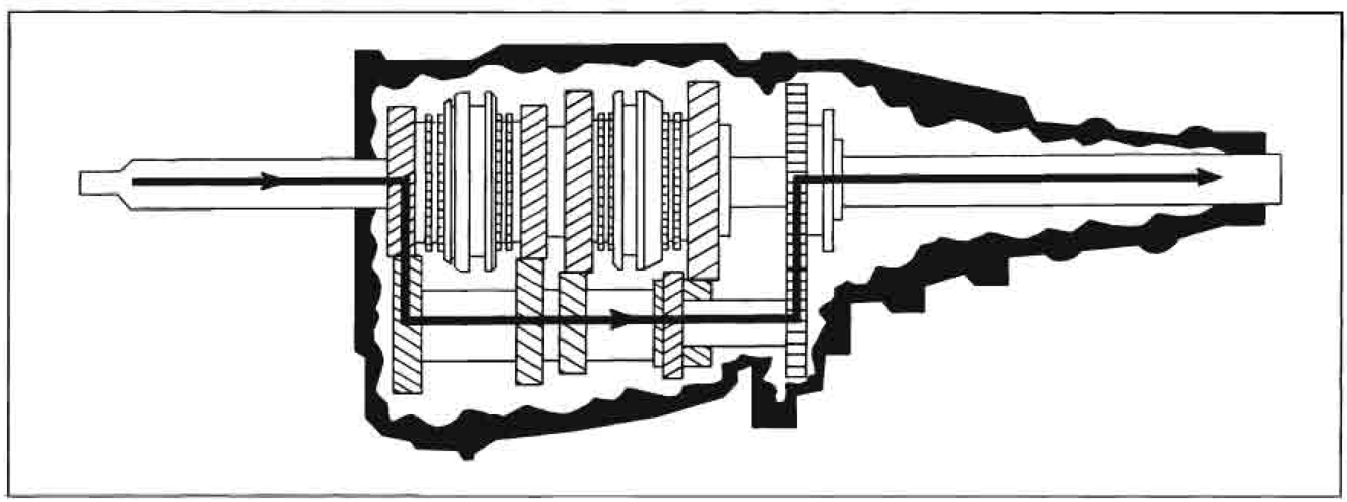


Fig. 7B-7 Four-Speed Synchro-Mesh—Power Flow in Reverse

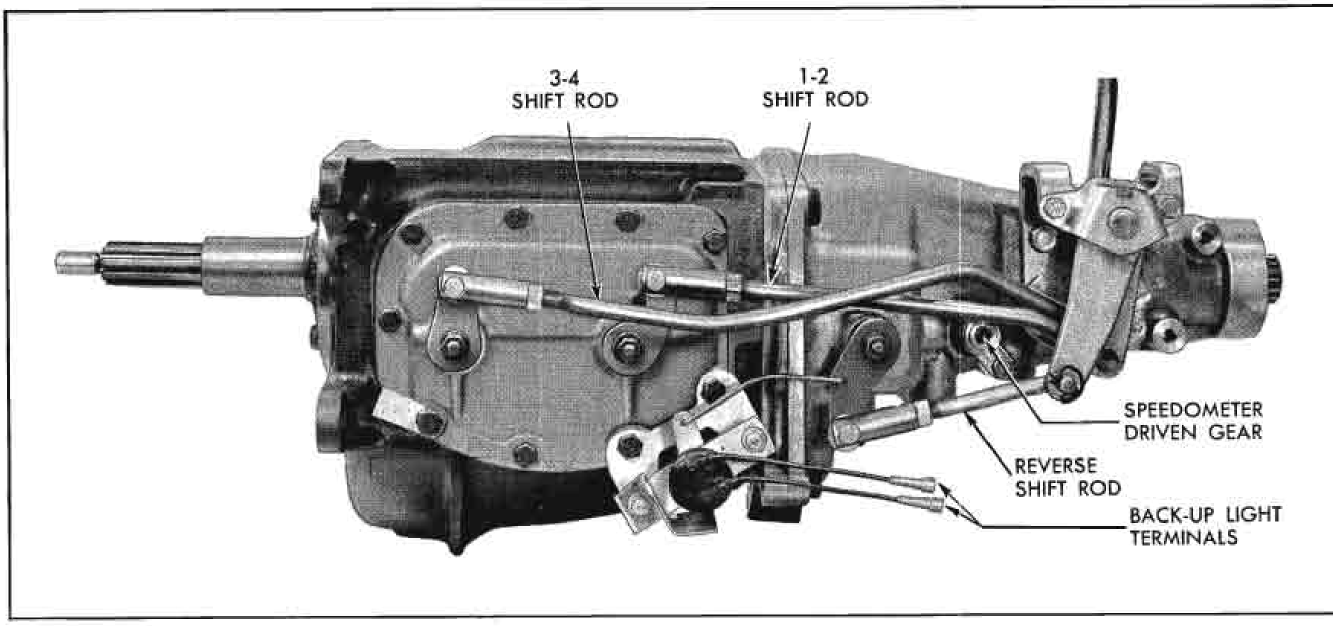


Fig. 7B-8 Four-Speed Synchro-Mesh Transmission—Side View

require adjustment of approximately one-half turn. Determine the rod and clevis requiring adjustment by sighting along the slot where the gauge block was used in Step 2 above.

NOTE: If transmission is to be removed from car, shift linkage should be properly adjusted before transmission is reinstalled.

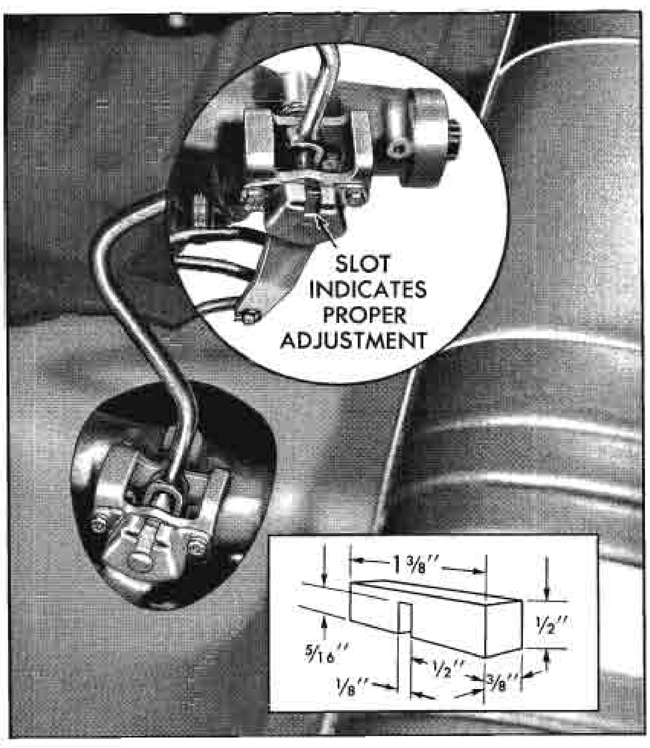


Fig. 7B-9 Shift Linkage Adjustment

MINOR REPAIRS

SPEEDOMETER DRIVEN GEAR—REMOVE

1. Disconnect speedometer cable.

2. Remove retainer to housing bolt and lock washer and remove retainer.

3. Insert screwdriver in slot in fitting and pry fitting, gear and shaft from housing.

4. Pry "O" ring from groove in fitting.

5. Check gear, shaft and fitting for wear and replace, if necessary.

SPEEDOMETER DRIVEN GEAR—REPLACE

1. Install new "O" ring in groove and insert shaft.

2. Hold the assembly so slot in fitting is toward boss on housing and install in housing.

3. Push fitting into housing until retainer can be inserted into groove.

4. Install retainer bolt and lock washer.

5. Connect speedometer cable to speedometer driven gear.

TRANSMISSION EXTENSION OIL SEAL—REMOVE AND REPLACE

To inspect or replace the rear extension oil seal, it is necessary to remove the propeller shaft drive line assembly from the vehicle.

1. Remove "U" bolt nuts, lock plates and "U" bolts from rear axle drive pinion flange.

2. Use suitable rubber band to hold bearings onto journals, if tie wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

3. Slide propeller shaft assembly rearward to disengage yoke from splines on transmission mainshaft.

4. Use punch or other suitable tool and loosen seal from extension and remove.

5. Wash counterbore with cleaning solvent and inspect for damage.

6. Inspect propeller shaft yoke for nicks, burrs or scratches which would cut new seal or cause seal to leak or damage bushing.

7. Coat new seal with sealing compound and press straight in bore of case extension.

8. Install propeller shaft assembly by reversing steps 1 through 3 above.

TRANSMISSION SIDE COVER—REMOVE AND DISASSEMBLE

It is not necessary to remove transmission from vehicle for inspection or replacement of parts in transmission side cover assembly, but the side cover assembly itself must be removed from transmission case.

1. Remove drain plug at bottom of transmission and drain lubricant.

2. Disconnect control rods from levers (Fig. 7B-8).

3. Remove transmission side cover assembly from transmission case.

4. Remove the outer shifter lever nuts and lock washers and pull levers from shafts.

5. Carefully push the shifter shafts into cover, allowing the detent balls to fall free, then remove both shifter shafts.

6. Remove interlock sleeve, interlock pin and poppet spring.

7. Inspect and replace necessary parts.

TRANSMISSION SIDE COVER—ASSEMBLE AND REPLACE

1. Install interlock sleeve and one shifter shaft, positioning shift fork retaining hole toward flat, or top side, of cover.

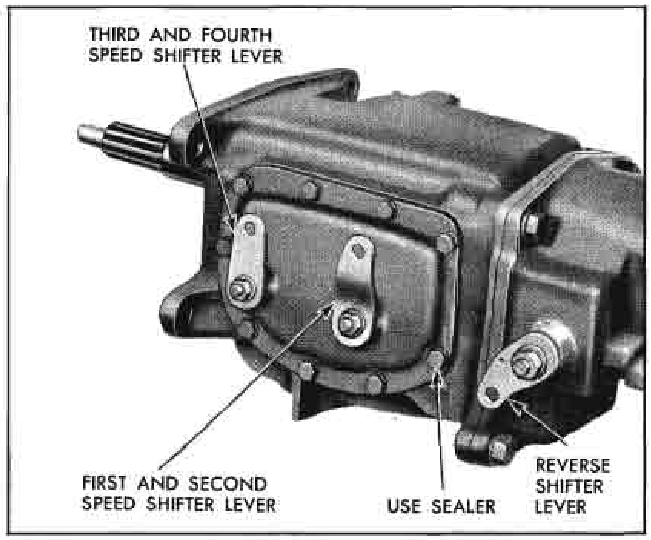


Fig. 7B-10 Sealing Side Cover Attaching Bolt

2. Line up center, or neutral, groove of shifter shaft with interlock sleeve.

3. Place steel detent ball into sleeve followed by poppet spring and interlock pin.

4. Start second shifter shaft into position and place second detent ball on poppet spring. Compress ball and spring with screwdriver and, with center groove lined up with detent ball, push the shifter shaft fully in.

5. Install shifter levers on outer ends of shifter shafts.

6. With transmission in neutral and shifter forks and levers in place, lower side cover into place. Install attaching bolts using sealer on the lower right bolt (Fig. 7B-10) and tighten evenly to 10-20 lb. ft. torque.

7. Remove filler plug at side of transmission and add 2.5 pints of SAE 80 "Multi-Purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole.

MAJOR REPAIRS

TRANSMISSION—REMOVE AND OVERHAUL

1. Remove drain plug at bottom of transmission and drain lubricant.

2. Remove six metal boot retainer to floor plate attaching screws (Fig. 7B-11), and slide boot over shift stick.

3. Disconnect the speedometer cable from speedometer driven gear fitting and disconnect back-up light leads from back-up light switch (Fig. 7B-8).

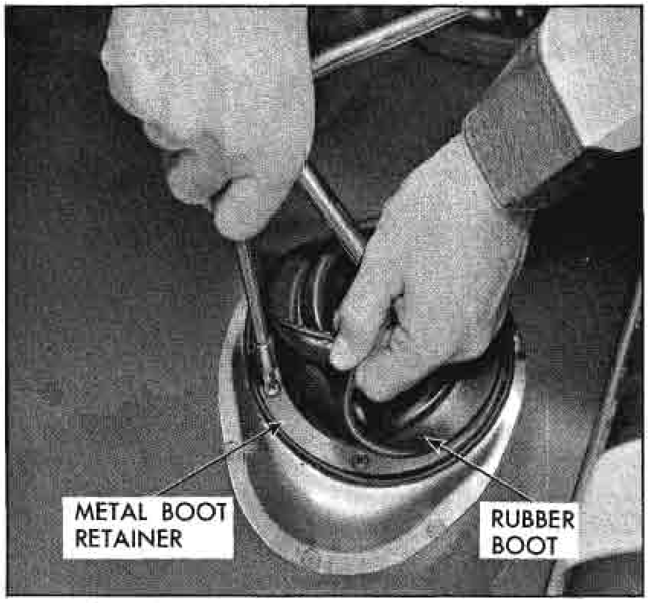


Fig. 7B-11 Removing Rubber Boot and Retainer

4. Disconnect shift control rods from shifter levers. Remove three shift bracket to extension screws and remove manual shift lever and bracket.

5. Remove propeller shaft drive line assembly.

a. Remove "U" bolt nuts, lock plates and "U" bolts from rear axle drive pinion flange.

b. Use a suitable rubber band to hold bearing onto journals, if the wire has been removed, to prevent loss of needle bearings when rear joint is disconnected.

c. Remove complete drive line assembly by sliding rearward to disengage yoke from splines on transmission mainshaft.

6. Support rear of engine and remove two transmission extension bracket to cross member support retaining nuts.

7. Remove the two top transmission to clutch housing bolts and insert two transmission aligning studs in these holes.

NOTE: The use of two aligning studs during this operation will support the transmission and prevent damage to the clutch disc through springing.

8. Remove the two lower transmission to clutch housing bolts.

9. Tilt rear of extension upward to disengage bracket studs from cross member support and withdraw transmission from clutch housing.

NOTE: On long wheelbase cars, it is necessary to remove the cross member support before removing transmission because of the additional length of the transmission rear extension.

10. Remove the transmission.

TRANSMISSION—DISASSEMBLE

1. Remove transmission side cover assembly from transmission case.

NOTE: If cover assembly is to be disassembled for inspection or replacement of worn parts, follow procedures 3 through 6 under TRANSMISSION SIDE COVER–REMOVE AND DISASSEMBLE.

2. Remove clamp, bracket and insulator assembly from transmission rear extension.

3. Remove four bolts from front bearing retainer and remove retainer and gasket.

4. Drive lock pin from bottom side of reverse shifter lever boss and pull shifter out about 1/8". This disengages the reverse shift fork from reverse gear.

5. Remove five bolts attaching the case extension to the rear bearing retainer. Tap extension with soft hammer in a rearward direction to start. When the reverse idler shaft is out as far as it will go, move extension to left so reverse fork clears reverse gear and remove extension and gasket.

6. Remove special snap ring from end of mainshaft.

7. Remove speedometer drive gear with J-5814-A as shown in Fig. 7B-12.

8. The rear section of the reverse idler gear, tanged thrust washer and reverse gear may now be removed.

9. Remove the self-locking bolt attaching the rear bearing retainer to transmission case. Carefully remove the entire mainshaft assembly.

10. Lift the front reverse idler gear and thrust washer from case.

11. Unload 14 bearing rollers from main drive gear and remove fourth speed synchronizing ring.

12. Remove the main drive gear snap ring as shown in Fig. 7B-13, and remove spacer washer.

13. With soft hammer, tap main drive gear down from front bearing as shown in Fig. 7B-14.

14. From inside case, tap out front bearing and snap ring.

15. From the front of the case, tap out the countershaft, using loader J-5589, as shown in Fig. 7B-15. Remove the countergear and both tanged washers. Remove loader J-5589 from countergear.

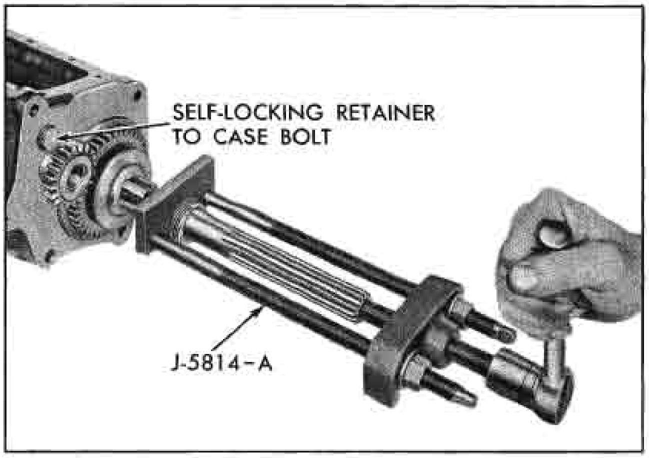


Fig. 7B-12 Removal of Speedometer Drive Gear

16. Remove the 80 rollers, six .050" spacers and roller spacer from countergear (Fig. 7B-16).

17. Remove mainshaft front snap ring, as shown in Fig. 7B-17, and slide third and fourth speed clutch assembly, third speed gear and synchronizing ring, second and third speed gear thrust washer (needle roller bearing), second speed gear and second speed synchronizing ring from front of mainshaft.

18. Spread rear bearing retainer snap ring and press mainshaft out of the retainer (Fig. 7B-18).

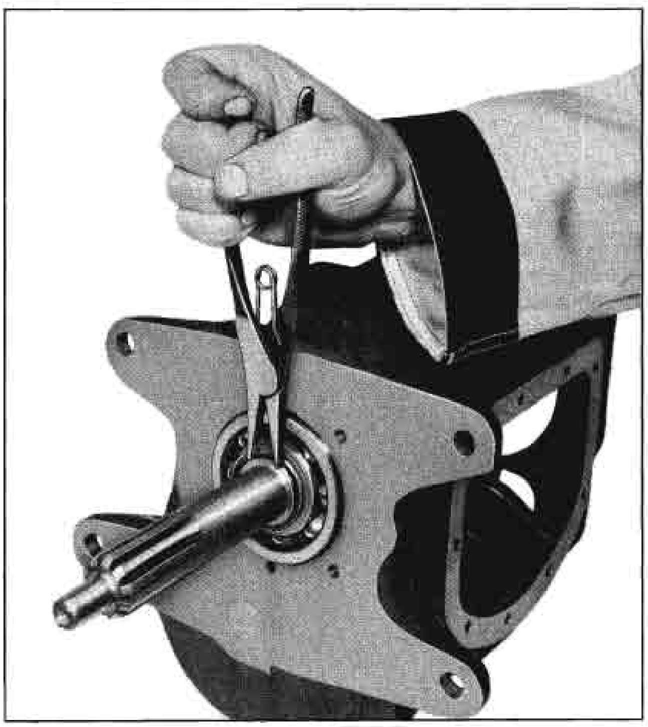


Fig. 7B-13 Removing or Replacing Main Drive Gear Snap Ring

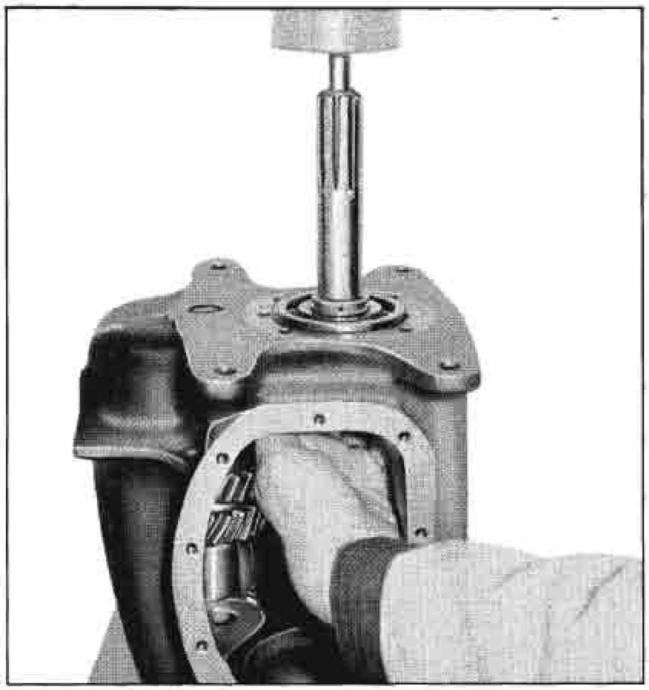


Fig. 7B-14 Removing Main Drive Gear from Front Bearing

19. Remove the mainshaft rear snap ring. Support first and second speed clutch assembly, as shown in Fig. 7B-19, and press on rear of mainshaft to remove shaft from rear bearing, first speed gear thrust washer, first speed gear and synchronizing ring, first and second speed clutch sliding sleeve, and first speed gear bushing.

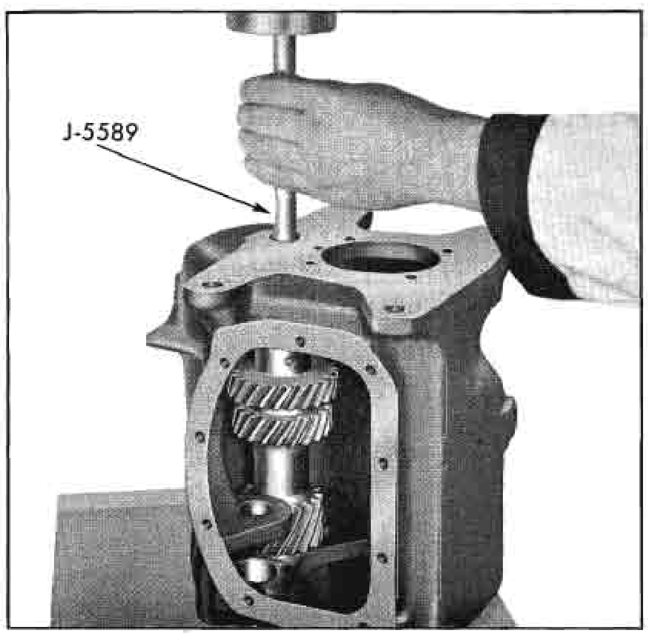
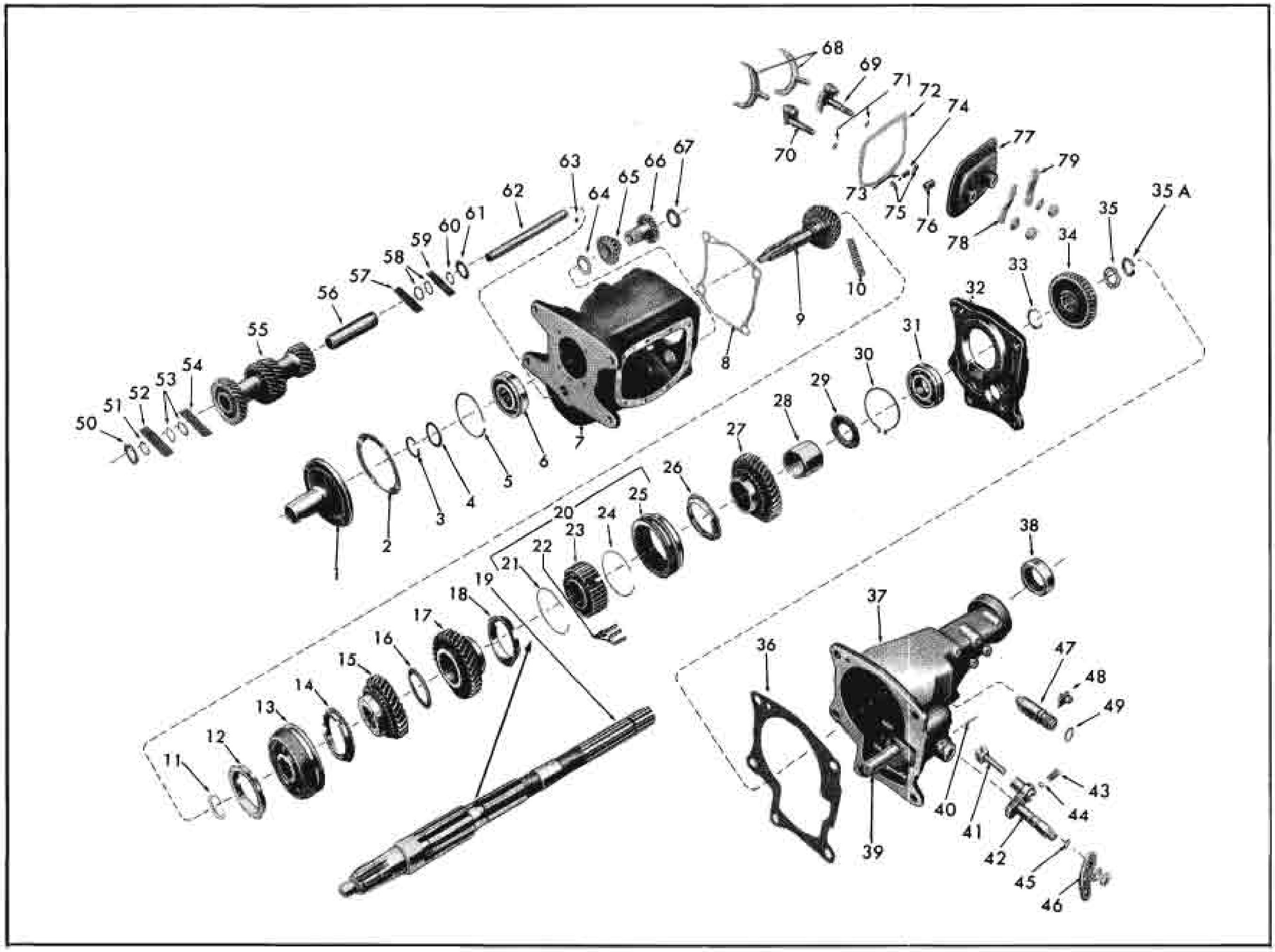


Fig. 7B-15 Removal of Countershaft



1. Bearing Retainer
2. Gasket
3. Selective Fit Snap Ring
4. Spacer Washer
5. Bearing Snap Ring
6. Main Drive Gear Bearing
7. Transmission Case
8. Rear Bearing Retainer Gasket
9. Main Drive Gear
10. Bearing Rollers (14)
11. Snap Ring (.086" to .088")
12. Fourth Speed Gear Synchronizing Ring
13. Third and Fourth Speed Clutch Sliding Sleeve
14. Third Speed Synchronizing Ring
15. Third Speed Gear
16. Second and Third Speed Gear Thrust Washer (Needle Roller Bearing)
17. Second Speed Gear
18. Second Speed Gear Synchronizing Ring
19. Mainshaft
20. First and Second Speed Clutch Assembly
21. Clutch Key Spring
22. Clutch Keys
23. Clutch Hub
24. Clutch Key Spring
25. First and Second Speed Clutch Sliding Sleeve
26. First Speed Gear Synchronizing Ring
27. First Speed Gear
28. First Speed Gear Bushing
29. First Speed Gear Thrust Washer
30. Rear Bearing Snap Ring
31. Rear Bearing
32. Rear Bearing Retainer
33. Selective Fit Snap Ring
34. Reverse Gear
35. Speedometer Drive Gear

35A. Special Snap Ring

36. Rear Bearing Retainer to Case Extension Gasket
37. Case Extension
38. Rear Oil Seal
39. Reverse Idler Shaft
40. Reverse Shifter Shaft Lock Pin
41. Reverse Shift Fork
42. Reverse Shifter Shaft and Detent Plate
43. Reverse Shifter Shaft Ball Detent Spring
44. Reverse Shifter Shaft Detent Ball
45. Reverse Shifter Shaft "O" Ring Seal
46. Reverse Shifter Lever
47. Speedometer Driven Gear and Fitting
48. Retainer and Bolt
49. "O" Ring Seal
50. Tanged Washer
51. Spacer (.050")
52. Bearing Rollers (20)
53. Spacers (2—.050")
54. Bearing Rollers (20)
55. Countergear
56. Countergear Roller Spacer
57. Bearing Rollers (20)
58. Spacers (2—.050")
59. Bearing Rollers (20)
60. Spacer (.050")
61. Tanged Washer
62. Countershaft
63. Countershaft Woodruff Key
64. Reverse Idler Front Thrust Washer (Flat)
65. Reverse Idler Gear (Front)
66. Reverse Idler Gear (Rear)
67. Tanged Thrust Washer
68. Forward Speed Shift Forks
69. First and Second Speed Gear Shifter Shaft and Detent Plate
70. Third and Fourth Speed Gear Shifter Shaft and Detent Plate
71. "O" Ring Seals
72. Gasket
73. Interlock Pin
74. Poppet Spring
75. Detent Balls
76. Interlock Sleeve
77. Transmission Side Cover
78. Third and Fourth Speed Shifter Lever
79. First and Second Speed Shifter Lever

Fig. 7B-16 Four-Speed Synchro-Mesh Transmission—Exploded View

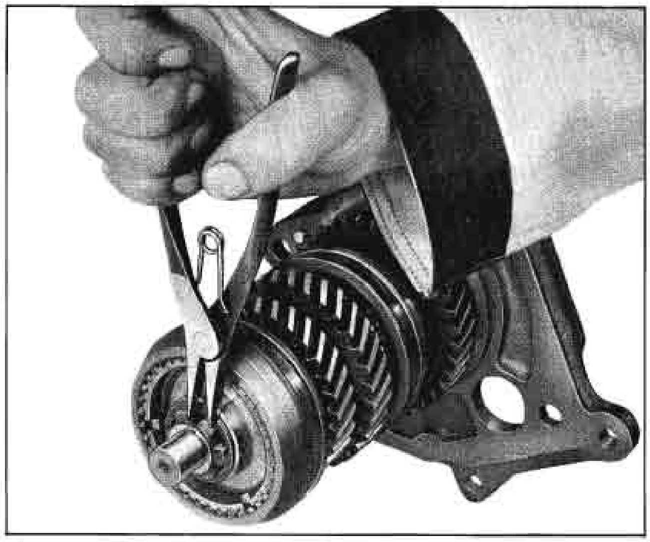


Fig. 7B-17 Removing or Replacing Mainshaft Front Snap Ring

REVERSE SHIFTER SHAFT AND SEAL—REMOVE AND REPLACE

1. With case extension removed from transmission the reverse shifter shaft lock pin will already be removed.

2. Remove shift fork.

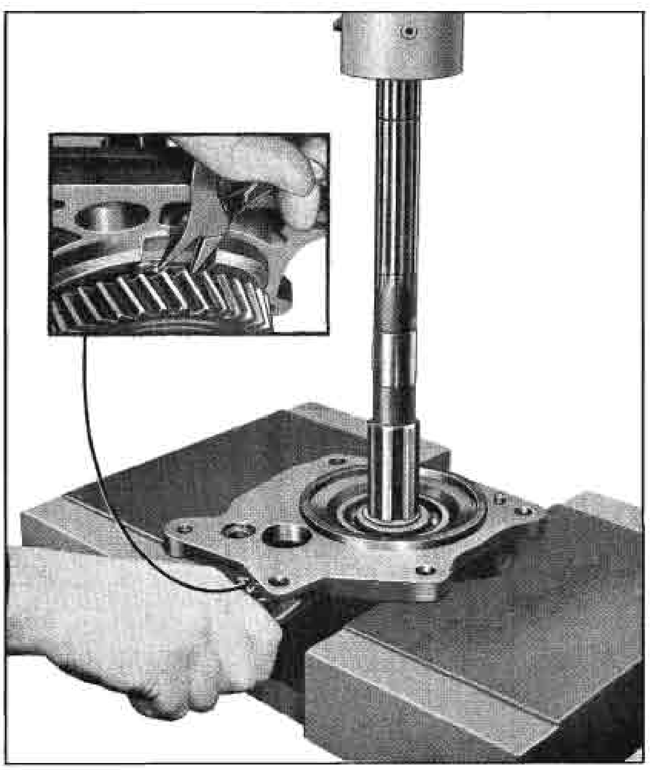


Fig. 7B-18 Removal of Mainshaft from Rear Bearing Retainer

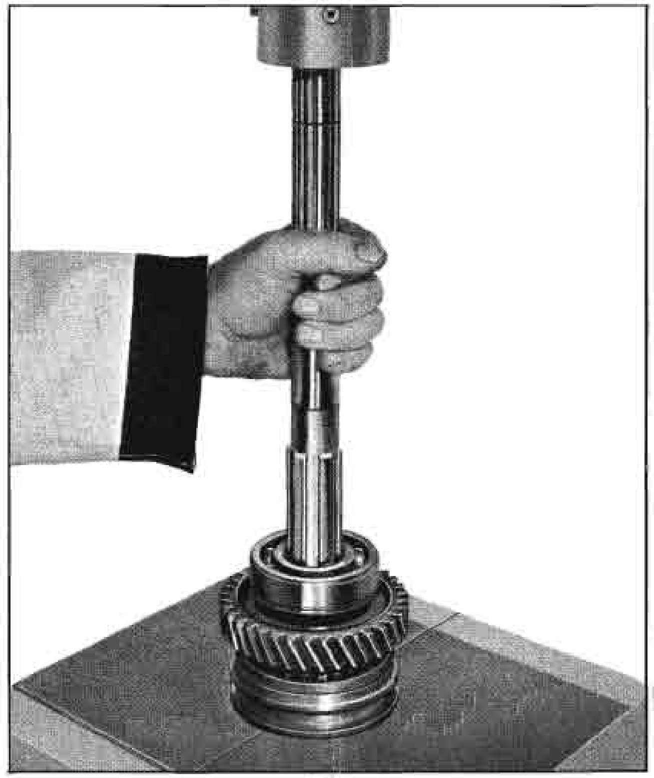


Fig. 7B-19 Removing Mainshaft from Rear Bearing and Clutch Assembly

3. Carefully drive shifter shaft into case extension, allowing ball detent to drop into case. Remove shaft and ball detent spring.

4. Place ball detent spring into detent spring hole and start reverse shifter shaft into hole in boss.

5. Place detent ball on spring and, holding ball down with a suitable tool as shown in Fig. 7B-20, push the shifter shaft into place and turn until the ball drops into place in detent on the shaft detent plate.

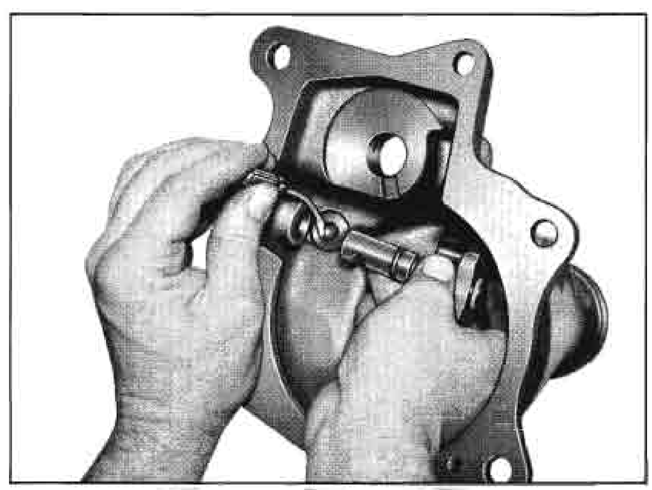


Fig. 7B-20 Installing Reverse Shifter Shaft

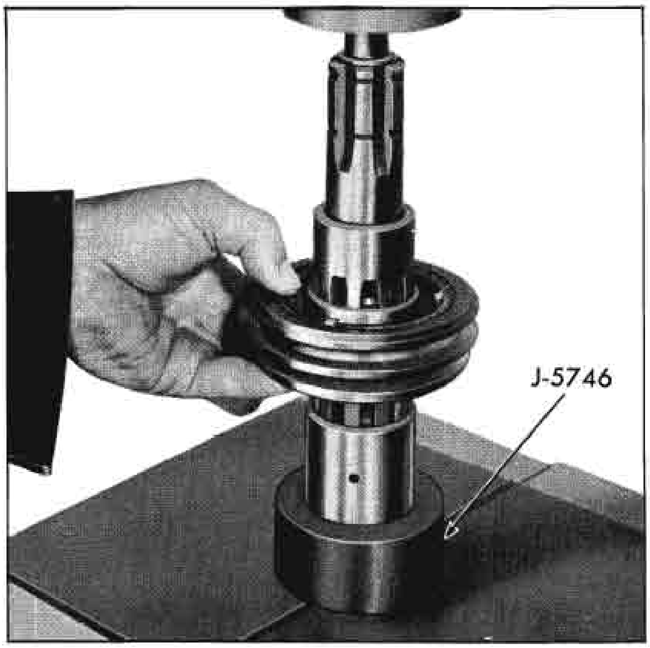


Fig. 7B-21 Installing First Speed Gear Bushing

6. Install shift fork.

NOTE: Do not drive the shifter shaft lock pin into place until the extension has been installed on the transmission case.

CLUTCH KEYS AND SPRINGS—REMOVE AND REPLACE

NOTE: The clutch hubs and sliding sleeves are a selected assembly and should be kept together as originally assembled, but the three keys and two springs may be replaced if worn or broken.

1. Push the hub from the sliding sleeve. The keys will fall free and the springs may be easily removed.

2. Place the two springs in position (one on each side of the hub), so a tanged end of each spring falls into the same keyway in the hub. Place the keys in position and, holding them in place, slide the hub into the sleeve.

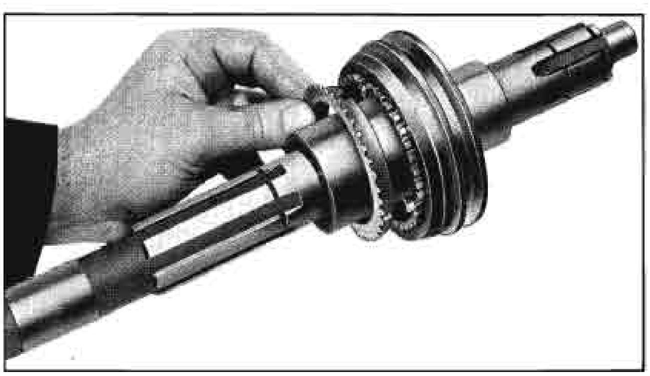


Fig. 7B-22 Installing Synchronizer Ring

CLEANING AND INSPECTION

TRANSMISSION CASE

Wash the transmission case inside and out with a cleaning solvent and inspect for cracks. Inspect the front face which fits against clutch housing for burrs and if any are present, dress them off with a fine cut mill file.

FRONT AND REAR BEARINGS

1. Wash the front and rear bearings thoroughly in a cleaning solvent.

2. Blow out bearings with compressed air.

CAUTION: Do not allow the bearings to spin, turn them slowly by hand. Spinning bearings will damage the race and balls.

3. Make sure the bearings are clean, then lubricate them with light engine oil and check them for roughness. Roughness may be determined by slowly turning the outer race by hand.

BEARING ROLLERS AND SPACERS

All main drive gear and countergear bearing rollers should be inspected closely and replaced if they show wear. Inspect countershaft at the same time and replace if necessary. Replace all worn spacers.

GEARS AND BUSHING

Inspect all gears and first speed gear bushing and, if necessary, replace all that are worn or damaged.

TRANSMISSION—ASSEMBLE

MAINSHAFT—ASSEMBLE

1. From rear of mainshaft, assemble first and second speed clutch assembly to mainshaft (sliding clutch sleeve taper toward the rear, hub to the front) and, using J-5746, press the first speed gear bushing on shaft (Fig. 7B-21).

2. Install the first speed gear synchronizing ring so the notches in the ring correspond to the keys in the hub (Fig. 7B-22).

3. Install first speed gear (with hub toward the front) and the first speed gear thrust washer. Make certain that the grooves in the washer are facing the first speed gear.

4. Using J-5746, press on the rear bearing with the snap ring groove toward the front of the transmission

(Fig. 7B-23). Make cerain bearing is firmly seated against the shoulder on the mainshaft.

5. Choose the correct selective fit snap ring and install it in the groove in mainshaft behind the rear bearing. Snap rings are available in three thicknesses: .087", .093" and .099". Use ring that will produce from zero to .005" clearance between the rear face of the bearing and the front face of the snap ring.

NOTE: Always use new snap ring when reassembling transmission and do not expand the snap ring further than is necessary for assembly.

6. From the front of the mainshaft, install the second speed gear synchronizing ring so notches in the ring correspond to the keys in the hub.

7. Install the second speed gear (with the hub of the gear toward the back of the transmission) and install the second and third speed gear thrust washer (needle roller bearing).

8. Install the third speed gear (hub to front of transmission) and the third speed gear synchronizing ring (notches to front of transmission).

9. Install the third and fourth speed gear clutch assembly (hub and sliding sleeve) with taper toward the front, making sure that the keys in the hub correspond to the notches in the third speed gear synchronizing ring.

10. Install snap ring (.086" to .088" thickness) in the groove in mainshaft in front of the third and fourth speed clutch assembly.

11. Install the rear bearing retainer plate (Fig. 7B-24). Spread the snap ring on the plate to allow the snap ring to drop around the rear bearing and press on the end of the mainshaft until the snap ring engages the groove in the rear bearing.

12. Install the reverse gear (shift collar to rear).

13. Press speedometer drive gear onto the mainshaft using a suitable press plate. Position the speedometer gear to get a measurement of 4½" from the center of the gear to the flat surface of the rear bearing retainer (Fig. 7B-25).

CAUTION: Make certain correct speedometer drive gear is installed. Refer to Speedometer Gear Usage Chart on page 7B-20.

14. Install special snap ring in groove at rear of mainshaft (Fig. 7B-16).

COUNTERGEAR—ASSEMBLE

1. Install roller spacer in countergear.

2. Using heavy grease to retain the rollers, install 20 rollers in either end of the countergear, two .050" spacers, 20 more rollers, then one .050" spacer. Install

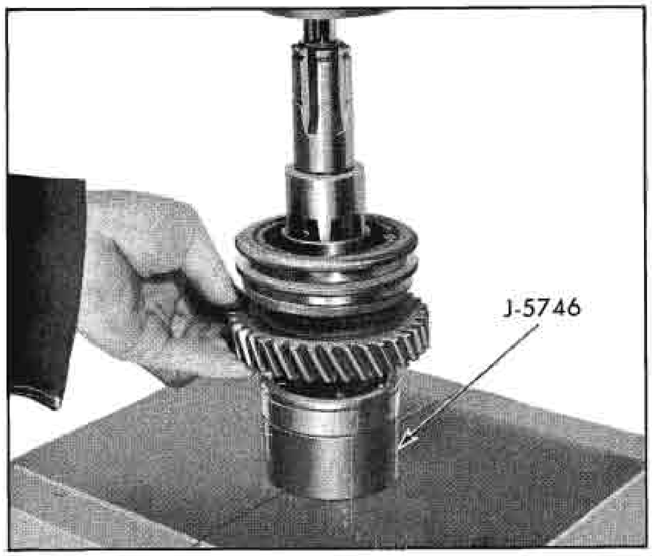


Fig. 7B-23 Installing Rear Bearing

in the other end of the countergear, 20 rollers, two .050" spacers, 20 more rollers, and another .050" spacer (Fig. 7B-26). Insert loader J-5589 in countergear to retain rollers.

TRANSMISSION ASSEMBLY—ASSEMBLE

1. Rest the transmission case on its side with the side cover opening toward the assembler. Put countergear tanged thrust washers in place, retaining them with heavy grease and making sure that tangs are resting in notches in case.

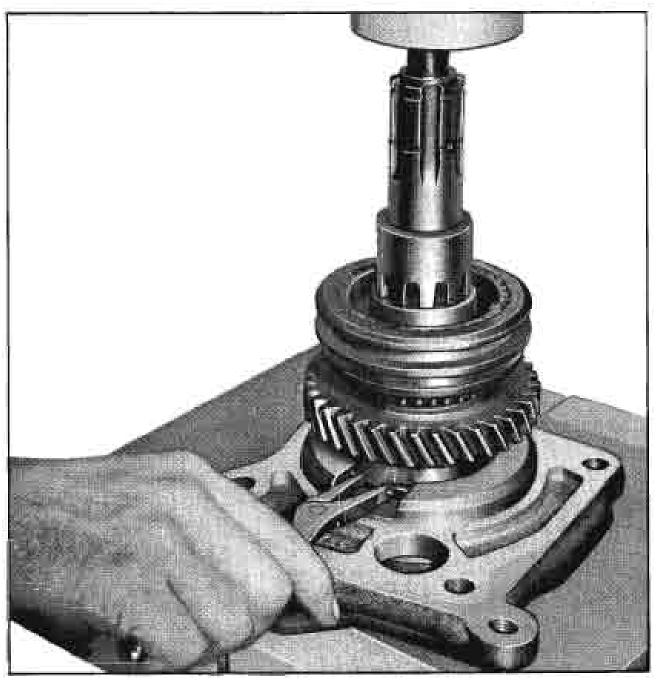


Fig. 7B-24 Installing Rear Bearing Retainer

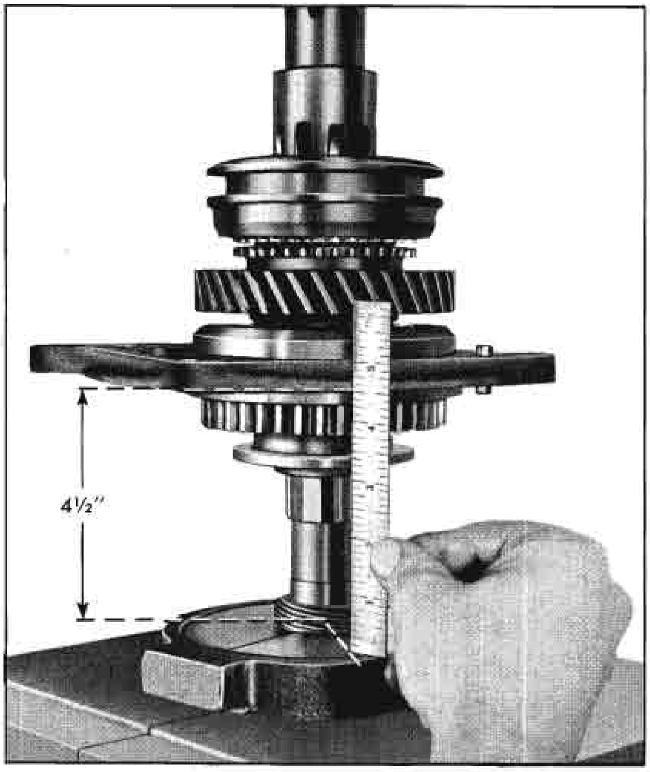


Fig. 7B-25 Installing Speedometer Drive Gear

2. Set countergear in place in bottom of transmission case, making sure that tanged thrust washers are not dislodged.

3. Press bearing onto main drive gear (snap ring groove to front)using J-5746 (Fig. 7B-27). Firmly seat bearing against shoulder of main drive gear.

4. Install spacer washer and selective fit snap ring in groove on gear stem.

NOTE: The snap ring is available in three thicknesses: .087", .093" and .099". Use the ring that will produce from zero to .005" clearance between the rear face of the snap ring and the front face of the spacer washer.

5. Install the main drive gear and bearing assembly through the side cover opening and into position

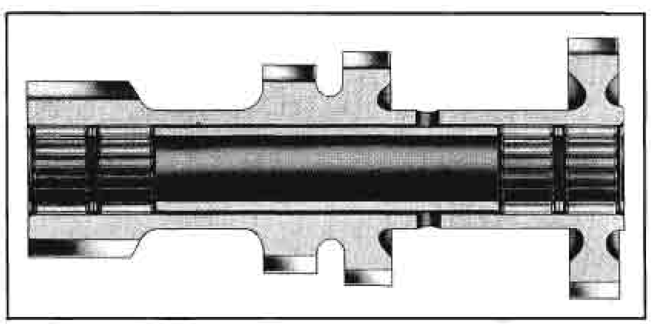


Fig. 7B-26 Cross Section of Countergear Assembly

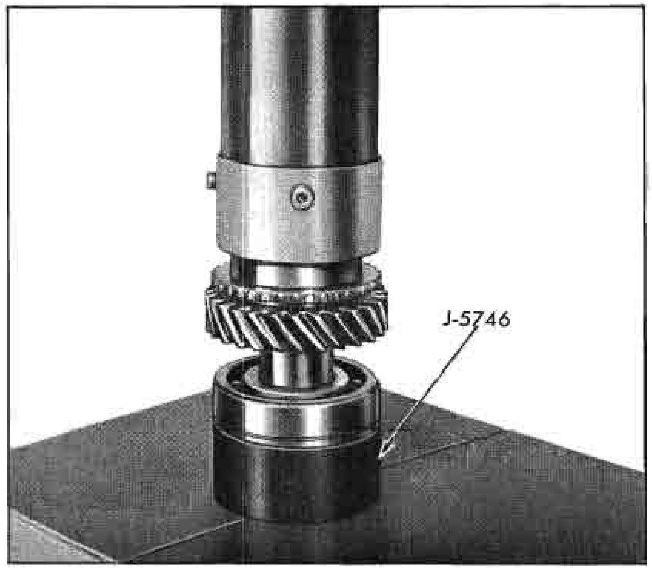


Fig. 7B-27 Installing Main Drive Gear Bearing

in transmission front bore. Tap lightly into place, if necessary, with a plastic hammer. Place snap ring in groove in front bearing.

6. With the transmission resting on its front face, move countergear into mesh with main drive gear. Be sure thrust washers remain in place. Install woodruff key into end of countershaft and, from rear of case, tap or press shaft (Fig. 7B-28), until end of shaft is flush with rear of transmission case and loader J-5589 is displaced.

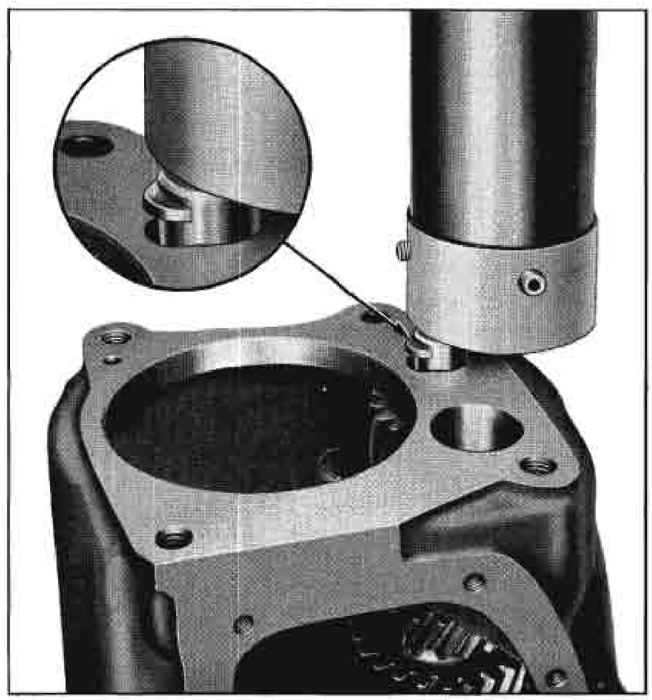


Fig. 7B-28 Installing Countershaft

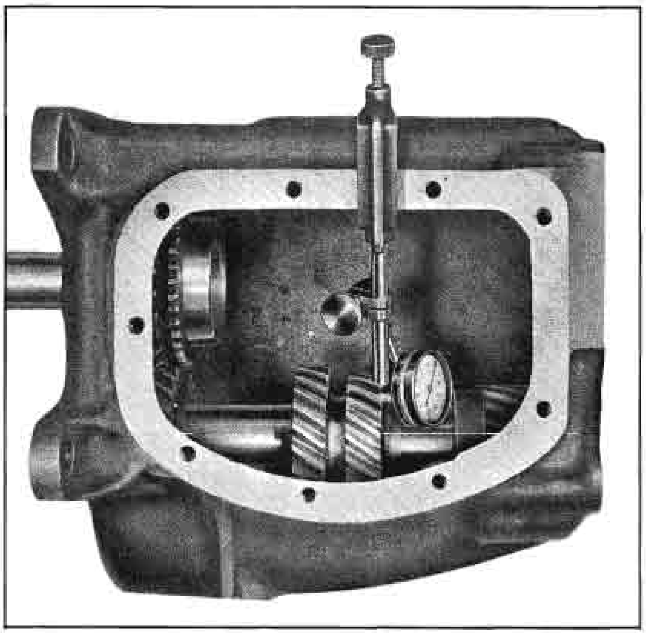


Fig. 7B-29 Checking Countergear End Play

7. Attach a dial indicator as shown in Fig. 7B-29, and check the end play of the countergear. End play must not be more than .025".

8. Install the fourteen (14) bearing rollers into main drive gear, using heavy grease to hold the bearings in place.

9. Using heavy grease, place gasket in position on front face of rear bearing retainer.

10. Install the fourth speed synchronizing ring on main drive gear with the clutch key notches toward the rear of the transmission.

11. Position the reverse idler gear thrust washer (untanged) on the machined face of the ear cast in the case for the reverse idler shaft. Position the front reverse idler gear on top of the thrust washer, with the hub facing toward rear of the case.

12. Lower the mainshaft assembly into the case making certain that the notches on the fourth speed synchronizing ring correspond to the keys in the clutch assembly (Fig. 7B-30).

13. Install the self-locking bolt attaching rear bearing retainer to transmission case (Fig. 7B-31). Torque to 20-30 lb. ft.

14. From the rear of the case, insert the rear reverse idler gear, engaging the splines with the portion of the gear within the case.

15. Using heavy grease, place gasket into position on rear face of rear bearing retainer.

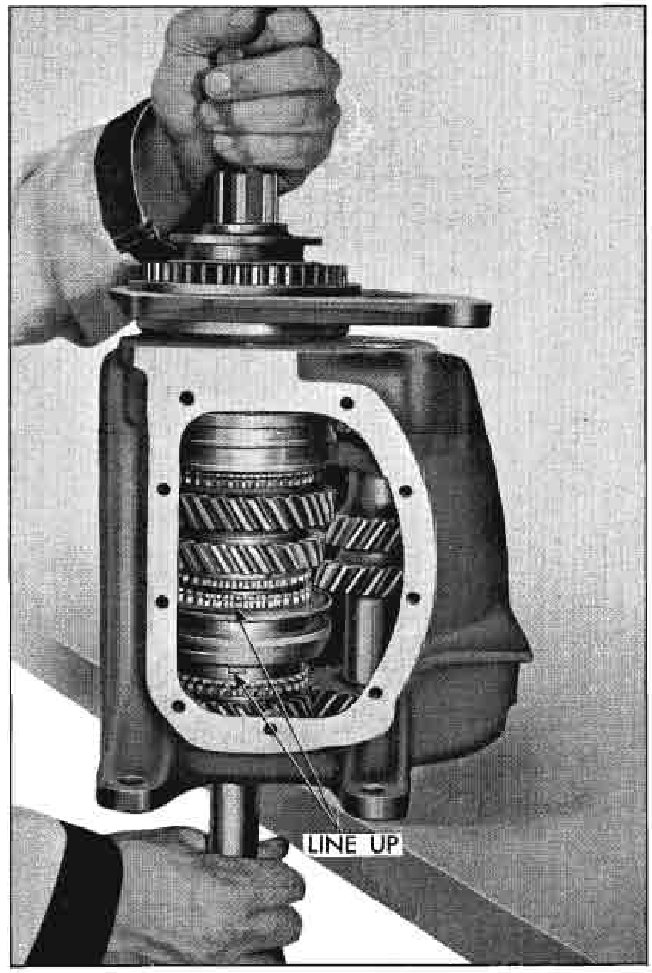


Fig. 7B-30 Installing Mainshaft Assembly

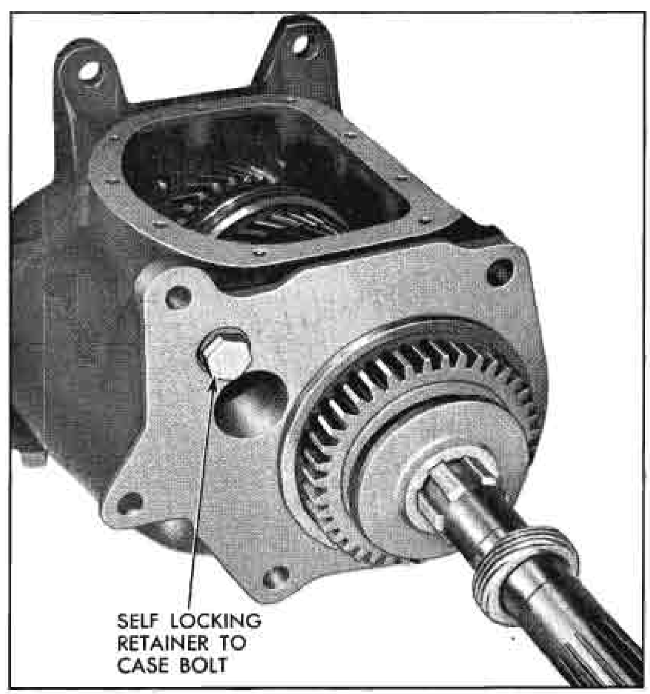


Fig. 7B-31 Self-Locking Retainer to Case Bolt

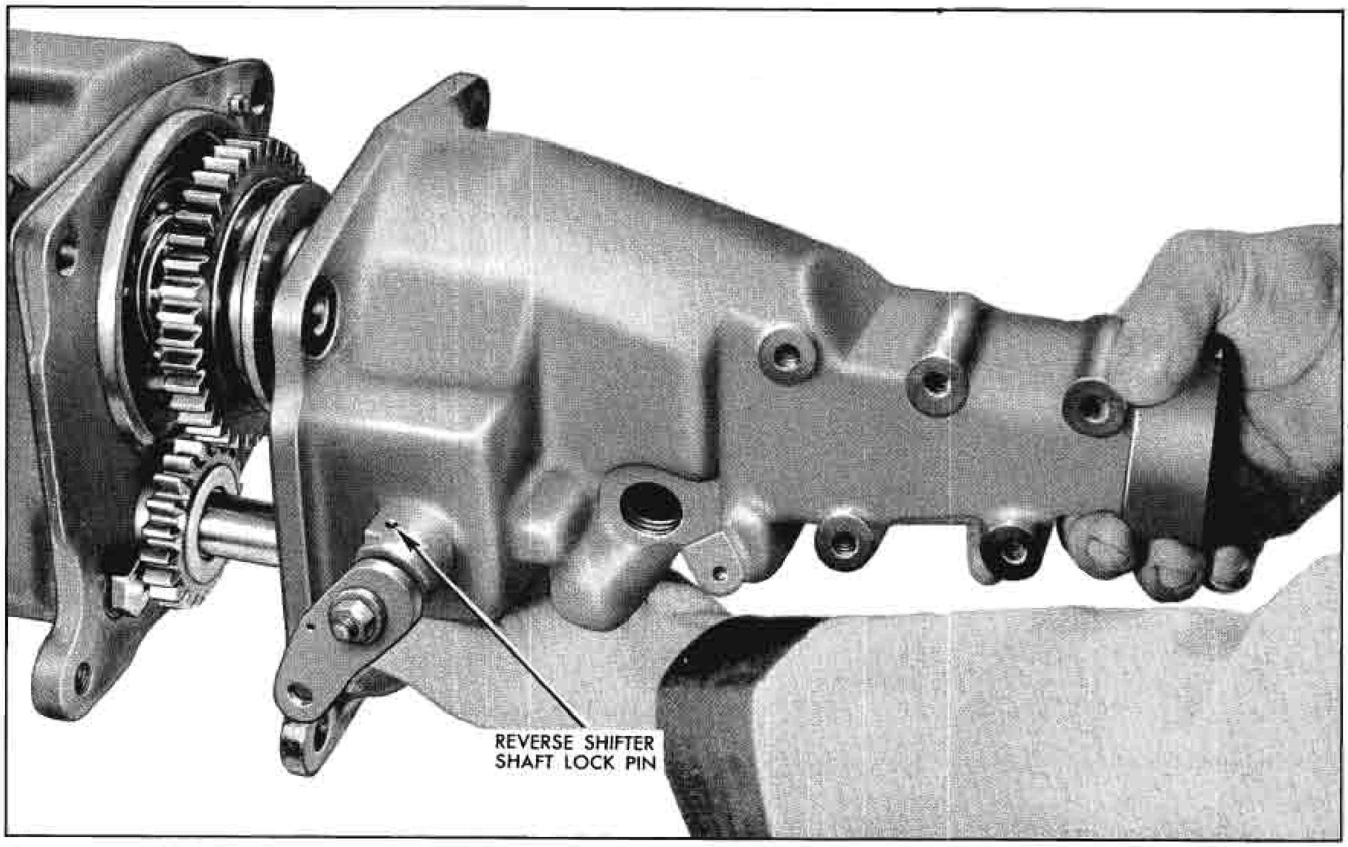


Fig. 7B-32 Installing Rear Extension on Transmission Case

16. Install the remaining tanged thrust washer into place on reverse idler shaft, making certain the tang on the thrust washer is in the notch in the idler thrust face of the extension.

17. Place the two clutches in neutral position.

NOTE: If locking-up of gears is encountered, a small amount of petrolatum may be applied to the first speed gear synchronizing ring, enabling it to turn freely on first speed gear hub.

18. Pull reverse shifter shaft to left side of extension and rotate shaft to bring reverse shift fork to extreme forward position in extension. Line up forward and rear reverse idler gears, making certain front thrust washer is in place.

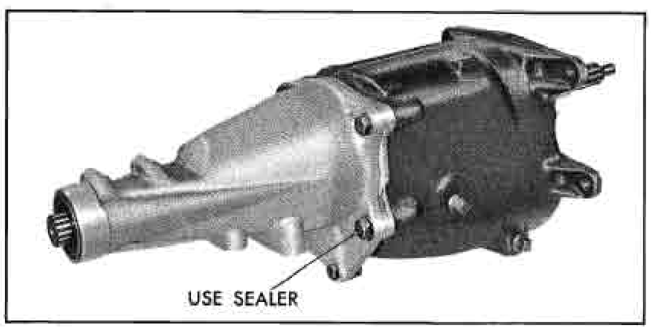


Fig. 7B-33 Sealing Lower Right Attaching Bolt

19. Start the extension onto the transmission case (Fig. 7B-32), by carefully inserting reverse idler shaft through reverse idler gears. Slowly push it on shifter shaft until shift fork engages reverse gear shift collar. When the fork engages, rotate the shifter shaft to move the reverse gear rearward permitting the extension to slide onto the transmission case.

20. Install three extension and retainer to case attaching bolts (torque 35-45 lb. ft.) and two extension to retainer attaching bolts (torque 20-30 lb. ft.). Use suitable sealer on the lower right attaching bolt as viewed from rear (Fig. 7B-33).

21. Adjust reverse shifter shaft so that groove in shaft lines up with hole in boss and drive in lock pin from the top of boss.

22. Install the main drive gear bearing retainer and gasket, making certain oil well lines up with oil outlet hole. Install four attaching bolts, using a suitable sealer on bolts. Tighten to 15-20 lb. ft. torque.

23. Install a shift fork in each clutch sleeve.

24. With both clutches in neutral, install side cover gasket and carefully lower side cover into place.

NOTE: If side cover is disassembled, refer to steps 1 through 5 under TRANSMISSION SIDE COVER–ASSEMBLE AND INSTALL.

25. Install attaching bolts and tighten evenly (10-20 lb. ft. torque) to avoid side cover distortion. Use suitable sealer when installing the lower right bolt.

26. Install first and second, and third and fourth shifter levers, lock washers and nuts.

NOTE: The transmission should "overshift" slightly in all ranges.

27. Install clamp, bracket and insulator assembly on transmission rear extension.

TRANSMISSION—INSTALL IN VEHICLE

1. Raise transmission until rear extension can be moved rearwards over center cross member support.

NOTE: If it was necessary to remove cross member support before removing transmission, install support while transmission is held in a raised position.

2. Move transmission forward until extension bracket studs engage holes in cross member support and main drive gear shaft enters clutch housing. Care should be taken to make certain clutch release bearing remains seated.

3. Install aligning stud in lower right transmission to clutch housing bolt hole for alignment.

4. Install two upper transmission to clutch housing mounting bolts and washers and tighten securely to 45-60 lb. ft. torque. Remove aligning stud and install two lower mounting bolts and washers and tighten 45-60 lb. ft. torque.

5. Install two rear extension bracket to cross member support retaining nuts and tighten 25-35 lb. ft. torque.

6. Install propeller shaft drive line assembly by reversing steps a. through c. under TRANSMISSION–REMOVE FROM VEHICLE.

7. Install manual shift lever through floor of vehicle and secure shift bracket to transmission rear extension with three bracket to extension bolts. Tighten 25-35 lb. ft. torque.

8. Connect shifter rods to shift bracket at rear extension, using spring-type lock pins (Fig. 7B-34). Connect shifter rods to shift levers, using 1/4" cotter pins. (Longer pins will cause binding during shifting operation.)

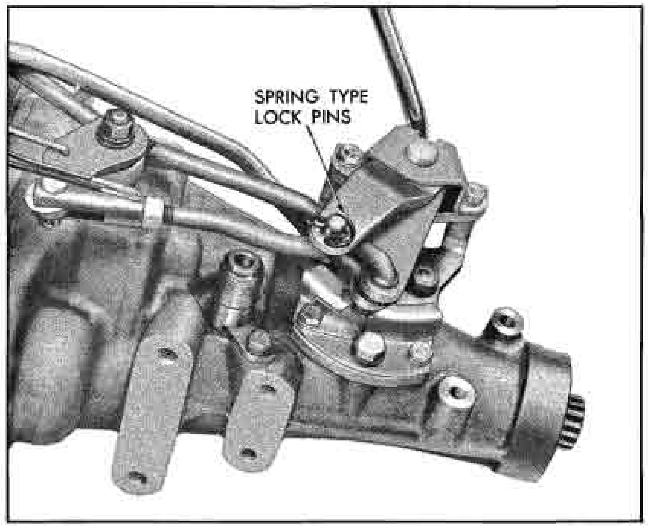


Fig. 7B-34 Installing Spring-Type Lock Pin

9. Connect speedometer cable to speedometer driven gear and tighten securely.

10. Connect back-up light leads to back-up light switch leads, using female connectors (Fig. 7B-35).

11. Slide rubber boot with metal boot retainer over shift stick and secure to floor plate with six metal screws.

12. Remove filler plug at side of transmission and add 2.5 pints of SAE 80 "Multi-purpose Gear Lubricant". Lubricant level should be approximately level with bottom of filler plug hole.

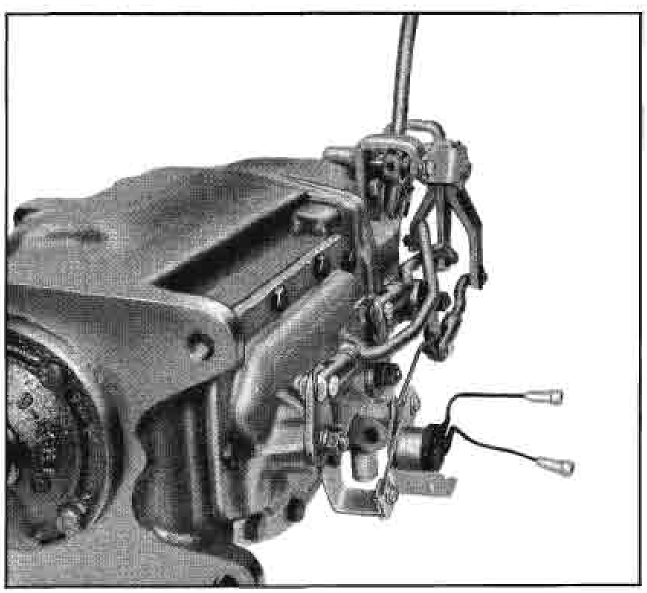


Fig. 7B-35 Back-up Light Switch Assembly

TROUBLE DIAGNOSIS AND TESTING

TROUBLE	REMEDY
SLIPS OUT OF HIGH GEAR	
a. Transmission loose on clutch housing.	a. Tighten mounting bolts.
b. Does not fully engage.	b. Adjust threaded clevis on each shift rod until proper adjustment is attained.
c. Damaged mainshaft pilot bearing.	c. Replace pilot bearing.
d. Main drive gear bearing retainer broken or loose.	d. Tighten or replace main drive gear bearing retainer.
e. Dirt between transmission case and clutch housing.	e. Clean mating surfaces.
f. Misalignment of transmission.	f. Shim between transmission case and clutch housing.
SLIPS OUT OF REVERSE GEAR	
a. Reverse gear damaged from operating at part engagement.	a. Determine cause. For example: worn shift fork and control lever or rod interference. Replace worn or bent parts.
b. Improperly adjusted linkage.	b. Adjust linkage.
NOISY IN ALL GEARS	
a. Insufficient lubricant.	a. Fill to correct level.
b. Worn countergear bearings.	b. Replace countergear bearings and shaft.
c. Worn or damaged main drive gear and countergear.	c. Replace worn or damaged gears.
d. Damaged main drive gear or mainshaft ball bearings.	d. Replace damaged bearings or gear.
NOISY IN HIGH GEAR	
a. Damaged main drive gear bearing.	a. Replace damaged bearing.
b. Damaged mainshaft bearing.	b. Replace damaged bearing.
NOISY IN THIRD GEAR	
a. Damaged or worn third speed constant mesh gears.	a. Replace damaged gears.
b. Worn or damaged countergear rear bearings.	b. Replace countergear bearings and shaft.
NOISY IN SECOND GEAR	
a. Damaged or worn second speed constant mesh gears.	a. Replace damaged gears.
b. Worn or damaged countergear rear bearings.	b. Replace countergear bearings and shaft.

TROUBLE	REMEDY
NOISY IN FIRST GEAR	
a. Damaged or worn first speed constant mesh gears.	a. Replace damaged gears.
b. Worn or damaged countergear rear bearings.	b. Replace countergear bearings and shaft.
NOISY IN REVERSE ONLY	
a. Worn or damaged reverse idler gear.	a. Replace reverse idler gear assembly.
b. Worn reverse idler bushings.	b. Replace reverse idler gear assembly.
c. Damaged or worn reverse speed gear.	c. Replace reverse gear.
NOISY IN NEUTRAL WITH ENGINE RUNNING	
a. Damaged main drive gear bearing.	a. Replace damaged bearing.
NOISY IN ALL REDUCTION GEARS	
a. Insufficient lubricant.	a. Fill to correct level.
b. Worn or damaged main drive gear or countergear.	b. Replace faulty or damaged gears.
EXCESSIVE BACKLASH IN SECOND ONLY	
a. Second speed gear bearing thrust washer worn.	a. Replace bearing thrust washer.
b. Mainshaft rear bearing not properly installed in retainer.	b. Replace bearing, snap ring or retainer as necessary.
c. Worn countergear rear bearings.	c. Replace countergear bearings and shaft.
EXCESSIVE BACKLASH IN ALL REDUCTION GEARS	
a. Worn countergear bushings.	a. Replace countergear.
b. Excessive end play in countergear.	b. Replace countergear thrust washers.
LEAKS LUBRICANT	
a. Excessive amount of lubricant in transmission.	a. Drain to correct level.
b. Loose or broken main drive gear bearing retainer.	b. Tighten or replace retainer.
c. Main drive gear bearing retainer gasket damaged.	c. Replace gasket.
d. Cover loose or gasket damaged.	d. Tighten cover or replace gasket.
e. Operating shaft seal leaks.	e. Replace operating shaft seal.
f. Countershaft loose in case.	f. Replace case.

TRANSMISSION SPECIFICATIONS

Four-speed synchro-mesh transmissions used on Catalina, Grand Prix and Safari models (except those with 3.90 axle ratio) are identified by light green paint daub on top of transmission case extension; transmissions used on above models with 3.90 axle ratio are identified by a yellow paint daub on extension. Star Chief and Bonneville models (except 3.90 axle ratio) have a light blue paint daub on extension while those models with 3.90 axle ratio have a white paint daub on the transmission extension.

The transmission face, clutch housing and block are accurately squared in production so that each unit may be interchanged as necessary. Special alignment of these assemblies is not necessary if they are installed properly.

Shift Positions	Gear Ratios
First	2.54:1
Second	1.92:1
Third	1.51:1
Fourth	1.00:1
Reverse	2.61:1
Lubricant Capacity	2.5 pints

TORQUE SPECIFICATIONS

	Lb. Ft.
Self-Locking Retainer to Case Bolt	20-30
Extension and Retainer to Case Bolts	35-45
Extension to Retainer Bolts	20-30
Main Drive Gear Bearing Retainer Bolts	15-20
Transmission Side Cover Bolts	10-20
Transmission to Clutch Housing Bolts	45-60
Shift Rod Trunnion Jam Nuts	15-20
Gearshift Lever Bracket to Transmission Bolts	25-35
Extension Bracket Support to Cross Member Nuts	25-35
Drain Plug	25-35
Filler Plug	25-35

SPEEDOMETER GEAR USAGE CHART
4-SPEED SYNCHRO-MESH TRANSMISSION WITH 8.00 x 14 TIRES

	Drive Gear		Gear Thickness	Speedometer Driven Gear		
Rear Axle Ratio	Dia. Pitch	No. Teeth		Dia. Pitch	No. Teeth	Color
43:10 (4.30)	30	8	0.530″	30	24	Yellow
41:10 (4.10)	30	8	0.530″	30	24	Yellow
39:10 (3.90)	30	8	0.530″	30	22	Green
40:11 (3.64)	28	8	0.610″	28	21	Red
41:12 (3.42)	28	8	0.610″	28	20	Blue
42:13 (3.23)	28	8	0.610″	28	19	Lt. Green
40:13 (3.08)	28	8	0.610″	28	18	Brown

Fig. 7B-36 Speedometer Gear Usage Chart

SPECIAL TOOLS

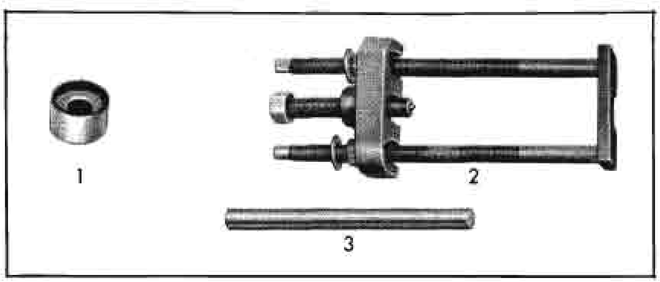


Fig. 7B-37 Four-Speed Transmission Special Tools

1. J-5746—Bearing and Bushing Installer
2. J-5814-A—Speedometer Drive Gear Remover
3. J-5589—Countergear Loader

FUEL TANK AND EXHAUST SYSTEM

CONTENTS OF THIS SECTION

FUEL TANK

DESCRIPTION

The fuel tank on all models except Safari is located under the floor pan behind the rear axle. This tank is retained with two metal straps and can be removed without disturbing any sheet metal. The straps hook into the floor pan outer panel at one end (Fig. 8-1) and are retained with a bolt through the floor pan rear reinforcement panel at the other (Fig. 8-2).

A 2½" vent pipe inside the fuel tank filler pipe (on all models except Safari) extends the entire length of the filler pipe and is held securely with two clips (Fig. 8-3). This pipe allows trapped air inside the

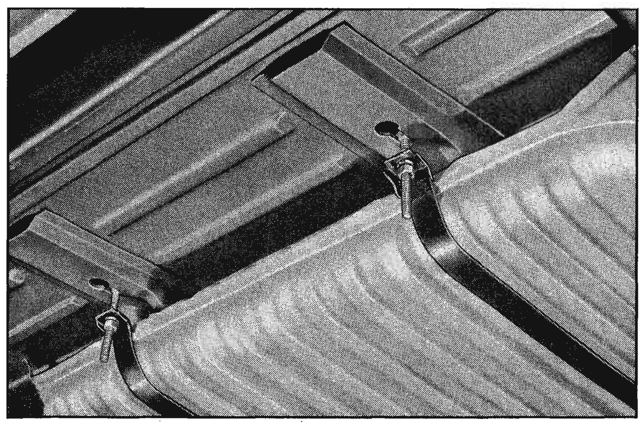


Fig. 8-2 Fuel Tank Retained at Rear

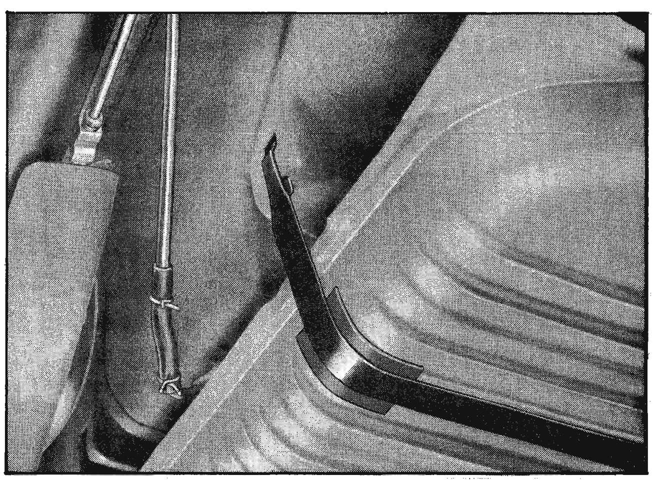


Fig. 8-1 Fuel Tank Retained at Front

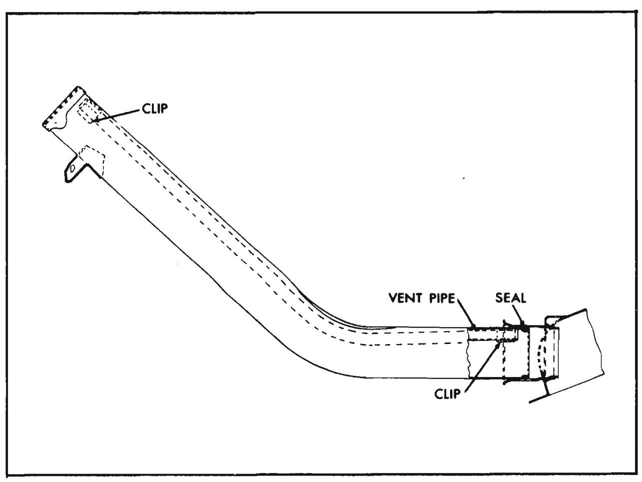


Fig. 8-3 Fuel Filler Pipe Positioned in Tank

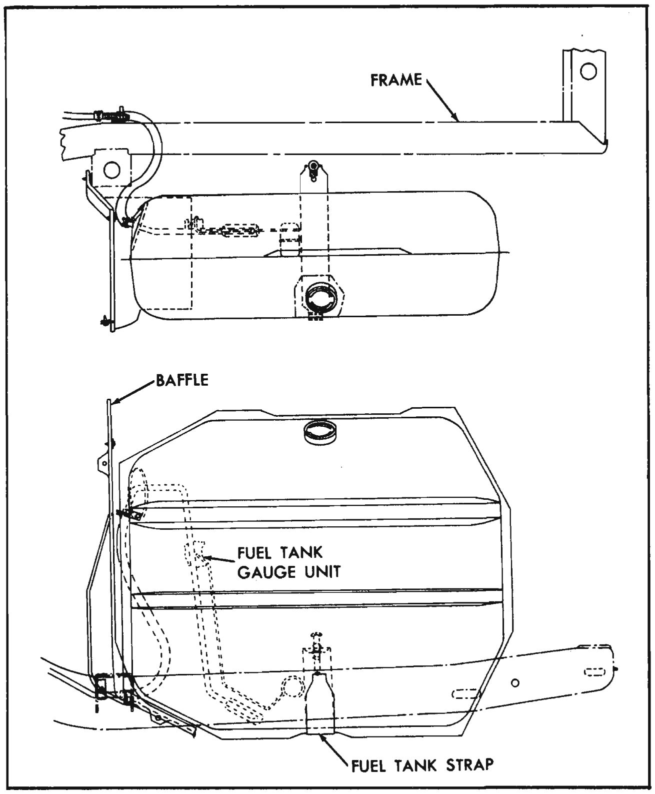


Fig. 8-4 Safari Fuel Tank Installation

fuel tank to exhaust quickly when filling the tank. To facilitate servicing, the fuel tank filler pipe is a separate piece and incorporates a rubber "O" ring seal to provide a gasoline tight joint at the tank (Fig. 8-3).

Fuel tank for all Safari models is located between the right rear fender outer panel and inner panel. It is retained at its upper end by a formed section in the left rear quarter panel and held secure at the bottom with one wide metal strap; one end hooks into the outer side of the quarter panel, the other, with a bolt through the floor pan rear reinforcement panel (Fig. 8-4).

The tank filler for all models is at outer side of left rear fender. A spring hinge is used on the inner side of the door assembly to assure rattle free retention when closed.

FUEL TANK FILLER CAP

Vented filler caps are used on all Pontiacs. All models except Safari have small passages in the filler cap and, also, the fuel tank is vented by a depression extending the full width of the filler pipe end, just under the filler cap.

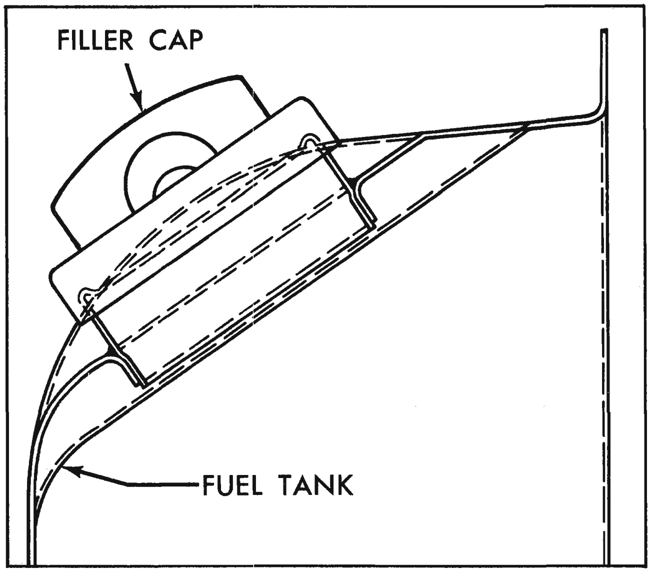


Fig. 8-5 Safari Fuel Tank Cap in Position

Because of its location and design the filler cap for Safari models is attached directly to the tank (Fig. 8-5) and no filler pipe, as such, is used. When the tank is full or nearly so, possibility of fuel over flow out a "vent" is checked by a dual purpose filler cap. This cap is designed to vent the tank and to check over flow of fuel out the vented cap (Fig. 8-6).

A "floating" valve (designed like a dished welch plug) is housed in the lower portion of the filler cap. When fuel level in the tank is below the bottom of the filler cap the tank is vented through a hole in the bottom of the check valve, under an opening at the bottom of the check valve and out opening within the valve to the outside. When the fuel tank is full, or fuel is sloshed onto the cap, fuel can enter into the hole at the bottom of the cap and enter the check valve area. This forces the check valve to seat and seal off any attempted escape of fuel. If, however, fuel or vapor pressure builds up $\frac{3}{4}$ to $1\frac{1}{4}$ psi the spring loaded safety valve opens to relieve excess pressure.

TANK GAUGE UNIT

The fuel tank filter and tank gauge unit are one assembly. The tank filter has a mesh sufficiently fine to prevent passage of water and assures that the particles that pass through are too small to interfere with valve operation in the fuel pump. The filter is of double plastic wrap construction with a heat sealed end (on all models except Safari) and offers a large filtering area and does not require cleaning. It is so designed that it will not rattle on the bottom of the tank.

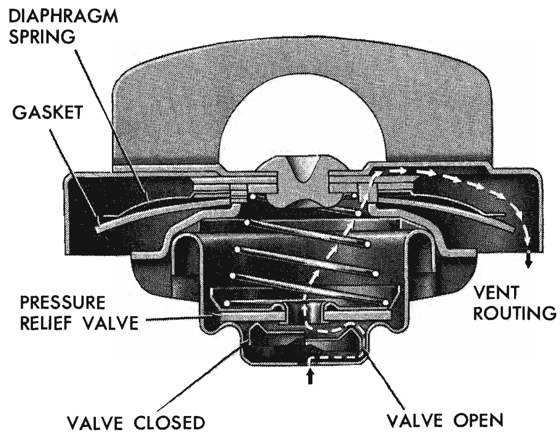


Fig. 8-6 Safari Fuel Tank Filler Cap

Fuel tank gauge units for Safari models have an all plastic filter end which rests just above the bottom of the tank. Four fuel tank gauge units are required to service all models.

Construction and location of fuel tanks make it necessary to provide a fuel tank gauge unit for all models except Safari (Fig. 8-7) and also for Safari models only. All models equipped with air conditioning are designed with a fuel system vapor separation line which returns to the tank via an additional pipe through the fuel gauge tank unit.

FUEL LINES

The fuel pipe from tank to engine runs on the left side of body. The gasoline line has two hose connections, one connecting the fuel pump inlet line to the front gasoline line and one connecting the rear gasoline line to the tank gauge unit. All hoses are secured to the gasoline lines by wire type hose clamps.

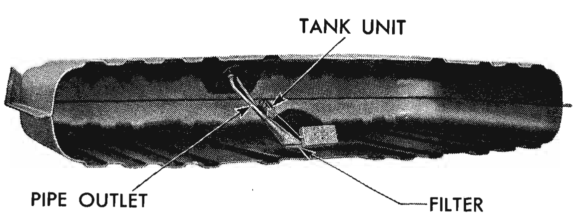


Fig. 8-7 Fuel Gauge Tank Unit Installed in Tank

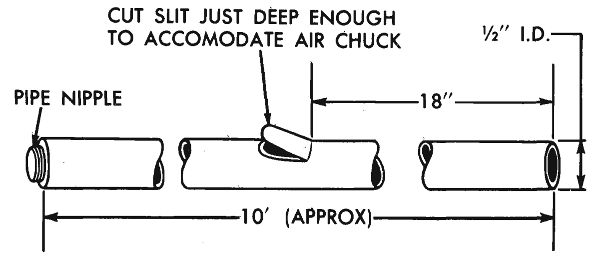


Fig. 8-8 Fuel Tank Drain Hose

SERVICES AND REPAIRS

FUEL TANK—DRAIN

1. Insert a length of hose (refer to Fig. 8-8 for details) into the gas tank, pipe nipple end first, until weighted end of hose rests on bottom of tank.

2. With chuck of air hose inserted into hose slit, a short blast of air will cause the gas to flow.

NOTE: The tank can be drained rapidly by raising the car several feet off the floor when performing the above operation.

FUEL TANK FILLER PIPE AND SEAL—REMOVE AND REPLACE

FILLER PIPE AND SEAL—REMOVE

1. Remove filler pipe by removing filler pipe screw from bracket.

2. Pull filler pipe from tank.

3. Remove seal from filler pipe recess (Fig. 8-9) using a screw driver or similar tool.

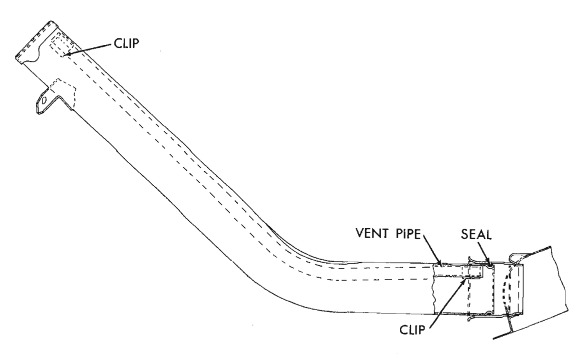


Fig. 8-9 Filler Pipe Installed in Tank

FILLER PIPE AND SEAL—REPLACE

1. Lubricate inner diameter of adapter in tank.

2. Place new seal in recess of filler pipe (Fig. 8-9) and position in tank.

3. Install screw in filler pipe bracket and tighten securely.

FUEL TANK—REMOVE AND REPLACE

1. Drain tank.

2. Disconnect wire from fuel gauge tank unit.

3. Disconnect fuel hose at gauge unit.

4. Remove screw from filler pipe bracket and remove filler pipe.

5. Disconnect support straps and lower tank.

6. Replace tank by reversing above steps.

TROUBLE DIAGNOSIS

LEAKS

Before removing fuel tank to correct a leak, a careful inspection of the tank should be made to determine as accurately as possible the source of leak. So called "seam leaks" very often turn out to be leaks at the filler neck or loose screws at the fuel gauge tank unit. In both these cases the gasoline runs down on the flange of the seam and drips off at points along the seam giving the false indication of leaking seams.

NOISES

Fuel tanks which have a rattle or buzzing sound can be corrected by adding insulation between the floor pan and tank. Stones on top of the tank may also be the cause and should be removed.

NOTE: Tanks *do not* have baffles and therefore should not be changed due to "loose baffles in tank".

TANK UNIT

Diagnosis for the fuel gauge tank unit appears in the ELECTRICAL AND INSTRUMENTS Section.

EXHAUST SYSTEM

DESCRIPTION

The major units comprising the exhaust system on Pontiac models are: a welded "Y" type exhaust crossover pipe, exhaust pipe, muffler and muffler tail pipe. The tuning chambers in the muffler have been designed to provide maximum muffling performance.

The exhaust crossover pipe attaches to both (right and left) bank exhaust manifolds, passes beneath the engine and joins the front exhaust pipe.

A single piece tail pipe connects to the muffler and is supported as shown in Figs. 8-10 and 8-11.

All models use the same type of zinc coated muffler, which is oval shaped, has multiple pipes, and operates on the reverse flow principle. Clamps are used to secure the muffler to the exhaust pipe and tail pipe.

The muffler and single-piece tail pipe are supported at two points by flexible supports. One support immediately behind the muffler attaches to the

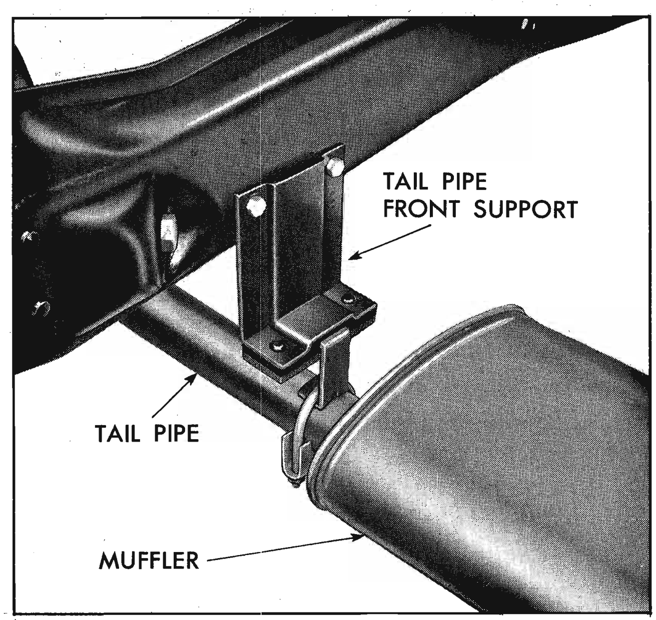


Fig. 8-10 Location of Tail Pipe Front Support Assembly

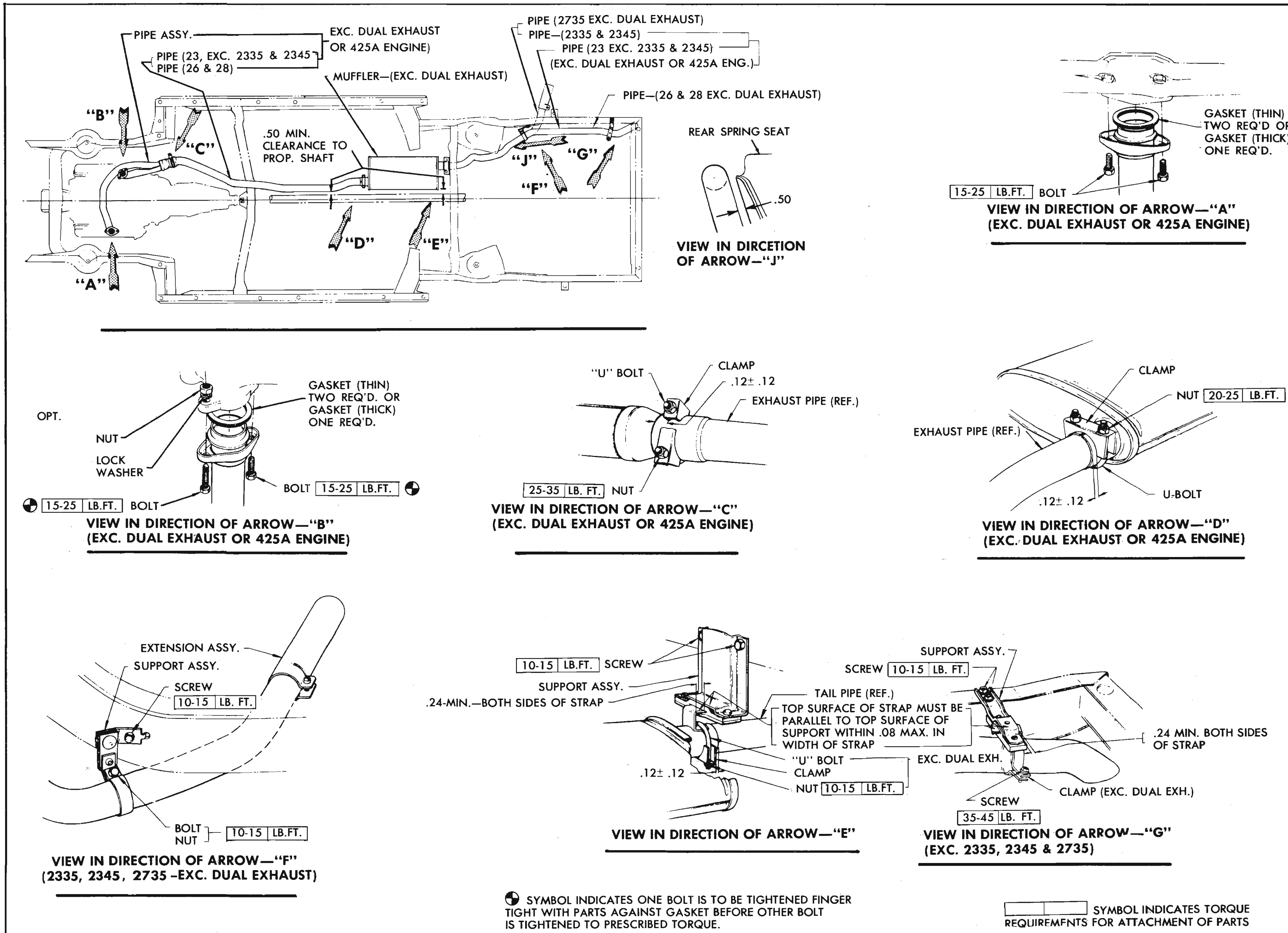


Fig. 8-11 Installation Details of Single Exhaust System

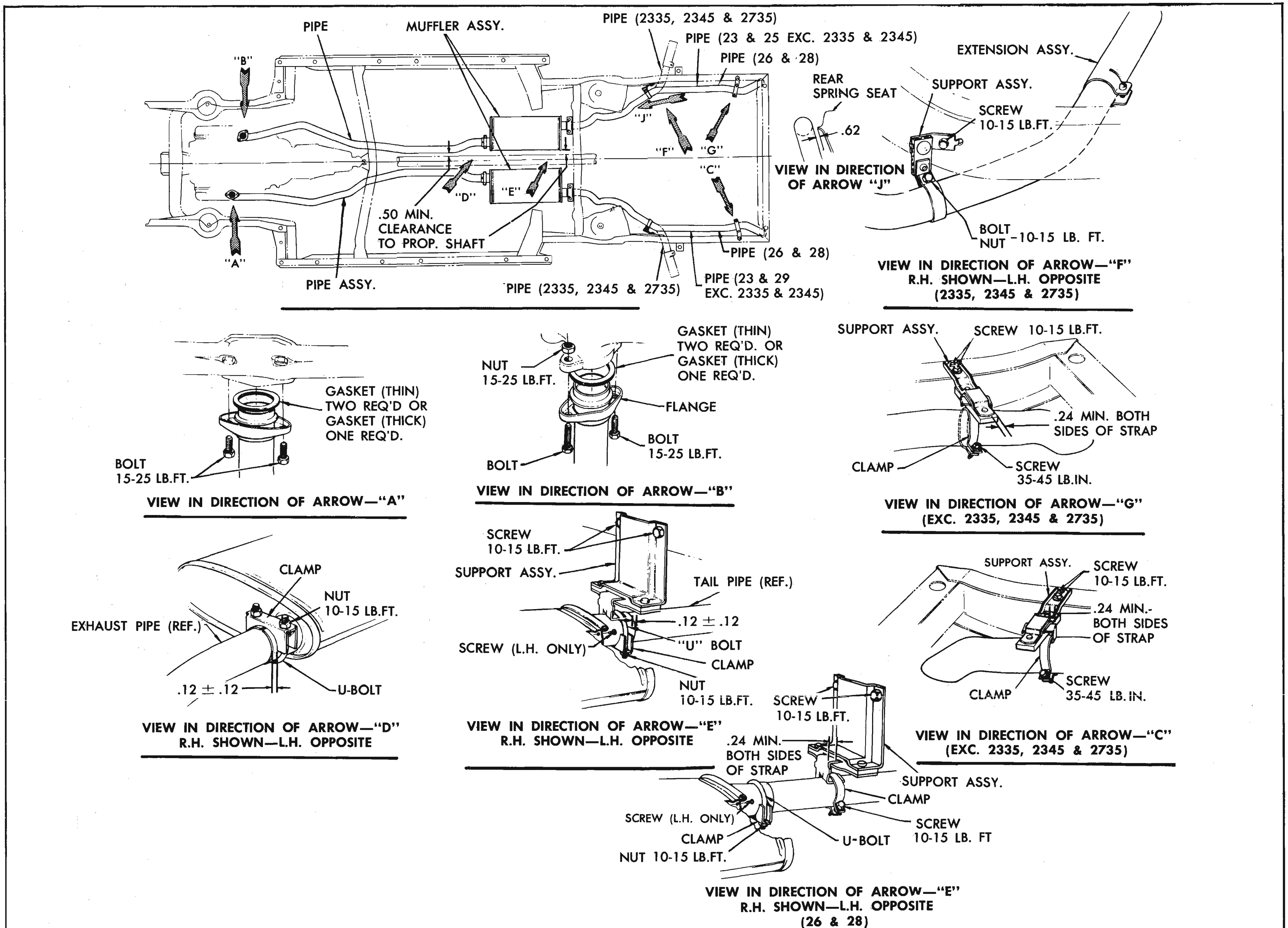


Fig. 8-12 Installation Details of Dual Exhaust System Less 425A Engine

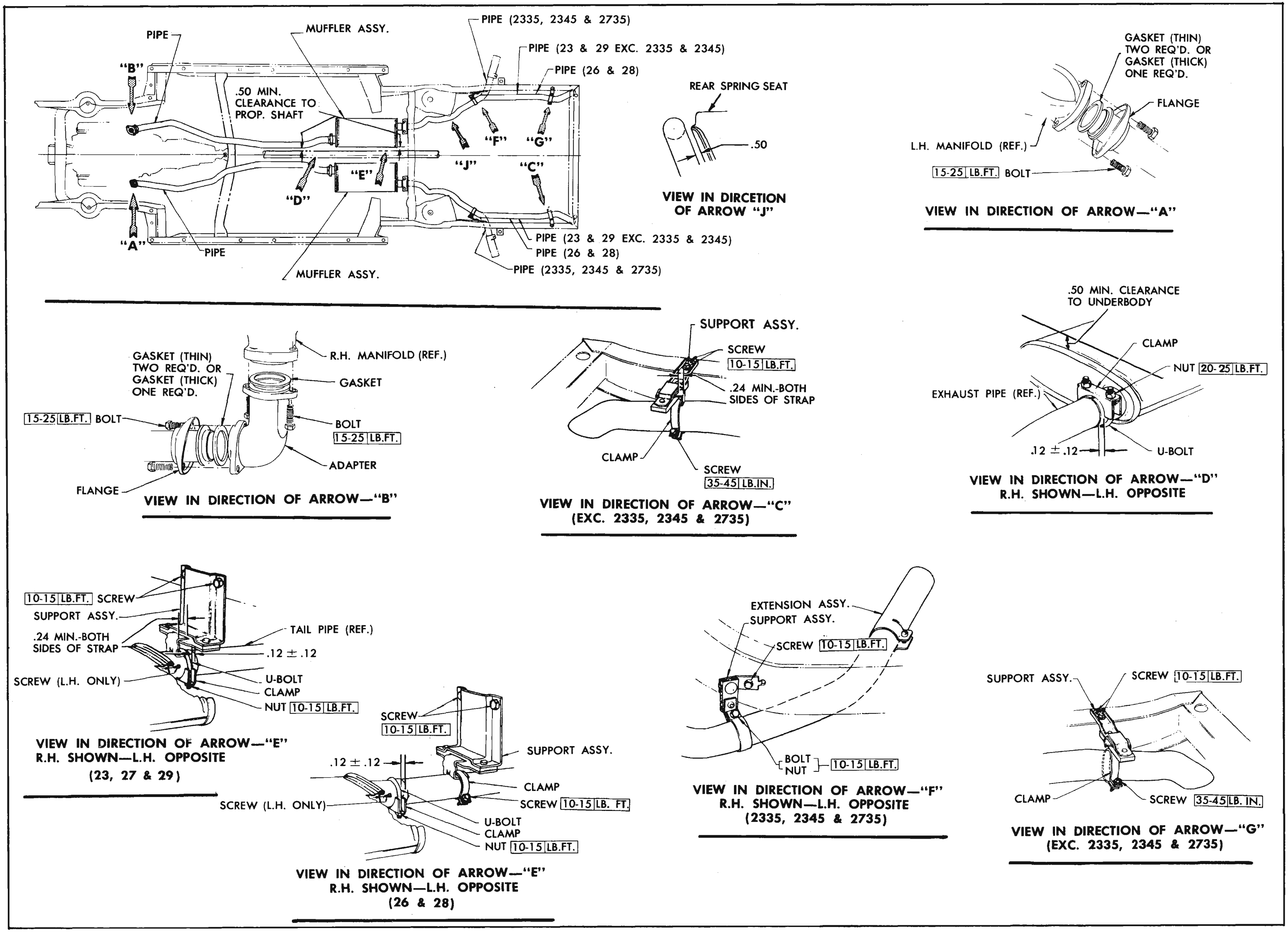


Fig. 8-13 Installation Details of Dual Exhaust System with 425A Engine

right side of the frame member. This support uses tire carcass reinforcing a butyle strap. The tail pipe rear support has its flexible portion of butyle strap construction.

The installation of these supports is very important. Improperly installed supports can cause annoying vibrations which are difficult to diagnose. Figs. 8-11 through 8-13 illustrate the correct location and installation of supports.

Figs. 8-11 through 8-13 illustrate the Safari rear support and Safari tail pipe extension. Particular attention should be paid to the dimensional requirements and that surfaces of strap are parallel.

SERVICES AND REPAIRS

EXHAUST MANIFOLD CROSSOVER PIPE—REMOVE AND REPLACE

1. Disconnect pitman arm at pitman shaft.
2. Disconnect crossover pipe at right and left exhaust manifolds.
3. Loosen exhaust manifold to exhaust pipe clamp.
4. Loosen tail pipe front bracket clamp (behind muffler).
5. Move exhaust pipe and muffler assembly rearwards.
6. Disconnect crossover pipe from exhaust pipe and remove crossover pipe assembly.
7. Install crossover pipe with new gaskets by reversing above steps.

NOTE: Insert and secure exhaust manifold to manifold bolts on both sides finger tight. Then tighten all bolts to 15-25 lb. ft. torque.

EXHAUST PIPE—REMOVE AND REPLACE

1. Loosen clamp retaining exhaust pipe to muffler inlet.
2. Remove exhaust pipe.
3. Replace exhaust pipe by reversing above steps.

NOTE: Tighten exhaust crossover to exhaust pipe clamp bolt nuts to 20-25 lb. ft. torque.

MUFFLER—REMOVE AND REPLACE

1. Loosen U-bolt clamp at muffler.
2. Loosen U-bolt clamp at rear of muffler and remove muffler.
3. Replace muffler by reversing above steps.

TAIL PIPE—REMOVE AND REPLACE

1. Jack rear of car up to allow clearance between frame and rear axle housing.
2. Loosen U-bolt clamp from muffler support at rear of muffler.
3. Remove U-bolt clamp from intermediate support.
4. Remove clamp from rear support.
5. Work tail pipes loose from muffler outlet and remove tail pipes from rear of car.
6. Replace tail pipes by reversing above steps.

SPECIFICATIONS

Fuel Tank Capacity:	
All except Safari Models	25 gal.
Safari Models	19 gal.
Exhaust Crossover Pipe Diameter	2″
Exhaust Pipe Diameter (Single)	2¼″
Exhaust Pipe Diameter (Dual)	2″
Exhaust Pipe Diameter (Dual 425A)	2¼″
Tail Pipe Diameter (Single)	2″
Tail Pipe Diameter (Dual)	1¾″
Tail Pipe Diameter (Dual 425A)	2″

WRENCH TORQUE SPECIFICATIONS

(Torque in lb. ft. unless otherwise shown)

TORQUE	SIZE	APPLICATION
		Fuel Tank and Gauge Unit
10-35 Lb. In.	No. 10-12	Screw—Fuel Tank Splash Baffle to Body
15-25 Lb. In.	No. 10-32	Screw and Lockwasher Assy.—Fuel Tank Outlet Fittings to Tank
40-80 Lb. In.	No. 14-10	Screw—Fuel Tank Filler Pipe Assy. to Body Bracket
15-25 Lb. In.	No. 10-32	Nut—Fuel Tank Gauge Terminal
		Fuel Tank Mounting and Fuel Pipes
35-90 Lb. In.	1/4-20	Screw—Fuel Pipe Clip to Frame
50-100 Lb. In.	3/8-16	Nut—Fuel Tank Strap to Body (Reinforced End)
*	1/4 NPTF	Fitting—Fuel Pump Hose to Pump (Inlet)
		Muffler—Exhaust Pipe—Tail Pipe
35-45 Lb. In.	No. 14-10	Screw—Tail Pipe Rear Support Clamp
10-15	5/16-24	Nut—Muffler to Exhaust Pipe Clamp "U" Bolt
10-15	5/16-24	Nut—Muffler Tail Pipe Clamp "U" Bolt
25-35	3/8-24	Nut—Exhaust Tail Pipe Clamp "U" Bolt
15-25	3/8-16	Bolt—Crossover Pipe to R and L Manifolds
18-30	3/8-24	Bolt—Crossover Pipe to RH Manifold
10-15	5/16-18	Screw—Tail Pipe Rear Support to Frame
10-15	5/16-24	Bolt and Nut—Tail Pipe Rear Support Clamp
10-15	5/16-18	Screw—Tail Pipe Front Support to Frame

NOTE (*) Torque not a requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.

(Also refer to Engine Wrench Torque Specifications)

STEERING

CONTENTS OF THIS SECTION

STANDARD STEERING GEAR

GENERAL DESCRIPTION

The standard steering gear (Fig. 9-1) is of the recirculating ball nut type having a gear ratio of 24 to 1 with an overall ratio of 29 to 1. The steering shaft, worm shaft and worm nut are all in line making a compact and easily serviced gear.

The steering shaft and worm shaft are separated with a flexible coupling which permits removal of the gear assembly or steering shaft (and column) independent of each other.

The mechanical element of this steering gear is a low-friction, high-efficiency recirculating ball system in which steel balls act as a rolling thread between the steering worm and nut. The nut is one piece and is geared to the sector of the pitman shaft. Lash between the pitman shaft and rack-piston nut is maintained by an adjusting screw which is retained in the end of the pitman shaft gear (Fig. 9-2).

The ball nut, mounted on the worm, is driven through steel balls which circulate in helical grooves in both the worm and nut. Ball return guides, attached to the nut, serve to recirculate the two sets of twenty-five balls each in the grooves.

As the steering wheel is turned to the right, the nut moves upward. When the wheel is turned to the left the nut moves downward.

The teeth on the sector, which are forged as part of the pitman shaft, and the ball nut are so designed that a tighter fit exists between the two when the front wheels are straight ahead. Proper engagement

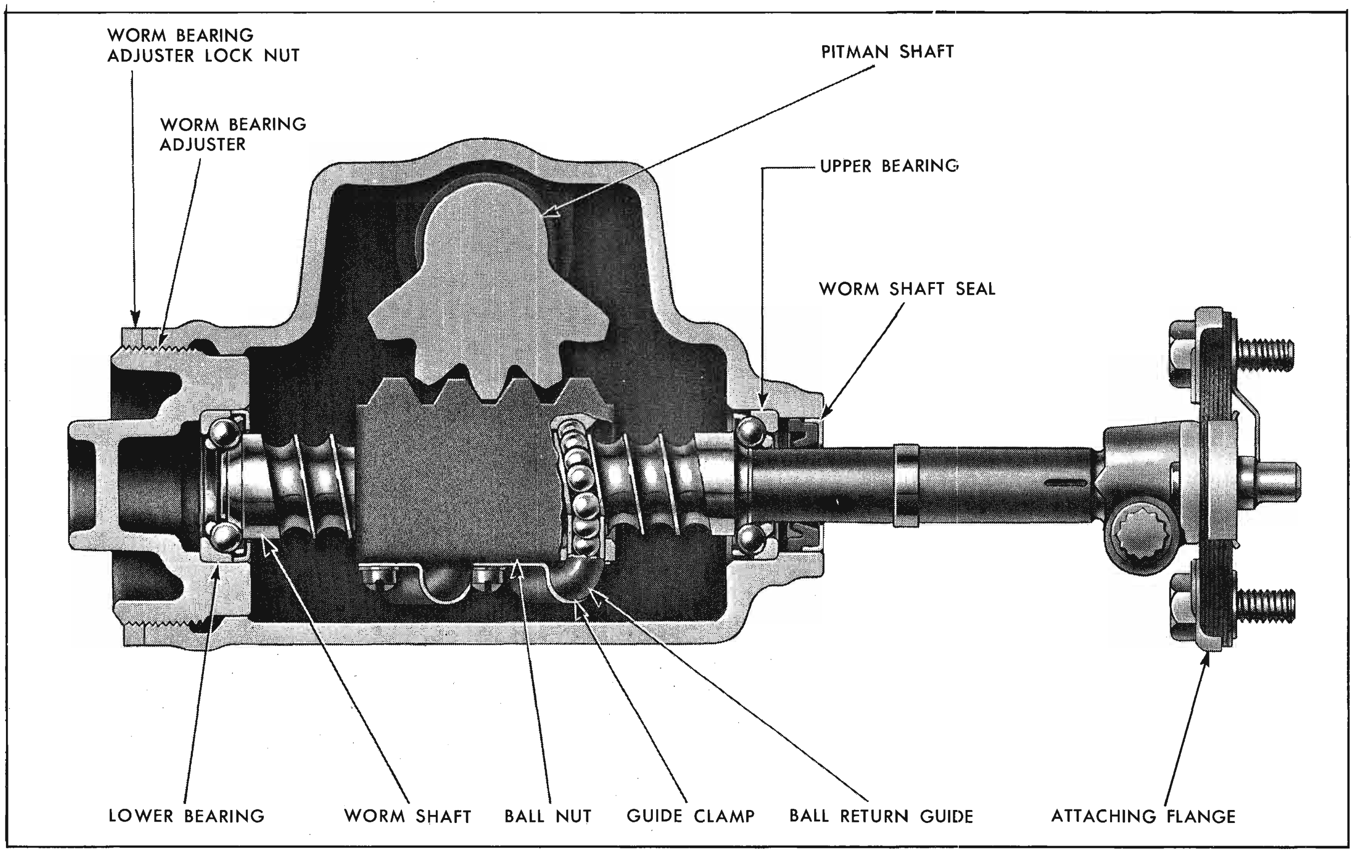


Fig. 9-1 Cross Section of Standard Steering Gear

between the sector and the ball nut is obtained by an adjusting screw which moves the pitman shaft endwise permitting desired engagement of the tapered teeth of the ball nut and sector gear. The worm bearing adjuster can be turned to provide proper preloading of the upper and lower bearings.

PERIODIC SERVICE

Periodic service consists of periodical lubrication as outlined in GENERAL LUBRICATION Section.

ADJUSTMENTS ON CAR

Correct adjustment of the steering gear is extremely important and can only be obtained by following the correct procedure. Before any adjustments are made to the steering gear in an attempt to correct such conditions as shimmy, hard or loose steering and road shocks, careful check should be made to determine that front end alignment, shock absorbers, wheel balance and tire pressure are correctly adjusted and/or operating satisfactorily.

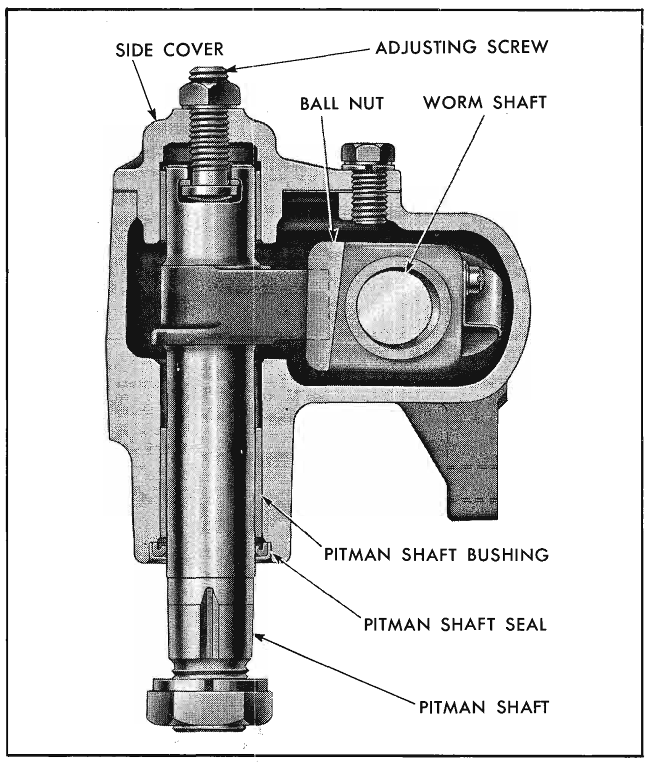


Fig. 9-2 Cross Section Through Pitman Shaft

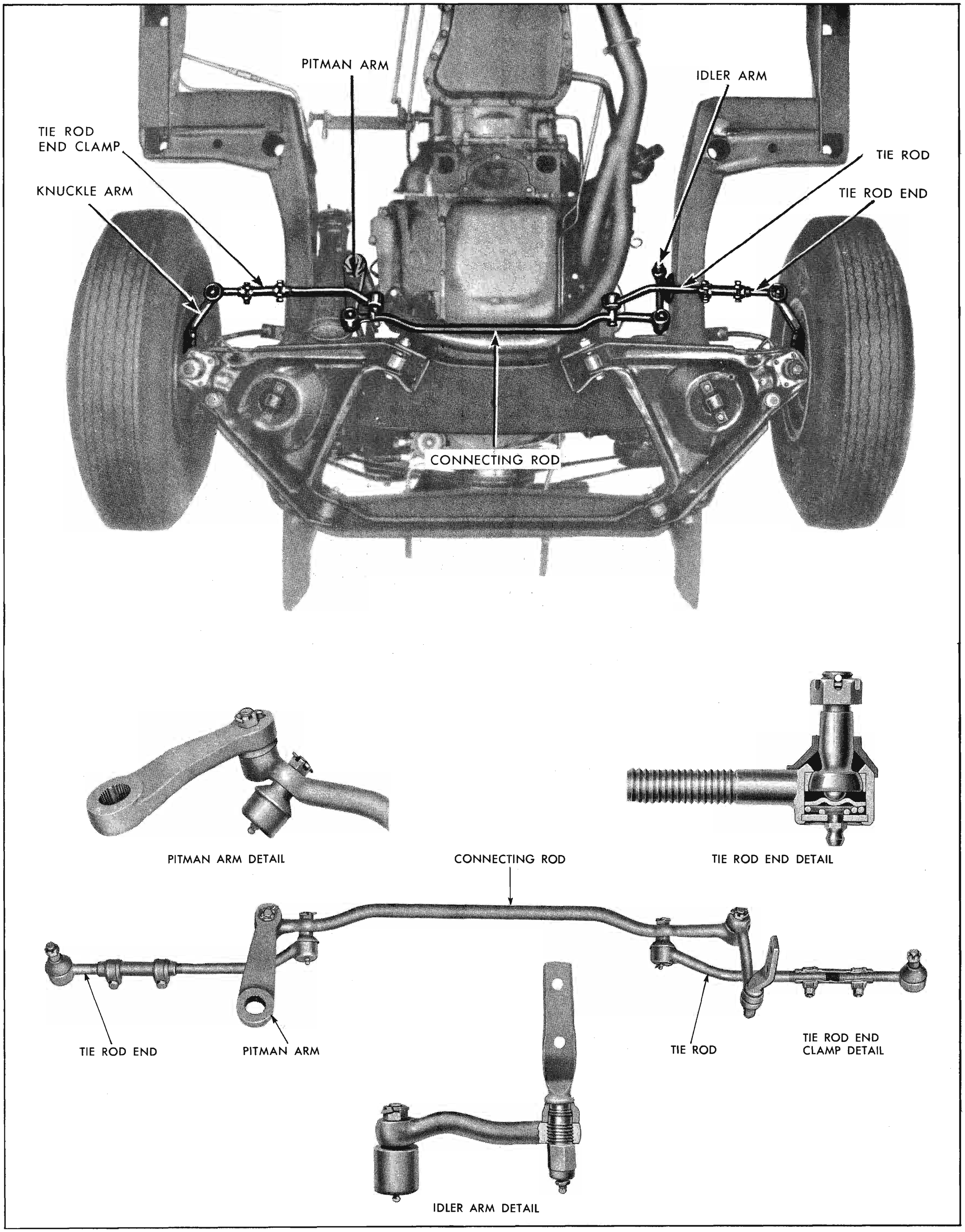


Fig. 9-3 Steering Linkage

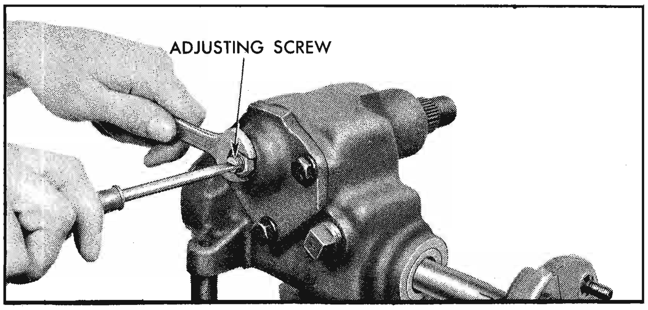


Fig. 9-4 Adjusting Pitman and Ball Nut Backlash

There are two adjustments on the recirculating ball type steering gear:

1. Worm bearing preload adjustment.

2. Sector and ball nut backlash adjustment.

CAUTION: It is very important when adjusting the steering gear that the adjustments be made in the above sequence. Failure to do so will result in damage to the steering gear.

ADJUST WORM BEARING PRELOAD

1. Disconnect steering connecting rod from pitman arm (Fig. 9-3).

2. Loosen pitman shaft adjusting screw lock nut and back off adjusting screw a few turns (Fig. 9-4).

3. Remove horn button or horn ring and steering wheel.

4. With inch pound torque wrench attached to a ⅝"-12 point socket, measure and record at least 30° off center (Fig. 9-5).

NOTE: Do not use a torque wrench having maximum torque reading of more than 100 inch pounds. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.

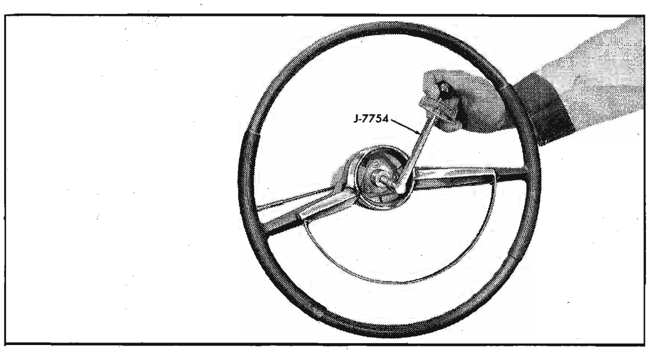


Fig. 9-5 Checking Steering Gear Adjustment

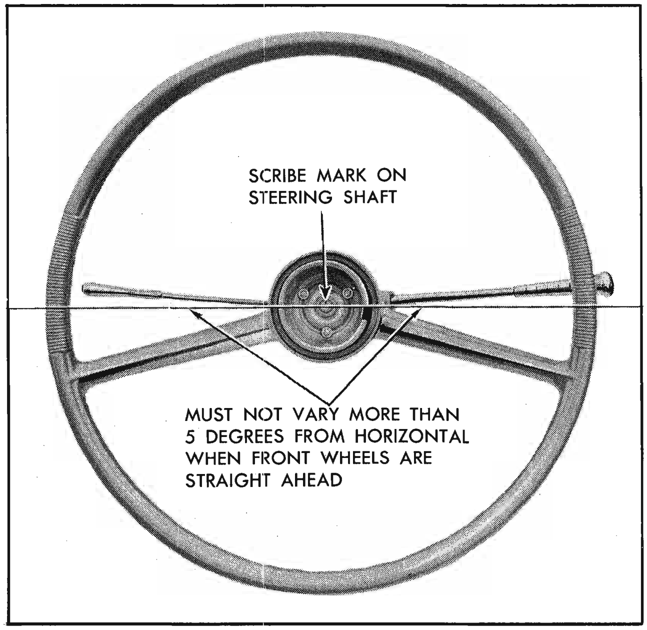


Fig. 9-6 Locating Steering Wheel Position

5. Torque required should be between 6-10 lb. ins. To correct, loosen worm bearing adjuster lock nut with brass drift and turn adjuster to bring spring scale pull within limits.

6. Retighten lock nut when adjustment is correct and recheck as in step 4 above.

ADJUST SECTOR AND BALL NUT BACKLASH

1. When worm bearing preload has been adjusted correctly, pitman shaft adjusting screw should be turned clockwise until a pull equal to the worm bearing preload plus 2-6 lb. ins. is required to turn the wheel through center.

2. Tighten pitman shaft adjusting screw lock nut, and recheck adjustment.

3. Reassemble steering connecting rod to pitman arm. Set spokes of steering wheel in straight ahead position (mark on steering shaft up, Fig. 9-6). If road wheels are not straight ahead, adjust steering tie rods.

MINOR REPAIRS

STANDARD STEERING WHEEL— REMOVE AND REPLACE

REMOVE

1. Remove horn button (Fig. 9-7).

2. Remove three screws and insulators and remove horn button retainer.

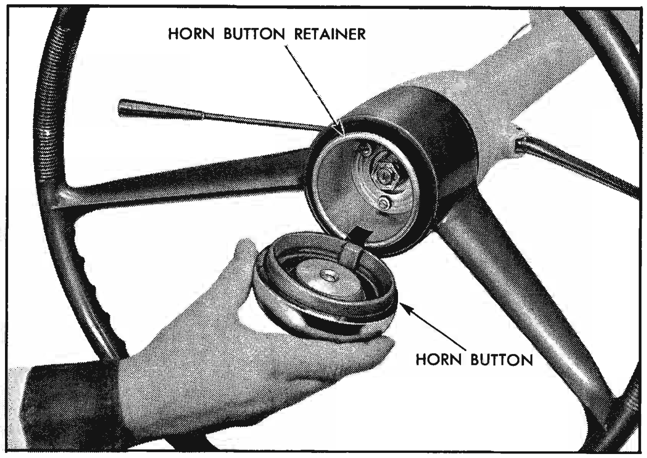


Fig. 9-7 Removing Standard Steering Wheel Horn Button

3. Remove contact ring.

4. Remove pivot contact, spring and insulator.

5. Remove lock nut, retaining nut and washer from steering gear shaft.

6. Remove contact plate.

7. Remove steering wheel from shaft, using puller J-3044.

8. Remove coil spring and seat from steering gear shaft.

REPLACE

1. Install seat and spring on steering gear shaft.

NOTE: If new steering wheel is to be installed, make certain direction signal cancelling pin is installed in hub at rear of new wheel.

2. Install steering wheel over shaft, making certain splines on inner bore of wheel align with outside diameter of shaft.

NOTE: Scribe mark on steering shaft must be positioned at top of shaft and steering wheel must not vary more than five degrees from horizontal when front wheels are straight ahead (Fig. 9-6).

3. Install contact plate.

4. Install washer and steering wheel retaining nut.

5. Tighten retaining nut until steering wheel is drawn down to within .090"-.120" of actuator assembly. Torque nut 20-35 lb. ft.

6. Install lock nut and torque 60-120 lb. in.

7. Install pivot contact, spring and insulator.

8. Install contact ring.

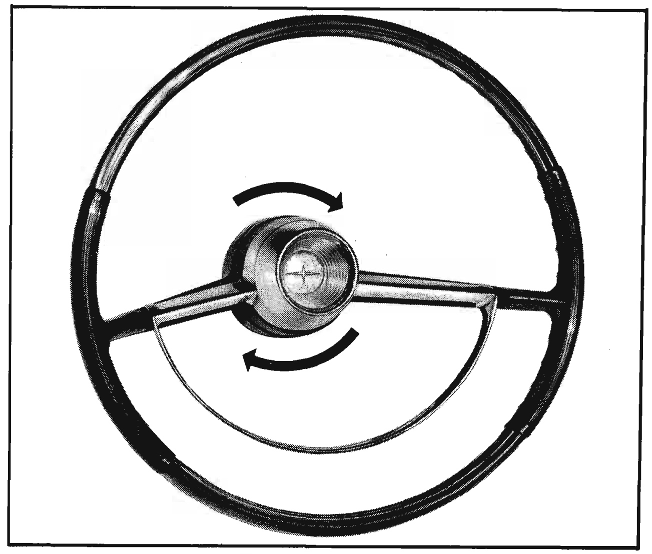


Fig. 9-8 Removing Deluxe Steering Wheel Horn Button

9. Install horn button retainer, three screws and insulators. Tighten screws securely.

10. Install horn button, making certain rubber flange on inner side of horn button lines up with notch of horn button retainer.

DELUXE STEERING WHEEL—REMOVE AND REPLACE

REMOVE

1. Twist steering wheel ornament and lift to remove (Fig. 9-8).

2. Remove lock nut, retaining nut and washer from steering gear shaft.

3. Pull horn ring and contact assembly from steering gear shaft.

4. Remove three contact assembly to horn ring retaining screws and remove contact assembly from horn ring.

5. Remove pivot contact, spring and insulator from hub of steering wheel.

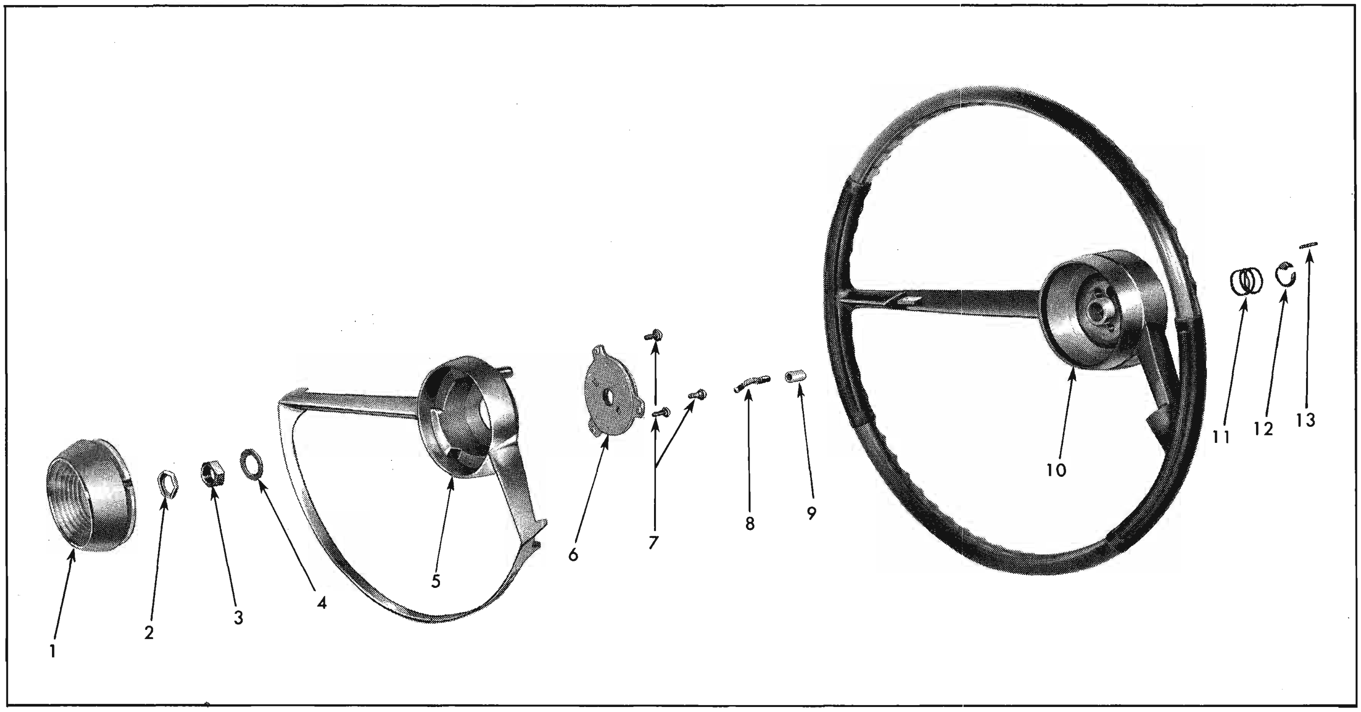
6. Remove steering wheel from shaft, using puller J-3044.

7. Remove coil spring and seat from steering gear shaft.

REPLACE

1. Install seat and spring on steering gear shaft.

NOTE: If new steering wheel is to be installed, make certain direction signal cancelling pin is installed in hub at rear of new wheel.



1. Ornament Assembly
2. Lock Nut
3. Nut
4. Washer
5. Horn Ring
6. Contact Assembly
7. Contact Retaining Screws
8. Connector Contact Assembly
9. Connector Insulator
10. Steering Wheel
11. Shaft Upper Bearing Spring
12. Shaft Upper Spring Seat
13. Slotted Spring Pin

Fig. 9-9 Deluxe Steering Wheel—Exploded View

2. Install steering wheel over shaft, making certain splines on inner bore of wheel and O.D. of shaft, line up.

NOTE: Scribe mark on steering shaft must be positioned at top of shaft and steering wheel must not vary more than five degrees from horizontal when front wheels are straight ahead (Fig. 9-6).

3. Install pivot contact, spring and insulator in hub of wheel.

4. Install contact assembly on rear of horn ring and insert three contact assembly to horn ring retaining screws. Tighten screws until snug.

5. Install horn ring and contact assembly on steering gear shaft.

6. Install washer and steering wheel retaining nut and torque 20-35 lb. ft.

7. Install lock nut and torque 60-120 lb. in.

8. Install steering wheel ornament, twisting to seat.

STEERING COLUMN (SYNCHRO-MESH TRANSMISSION)—OVERHAUL

REMOVE

1. Disconnect first and reverse shifter rod from lower lever and second and third shifter rod from upper lever at steering column (Fig. 9-10).

2. Remove nut and washer from bottom steering column clamp bolt (Fig. 9-11).

3. Remove two steering shaft to steering gear retaining bolts.

4. Remove steering wheel as outlined under STANDARD STEERING WHEEL—REMOVE or DELUXE STEERING WHEEL—REMOVE.

5. Remove two steering column bracket to instrument panel attaching screws and washers and remove bracket and insulator.

6. Remove six screws securing toe pan to floor pan.

7. Remove two steering column seal retainer to cover plate screws.

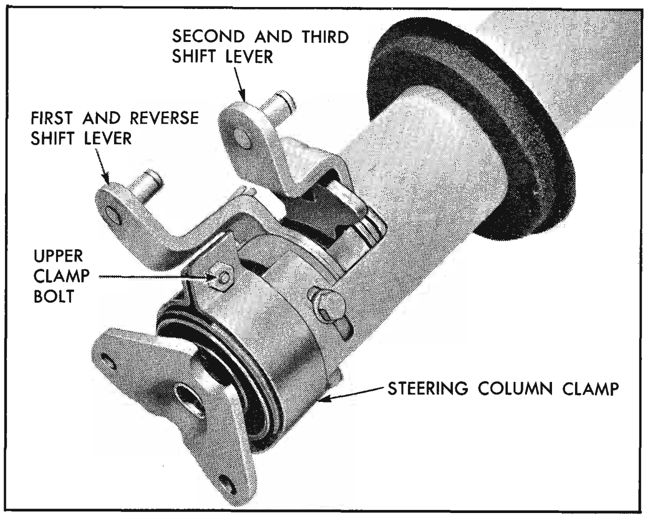


Fig. 9-10 Disconnecting Shifter Rods

8. Disengage clutch rod at clutch pedal by removing cotter pin.

NOTE: It is not necessary to loosen clutch rod clevis adjusting nuts to disconnect clutch rod from clutch pedal.

9. Push clutch rod insulator through hole in toe pan.

10. Lift toe pan over end of clutch rod and remove.

11. Disconnect horn cable from terminal.

12. Remove wiring connectors from back-up light and direction indicator switch terminals.

13. Rotate steering column so that back-up light and turn indicator switch assemblies will clear dash panel and withdraw entire steering column and shaft assembly.

STEERING COLUMN (SYNCHRO-MESH TRANSMISSION)—DISASSEMBLE

1. Loosen upper bolt on steering column clamp and slip clamp over lower end of column.

2. Remove steering gear shaft from lower end of steering column housing.

3. Remove screw and star washer securing back-up light switch assembly and remove switch from steering column housing.

4. Remove back-up light trip lever retaining screw and washer and remove lever through opening in steering column housing (Fig. 9-12).

5. Remove two screws and star washers and remove direction signal switch assembly and horn wire retainer from steering column housing.

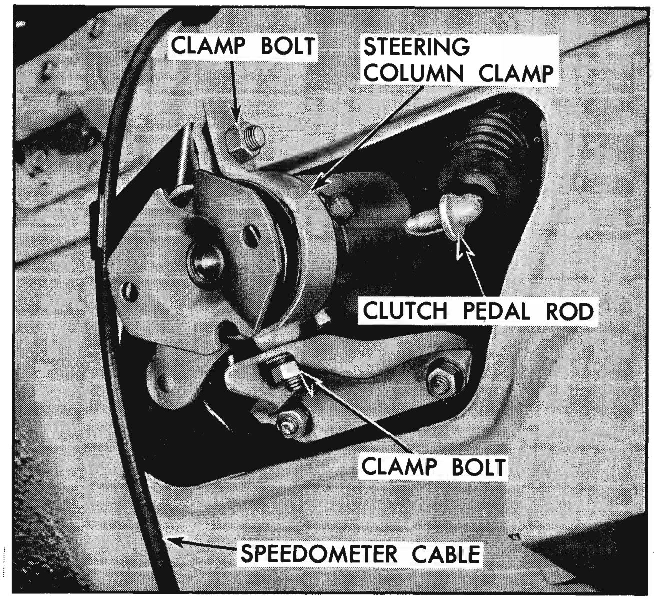


Fig. 9-11 Location of Nut and Washer

6. Hold actuator rod anti-rattle coil spring and bearing plate and remove hairpin type spring actuator lever from actuator rod (Fig. 9-13).

NOTE: A rag or steering column insulator felt stuffed into the opening below the actuator rod will prevent loss of coil spring.

7. Remove anti-rattle spring and bearing plate.

8. Pull actuator rod out from top end of steering column.

9. Remove horn contact assembly and horn wire from end of upper bearing support assembly.

10. Remove three screws which retain actuator housing and remove housing (Fig. 9-14).

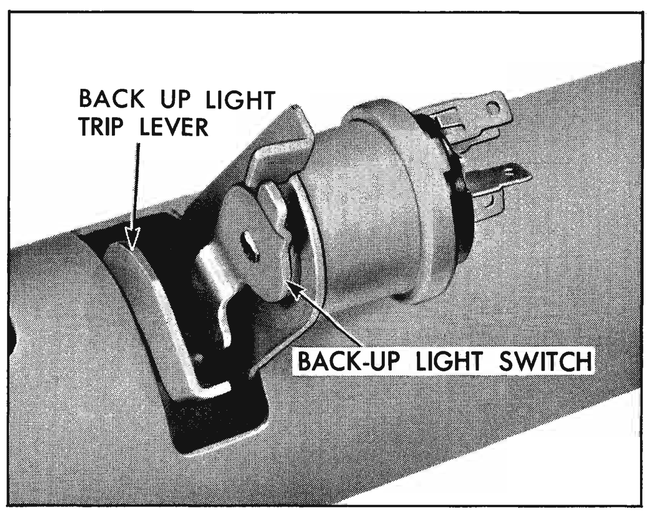


Fig. 9-12 Back-Up Light Trip Lever Location

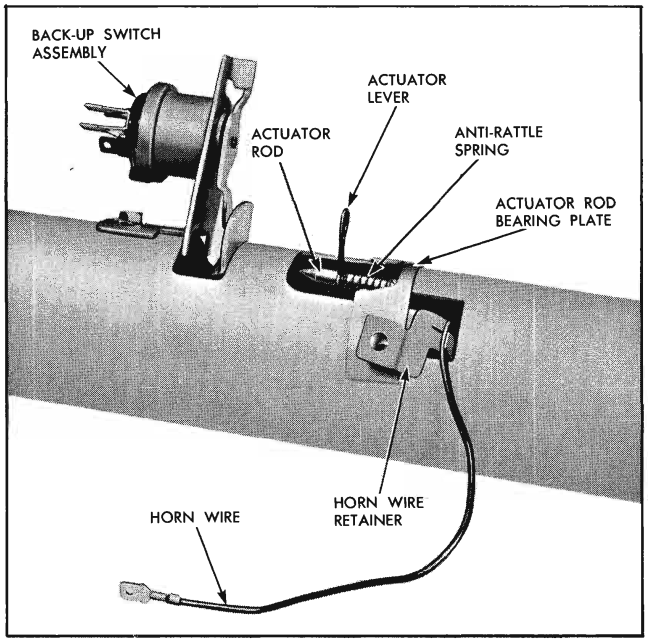


Fig. 9-13 Location of Actuator Lever

11. Actuator yoke can be removed from housing by removing control lever and pressing out shield.

12. Remove upper bearing support assembly from top end of shifter tube (Fig. 9-15).

13. Remove bearing sleeve from inside bearing.

14. Remove flat washer and wave washer from shifter tube.

15. Disengage and remove bearing support lock plate (Fig. 9-16).

16. Tap out gearshift lever pivot pin, using punch.

17. Remove gearshift lever and, using needle nose pliers, remove anti-rattle spring (Fig. 9-17).

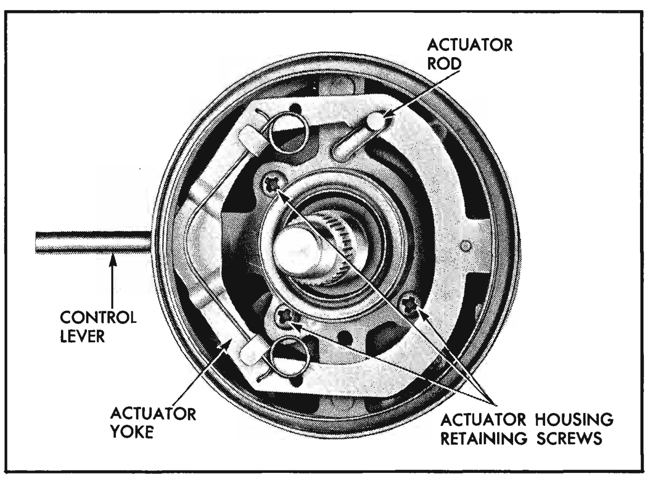


Fig. 9-14 Location of Actuator Yoke

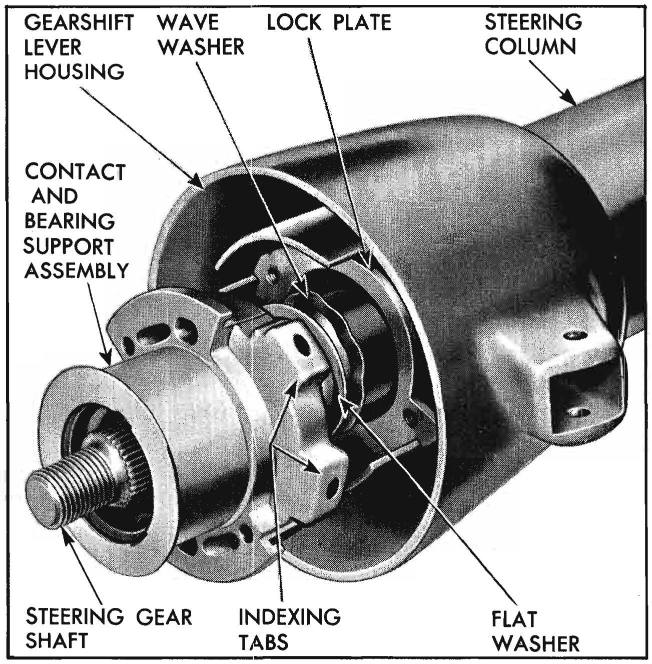


Fig. 9-15 Removing Upper Bearing Assembly

18. Slide gearshift lever housing off end of steering column.

19. Remove rear retainer plate from shifter tube (Fig. 9-18).

20. Using screwdriver or other suitable tool, remove seal from lower end of steering column housing.

21. Remove three lower bearing adjusting bolts and remove lower bearing and first and reverse shift lever assembly from shifter tube.

22. Using soft hammer, tap upper end of shifter tube until tube, with second-third shift lever assembly, and upper bearing is free, and remove entire assembly from lower end of steering column.

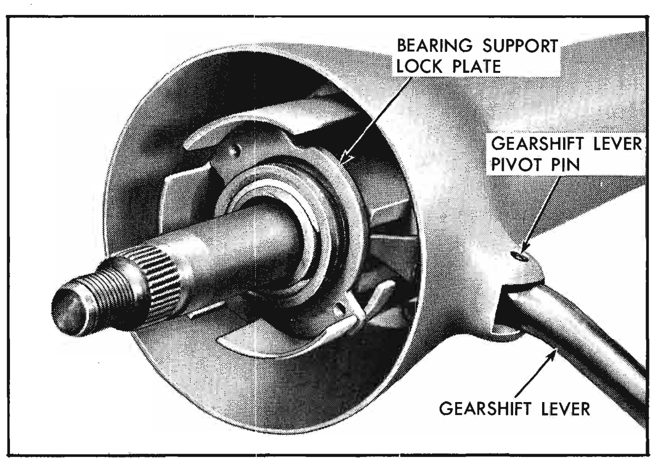


Fig. 9-16 Location of Bearing Support Lock Plate

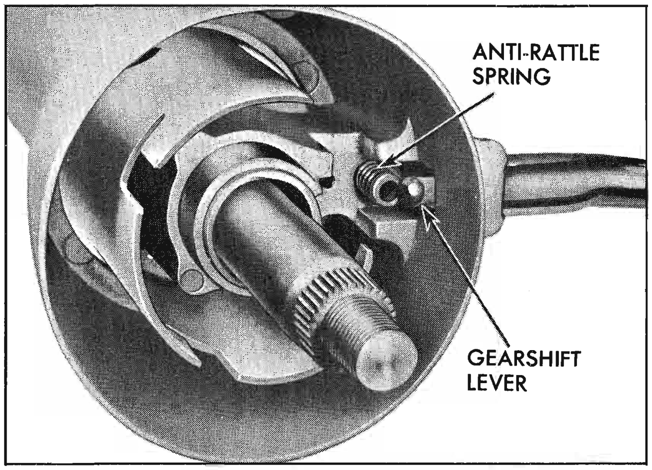


Fig. 9-17 Location of Shift Lever Spring

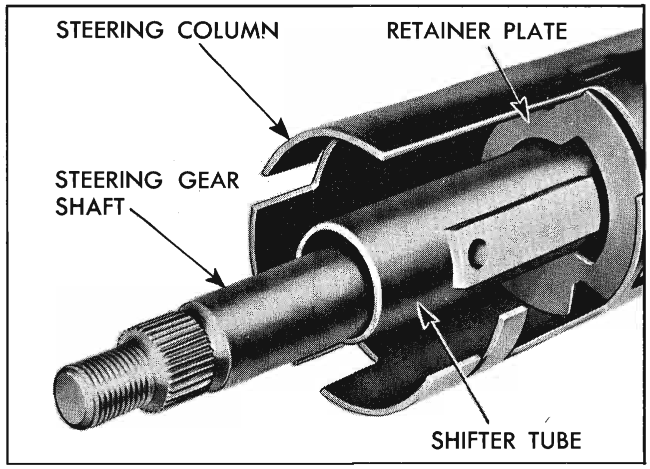
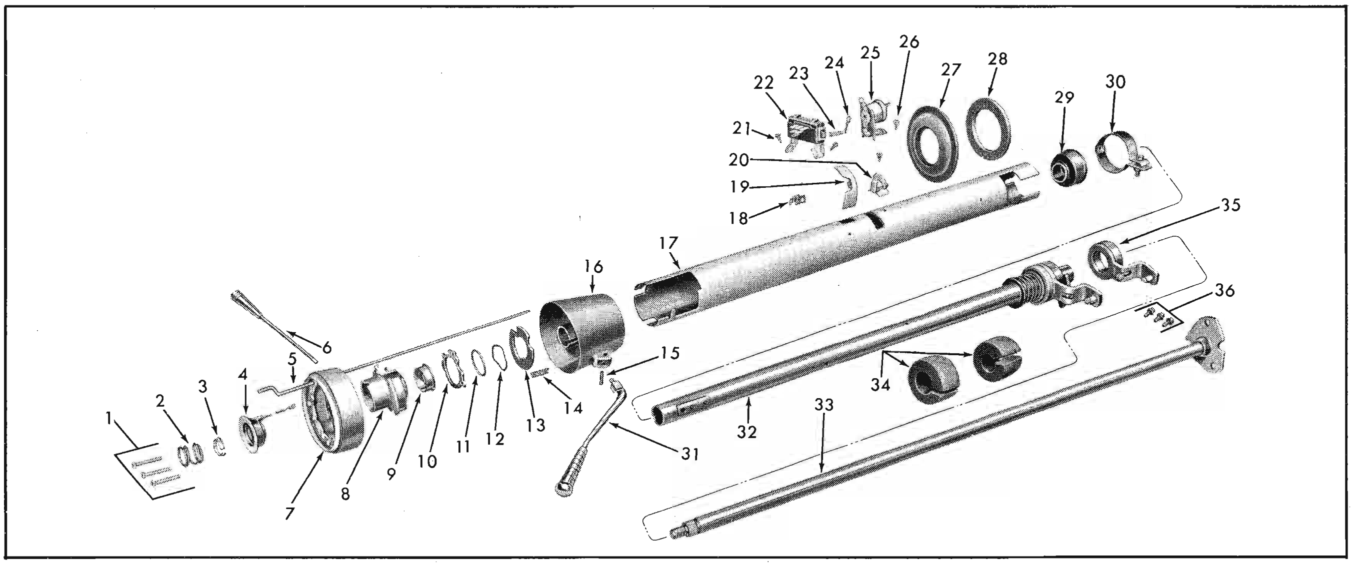
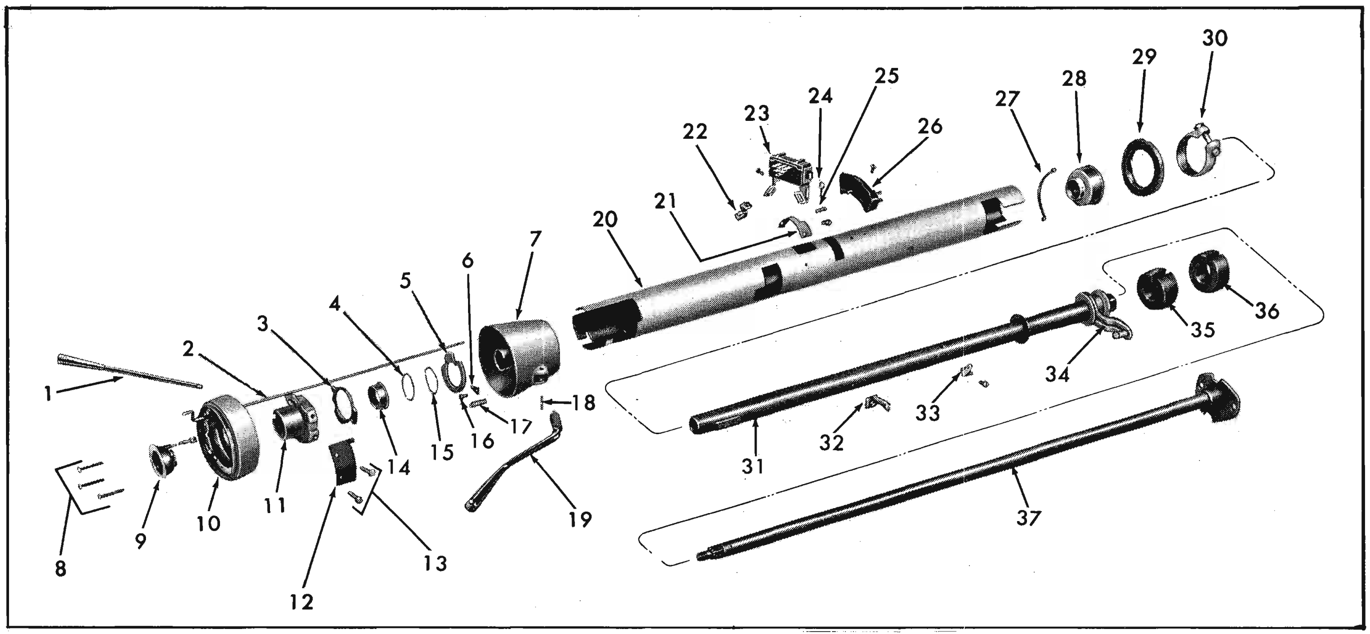


Fig. 9-18 Location of Retainer Plate



1. Screw, Strg. Shaft Upper Brg. (#8-32 x 1 1/4")
2. Spring, Strg. Shaft Upper Brg.
3. Seat, Strg. Shaft Upper Brg. Spring
4. Contact and Cable, Horn Button
5. Rod, Switch Actuator
6. Lever Assy., Direction Signal Switch
7. Housing Assy., Direction Signal Switch
8. Support, Gearshift Shaft Upper Bearing
9. Plate, Contact Upper Brg.
10. Plate, Brg. Support and Direction Signal Lock
11. Washer, Gearshift Lever—Thrust
12. Washer, Gearshift Lever Housing—Wave
13. Retainer, Gearshift Lever Housing
14. Spring, Gearshift Lever Tension
15. Pin, Gearshift Lever Pivot
16. Housing Assy., Gearshift Lever Support
17. Jacket, Strg. Column
18. Retainer, Horn Cable
19. Bearing, Actuator Rod
20. Lever, Trans., Neutralizer and Back-Up Lamp Switch
21. Screw (No. 10—16 x 3/8")
22. Switch Assy., Direction Signal
23. Spring, Switch Actuator Rod Anti-Rattle
24. Lever, Direction Signal Switch Actuator
25. Switch Assy., Back-Up Lamp
26. Screw, Back-Up Lamp Switch
27. Grommet, Strg. Column Toe Plate
28. Seal, Strg. Column—Felt
29. Adapter Assy., Strg. Shaft Lower Brg.
30. Clamp, Strg. Shaft Jacket
31. Lever, Transmission Gearshift
32. Tube Assy., Strg. Column Gearshift
33. Shaft and Flange, Strg. Gear Upper
34. Insulator, Strg. Column
35. Lever, Gearshift Lower Control
36. Bolt, Gearshift Lower Brg. to Jacket

Fig. 9-19 Steering Column for Synchro-Mesh Transmission—Exploded View



1. Lever Assy., Direction Signal Switch
2. Rod, Switch Actuator
3. Plate, Brg. Support and Direction Signal Lock
4. Washer, Gearshift Lever—Thrust
5. Retainer, Gearshift Lever Housing
6. Pin, Strg. Column Gearshift Tube Locating
7. Housing, Gearshift Lever Support
8. Screw, Strg. Shaft Upper Brg.
9. Contact and Cable, Horn Button
10. Housing Assy., Direction Signal Switch
11. Support, Gearshift Shaft Upper Brg.
12. Plate, Gearshift Interlock
13. Screw, Housing Shield
14. Plate, Contact Upper Brg.
15. Washer, Gearshift Lever Housing —Wave
16. Screw, Lock Plate
17. Spring, Gearshift Lever Tension
18. Pin, Gearshift Lever Pivot
19. Lever, Transmission Gearshift
20. Jacket, Strg. Column
21. Bearing, Actuator Rod
22. Retainer, Horn Cable
23. Switch Assy., Direction Signal
24. Lever, Direction Signal Switch Actuator
25. Spring, Switch Actuator Rod Anti-Rattle
26. Switch Assy., Back-Up Lamp
27. Spring, Gearshift Tube Anti-Rattle
28. Adapter Assy., Strg. Shaft Lower Brg.
29. Seal, Strg. Column—Felt
30. Clamp, Strg. Shaft Jacket
31. Tube Assy., Strg. Column Gearshift
32. Lever, Trans. Gearshift Indicator
33. Lever, Trans. Neutralizer and Back-Up Lamp Switch
34. Lever, Gearshift Lower Control
35. Insulator, Steering Column
36. Insulator, Steering Column
37. Shaft and Flange, Strg. Gear Upper

Fig. 9-20 Steering Column for Hydra-Matic Transmission—Exploded View

23. Remove belt insulators from inside of steering column.

24. Remove rubber grommet from steering column.

STEERING COLUMN (SYNCHRO-MESH TRANSMISSION)—ASSEMBLE

1. Install new rubber grommet over steering column, positioning grommet toward upper end of column.

2. Install new belt insulators over shifter tube, positioning them just above spring upper bearing and second-third shift lever assembly.

3. Insert shifter tube with bearing and second-third shift lever assembly into lower end of steering column, making certain belt insulators remain in position.

4. Using soft hammer, tap lower end of shifter tube until upper bearing is firmly seated against flanges in steering column.

5. Assemble first and reverse shift lever assembly in lower bearing and check for free rotation of lever in bearing.

NOTE: Clean bearing surfaces with emery cloth, if necessary, to insure freedom of rotation.

6. Install spacer, first-reverse shift lever assembly and lower bearing over end of shifter tube, seating firmly against spacer.

7. Line up three adjusting bolt holes in lower bear-

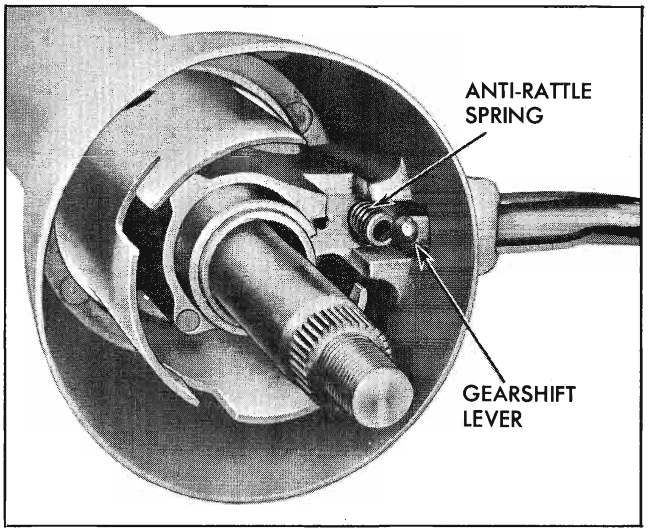


Fig. 9-21 Installing Anti-Rattle Spring

ing with three slots in column housing and insert three adjusting bolts finger tight.

8. Rotate lower bearing and adjust to obtain .012" maximum end play.

NOTE: Shift levers must rotate freely after adjustment.

9. Torque three lower bearing adjusting bolts to 85-125 lb. in.

10. Install new tube support bearing in lower end of steering column housing and seat firmly, using soft hammer.

11. Install steering column clamp over lower end of steering column.

NOTE: Upper clamp bolt should be finger tightened only.

12. Install rear retainer plate over upper end of shifter tube.

13. Install gearshift lever housing over end of steering column.

14. Using needle nose pliers, insert gearshift lever anti-rattle spring in depression located in housing (apply grease to spring to prevent squeak), (Fig. 9-21).

15. Install gearshift lever, depressing anti-rattle spring as lever is inserted.

NOTE: Use shim stock over spring to aid in assembly of gearshift lever.

16. Install new pivot pin through housing and gearshift lever, tapping pin in until flush with surface of gearshift lever boss on housing.

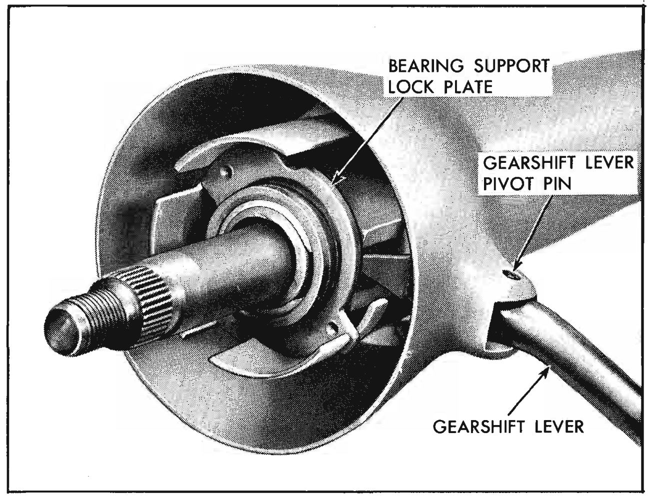


Fig. 9-22 Bearing Support Lock Plate in Position

17. Install bearing support lock plate, engaging flanges on plate in notches of steering column housing (Fig. 9-22).

18. Install wave washer and flat washer over end of shifter tube, positioning wave washer toward lock plate.

19. Install new sleeve in inside diameter of upper bearing, flanged side out, and position upper bearing support over shifter tube, indexing two tabs of support in cutouts at upper end of steering column (Fig. 9-23). The bearing support will properly center shifter tube at upper end of column.

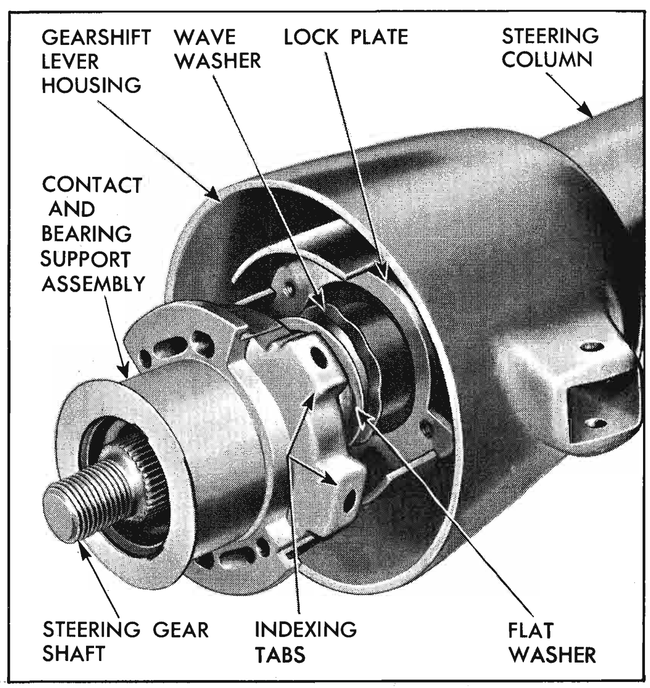


Fig. 9-23 Installing Bearing Support Assembly

20. Install horn wire and contact assembly in end of bearing support, snaking wire through outer slots of bearing support lock plate and retainer plate and between steering column housing and shifter tube.

NOTE: Attaching a suitably firm wire to end of horn wire will simplify installation of horn wire in steering column.

21. Pull end of horn wire out appropriate opening in steering column housing.

22. Install actuator housing over upper bearing support and insert three retaining screws. Torque 10-35 lb. in.

23. Install actuator rod bearing plate, direction signal switch and horn wire retainer in appropriate position on housing.

24. Insert two screws and star washers, finger tight.

25. Insert actuator rod through opening in actuator housing, and engage lower end of rod in retaining hole of bearing plate.

26. Engage top end of actuator rod in slot of actuator housing.

27. Install anti-rattle spring on lower end of actuator rod, exercising extreme care to prevent spring from falling inside steering column housing.

28. With carrier in neutral, insert .090″-.093″ dia. gauge into two holes in switch bracket and install actuator lever, engaging lever on prong of switch.

29. Torque two direction signal switch retaining screws 10-35 lb. in.

NOTE: There should be no tension on actuator rod when screws are tightened.

30. Insert horn wire through wire retainer.

31. Install back-up light trip lever through lower opening in steering column housing and position on shifter tube. Insert retaining screw and star washer and tighten securely.

32. Install back-up light switch assembly on steering column housing and insert retaining screw and star washer. Tighten securely.

NOTE: When upper shift lever is placed in "reverse" position and released, trip lever must hold back-up light switch lever in "on" position. If necessary, bend trip lever to obtain this condition, making certain the movement of upper shift lever to "second" position does not actuate switch.

33. Insert steering gear shaft at lower end of steering column housing, being extremely careful not to damage seal.

STANDARD (SYNCHRO-MESH TRANSMISMISSION) STEERING COLUMN–INSTALL

1. Insert lower end of steering column assembly through opening in floor of vehicle, lowering column until steering shaft flange and steering gear housing flange meet.

2. Position steering column clamp so that lower clamp bolt can be inserted through hole in brace and install retaining nut and washer. Tighten nut securely.

3. Insert two steering shaft to steering gear retaining bolts, but do not tighten.

4. Install instrument panel bracket and insulator around steering column and insert attaching screws and washers, but do not tighten.

5. Securely tighten steering shaft to steering gear retaining bolts.

6. Securely tighten steering column bracket to instrument panel attaching screws.

7. Attach steering column seal retainer to cover plate with two screws.

8. Insert clutch rod through hole in toe pan and position toe pan around steering column.

9. Install clutch rod insulator through hole in toe pan so that clutch rod is held firmly.

10. Insert six toe pan retaining screws and tighten securely.

11. Position rubber grommet against toe pan.

12. Engage clutch rod with clutch pedal and insert cotter pin.

NOTE: If clutch rod clevis adjusting nuts were not loosened during disassembly, clutch pedal height will probably be correct.

13. Connect horn cable to horn terminal.

14. Plug in wiring connectors at back-up light and direction indicator switch terminals.

15. Install steering wheel as outlined under STANDARD STEERING WHEEL–REPLACE or DELUXE STEERING WHEEL–REPLACE.

16. When steering wheel is drawn down to within .090″-.120″ of actuator assembly, tighten top steering column clamp bolt 10-20 lb. ft. torque.

17. Connect first and reverse shifter rod to lower lever and second and third shifter rod to upper lever at steering column (Fig. 9-24).

18. Place gauge J-8638 in position, and with both lower steering column shift levers held in neutral position and both transmission shift levers in neutral detent, adjust rods by adjusting nuts at both sides of trunnion at shift levers.

19. Torque lock nuts at both sides of trunnions 60-120 lb. in.

20. Adjust pedal lash by loosening clutch fork rod adjusting lock nut (Fig. 9-25).

21. Remove lash (release bearing touching clutch pressure plate levers) with adjusting nut, then back off adjusting nut 3½ to 3¾ turns. Pedal lash should be approximately ¾".

22. Tighten lock nut to 60-120 lb. in. torque.

23. If clutch pedal height is not correct (6-6¼" above floor mat of vehicle), adjust clevis at end of clutch rod until proper height is attained.

24. Check shift pattern movement with engine off; then start engine and perform shift pattern.

NOTE: If shifter rod adjustments are made as outlined above, and clutch pedal height and lash are correct, shifting should be smooth in and out of any gear with proper movement of selector lever by the operator.

REPLACE STEERING LINKAGE

Steering connecting rod may be removed from both tie rods, pitman arm and idler arm by removing the ball shaft nut (Figs. 9-26 and 9-27). Since the connecting rod is a solid shaft, it may be replaced by installing new rod and connecting to pitman arm, tie rods, and idler arm.

After steering connecting rod is removed pitman arm may be removed from pitman shaft by removing the nut and lock washer and by using puller J-5504. To install pitman arm on pitman shaft, replace arm, lock washer and nut and tighten to 110-140 lb. ft. torque.

After steering connecting rod is removed, idler arm may be removed by removing two bolts which retain idler support to frame. The idler support and idler arm may then be separated, first threading idler support from bushing and then threading the idler arm from bushing. In reassembling, install bushing in idler arm and tighten to 100 lb. ft. torque. Next, thread

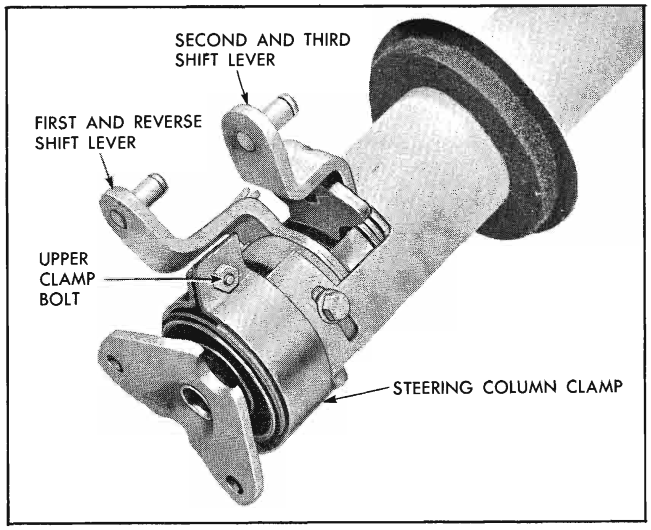


Fig. 9-24 Shifter Lever Identification

idler support and seal into bushing until distance between upper face of lever and shoulder on support is approximately $1\frac{1}{16}$". Install assembly on frame with two attaching bolts and tighten to 18-20 lb. ft. torque.

Tie rod assembly may be removed from car by removing cotter pin and castellated nut on tie rod ends at steering arms. To separate tie rod and tie rod end, loosen two bolts on tube and clamp assembly, and thread out the part to be replaced. To reassemble, thread new part into tube and clamp assembly to approximate original location, place tie rod end with dust cover in steering arm, tighten castellated nut securely, and install new cotter pin.

When new tie rods or tie rod ends are installed it is necessary to check toe-in. Check clamp bolts on

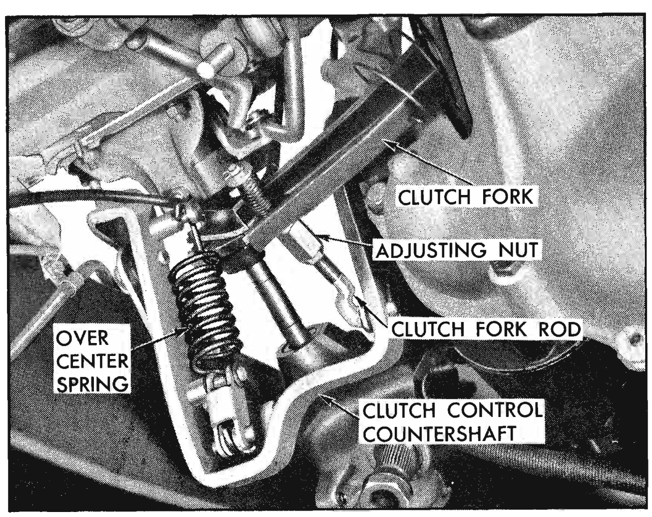


Fig. 9-25 Adjusting Pedal Lash

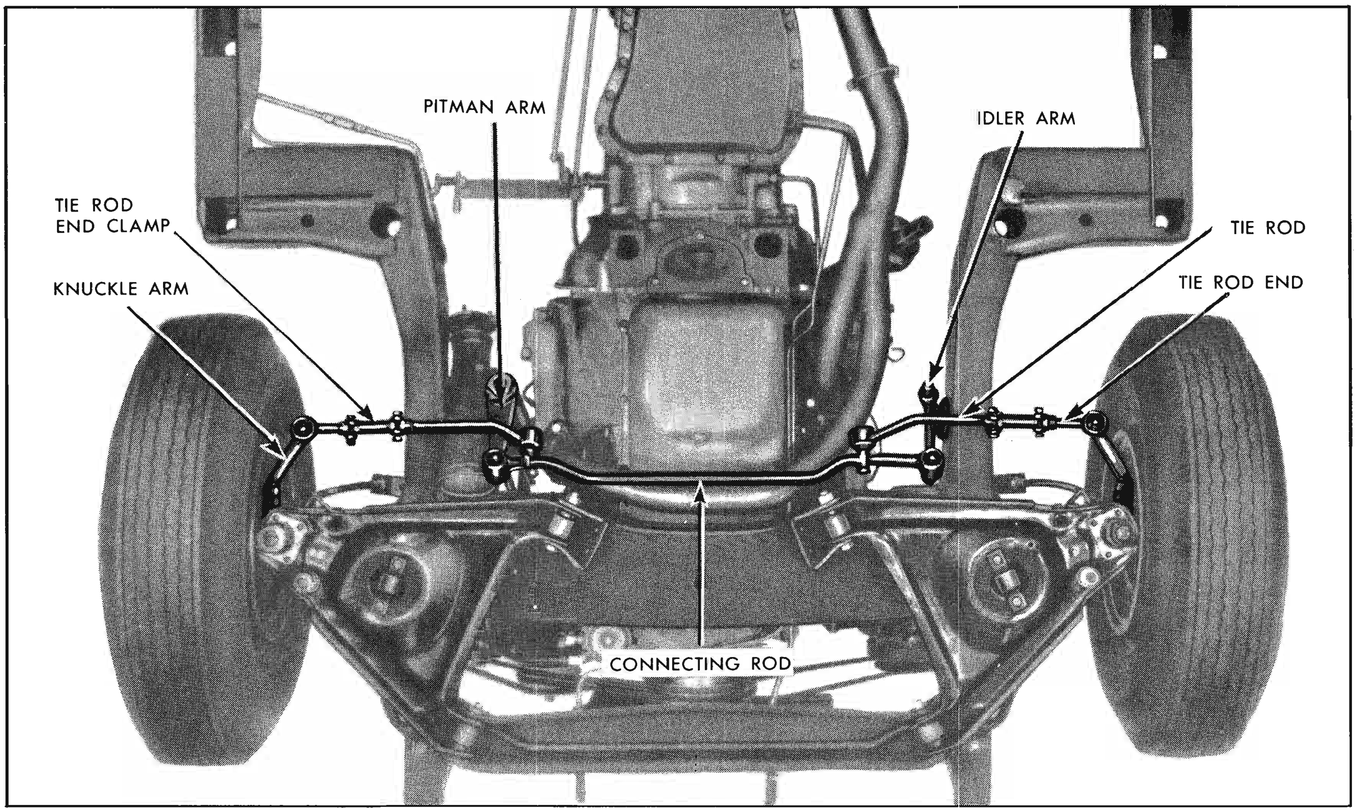


Fig. 9-26 Steering Linkage Identification

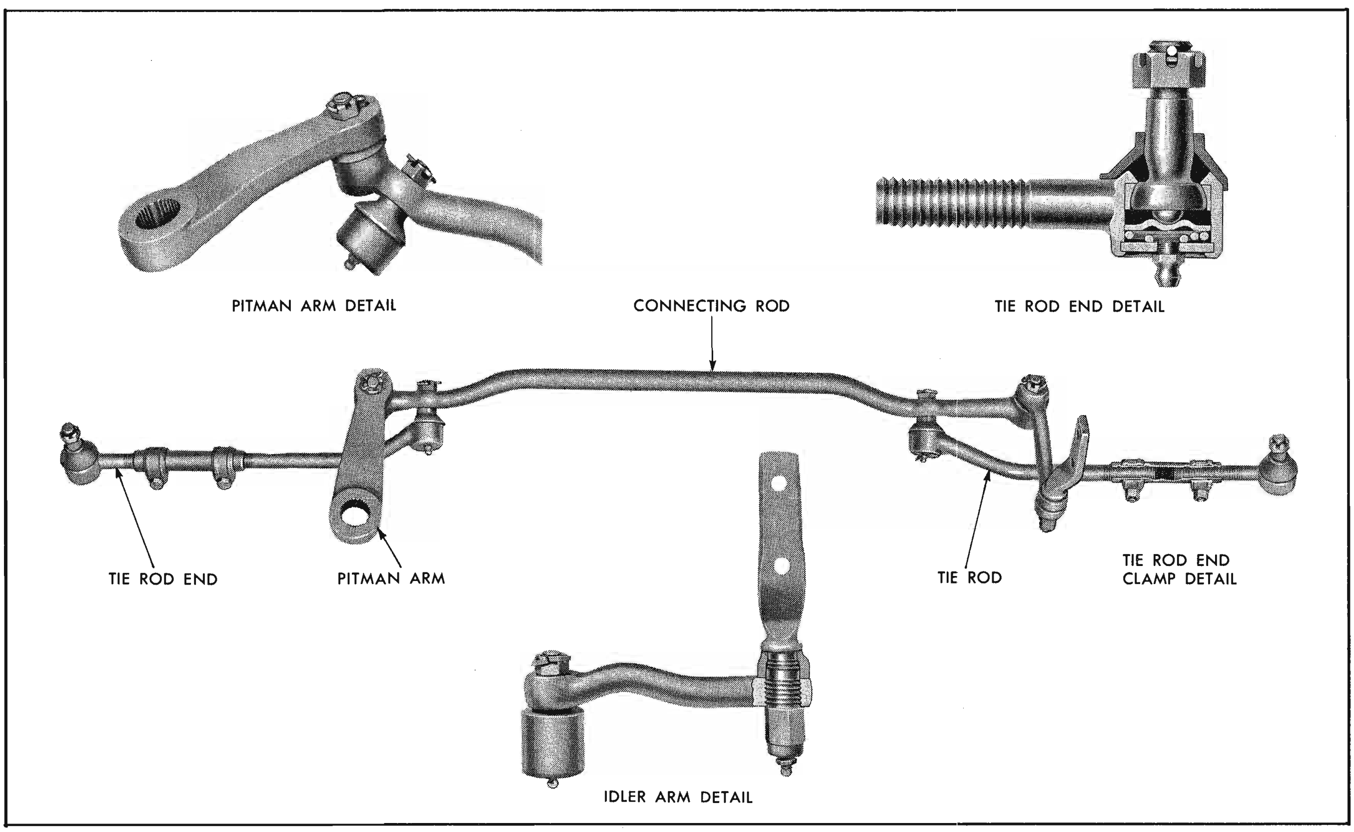


Fig. 9-27 Steering Linkage Details

tie rod adjuster sleeve assembly for tightness (15-20 lb. ft. torque) and make sure bolts are to lower rear and at 45° angle from horizontal with nuts in up position (Figs. 9-26 and 9-27).

Whenever work is done on steering linkage it should be lubricated.

STEERING GEAR—REMOVE

1. Disconnect pitman arm from pitman shaft using J-5504.

2. Scribe a mark on the worm shaft flange and steering shaft and disconnect lower flange from steering shaft.

3. Remove three steering gear housing to frame bolts.

STEERING GEAR—DISASSEMBLE

Disassemble and reassemble steering gear and subassemblies on a clean work bench, preferably while the assembly is mounted on a holding fixture (J-5205 or J-6448-01).

CAUTION: DO NOT clamp housing in vise. Cleanliness is of utmost importance; therefore, bench, tools, and parts must be kept clean at all times.

Before disassembling gear, thoroughly clean exterior with suitable solvent and drain as much fluid as possible. Assist draining by turning gear flange through its entire range two or three times.

1. Mount steering gear assembly on holding fixture J-5205.

2. Rotate wormshaft with lower flange assembly until wheel is in center of travel. Remove three side cover screws and adjusting screw nut.

3. Remove side cover and gasket by turning adjusting screw clockwise through cover (Fig. 9-28).

4. Remove adjusting screw from slot in end of pitman shaft. Make sure shim found on adjusting screw remains with screw (Fig. 9-29).

5. Remove pitman shaft from housing using care that threads do not damage seal in housing.

6. Loosen worm bearing adjuster lock nut with brass drift and remove adjuster and lower bearing.

7. Remove lower flange assembly.

8. Push worm and shaft assembly, with ball nut assembly, through bottom of housing and remove upper bearing.

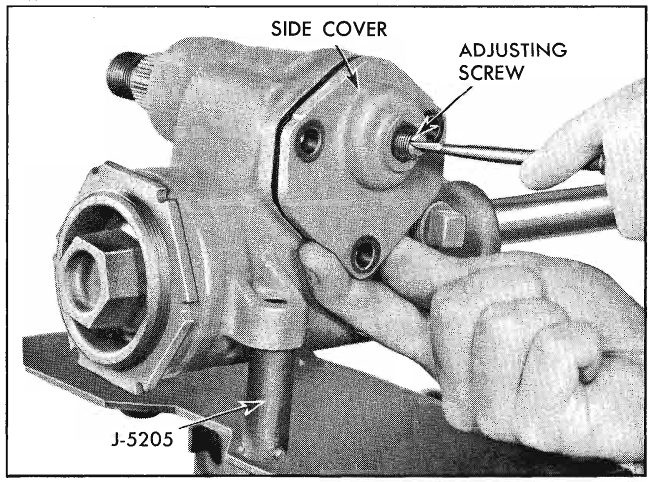


Fig. 9-28 Removing Side Cover

9. Clean grease from worm and shaft assembly and also from inside gear housing.

10. Remove ball nut return guide clamp by removing one screw, remove guides, turn ball nut over and remove balls. Rotating shaft slowly from side to side will aid in removing balls.

11. Remove ball nut from worm.

NOTE: Unless all balls are removed nut cannot be removed.

CLEANING AND INSPECTION

1. Remove gear housing from holding fixture.

2. Wash all parts in clean kerosene or other suitable solvent.

3. Inspect all bearings, bearing cups, worm groove, bushings, seals, teeth for scoring, wear, pitting, etc., which would necessitate replacement.

4. Inspect housing and cover for sand holes or cracks.

If pitman shaft bushing, seal, upper and lower bearing cups, steering gear housing or column jacket are worn excessively or damaged, replace parts.

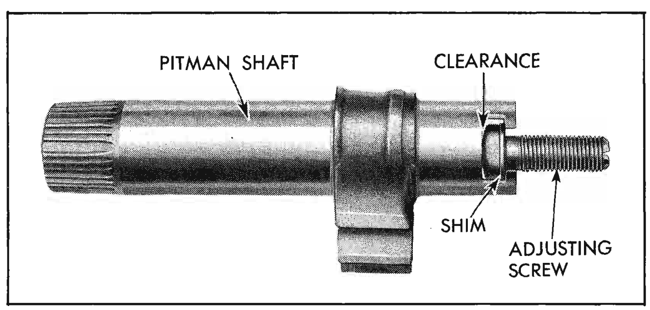
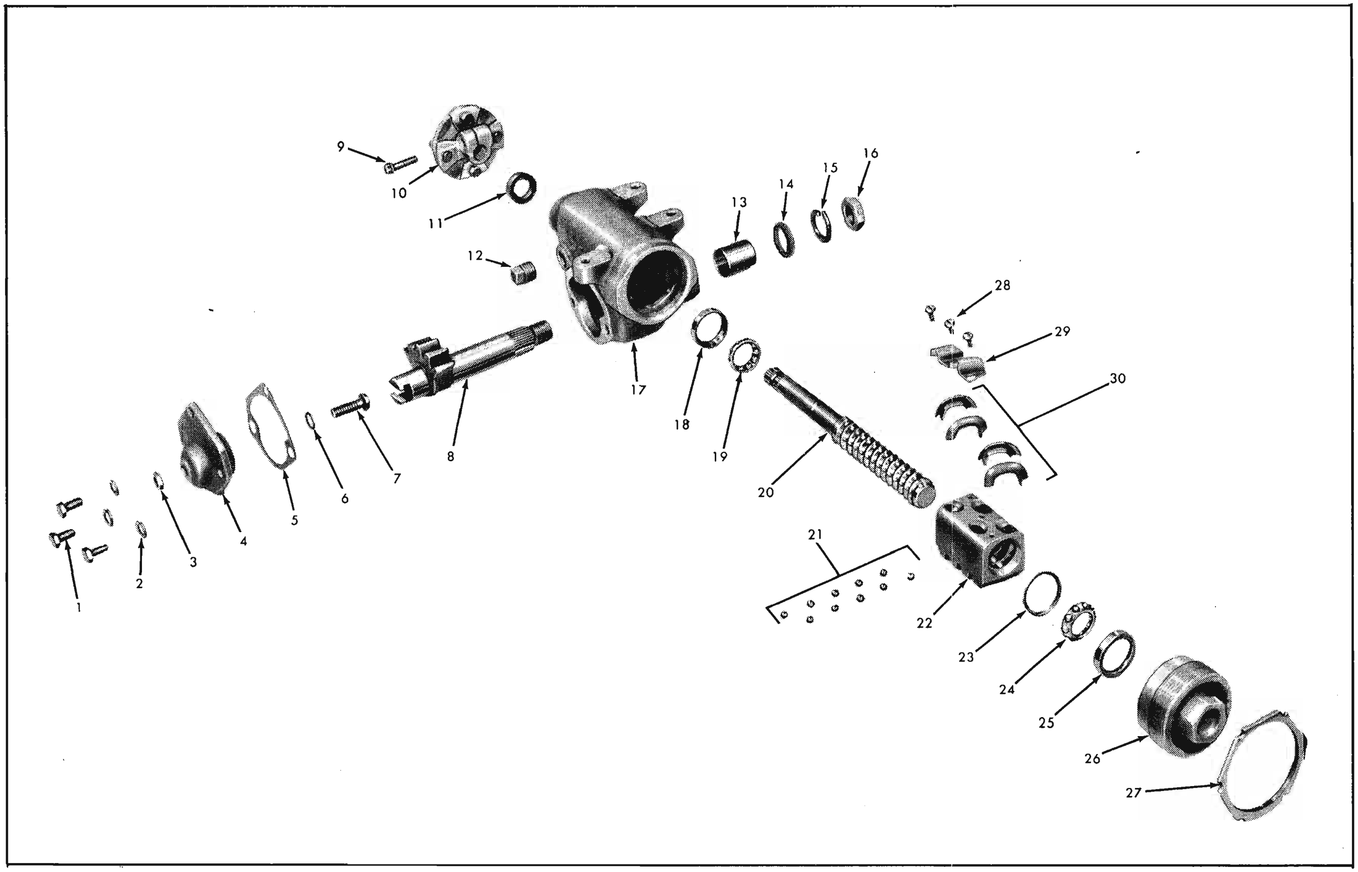


Fig. 9-29 Pitman Shaft and Adjusting Screw



1. Side Cover Bolts
2. Side Cover Bolt Washers
3. Adjusting Screw Lock Nut
4. Side Cover
5. Side Cover Gasket
6. Adjusting Screw Shim
7. Adjusting Screw
8. Pitman Shaft
9. Flange Assembly Bolt
10. Coupling and Lower Flange Assembly
11. Steering Shaft Seal
12. Filler Plug
13. Pitman Shaft Bushing
14. Pitman Shaft Seal
15. Pitman Shaft Nut Lock Washer
16. Pitman Shaft Nut
17. Steering Gear Housing
18. Upper Bearing Cup
19. Upper Bearing
20. Worm and Steering Shaft
21. Balls
22. Ball Nut
23. Lower Bearing Retainer
24. Lower Bearing (Worm Thrust)
25. Lower Bearing Cup (Worm Thrust)
26. Worm Bearing Adjuster
27. Worm Bearing Adjuster Lock Nut
28. Ball Return Guide Clamp Screws
29. Ball Return Guide Clamp
30. Ball Return Guides

Fig. 9-30 Standard Steering Gear—Exploded View

REPLACE PITMAN SHAFT BUSHING

1. Remove pitman shaft seal.

2. Drive out bushing with tool J-1614 (Fig. 9-31).

3. Install new bushing with same tool, driving seal in *towards* center of gear housing. Inner end of bushing must be flush with inside surface of housing at the seal seat.

4. Install new pitman shaft seal using suitable socket as driver.

REPLACE PITMAN SHAFT SEAL

1. Remove pitman shaft seal with screwdriver or suitable tool.

2. Install new seal using suitable socket as driver.

REPLACE UPPER OR LOWER BEARING CUPS

UPPER CUP

Remove gear housing upper seal assembly. Using suitable punch, remove upper cup from gear housing. Install bearing cup in housing using J-5755. Replace seal.

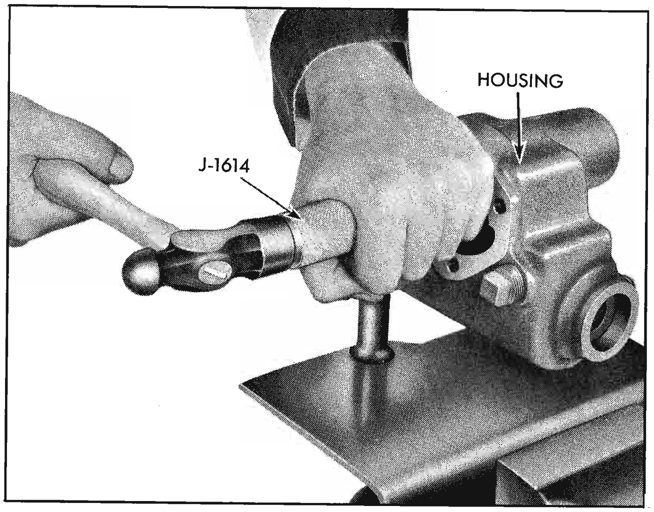


Fig. 9-31 Removing Pitman Shaft Bushing

LOWER CUP

1. Remove lower cup from worm bearing adjuster (Fig. 9-32) using tool J-5754 and J-2619B slide hammer.

2. Install bearing cup in worm bearing adjuster (Fig. 9-33) using tool J-5755.

STEERING GEAR—ASSEMBLE

NOTE: All seals, bushings and bearings should be prelubricated before assembly.

1. Position ball nut on shaft so that deep side of teeth are located as shown in Fig. 9-34.

2. Install 19 balls in each circuit of ball nut (rock steering shaft slightly to aid in installing balls) and insert 6 balls in each return guide using petrolatum

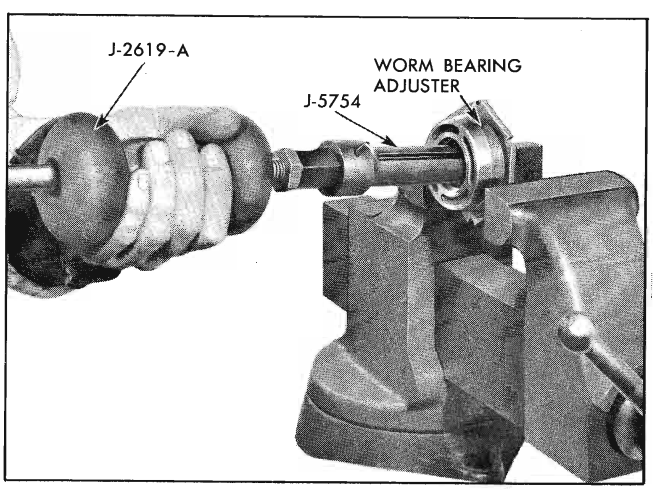


Fig. 9-32 Removing Bearing Cup from Worm Bearing Adjuster

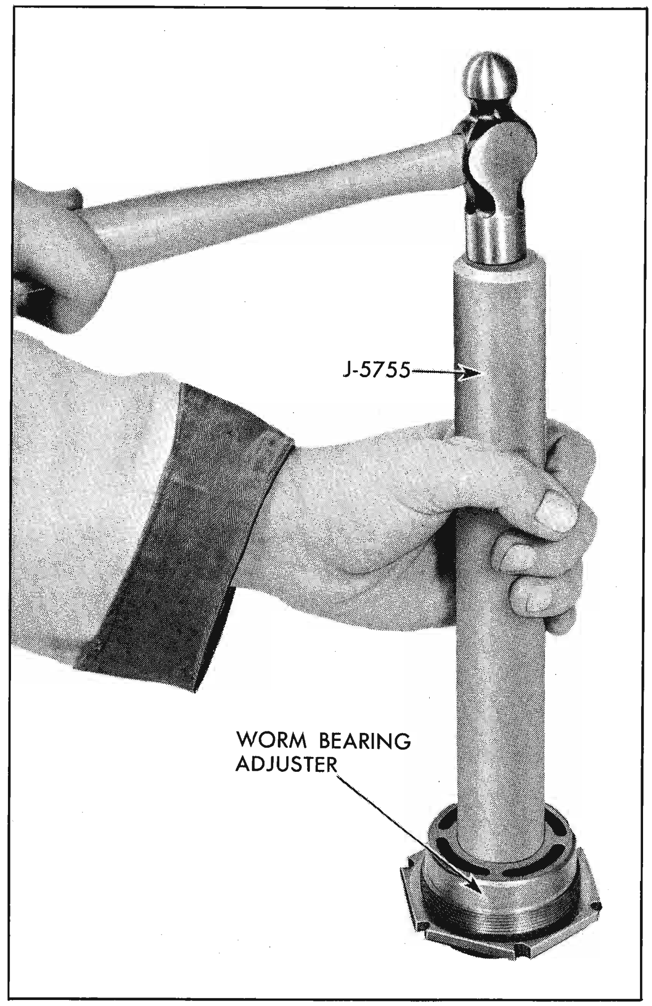


Fig. 9-33 Replacing Bearing Cup

to hold balls in place. Install return guide clamp and screw.

CAUTION: Do not rotate worm shaft while installing balls, since balls may enter crossover passage between circuits. This will cause improper operation of ball nut.

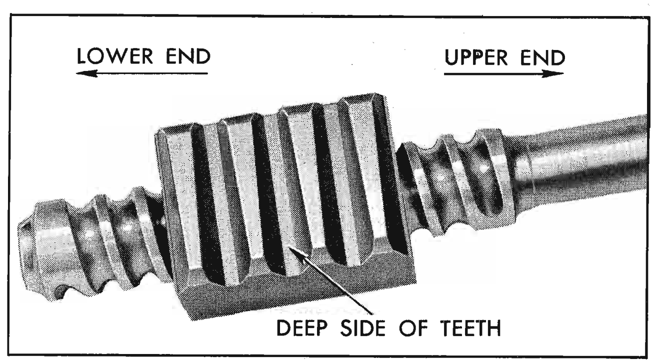


Fig. 9-34 Ball Nut Properly Installed on Shaft

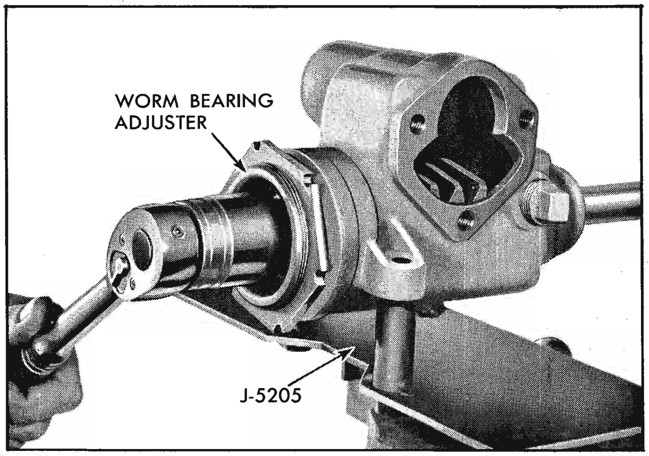


Fig. 9-35 Adjusting Worm Bearing Preload

3. Place upper bearing on worm shaft. Center ball nut on worm, then slide worm shaft, bearing and nut into housing.

4. Place lower bearing in worm adjuster and install bearing retainer over bearing using J-5813. Install adjuster in housing.

NOTE: Adjuster should be installed just tight enough to hold bearing races in place. Install adjuster lock nut loosely.

5. Slip lower flange assembly on shaft and turn steering gear from one extreme to the opposite to make certain there are no unusual binds and remove flange assembly.

NOTE: Never allow ball nut to strike the ends of the ball races in worm due to the possibility of damage to ball guides.

a. Using a $1\frac{1}{16}''$-12 point deep socket and inch pound torque wrench, measure torque required to keep wrench in motion when off high point of gear. Torque required should be $\frac{3}{8}$ to $\frac{7}{8}$ lb. in.

b. If torque does not meet above specification, loosen worm bearing adjuster lock nut (Fig. 9-35) and turn adjuster to bring torque within $\frac{3}{8}$ to $\frac{7}{8}$ lb. in. limits.

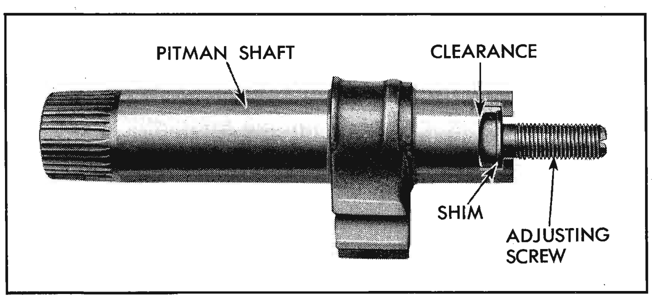


Fig. 9-36. Pitman Shaft and Adjusting Screw

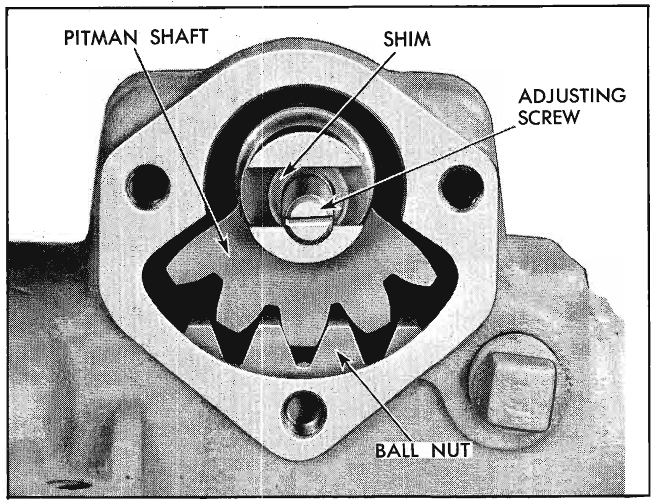


Fig. 9-37 Positioning Pitman Shaft and Ball Nut

c. Tighten lock nut and recheck torque.

d. Remove $1\frac{1}{16}''$ socket and torque wrench.

6. Install pitman shaft adjusting screw and selective shim in pitman shaft (Fig. 9-36).

NOTE: Screw must be free to turn, but have no more than .002″ end play. If end play of screw in slot is too tight or too loose, select new shim to give proper clearance. Shims are furnished in four thicknesses: .063″, .065″, .067″, and .069″.

7. Position pitman shaft seal on pitman shaft and seat seal using suitable socket as a driver.

8. Install pitman shaft and adjusting screw with sector and ball nut teeth positioned as shown in Fig. 9-37.

9. Install side cover and gasket on adjusting screw, turning screw counterclockwise until it projects through cover $\frac{5}{8}''$ to $\frac{3}{4}''$.

10. Install three cover attaching screws.

11. Tighten pitman shaft adjusting screw so that teeth on shaft and ball nut engage but do not bind. Final adjustment will be made later.

12. Fill steering gear with all-season steering gear lubricant and install filler plug.

13. Adjust sector preload and ball nut backlash as follows:

a. Place a $1\frac{1}{16}''$-12 point socket and lb. in. torque wrench over end of worm shaft.

b. Tighten pitman shaft adjusting screw as necessary to obtain a reading of 1 to 2 lb. ft. torque when the worm gear is turned through the high point (Fig. 9-38).

c. Tighten pitman shaft adjusting screw lock nut and recheck adjustment.

STEERING GEAR—INSTALL

1. Align scribe marks on steering and worm shaft flange.

2. Position steering gear assembly in car.

NOTE: Metal to metal contact between flanges on stub shaft assembly and steering shaft assembly will transmit and amplify gear noise to driver.

3. Install steering housing to frame bolts and tighten housing to frame bolts to 80-90 lb. ft. torque.

4. Install pitman arm and secure with lock washer and nut. Tighten nut to 100-125 lb. ft. torque.

5. Install two flange attaching nuts and lock washers and tighten to 10-20 lb. ft. torque.

6. Align steering column jacket and shaft assembly and steering gear so head of lower coupling bolt has ¼ inch clearance from flange on steering shaft. Adjust the steering mast jacket assembly up or down. A metal to metal contact at this point will transmit the slightest noise to the driver.

7. Be sure pins are properly positioned.

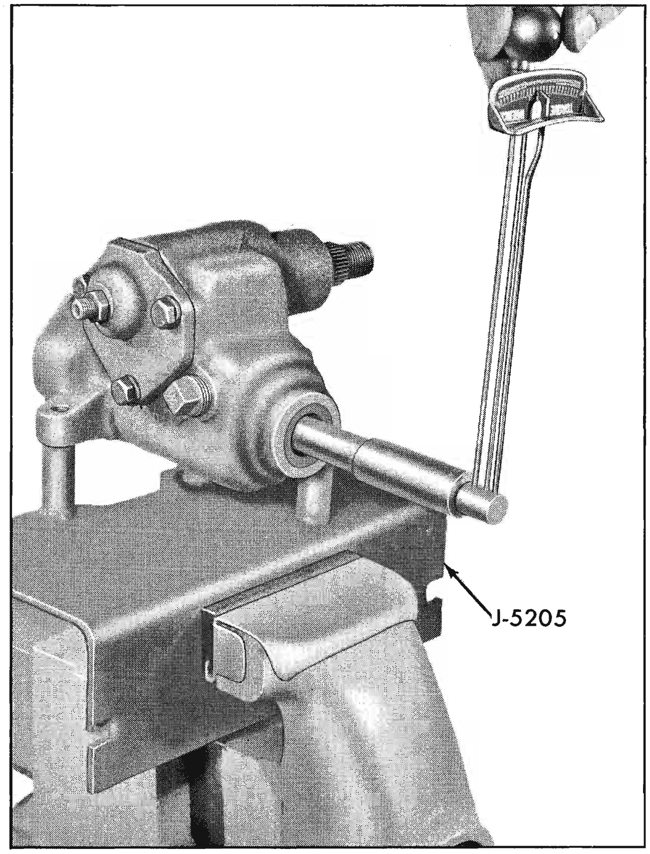


Fig. 9-38 Adjusting Worm Gear Through High Point

STEERING GEAR TROUBLE DIAGNOSIS

(See SUSPENSION TROUBLE DIAGNOSIS AND TESTING, Section 3, for Additional Information.)

CONDITION	CAUSE	REMEDY
Hard steering while driving	Frozen steering shaft bearings	Replace bearings
	Lower coupling flange rubbing against steering shaft	Loosen bolt and assemble properly
	Steering wheel rubbing against gearshift bowl	Adjust jacket endwise
	Steering gear or connections adjustment too tight	Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary
	Front spring sagged	Check front end jounce height. Jounce height should be approximately the same at both wheels. Compare dimensions with those on car having about same mileage and equipment and believed to be standard. Replace front springs if sagged
	Frame bent or broken	Repair or replace frame as necessary

CONDITION	CAUSE	REMEDY
Hard steering while driving (Continued)		
	Steering knuckle bent	Install new knuckle
	Ball joint galled or too tight	Replace ball joint
	Low or uneven tire pressure	Inflate tires to recommended pressure
	Steering gear or connections adjusted too tight	Test steering system for bind with front wheels off floor. Adjust, as necessary, and lubricate
	Insufficient or incorrect lubricant used	Check lubricant in steering gear and lubricate steering system as required
	Excessive caster	Check caster and adjust as necessary
	Suspension arms bent or twisted	Check camber and caster. If arms are out of car, compare with new arms and replace if bent
Poor return of steering	Frozen steering shaft bearings	Replace bearings
	Lower coupling flange rubbing against steering shaft	Loosen bolt and assemble properly
	Steering wheel rubbing against gearshift bowl	Adjust jacket endwise
	Tires not properly inflated	Inflate to specification
	Incorrect caster or toe-in front wheels	Adjust to specification
	Tight steering linkage	Lubricate—check end plugs
	Tightness of suspension ball joints	Lubricate or otherwise free up
	Steering adjustment tight	Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary
	Tight sector to worm nut adjustment	Adjust in car to specification
	Worm bearing adjustment too tight	Remove gear and adjust to specification
	Nut and worm preload too tight	Remove gear and replace balls as required
Car leads to one side or the other	Due to front end misalignment	Adjust to specification
Excessive wheel kickback or loose steering	Lash in steering linkage	Adjust parts affected
	Excessive lash between pitman shaft sector and nut	Adjust to specification

CONDITION	CAUSE	REMEDY
Excessive wheel kickback or loose steering (Continued)		
	Ball nut and worm preload	Check worm bearing adjustment and overcenter adjustment. Check for looseness in steering linkage. If complaint still exists, remove rack-piston and worm, and change balls to obtain specified preload.
	Ball joints too loose	Replace ball joints
	Front wheel bearings incorrectly adjusted or worn	Adjust and/or replace front wheel bearings
Hard Steering when parking	Lack of lubrication in linkage or front suspension	Add lubricant where needed
	Tires not properly inflated	Inflate to recommended pressure

SPECIFICATIONS

Type .... Saginaw Recirculating Ball Nut
Steering Gear Ratio Overall 29:1
Lubricant .... See Lubrication Section
Lubricant Capacity .... 13 Fluid Ounces
Worm Bearing Preload ....6-10 lb. in.
Total Overcenter Load Worm Bearing plus 2-6 lb. in.

WRENCH TORQUE SPECIFICATIONS

(Torque in lb. ft. unless otherwise specified.)

TORQUE	SIZE	APPLICATION
		Steering Gear and Pitman Arm
70-90	7/16-14	Bolt—Steering Gear Assembly to Frame
110-140	7/16-14	Nut—Pitman Arm Shaft (Standard Steering)
10-20	3/8-24	Bolt and Nut—Steering Column Jacket Clamp
		Steering Wheel
20-35	1/2-20	Nut—Steering Wheel to Steering Column Shaft
60-120 Lb. In.	1/2-20	Nut—Steering Wheel to Steering Column Shaft Nut Lock
		Steering Column Bracket
10-35 Lb. In.	No. 10-24	Nut—Steering Column Upper Bracket to Instrument Panel
10-20	5/16-18	Screw—Steering Column Lower Bracket to Mtg. Bracket
10-35 Lb. In.	No. 10-16	Screw—Steering Column Opening Cover Plate to Floor
10-20	3/8-24	Bolt—Steering Column Shaft Jacket Lower Clamp
		Steering Linkage
*	1/8 NPTF	Fitting—Steering Gear Connecting Rod Lubrication
*	1/4-28	Fitting—Steering Knuckle Tie Rod Ball Lubrication
14-20	3/8-24	Bolt and Nut—Steering Knuckle Tie Rod Tube Clamp
18-30	3/8-24	Bolt—Steering Connecting Rod Idler Lever Support to Frame
55-70	1/2-20	Nut—Steering Linkage (Ball Socket Stud) to Pitman Arm
55-70	1/2-20	Nut—Steering Connecting Rod to Tie Rod Ball Stud
55-70	1/2-20	Nut—Steering Connecting Rod to Idler Arm
50-65	1/2-20	Nut—Steering Tie Rod Ball Stud to Steering Knuckle

NOTE (*) Torque not a requirement, other means of control and/or specifications used, checked for alignment, bottoming, height and/or leaks.

SPECIAL TOOLS

J-544-A	Tension Scale (0-4#)
J-2619-B	Slide Hammer
J-3044	Steering Wheel Puller
J-5504-B	Pitman Arm Puller
J-5754	Steering Shaft Worm Bearing Cup Remover (Use with J-2619-B)
J-5755	Steering Shaft Worm Bearing Cup Remover
J-5787	Pitman Shaft Seal Protector
J-5813	Pitman Shaft Seal Installer
J-6448-01 or J-5205	Steering Gear Holding Fixture

Fig. 9-39 Standard Steering Gear—Special Tools

POWER STEERING GEAR

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

The Rotary Valve Safety power steering gear assembly operates entirely on displacing oil to provide hydraulic oil pressure assists only when turning. As the entire gear assembly is always full of oil, all internal components of the gear are immersed in oil making periodic lubrication unnecessary. In addition this oil acts as a cushion to absorb road shocks that may be transmitted to the driver.

The steering shaft, hydraulic valve, worm and the rack-piston nut are all in line making a compact and space saving gear. All oil passages are internal except the pressure and return hoses between the gear and pump.

The rotary valve feature is a new concept in driver ease and control. It provides a smooth transmission through the driving range of steering wheel effort. A torsion bar transmits the "road feel" to the driver. Response of the steering gear to effort applied to the steering wheel has been greatly increased. This increased response gives the driver greater control and minimizes over-steering.

DESIGN

Design of the new gear with fewer parts reduces the over-all size and weight. In addition, this simple design requires fewer service tools. Being a self-bleeding unit the steering gear requires no external bleeding.

The mechanical element of this steering gear is a low-friction, high-efficiency recirculating ball system in which steel balls act as a rolling thread between the steering worm and rack-piston nut. The rack-piston nut is one piece and is geared to the sector of the pitman shaft. Lash between the pitman shaft and rack-piston nut is maintained by an adjusting screw which is retained in the end of the pitman shaft gear (Fig. 9A-1).

The rotary valve assembly is contained in the gear housing. It is shown schematically in Figs. 9A-2, 9A-3 and 9A-4, and is an open-center, rotary type valve. The valve spool is inside the valve body and is held in a neutral position by a torsion bar attached to one end of the valve body through the torsion bar cap and extends through this valve. The other end of the torsion bar is attached to a stub shaft assembly which in turn is splined to the gear flange that bolts to the steering shaft flange.

Twisting of the torsion bar allows the valve spool to displace or move its position in relation to the valve body, thereby, directing oil to the proper area in the gear to provide a hydraulic assist on turns. During the turn the steering worm turns in the same direction as the turn. This causes the rack-piston nut to move which in turn applies a turning effort to the pitman shaft gear.

While the advantages of the rotary valve safety power steering gear design are many, the most important of these are light turning effort, increased response, smoothness of gear operation and a "fail-safe" feature. This feature provides for manual operation if for any reason the power system should fail or become inoperative.

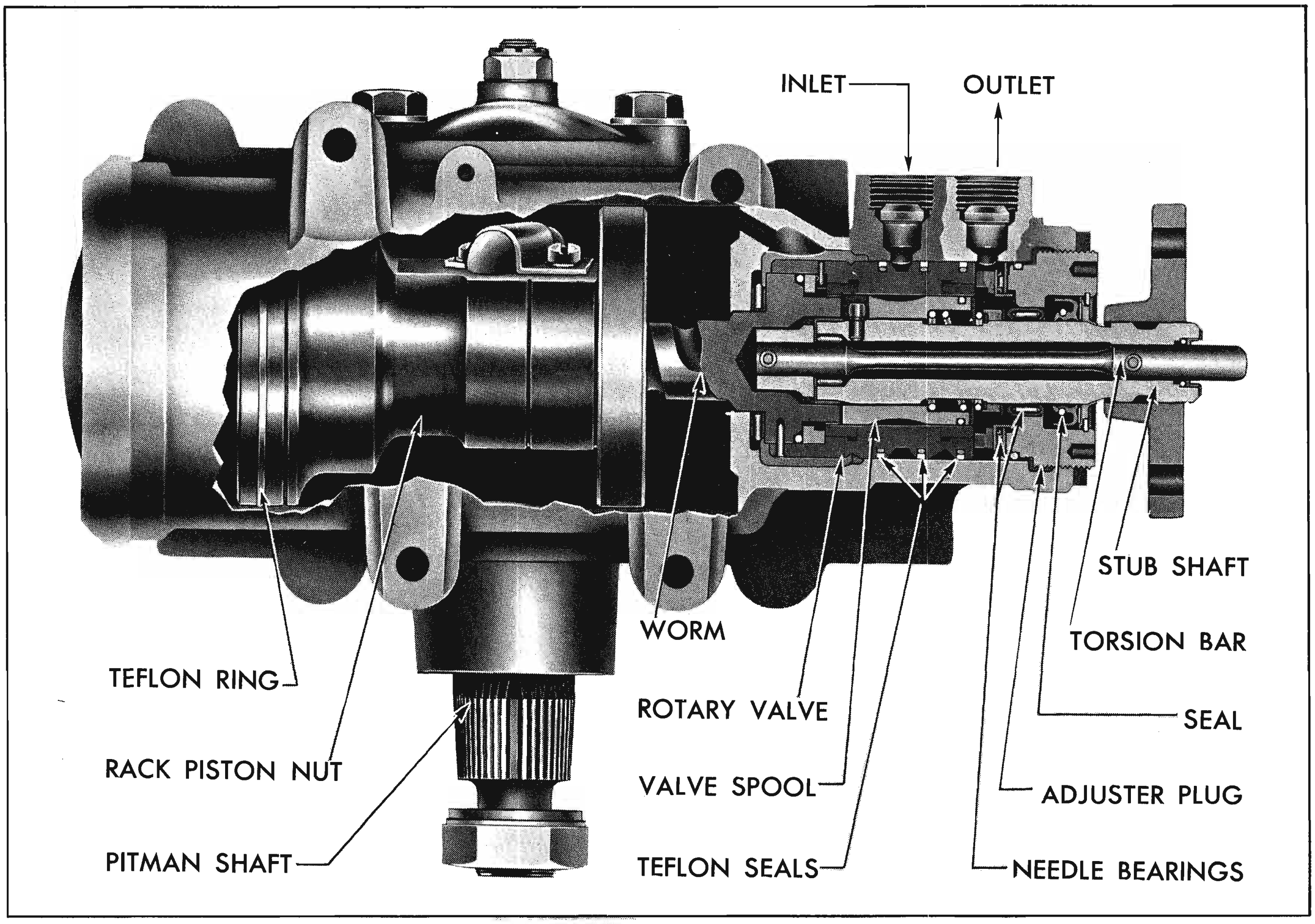


Fig. 9A-1 Power Steering Gear—Sectional View

OPERATION

OPERATING PRESSURES

Under normal driving conditions, the hydraulic oil pressure in the power cylinder should not exceed 40-100 psi. Pressure for turning corners should be approximately 100-600 psi. Parking pressure, the most difficult of turning conditions, should range from 600 psi to 1300 psi depending upon roadbed conditions and the weight of the car. The steering gear ratio is 17.5 to 1. The over-all steering ratio of the power steered car is approximately 22 to 1. During normal driving, the steering wheel effort will range from 1 pound to 2 pounds. The parking effort will range from 2 pounds to 3½ pounds, again depending upon roadbed conditions.

OIL FLOW—STRAIGHT-AHEAD POSITION

The rotary valve assembly contains a valve spool which is a selective slip fit inside the valve body and is positioned so the grooves and lands on the outside surface of the valve spool align with the lands and grooves on the inside surface of the valve body (Fig. 9A-2). Grooves are slightly wider than their mating land and clearance on both sides of the land provides the "open" position. A stub shaft assembly (stub shaft and a torsion bar pinned together at one end) extends through and is attached to one end of the rotary valve assembly; a pin locks the stub shaft and the valve spool together and a pin in the valve body retains the torsion bar assembly.

In the straight-ahead or neutral position, oil flows from the power steering pump through the "open" position of the rotary valve assembly (Fig. 9A-2), and back to the power steering pump reservoir without circulating in the power cylinder in which the rack-piston is located. Since all passages are open, flow resistance is low in the neutral position, and since the valve remains in this position at all times except when steering in turns, the power required to operate the pump is at the minimum.

The power cylinder is full of oil at all times, although in the straight-ahead position the pressure on both sides of the rack piston is equal and very low.

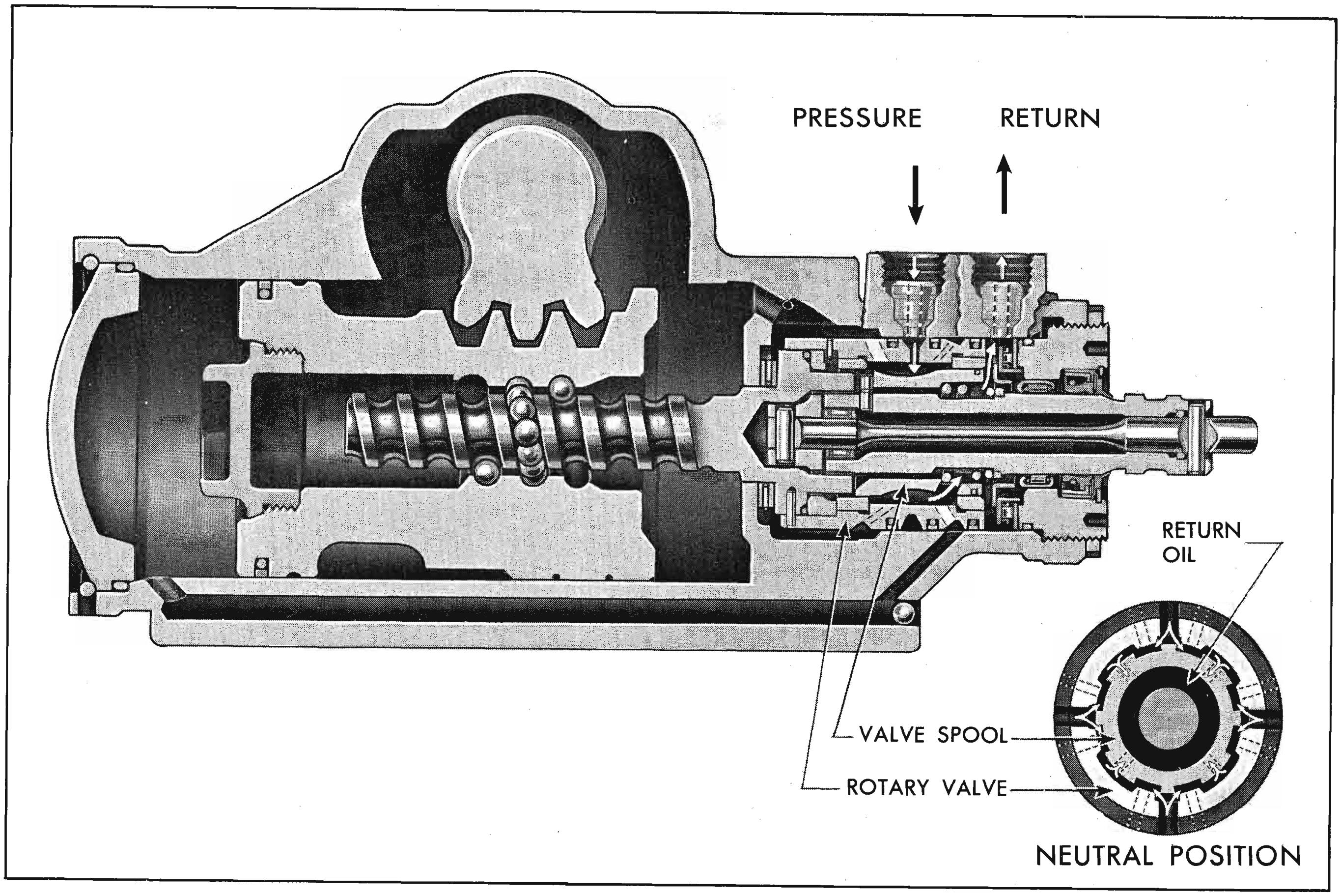


Fig. 9A-2 Oil Flow—Straight Ahead Position

Oil from the steering gear pump flows through a passage in the gear housing to an annular groove around the valve body. Four holes evenly spaced around the valve are drilled from the bottom of this groove through the valve body wall to a groove on the inside surface of the valve body. Eight pressure holes evenly spaced around the valve body are also drilled through the valve body wall but these are through a land portion on the inside surface of the valve body with one hole on each side of the four inlet pressure holes.

When no twisting force is applied to the steering gear stub shaft assembly from the steering wheel there is sufficient clearance between the land groove alignment of the valves to permit oil to flow between the valves. Oil flows back to the pump via four drilled holes through the valve spool wall that align with a groove on the stub shaft assembly. From here oil flows around the stub shaft to an area between the rotary valve assembly and adjuster plug assembly, through the return port to the pump.

Oil in the power cylinder acts as a cushion that absorbs road shocks that may be transmitted to the steering wheel, for increased safety and reduces driving fatigue. In addition, this oil lubricates all internal components of the gear, making it unnecessary to lubricate the gear at any time.

OIL FLOW—RIGHT TURN POSITION

When a right turn is executed, oil from the power steering pump flows through the rotary valve assembly, through the steering gear housing to an area between the housing end plug and the rack piston nut to assist in forcing the rack to turn the pitman shaft and steering linkage for assist in the turn.

When the steering wheel is turned to the right, resistance to turning is encountered between the front wheels and the roadbed tending to twist the stub shaft assembly. Since the stub shaft assembly is pin locked to the torsion bar at one end and the opposite end indexes the valve spool by a pin on the stub shaft, the twisting action moves the valve spool to the right in relation to the valve body. This slight movement causes the land in the valve spool to restrict the right side opening between the valve spool land and valve body lands and opens the clearance on the left side of the spool lands (Fig. 9A-3).

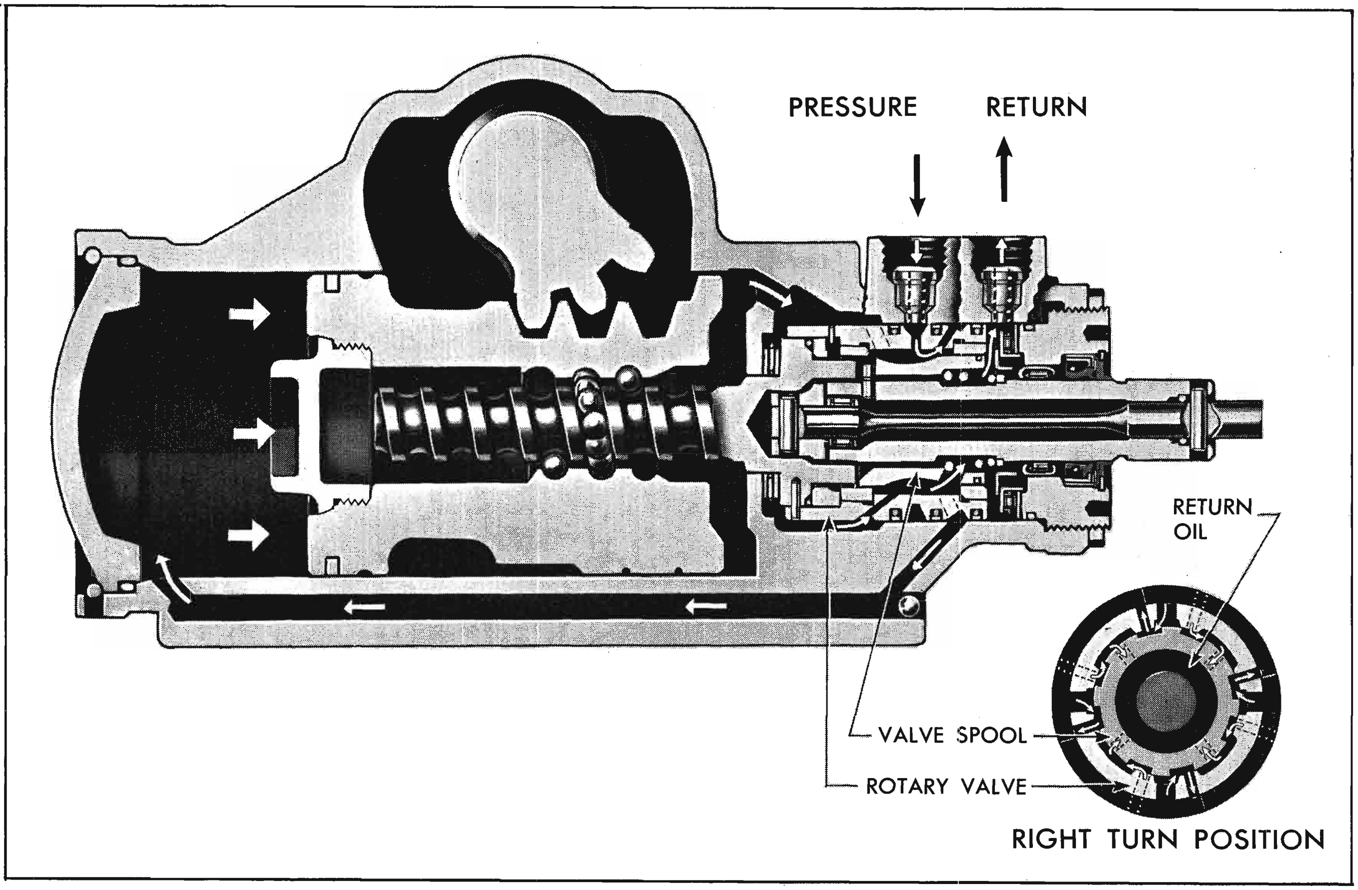


Fig. 9A-3 Oil Flow—Right Turn Position

The right openings being restricted permits oil to flow through the unrestricted passages to the left (Fig. 9A-3) to an annular groove around the valve body which aligns with an oil passage in the gear housing.

Oil is then directed to flow between the housing end plug and the rack-piston nut to force the rack upward permitting the steering worm to screw into the rack-piston nut. This forces the pitman shaft to turn and reduces driver turning effort in executing the right turn. The oil in the upper end of the cylinder is simultaneously forced out through the rotary valve and back to the pump reservoir.

The higher the resistance to turning between the roadbed and the front wheels, the more the valve spool is displaced, and the higher the oil pressure on the lower end of the rack-piston nut. Since the amount of valve displacement and, consequently, the amount of hydraulic pressure built in the cylinder is dependent upon the resistance to turning, the driver is assured of the proper amount of smooth hydraulic assistance at all times.

As the driver stops applying steering effort to the steering wheel and then relaxes the wheel, the spool valve is forced back into its neutral position by the "untwisting" of the torsion bar. The spool valve lands and grooves align themselves with the grooves and lands in the valve body providing a balanced clearance between the land-groove alignment. When this happens, the oil pressure is again equal on both sides of the rack-piston nut and the steering geometry of the car causes the wheels to return to the straight-ahead position.

OIL FLOW—LEFT TURN POSITION

Executing a left turn causes oil to flow from the power steering pump through the rotary valve assembly and to the area between the rotary valve assembly and the rack-piston nut rack via a drilled passage in the steering gear housing to assist in forcing the rack to turn the pitman shaft and linkage for added assist in the turn.

When the steering wheel is turned to the left, resistance to turning is encountered between the front wheels and the roadbed tending to twist the stub shaft assembly. Since the stub shaft assembly is pin-locked to the torsion bar at one end and the opposite end indexes the valve spool by means of a pin in the

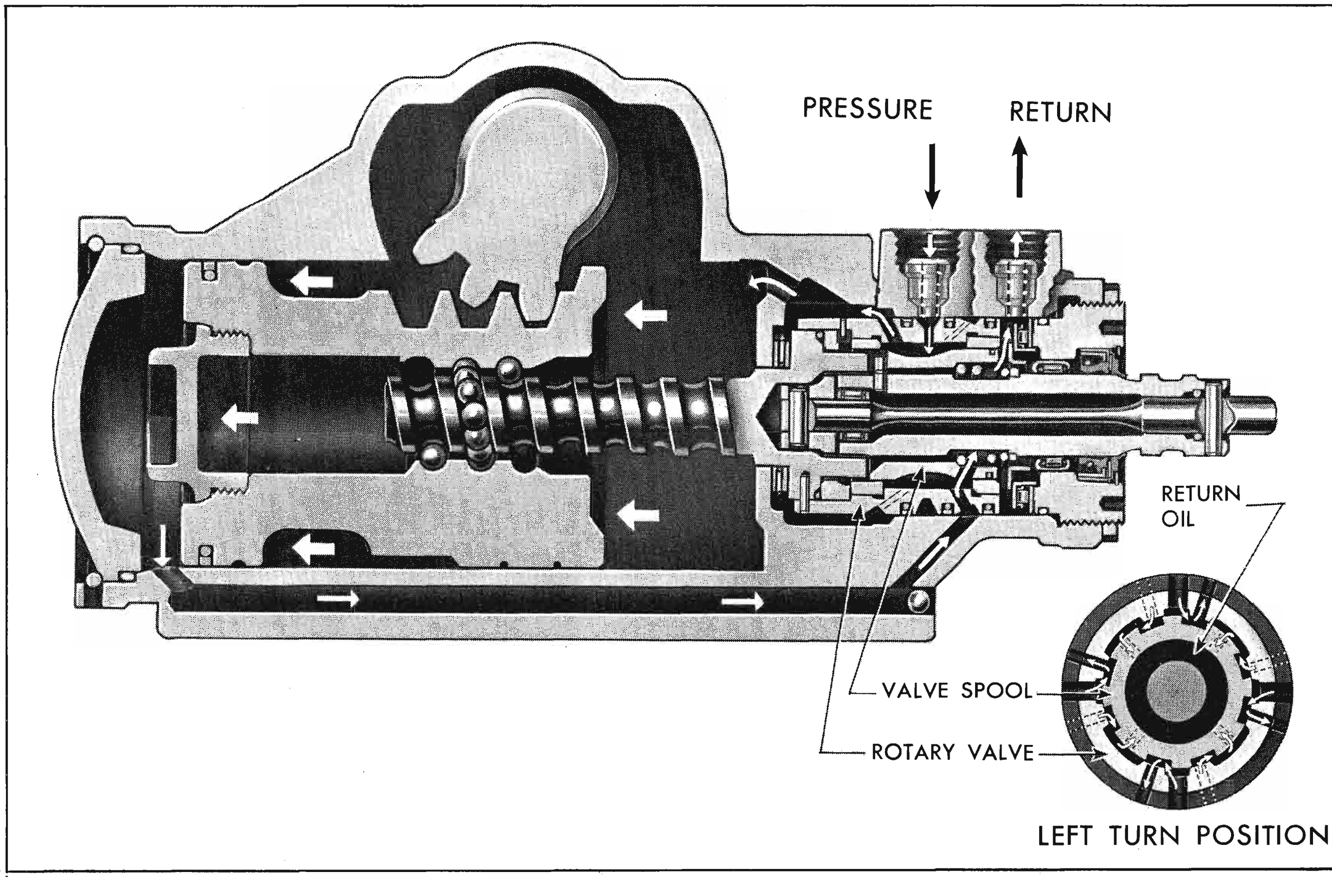


Fig. 9A-4 Oil Flow—Left Turn Position

stub shaft, the twisting action moves the valve spool to the left in relation to the valve body. This slight movement causes the land on the valve spool to restrict the left side opening between valve spool lands and the valve body lands and opens the clearance on the right side of spool lands (Fig. 9A-4).

The left openings being restricted permits oil to flow through the unrestricted passages to the right to an annular groove around the valve body which aligns with an oil passage in the gear housing.

Oil is then directed to flow between the rotary valve assembly and the rack-piston nut via a drilled passage in the steering gear housing to force the rack-piston nut downward. This forces the pitman shaft to turn and reduces driver turning effort in executing the left turn. The oil in the lower end of the housing is simultaneously forced out through the rotary valve from a drilled passage in the housing and back to the pump reservoir.

The higher the resistance to turning between the roadbed and the front wheels, the more the valve spool is displaced, and the higher the oil pressure on the upper end of the rack-piston nut. Since the amount of valve displacement and, consequently, the amount of hydraulic pressure built in the cylinder is dependent upon the resistance to turning, the driver is assured of the proper amount of smooth hydraulic assistance at all times.

As the driver stops applying steering effort to the steering wheel and then relaxes the wheel, the spool valve is forced back into its neutral position by the "untwisting" of the torsion bar. The spool valve lands and grooves align themselves with the grooves and lands in the valve body providing a balanced clearance between the land-groove alignment. When this happens, the oil pressure is again equal on both sides of the rack-piston nut and the steering geometry of the car causes the wheels to return to the straight-ahead position.

PERIODIC SERVICE RECOMMENDATIONS

Since the steering gear is constantly lubricated, it is only necessary to periodically check the level in the pump reservoir.

ADJUSTMENTS ON CAR

Before making adjustments to the power steering gear to correct conditions such as, shimmy, hard or loose steering, road shock, wander or weave, a check should be made of front end alignment, shock absorbers, wheel balance, or for tight front wheel bearings, loose steering rod ends or loose pitman arm.

CHECK STEERING GEAR ADJUSTMENT

1. Disconnect steering gear connecting rod from pitman arm.

2. Remove horn button or horn ring and steering wheel.

3. With inch pound torque wrench attached to a 5/8"-12 point socket, measure and record readings taken from the following steering gear positions. See Fig. 9A-5.

NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 inch pounds. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.

a. One full turn off center high point. This reading represents adjuster plug preload plus resistance offered by seals and bearings and should not exceed 10 lb. in. torque. If the reading is below 3 lb. in. torque, it may indicate some lash in the thrust bearing.

NOTE: If the reading for "a" is not in specifications, correct adjuster plug bearing preload as follows: Loosen adjuster plug lock nut, using drift or similar tool, and move flexible coupling (by turning steering wheel) as necessary to permit installation of tool J-7624 on adjuster plug (Fig. 9A-10). Tighten plug as required to obtain proper reading (3-5 lb. in.) and tighten adjuster plug lock nut. If after obtaining proper adjuster plug bearing preload in "a" and the torque reading in "b" is not within specification, then DO NOT remove gear assembly to refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment ("a") and over center adjustment ("c") should correct the problem if it lies in the steering gear.

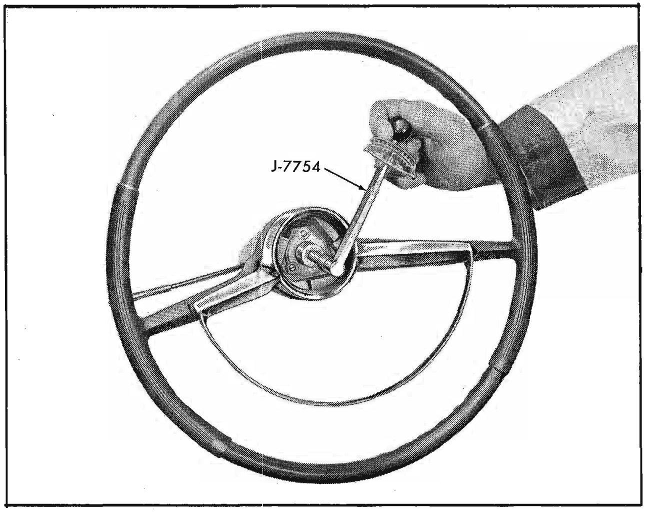


Fig. 9A-5 Checking Steering Gear Adjustment

b. One-half turn off center high point. This reading represents resistance offered in "a" above and also worm preload as determined by the size of the balls used in the rack-piston nut. This reading should be 0.5 to 5.0 lb. in. torque higher than the reading obtained in "a" above.

c. Through center high point. This reading represents resistance offered in "b" above and also pitman shaft lash. This reading should be 4.0 to 8.0 lb. in. torque higher than the reading obtained in "b" above, and should not exceed 18 lb. in.

4. If reading in step "3c." above is not within specifications, loosen pitman shaft gear lash adjuster nut and adjust to load specified in "c", using 7/32" allen wrench. Tighten lock nut to 20 to 30 lb. ft. torque.

NOTE: Final adjustment should always be made in a clockwise or downward direction.

5. Reassemble horn button or horn ring and steering wheel.

6. Reassemble connecting rod pitman arm. Screw in end plug until tight; then back off to align cotter pin hole, insert and lock cotter pin.

MINOR REPAIRS

The following operation may be performed with the steering gear in the car.

REMOVAL OF PITMAN SHAFT SEALS WITH GEAR IN CAR

NOTE: Removal of seals can be accomplished with the steering gear in the car using hydraulic

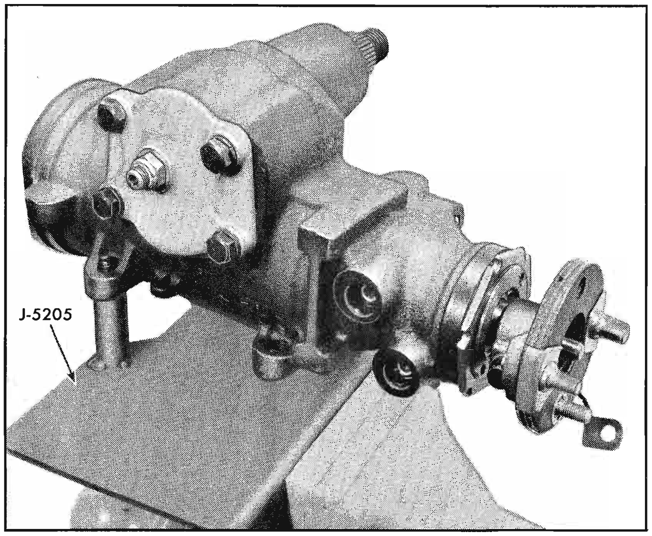


Fig. 9A-6 Steering Gear Mounted on Tool J-5205

pressure from the gear assembly to force the seals out of pitman shaft bore.

1. Remove pitman arm retaining nut and lock washer.

2. Remove pitman arm using tool J-5504.

3. Remove pitman shaft outer dust seal retaining ring using J-4245 pliers.

4. Remove outer dust seal using screwdriver or similar tool and place a cloth around housing and pitman shaft to absorb oil leakage from seal bore.

5. Hold a clean dry pan under the gear housing and with engine running, momentarily turn steering gear to extreme left position for not more than two seconds. This will build up pressure on upper side of piston and in pitman shaft chamber forcing seals and inner back-up washer out of bore.

NOTE: If pressure of oil does not remove seals, turn off engine, remove pitman shaft assembly and remove seals in normal manner being careful not to score the seal bore in housing.

6. Turn off engine.

7. Remove steering gear assembly to replace seals.

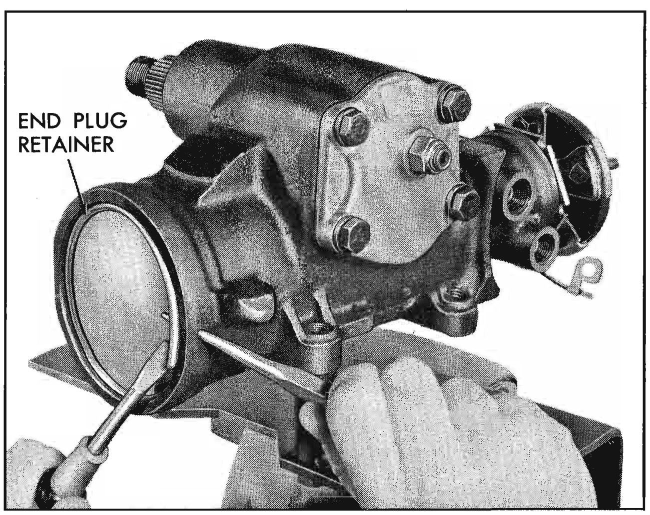


Fig. 9A-7 Removing End Plug Retaining Ring

STEERING GEAR—REMOVE

1. Disconnect pressure and return hose assemblies from housing.

2. Disconnect pitman arm from pitman shaft using J-5504.

3. Scribe mark on steering shaft worm shaft flange and disconnect gear lower flange from steering shaft.

4. Remove gear housing to frame bolts noting number and location of gear to frame shims (if any).

5. Remove steering gear assembly.

STEERING GEAR—DISASSEMBLE

Disassemble and reassemble steering gear and subassemblies on a clean work bench, preferably while the assembly is mounted on a holding fixture (J-5205 or J-6448-01) as shown in Fig. 9A-6.

CAUTION: DO NOT clamp housing in vise.

Cleanliness is of utmost importance; therefore, bench, tools, and parts must be kept clean at all times.

Before disassembling gear, thoroughly clean exterior with suitable solvent and drain as much fluid as possible. Assist draining by turning gear flange through its entire range two or three times.

REMOVE HOUSING LOWER END PLUG AND RACK-PISTON NUT END PLUG

1. Remove end plug retaining ring as shown in Fig. 9A-7.

2. Rotate gear (stub shaft) flange to the left and force end plug out of housing and discard end plug "O" ring seal.

CAUTION: DO NOT turn flange any farther than absolutely necessary or balls from ball nut and worm circuit may escape from this circuit and lay loose inside the rack-piston nut chamber.

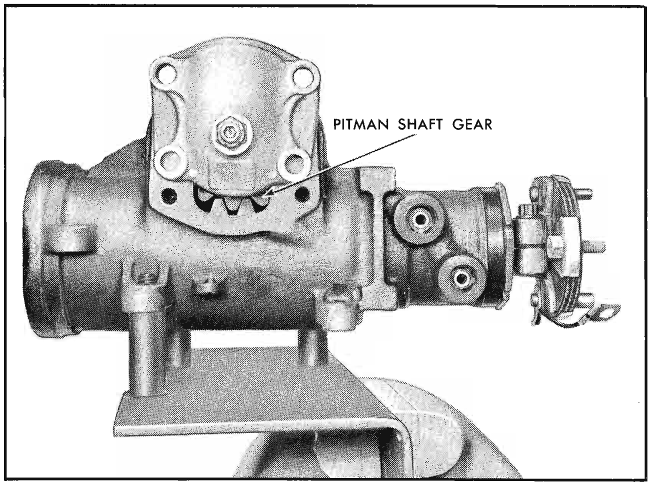


Fig. 9A-8 Position of Pitman Shaft Gear for Removal

3. Remove rack-piston nut end plug retaining ring using ½" square drive (from socket set).

REMOVE PITMAN SHAFT GEAR AND SIDE COVER

1. Remove side cover retaining screws and washers.

2. Rotate cover as necessary to see when pitman shaft is centered in gear housing opening while rotating gear (stub shaft) flange. See Fig. 9A-8.

3. Remove pitman shaft and cover assembly.

4. Remove side cover "O" ring seal and discard.

REMOVE RACK—PISTON NUT

1. Holding arbor tool J-7539 against the end of steering worm, rotate stub shaft flange to the left until rack-piston is free from worm. See Fig. 9A-9.

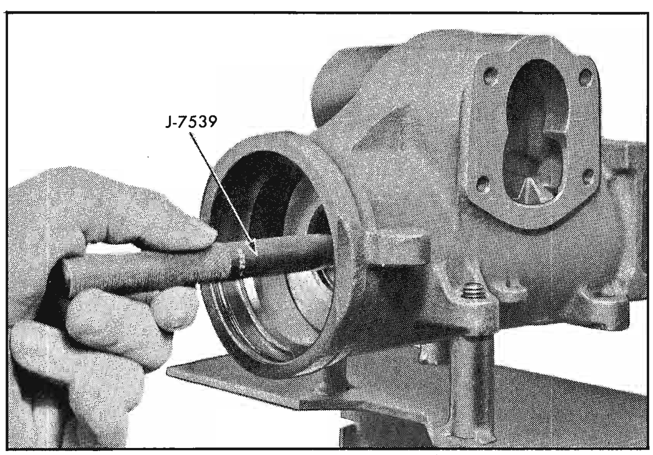


Fig. 9A-9 Arbor J-7539 Against End of Steering Worm

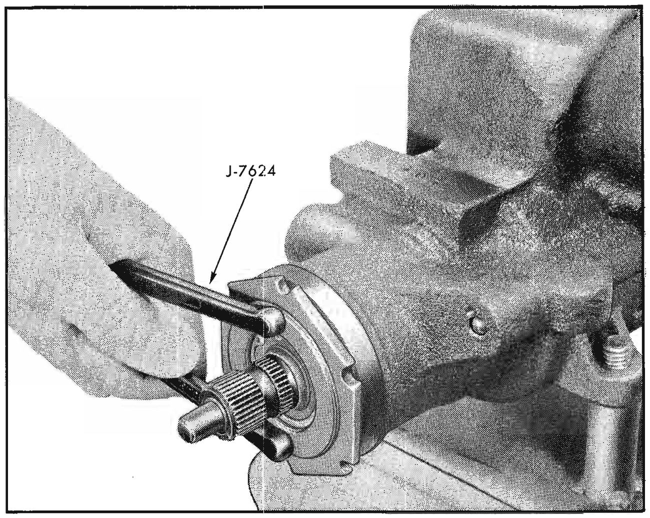


Fig. 9A-10 Removing Adjuster Plug Assembly

2. With arbor in rack-piston, remove rack-piston nut from housing bore.

NOTE: The arbor prevents balls from falling out of rack-piston nut.

REMOVE ADJUSTER PLUG ASSEMBLY, ROTARY VALVE WITH WORM SHAFT AND PIN ASSEMBLY AS AN INTEGRAL UNIT

1. Remove flange locking bolt and remove flange.

2. Remove adjuster plug lock nut using punch or suitable spanner wrench such as J-972 or J-7624.

3. Remove adjuster plug assembly using a spanner as shown in Fig. 9A-10.

4. Push on end of worm shaft with a hammer handle while pulling on stub shaft with slight rotary motion.

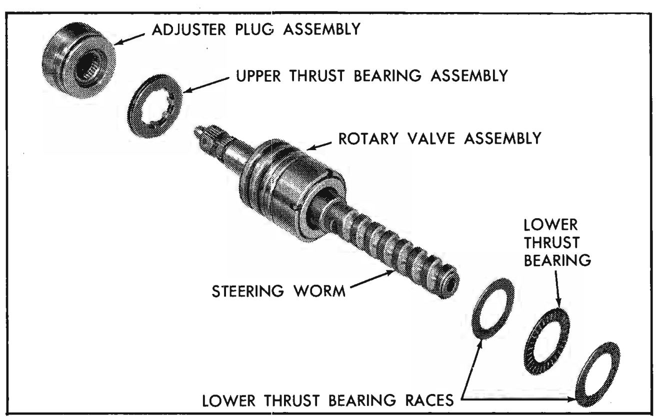


Fig. 9A-11 Adjuster Plug Removal

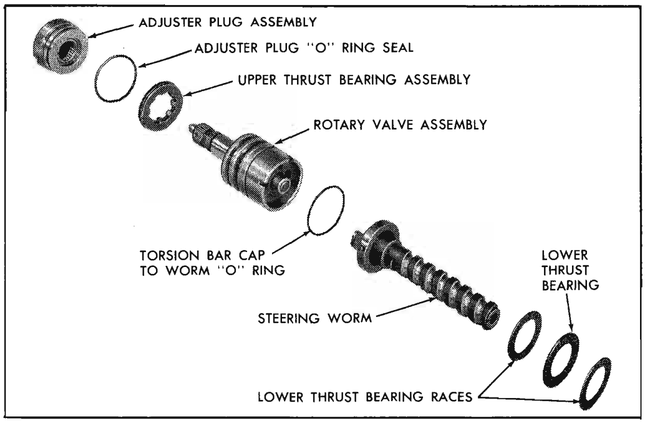


Fig. 9A-12 Location of Torsion Bar Cap to Worm "O" Ring

5. Remove adjuster plug, rotary valve and worm shaft assembly as an integral unit.

6. Remove adjuster plug and bearing assembly from rotary valve and torsion bar by pulling straight out (Fig. 9-11). DO NOT disassemble upper bearing assembly.

7. Separate worm shaft and valve assembly by pulling apart.

8. Remove lower bearing and discard torsion bar cap to worm "O" ring seal (in the Rotary Valve). See Fig. 9A-12.

9. Remove lower bearing races and bearing (these parts may come out with worm shaft or remain in the housing).

10. Remove adjuster plug "O" ring seal and discard.

DISASSEMBLE PITMAN SHAFT GEAR AND SIDE COVER

1. Hold lash adjuster with $\frac{7}{32}''$ allen wrench and remove lash adjuster nut and discard.

2. Screw lash adjuster out of side cover.

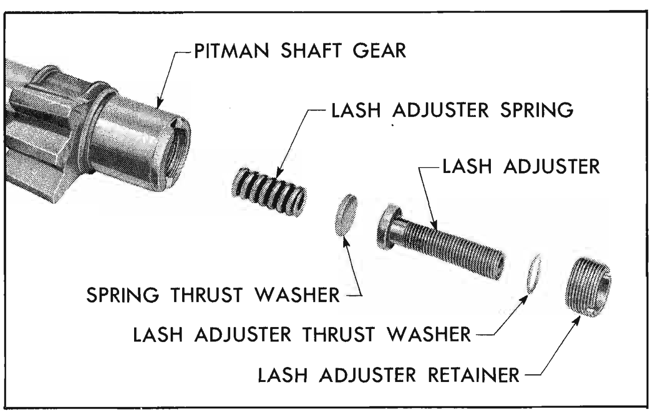


Fig. 9A-13 Parts in End of Pitman Shaft Gear —DO NOT DISASSEMBLE—

NOTE: Do not disassemble pitman shaft and component parts as these are serviced as an assembly. See Fig. 9A-13.

DISASSEMBLE RACK—PISTON NUT

1. Place the rack-piston nut assembly on a clean cloth.

2. Remove arbor tool J-7539, ball return guide, and balls making sure all of the balls are caught on the cloth (11 bright and 11 black).

3. Remove and discard Teflon ring and back-up seal from rack-piston nut.

DISASSEMBLE ADJUSTER PLUG

1. Mount adjuster plug in vise having brass jaws.

2. Remove retaining ring using tool J-4245 (No. 3 Truarc) and stub shaft dust seal.

3. Remove and discard stud shaft seal.

4. Inspect needle bearing in adjuster plug, if rollers are broken or pitted, remove needle bearing using the handle end of tool J-5188. Discard the bearing (Fig. 9A-14).

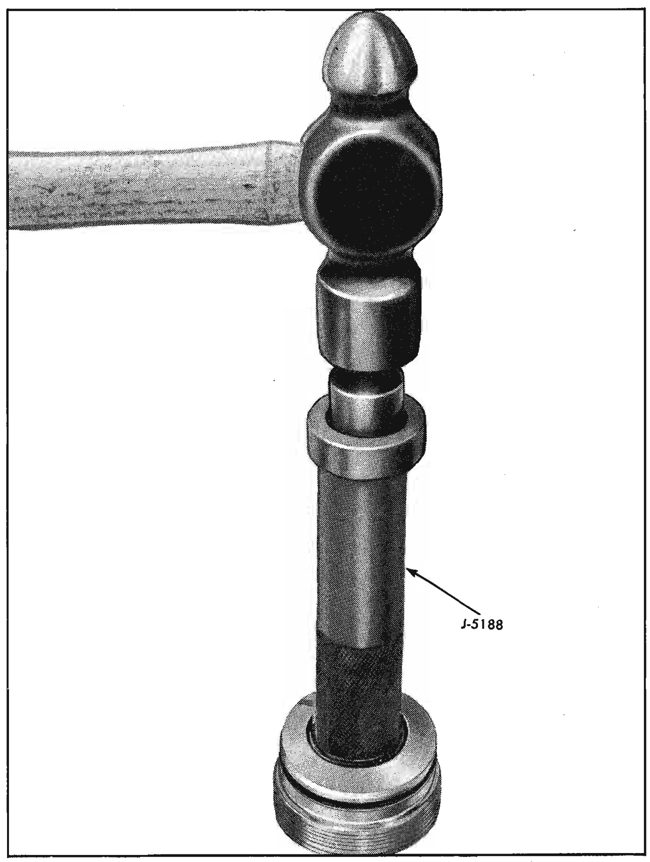


Fig. 9A-14 Removing Adjuster Plug Needle Bearing

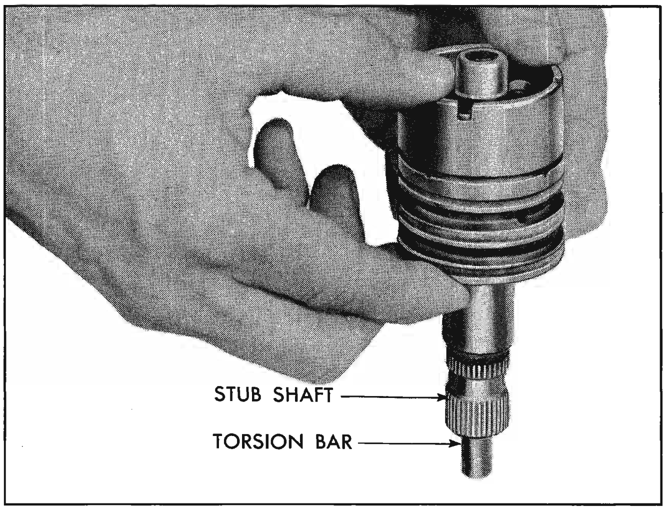


Fig. 9A-15 Tapping to Loosen Valve Spool

VALVE SPOOL DAMPENER "O" RING—REPLACE (ONLY IF NECESSARY DUE TO "SQUAWK" IN GEAR)

The rotary valve assembly includes the valve body, valve spool and the stub shaft assembly. All these parts are precision units and are hydraulically balanced at the factory.

Under no conditions are parts in this unit to be replaced or interchanged with other parts or units. If unit parts are scored or damaged the entire rotary valve assembly is to be replaced.

NOTE: If the valve spool dampener "O" ring requires replacement perform the following operations.

1. Work spool spring onto bearing diameter of the stub shaft and remove spool spring.

2. Tap end of stub shaft assembly gently against workbench to remove valve spool (Fig. 9A-15).

CAUTION: The diametrical clearance between the valve body and the spool may be as low as .0004". The slightest cocking of the spool may jam it in the valve body (Fig. 9A-16).

3. Remove and discard valve spool dampener "O" ring.

4. Install valve spool dampener "O" ring seal in valve spool groove, then lubricate seal in type A hydraulic fluid. Do not allow seal to twist in the groove.

5. With notch end of spool towards valve body, install spool, aligning spool notch with pin in stub shaft. See Fig. 9A-17.

CAUTION: Because of the small clearance between the valve spool and valve body, extreme care must be taken when assembling these parts. Push the spool evenly and slowly with a slight oscillating motion until spool reaches drive pin. Before pushing spool completely in, make sure dampener "O" ring seal is evenly distributed in spool groove. Slowly push spool completely in, with extreme care taken not to cut or pinch the "O" ring seal.

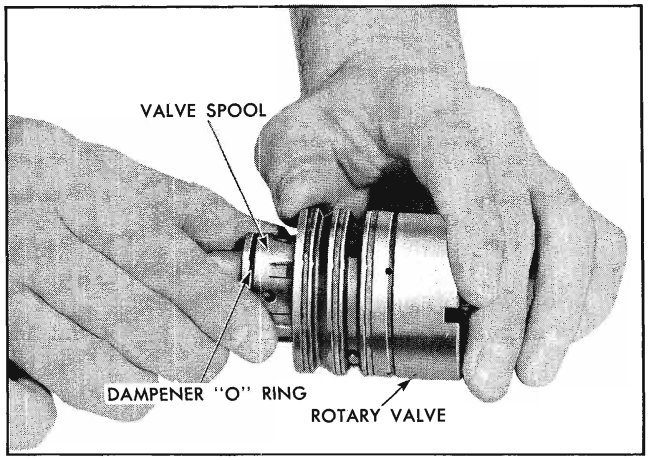


Fig. 9A-16 Removing Valve Spool from Rotary Valve

6. Slide spool spring over stub shaft and work the spring in position.

DISASSEMBLE ROTARY VALVE (ONLY IF NECESSARY)

1. Work spool spring onto bearing diameter of the stub shaft and remove spool spring.

2. Tap end of stub shaft assembly gently against workbench to remove valve spool (Fig. 9A-15).

CAUTION: The diametrical clearance between the

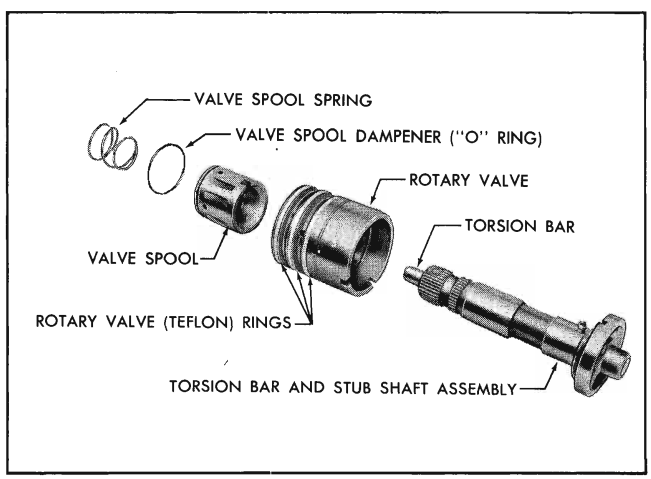


Fig. 9A-17 Rotary Valve—Exploded View

valve body and the spool may be as low as .0004". The slightest cocking of the spool may jam it in the valve body (Fig. 9A-16).

If slight sticking occurs, make a gentle attempt to reverse the removal procedure. If this does not free the spool, it has become cocked in the valve body bore and may be removed later.

3. Remove and discard valve spool dampener "O" ring.

4. Remove stub shaft, torsion bar (small diameter bar extending through stub shaft) and valve cap assembly by tapping end of torsion bar lightly with a plastic hammer. This will dislodge the cap from valve body cap pin. See Fig. 9A-17. Do not disassemble stub shaft assembly. The parts are pinned together and are serviced as an assembly.

5. If valve spool has become cocked as described in step 3, it can now be freed as follows:

a. Inspect parts to determine in which direction the spool is cocked.

b. A few very light taps with a soft plastic or rawhide hammer should align and free the spool in the bore.

c. Remove and discard "O" ring dampener seal from valve spool.

6. Carefully remove and discard valve body Teflon rings and ring back-up "O" ring seals.

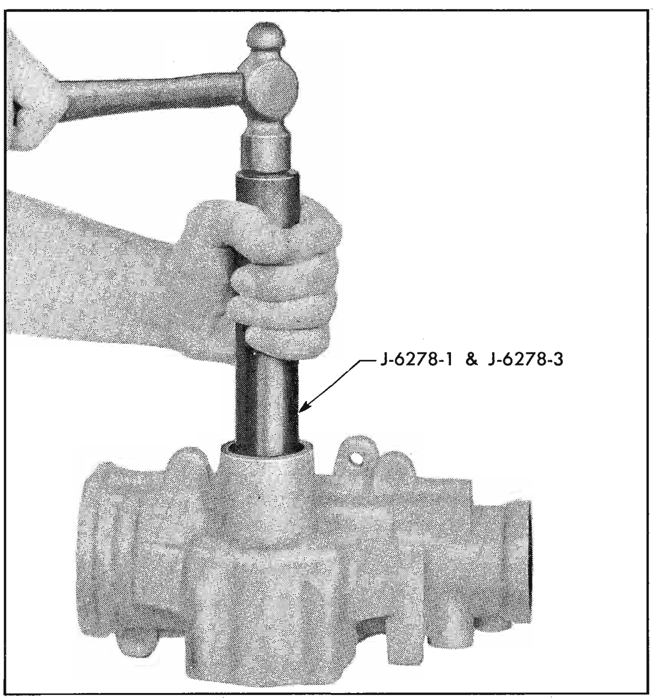


Fig. 9A-18 Removing Pitman Shaft Needle Bearing

DISASSEMBLE HOUSING

1. Remove pitman shaft outer dust seal back-up washer retaining ring using pliers J-4245.

2. Remove outer dust seal back-up washer.

3. Remove seal (double lip) by inserting offset screwdriver between seal and back-up washer and prying out of housing.

CAUTION: Do not damage housing bore when removing seal.

4. Remove back-up washer.

5. Remove seal (single lip) by cutting and collapsing seal.

CAUTION: Do not damage housing bore when removing seal.

6. If pitman shaft needle bearings are to be replaced, remove bearing by driving out of housing using tool J-6278-1 with adapter J-6278-3. See Fig. 9A-18.

7. If connectors are to be removed, tap threads in holes of connectors using $\frac{5}{16}$-18 NF tap. See Fig. 9A-19.

8. Remove connectors by using threaded bolt into tapped holes with washer and nut as extractor (Fig. 9A-20).

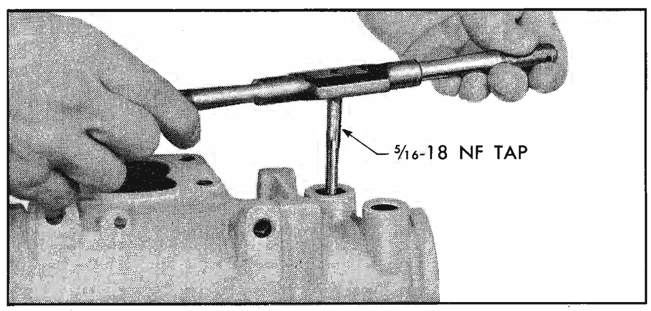


Fig. 9A-19 Tapping Connector Hole

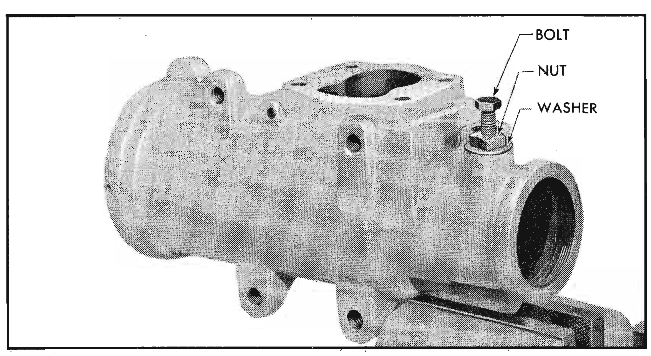
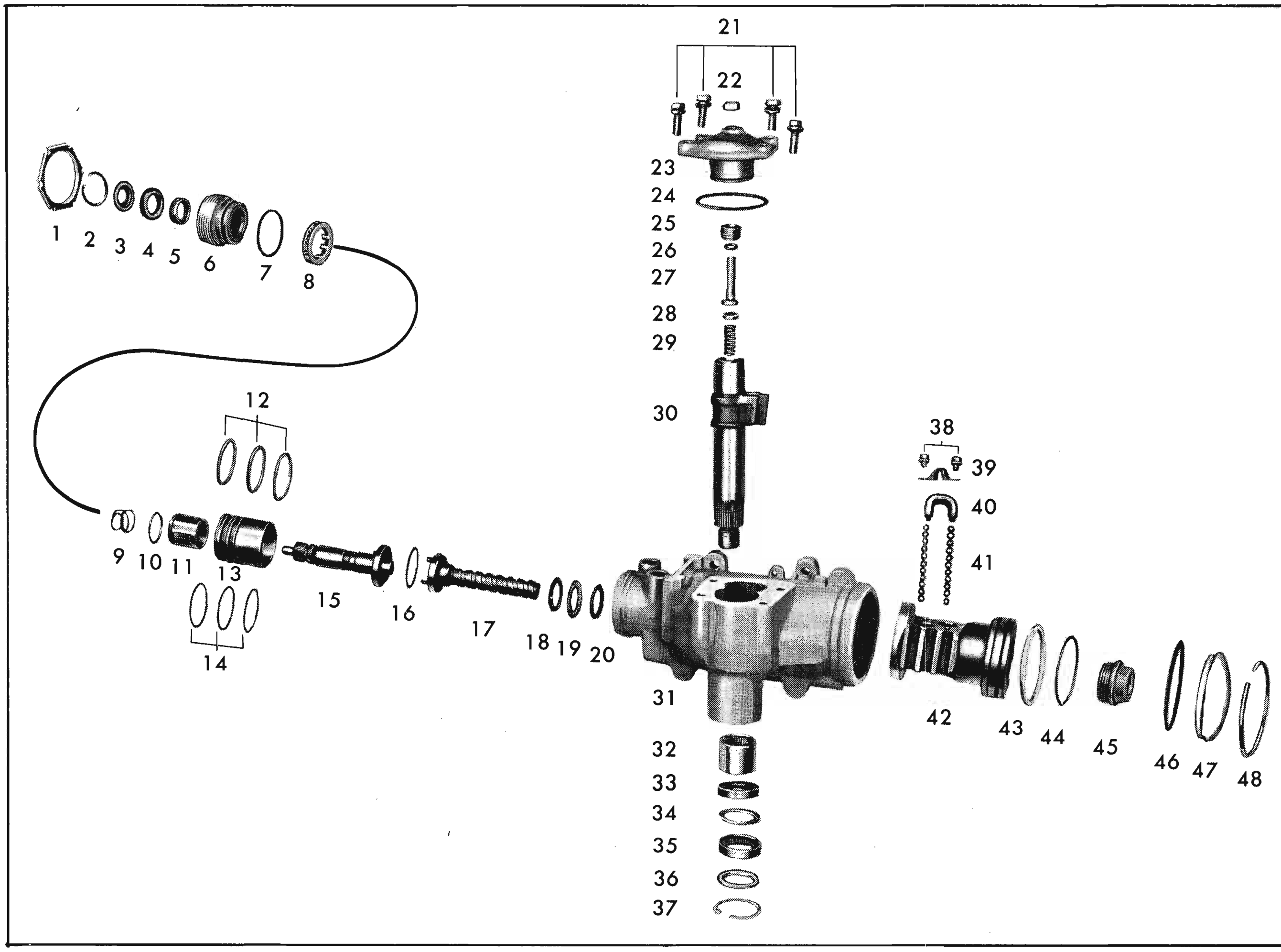


Fig. 9A-20 Removing Connector



1. Adjuster Plug Lock Nut
2. Retaining Ring
3. Adjuster Plug Seal Back-Up Washer
4. Adjuster Plug Seal
5. Adjuster Plug Needle Bearing
6. Adjuster Plug
7. Adjuster Plug "O" Ring Seal
8. Thrust Bearing
9. Valve Spool Spring
10. Valve Spool Dampener ("O" Ring)
11. Valve Spool
12. Rotary Valve Teflon Seals
13. Rotary Valve
14. Rotary Valve "O" Ring Seals
15. Torsion Bar and Stud Shaft Assembly
16. Torsion Bar Cap to Worm "O" Ring
17. Worm Shaft
18. Worm Thrust Bearing Inner Race
19. Worm Thrust Bearing
20. Worm Thrust Bearing Outer Race
21. Side Cover Screws
22. Lash Adjuster Lock Nut
23. Side Cover
24. Side Cover "O" Ring Seal
25. Lash Adjuster Retainer
26. Lash Adjuster Thrust Washer
27. Lash Adjuster
28. Spring Thrust Washer
29. Lash Adjuster Spring
30. Pitman Shaft
31. Steering Gear Housing
32. Pitman Shaft Needle Bearing
33. Single Lip Oil Seal
34. Inner Back-Up Washer
35. Double Lip Oil Seal
36. Outer Back-Up Washer
37. Retaining Ring
38. Ball Return Guide Retainer Screws
39. Ball Return Guide Retainer
40. Ball Return Guide
41. Rack—Piston Nut Balls
42. Rack—Piston Nut
43. Rack—Piston Nut Ring
44. Rack—Piston Nut Ring Back-Up Seal
45. Rack—Piston Nut End Plug
46. End Plug "O" Ring Seal
47. Housing Lower End Plug
48. Housing Lower End Plug Retainer

Fig. 9A-21 Power Steering Gear Assembly—Exploded View

CLEANING AND INSPECTION

Carefully wash all parts in a suitable cleaning solvent.

CAUTION: Do not use solvent on oil seals and "O" rings which are going to be replaced (Fig. 9A-21).

INSPECTION OF PITMAN SHAFT GEAR AND SIDE COVER

1. Inspect pitman shaft bearing surface in side cover for excessive wear or scoring. If badly worn or scored, replace side cover and bushing assembly.

2. Check pitman shaft sector teeth, bearing and seal surfaces and replace if badly worn, pitted or scored.

3. Check lash screw for end play.

If end play is noticed in step 3, replace pitman shaft gear assembly.

INSPECTION OF RACK—PISTON NUT AND WORM

1. Inspect worm and rack-piston nut grooves and all of the balls for excessive wear or scoring. If either the worm or rack-piston nut needs replacing, both must be replaced as a matched assembly.

2. Inspect ball return guides, making sure that ends where balls enter and leave guides are not damaged.

3. Inspect lower thrust bearing and races for excessive conditions of wear, pitting, scoring, or cracking. If any of these conditions are found, replace the thrust bearing and races.

4. Inspect rack-piston nut teeth for pitting, wear, and scoring.

5. Inspect outside surface of rack-piston nut for wear, scoring, or burrs.

6. Inspect thrust bearing rollers and races for excessive conditions of wear, piting, scoring, cracking, or brinelling. If any of these conditions are found, replace the thrust bearing assembly.

INSPECTION OF ROTARY VALVE

1. If there was evidence that the torsion bar to stub shaft "O" ring seal has been leaking, (oil leak between the stub shaft and torsion bar at the stub shaft coupling flange) the entire rotary valve assembly should be replaced if it cannot be properly sealed.

NOTE: Since the seal betwen the stub shaft and the torus bar at the stub shaft coupling flange is a permanent static seal which should never be replaced, it is permissible to make a permanent mechanical seal installation instead of replacing the entire valve assembly.

Clean the area around the intersection of the torsion bar and stub shaft and around the balancing pin (both ends) with solvent and/or a wire brush. Dry thoroughly and apply a liquid sealant which would flow into the area between these pieces and then harden. Devcon "B" or equivalent (commercially available products) will work very well in this application.

2. If any part or parts of the rotary valve assembly (including stub shaft assembly) are badly worn, cracked, pitted or broken, the entire rotary valve assembly should be replaced. A slight polishing on the valving surfaces is normal.

INSPECTION OF GEAR HOUSING

1. Inspect gear housing for any defects in the piston bore or the rotary valve bore. Inspect all retaining ring grooves and seal surfaces for scratches or nicks. If any major defects are found, the housing should be replace.

NOTE: A slight polishing of the cylinder bore by the piston is not uncommon and does not affect the operation of the gear.

2. Inspect ball plug in the housing, if leaking or raised above the housing surface, drive in flush to $\frac{1}{16}''$ below the surface. The ball plug can be tightened by staking the housing. The housing should be replaced only if leaks in this area cannot be properly sealed.

Clean area of leak with solvent and/or a wire brush. Dry thoroughly and apply a liquid sealant which will flow into the area between the ball plug and the housing and then harden. Devcon "B" or equivalent (commercially available products) should seal such leaks.

3. Inspect the connectors. If badly brinelled or scored, replacement will be necessary.

4. Inspect pitman shaft gear needle bearing; if worn or pitted, replace.

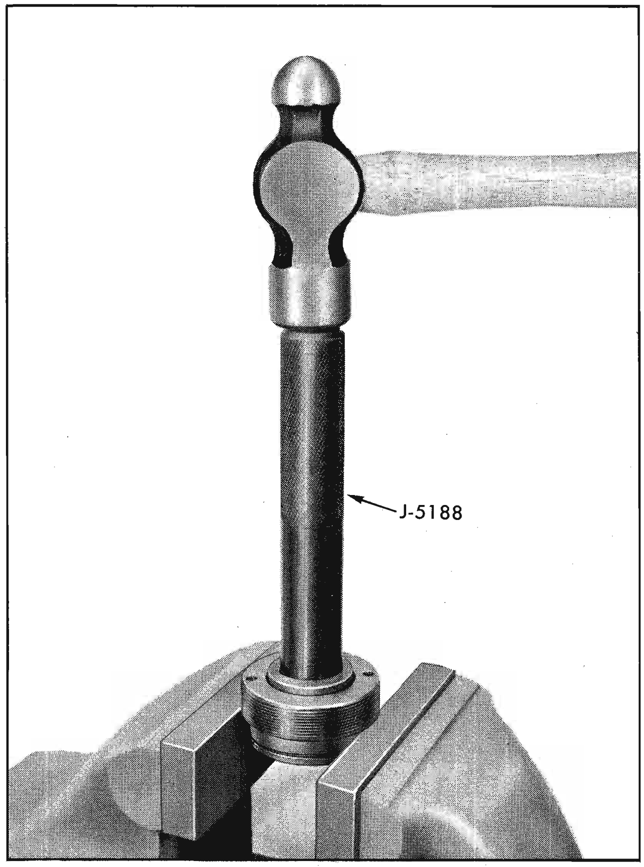
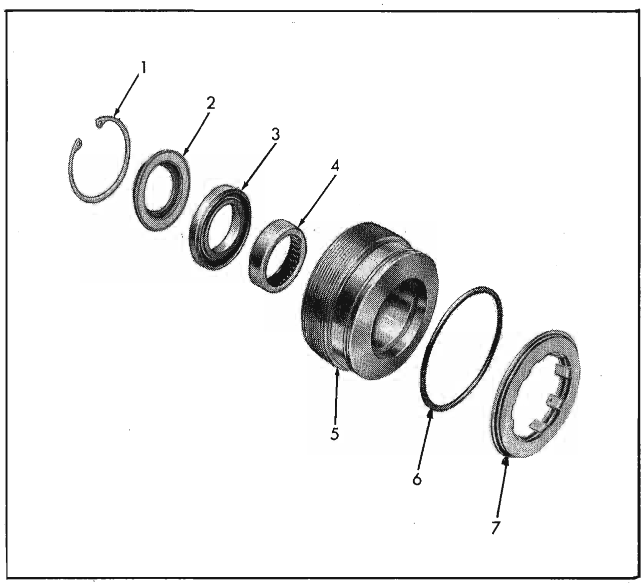


Fig. 9A-22 Installing Adjuster Plug Needle Bearing



1. Retaining Ring
2. Adjuster Plug Seal Dust Seal
3. Adjuster Plug Seal
4. Adjuster Plug Needle Bearing
5. Adjuster Plug
6. Adjuster Plug "O" Ring Seal
7. Thrust Bearing Assembly

Fig. 9A-23 Adjuster Plug—Exploded View

SUB-ASSEMBLIES—ASSEMBLE

Lubricate all parts as they are assembled.

ASSEMBLE PITMAN SHAFT GEAR AND SIDE COVER

1. Screw lash adjuster through side cover until cover bottoms on pitman shaft gear.

2. Install lash adjuster lock nut while holding lash adjuster with $\frac{7}{32}''$ allen wrench.

ASSEMBLE ADJUSTER PLUG

1. Mount adjuster plug in vise having brass jaws.

2. If needle bearing was removed, assemble needle bearing by pressing towards thrust bearing end of adjuster plug against identification end of bearing using tool J-5188. See Fig. 9A-22. End of bearing to be flush with bottom surface of stub shaft seal bore.

3. Lubricate new stub shaft seal with petrolatum and, using tool J-5188, install far enough to provide clearance for dust seal and retaining ring. Lubricate new dust seal with petrolatum and install with rubber surface on shaft outward.

4. Install new retaining ring with tool J-4245, making certain that the ring is properly seated.

ASSEMBLE ROTARY VALVE

1. Assemble one valve body Teflon ring back-up "O" ring seal in each groove on valve body. Do not allow seals to become twisted.

2. Assemble valve Teflon rings in ring grooves over the "O" ring seals by carefully slipping the rings over valve body. The rings may appear loose or twisted in the grooves, but the heat of the oil after assembly will cause them to straighten.

3. Install valve spool dampener "O" ring seal in valve spool groove, then lubricate seal in Type A hydraulic fluid. Do not allow seal to twist in the groove.

4. Assemble stub shaft assembly in valve body aligning the groove in the valve cap with pin in valve body (Fig. 9A-24). Press on cap until cap is against the shoulder in valve body with valve body pin in the cap groove. Hold these parts together during the rest of the assembly.

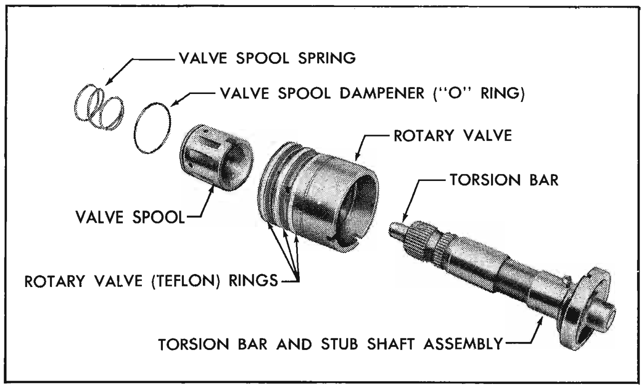


Fig. 9A-24 Rotary Valve—Exploded View

5. With notch end of spool towards valve body, install spool, aligning spool notch with pin in stub shaft.

CAUTION: Because of the small clearance between the valve spool and valve body, extreme care must be taken when assembling these parts. Push the spool evenly and slowly with a slight oscillating motion until spool reaches drive pin. Before pushing spool completely in, make sure dampener "O" ring seal is evenly distributed in spool groove. Slowly push spool completely in, with extreme care taken not to cut or pinch the "O" ring seal.

6. Slide spool spring over stub shaft and work the spring in position.

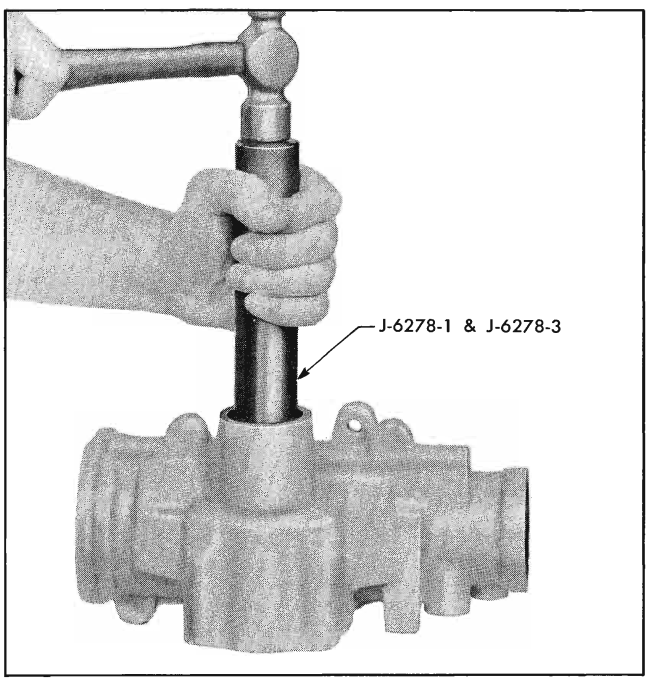


Fig. 9A-25 Installing Pitman Shaft Needle Bearing

7. Lubricate cap to worm "O" ring seal and install in valve assembly.

NOTE: If during the assembly of the valve, the stub shaft and cap assembly is allowed to slip out of engagement with the valve body pin, the spool will be permitted to enter valve body too far. The dampener "O" ring seal may expand into valve body oil grooves preventing removal of spool.

a. Remove valve spool spring and disassemble rotary valve assembly

b. Press on spool until the "O" ring seal is cut and spool can be removed.

c. Replace "O" ring seal and proceed with assembly as before.

ASSEMBLE HOUSING

1. With stamped end of needle bearing against shoulder of adapter J-6278-3, use Remover and Replacer J-6278-1 to drive pitman shaft needle bearing into bore from outside of housing until flush-to-$\frac{1}{32}''$ below shoulder. Make sure needle bearings rotate freely (Fig. 9A-25).

2. Lubricate the cavity between lips of pitman shaft (double lip) seal with high melting point, water resistant wheel bearing lubricant.

3. Lubricate and install pitman shaft seals; single lip seal, inner back-up washer, double lip seal, outer dust seal and retaining ring in housing bore (Fig. 9A-26). Use tool J-6219 (Fig. 9A-27) for seals and J-4245 for retaining ring. Make sure seal lips are properly positioned, retaining ring is seated, and that approximately $\frac{1}{16}''$ clearance is maintained between the inner seal (single lip) and the bearing.

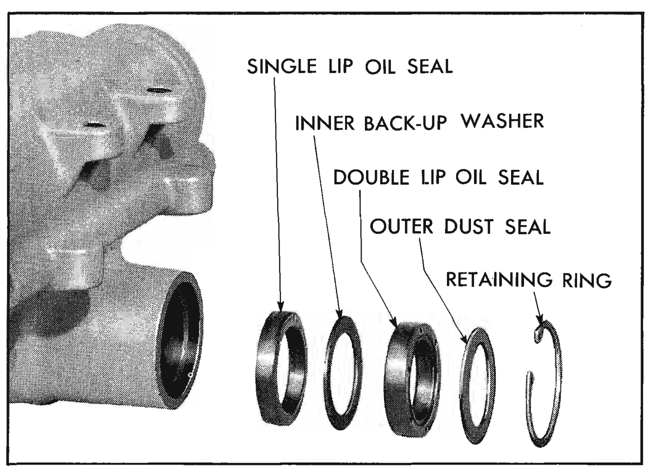


Fig. 9A-26 Pitman Shaft Seals and Washers

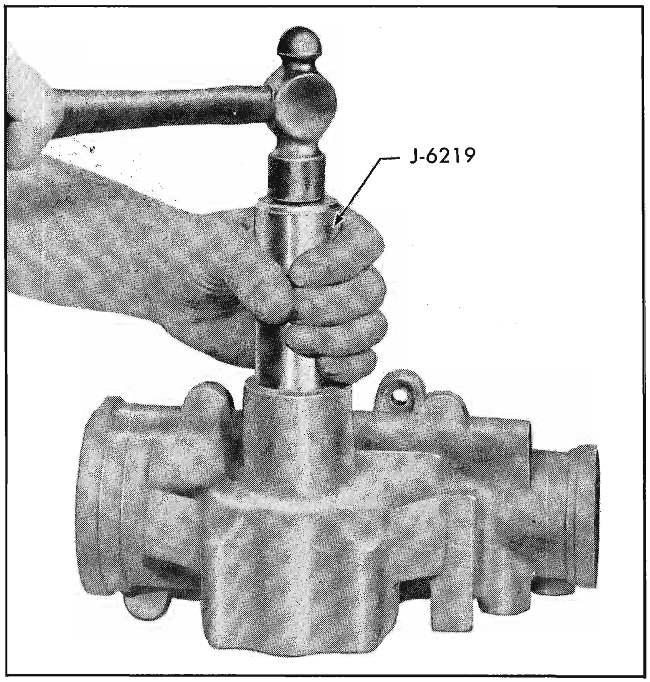


Fig. 9A-27 Installing Pitman Shaft Seals Using J-6219

4. If connectors were removed, install new connectors by driving into place with tool J-6217 (Fig. 9A-28).

ASSEMBLE RACK—PISTON NUT AND WORM

1. Lubricate and install new ring back-up seal and

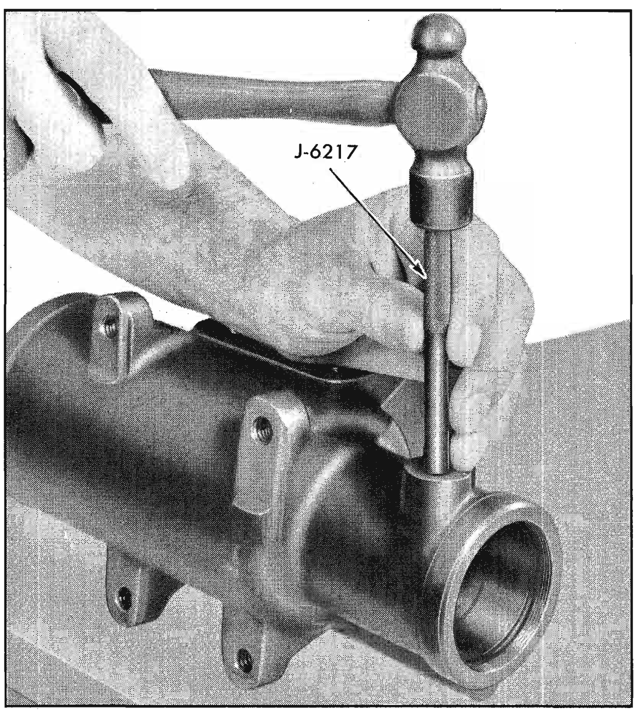


Fig. 9A-28 Installing Connector Using J-6217

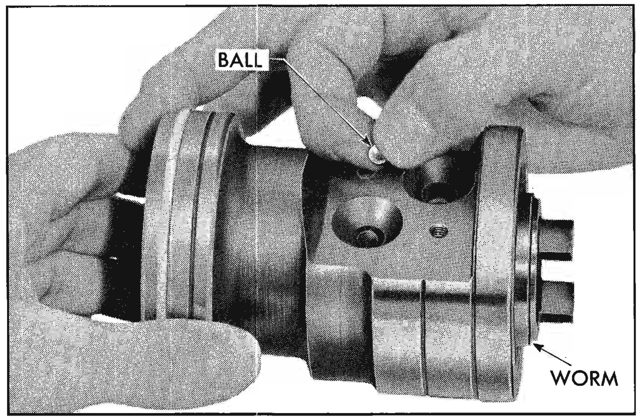


Fig. 9A-29 Loading Rack—Piston Nut

Teflon piston ring on rack-piston nut being careful ring and seal do not twist during installation.

2. Insert worm into rack-piston nut to bearing shoulder (Fig. 9A-29).

3. Align ball return guide holes with worm groove. Load 15 balls into the guide hole nearest the Teflon piston ring while slowly rotating worm to left to feed balls through the circuit. Alternate black balls with the silver balls. If balls are installed properly the worm should turn out of rack-piston nut.

4. Fill one-half of ball return guide with the remaining 7 balls. Place the other guide over the balls and plug each end with heavy grease to prevent the balls from falling out when installing guides into rack-piston nut (Fig. 9A-30).

5. Insert guides into guide holes of the rack-piston nut. Guides should fit loosely.

6. Place return guide clamp over guides and install two screw and lock washer assemblies and tighten to 8-12 lb. ft. torque.

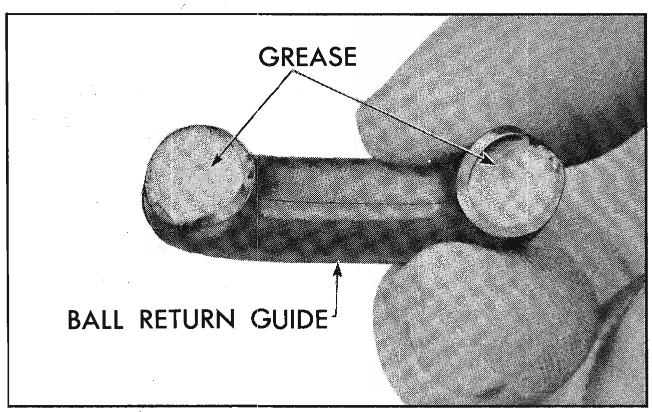


Fig. 9A-30 Ball Return Guide

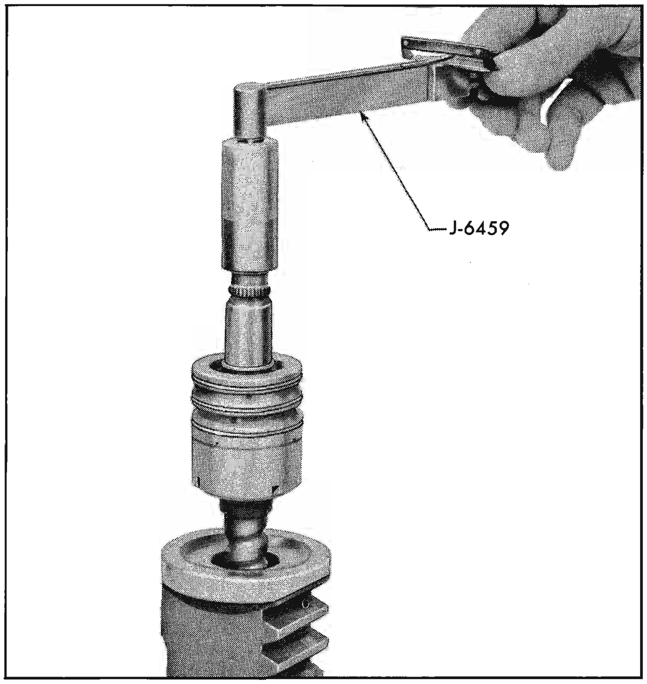


Fig. 9A-31 Checking Worm Preload

CHECK WORM PRELOAD

The worm groove is ground with a high point in the center. When the rack-piston nut passes over this high point, a preload of 0.5-5.0 lb. in torque should be obtained.

NOTE: DO NOT refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment and over center adjustment should correct the problem if it lies in the steering gear.

1. With worm pointing up, lightly clamp rack-piston nut in a bench vise having brass jaws.

CAUTION: Do not hold rack-piston nut in area of Teflon ring.

2. Place valve assembly on worm, engaging worm drive pin.

3. Rotate worm until it extends 1¼ inches from rack-piston nut to thrust bearing face. This is the center position.

4. Attach an inch-pound torque wrench with ¾ inch 12-point socket to stub shaft (Fig. 9A-31).

5. Oscillate wrench through a total arc of approximately 60 degrees in both directions several times and take a reading. The highest reading obtained with worm rotating should be between 0.5 to 5.0 lb. in. torque. Record torque when in specifications.

NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one-half of this total as the average torque.

NOTE: DO NOT refit rack-piston balls unless a complaint of loose steering is received. Upon such a complaint, a thrust adjustment and over center adjustment should correct the problem if it lies in the steering gear. If balls were pitted or rough then select the proper ball size for proper adjustment.

6. If the reading is too high or low (on new balls only), disassemble and reassemble using next size smaller (or larger) balls and recheck.

Table of Selective Sizes of Steering Nut Balls

6	.28117″	5685706
7	.28125″	5685707
8	.28133″	5685708
9	.28141″	5685709
10	.28149″	5685710
11	.28157″	5685711

A rack-piston nut with a ball size of 7 does not have a number stamped on the flat surface. For ball sizes other than No. 7, the ball size is stamped on the flat surface of the rack-piston nut. In order to obtain proper worm bearing preload install the proper new balls.

7. Remove rotary valve assembly from worm head.

8. Position arbor (tool J-7539) against worm end. Turn worm out of rack-piston assembly following worm end with arbor. Do not allow arbor to separate from worm until rack-piston nut is fully on the arbor. The arbor now keeps the balls from dropping out of the ball nut.

ASSEMBLE WORM SHAFT, ROTARY VALVE ASSEMBLY AND ADJUSTER PLUG AS AN ASSEMBLY

1. Assemble lower thrust bearing and races on worm (Fig. 9A-32).

2. Be sure "O" ring seal is between valve body and worm head and assemble valve assembly to worm by aligning slot in valve body with pin on worm head.

3. Install upper thrust bearing assembly so flat surface of bearing contacts rotary valve assembly. (Retaining tabs should face adjuster plug.)

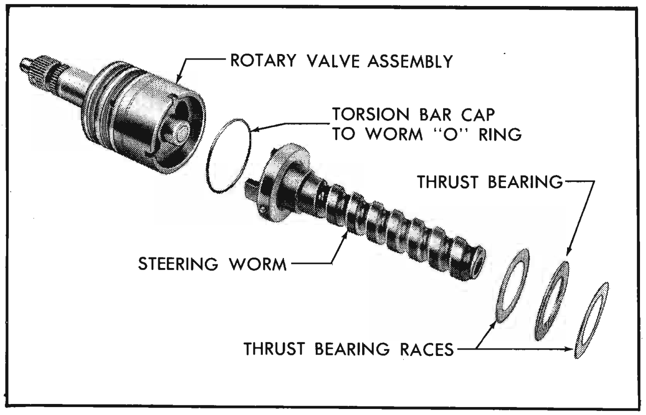


Fig. 9A-32 Worm Shaft and Rotary Valve—Exploded View

4. Install new "O" ring on adjuster plug.

5. Install adjuster plug assembly on stub shaft so bearing rests against upper bearing assembly.

STEERING GEAR—ASSEMBLE

ADJUST THRUST BEARING PRELOAD

1. Install worm valve assembly and adjuster plug in housing as integral unit.

2. Tighten adjuster plug snug in gear housing and back off slightly (1/8 turn maximum.)

3. With torque wrench on stub shaft read torque required to rotate worm, valve assembly, and stub shaft in housing (drag).

4. Turn adjuster plug in until torque reading increased 1-3 lb. in. above drag reading obtained in (4) above.

NOTE: Do not use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.

5. Install adjuster plug lock nut and tighten to 50-110 lb. ft. torque.

6. Recheck thrust bearing preload. Total thrust bearing adjustment plug drag should not exceed 10 lb. in. torque.

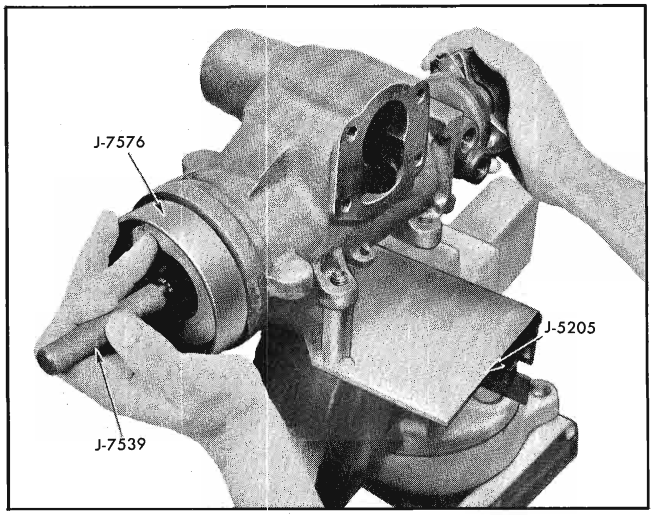


Fig. 9A-33 Installing Rack—Piston Nut

REPLACE RACK-PISTON

1. Slip stub shaft flange onto end of stub shaft.

2. Holding Teflon ring compressor sleeve tool J-7576 tightly against the shoulder of gear housing insert the rack-piston nut and arbor into housing holding the arbor (tool J-7539) until arbor contacts worm end. See Fig. 9A-33.

3. Holding the arbor tight against the worm, turn stub shaft flange (and worm) to draw ball nut onto worm and into housing until the arbor is free.

CAUTION: Be certain that no balls drop out.

4. Remove arbor and sleeve.

REPLACE PITMAN SHAFT GEAR AND SIDE COVER

1. Turn steering worm until center groove of rack-piston is aligned with center of pitman shaft needle bearing.

2. Install new side cover "O" ring seal.

3. Install pitman shaft gear so that the center tooth of gear meshes with the center groove of rack-piston. Make sure that side cover "O" ring seal is in place before pushing cover against housing.

4. Install side cover screws and tighten to 25 to 35 lb. ft. torque.

5. Install end plug in rack-piston nut using 1/2" square drive and tighten to 35-65 lb. ft. torque.

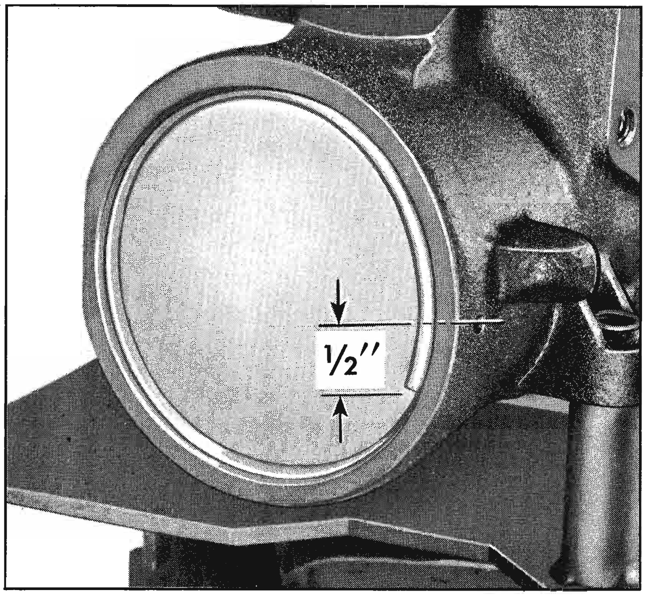


Fig. 9A-34 Installing End Plug Retainer Ring

REPLACE HOUSING LOWER END PLUG

1. Install new housing end plug "O" ring seal.

2. Insert end plug into gear housing and seat against "O" ring seal. Slight pressure may be necessary to seat end plug properly.

3. Install end plug retainer ring so end of ring extends over and at least ½" beyond the ring removal assist hole (Fig. 9A-34).

ADJUST PITMAN SHAFT PRELOAD THROUGH CENTER HIGH POINT

NOTE: DO NOT use a torque wrench having maximum torque reading of more than 100 lb. in. When taking following torque readings, take a reading pulling the torque wrench to the right and a reading pulling the torque wrench to the left. Total both readings and take one half of this total as the average torque.

Using a ¾"-12 point deep socket and inch-pound torque wrench, (Fig. 9A-35) take a reading through the center position to determine total drag, thrust bearing adjustment, and rack and worm preload. Adjust lash adjuster so torque is between 4 and 8 lb. in. in excess of the total reading found above.

Total over center preload must not exceed 18 lb. in. through center high point when rotating worm shaft through an arc of approximately 20°. Tighten lash adjuster nut to 20-30 lb. ft. torque. Recheck preload after nut has been tightened.

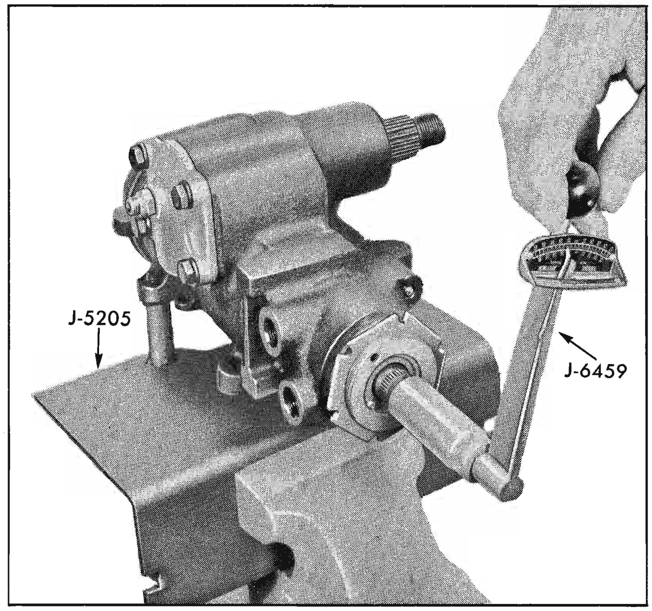


Fig. 9A-35 Adjusting Pitman Shaft Preload

REPLACE STUB SHAFT FLANGE

1. Replace stub shaft flange, aligning the flat surface on the stub shaft serrations with the flat section in the flange hole.

2. Install flange clamping bolt and tighten to 25 to 35 lb. ft. Be sure to position flange so that it clears the end of the adjuster plug by approximately $1/16$ inch and rotates without interference with the adjuster plug.

STEERING GEAR—INSTALL

1. Position steering gear assembly in car aligning large head rivet in widest upper flange opening.

NOTE: If same gear housing is replaced, locate any ⅛" standard washer shims that were removed in their original position between housing and frame. If steering gear has new housing or requires any alignment, flat washers of appropriate thickness and diameter should be selected for proper alignment of steering gear and steering column assembly. Metal to metal contact between flanges on stub shaft assembly and steering shaft assembly will transmit and amplify gear noise to the driver.

2. Install steering housing to frame bolts finger tight. Shift gear assembly to obtain best alignment with flange on steering shaft. Tighten housing to frame bolts to 70-90 lb. ft. torque.

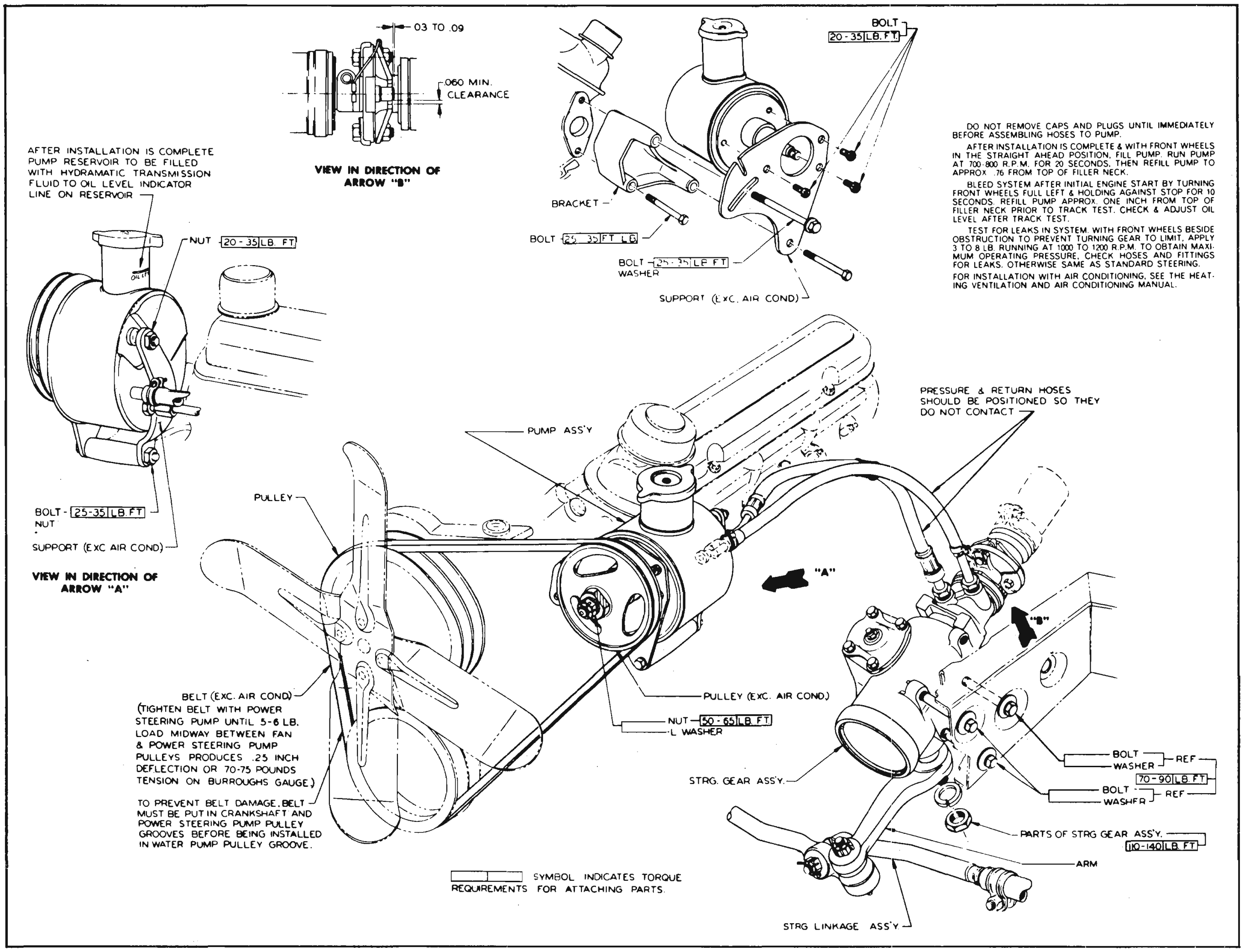


Fig. 9A-36 Installation of Power Steering Gear Assembly

3. Install pitman arm and secure with lock washer and nut. Tighten nut to 110-140 lb. ft. torque.

4. Connect pressure and return hose assemblies to gear assembly and tighten to 20-30 lb. ft. torque.

5. Install two flange flexible coupling attaching nuts and lock washers and tighten to 10-20 lb. ft. torque.

6. Align steering column jacket and shaft assembly and steering gear so head of lower coupling bolt has ¼ inch clearance from flange on steering shaft. This can be accomplished by shifting either the steering gear assembly or the steering mast jacket assembly up or down (see View in Direction of Arrow "B" in Fig. 9A-36). A metal to metal contact at this point will transmit the slightest noise to the driver.

7. Be sure pins are positioned as shown in Fig. 9A-36.

8. Check fluid level in pump reservoir. Fluid should be up to oil level mark in reservoir. Add Automatic Transmission Fluid Type A identified by an AQ-ATF qualification number as necessary. With front wheels off floor start engine and bleed hydraulic system by manually steering through cycle several times until there is no evidence of air bubbles in reservoir. Recheck fluid level and lower car.

POWER STEERING GEAR TROUBLE DIAGNOSIS

CONDITION	CAUSE	REMEDY
1. Hard steering while driving	Frozen steering shaft bearings	Replace bearings
	Lower coupling flange rubbing against adjuster	Loosen bolt and assemble properly
	Steering wheel rubbing against gear-shift bowl	Adjust jacket endwise
	Steering adjustment tight	Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball Readjust if necessary
2. Poor return of steering	Frozen steering shaft bearings	Replace bearings
	Lower coupling flange rubbing against adjuster	Loosen bolt and assemble properly
	Steering wheel rubbing against gear-shift bowl	Adjust jacket endwise
	Tires not properly inflated	Inflate to specification
	Incorrect caster or toe-in front wheels	Adjust to specification
	Tight steering linkage	Lubricate—check end plugs
	Steering gear misalignment	Re-shim at frame
	Tightness of suspension ball joints	Lubricate or otherwise free up
	Steering adjustment tight	Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball Readjust if necessary
	Tight sector to rack-piston adjustment	Adjust in car to specification
	Thrust bearing adjustment too tight	Remove gear and adjust to specification
	Rack-piston-nut and worm preload too tight	Remove gear and replace balls as required
	Sticky valve spool	Remove and clean valve or replace valve
3. Car leads to one side or the other.	Due to front end misalignment	Adjust to specification
	Unbalanced or badly worn valve NOTE: If this is cause, steering effort will be very light in direction of lead and heavy in opposite direction.	Replace valve

CONDITION	CAUSE	REMEDY
4. Momentary increase in effort when turning wheel fast to the right.	Low oil level in pump	Check oil level in pump reservoir
	Pump belt slipping	Tighten or replace belt
	High internal leakage	Replace rack-piston nut piston ring, ring back-up seal, and/or replace valve
5. Momentary increase in effort when turning wheel fast to the left.	Low oil level in pump	Check oil level in pump reservoir
	Pump belt slipping	Tighten or replace belt
	High internal leakage	Replace rack-piston nut piston ring, ring back-up seal, valve body to worm seal and/or replace valve
6. External oil leaks (wipe gear thoroughly and make sure source of leakage is determined).	Loose hose connections	Tighten
	Damaged hose	Replace
	Side cover O-ring seal	Replace seal
	Pitman shaft seals	Replace seals
	Housing end plug seal	Replace seal
	Adjuster plug seals	Replace seals
	Torsion bar seal	Replace rotary valve assembly
7. Gear noise (rattle or chuckle).	Loose over-center adjustment NOTE: A slight rattle may occur on turns because of the increased lash off the "high point". This is normal and the lash must not be reduced below the specified limits to eliminate this slight rattle.	Adjust to specification
8. Gear noise ("hissing" sound).	Gear loose on frame	Check gear-to-frame mounting bolts. Tighten bolts to specifications.
	There is some noise in all power steering systems. One of the most common is a "hissing" sound most evident at standstill parking. There is no relationship between this noise and performance of the steering. Hiss may be expected when steering wheel is at end of travel or when slowly turning at standstill.	Do not replace valve unless "hiss" is extremely objectionable. Slight hiss is satisfactory and in no way affects steering. A replacement valve may also exhibit slight noise and is not always a cure for the objection. Investigate clearance around safety drive bolts. Be sure steering shaft and gear are aligned so the flexible coupling rotates in a flat plane and is not distorted as shaft rotates. Any metal to metal contact through the flexible coupling will transmit the valve hiss into the car.

CONDITION	CAUSE	REMEDY
9. Excessive wheel kickback or loose steering.	Lash in steering linkage	Adjust parts affected
	Air in system	Add oil to pump reservoir and bleed system of air
	Excessive lash between pitman shaft sector and rack-piston	Adjust to specification
	Loose thrust bearing adjustment	Remove gear and adjust to specification
	Ball nut and worm preload	Check thrust bearing adjustment and over center adjustment. Check for looseness in steering linkage. If complaint still exists, remove rack-piston and worm, and change balls to obtain specified preload.
	Ball Joints loose	See Ball Joints under FRONT SUSPENSION.
	Front wheel bearings incorrectly adjusted or worn	Adjust or replace front wheel bearings
10. Steering wheel surges or jerks when turning with engine running, especially during parking.	Loose pump belt	Adjust to specification
11. Hard steering when parking.	Loose pump belt	Adjust to specification
	Low oil level in reservoir	Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage
	Lack of lubrication in linkage or front suspension	Add lubricant where needed
	Tires not properly inflated	Inflate to recommended pressure
	Insufficient oil pressure	If all of the above checks do not reveal the cause of hard steering, make the following tests of oil pressure: 1. Disconnect the pressure line at oil pump. Attach gauge to pump. Connect the hose to end of gauge where the valve is located. 2. With engine at warm idle and gauge valve open, note the oil pressure on the gauge while turning steering wheel from one extreme position to the other. Especially note the maximum pressure which can be built up

CONDITION	CAUSE	REMEDY
11. Hard Steering when parking—continued	Insufficient oil pressure—continued	with the wheel held in either right or left extreme position.

CAUTION: Do not hold wheel in extreme position for an extended period of time because it will drastically increase the oil temperature and will cause undue wear on the oil pump.

3. With oil temperature between 150°F and 170°F, as measured with a thermometer in the reservoir, the maximum oil pressure should not be less than 925 psi for satisfactory power steering operation.

4. If the maximum oil pressure is less than 925 psi, it indicates trouble in the pump, oil hoses, steering gear, or a combination of these parts. To eliminate the hoses and gear, close the gauge valve and quickly test pressure of the pump only with the engine at warm idle, then open the valve to avoid increasing oil temperature.

5. Comparing the maximum pressures obtained in these two tests will indicate source of trouble as follows:

    a. First test (step 2) pressure low, and second test (step 4) pressure normal — indicates faulty external oil lines or steering gear.

    b. First test (step 2) and second test (step 4) pressures equally low — indicates faulty oil pump.

If above test shows trouble to be in pump, see pump section.

If trouble is shown to be in steering gear or hoses, examine for external oil leaks as under Condition No. 6.

CONDITION	CAUSE	REMEDY
11. Hard steering when parking—continued	Low oil pressure due to restriction in hoses:	
	a. Check for kinks in hoses	Remove kink
	b. Foreign object stuck in hose	Remove hoses and remove restricting object or replace hose.
	Low oil pressure due to steering gear:	
	a. Pressure loss in cylinder due to worn piston ring, damaged ring back-up seal or scored housing bore.	Remove gear from car for disassembly and inspection of ring, back-up seal and housing bore.
	b. Leakage at valve rings and/or valve body to worm seal	Remove gear from car for disassembly and replace ring or seal.
	c. Loose fit of spool in valve body or leaky valve body	Replace rotary valve assembly.
	Loss of assist coming out of left turn:	Check oil level in pump reservoir
		Tighten or replace belt.
		Replace rack-piston nut, piston ring and ring back up seal. When the rack-piston nut is out, make sure there is a chamfer on both sides of the ring groove, otherwise replace nut with one having a chamfer on both sides of the ring groove
12. Valve squawk when turning or when recovering from a turn	Cut or worn dampener ring on valve spool	Replace dampener ring, being careful not to cut the new ring at installation
	Loose or worn rotary valve parts	Replace rotary valve assembly
13. No effort required to turn	Broken torsion bar	Replace rotary valve assembly

POWER STEERING GEAR SPECIFICATIONS

Over All Steering Ratio .... approx. 22 to 1

Steering Gear Ratio .... 17.5 to 1

Steering Wheel Effort

Normal Driving .... 1 to 2 lbs.

Parking .... 2 to 3.5 lbs.

Torque

Adjuster Plug Lock Nut .... 50-110 lb. ft.

Lower Flange Attaching Bolt .... 25-35 lb. ft.

Pitman Arm Lock Nut .... 110-140 lb. ft.

Pitman Shaft Preload Lash Adjuster Lock Nut .... 20-30 lb. ft.

Pressure Hose Connector at Gear .... 20-30 lb. ft.

Rack-Piston Nut End Plug .... 35-65 lb. ft.

Return Hose Connector at Gear .... 20-30 lb. ft.

Side Cover Screws .... 25-35 lb. ft.

Steering Gear Housing to Frame Bolts .... 70-90 lb. ft.

POWER STEERING VANE TYPE PUMP

CONTENTS OF THIS SECTION

GENERAL DESCRIPTION

The power steering gear pump has an outlet capacity of 1.75 gal. per min. at idle and is mounted on the engine in position to be driven by a belt from the crankshaft harmonic balancer. Maximum output of 2.3 gal. per min. is obtained when operating at 1500 rpm against a 50 psi pressure.

The component parts of the power steering pump are encased in a reservoir, Fig. 9A-38, filled with oil used for the power steering gear. The reservoir has a filler neck with a vented cap and is fastened to the pump housing leaving only the housing face and shaft hub exposed.

A pump housing within the reservoir houses a babbitt bushing and a shaft seal, and has two openings from the rear side. The larger of these openings has two dowel pins in the pump inner face that hold the functional parts of the pump; the thrust plate, rotor ring which contains the rotor and vanes, and the pressure plate. The smaller opening receives a flow control valve and spring.

THRUST PLATE

The thrust plate is located adjacent to the inner face of the pump housing. One side of the thrust plate performs the function of taking the rearward shaft thrust. The other side consists of six crescent or kidney shaped slots (cavities) and two holes that extend through the plate.

Four of the crescent shaped slots are located around the drive shaft hole (but are not connected with each other) and are for undervane oil pressure. The other two slots are for discharging the oil under pressure into a high pressure area that provides oil for the gear. These two slots are in line with the two crossover holes in the pump ring which feeds high pressure (discharging) oil through the pressure plate into the high pressure area to provide oil requirements as called for by the steering gear.

The two open cavities diametrically opposite from each other and at the surface of the thrust plate are for intake of oil from the suction part of the pump.

PUMP RING

The pump ring is a flat plate with a cam surface center opening. This ring encompasses the rotor and vanes and is located adjacent to the face of the thrust plate on the same two dowel pins that retain the thrust plate. The rotor is loosely splined to the pump drive shaft and, therefore, turns with the shaft. Ten slots for vanes are evenly spaced around the rotor and extend from the rotor outer diameter inward to the center approximately $1\frac{3}{32}''$ deep.

PRESSURE PLATE

The pressure plate contains six holes or cavities that extend through the plate and two "blind" slots. Four of the "through" holes around the drive shaft hole are connected to high pressure oil. This oil is used to supply oil pressure to the vanes to insure their following the cam surface in the pump ring. The other two holes are for discharging the oil under pressure to the high pressure area for gear use.

The two blind slots are radially open to the suction part of the pump and intake oil flows through these openings.

FLOW CONTROL VALVE

The purpose of the flow control valve is to control power steering system pressures and thereby oil flow to the gear as required under various operating conditions.

This valve assembly consists of a plunger, plunger screw, ball check, ball check guide and ball check guide spring. A screen in the end of the plunger screw is designed to keep dirt and foreign material out of the ball check area. Selective shims are used between the plunger screw and the valve plunger as required to calibrate the flow control valve assembly (with proper pressure in the ball check valve guide spring) to permit proper relief of pressure within the pump under high pump pressure operation.

Due to selective parts controlling calibration of this valve the flow control valve assembly is only serviced as an assembly.

RESERVOIR

The reservoir is an oil storage space and provides a means of directing the return oil back to the pump.

DRIVE SHAFT

The pump drive shaft is belt-driven by the crankshaft harmonic balancer and extends through all the major parts mentioned above except the pressure plate. The pump shaft rotates at a pump to engine ratio of 1.25 to 1.

OPERATION

(Figs. 9A-38, 9A-39 and 9A-40)

FILLING THE PUMP AND GEAR (FIG. 9A-38)

When the pump and power steering gear are completely void of oil, adding oil to the reservoir will completely envelope the pump housing assembly which is inside the reservoir. Oil is drawn into the intake portion of the pump by suction (and weight of oil) causing it to flow through a drilled passage in the lower portion of the housing (5) to another drilled hole leading to a groove around the rotor ring (4) to tend to fill this area and also the two suction "openings" on the surface of the thrust plate (1) and two suction openings in the pressure plate. Oil fills the lower opening in the thrust plate to feed the rising portion of the rotor ring. Air is pumped out of the pump through the gear oil circuit to the gear, then to return to the reservoir clearances of the parts and out the vented cap.

As the rotor is splined to the drive shaft, it turns with the shaft and the vanes follow the cam surface machined in the pump ring. The cam is designed with two vane rising and two falling areas and, therefore, causes a complete pumping cycle to occur every 180 degrees of pump drive shaft rotation. Centrifugal force throws the vanes against the ring to pick up a little oil to be forced into the high pressure area.

Some oil will leak along the pump drive shaft to the shaft seal and to the area behind the thrust plate (via drilled passages in the housing). Leakage oil past the shaft is intended for lubrication of the shaft. The bleed passage to the area behind the thrust plate prevents pressure build up on the shaft seal.

As more and more oil is picked up by the vanes, more oil will be forced into the cavities of the thrust plate and then to flow through the two crossover holes in the rotor ring and the pressure plate only to empty into the high pressure area of the pump between the pressure plate and the housing end plate (10).

As the high pressure area fills (10), some oil flows under the vanes through fully open crescent shaped slots in the pressure plate while the vanes are rising to force them to follow the cam surface of the rotor ring. The two holes drilled through the crescent shaped slots in the pressure plate are intended to restrict oil as it is forced out from under the vanes when they are falling.

When the flow controlling rotary valve in the steering gear is in the "neutral" or straight ahead, oil flows from the pump through the open center rotary valve in the gear and back to the pump reservoir without traveling through the power cylinder of the gear. At engine idle, or slightly below, the flow control valve remains closed or nearly so, because pump output is not high enough nor is oil pressure in the pump high enough to overcome the control valve spring to open the flow control valve.

When engine speed is increased, pump output and oil pressure is also increased and the flow of oil exceeds the predetermined power steering requirements. Therefore, the increase in oil pressure overcomes opposing pressure of the control valve spring to open the valve farther, which in turn lowers system pressure and also limits temperature rise in the system.

With the increase in engine rpm, oil pressure is more than adequate to supply the system requirements and overcome the force of the flow control valve spring. This allows the valve to open and direct oil to a by-pass hole thereby diverting oil into the pump intake chamber and oil is by-passed within the pump. The by-passing of this oil is of a high velocity discharging past the valve into the intake chamber and picks up make-up oil from the reservoir on the jet pump principle. During the straight ahead position, pressure should not exceed approximately 100 psi.

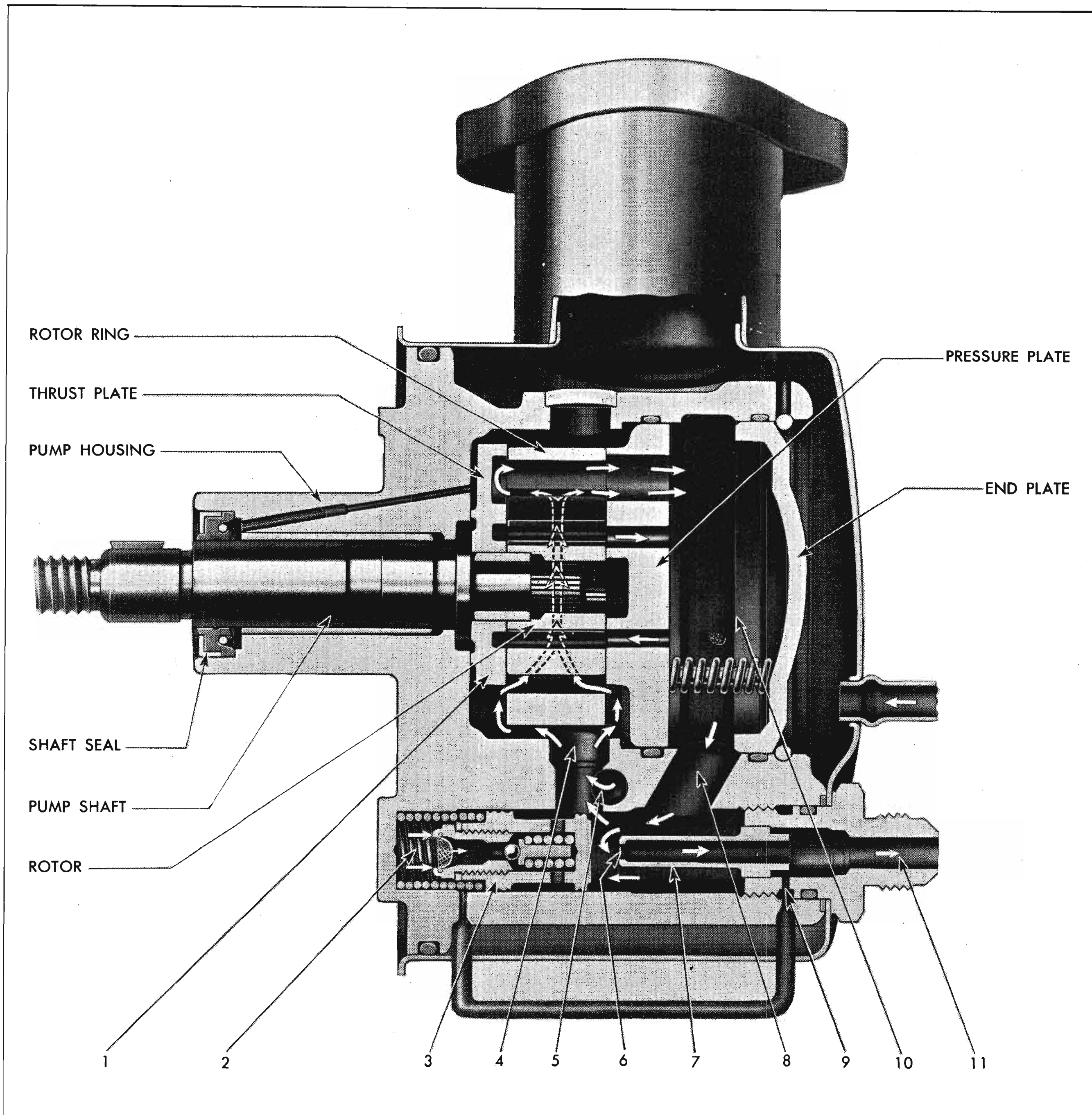


Fig. 9A-38 Oil Flow—High Speed, No Turn, Straight Ahead

FLOW CONTROL VALVE PRESSURE RELIEF

When the steering gear rotary valve assembly is positioned such that it is fully actuated in either direction, the flow of oil from the pump is blocked or restricted for a quick return to the pump. (This condition would occur against the wheel stops or when movement of the wheels is restricted resulting in higher system pressures.)

In order to keep pressures and temperatures at a minimum, the pressure relief ball check is forced off its seat allowing a small amount of oil to flow into the intake chamber. This flow of oil, passing through the valve plunger screw and the flow control valve pressure relief orifice, causes a pressure drop and resulting lower pressure at the lower end of the control valve to provide additional control of the excessive pressure in the system under these conditions.

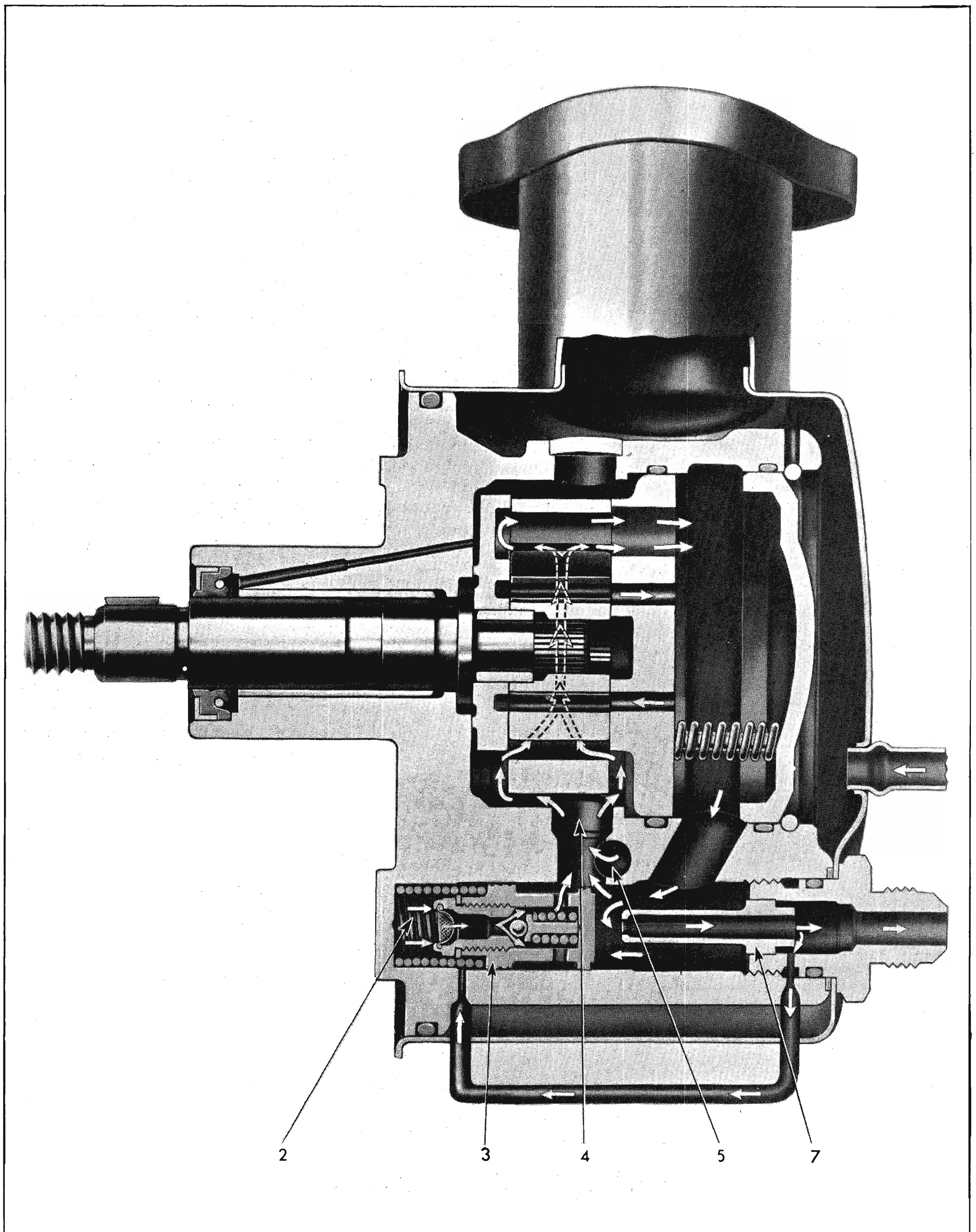


Fig. 9A-39 Oil Flow—Turn Against Resistance

Relief pressure under maximum conditions will control between 900 and 1200 psi, depending upon volume requirements.

The flow control valve, therefore, is designed to control the power steering pump oil flow capacity to the gear under various operating conditions. At idle speed the valve is closed and opens just above idle speed. It remains open in varying degrees depending upon engine speed, and system pressures under various operating conditions. As the system requirements approach or exceed maximum pressure within the system, the ball check within the flow control valve opens to provide additional relief of pressure and oil flow to the gear.

OIL FLOW—HIGH SPEED, NO TURN, STRAIGHT AHEAD (Fig. 9A-38)

From the high pressure area (10), the oil flows through a drilled passage (8) leading to the flow control valve (3) and also through a passage drilled through the union and control valve plunger assembly (7) gear oil orifice (6). From this passage oil is directed to the steering gear. The gear oil passage (11) is also connected to the area that houses the flow control valve assembly and spring (2). This connecting passage is through a drilled hole (a pressure sensing orifice (9) in the union and flow control valve plunger assembly) leading to the spring chamber (2) behind the control valve assembly. (The passage from the gear oil fill line to the valve spring chamber is shown as an external passage only because it is a pressure sensitive control to the control valve assembly only when pressure and flow in the line from the pump to gear varies.)

Oil to the gear is supplied until all air has been forced out of the gear via the pump return line. The gear may be filled by turning through the full right and left turns a few times.

When the quantity of oil displaced by the pump exceeds the predetermined steering system requirements, a pressure drop occurs through the gear oil orifice (6). This unbalance of pressure within the passage to the gear, as well as the passage behind the flow control valve, causes the flow control to move due to pressure in the high pressure area (10) continuing to build oppose force of the flow control valve spring plus any oil pressure assisting the spring. When this occurs, the flow control valve assembly (3) starts to move back, keeping the flow control valve ball check seated, thereby providing control of "excess" oil flow back through passages leading to the suction or intake part of the pump.

Figure 9A-38 shows typical pump operation at high speed. In this case, the flow control valve has opened to allow all oil flow in excess of system requirements to bypass into the intake chamber of the pump.

OIL FLOW—TURN AGAINST RESISTANCE (Fig. 9A-39)

During a turn where resistance is offered to the pitman shaft and rack-piston nut, the action of the rotary valve directs the oil to increase the pressure in the gear oil passages as well as the pump to gear oil inlet pressure line. The pressure extends to the high pressure chamber as well as through the "external" pressure sensing passage and orifice to the flow control valve spring chamber (2). Pressure in the chamber continues to build up until it overcomes the opposing spring pressure on the valve ball check in the flow control valve (3).

Here again, the flow of the pump in addition to the pressure required of the gear determines the movement of the control valve. The relief check ball remains closed except when the steering stops are reached or the wheels are restricted from moving. The pump will not go into pressure relief unless the flow is completely blocked by the extreme movement of the steering gear valve.

Supercharging occurs as a result of the pressure oil in the area around the union and flow control valve plunger (7) discharging into the suction passage (4) at high velocity, picking up any needed additional or "makeup" oil from the reservoir through housing oil inlet passage (5) on the jet-pump principle. Then by a reduction of velocity in the suction passage (4), velocity energy is converted into supercharge pressure (Fig. 9A-39).

OIL FLOW—LOW SPEED OR PARTIAL TURN

Figure 9A-40 shows typical pump operation when the car is being driven at low speed during a partial turn.

Movement of the flow control valve in this and any maneuver other than pressure relief is controlled by pressure unbalance due to flow through the gear oil orifice so the flow control valve opens to relieve any excessive pressure.

PERIODIC SERVICE RECOMMENDATIONS

No periodic service of the pump is required except checking oil level in reservoir as outlined in GENERAL LUBRICATION Section.

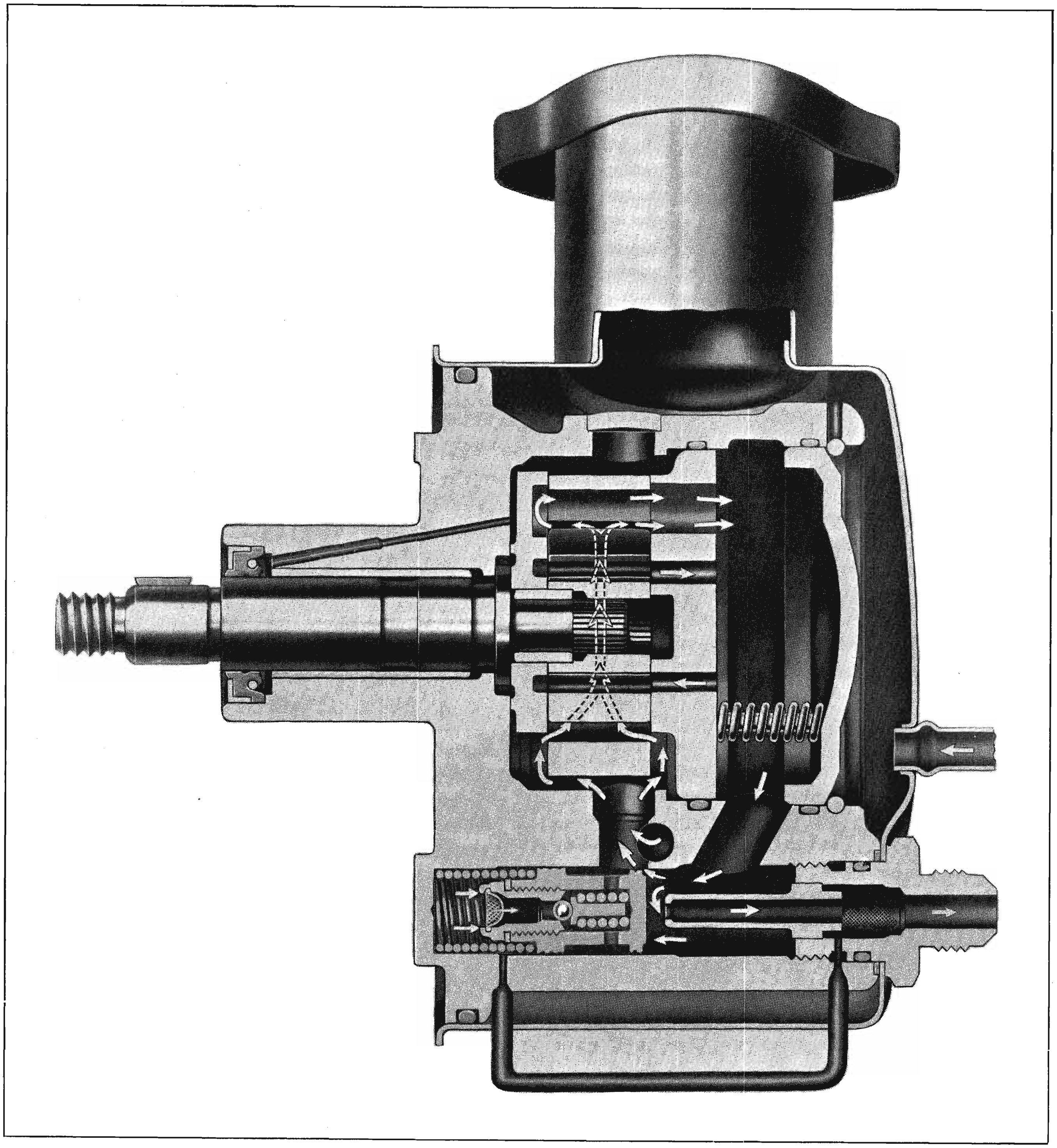


Fig. 9A-40 Oil Flow—Low Speed or Partial Turn

ADJUSTMENTS ON CAR

PUMP BELT TENSION ADJUSTMENT

1. Loosen pump plate (support) to bracket bolts two full turns.

2. Tighten belt with power steering pump to give ¼" belt deflection when a 5-6 pound load is applied midway between fan and power steering pulleys or 70-75 lbs. as indicated on the Burroughs gauge.

3. Holding adjustment, tighten pump plate to bracket bolts.

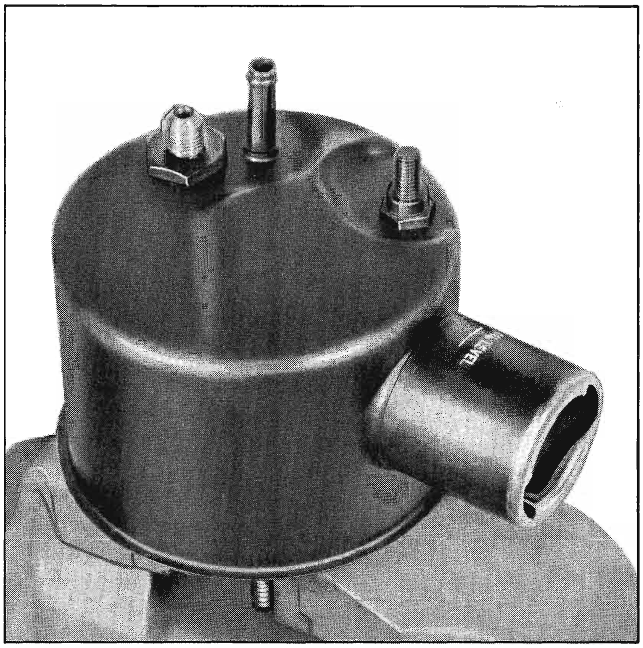


Fig. 9A-41 Pump Mounted in Vise

PUMP—REMOVE FROM CAR

1. Disconnect hoses at pump. When hoses are disconnected, secure ends in a raised position to prevent drainage of oil.

2. Install two caps at pump fittings to prevent drainage of oil from pump.

3. Remove drive pulley attaching nut.

4. Loosen bracket to pump mounting bolts.

5. Remove pump belt.

6. Slide pulley from shaft. Do not hammer pulley off shaft as this will damage the pump.

7. Remove bracket to pump bolts.

8. Drain pump of oil.

9. Clean exterior of pump.

POWER STEERING PUMP—DISASSEMBLE

1. Place pump in vise having brass jaws.

NOTE: Secure at pump housing hub only enough to hold pump (Fig. 9A-41).

2. Remove pump rear mounting studs.

NOTE: The mounting stud has an "O" ring seal in the counterbore of the stud nut.

3. Remove union and control valve plunger assembly carefully since this part is under spring tension. Discard "O" ring seal.

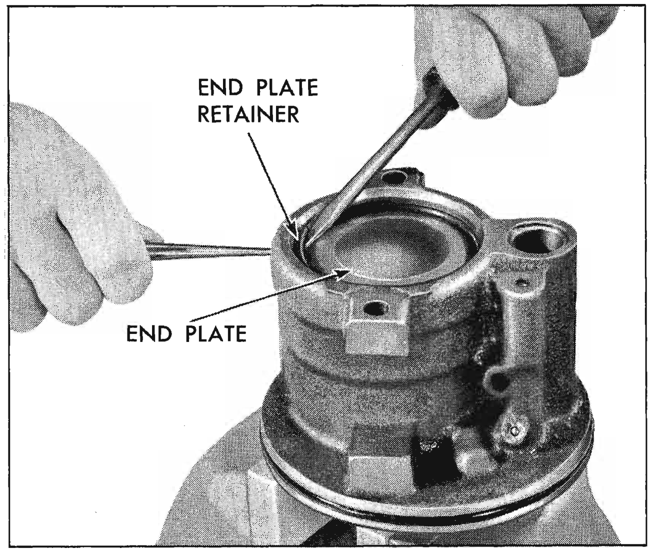


Fig. 9A-42 Removing End Plate Retaining Ring

4. Rock reservoir back and forth and remove reservoir from housing. Discard housing to pressure outlet passage seal.

CAUTION: Do ot scratch inside surface of reservoir on sharp corners of pump casting as this may cause an oil leak at the pump to reservoir seal.

5. Remove end plate retaining ring as shown in Fig. 9A-42. (Depressing the end plate will assist in removing the ring.)

6. Remove end plate and pressure plate springs.

7. Remove pump from vise.

8. Invert pump and remove flow control valve assembly and spring.

NOTE: Do not disassemble the flow control valve assembly as this unit is pre-set at the factory and is serviced as an assembly.

9. Remove shaft key.

10. Place pump shaft on bench and press until shaft is free. See Fig. 9A-43.

11. Invert pump and remove shaft and rotary group.

12. Remove pump to reservoir "O" ring, pressure plate to housing "O" ring and end plate to pump "O" ring. Discard "O" rings.

13. Remove pump shaft seal by prying up with screwdriver (Fig. 9A-44).

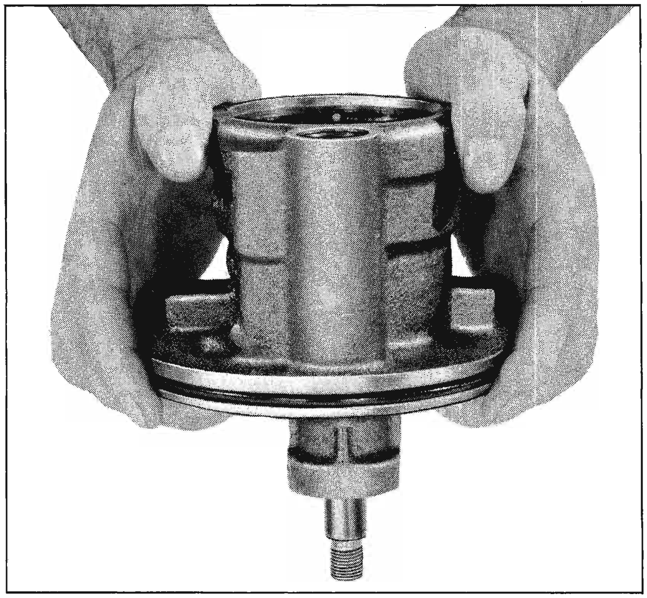


Fig. 9A-43 Removing Pump Shaft

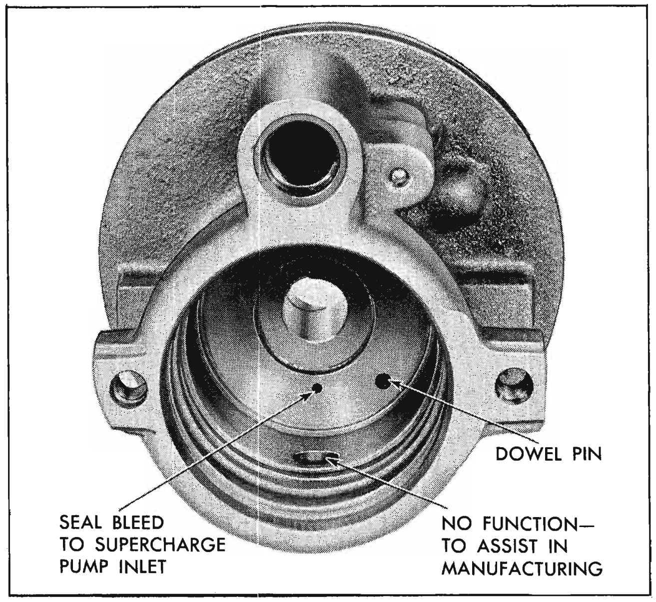


Fig. 9A-45 Pump Oil Hole Identification

CLEANING AND INSPECTION

1. Carefully wash all parts in a suitable cleaning solvent except "O" rings and drive shaft seal which are to be replaced.

2. Inspect pump flow control valve bore for excessive conditions of scores and wear.

3. Inspect flow control valve for free movement in its bore. Inspect all passages in cover and body for obstruction or dirt.

4. Inspect pressure plate for scoring.

5. Inspect contour surface of pump ring for excessive wear. (Chatter marks indicate a noisy pump.)

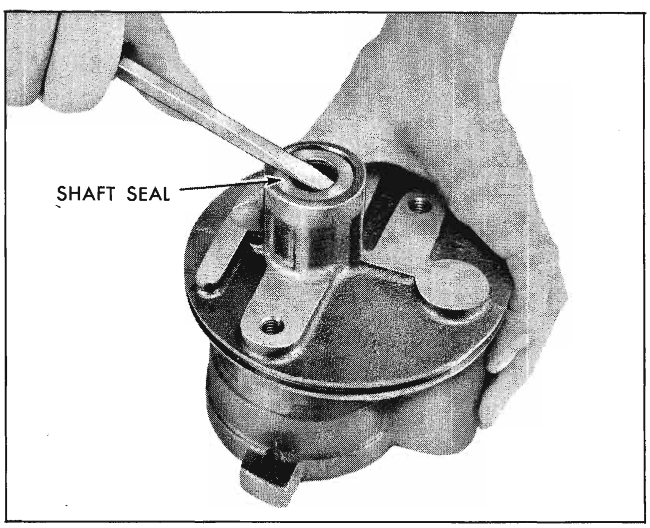


Fig. 9A-44 Removing Shaft Seal

6. Inspect rotor faces for metal pick up or scoring.

7. Check vanes for bind in slots of rotor.

8. Inspect face of pump body for scoring or wear.

9. Inspect drive shaft seal surface for scratches and wear.

10. Inspect drive shaft babbitt faced bushing for wear. (Bushing and housing are serviced as an assembly.)

11. Inspect oil passages for obstructions and remove any foreign material (Figs. 9A-45, 9A-46, and 9A-47).

FLOW CONTROL VALVE

If flow control valve is stuck, dislodge by jarring pump housing. If pump control valve bore is badly worn or scored, replace pump housing. If necessary to clean or repair pressure relief valve, replace control valve.

NOTE: The control valve assembly is calibrated at the factory and components of assembly cannot be serviced.

INTERNAL GROUND SURFACES OF PUMP

If pressure plate, pump body, rotor or pump ring is lightly scored, lap the scored surfaces with a lapping compound on a flat surface until the surfaces are smooth.

NOTE: Thoroughly clean in a suitable solvent when lapping operation is completed.

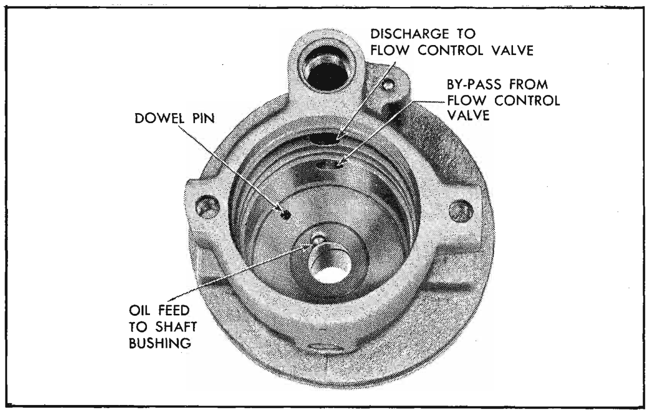


Fig. 9A-46 Pump—Oil Hole Identification

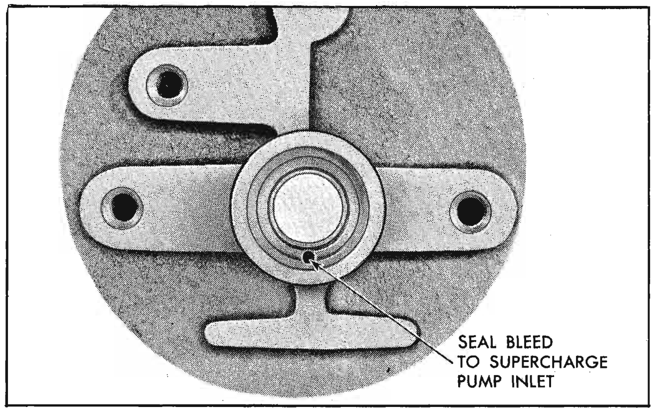
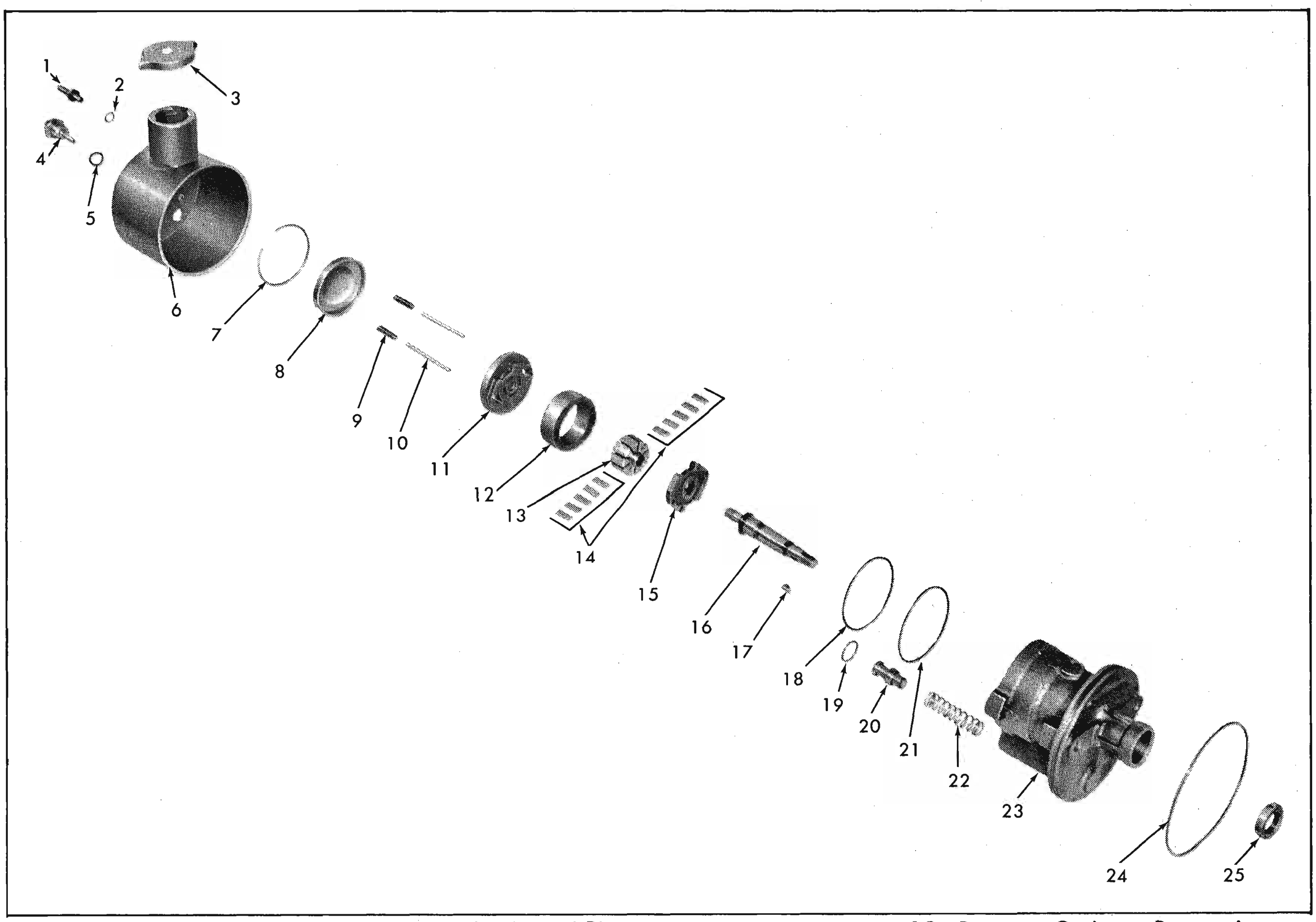


Fig. 9A-47 Pump—Oil Hole Identification



1. Mounting Studs
2. Mounting Stud "O" Ring
3. Filler Cap
4. Discharge Outlet and Control Valve Plunger Assembly
5. Discharge Outlet "O" Ring
6. Reservoir
7. End Plate Retainer
8. End Plate
9. Pressure Plate Springs
10. Dowel Pins
11. Pressure Plate
12. Rotor Ring
13. Rotor
14. Rotor Vanes
15. Thrust Plate
16. Pump Shaft
17. Shaft Key
18. Pump Housing to End Plate "O" Ring
19. Pressure Outlet to Reservoir "O" Ring
20. Control Valve Assembly
21. Pump Housing to Pressure Plate "O" Ring
22. Control Valve Spring
23. Pump Housing
24. Housing to Reservoir "O" Ring
25. Shaft Seal

Fig. 9A-48 Power Steering Pump—Exploded View

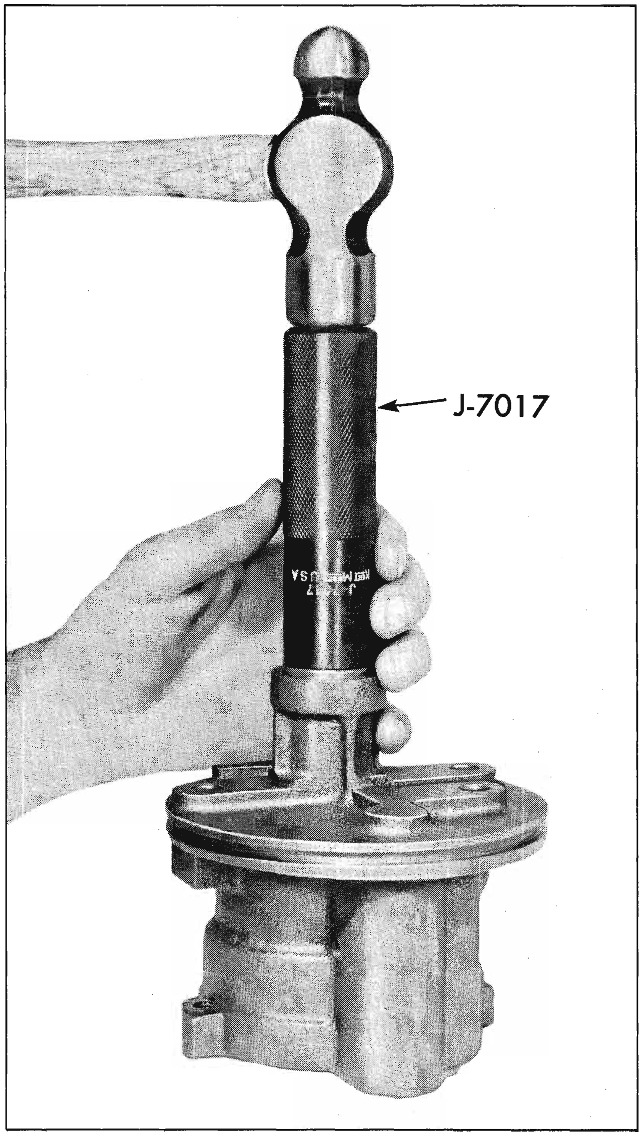


Fig. 9A-49 Installing Shaft Seal Using J-7017

STEERING PUMP—ASSEMBLE

Carefully clean all parts. "O" ring seals and the drive shaft seal which are not to be replaced should not be immersed in cleaning solvent. Lubricate all "O" ring seals and the drive shaft seal with petrolatum and install in proper location.

Be sure all metal parts are clean during reassembly.

1. Install pump shaft seal using J-7017 (Fig. 9A-49).

2. Insert shaft into housing being sure shaft seats. (Place thumb on splined end and press to insure seating.)

NOTE: Be careful not to damage the shaft seal with the threaded end of shaft.

3. Mount pump with "hub" down in vise, having brass jaws. DO NOT apply excessive pressure to hold pump.

4. Install dowel pins and thrust plate on pins with ported face to rear of pump housing.

5. Install rotor ring on dowel pins making sure holes in ring align with the cavities in the thrust plate. (Fig. 9A-50) and that the arrow on the rotor ring points in the direction of pump rotation.

6. Install rotor, which must be free on splines, on pump shaft over splined end with sleeve toward front of pump.

7. Install vanes in rotor slots (Fig. 9A-51) with radius edge towards cam surface of the rotor ring.

8. Lubricate and install pressure plate to housing "O" ring.

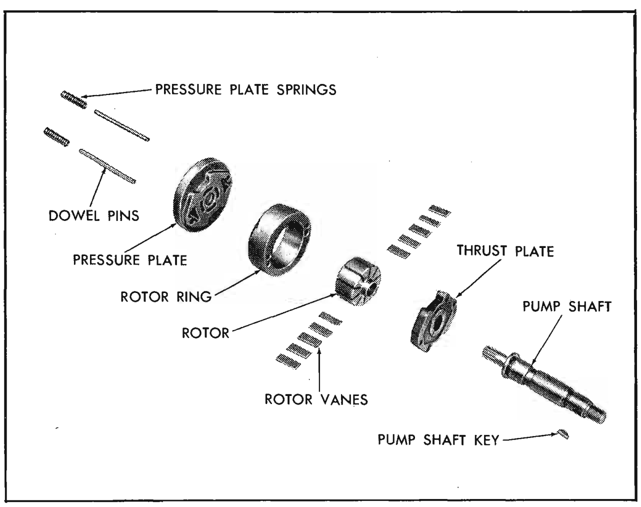


Fig. 9A-50 Shaft and Rotary Group—Exploded View

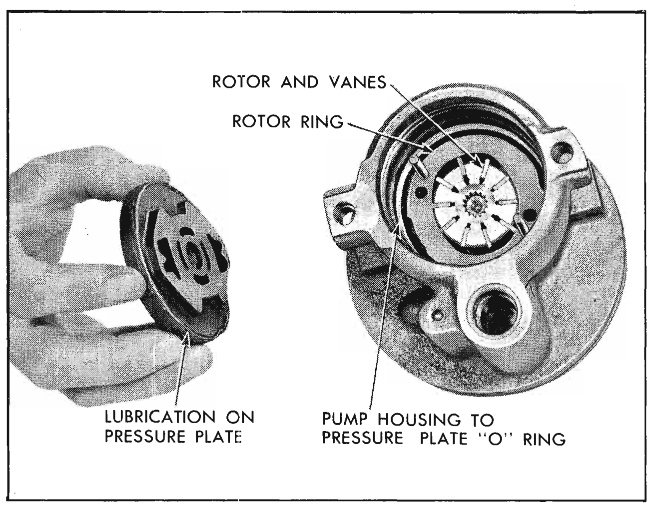


Fig. 9A-51 Installing Pressure Plate

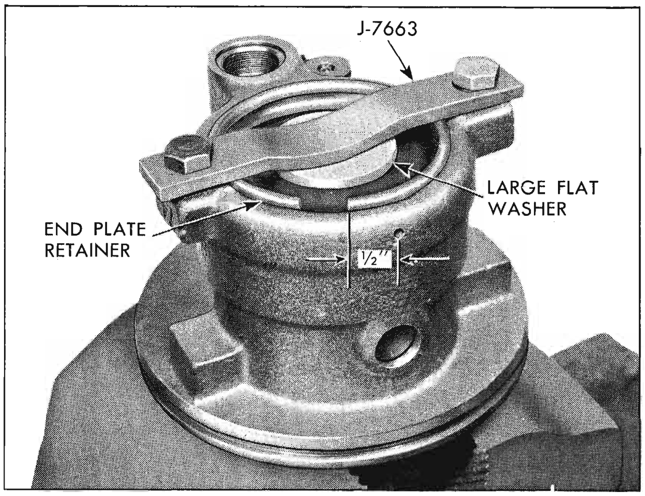


Fig. 9A-52 Installing End Plate Using J-7663

9. Lubricate outside diameter and edge with radius of pressure plate with vaseline (to insure against damaging "O" ring) and install on dowel pins with ported face toward the pump ring, see Fig. 9A-51. Apply pressure to outer edge only to seat pressure plate. DO NOT press or hammer on the center of the pressure plate as this will score the face of the plate towards the pump rotor causing permanent distortion with resulting pump failure. (Pressure plate will travel about $\frac{1}{16}''$ to seat.)

10. Lubricate and install end plate "O" ring.

11. Install pressure plate springs, one over each dowel pin.

12. Install end plate as follows:

a. Lubricate outside diameter and chamfer of end plate with vaseline to insure against damaging "O" ring.

b. Place end plate into position.

c. Place end plate retainer on end plate so end of retainer extends approximately ½" beyond retainer removal assist hole in pump (Fig. 9A-52).

d. Install in housing using J-7663 as shown in Fig. 9A-52.

NOTE: Be sure end plate retainer is completely seated in the groove of the housing.

13. Install new housing "O" ring seal and lubricate outer surface with petrolatum.

14. Lubricate and install new housing to reservoir "O" ring (rectangular section seal) at outlet pressure cavity (Fig. 9A-53).

15. Place new stud "O" ring seals on studs.

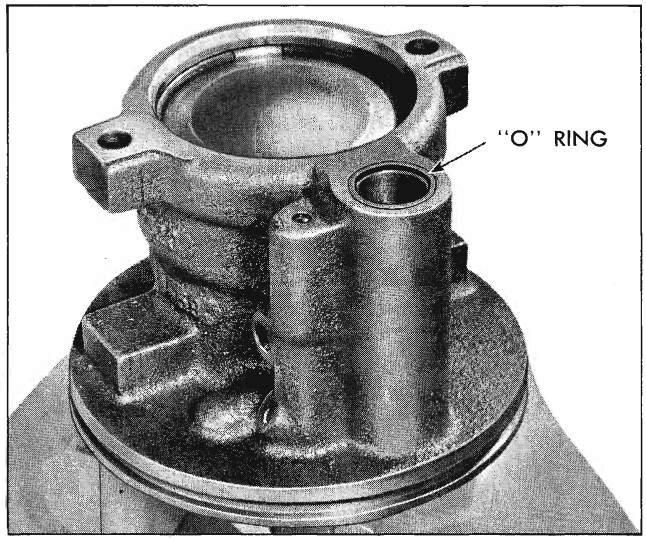


Fig. 9A-53 Housing To Reservoir "O" Ring in Position

16. Install reservoir and start ends of studs into housing to assist in aligning housing.

CAUTION: DO NOT scratch "O" ring inside surface of pump housing casting as this may cause an oil leak at the pump to reservoir seal.

NOTE: Make sure reservoir is firmly seated and is over housing "O" ring seal by tapping down around edge of closed end of reservoir before securing studs. DO NOT seat reservoir by tightening studs.

17. Secure studs to 25-30 lb. ft. torque.

18. Install flow control spring.

19. Install flow control valve assembly making sure hex head (with screen) end goes into bore first (Fig. 9A-54).

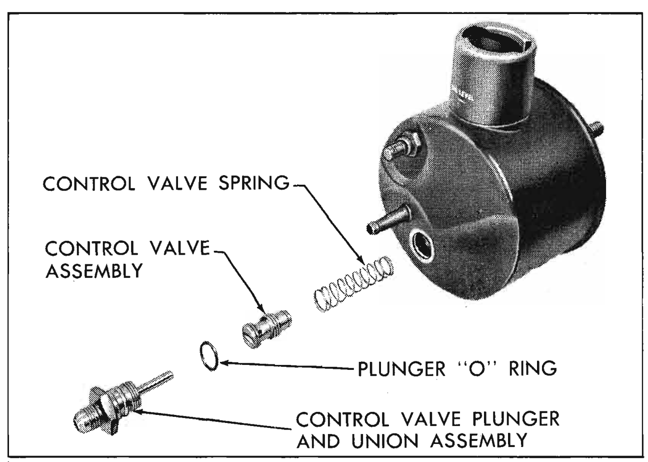


Fig. 9A-54 Flow Control Valve and Related Parts

20. Install union with new union "O" ring seal on union. Tighten to 25-35 lb. ft. torque.

21. Install drive shaft key supporting end shaft on the opposite side of key when installing key.

STEERING PUMP—INSTALL

1. Position pump assembly on mounting bracket with holes lined up and install bolts loosely.

2. Slide pulley on shaft. DO NOT hammer pulley on.

3. Install pulley nut finger tight against pulley.

4. Connect and tighten hose fittings. Tighten outlet fitting to 20-30 lb. ft. torque.

5. Fill reservoir. Bleed pump by turning pulley backward (counter-clockwise as viewed from front) until air bubbles cease to appear.

6. Install pump belt over pulley.

7. Move pump until belt has ¼" deflection when a 5-6 lb. load is applied midway between fan and power steering pump pulley or 70-75 lb. as indicated on the Burroughs gauge. Tighten mounting screws.

8. Tighten pulley nut to 50-65 lb. ft. torque.

TROUBLE DIAGNOSIS

1. PUMP NOISE:

The power steering pump is *not* completely noiseless. Some noise will be present at standstill parking. Particularly when the wheels are against the wheel stops. Power steering pump noise can be confused with many other things, such as, transmission, rear axle, generator, etc. If it is determined that excessive noise is present, remove the pump drive belt, determining for sure if the pump is at fault. If it is determined that excessive pump noise is present, the following steps should be taken in order given:

A. Check belt tightness.

B. Check oil level, filling to level if necessary.

C. Check to make sure hoses are not touching any other parts of the car, particularly sheet metal.

D. Check the presence of air in the oil. Air will show up as bubbles or the oil will appear milky. Small amounts of air cause extremely noisy operation. If air is present:

1. Tighten all fittings and bolts.

2. Check the entire system for source of air leak. Air can leak into the system at any place, and usually occurs at joints in the system where oil passes through at high velocity such as hose connections or at the drive shaft seal.

After each step in attempting to eliminate air, the pump should be operated for a few minutes at idle speed while occasionally turning the steering wheel between extreme turns to allow the air to bleed out of the oil.

E. If after Step D there is no air present, install pressure gauge in the pressure line between the pump and gear. If, when racing the engine to about 1000 rpm and without turning the steering wheel, the pressure exceeds 125 psi, the hoses and/or steering gear are restricting the oil flow and these parts should be examined to determine the cause of restriction.

F. If the pressure in Step E is less than 125 psi, it will be necessary to remove the pump from the car and disassemble, or partially disassemble, following the steps outlined under "Disassemble Power Steering Pump."

G. Check the pressure plate for scoring.

NOTE: A high polish is always present on the face as a result of normal wear. Do not confuse this with scoring. Light scoring can be cleaned up by carefully lapping on a flat surface. Be sure to thoroughly wash away all lapping compound.

H. Check the vanes to insure that the radius edge is toward the outside and that they operate freely in the rotor slots.

I. Check the contour surface of the pump ring for extreme wear. Normally there may be some scuff marks and uniform wear. This is not detrimental to pump noise or function. However, if the wear consists of chatter marks or gouges that can be felt with the finger, both the ring and vanes should be replaced. The vanes should be replaced also because if the ring is worn sufficiently to be felt with the finger, the vanes usually are worn out quite badly, too.

J. Check the face of the thrust plate for scoring. Light scoring or pick-up can be cleaned up by lapping (see G above).

K. Check rotor faces for metal pick-up or scoring. Light scoring or pick up can be cleaned up by lapping (see G above).

L. The pump bushing is rarely, if ever, responsible for noisy operation.

M. Some pump noise is caused by the flow control valve assembly. If other measures fail, install a new plunger and spring only if the noise is objectionable.

N. A swish noise when slow speed cornering or a growl that cannot be corrected by bleeding system of air. Replace flow control valve only after smoothing edges of valve with fine hone does not reduce noise.

2. *PUMP LEAKS:*

A. Tighten all fittings and bolts.

B. Possible sources of pump leakage are as follows:

LEAK SOURCE	CAUSE	REMEDY
Top of reservoir	Reservoir too full	Fill to proper level.
	Excessive air present in oil.	Proceed as in I-D above to determine cause of air.
At reservoir	"O" ring out or improperly installed	Replace "O" ring or install properly.
	Reservoir damaged.	Replace reservoir.
At the pressure fitting or stud.	Not tightened sufficiently.	Torque to 25-35 foot-pounds.
	Cross threaded or defective seat on fittings or hose or damaged seals.	Correct as necessary.
At shaft seal	Defective seal or damaged shaft.	Replace seal and/or shaft.
Leaks in metal parts	Defective castings.	Replace.

3. *INOPERATIVE, POOR OR NO ASSIST:*

A. Check for loose drive belt.

B. Check and fill reservoir, bleed steering gear.

C. Determine the source of trouble; that is, pump, steering gear or hoses. Install pressure gauge in the pressure line between the pump and gear.

Test No. 1—Oil Circuit Open:

1. Install a pressure gauge in the pressure line between the pump and gear.

2. Turn the steering wheel from one end to the other and note the pressure on the gauge while holding the wheel momentarily against each end. This maximum pressure reading should not be less than 900 psi with the engine idling at 500 rpm, the selector in the "Dr" range, and the oil temperature in the reservoir between 150°F. to 170°F. as measured with a thermometer.

NOTE: To obtain temperatures of 150°F. to 170°F. desired for testing, turn wheels through normal operating range several times.

CAUTION: DO NOT HOLD THE STEERING WHEEL AGAINST THE STOP FOR ANY EXTENDED PERIOD OF TIME.

If the maximum pressure is below specification, it indicates there is some trouble in the hydraulic circuit. However, it does not indicate whether the pump or the gear is at fault. To determine if the pump alone or the gear alone, or if both, are at fault, proceed with Test No. 2. It will not be necessary to proceed with Test No. 2 if the pressure as read for each end is more than 40 psi different, since in this case the steering gear is at fault.

Test No. 2—Oil Circuit Closed:

1. Set engine idle to 500 rpm; selector lever in "Dr" range (in neutral, if synchro-mesh).

2. Turn the shut-off valve of gauge to the closed position.

NOTE: Shut-off valve must be located between the gauge and the steering gear.

3. Observe and compare the maximum pump pressure at idle. It should not be less than that specified (900 psi).

NOTE: By comparing this reading with Test No. 1 (testing complete circuit), it is possible to determine whether the fault is with the pump or the steering gear, or both.

Diagnosis Above Test Results.

1. First test below specifications, second test equal to specification or greater—the steering gear is at fault.

2. First test below specification, second test not more than 50 psi greater—the pump is at fault.

D. If pump is determined to be at fault, proceed as follows:

1. Remove reservoir and flow control valve. Be sure the flow control valve operates freely in the pump housing bore. If stuck, dislodge. Check for burrs or dirt that may cause a sticky valve.

2. Check the small screw in the end of the flow control valve for looseness. If loose, tighten, being careful not to damage machined surfaces.

3. Insure that the pressure plate is flat against the pump ring.

4. Check the pressure plate, thrust plate, rotor and ring for scoring as described under "Pump Noise".

5. Check the vanes as described under PUMP NOISE.

6. The internal parts of the flow control valve may be at fault. Try a new assembly. Do not attempt to service parts as this assembly is properly calibrated at the factory.

E. If steering gear is at fault, see section on POWER STEERING GEAR.

1. PUMP NOISE:

CAUSE	REMEDY
A. Loose belt	Tighten belt
B. Hoses touching other parts of car	Adjust hose positions
C. Low oil level	Fill reservoir
D. Air in the oil	Locate source of air leak and correct.
E. Excessive back pressure caused by hoses or steering gear.	Locate restriction and correct
F. Scored pressure plate (may have been caused by installing the pressure plate by applying force to the center of the plate).	Lap away light scoring. Replace heavily scored or galled part
G. Vanes not installed properly	Install properly
H. Vanes sticking in rotor slots	Free up by removing burrs or dirt
I. Defective flow control valve	Replace flow control valve assembly
J. Extreme wear of pump ring	Replace pump ring
K. Face of thrust plate scored	Lap away light scoring. Replace heavily scored part
L. Scored rotor	Lap away light scoring. Replace heavily scored part
M. Vibration or buzz	Check pump mounting and torque on all attaching nuts and bolts

2. PUMP LEAKS:

LOCATION	CAUSE	REMEDY
A. Top of reservoir	Reservoir too full	Fill to proper level
B. At reservoir	Air in the oil	Locate source of air leak and correct
	"O" ring cut	Replace "O" ring
	"O" ring improperly installed	Install properly, if damaged, replace

2. *PUMP LEAKS (Continued)*

LOCATION	CAUSE	REMEDY
C. At pressure fitting or studs	Not tightened sufficiently	Tighten to 25-35 lb. ft. torque
	Cross threaded or damaged seat	Replace damaged parts
	Defective seat on hose end	Replace hose
	Damaged seals	Replace seals
D. At the shaft seal	Defective seal and/or shaft	Replace seal and/or shaft
E. Leaks in metal parts	Damaged or defective parts	Replace parts as necessary

3. *INOPERATIVE, POOR OR NO ASSIST:*

CAUSE	REMEDY
A. Loose drive belt	Tighten belt
B. Low oil level	Fill reservoir
C. Air in the oil	Locate source of air leak and correct
D. Defective hoses or steering gear as determined by tests.	Correct. See "Power Steering Gear" section
E. Flow control valve stuck	Remove burrs or dirt. If bore damaged beyond repair replace pump housing
F. Loose screw in end of flow control valve	Tighten
G. Pressure plate not flat against ring	Correct by lapping or replace
H. Extreme wear of pump ring	Replace part
J. Scored pressure plate, thrust plate and/or rotor	Lap away light scoring. Replace heavily scored parts
K. Vanes not installed properly	Install properly
L. Vanes sticking in rotor slots	Free up by removing burrs or dirt
M. Faulty flow control valve assembly	Replace assembly
N. Oil gushes or squirts from under filler cap when car is steered manually or road wheels are turned manually—*normal*—oil level should be checked after manual operation.	When engine is not running, wheel must be turned slowly to eliminate oil loss

POWER STEERING PUMP SPECIFICATIONS

Pump Output

Minimum . . . . 1.75 gpm at Idle Speed

Maximum (against 50 psi pressure) . . . . 2.3 gpm at 1500 rpm

Torque

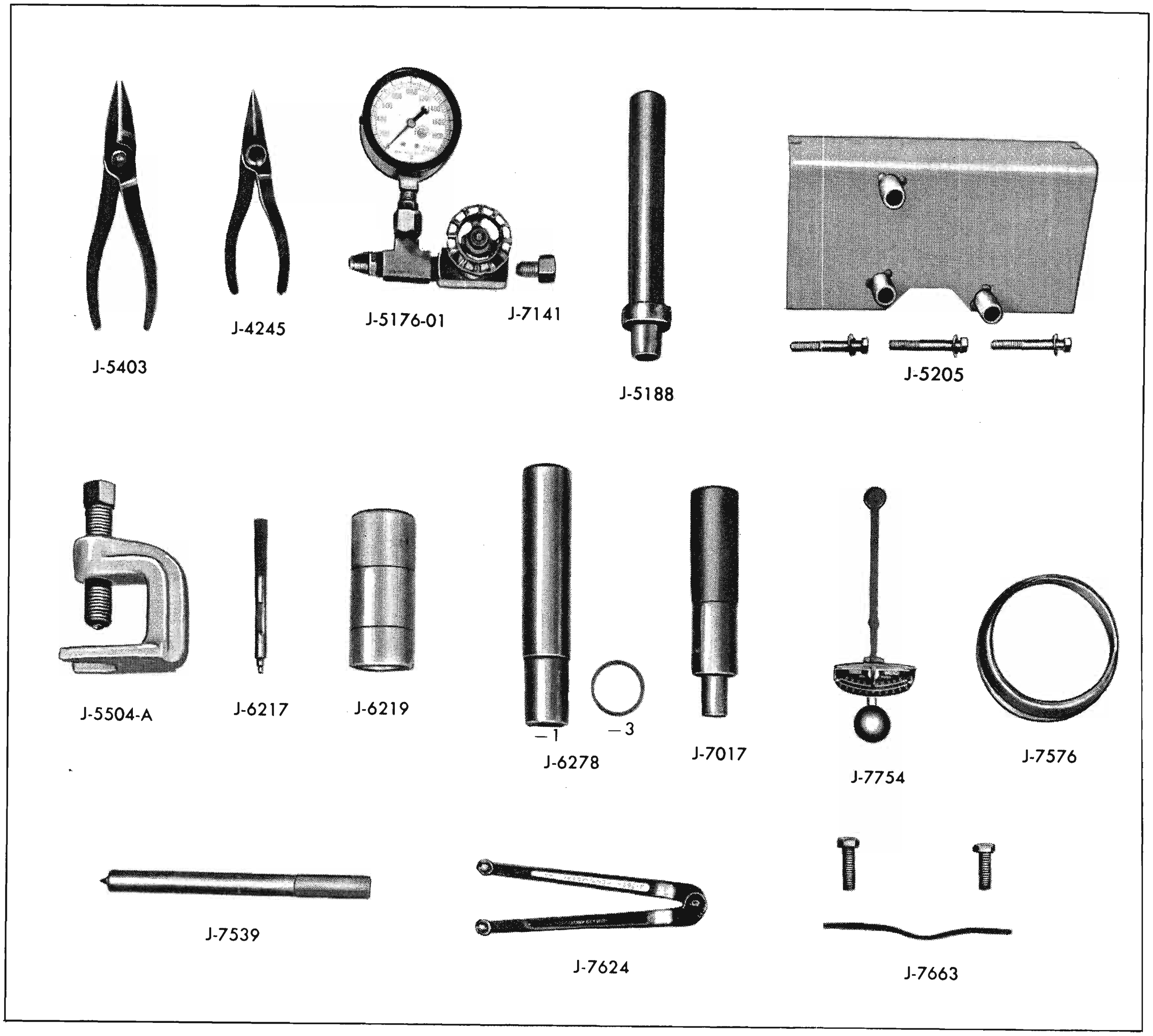
Fitting and Plunger Assembly . . . . 25-35 lb. ft.

Hose Connector at Fitting . . . . 20-30 lb. ft.

Mounting Stud . . . . 25-35 lbs. ft.

Pulley Nut . . . . 50-65 lbs. ft.

SPECIAL TOOLS



J-4245	Truarc Pliers #3 Internal
J-5176-01	Pressure Checking Gauge (o-2000 lbs.)
J-5188	Valve Cover Seal Installer
J-5403	Truarc Pliers #1 Internal
J-5504-A	Pitman Arm Puller
J-6217	Valve Connector Installer
J-6219	Pitman Shaft Seal Installer
J-6278	Pitman Shaft Bushing Remover and Replacer
J-5205	Steering Gear Holding Fixture
J-7017	Oil Pump Seal Installer
J-7141	Gauge Adapter (For J-5176-01)
J-7539	Ball Nut Loading Arbor
J-7576	Back Piston Installer
J-7624	Adjustable Spanner Wrench
J-7663	Pump Cover Installing Clamp
J-7754	Torque Wrench (0-25 in. lb.)

Fig. 9A-55 Power Steering Pump and Gear Special Tools

CHASSIS SHEET METAL

CONTENTS OF THIS SECTION

BUMPERS

Front and rear bumpers are of one piece construction. Attachment of these bumpers is such that slotted holes are appropriately located in the frame, bumper to frame bars, and bumper to frame braces to provide fore and aft as well as lateral adjustment location of the bumper.

The front or rear bumper assembly may be adjusted as necessary by loosening the bracket to frame bolts and retightening after positioning the bumper. Front bumper height adjustment is controlled by eccentric bolts (one on each side at the front of the frame).

RADIATOR

The radiator assembly on all models is held secure by two cradle type brackets that fit into depressions in the radiator lower tank at the bottom and one such "cradle" that holds the radiator top tank. The upper cradle is part of the engine fan top shield assembly which bolts to the fender to radiator support brace. On cars with air conditioning the engine fan top shield also attaches to the fan shroud.

Four radiator assemblies, each with a frontal core area of approximately 439 sq. in. and a 2″ thick core, are used as follows:

1. On all models equipped with synchro-mesh transmission (no oil cooler).

2. On 23 series cars equipped with Hydra-Matic transmission, air conditioning or used as police cars, (a one plate single center oil cooler).

3. On 24, 27 and 28 series cars equipped with Hydra-Matic transmission (a one plate single center oil cooler).

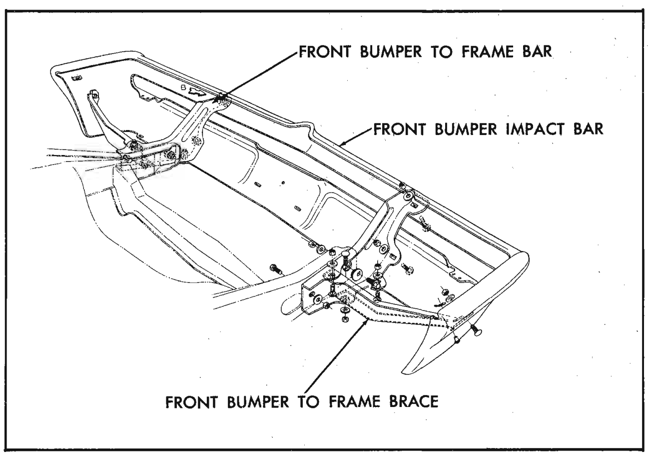


Fig. 10-1 Front Bumper Assembly—Installation Details

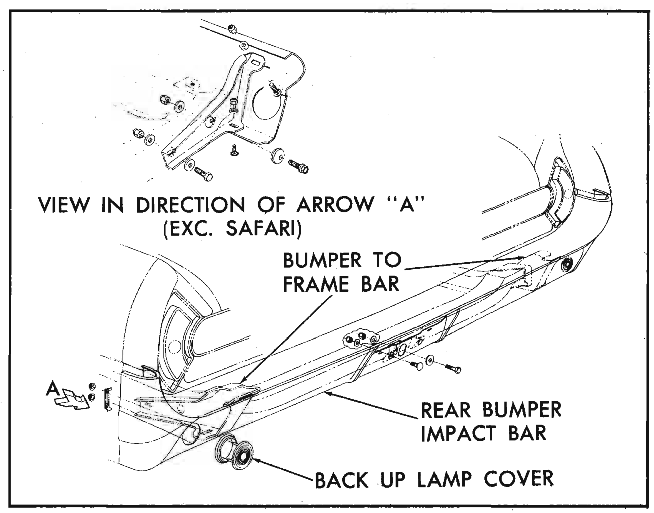


Fig. 10-2 Rear Bumper Assembly—Installation Details

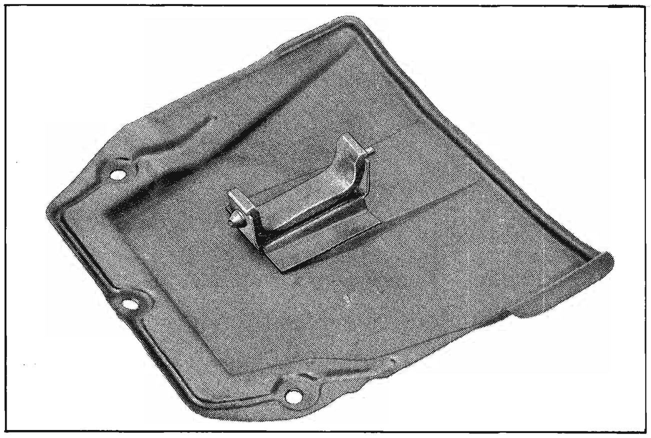


Fig. 10-3 Engine Fan Top Shield Assembly (Underside)

4. For all heavy duty requirements (a two plate single center oil cooler).

The only difference in the radiator assemblies used for applications of 2 and 3 above is in the heat constant of the core. A 13 lb. radiator pressure cap is used on all cars except those equipped with synchromesh transmission, 425E engine, or air conditioning. All cars equipped with synchro-mesh transmission, 425E engine or air conditioning use a 15 lb. radiator pressure cap.

RADIATOR ASSEMBLY—REMOVE AND REPLACE

1. Drain radiator.

2. Remove engine fan top shield assembly. Note that the upper portion of the radiator is held by a "cradle" type bracket on the bottom side of the engine fan top shield assembly (Fig. 10-3).

3. Disconnect upper and lower engine coolant hoses.

4. On cars equipped with Hydra-Matic transmission, disconnect and plug transmission cooler lines.

5. On cars equipped with air conditioning remove the fan shroud.

6. Remove radiator assembly by pulling straight up. Note that the radiator assembly is held at the bottom by two "cradles" secured to the radiator shroud at bottom (Fig. 10-4).

7. Replace radiator assembly by reversing the above steps making sure radiator assembly lower cradles are located properly in the recess in the radiator lower tank.

8. Refill radiator.

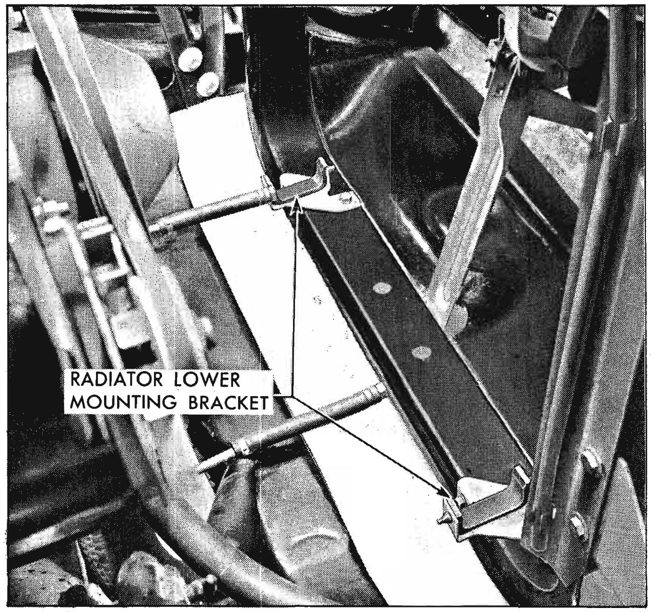


Fig. 10-4 Location of Radiator Assembly Lower Mounting Brackets

CHASSIS SHEET METAL ALIGNMENT

Proper alignment of the front end sheet metal will provide proper relationship of adjoining sheet metal parts, ease of hood operation, and eliminate squeaks, rattles and vibration. (See Figs. 10-5 through 10-8.)

FENDER

Vertical and fore and aft adjustment is provided at rear of fenders by enlarged holes in the fender bracket at the attaching points.

Fenders can be moved closer to or farther from the cowl by shifting in the enlarged hole in the fender bolts and may be adjusted vertically by adding or removing shims.

1. Check the spaces between the front door to fender rear edge and adjust as necessary to obtain a parallel space.

2. Check to insure that all connections at the fender attaching bolts are tight.

3. Look between rubber mount and frame (minimum $1/16''$ shim is necessary).

a. If mount is loose tighten to correct.

b. If mount is loose and car feels harsh or sheet metal seems to vibrate then add shims and recheck for fender rear edge to door alignment.

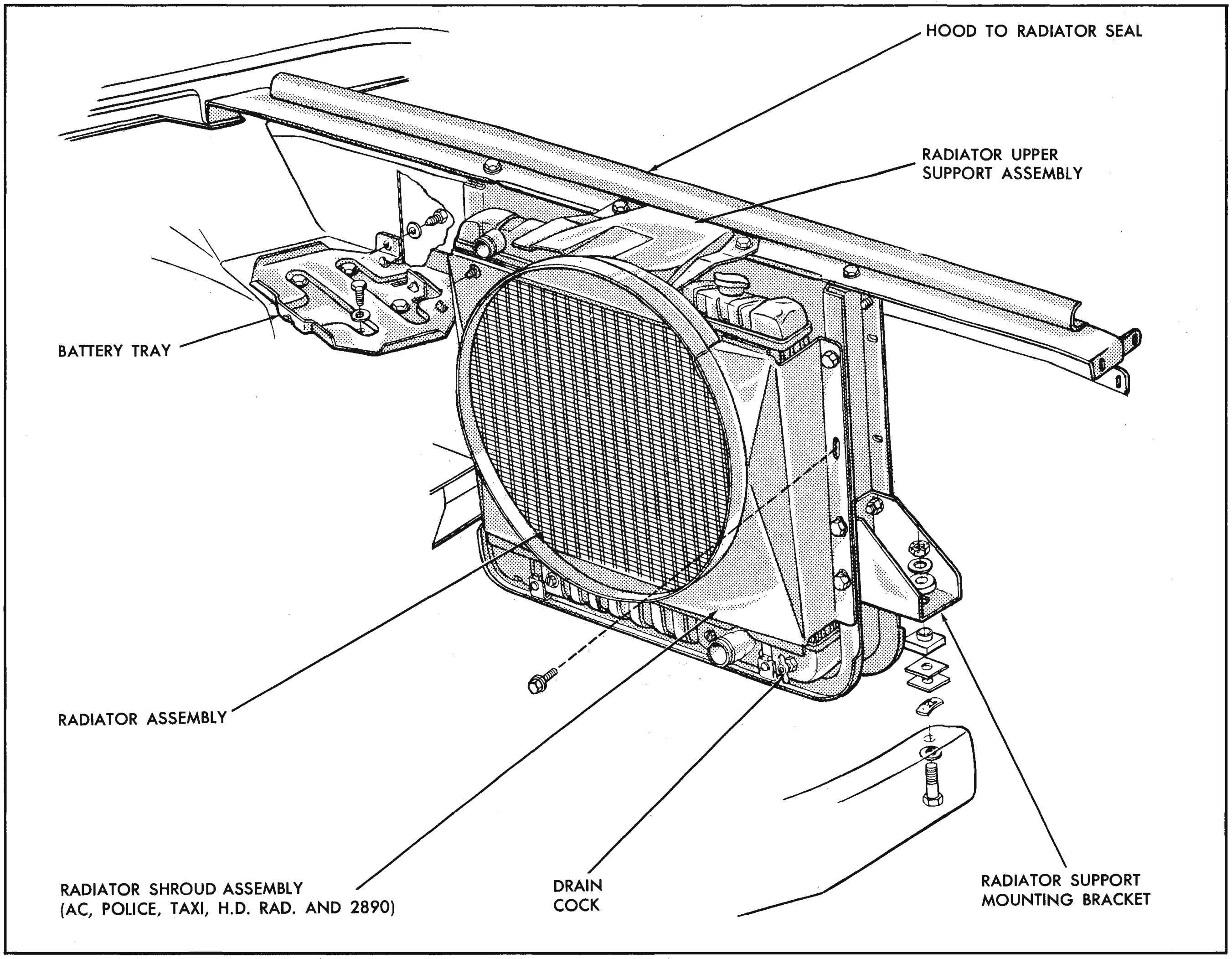


Fig. 10-5 Radiator Assembly—Installation Details

HOOD

The hood is of rigid sheet metal construction with the outer panel of single sheet metal with a rugged inner panel reinforcement. Further rigidity is given the hood by reinforcement braces and brackets strategically located not to interfere with adjustments or service repair operations.

1. Slotted holes in the hinge bracket to hood are provided to align hood to obtain parallel space between hood sides and fender.

2. The rear corners of the hood should be held down against the rear bumpers to keep rear of hood from "dancing" or vibrating. Check for proper tightness and height of hood rear bumper (to hood) as follows:

a. Loosen front end of hinge mounting bracket to fender.

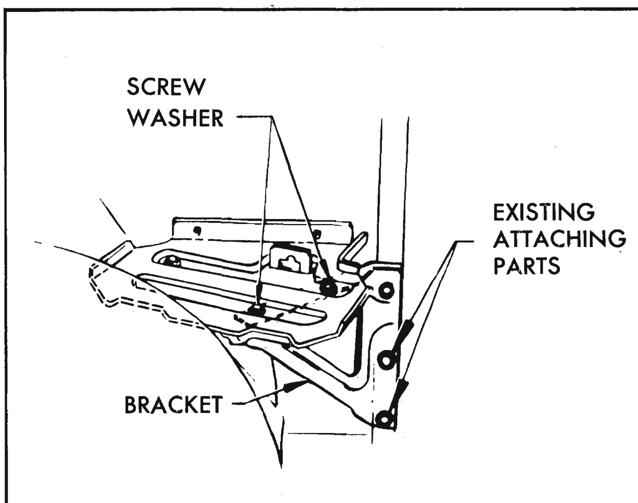


Fig. 10-6 Battery Tray—Installation Details

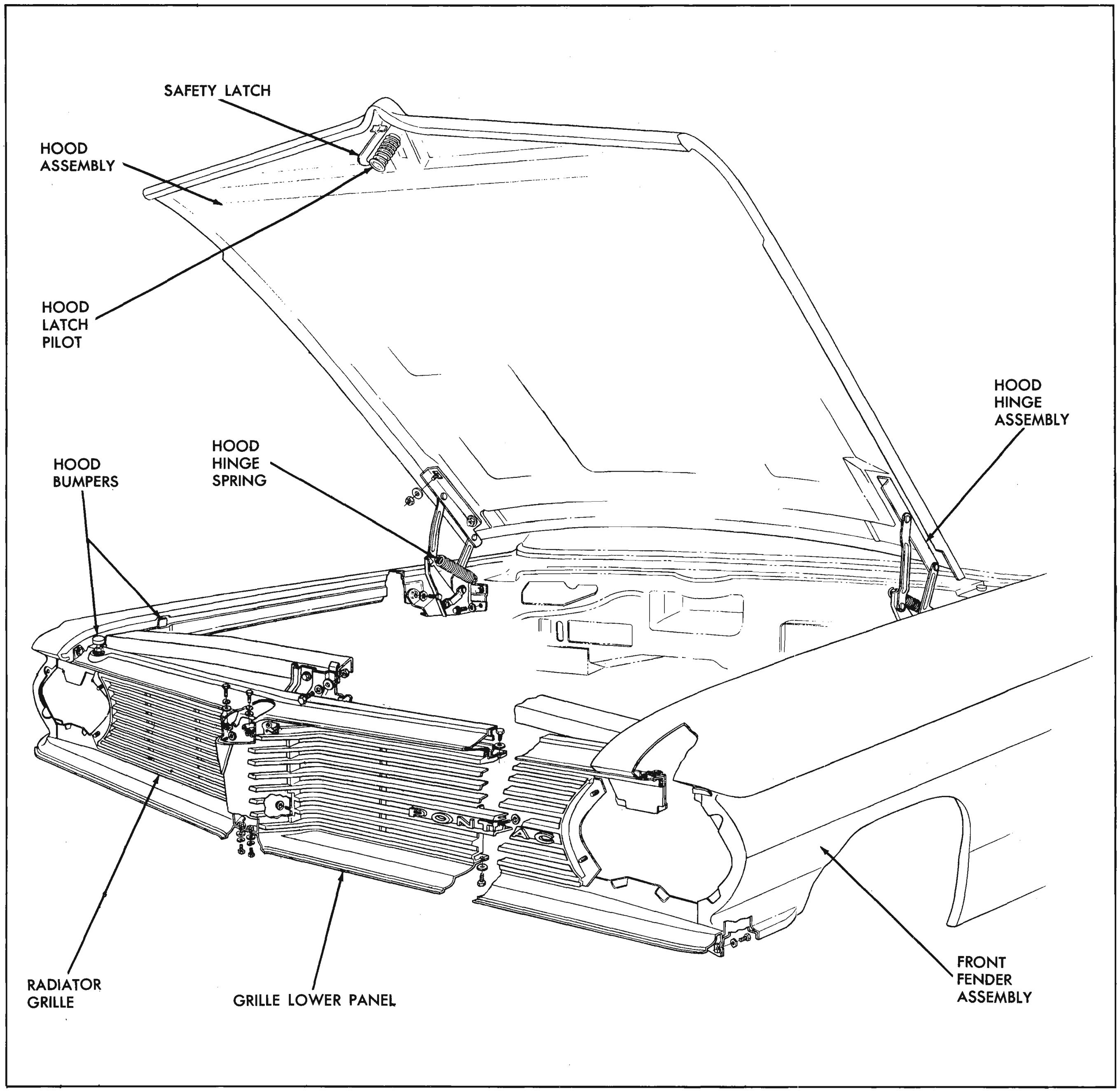


Fig. 10-7 Sheet Metal Parts—Hood and Grille Installation Details

b. Hold hood open as high as possible and force front of hinge up as far as possible.

c. Tighten fender connection.

If this does not correct condition, raise entire hinge by loosening bolts to shroud and pulling up on hinge.

NOTE: The portion of the hood hinge that attaches to the shroud has elongated holes at the top and at the bottom to take care of any body variations (at the dash shroud).

HOOD LATCH

A positive locking hood latch is used consisting of three assemblies: a latch bolt assembly (that fastens to the hood), a safety hook, and a latch assembly that fastens to the grille lower panel and radiator support assembly (Fig. 10-7).

The hood is opened by lifting release handle under front bumper bar upper section (Fig. 10-9), which in turn opens the latch.

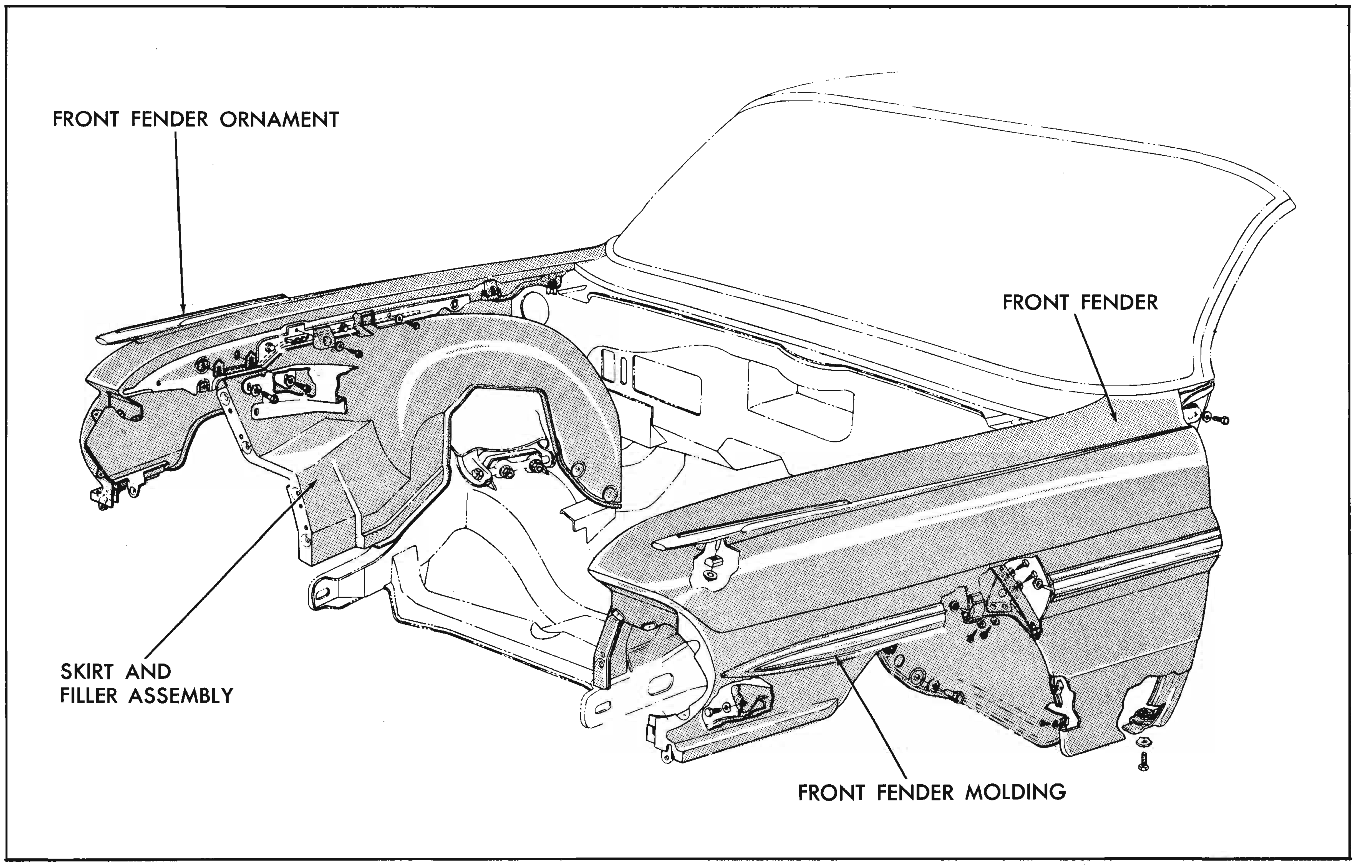


Fig. 10-8 Front Fenders—Installation Details

The safety hook is released by pulling the handle directly under the front center of the hood.

The latch bolt in the pilot assembly (attached to the hood assembly) may be adjusted longitudinally for alignment purposes, and can be vertically adjusted to obtain a tight hood to fender relationship.

HOOD LATCH BOLT (PILOT ASSEMBLY)—ADJUST

Should the hood release to safety latch position while driving on very bumpy or rough roads at high speed, loosen latch bolt assembly on hood (Fig. 10-10) and move rearward so that latch bolt spring retainer is 7/8" to rear of safety catch hole in front of hood latch support.

Proper adjustment of the hood latch bolt to provide for easy hood closing is as follows:

1. Check tightness of bracket from radiator support to hood latch striker plate.

2. Raise hood bumpers to align front of hood with fenders.

3. Press down on center of hood just forward of the moulding.

a. If some "give" or looseness is noticed, hood is not tight and will vibrate and raise up on corners at high speeds. In this case shorten latch bolt and recheck.

b. If hood is tight with no "give", then hood could be properly adjusted or could be too tight. Check as follows:

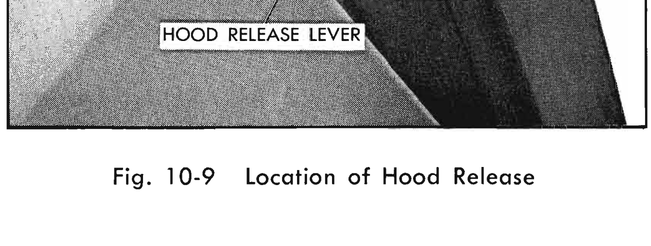


Fig. 10-9 Location of Hood Release

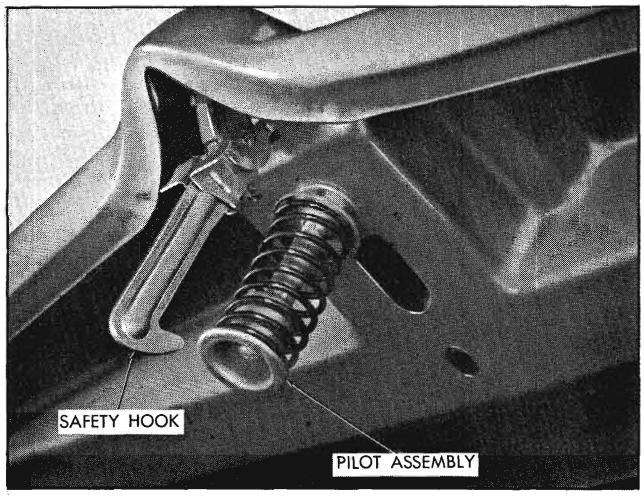


Fig. 10-10 Pilot Assembly and Safety Latch

(1) Close hood.

(2) Release latch and raise hood 10″-12″.

(3) Let hood fall of own weight.

(4) Adjust hood latch bolt to permit hood to close easily when hood drops of its own weight from 10″-12″ from closed position.

(5) Recheck 3 above.

HOOD HINGES

The hood is mounted on gear type hinges (Fig. 10-12), mounted on the front of the dash. Double assist overcenter springs are used, (one at each hood hinge) both ends of which are fastened to the arms of the hinge. This construction provides hold-open power.

A hood to hinge reinforcement bracket which has two points of attachment is used. Fore and aft adjustment of the hood is provided for by slotted holes in the bracket.

SHEET METAL—REMOVE AND REPLACE

FRONT FENDER—REMOVE AND REPLACE

NOTE: If the same fender is to be replaced, note postion, location and number of alignment shims used. (See Figs. 10-5 through 10-9).

1. Disconnect left and right parking lamp assemblies.

2. Remove front bumper assembly by removing bumper to frame attaching bolts (two at each side). Pull bumper assembly straight out.

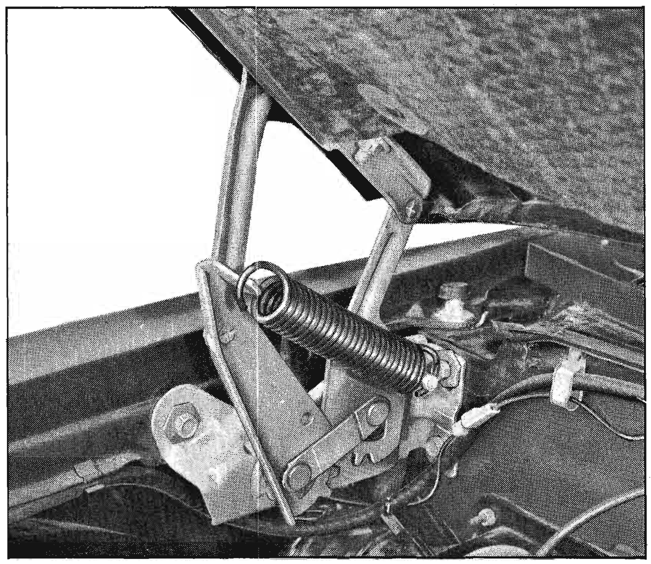


Fig. 10-11 Hood Hinge (Right Side)

3. Disconnect headlamps assembly.

4. Disconnect fender from fender skirt and hood hinge.

5. Disconnect fender from radiator baffle and fender brace.

6. Disconnect fender from cowl at door opening and rocker panel area.

7. Install fender by reversing the above steps.

8. Align fender with other body and sheet metal parts.

GRILLE ASSEMBLY—REMOVE AND REPLACE

This procedure is for removal of both the regular Pontiac grille assembly and the Grand Prix grille. The only difference between them is that the Grand Prix grille sections are composed of two parts, a casting and a stamping, which are bolted together. Other models have a one piece cast grille section.

1. Remove headlight doors and headlight assemblies.

2. Remove grille to center panel nuts (2 each side), grille to upper grille panel bolts (4 each side), and grille to lower panel bolts (4 each side). Remove grille sections.

3. Remove attaching bolts from upper grille panel to fenders (4 bolts, 2 screws), to grille center panel and hood latch (4 bolts), and to the radiator support (2 bolts). Remove the nuts from center emblem. Carefully remove upper grille panel. Remove decor strip

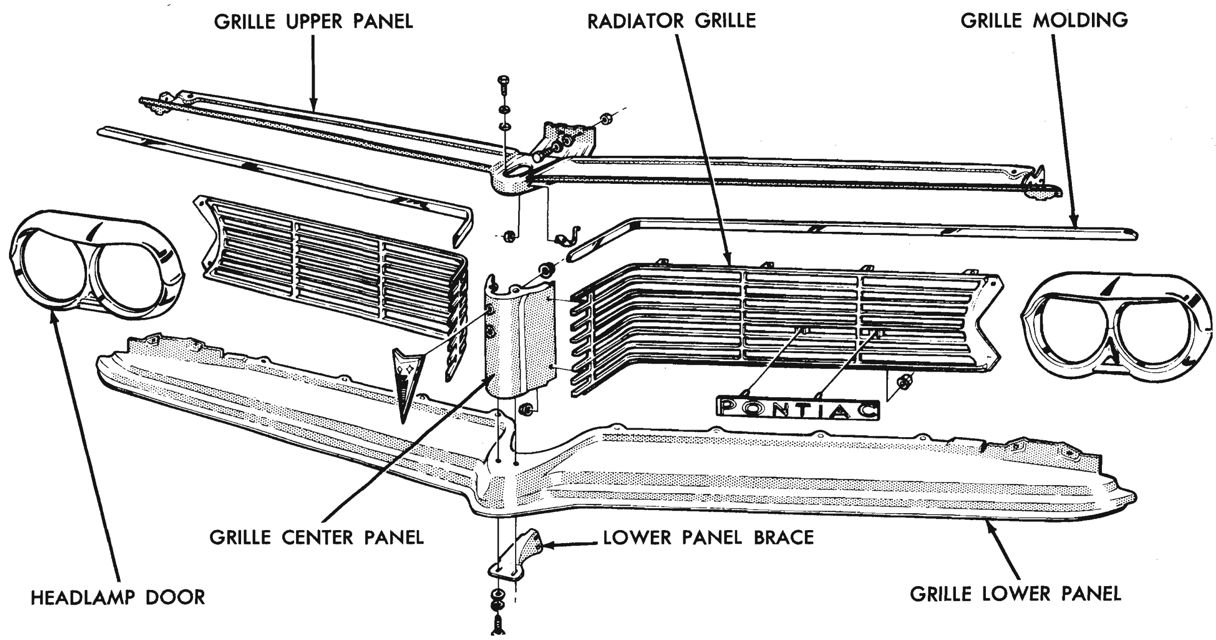


Fig. 10-12 Details of Radiator Grille Assembly

attaching nuts and remove strip.

4. Remove center grille panel by removing 2 bolts attaching it to the lower grille panel.

5. Remove the hood latch assembly to radiator support bolt to remove hood latch assembly.

6. Remove the front bumper assembly by disconnecting the parking light wires and removing the bumper to frame attaching bolts—two at each side. Pull bumper assembly straight out.

7. Remove lower grille panel to fender attaching bolts and remove panel.

8. Replace by reversing above steps. Be sure to re-connect headlight ground wires.

HOOD HINGE SPRING—REPLACE

Hood hinge springs can be removed by propping hood open, and pulling front of spring off of hinge. When replacing the spring, hook the rear end on pin first, then stretch the spring out and hook it at front.

HOOD HINGE—REMOVE AND REPLACE

1. Open hood.

2. While one man holds hood, remove spring, hinge to fender and cowl attaching screws, hinge to hood attaching nuts, and remove hinge.

3. Position new hinge to fender, install and tighten attaching screws.

4. Position hinge to hood and install flat washers, lock nuts and tighten just snug.

5. Replace spring.

6. Close hood and check hood alignment.

7. If hood is misaligned, measure amount of misalignment.

a. Open hood, mark position of hinge relative to hood.

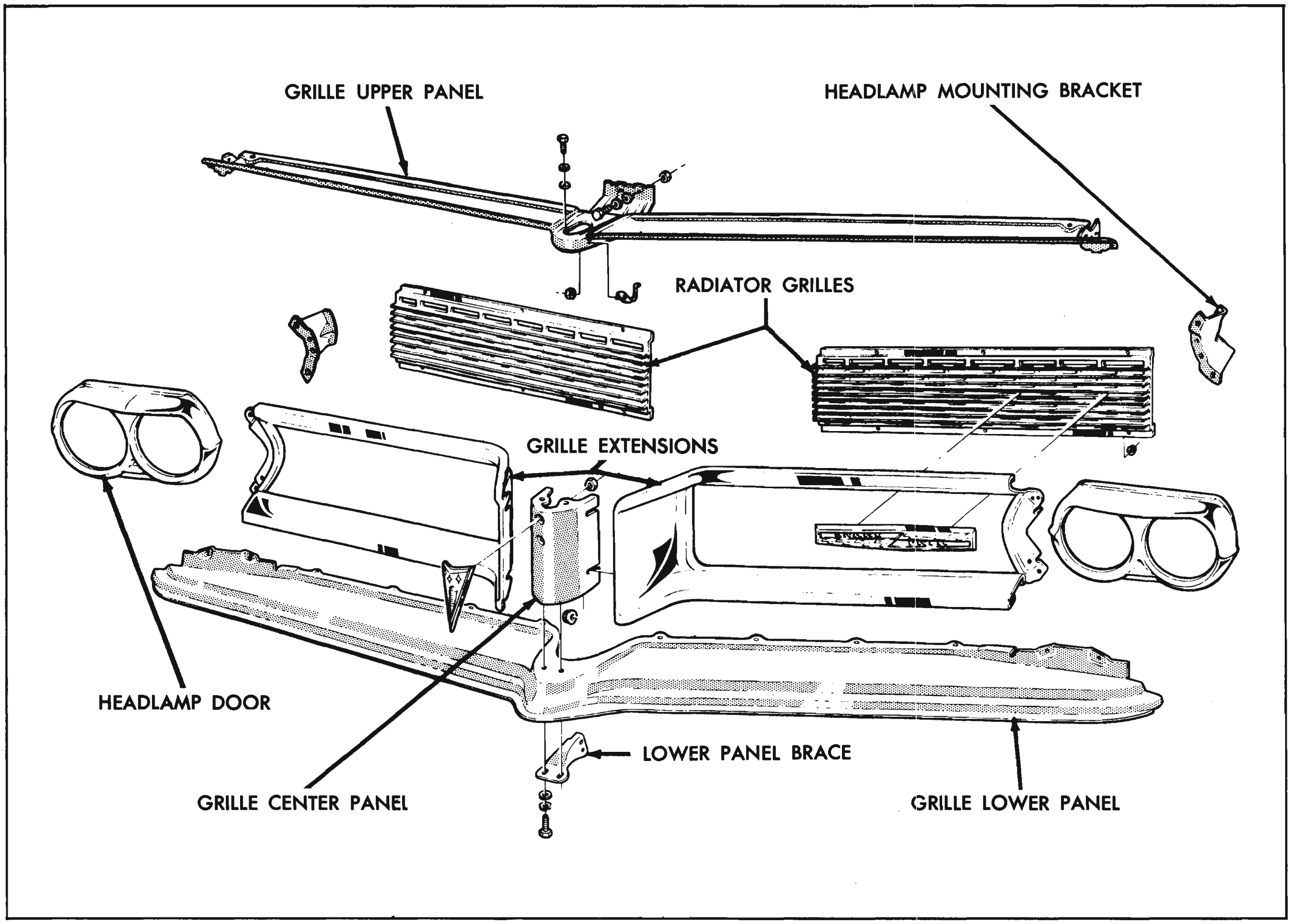


Fig. 10-13 Details of Radiator Grille Assembly—Grand Prix

b. Loosen hinge at hood and move hinge the amount it was off.

c. Tighten securely and recheck alignment.

HOOD—REPLACE

The hood can be removed very quickly by disconnecting it from the hinges at the hood reinforcement.

When replacing the hood, adjust the alignment, one hinge at a time, as outlined in steps 6 and 7 under HOOD HINGE—REMOVE AND REPLACE.

WRENCH TORQUE SPECIFICATIONS

(Torque shown in lb. ft. unless otherwise specified.)

TORQUE	SIZE	APPLICATION
		Front Fenders
50-80 Lb. In.	#14-10	Screw—Frt. Fender & Skirt Brkt. to Frt. Fender & Skirt
10-20	5/16-18	Screw—Frt. Fender to Rad. Support Brace
20-35	3/8-16	Nut—Frt. Fender to Upper Shroud Frt. & Hood Adj. Bumper
20-35	3/8-16	Screw—Frt. Fender to Upper Shroud Rear
20-35	3/8-16	Screw—Front Fender to Lower Shroud
40-50 Lb. In.	#14-10	Screw—Frt. Fender Skirt to Fender (Hood Opening)
8-15	#20-9	Screw—Front Fender Skirt to Baffle
10-15	5/16-18	Screw—Front Fender Skirt to Frame
50-80 Lb. In.	#14-10	Screw—Frt. Fender Skirt to Fender (Wheel Opening)

TORQUE	SIZE	APPLICATION
		Hood
20-35	3/8-16	Screw—Hood Hinge to Shroud
20-35	3/8-16	Screw—Hood Hinge to Fender
50-60 Lb. In.	1/4-20	Screw—Safety Catch to Hood
20-35	1/2-20	Nut—Hood Latch Pilot to Hood Jam
20-35	3/8-16	Nut—Hood to Hood Hinge Lock
8-15	#20-9	Screw—Hood Latch to Hood Latch Mtg. Brkt.
20-35	3/8-16	Screw—Hood Latch to Radiator Support
15-20	3/8-16	Nut—Frt. Hood Adjustable Bumper Jam
		Battery Support
8-15	5/16-18	Battery Tray Bracket to Radiator Support
8-15	No. 20-9	Screw—Battery Tray to Radiator Baffle
10-25	No. 20-9	Screw—Battery Tray to Battery Tray Bracket
10-15	5/16-18	Screw—Battery Tray to Fender Skirt
		Head Lamp Mounting
25-35 Lb. In.	No. 10-24	Screw—Headlamp
25-35 Lb. In.	No. 10-24	Screw—Headlamp Assy. to Reinforcement
5-15 Lb. In.	No. 8-15	Screw—Headlamp Door to Lamp
		Parking Lamps and Mounting
10-35 Lb. In.	No. 10-12	Nut—Parking and Signal Lamp Assy. to Impact Bar
		Tail and Rear License Lamps Mounting
15-25 Lb. In.	No. 10-12	Screw—Rear License Lamp Assy. to Impact Bar
		Horn—Wiring and Mountings
10-25	5/16-18	Nut—Horn Assy. to Radiator Support
60-95 Lb. In.	1/4-20	Screw—Horn Relay Assy. to Fender Skirt
20-35 Lb. In.	8-32	Screw—Horn Button Cup Bushing
15-25 Lb. In.	10-24	Nut—Horn Relay and Junction Block Terminal
60-120 Lb. In.	3/8-16	Nut—Battery Cable to Junction Block Terminal
		Radiator Mounting
8-15	5/16-18	Screw—Radiator Support Brace to Radiator Support
8-15	5/16-18	Screw—Radiator Mounting Bracket to Radiator Support
8-15	20-9	Screw—Radiator Support and Seals Assy. to Radiator Support Brace
20-35	7/16-20	Bolt and Nut—Radiator Support Mounting Bracket to Frame
10-20	5/16-18	Bolt and Nut—Radiator Support Mounting Bracket to Radiator Support
8-15	5/16-18	Bolt and Nut—Radiator Support to Filler
10-25	5/16-18	Screw—Radiator Support to Filler

TORQUE	SIZE	APPLICATION
		Radiator Grille and Baffles
60-80 Lb. In.	1/4-20	Screw—Radiator Grille to Upper and Lower Grille Panels
10-20	5/16-18	Bolt—Radiator Grille Center Panel to Upper and Lower Panels
10-20	5/16-18	Bolt—Radiator Grille Upper Panel to Fender
20-35 Lb. In.	3/8-16	Screw—Radiator Grille Upper Panel to Radiator Support
10-20 Lb. In.	5/16-18	Screw—Radiator Grille Lower Panel to Fender
		Radiator Fan Shroud
8-15	5/16-18	Screw—Engine Fan Top Shield to Fender Brace
		Radiator Fan Shroud (Air Conditioning)
8-15	5/16-18	Screw—Radiator Fan Shroud to Radiator Support
		Front and Rear Bumper and Parts
FRONT		
16-20	7/16-14	Nut—Bumper Impact Bar to Frame Bar Upper
16-20	7/16-14	Nut—Bumper Impact Bar to Frame Bar Intermediate
35-45	1/2-20	Nut—Bumper Impact Bar Frame Bar to Frame
16-20	7/16-14	Nut—Bumper Impact Bar to Frame Bar Lower
16-20	7/16-14	Nut—Bumper Impact Bar to Frame Bar Brace
16-20	7/16-14	Nut—Frame Bar Brace to Frame Bar
REAR		
16-20	7/16-14	Nut—Bumper Impact Bar to Frame Bars
16-20	7/16-14	Nut—Bumper Impact Bar to Center Bracket
35-45	1/2-20	Nut—Bumper Impact Bar Frame Bar to Frame
75-85	1/2-20	Bolt—Bumper Impact Bar to Frame Adjustment
60-120 Lb. In.	3/8-16	Nut—Bumper Impact Bar Step Assy. to Impact Bar (Sta. Wgn.)
16-20	7/16-14	Nut—Bumper Center Bracket to Frame
30-45	7/16-14	Bolt—Bumper Center Bracket to Frame

ELECTRICAL AND INSTRUMENTS

CONTENTS OF THIS SECTION

The electrical section is divided into subsections to simplify locating specific information. They are as follows:

Charging Circuit
Starting Circuit
Ignition Circuit
Lighting Circuit

The electrical system is 12 volts, therefore, care should be taken against accidental shorts when working on the various circuits. Any arcing around the battery could cause the hydrogen gas from the battery to ignite. In addition, tools involved in accidental short circuits may be severely damaged.

CHARGING CIRCUIT

GENERAL DESCRIPTION

The charging circuit includes the battery, generator, regulator and ammeter. The simplified wiring diagram (Fig. 11-1) illustrates this circuit.

BATTERY

DESCRIPTION

Two different batteries are standard equipment. The Model 458, 9 plate, 53 ampere-hour battery (Fig.

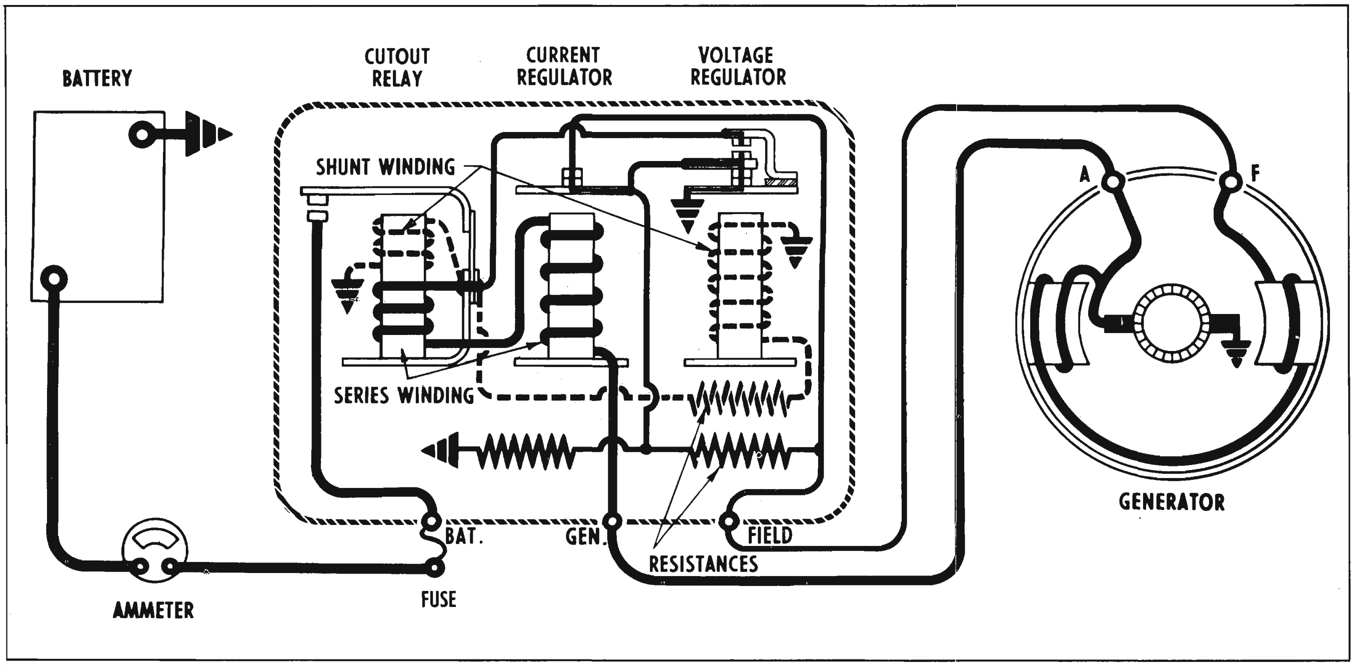


Fig. 11-1 Circuit Diagram of Charging Circuit with Double Contact Voltage Regulator

11-2) is generally used on cars equipped with the regular fuel 8.6:1 compression ratio engine.

A Delco Model 558, 11 plate, 61 ampere-hour battery is generally used as standard equipment on all cars equipped with the 10.25:1 or higher premium fuel engine.

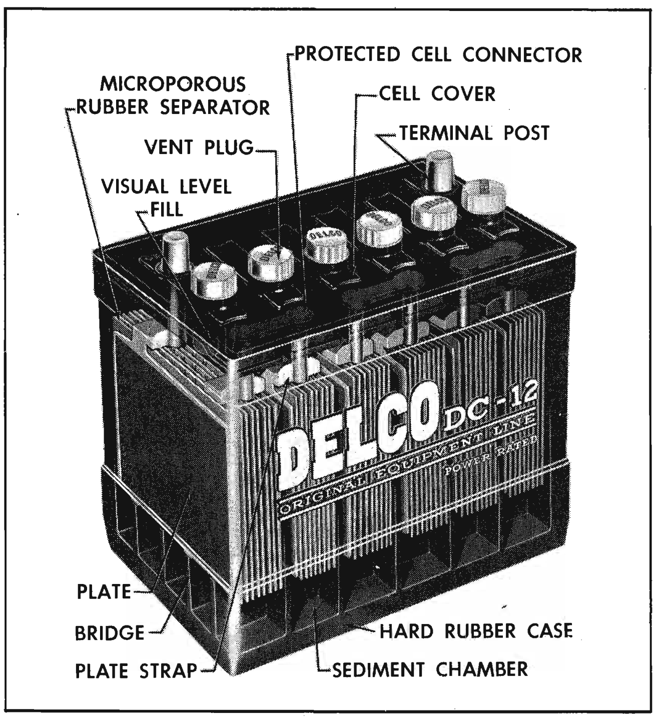


Fig. 11-2 12 Volt Battery

The Model 570, 11 plate, 72 ampere-hour battery is used for heavy duty.

These batteries have a specific gravity of 1.260-1.280 at full charge at 80°F. The battery date code is located on the second cell cover from the positive post end of the battery. This date code should always be included in product information reports or correspondence about batteries.

All three batteries are equipped with "visual level" cell covers to facilitate checking electrolyte level and to lessen the possibility of overfilling the battery.

These covers have a long, circular, tapered vent well with two small vertical slots diametrically opposite. Viewed from above, with the battery vent plugs removed, the lower end of the vent well appears as a ring with small portions of the circumference missing. As water is added to the cell, the surface of the rising liquid contacts the slotted lower end of the vent well causing a distortion of the reflecting surface of the liquid which is very noticeable. Thus, the lower end of the vent well serves as a reference point in determining proper electrolyte level. The cell is properly filled when the surface of the electrolyte touches the bottom of the vent well. If some overfilling occurs, the amount can be estimated readily by the height of liquid in the vent well itself.

A plastic coated metal hold down is used to prevent possibilities of grounding due to corrosion.

PERIODIC SERVICE

Liquid level in the battery should be checked every 2,000 miles or once a month. In extremely hot weather, the checking should be more frequent. If the liquid level is found to be low, *add water to each cell until the liquid level rises to the bottom of the vent well. DO NOT OVERFILL!* Distilled water, or water passed through a "demineralizer," should be used for this purpose in order to eliminate the possibility of harmful impurities being added to the electrolyte. Many common impurities will greatly shorten battery life.

The external condition of the battery and the battery cables should be checked periodically. The top of the battery should be kept clean and the battery hold-down bolts should be kept properly tightened. Particular care should be taken to see that the tops of 12-volt batteries are kept clean of acid film and dirt because of the high voltage between the battery terminals. For best results when cleaning batteries, wash first with a diluted ammonia or soda solution to neutralize any acid present and then flush off with clean water. Care must be taken to keep vent plugs tight so that the neutralizing solution does not enter the cell. The hold-down bolts should be kept tight enough to prevent the battery from shaking around in its holder so as not to damage the battery case, but they should not be tightened to the point where the battery case will be placed under a severe strain. The torque specification is 22-27 lb. in.

To insure good contact, the battery cables should be tight on the battery posts. If the battery posts or cable terminals are corroded, the cables should be disconnected and the terminals and clamps cleaned separately with a soda solution and a wire brush. After cleaning apply a thin coating of petrolatum on the posts and cable clamps to help retard corrosion.

MINOR REPAIRS

BATTERY CABLE REPLACEMENT

When replacing battery ground cable be sure the connections are secure.

The battery-to-starter cable is difficult to remove at the starting motor solenoid. For this reason the cable should be removed and replaced as an assembly with the starting motor. Before fastening cables to battery, clean battery post and lightly coat battery post and cable terminals with petrolatum.

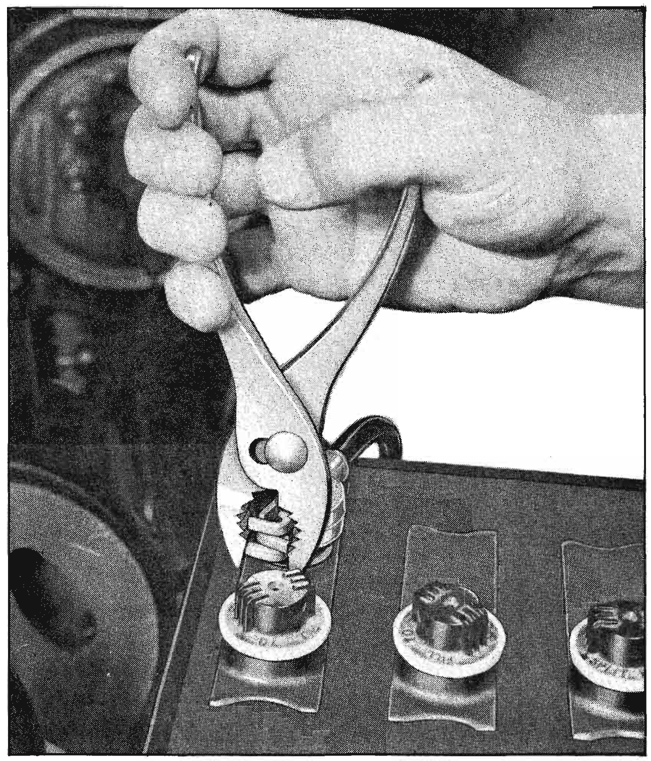


Fig. 11-3 Disconnecting Battery Cable

BATTERY SUPPORT REPLACEMENT

When replacing the battery support, it is very important that the outer edges of the battery bear firmly and evenly against the support. To provide even support, install shims as necessary between the corners of the support and the support bracket. Battery hold down clamp should be tightened to 22-27 lb. in. torque.

BATTERY TESTING, BOOSTING AND CHARGING

QUICK IN-THE-CAR BATTERY TEST

INSPECTION

Check outside of battery for damage or signs of serious abuse such as broken case or broken covers. Check inside of battery by removing the vent caps and inspecting for signs of abuse such as electrolyte level too low to see, or bad or unusual odors. If battery shows signs of serious damage or abuse, it should be replaced. If not, make light load test.

LIGHT LOAD TEST

Check electrical condition of battery cells as follows:

a. First, if electrolyte level is low, fill to split ring by adding water.

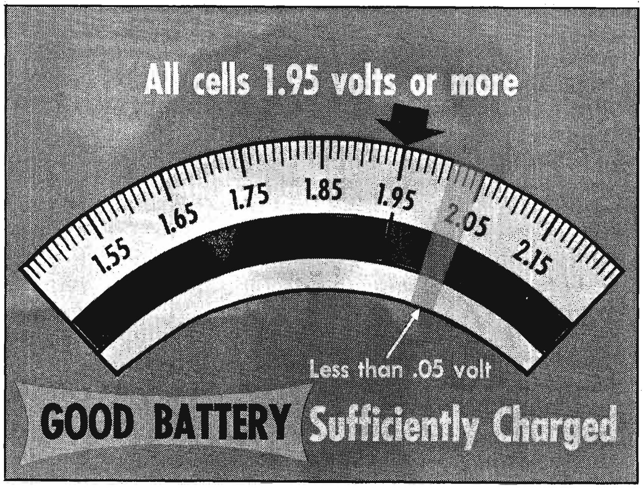


Fig. 11-4 Good Battery—All Cells 1.95 Volts or More

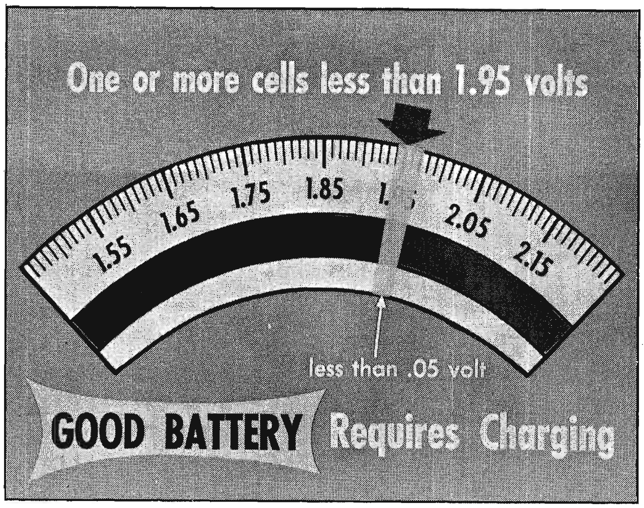


Fig. 11-5 Good Battery—Requires Charging

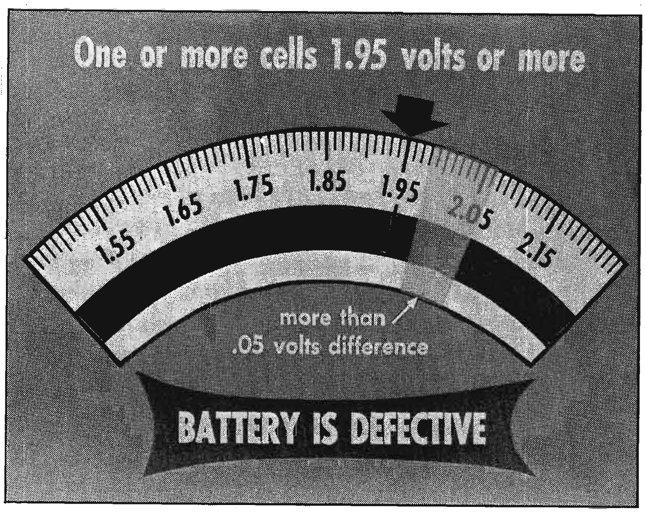


Fig. 11-6 Defective Battery—More than 0.05 Volts Difference

b. Then, place load on battery by holding starter switch "ON" for 3 seconds or until engine starts. It makes no difference whether starter turns engine or not. However, if engine starts, turn off ignition immediately.

c. Then, turn on headlights (low beam). After 1 minute, with lights still "ON", read individual cell voltages of battery with voltmeter (.01 volt division). Compare readings with the following:

UNIFORM READINGS

If any cell reads 1.95 volts or more and the difference between the highest and lowest cell is less than .05 volts, battery is good (Fig. 11-4). However, if any cell reads less than 1.95 volts, battery should be fully recharged for good performance (Fig. 11-5). See CHARGING AFTER LIGHT LOAD TEST.

NONUNIFORM READINGS

If any cell reads 1.95 volts or more and there is a difference of 0.05 volts or more between the highest and lowest cell, the battery should be replaced (Fig. 11-6).

LOW READINGS

If all cells read less than 1.95 volts, battery is too low to test properly (Fig. 11-7). FAILURE OF THE METER TO REGISTER ON ALL CELLS DOES NOT INDICATE A DEFECTIVE BATTERY. Boost charge battery and repeat the light load test. (See BOOST CHARGING FOR LIGHT LOAD TEST.) If battery is found to be good after boosting, it should be fully recharged for good performance.

If none of the cells come up to 1.95 volts after the first boost charge, the battery should be given a second boost. Batteries which do not come up after second boost charge should be replaced.

NOTE: If any battery found to be good by the Light Load Test does not perform satisfactorily in subsequent service, it should again be tested by the Light Load Test and if it still tests "good", it should be removed from the car and tested as outlined under OUT-OF-THE-CAR CHARGING AND TESTING.

IN-THE-CAR BOOSTING AND CHARGING

BOOST CHARGING FOR THE LIGHT LOAD TEST

Boost 12-volt passenger car batteries at 50 amperes for 20 minutes ($50 \times 20 = 1000$ ampere minutes). Boost all other batteries at 60 amperes for 30 minutes (60 × 30 = 1800 ampere minutes). If charger will not give these rates, charge for an equal number of ampere minutes at best rate available. For purposes of this test do not boost battery more than the amount indicated.

CHARGING AFTER THE LIGHT LOAD TEST

For best performance, a good battery should be fully charged before being returned to service.

If batteries are to be fully charged by means of a quick charger, the charge rate must be "tapered" (reduced to a safe limit) when the electrolyte temperature reaches 125°F or when gassing becomes excessive. Failure to do so may harm the battery.

OUT-OF-THE-CAR CHARGING AND TESTING

The procedures outlined below under SLOW CHARGING AND THE FULL CHARGE HYDROMETER TEST should be used on any battery originally found to be "good" by the light load test, but which has since failed to perform satisfactorily in service and which still tests "good" by the light load test.

CAUTION: The FULL CHARGE HYDROMETER TEST is not valid unless battery has been tested and found to be good by the light load test.

SLOW CHARGING

Adjust electrolyte to proper level by adding water, then charge battery at 5 amperes until fully charged. Full charge of the battery is indicated when all cell gravities do not increase when checked at three intervals of one hour and all cells are gassing freely.

Due to the low rate during slow charging, plenty of time must be allowed. Charge periods of 24 hours or more are often required.

THE FULL CHARGE HYDROMETER TEST

Make sure battery is fully charged as described above. HYDROMETER READINGS TAKEN ON PARTIALLY CHARGED BATTERIES ARE UNRELIABLE FOR THE FOLLOWING TEST:

1. Measure specific gravity of electrolyte in each cell and compare readings with the following:

2. If cell readings range between 1.230 and 1.310, the battery is ready for use. All it needed was a full charge. Any variation in the specific gravity between cells within this range does not indicate a defective battery.

3. If any cell reads less than 1.230 and

a. Battery has been in service 3 months or less,

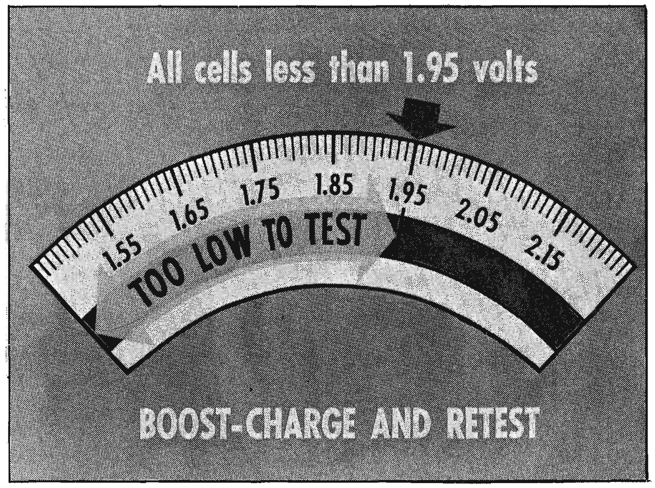


Fig. 11-7 Battery Too Low to Test

battery is good but it has been improperly filled with electrolyte or water and will give poor performance. To correct this condition, empty the electrolyte from any cell reading less than 1.230 and refill with 1.265 specific gravity battery grade electrolyte. The battery is now ready for use.

b. Battery has been in service more than 3 months, it should be replaced.

4. If any cell reads above 1.310 battery may be returned to service. However, specific gravities above 1.310 are harmful to the battery and will cause early failure. Such high readings are caused by the improper addition of electrolyte. Adjusting the specific gravity will not correct the damage that has been done by high gravity.

When replacing a battery see HANDLING WARRANTY to determine if warranty and adjustment policy applies.

BATTERY TROUBLE DIAGNOSIS

1. If the battery is undercharged, check for loose generator belt, defective generator, high resistance in the charging circuit, oxidized regulator contact points, or a low voltage setting. See CHECKS AND ADJUSTMENTS ON CAR.

2. If the battery uses too much water, lower the voltage regulator setting. See CHECKS AND ADJUSTMENTS ON CAR.

GENERATOR

GENERAL DESCRIPTION

Three 12-volt generators provide electrical output requirements for cars equipped with various accessories.

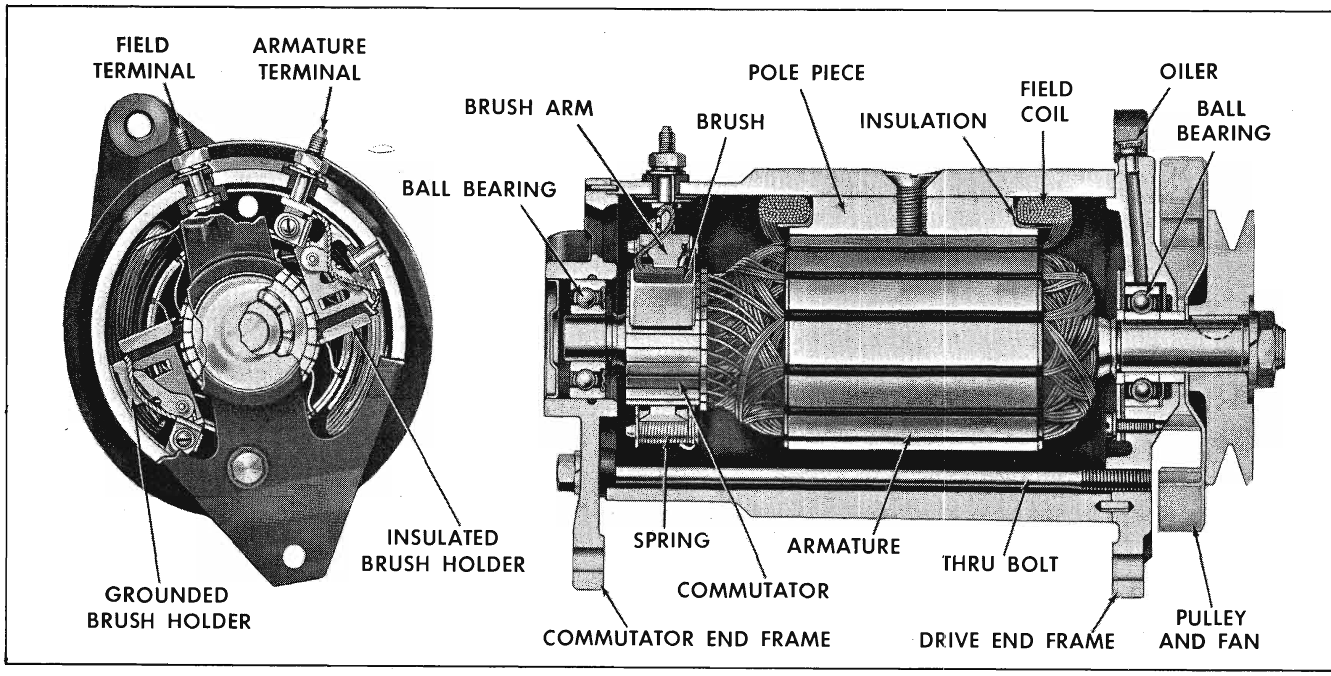


Fig. 11-8 Cross Section of Standard Generator Assembly (35 amp)

1. The standard duty 35 ampere generator assembly has a 2¾" diameter single pulley and is used on all models except heavy duty generator, Circ-L-Aire Conditioner, tri-carburetion, or 425-A engine. A ball bearing is located in both ends of the generator but only the front bearing (drive end) requires periodic lubrication at the oiler.

2. A heavy duty 28-45 ampere generator assembly (referred to as a 45 amp. generator) has a 2$\frac{7}{16}$" diameter pulley and is used on all models with Circ-L-Aire Conditioner and on special equipment heavy duty generator requirements except Circ-L-Aire Conditioner. (The 28 to 45 ampere output is dependent upon temperature. Higher temperatures lower output.)

The armature for this generator is supported on ball bearings at both the drive end and the commutator end. Oilers at each bearing permit periodic lubrication of the bearings.

3. A heavy duty 45 ampere extra low cut-in generator having a 2¼" diameter pulley is available for use on special equipment requiring heavy electrical loads at low speeds. The design of this generator is such that it provides a 3 to 12 amp. charge at engine idle speed. (This range is dependent upon temperature and idle speed.) Bearings at the drive end and commutator end support and keep the generator armature in true alignment. An oiler is provided at each bearing for periodic lubrication.

PERIODIC SERVICE

The hinge cap oilers of the generator should be filled with light engine oil once at each vehicle lubrication period.

There is no oiler at the commutator end on the 35 amp generator. It has a production packed rear bearing which should be repacked when brushes are serviced.

CAUTION: Do not fill oil cups with engine running.

Periodic servicing of the generator should include an inspection of the commutator and brushes for cleanliness and wear. If the commutator is dirty, it should be cleaned. If the brushes are worn down to less than half their original length, they should be replaced.

GENERATOR—REMOVE

1. Disconnect field, output and ground wires from generator.

2. Remove adjusting strap screw and remove fan belt from generator pulley.

3. Remove generator from mounting bracket.

GENERATOR—DISASSEMBLE

1. Place generator in bench vise; use vise as holding fixture only and be careful not to distort generator frame.

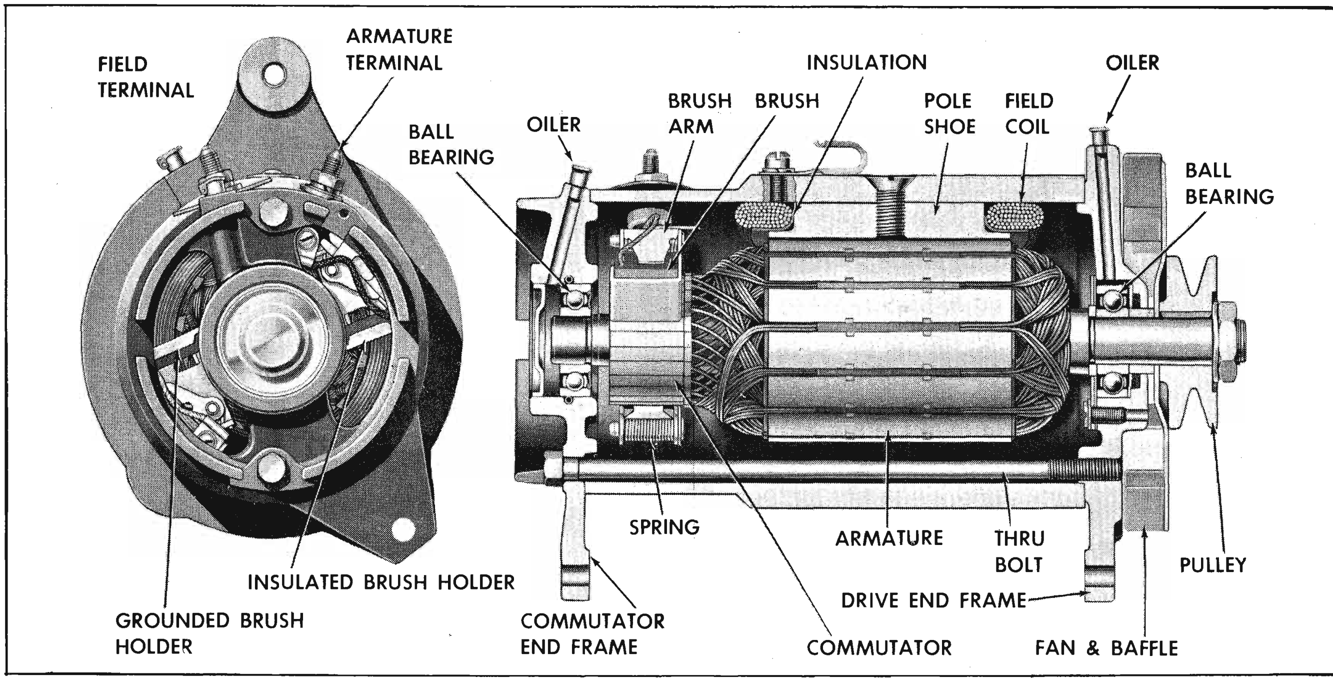


Fig. 11-9 Cross Section of Heavy Duty Generator Assembly

NOTE: Check brush spring tension before disassembling generator to determine if spring is weak or brush holder is gummy (Fig. 11-10). Proper spring tension is approximately 28 ounces.

2. Remove two through bolts and remove commutator end frame assembly.

3. Remove brushes.

4. Remove drive end frame assembly, with armature and pulley, from generator frame.

5. Remove drive pulley. A fan belt held tightly in the pulley groove will aid in holding the armature while removing the nut.

6. Remove drive pulley and key from armature shaft.

7. Remove spacer collar from armature shaft and then slide drive end frame from armature shaft. Bearing-assembly-spacer-inside washer will remain on armature shaft and may be lifted off after removing end frame from armature.

8. Remove bearing retainer plate and gasket from end frame.

9. Push ball bearing out of end frame and put in a clean place where grit or dirt will not enter.

10. Remove bearing felt washer and bearing felt from drive end frame.

CLEAN, INSPECT AND TEST GENERATOR

1. Wash all metal parts except the armature and fields in cleaning solvent. Fields and armature must never be cleaned with any degreasing solvents since this may damage the insulation.

NOTE: Armature and field coils may be cleaned by brushing with oleum spirits.

2. After a thorough cleaning in solvent inspect generator ball bearing for roughness, scored races, and deformed balls.

3. Check brush holders to see that they are not deformed or bent so as to interfere with holding brushes properly against commutator.

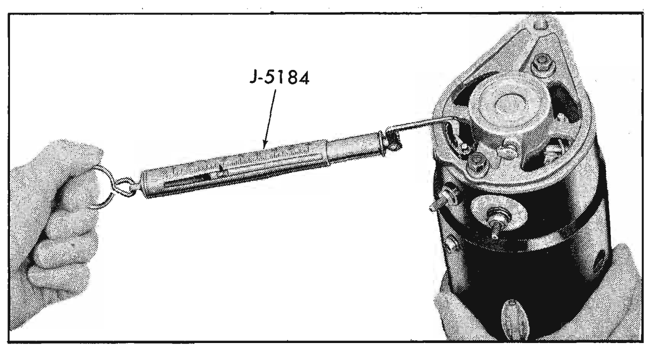


Fig. 11-10 Checking Brush Spring Tension

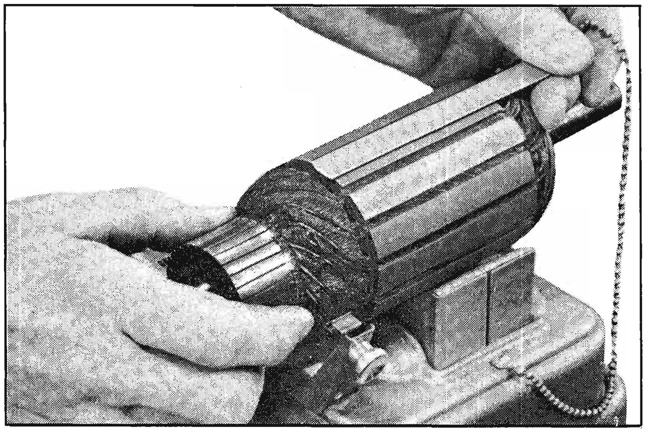


Fig. 11-11 Testing Armature for Shorts

4. Inspect armature commutator; if rough it must be turned down and insulation undercut. Inspect solder at points where armature wires fasten to ends of commutator riser bars to make sure solder is in place to ensure good connections.

5. If test equipment is available:

a. Check armature for shorts by placing on growler and with hack saw blade over armature core, rotate armature (Fig. 11-11). If saw blade vibrates, armature or commutator is shorted. Recheck after cleaning between the commutator bars and if saw blade still vibrates, armature is shorted and must be replaced.

b. Check armature for open circuit by making bar-to-bar check as shown in Fig. 11-12. Inconsistent variation in readings indicates an open armature.

c. Using a 110-volt test lamp, place one lead on armature core and other on commutator. If lamp lights, armature is grounded and must be replaced (Fig. 11-13).

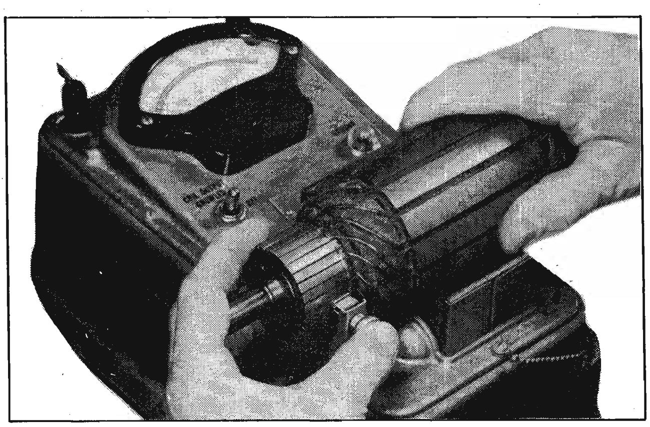


Fig. 11-12 Bar-to-Bar for Open Armature

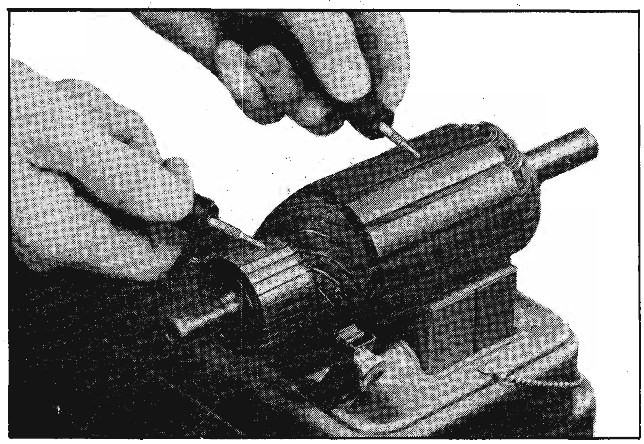


Fig. 11-13 Testing Armature for Ground

d. Using a 110-volt test lamp, place one lead on field terminal on generator frame and the other lead on armature terminal (Fig. 11-14). If lamp does not light, the field coils are open and must be replaced (unless a loose connection is found which can be soldered).

e. Using a 110-volt test lamp, place one lead on ground (touch to generator frame) and other lead on field terminal on generator frame (be sure free end of field wire is not touching ground and field terminal insulation is not broken). See Fig. 11-15. If lamp lights, the field coils are grounded. If ground in field coils cannot be located or repaired, coils must be replaced.

f. Using a 110-volt test lamp, place one lead on generator positive (or output) terminal on generator frame, and place other lead on ground (touch to generator frame). See Fig. 11-16. (Be sure loose end of terminal lead is not touching ground.) If lamp lights, positive terminal insulation through generator frame is broken down and must be replaced.

g. Using a 110-volt test lamp, place one lead on the positive or insulated brush holder and the other lead on ground. If lamp lights, the brush holder is grounded due to defective insulation at the frame (Fig. 11-17).

MINOR REPAIRS

LOOSE ELECTRICAL CONNECTIONS

When an open soldered connection is found during inspection, it may be resoldered provided rosin flux is used for soldering.

CAUTION: Acid flux must never be used on electrical connections.

TURNING COMMUTATOR

When inspection shows commutator roughness, it should be cleaned as follows:

1. Turn down commutator in a lathe until it is thoroughly cleaned.

CAUTION: Width of cut should not be beyond section previously turned.

2. Undercut insulation between commutator bars 1/32". This undercut must be the full width of insulalation and flat at the bottom; a triangular groove will not be satisfactory. After undercutting, the slots should be cleaned out carefully to remove any dirt and copper dust.

3. Sand the commutator lightly with No. 00 sandpaper to remove any slight burrs left from undercutting.

4. Recheck armature on growler for short circuits.

GENERATOR—ASSEMBLE

1. Repack ball bearing with a good grade of ball bearing grease working the grease well into the bearing.

2. Install felt washer and then steel washer in drive end frame.

3. Install ball bearing in drive end frame and then position gasket and bearing retainer on frame and install three retaining screws.

4. Place steel washer on drive end of armature shaft and then slip drive end frame assembly onto armature shaft.

5. Install spacer washer on armature shaft and slide it down into place in end frame against bearing inner race.

6. Position drive pulley key in armature shaft and install drive pulley on shaft.

7. Install drive pulley lock washer and nut and tighten.

8. Place armature and end frame assembly in field frame, aligning dowel pins with holes.

9. Install commutator end frame on field frame, aligning dowel pins with holes.

10. Install and tighten two generator through-bolts. Torque to 40-80 lb. in.

11. Install new brushes in brush holders by pulling back on brush arm and inserting brush in each holder

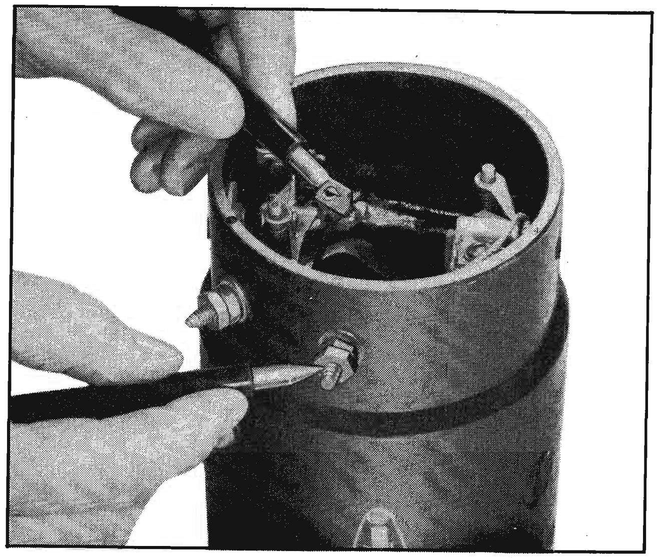


Fig. 11-14 Testing Field Coils for Open Circuit

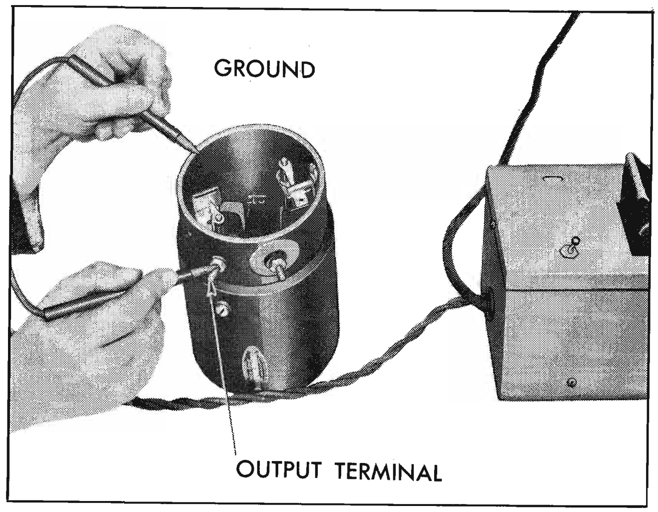


Fig. 11-15 Testing Field Coils for Ground

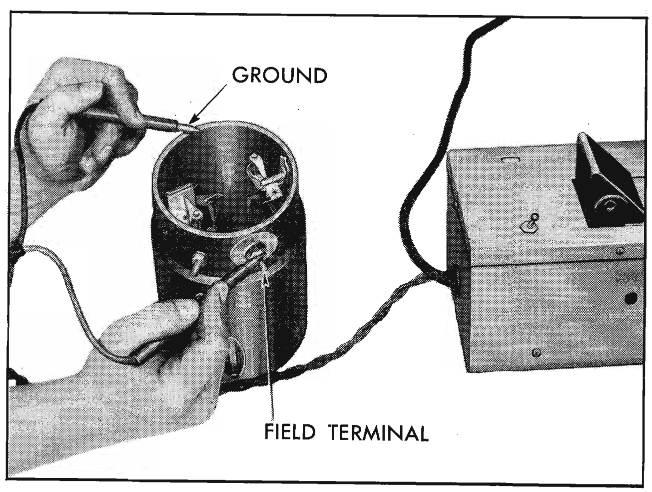


Fig. 11-16 Testing Positive Terminal for Ground

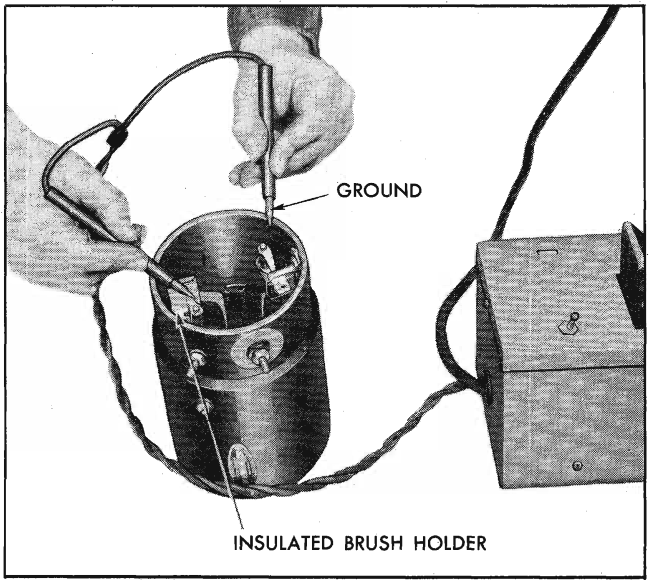


Fig. 11-17 Testing Positive Brush Holder for Ground

making sure that chamfered end of brush seats correctly on commutator. Brushes will be seated, if necessary, after installing generator in car.

12. Connect brush and field leads to brushes.

13. Fill reservoirs with engine oil.

GENERATOR—INSTALL

1. Place generator in position on mounting bracket and install bracket bolts. Tighten snugly.

2. Place fan belt over generator drive pulley and fasten adjusting strap screw to generator, but do not tighten brace bolt.

3. Install Borroughs gauge on generator drive belt and adjust to specified tension. Tighten adjusting strap screw with generator in this position and tighten bracket bolts securely.

4. Connect ground lead, positive generator lead and field lead to terminals on generator frame.

CAUTION: On radio equipped cars do not connect radio by-pass condenser to generator field terminal. It should be connected to generator output (A) terminal.

5: Polarize the generator by momentarily touching a jumper wire to the BAT and GEN terminals on regulator, *engine not running* (Fig. 11-18).

Failure to polarize a generator in agreement with the battery on a vehicle may result in burned cut-out relay points, a run-down battery, and possible serious damage to the generator itself.

Generators and regulators used on Pontiac cars are designed with the field circuit attached to the insulated brush inside the generator and grounded outside the generator at the regulator.

Generators of this design are polarized by connecting a jumper lead from the insulated or "hot" side of the battery to the armature terminal of the generator. On a vehicle, momentary touching of a short jumper lead between the battery and generator armature terminals of the regulator is all that is required to polarize the generator.

6. Start engine. If brushes squeak, seat them by placing brush seating paste on the commutator. The soft abrasive material of the paste will be carried under the brushes and wear the brush faces to the commutator contour in a few seconds.

GENERATOR TROUBLE DIAGNOSIS

GENERATOR BELT AND OUTPUT CHECK

1. Check belt tension and adjust as required.

2. Inspect commutator and, if dirty, clean by holding No. 00 sandpaper or a cleaning stone against it while generator is operating at idle speed.

CAUTION: Do not use emery cloth for cleaning armature.

3. With the engine operating at medium speed,

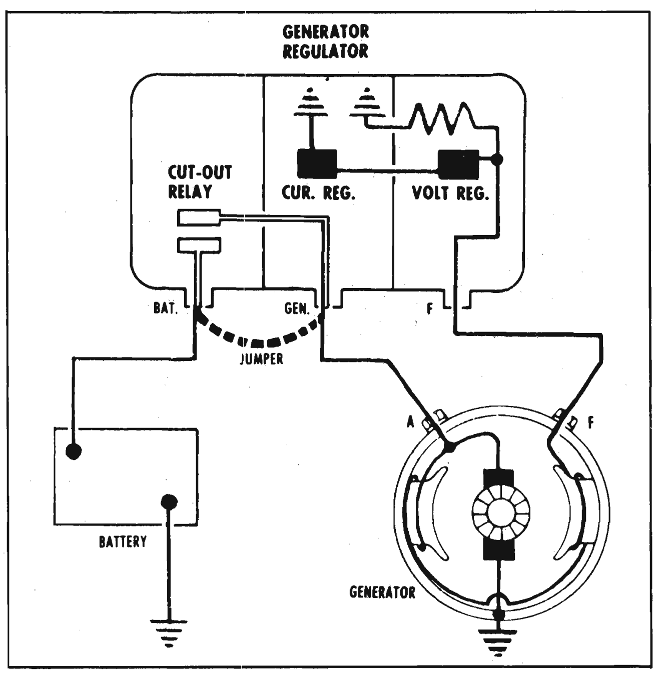


Fig. 11-18 Polarizing Generator

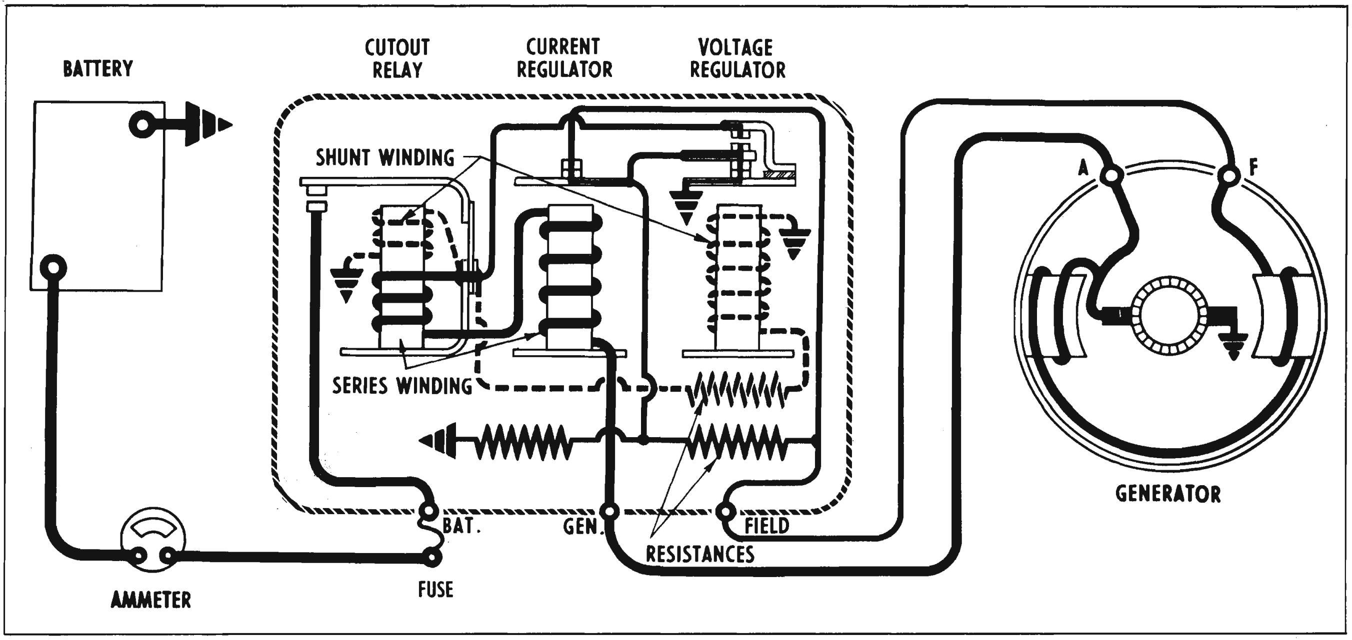


Fig. 11-19 Generator Regulator in Charging Circuit

momentarily ground the "F" terminal of the generator. Generator output should increase. If it doesn't, make a complete check of the generator.

CAUTION: Disconnect field lead from generator or regulator before making this check on double contact regulator.

4. If output is high and is not affected by grounding the "F" terminal of the generator, disconnect the lead from the "F" terminal of the generator. Generator output should fall off. If it does not, remove the generator and check it for a grounded field.

GENERATOR BRUSH NOISE

Generator brush noises can usually be eliminated by seating the brushes with the generator on the car. While brush seating compound will frequently provide satisfactory seating, the use of a brush seating stone as follows has been found to provide a more positive cure:

1. Start engine and run until it reaches normal operating temperature. (Brush noise may be more pronounced when generator is hot.)

2. Determine engine speed at which brush noise is loudest.

3. While running engine at speed where noise is loudest, very carefully stone commutator until noise disappears.

4. In rare instances, stoning may not eliminate the noise. In this case, remove the armature from the generator, turn down the commutator and undercut the mica. When reassembling generator, install new brushes.

REGULATOR

DESCRIPTION

REGULATOR (FOR 35, 28-45, 45 AMP. LOW CUT-IN GENERATOR)

A Delco-Remy three-unit, waterproof, 12-volt regulator is used on all car models. The regulator is designed for use with a negative grounded battery and a shunt type generator. The regulator contains three units—cutout relay, a voltage regulator and, a current regulator (Fig. 11-19).

CUTOUT RELAY – The purpose of the cutout relay is to close and open the charging circuit between the generator and battery. When the generator voltage reaches the value for which the cutout relay is adjusted, the contact points close and current flows from the generator toward the battery. When generator voltage falls below battery voltage, the contact points open to prevent battery discharge through the generator while the engine is idling or stopped.

A special 50 amp. fuse assembly is attached to the "BAT" terminal of all regulators. This fuse protects

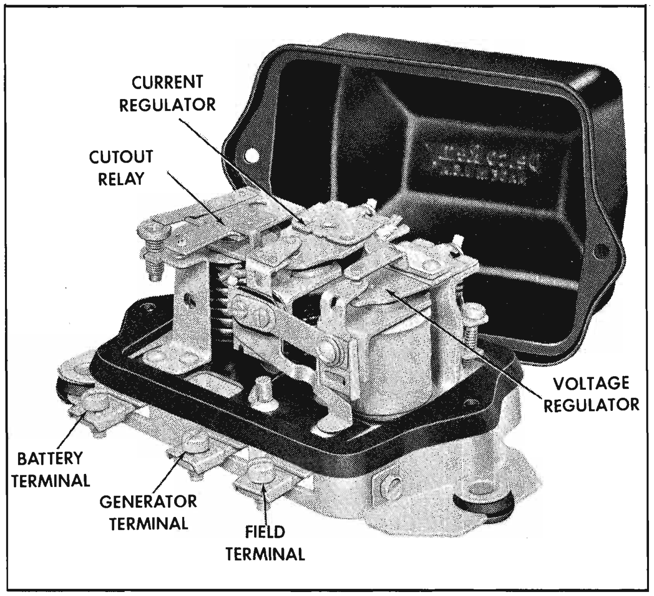


Fig. 11-20 Double Contact Regulator

the generator to regulator wiring and the generator armature from battery current if the cutout relay points are stuck in the closed position. Check this fuse for continuity if the battery is run down.

CURRENT REGULATOR—The purpose of the current regulator is to prevent overheating of the generator armature by limiting generator output. Vibrating contacts of the current regulator limit generator output by intermittently inserting resistance in the generator field circuit as required.

VOLTAGE REGULATOR—Due to the high field currents required, a regulator incorporating a double contact voltage regulator is used (Fig. 11-20).

The voltage regulator has a double set of contacts; one called the *lower set* of contacts (which is in series with the generator field circuit) and the other called the *upper set* of contacts (which shorts out the generator field circuit). This unit is checked and adjusted differently than the standard three-unit type voltage regulator.

The operation of the lower series set of contacts on the voltage regulator unit limits generator voltage by inserting a resistance in *series* with the generator field circuit. When this series resistance will not control the generator voltage at the predetermined setting, the generator voltage increases slightly causing the upper (shorting) contacts to operate. The upper (shorting) contacts place a *short* circuit directly across the generator field circuit, hence limiting the generator voltage to a predetermined value. Fig. 11-19 shows the charging circuit for the double contact regulator.

CAUTION: Never ground the generator field with this regulator connected to generator. This will burn up the upper set of contact points of the voltage regulator.

PERIODIC SERVICE

Normally, periodic service of the regulator is not required. However, it may occasionally be necessary to clean the regulator contact points as outlined under INSPECT AND ADJUST REGULATOR.

CHECKS AND ADJUSTMENTS ON CAR

Four regulator electrical checks can be made on the car—the settings of the cutout relay, voltage regulator, and current regulator, and a check for oxidized regulator contact points. Mechanical checks and adjustments requiring removal of the regulator from the car are discussed under INSPECT AND ADJUST REGULATOR.

The regulator cover must be in place and the regulator must be at operating temperature when the electrical settings are checked. For best results, the electrical checks should be made in the following order:

1. Voltage regulator setting.
2. Cutout relay closing voltage.
3. Current regulator setting.
4. Check for oxidized contact points.

The procedure required for making each of these checks follows.

NOTE: If special testing equipment is used, follow the manufacturer's instructions.

TESTING REGULATOR FOR OXIDIZED POINTS

Abnormal fluctuation of the charge indicator, or of the voltmeter or ammeter pointer while testing the voltage or current regulator indicates an oxidized condition of regulator contact points. This condition may cause a high resistance in the generator field circuit and reduced generator output. Test for oxidized contact points as follows:

1. With engine stopped, disconnect battery lead from regulator terminal marked "BAT". Connect ammeter red lead to "BAT" terminal and ammeter black lead to battery lead.

2. Turn on headlights. Start engine and adjust speed until test ammeter reads exactly 5 amperes.

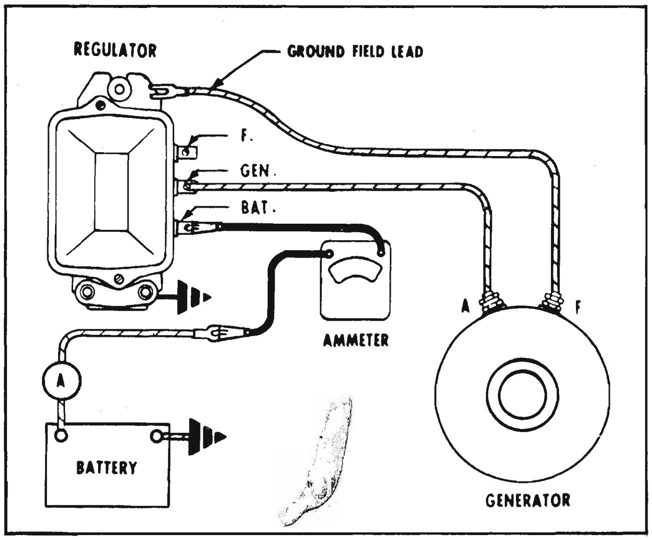


Fig. 11-21 Checking for oxidized points

3. Disconnect field lead from regulator "F" terminal and ground it on regulator base. See Fig. 11-21. If ammeter reading increases more than 2 amperes, oxidized contact points are indicated. Regulator should be removed and contact points cleaned before proceeding to any other regulator tests.

CAUTION: Never use a jumper to ground the generator or regulator field terminal when these units are connected and operating together, as this would burn the contacts of the voltage regulator.

TESTING CHARGING CIRCUIT WIRING

Excessive voltage drop in the charging circuit (resulting from poor connections or other high resistance) tends to keep the battery in an undercharged condition. To check voltage drop, proceed as follows (Fig. 11-22):

NOTE: Check fuse on battery terminal before proceeding. DO NOT ground "F" terminal of regulator or damage will result.

1. Make sure that all accessories are turned off and field rheostats are in place between the field lead to the regulator and ground.

2. Make sure that rheostat variable resistance is in the "OPEN" position. Set carburetor on high step of fast idle cam (approximately 1500 rpm). Then slowly turn variable resistance knob until ammeter reads 20 amperes.

3. Measure voltage drop at V-1, V-2, and V-3. Return rheostat knob to "OPEN" position immediately after taking readings. See Figure 11-24. Readings V-1 and V-3 should not exceed 0.3 volts each. Reading V-2 should not exceed 0.1 volt.

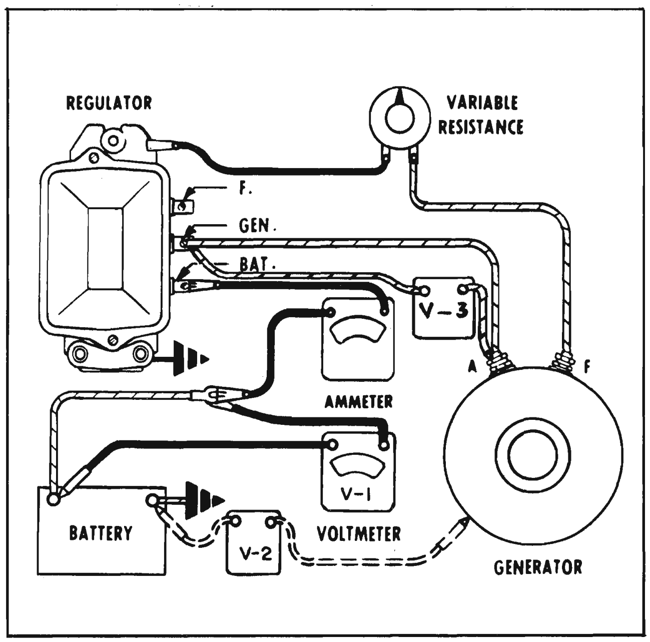


Fig. 11-22 Test Charging Circuit Voltage Drop

4. If any voltage reading exceeds these limits, excessive resistance is indicated in that part of the charging circuit. To correct, clean and tighten connections; if this fails to reduce voltage drop, replace faulty wire.

DOUBLE CONTACT REGULATOR

VOLTAGE REGULATOR SPECIFICATIONS
VS
REGULATOR AMBIENT TEMPERATURE

REGULATOR AMBIENT TEMPERATURE	VOLTAGE LOW		VOLTAGE HIGH
205° F	13.3	—	14.1
185° F	13.4	—	14.2
165° F	13.5	—	14.4
145° F	13.7	—	14.5
125° F	13.8	—	14.6
105° F	14.0	—	14.8
85° F	14.1	—	14.9
	NORMAL SPECIFICATION RANGE		

Fig. 11-23 Voltage Regulator Temperature Correction Chart

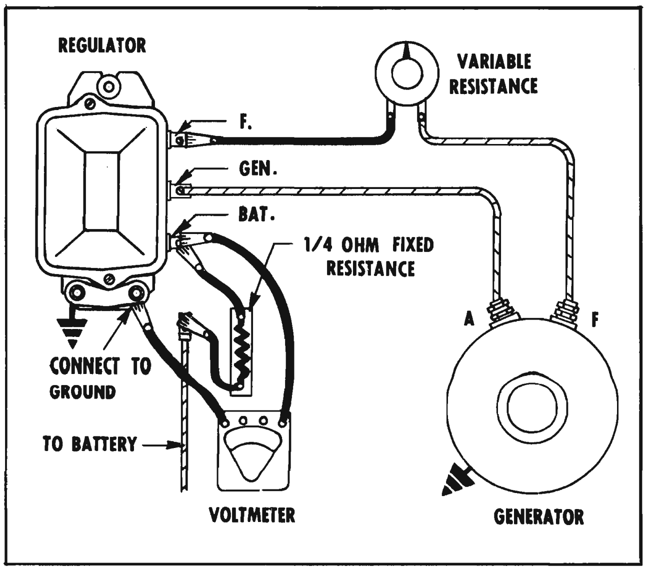


Fig. 11-24 Connections for Checking Voltage Regulator

5. If generator regulator tests are to be made leave ammeter and field rheostat in place, making sure rheostat is turned to the "OPEN" position.

TEST AND ADJUST REGULATOR

The regulator ambient temp should be noted and set according to Chart (Fig. 11-23).

Check the double contact voltage regulator as follows:

1. To properly adjust voltage regulator, battery must be fully charged to limit the charge rate to 1 to 10 amperes. If above 10 amps. insert a ¼ ohm resistor in series with the battery.

2. Connect a voltmeter from regulator "BAT" terminal to ground (Fig. 11-24).

3. Connect a 25 ohm (25 watt) variable resistance (which has an "open" position) between the regulator "F" (field) terminal and the field lead from the generator. (Connections to the variable resistance should be made so that all the resistance can be inserted into the circuit before opening the circuit.)

4. With variable resistance turned out, operate generator at medium speed so that the voltage regulator is operating on the upper set of contacts. Continue to operate for 15 minutes to establish operating temperature of voltage regulator. Regulator cover must be in place.

5. Cycle the generator by turning the variable resistance to the "open" position momentarily, then slowly cut all the resistance out. Regulator should be operating on upper contacts between 14.0 and 14.6 volts. This is the voltage setting of the regulator and may be adjusted in the conventional manner by turning the double slotted screw to adjust spring tension (Fig. 11-25).

6. Increase resistance slowly until regulator begins to operate on the lower contacts. The voltmeter should indicate a slight drop in voltage of 0.3 to 0.5 volts. This differential voltage may be increased by increasing the air gap and decreased by decreasing the air gap. Air gap adjustment should seldom be necessary on this regulator. However, if the adjustment screw is turned, it will also effect the setting of the regulator, so that the voltage adjustment procedure must be repeated. The regulator must be cycled each time before taking voltmeter readings, as previously described.

CAUTION: Never ground the generator field with this regulator connected to the generator. This will burn up the upper set of contact points of the voltage regulator.

When the "corrected" voltage regulator setting falls *within* the normal range given in the specifications and the battery condition has been *satisfactory, the voltage regulator setting should not be disturbed.*

When the "corrected" voltage regulator setting falls *inside or outside* the normal range given in the specifications but battery condition has been *unsatisfactory, tailor the voltage regulator setting* as follows:

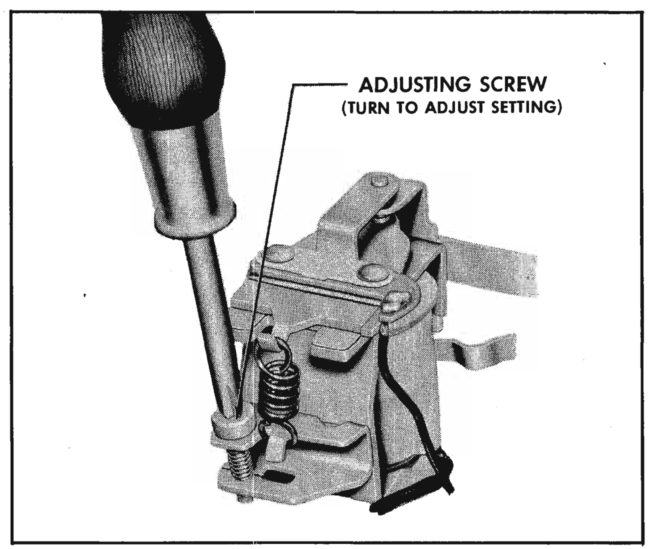


Fig. 11-25 Adjusting Voltage Regulator Setting

TAILOR VOLTAGE REGULATOR SETTING

The desired voltage regulator setting is that which keeps the battery in a satisfactory state of charge without causing excessive water usage (as evidenced by water consumption exceeding one ounce per cell each 1000 miles). In order to obtain the desired setting, tailor the voltage regulator setting.

a. When the battery uses too much water and the voltage setting is above the normal range, lower the "corrected" setting to 14.3 volts and check for an improved condition over a reasonable service period. When the battery uses too much water and the voltage setting is *within* the normal range, lower the setting 0.2 to 0.4 volt and check for an improved condition over a reasonable service period. Repeat until the battery remains charged with a minimum use of water.

b. When the battery is consistently undercharged and the "corrected" voltage setting is *below* the normal range, increase the "corrected" setting to 13.8-14.5 volts and check for an improved condition over a reasonable service period. When the battery is consistently undercharged and the "corrected" voltage setting is *within* the normal range, increase the setting 0.2 volt and check for an improved condition over a reasonable service period. Repeat until the battery remains charged with a minimum use of water.

NOTE: Avoid settings above 14.8 volts as these may cause damage to lights and other voltage sensitive equipment.

It rarely will be found necessary to use a voltage regulator setting outside the normal range in order to correct battery conditions. Batteries which do not respond to voltage regulator settings within the normal range usually will be found to be (1) batteries used in cars that are operated consistently at low speeds or in heavy traffic, or (2) batteries that have abnormal charging characteristics.

(1) When a car is operated consistently at low speeds or in heavy traffic the battery may remain undercharged even with a voltage regulator setting of 14.8 volts. Under these operating conditions, generator output and charging time may be insufficient to offset electrical loads on the battery. Periodic recharging of the battery from an outside source or replacement of the original generator with a special generator will be required in these cases.

(2) Batteries suspected of having abnormal charging characteristics should be removed for a complete check. If the checks outlined under BATTERY CHARGING indicate that the battery is still serviceable, a voltage regulator setting outside the normal range may be adopted provided it does not cause damage to lights or other voltage sensitive equipment or cause the battery to use water.

NOTE: Bulb life will be shortened by setting the voltage regulator above the specified voltage.

On new cars or on other applications where no battery history is available, any "corrected" voltage regulator setting found within the normal range may be considered satisfactory unless local conditions or subsequent battery performance indicate the need for tailoring the voltage regulator setting.

When the need for changing the voltage regulator setting has been established, proceed as follows: Remove the regulator cover and turn adjusting screw clockwise to raise the setting, counterclockwise to lower the setting. Before taking the new reading after each adjustment, replace the regulator cover as quickly as possible and cycle the generator.

CAUTION: Final adjustment should always be made by increasing spring tension to assure contact between the screw head and spring support (Fig. 11-26).

Sometimes the spring support does not follow the screw head as spring tension is decreased, and it will be necessary to bend the spring support to insure contact between the screw head and spring support. Failure of the voltage regulator unit to "hold" its setting usually results from (1) setting or checking the voltage regulator at other than operating temperature, and (2) the screw head not touching the spring support after final adjustment is completed.

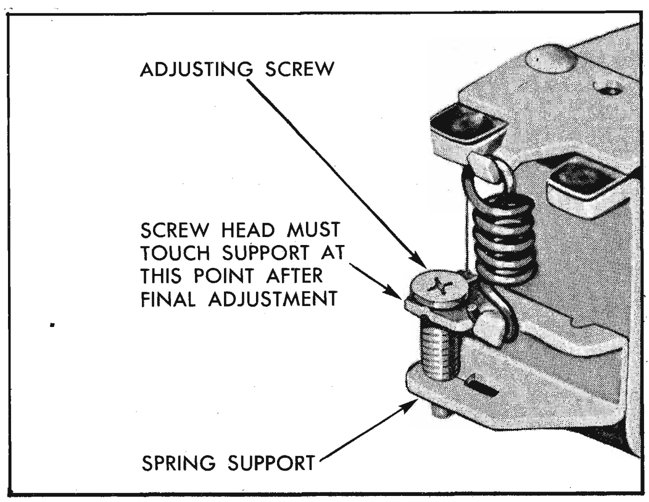


Fig. 11-26 Proper Relationship of Spring Support and Adjusting Screw

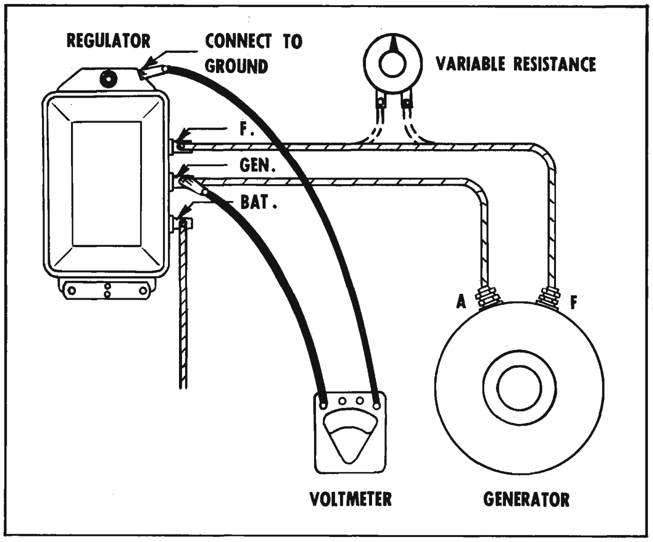


Fig. 11-27 Connections for Checking Closing Voltage

TEST AND ADJUST CUTOUT RELAY CLOSING VOLTAGE

NOTE: It is seldom necessary to check the closing voltage of the cutout relay as long as the relay functions to close and open the charging circuit. Any setting that fails within the specified range is satisfactory as long as the setting is at least 0.5 volt below the voltage regulator setting.

1. Connect a voltmeter between the regulator "GEN" terminal and ground (Fig. 11-27).

2. Check cutout relay closing voltage by *either of* the following methods.

a. Slowly increase generator speed and note the voltage at which the relay closes. Decrease generator speed and make sure the cutout relay contact points open.

b. Connect a 25 ohm, 25 watt variable resistor in the field circuit. Operate the generator at medium speed at maximum resistance (with all the resistance of the variable resistor turned in the circuit). Slowly decrease (turn out) the resistance, and note the voltage at which the contact points close. Slowly increase the resistance and make sure that the contact points open.

3. Adjust the closing voltage by turning the adjusting screw (Fig. 11-28). Turn the screw clockwise to increase the setting and counterclockwise to decrease the setting.

TEST AND ADJUST CURRENT REGULATOR

It is seldom necessary to check the setting of the current regulator unless the generator armature shows signs of overheating. Any setting that falls within the specified range is satisfactory.

1. Connect an ammeter into the charging circuit and connect voltmeter from "BAT" to ground (Fig. 11-29).

2. Turn on all accessory load (lights, radio, etc.) and connect any additional load such as carbon pile or bank of lights across the battery to drop system voltage to 12.5-13.0 volts.

3. Operate the generator at 1600 engine rpm for at least 15 minutes to establish operating temperature. The regulator cover must be in place.

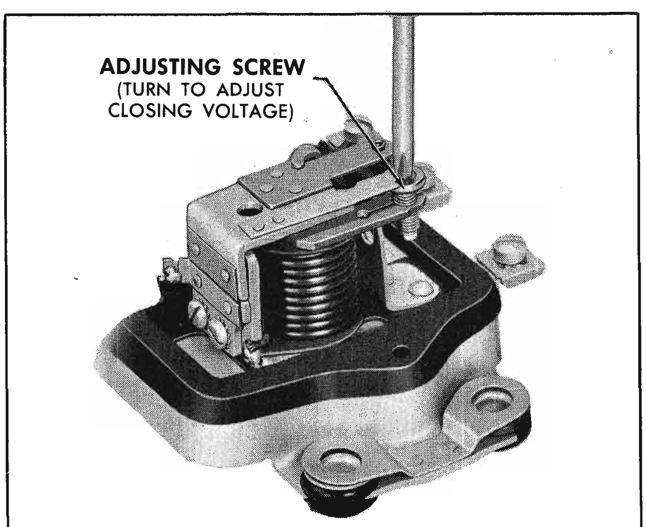


Fig. 11-28 Adjusting Closing Voltage

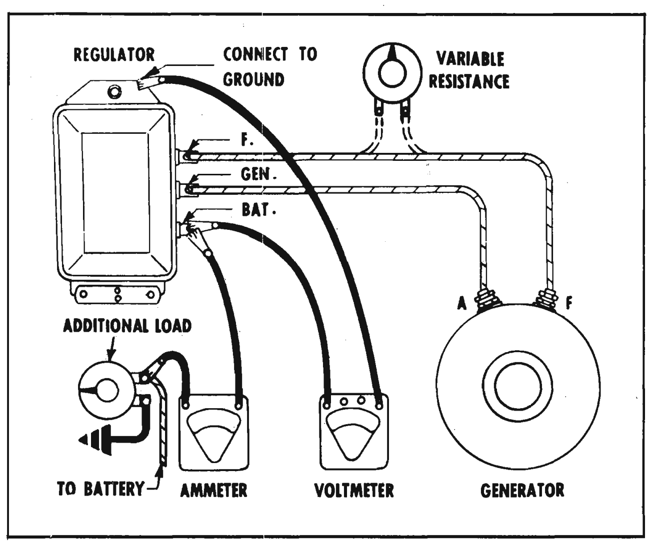


Fig. 11-29 Connections for Checking Current Regulator

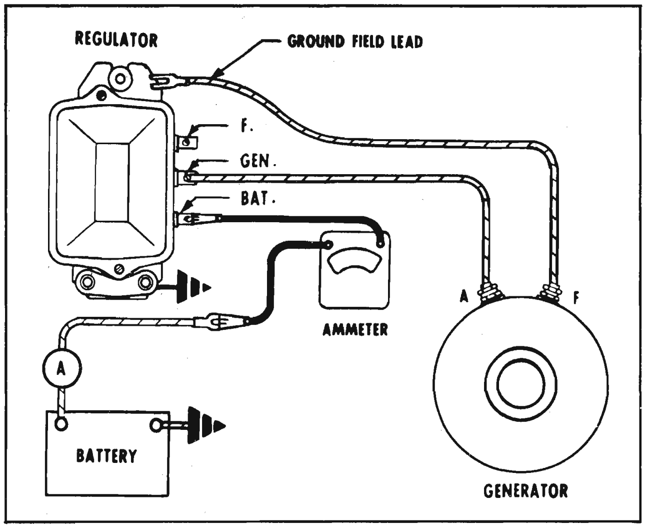


Fig. 11-30 Checking for Oxidized Points on Regulator

4. Cycle the generator by stopping engine, restarting and returning 1000 engine rpm and note the current regulator setting.

5. Adjust the current setting in the same manner as that used for adjusting the voltage regulator setting.

REGULATOR—REMOVE

While electrical adjustments are made with the regulator on the car as outlined under CHECKS AND ADJUSTMENTS ON CAR, it is necessary to remove the regulator for cleaning contact points and adjusting air gaps on the three regulator units.

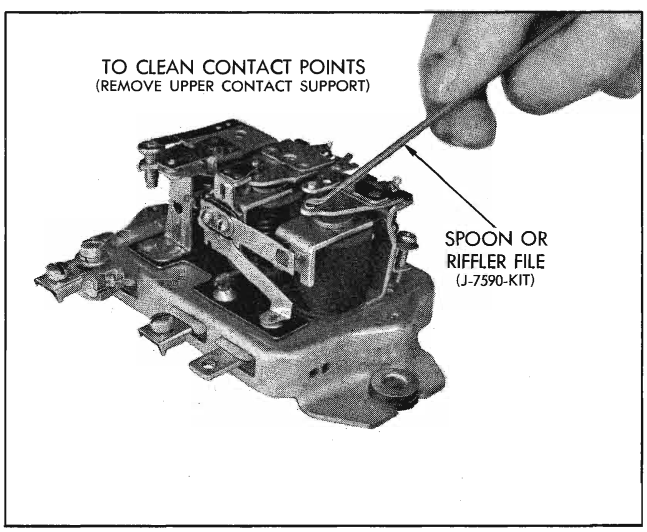


Fig. 11-31 Cleaning Regulator Contact Points

To remove the regulator it is merely necessary to disconnect the leads from the regulator and remove the regulator to dash mounting screws.

INSPECT AND ADJUST REGULATOR

CONTACT POINTS

The regulator contact points will not operate indefinitely without some attention. Eventually they will oxidize and cause lower generator output which may contribute to a discharged battery. A large majority of replaced regulators could be returned to service by cleaning the contact points and adjusting the electrical settings.

The large flat contact point located on the armature of the voltage regulator (Fig. 11-31), and on the upper contact support of the current regulator will usually require the most attention. It is not necessary to have a flat surface on this contact point but all oxides should be removed with a riffler file so that pure metal is exposed.

The small soft-alloy contact point, located on the upper contact support of voltage regulator and on the armature of current regulator for negative grounded regulator units, does not oxidize. This contact point may be cleaned with crocus cloth or other fine abrasive material followed by a thorough wash with clear carbon tetrachloride to remove any foreign material remaining on the contact surface.

CAUTION: Do not file contact points exessively. Never use sandpaper or emery cloth.

The contact points of the double contact regulator are all of soft-alloy material and should be cleaned by the method given above for the soft point of the standard voltage and current regulator.

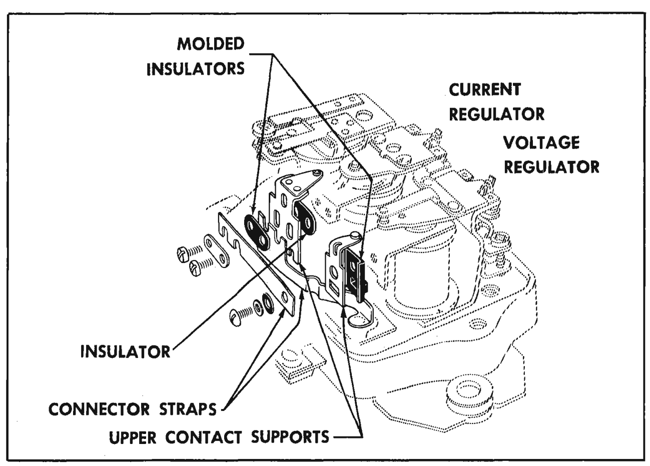


Fig. 11-32 Regulator Contact Mounting

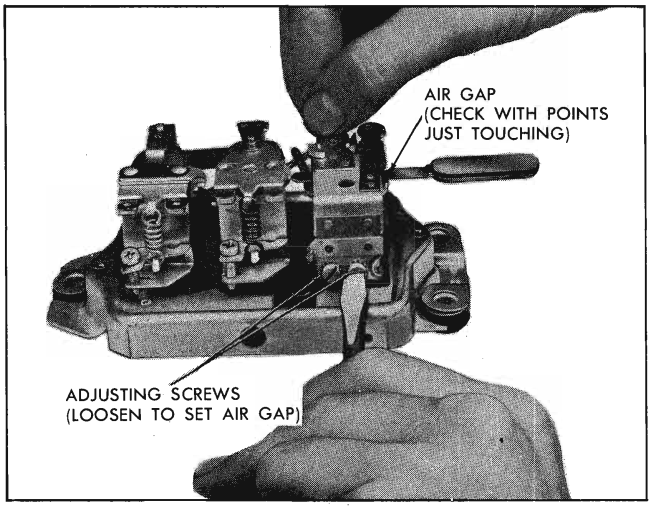


Fig. 11-33 Adjusting Cutout Relay

If it is desirable to replace the contact points of the regulator, reassemble regulator as shown in Fig. 11-32.

CUTOUT RELAY INSPECTION AND GAP ADJUSTMENT

1. Place fingers on armature directly above core and move armature directly down until points just close and then measure air gap between armature and center of core. Air gap should be .020″.

Check to see that both points close simultaneously; if not, bend spring finger so that they do. To adjust

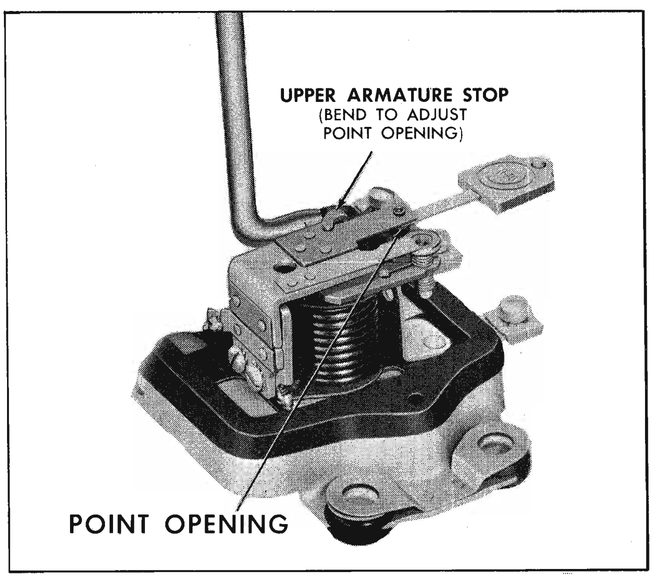


Fig. 11-34 Adjusting Cutout Relay Point Opening

air gap, loosen two screws at back of relay and raise or lower armature as required. Tighten screws securely after adjustment (Fig. 11-33).

2. Check point opening and adjust to .020″ by bending upper armature stop (Fig. 11-34).

VOLTAGE REGULATOR INSPECTION AND GAP ADJUSTMENT

1. With lower contacts touching, measure air gap between armature and winding core as shown in Fig. 11-35.

2. Adjust by loosening contact support bracket screw approximately 1/8 to 1/4 turn. Place a screwdriver in slot in contact support bracket and into the moulded insulator as shown in Fig. 11-35. Raise on the handle of the screwdriver to increase air gap and lower the handle of the screwdriver to lower air gap.

3. Retighten contact support bracket screw securely after adjustmest.

DUAL CONTACT VOLTAGE REGULATOR POINT OPENING

1. Push armature down until the lower set of contacts are just touching, measure point opening between upper set of contacts (Fig. 11-36). Point opening should be .016″.

2. Adjust by bending the upper contact arm on the armature assembly.

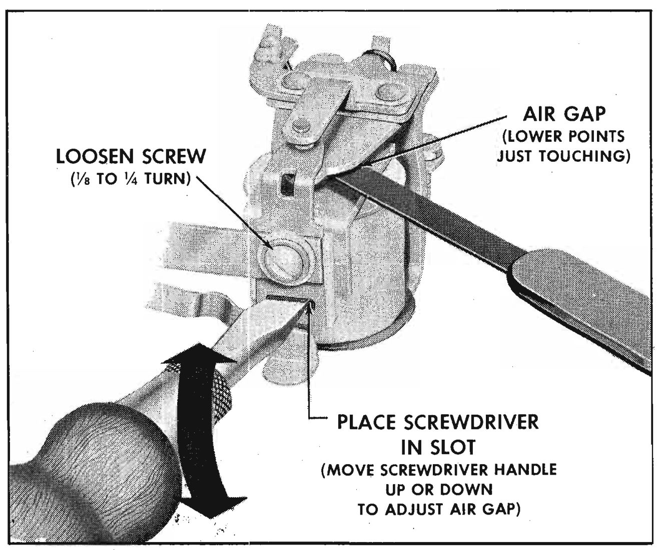


Fig. 11-35 Voltage Regulator Air Gap Check and Adjustment

REGULATOR—INSTALL

1. Install regulator and tighten mounting screws to approximately 15 lb. in. torque.

CAUTION: Do not tighten the mounting screws excessively as this will destroy the cushioning effect of rubber grommets in the mounting.

2. Attach "BAT", "GEN", "F" (field) and ground leads to regulator and polarize generator by momentarily touching a jumper wire to the "BAT" and "GEN" terminals on the regulator before starting the engine.

3. Check and adjust the electrical settings of the regulator on the car as outlined under CHECKS AND ADJUSTMENTS ON CAR.

REGULATOR TROUBLE DIAGNOSIS

Measure the voltage between the BAT terminal of the regulator and ground at (1) idle speed, and (2) medium engine speed. The voltage should be higher at a medium engine speed than it is at idle speed.

a. If it is not and the generator passes its tests above, make a complete check of the regulator.

b. If the voltage is higher at minimum engine speed than at idle the voltage regulator setting still may require adjustment if the battery remains undercharged or uses too much water.

NOTE: If zero voltage—check for blown fuse.

Neither headlight flicker nor ammeter pointer fluctuation is necessarily indicative of a defective regulator; flicker is normal in most cars, particularly during winter months when the electrical loads and charging circuit voltages are higher. Since the charging system voltage is controlled by the vibrating contact points, the contact points work much harder resulting in a greater degree of contact oxidation during winter driving than occurs in the warmer months of the year.

Regulator contact points are normally self-cleaning, but when operating rapidly the self-cleaning feature may not be sufficient to remove all the oxide accumulation and, therefore, the points will not conduct properly. Thus, regulator system voltage drops momentarily until the contact points do clean themselves, and its is during this time that the operator notices the car headlights flicker, the ammeter pointer flutters or both.

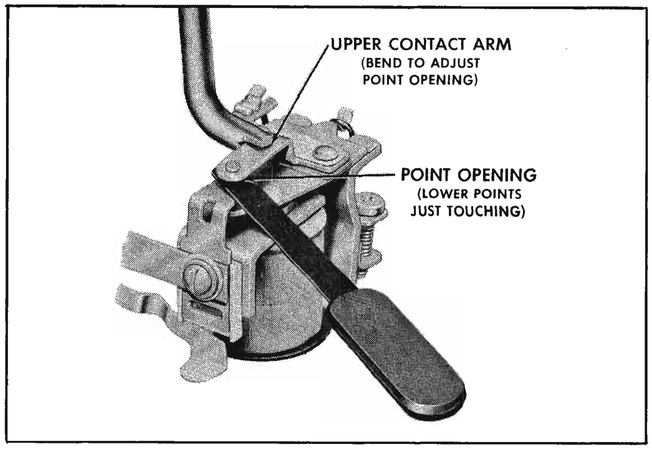


Fig. 11-36 Point Opening Adjustment

Before replacing a voltage regulator which is assumed to be defective because of headlight flicker or ammeter pointer flutter, make sure:

a. Battery cable and other electrical connections in the charging circuit are clean and secure.

b. That apparent malfunction is not merely due to a light oxide accumulation on the contact points.

c. Voltage regulator is properly cleaned and adjusted.

Cleaning regulator contact points will minimize headlight flicker or ammeter pointer flutter temporarily the same as installing a new regulator; but, under cold weather operating conditions, neither cleaning of points or installation of a new voltage regulator will assure that flicker or pointer fluctuation will not recur.

AMMETER

DESCRIPTION

The ammeter is connected in the charging circuit and indicates whether current is flowing into or out of the battery. While the ammeter indicates whether or not the battery is being charged, it is not intended to indicate the amount and no attempt should be made to interpret the ammeter reading in amperes.

Due to the vibrating action of the contact points in the current and voltage regulator units, the ammeter needle may oscillate under certain operating conditions. Unless the regulator has oxidized contact points (see CHECK FOR OXIDIZED REGULATOR CONTACT POINTS), *this oscillation* does not indicate any regulator trouble and it *must not be used alone as a basis for replacing the regulator.*

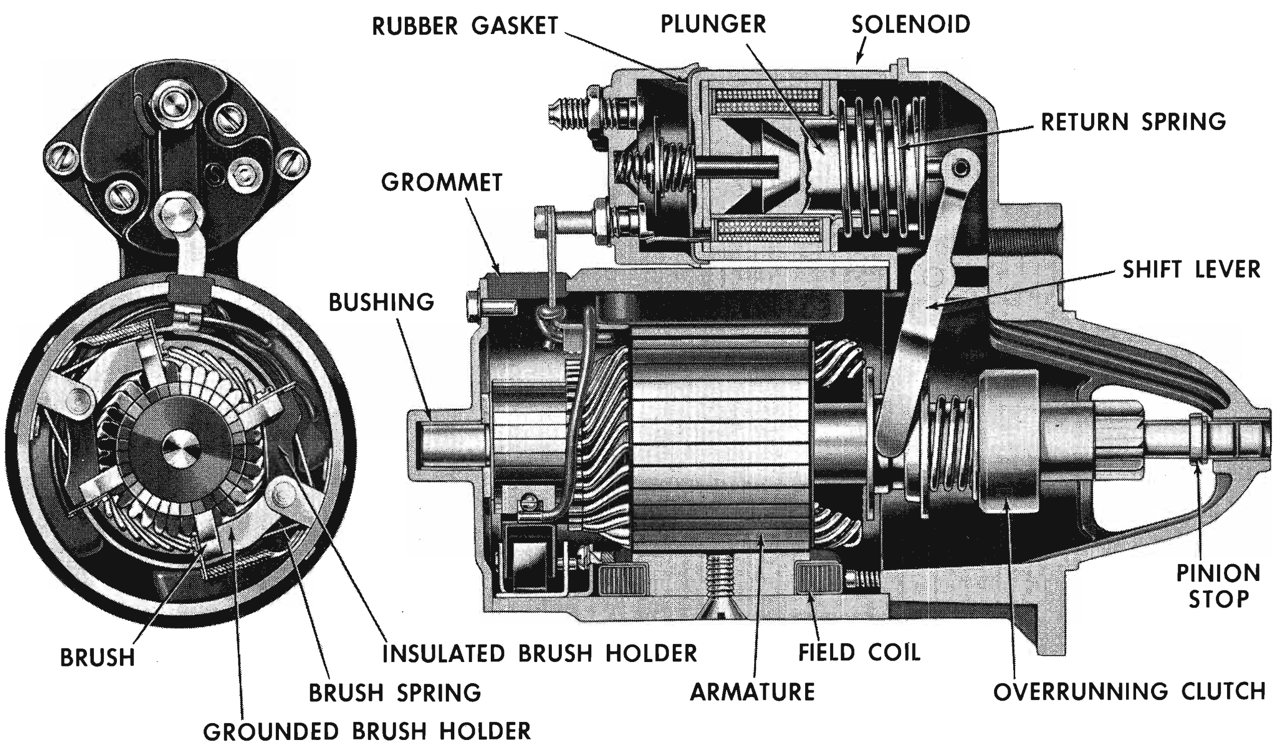


Fig. 11-37 Cross Section of Starter Motor and Solenoid Assembly—Synchro-Mesh Transmission

STARTING CIRCUIT

GENERAL DESCRIPTION

The starting circuit includes the cranking motor, solenoid, and battery. The "enclosed shift lever" cranking motor (Fig. 11-37) is a 12-volt extruded frame type unit.

The cranking motor used on the premium fuel engine has a heavier armature and stronger field than that used on the standard fuel engine. This gives improved starting torque where needed on the higher compression ratio engine. The drive end housing on both cranking motors is extended to enclose the entire shift lever mechanism and plunger protecting them from exposure to road dirt, icing conditions, and splash.

The solenoid is flange mounted onto the drive end housing and is sealed to the drive housing by a sealing compound. The shift lever return spring is a compression type and is located inside the solenoid case. Shunt coil and series fields are connected directly to the solenoid terminal. A rubber grommet assembled in frame around the coil leads insulates the bar from ground and also prevents dirt, water, and oil from entering the motor.

Both motors have four pole shoes and a compound field. Three field coils connected in series from the solenoid to the insulated brushes, and one shunt coil connected from the solenoid to ground are provided on the synchro-mesh. Two field coils connected in series from the solenoid to the insulated brushes and two shunt coils connected from the solenoid to ground are provided on the starter motor for premium fuel engines.

A small diameter overrunning clutch type of drive is used to engage the cranking motor pinion with the flywheel. The overrunning action of the clutch protects the cranking motor armature from excessive speed when the engine fires. The flange mounted solenoid switch operates the overrunning clutch drive by means of a linkage to shift lever. When the control switch is closed, the solenoid is energized, shifting the cranking motor pinion into mesh with the flywheel. The main contacts of the solenoid are then closed so that battery current is delivered to the cranking motor.

The armature shaft and clutch have mating spiral splines which prevent transmission of full cranking power until the clutch pinion is fully engaged in the flywheel ring gear. A special "assist" spring is located around the armature shaft between the end fiber of the armature and the collar of the clutch drive. This "assist" spring aids the solenoid in overcoming the return spring force in the first movement of the clutch along the armature shaft. A pinion stop, consisting of a snap ring and retainer, and a thrust collar assembled on the armature shaft, takes all the end thrust.

The brush rigging has brush arm supports attached directly to the extruded section of the field frame. One ground brush and one insulated brush are pivoted from the same brush holder support; thus only two brush holder supports are required. A single ribbon type spring applies tension to each pair of brushes.

PERIODIC SERVICE

No periodic lubrication of the starting motor or solenoid is required. The motor and brushes cannot be inspected without disassembling the unit so no service is required on the motor or solenoid between overhaul periods.

CHECKS AND ADJUSTMENTS ON CAR

Although the starting motor cannot be checked against specifications on the car, a check can be made for excessive resistance in the cranking circuit. To check for excessive resistance in the cranking circuit, measure:

1. The voltage drop, during cranking, between the insulated battery post and the battery terminal of the solenoid.

2. The voltage drop, during cranking, between the battery terminal of the solenoid and the motor terminal of the solenoid.

3. The voltage drop, during cranking, between the grounded battery post and the starting motor frame.

CAUTION: To prevent the engine from firing during the above checks, disconnect the primary lead to the distributor, either at the distributor or at the coil.

If the voltage drop for any one of the above three checks exceed 0.2 volt, excessive resistance is indicated in that portion of the cranking circuit being checked. Locate and eliminate the cause for any excessive voltage drop in these circuits in order to obtain maximum efficiency of the cranking system.

When the solenoid fails to pull in, the trouble may be due to excessive voltage drop in the solenoid control circuit. To check for this condition, close the starting switch and measure the voltage drop between the battery terminal of the solenoid and the switch terminal of the solenoid. Excessive resistance in the solenoid control circuit is indicated and should be corrected if the voltage drop exceeds 3.5 volts.

If the voltage drop does not exceed 3.5 volts and the solenoid does not pull in, measure the voltage available at the switch terminal of the solenoid. If the solenoid does not feel warm, it should pull in whenever the voltage available at the switch terminal is 7.7 volts or more (when the solenoid feels warm, it will require a somewhat higher voltage to pull in).

STARTING MOTOR—REMOVE

1. Disconnect battery to starting motor cable from battery post.

2. Remove rubber cover from junction block on left fender skirt by pulling straight off.

3. Disconnect junction block to solenoid wires from junction block noting which terminal each wire is removed from.

4. Remove battery cable from clip on junction block.

5. Raise front of car and place car stand under front suspension.

6. Remove engine side apron from below starting motor.

7. Pull battery cable and solenoid wire loom down so they hang free of surrounding parts.

8. Remove starting motor mounting screws and remove starting motor with cable and solenoid wire loom.

9. Remove wires from solenoid and cable from clamp or solenoid bracket.

STARTING MOTOR—DISASSEMBLE

1. Disconnect the field straps from terminal on solenoid.

2. Remove through bolts.

3. Remove commutator end frame, field frame assembly and armature assembly from drive housing.

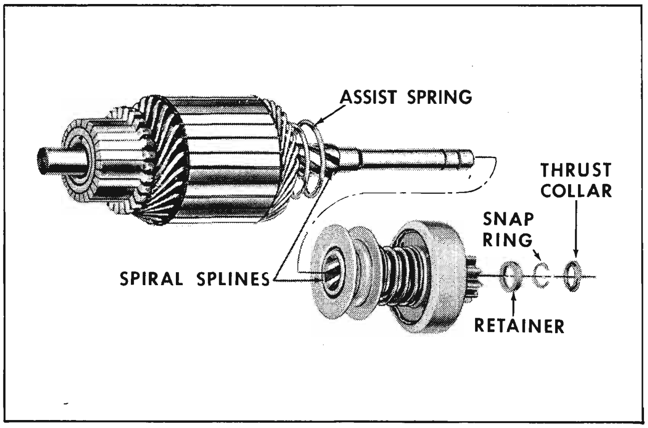


Fig. 11-38 Armature and Overrunning Clutch Assembly—Exploded View

4. Remove overrunning clutch from armature shaft as follows:

a. Slide thrust collar (Fig. 11-38) off end of armature shaft.

b. Slide a standard half inch pipe coupling or other metal cylinder of suitable size (an old pinion of suitable size can be used if available) onto shaft so end of coupling or cylinder butts against edge of retainer (Fig. 11-39). Tap end of coupling with hammer, driving retainer towards armature and off snap ring.

c. Remove snap ring from groove in shaft using pliers or other suitable tool. If snap ring is too badly distorted during removal it will be necessary to use a new one when reassembling clutch.

d. Slide retainer and clutch from armature shaft.

CLEAN, INSPECT AND TEST STARTING MOTOR

1. Clean all starting motor parts, but *do not use grease dissolving solvents for cleaning the overrunning clutch, armature, and field coils* since such a solvent would dissolve the grease packed in the clutch mechanism and would damage armature and field coil insulation.

2. To check condition of solenoid contacts care must be taken in removing the cover from the solenoid.

a. Remove *only* nuts from the motor solenoid terminal and switch "S" terminal and the two attaching screws, then remove cover.

CAUTION: These terminal studs have welded lead connections—do not twist during removal of nuts.

b. If the contacts are slightly burned or dirty, the contacts should be cleaned. When the contacts are badly burned, the burned parts should be replaced.

c. When reassembling the cover on the solenoid make sure the terminal studs are properly positioned in cover before installing the nuts. The cover gasket must be centered under the cover to insure proper sealing.

3. Test overrunning clutch action. The pinion should turn freely in the overrunning direction. Check pinion teeth to see that they have not been chipped, cracked, or excessively worn. Replace assembly if necessary. Badly chipped pinion teeth may indicate chipped teeth on the ring gear. This should be checked under such conditions and replaced if necessary.

4. Check brush holders to see that they are not deformed or bent, and that they properly hold brushes against the commutator.

5. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly in the bushing. If the bushing is worn, it should be replaced.

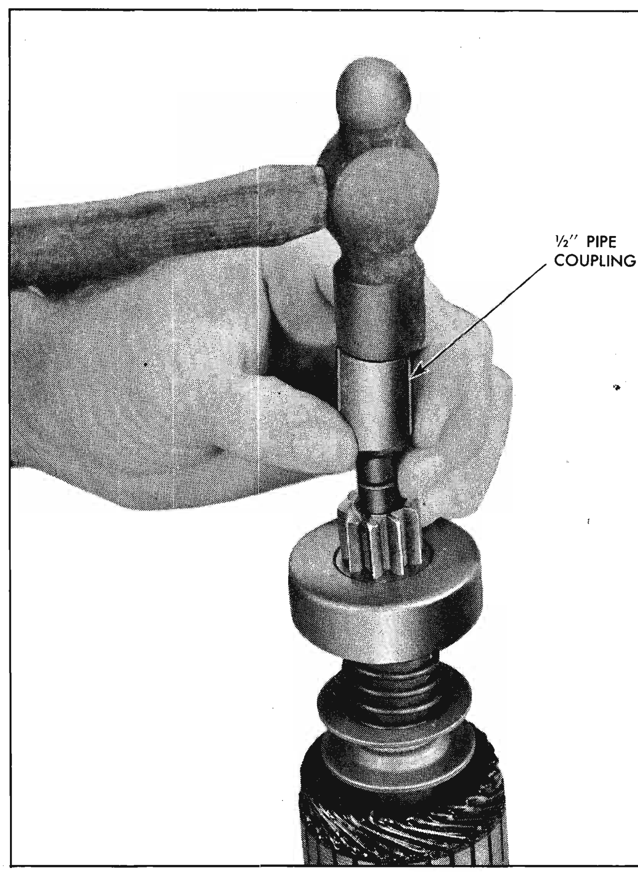


Fig. 11-39 Driving Retainer Off Snap Ring

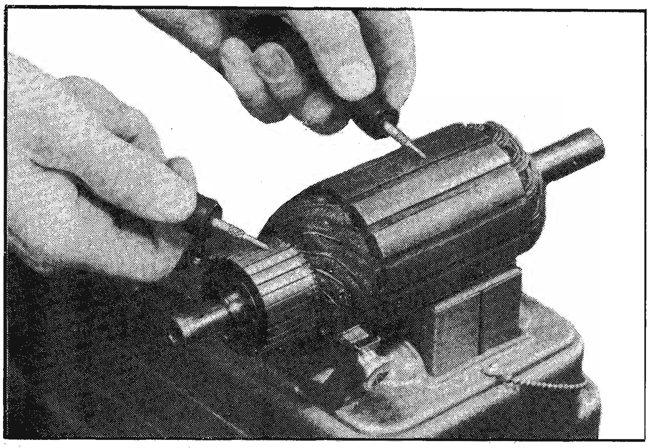


Fig. 11-40 Testing Armature for Ground

6. Inspect armature commutator. If commutator is rough or out of round, it should be turned down and undercut. Inspect the points where the armature conductors join the commutator bars to make sure that it is a good firm connection. A burned commutator bar is usually evidence of a poor connection.

7. If test equipment is available, perform the following tests:

a. Check the armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Recheck after cleaning between the commutator bars. If saw blade still vibrates, replace the armature.

b. Using 110-volt test lamp, place one lead on the armature core or shaft and the other on the commutator (Fig. 11-40). If the lamp lights, the armature is grounded and must be replaced.

c. Using a 110-volt test lamp, place one lead on each end of the field coils connected in series (Fig. 11-41). If the lamp does not light, the field coils are open and will require repair or replacement.

d. Using a 110-volt test lamp, place one lead on the connector strap and the other on the field frame (Fig. 11-42). Disconnect the shunt coil or coils ground before this check is made. If the lamp lights, the field coils are grounded and the defective coils will require repair or replacement.

e. Using a 110-volt test lamp, place one lead on each end of the shunt coil or coils (Fig. 11-43). Disconnect the shunt coil grounds before this check is made. If the lamp does not light, the shunt coil is open and will require replacement.

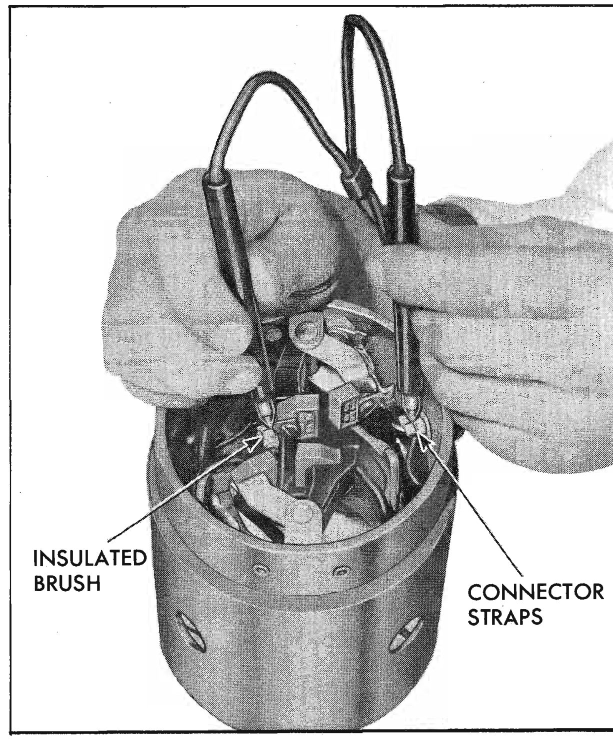


Fig. 11-41 Testing Field Coils for Open Circuit

f. Check the current draw of the solenoid windings. To check the current draw of the hold-in winding, connect a variable source of voltage (in series with an ammeter) to the switch terminal of the solenoid and ground. To check the current

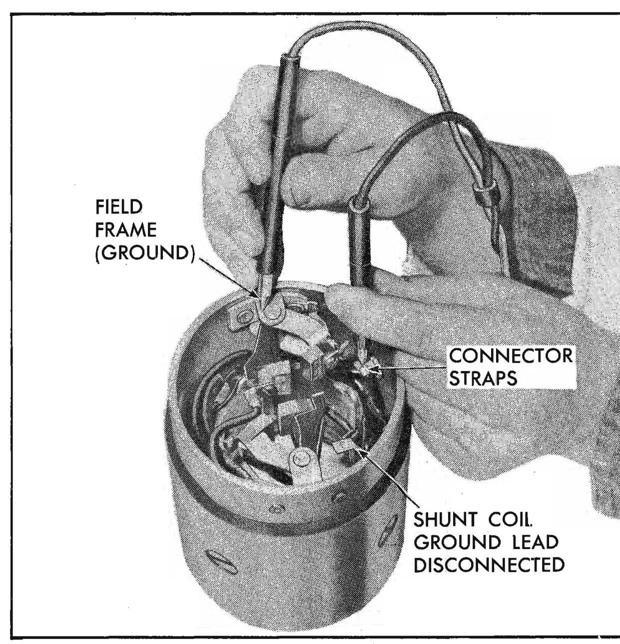


Fig. 11-42 Testing Field Coils for Ground

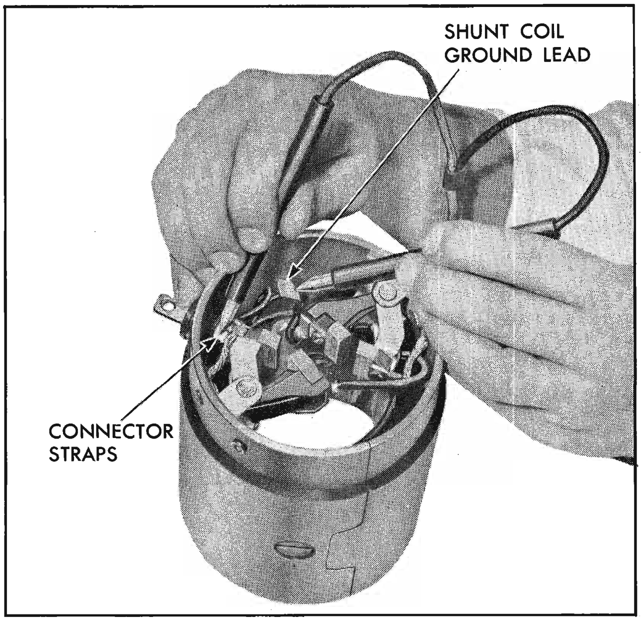


Fig. 11-43 Testing Shunt Coil for Open Circuit

draw of both windings, ground the solenoid motor terminal, and connect a source of voltage (in series with an ammeter) to the switch terminal of the solenoid and ground.

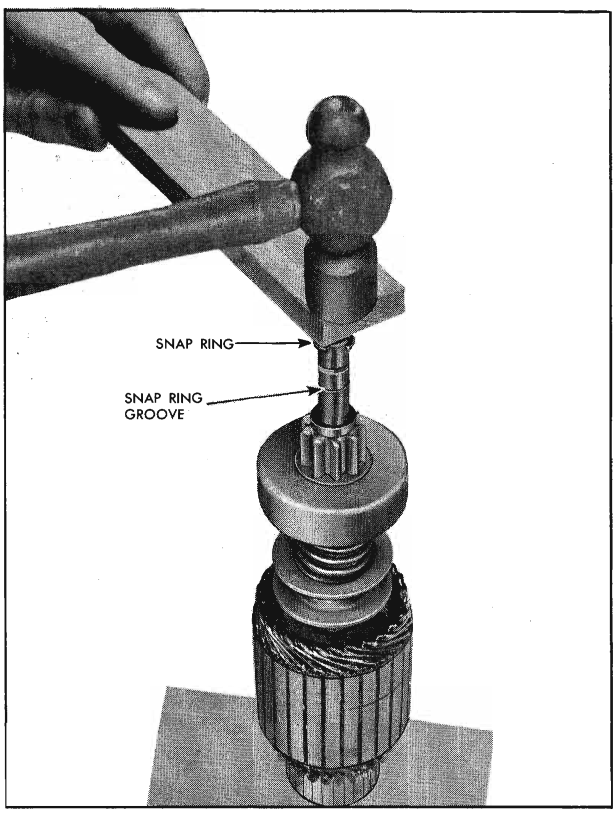


Fig. 11-44 Forcing Snap Ring Onto Armature Shaft

CAUTION: Either of the above checks must be completed in a minimum length of time to prevent heating of the solenoid windings. Heating will cause the current draw readings to be below the specifications which are based on a temperature of 80° F. (See SPECIFICATIONS).

STARTING MOTOR—ASSEMBLE

1. Assemble overrunning clutch to armature shaft as follows:

a. Lubricate drive end of armature shaft with light engine oil.

b. Slide clutch assembly onto armature shaft with pinion outward.

c. Slide retainer onto shaft with cupped surface facing end of shaft.

d. Stand armature on end on wood surface wtih commutator down. Position snap ring on upper end of shaft and hold in place with a block of wood. Hit wood block a blow with hammer forcing snap ring over end of shaft. Slide snap ring past the grease groove to the snap ring groove (Fig. 11-44).

e. Assemble thrust collar on shaft with shoulder next to snap ring (Fig. 11-45).

f. Place armature flat on work bench, and position retainer and thrust collar next to snap ring.

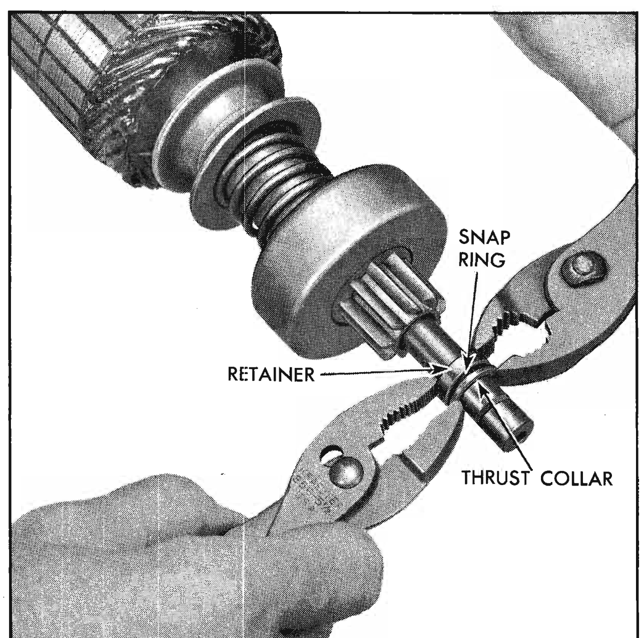


Fig. 11-45 Forcing Retainer Over Snap Ring

Then, using two pairs of pliers at same time (one pair on either side of shaft), grip retainer and thrust collar and squeeze until retainer is forced over snap ring (Fig. 11-45).

2. Place four or five drops of light engine oil in drive housing bushing. Make sure thrust collar is in place against snap ring and retainer and slide armature and clutch assembly into place in drive housing, engaging shift lever with clutch.

3. Position field frame over armature, apply sealing compound between frame and solenoid case. Position frame against drive housing using care to prevent damage to brushes.

4. Place four or five drops of light engine oil in bushing in commutator end frame. Place leather thrust washer on armature shaft and slide commutator end frame onto shaft.

5. Install through bolts and tighten securely.

6. Reconnect the field coil leads to the motor solenoid terminal.

7. Check pinion clearance as follows:

Connect a voltage source of approximately 6 volts (three battery cells in series or 6-volt battery) between the solenoid switch terminal and ground.

CAUTION: Do not connect the voltage source to the ignition coil terminal of the solenoid. Do not use a 12-volt battery instead of the 6 volts specified, as this will cause the motor to operate. As a further precaution to prevent motoring, connect a heavy jumper lead from the solenoid motor terminal to ground. After energizing the solenoid with the clutch shifted forward, push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gauge (Fig. 11-46).

The clearance between the end of the pinion and the pinion stop, with the pinion in cranking position, should be .010″-.140″. When the clearance is out of these limits it may indicate excessive wear of solenoid linkage, shift lever yoke buttons, or improper assembly of the shift lever mechanism. When shift lever mechanism is correctly assembled, the pinion clearance will fall within the specified limits.

8. Test the free speed of the starting motor. To make this test, connect a battery in series with an ammeter to the starting motor terminal and ground. Use an r.p.m. indicator to determine the speed reached by the starting motor (see SPECIFICATIONS). Failure of the starting motor to perform according to specifications may be due to tight or dirty bearings, or high resistance connections.

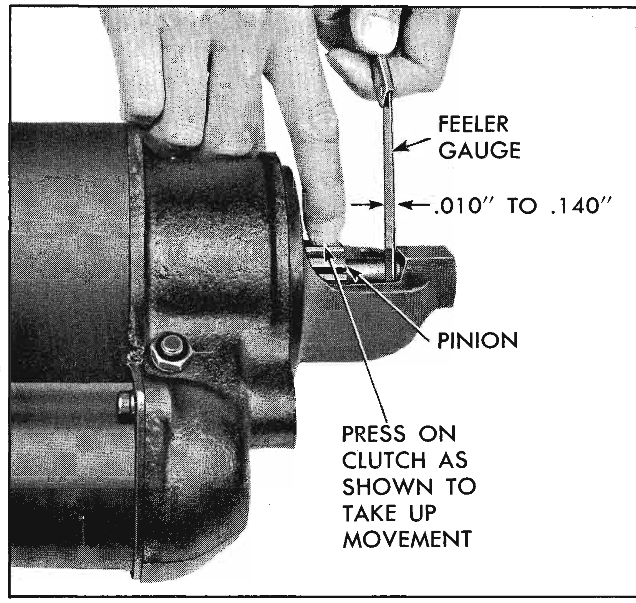


Fig. 11-46 Measuring Pinion Clearance

STARTING MOTOR—INSTALL

1. Connect battery cable and solenoid wires to solenoid as shown in Fig. 11-47.

NOTE: Connect purple (or violet) wire to terminal marked "S".

2. Install starting motor on engine and tighten mounting screws securely.

3. Push cables up where they can be reached from above car, then lower car.

Fig. 11-47 Wires and Cables Connected to Solenoid

4. Route solenoid to junction block wire loom around cable guide on cover of power brake unit (if so equipped), beneath steering column and connect wires to junction block. Connect wires to terminals which have matching wires on opposite side. Replace rubber cover on junction block by pressing firmly onto terminal studs.

5. Route battery cable around cable guide on cover of power brake unit (if so equipped), beneath steering column and through clamp on fender skirt junction block. Bend clamp over cable securely and connect cable to battery post.

STARTING MOTOR CIRCUIT TROUBLE DIAGNOSIS

CAUTION: Specific gravity of battery must be 1.215 or higher before making the following tests.

1. If the solenoid does not pull in, measure the voltage between the switch "S" terminal of the solenoid and ground with the starting switch closed.

CAUTION: If the solenoid feels warm, allow to cool before checking. If the voltage is less than 7.7 volts, check for excessive resistance in the solenoid control circuit. If the voltage exceeds 7.7 volts, remove the starting motor and check (1) solenoid current draw, (2) starting motor pinion clearance, and (3) freedom of shift lever linkage.

2. If the solenoid "chatters" but does not hold in, check the solenoid for an open "hold-in" winding.

3. If motor engages but does not crank or cranks slowly, check for excessive resistance in the external cranking circuit or within the starting motor.

IGNITION CIRCUIT

GENERAL DESCRIPTION

The ignition circuit (Fig. 11-48) includes the distributor, ignition coil, ignition resistance, ignition switch, spark plugs, battery, and the resistance type secondary cables.

The distributor and spark plugs are the only ignition system components that require periodic service. The remainder of the ignition system requires only periodic inspection to check operation of the units, tightness of the electrical connections, and condition of the wiring. When checking the coil, test with a reputable tester.

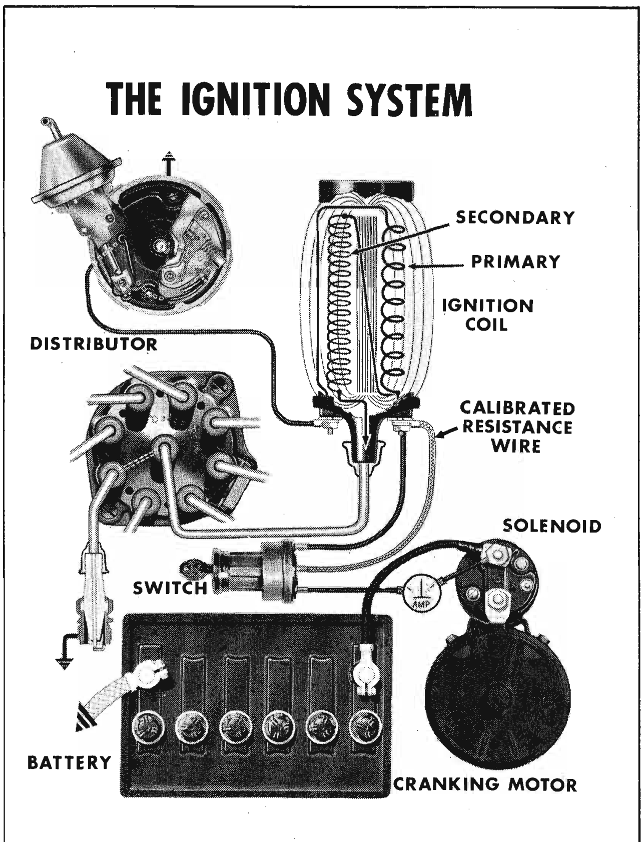


Fig. 11-48 Ignition Circuit Schematic

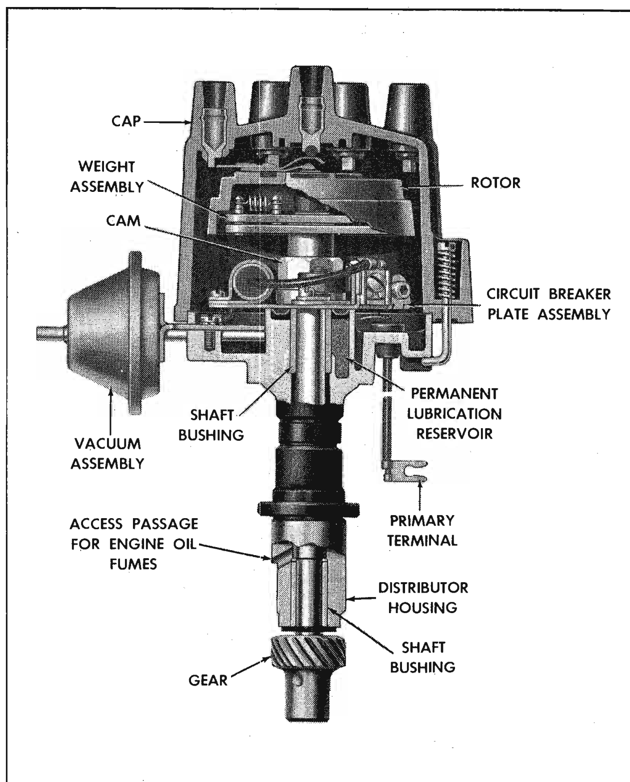


Fig. 11-49 Cross Section of Distributor

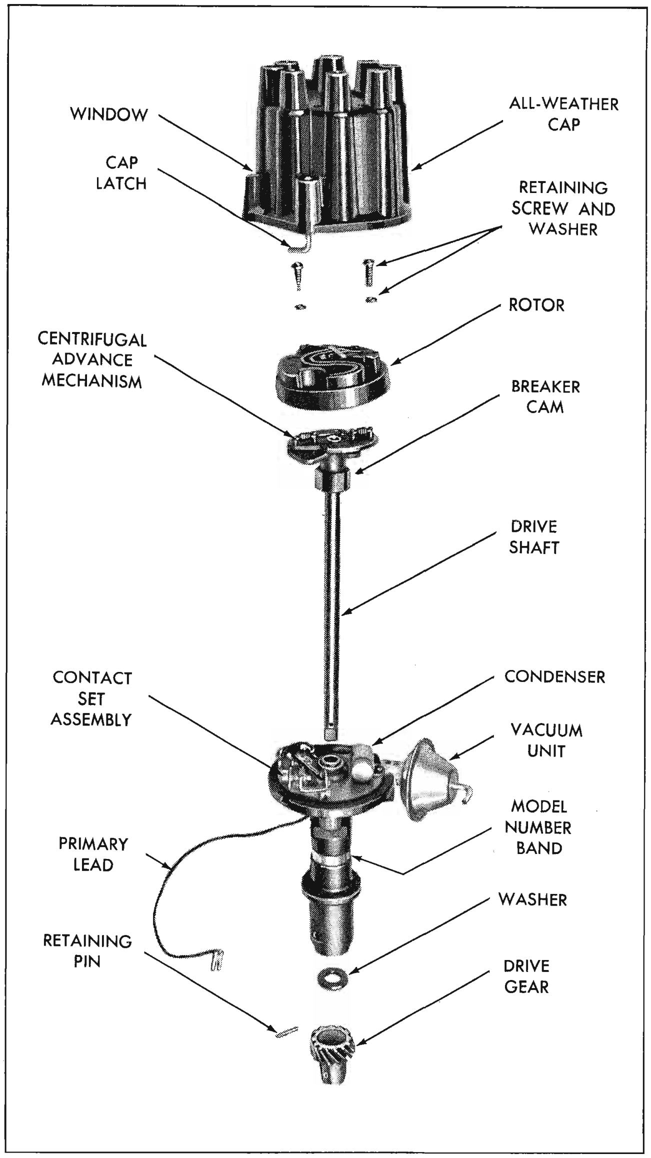


Fig. 11-50 Distributor—Partially Exploded

DISTRIBUTOR

DESCRIPTION

The external adjustment type distributor is shown in Figs. 11-49 and 11-50. The cap has a window for adjusting dwell angle with the cap in place. Adjustment of dwell can be made on the car while the engine is operating or while the distributor is being operated on a distributor tester. The centrifugal advance components have been relocated above the breaker plate and cam. This arrangement allows the cam and the breaker lever to be located directly adjacent to the upper bearing for increased stability. The breaker plate is of one piece construction and rotates on the outer diameter of the upper bearing. The plate is held in position by a retainer clip in the upper shaft bushing. The molded rotor serves as a cover for the centrifugal advance mechanism. The vacuum control unit is mounted under the movable breaker plate to the distributor housing. The contact set is attached to the movable breaker plate. The service replacement contact set has the breaker lever spring tension and point alignment preadjusted at the factory and is serviced as one complete assembly. Only the point opening (dwell angle) requires adjustment after replacement.

The vacuum advance on 315 Hydra-Matics and all Synchro-Mesh cars is connected directly to manifold vacuum so there is full vacuum advance at idle. During acceleration or when the engine is pulling heavy, the vacuum is not sufficient to actuate the diaphragm and the movable plate is held in the retarded position by a calibrated return spring which bears against the vacuum diaphragm.

Cars equipped with model 10 Hydra-Matics do not have distributor vacuum at idle but operate similarly above idle speed.

The centrifugal advance mechanism consists of a contrifugal advance cam actuated by two centrifugal weights controlled by springs. As the speed of the distributor shaft increases with engine speed, the weights are thrown outward against the pull of the springs. This advances the breaker arm causing the contact points to open earlier and thus advancing the spark.

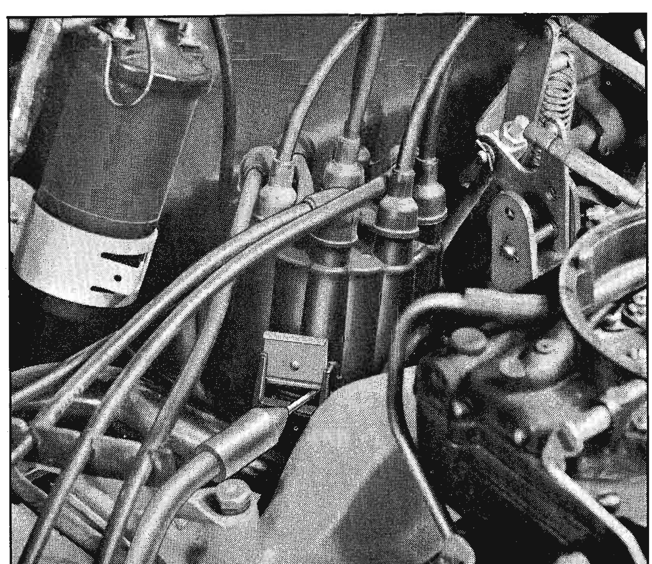


Fig. 11-51 Adjusting Dwell Angle

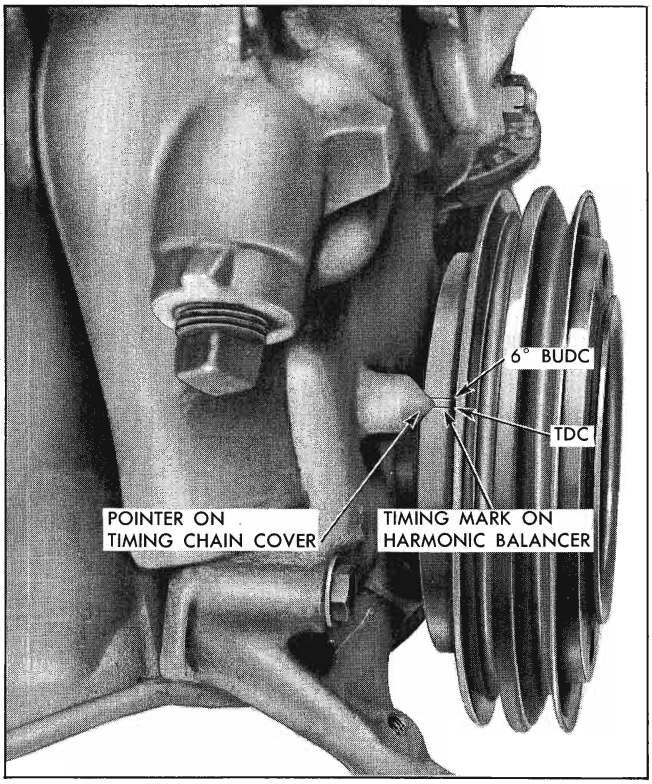


Fig. 11-52 Timing Marks and Pointer

PERIODIC SERVICE

A permanent lubricant reservoir is built into the distributor housing to lubricate the upper end of the shaft. No periodic lubrication is required.

When replacing the contact set assembly apply a trace of petrolatum to the breaker cam. No other lubrication is required. The movable breaker plate is lubricated by lubricant from the upper shaft bushing.

This distributor also requires periodic inspection of cap and rotor, wiring, and point condition, and a check for correct spark timing. This should be done at each tune-up and at least every spring and fall.

ADJUSTMENTS ON CAR

ADJUSTMENTS OF DWELL ANGLE ON THE CAR

1. With the engine operating, raise the window provided in the cap.

2. Insert a "Hex" type wrench into the head of the adjusting screw as shown in Fig. 11-51.

3. Turn screw to adjust point opening by one of the following methods:

PREFERRED METHOD

Turn the adjusting screw until the 28°-32° dwell is obtained as measured by a dwell meter. (When using dwell meter be sure to test distributor resistance before testing dwell angle.)

NOTE: Providing the dwell meter is accurate and is used correctly, points can be set very accurately. Several design features such as the use of the upper shaft bushing as a bearing for the breaker plate, and the construction of the advance mechanism have made this possible.

ALTERNATE METHOD

Turn the adjusting screw (clockwise) until the engine begins to misfire. Then turn the screw one-half turn in the opposite direction (counterclockwise). This will give the proper dwell angle.

IGNITION TIMING

Correct timing of the spark, with relation to engine piston position, is made in the shop by use of a power timing light and timing marks on the harmonic balancer (Fig. 11-52).

It is imperative due to full vacuum advance at idle to disconnect the distributor vacuum advance line before setting ignition timing.

At the time the spark is adjusted, the general appearance of the breaker points should be observed. If a smudge line appears on the point support and breaker plate just beneath the points, burned points (from oil or crankcase vapor between the points)

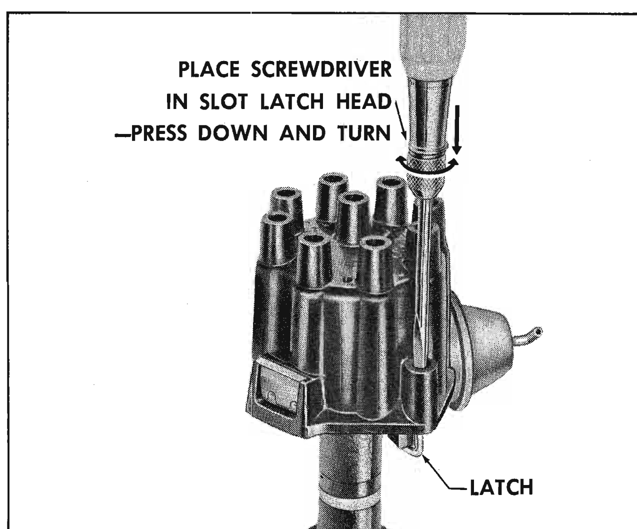


Fig. 11-53 Removing Distributor Cap

are very probable. Points which have gone several thousand miles will have a rough surface, but this does not mean the points are worn out. The roughness between points matches so that a large contact area is maintained and the points will continue to provide satisfactory service. If dirt or scale are present the points should be cleaned with a few strokes of a clean, fine-cut, contact file. Do not attempt to remove all roughness or dress the point surfaces down smooth. Never use emery cloth or sandpaper to clean points. If points are burned or badly pitted they should be replaced and the cause of this condition found and corrected. If this is not done the new points will also burn and pit in a short time.

Adjust ignition timing as follows:

1. Adjust breaker point gap as outlined under ADJUSTMENT OF DWELL ANGLE ON THE CAR.

It is imperative due to full vacuum advance at idle to disconnect the distributor vacuum advance line before setting ignition timing.

2. Connect power timing light.

3. Loosen distributor clamp screw and rotate distributor until power timing light shows that pointer is at 6° BTDC mark on harmonic balancer (see SPECIFICATIONS.) Tighten distributor clamp screw to 12-15 lb. ft. torque.

DISTRIBUTOR—REMOVE

1. Disconnect distributor-to-coil primary wire.

2. Remove distributor cap.

NOTE: Unlatch cap by using screwdriver to disengage latches as shown in Fig. 11-53.

3. Crank engine so rotor is in position to fire No. 1 cylinder and timing mark on harmonic balancer is indexed with pointer.

4. Remove vacuum line from distributor.

5. Remove distributor clamping screw and hold-down clamp.

6. Remove distributor and distributor to block gasket. It will be noted that the rotor will rotate as the distributor is pulled out of the block. Note the relationship of the rotor and the distributor housing after removal so that the rotor can be set in the same position when the distributor is being installed.

NOTE: Always set distributor in upright position so oil from distributor shaft will not run out onto breaker plate and points.

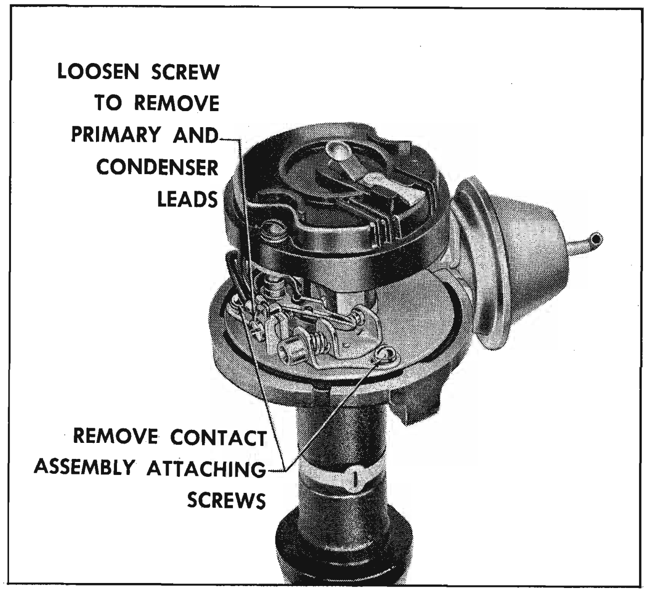


Fig. 11-54 Distributor Contact Details

7. If distributor cap requires removal for purpose of cleaning and inspection, mark position on cap tower for lead to No. 1 cylinder. This will aid in rapid reinstallation of leads on cap in right order.

INSPECT AND CHECK DISTRIBUTOR

With the distributor removed from the vehicle it is advisable to place the distributor in a distributor testing machine or synchroscope. When mounting distributor in tester, first secure the gear in the drive mechanism, then push distributor housing down toward the gear to take up end play between the gear and housing, and finally secure the housing in the tester. Test the distributor for variation of spark, correct centrifugal and vacuum advance, and condition of contacts. This test will give valuable information on the distributor condition and indicate parts replacement which may be necessary.

When checking the distributor condenser it should be checked with a reliable make of condenser tester. The condenser should be checked for the following properties: (1) insulation resistance (or leakage), (2) series resistance, (3) breakdown test, (4) capacity (mfd.).

REPLACE DISTRIBUTOR CONTACT SET

The contact point set is replaced as one complete assembly. The breaker lever spring tension and point alignment of the service contact set have been pre-adjusted at the factory. Only the point opening requires adjusting after replacement.

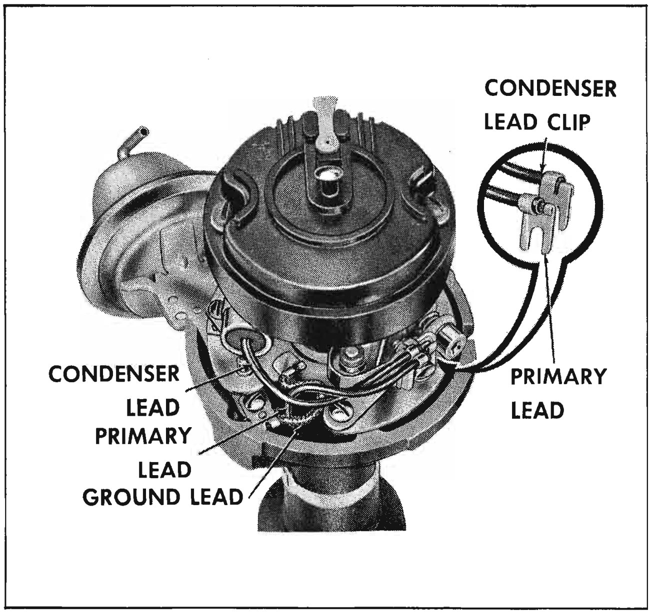


Fig. 11-55 Arrangement of Condenser and Primary Leads

Replace contact set as follows:

1. Remove two attaching screws (Fig. 11-54) which hold base of contact set assembly in place.

2. Remove condenser lead and primary lead from nylon insulated connection by turning screw (Fig. 11-54) in contact set.

3. Replacement is the reverse of removal.

CAUTION: Make sure the condenser lead and primary lead are located as in Fig. 11-55. Leads must be properly located to eliminate interference between leads and cap, weight base, or breaker plate.

4. Apply a trace of petrolatum to the breaker cam.

ADJUST DISTRIBUTOR DWELL ANGLE

The following method can be used to adjust the dwell angle to the proper setting with the distributor removed from the car.

NOTE: Dwell should always be rechecked after the distributor is installed in the car.

1. With distributor mounted in distributor testing machine, connect the dwell meter to the distributor primary lead.

2. With the distributor operating turn the adjusting screw (Fig. 11-51) until the proper dwell angle is obtained.

DISTRIBUTOR—DISASSEMBLE

1. Remove the rotor by removing the two attaching screws, lock washers, and flat washers (Fig. 11-56).

NOTE: It will be observed that the rotor is doweled to the weight base so that it can be installed in only one position.

2. Remove both the weight springs and both the advance weights.

3. Remove retaining pin from the gear by driving it out of the gear with a drift and hammer.

CAUTION: Distributor should be supported in such a way that the distributor shaft will not be damaged when driving the pin out.

4. Slide gear and washer off the shaft.

5. Pull shaft and cam-weight base assembly from the housing.

6. Remove contact set assembly.

7. Remove condenser hold-down screw, condenser and bracket from the breaker plate.

8. Remove spring retainer and raise plate from the housing.

9. Remove two attaching screws and lock washers and plate ground lead, and remove the vacuum advance unit.

10. Remove felt washer from around bushing in the housing.

NOTE: No attempt should be made to service the shaft bushings in the housing, as the housing and bushings are serviced as a complete assembly.

DISTRIBUTOR—ASSEMBLE

Assembly of the distributor is the reverse of the disassembly procedure outlined above. When installing the gear on the shaft use a new retaining pin. The pin must be tight in the hole to prevent any movement between the gear and the shaft.

Note that the rotor can be installed in only one position. It will be broken if an attempt is made to install it backwards.

DISTRIBUTOR—INSTALL

1. Check to see that engine is at firing position for No. 1 cylinder (No. 1 piston at top of compression stroke) and timing mark on harmonic balancer is indexed with pointer (Fig. 11-57).

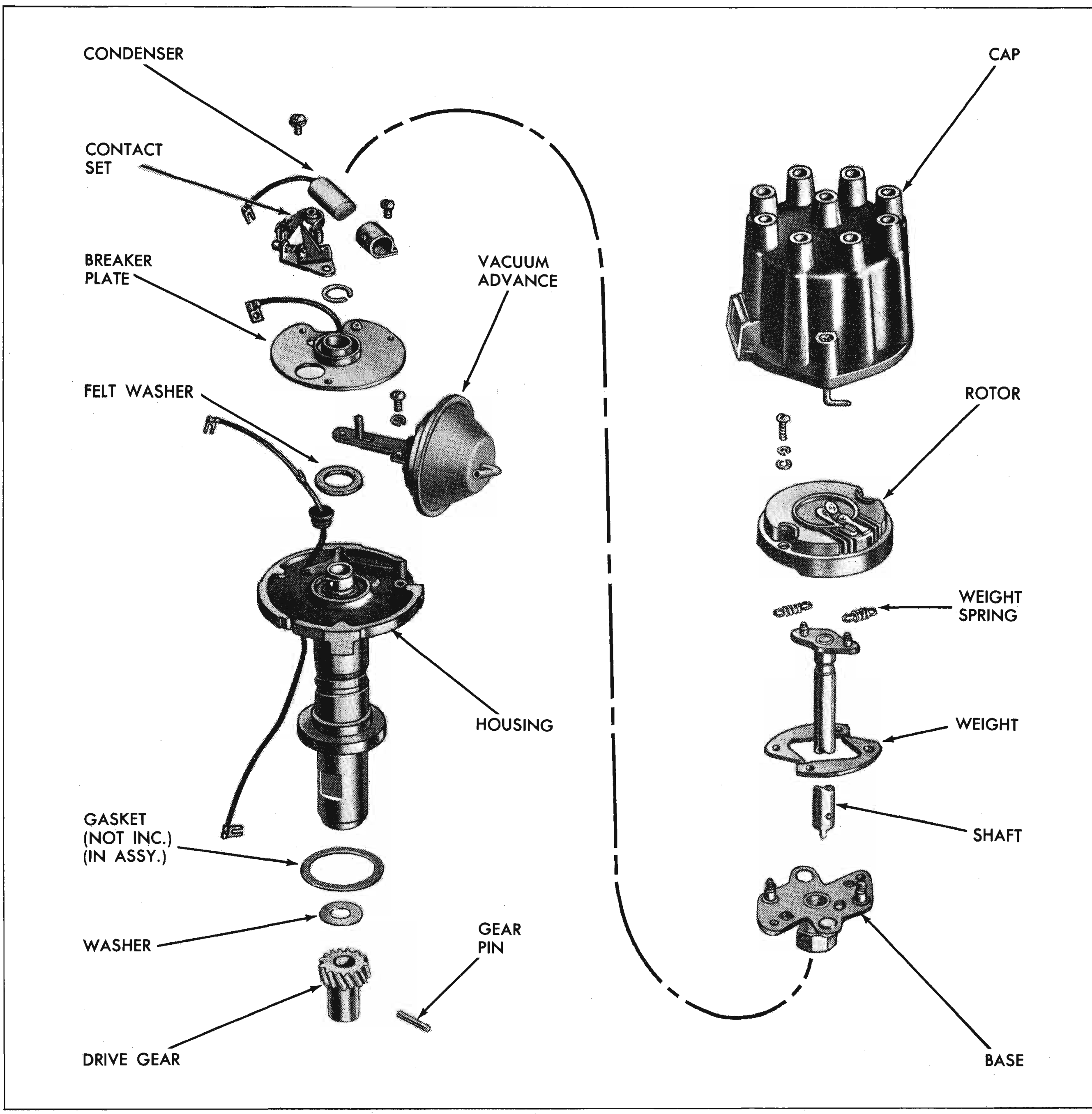


Fig. 11-56 Distributor Assembly—Exploded View

2. Position new distributor to block gasket on block.

3. Install distributor in block so that vacuum diaphragm faces the left side of the engine and rotor points toward contact in cap for No. 1 cylinder. Before installing distributor, index rotor with housing as noted when distributor was removed. This will simplify indexing the distributor shaft and gear with the oil pump drive shaft and the drive gear on the camshaft. Distributor and rotor will be positioned as shown in Fig. 11-58 when properly installed with No. 1 piston in firing position.

4. Replace distributor clamp leaving screw loose enough to allow distributor to be turned for adjustment.

5. Attach vacuum line to distributor.

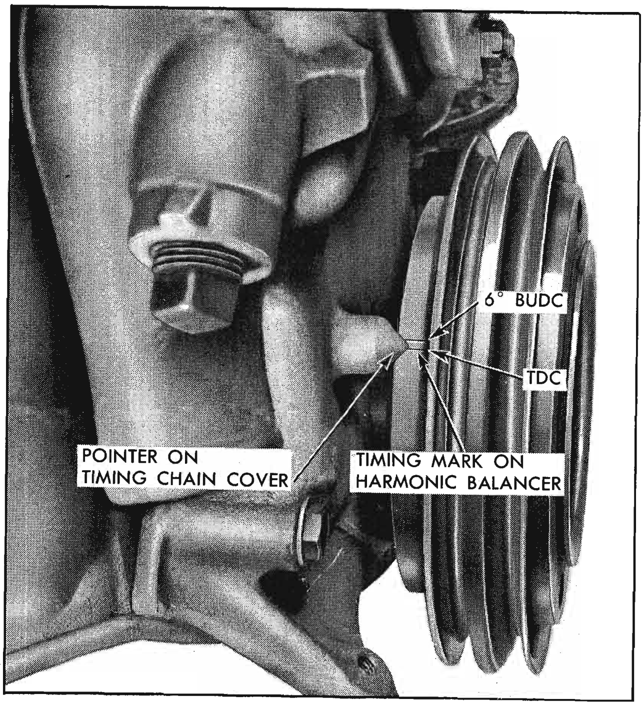


Fig. 11-57 Timing Marks and Pointer

6. Install spark plug wires in distributor cap. Place wire for No. 1 cylinder in tower shown in Fig. 11-59 (marked on old cap during disassembly) then install remaining wires counterclockwise around the cap according to the firing order (1-8-4-3-6-5-7-2).

When installing new wires, they should be located in wire supports as shown in Fig. 11-60.

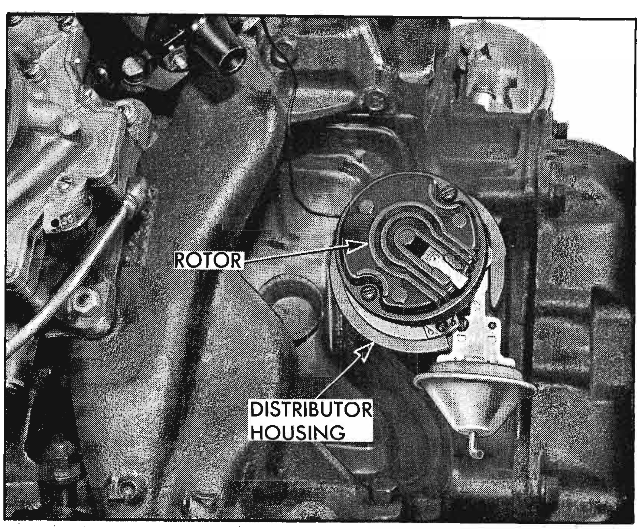


Fig. 11-58 Relationship of Distributor Housing and Rotor in Firing Position for No. 1 Cylinder

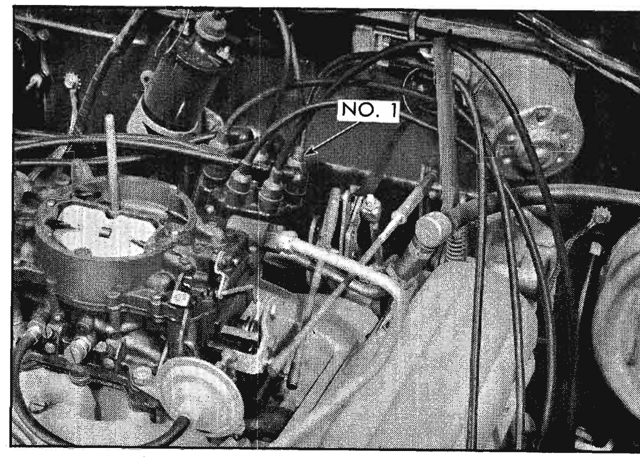


Fig. 11-59 Location of No. 1 Spark Plug Cable Terminal

7. Attach distributor to coil primary wire.
8. Replace distributor cap.
9. Adjust dwell and timing.

SPARK PLUGS

DESCRIPTION

AC type 45S spark plugs are used in all engines. These spark plugs provide optimum performance for all normal service. AC type 43S spark plugs are recommended for high speed driving.

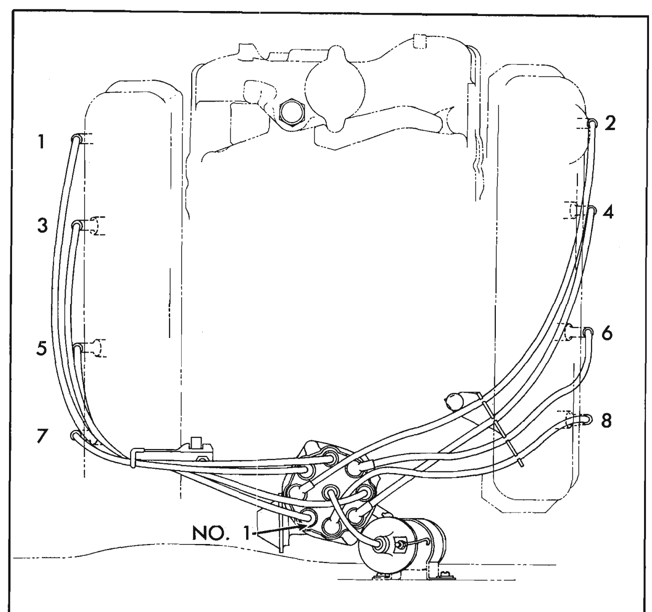


Fig. 11-60 Arrangement of Spark Plug Wires in Supports

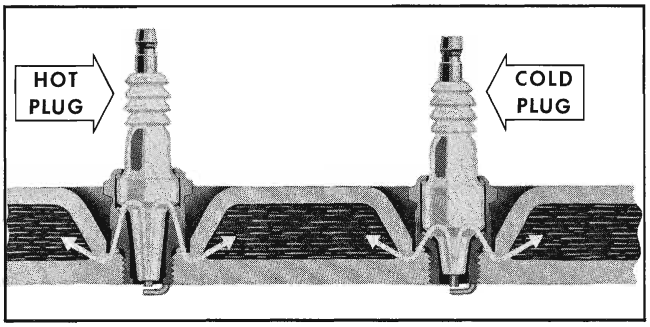


Fig. 11-61 Spark Plug Heat Range

Normal or average service is assumed to be a mixture of idling, slow speed, and high speed operation with some of each making up the daily total driving. Occasional or intermittent high speed driving is essential to good spark plug performance as it provides increased and sustained combustion heat that burns away any excess deposits of carbon or oxide that may have accumulated from frequent idling or continual stop-and-go or slow-speed driving.

Spark plugs in Pontiac engines are protected by an insulating nipple made of special heat resistant material which covers the spark plug terminal and extends downward over a portion of the plug insulator. These nipples prevent "flash-over," with resulting missing of the engine, even though a film is allowed to accumulate on the exposed portion of the plug porcelains.

IMPORTANT: Do not mistake "corona" discharge for "flash-over" or a shorted insulator. Corona is a steady blue light appearing around the insulator, just above the shell crimp. It is the visible evidence of a high tension field, and has no effect on ignition performance. Usually it can be detected only in darkness. This discharge may repel dust particles, leaving a clear ring on the insulator just above the shell. This ring is sometimes mistakenly regarded as evidence that combustion gases have blown out between shell and insulator.

All spark plugs have a type number on the insulator which designates the thread size as well as relative position of the plug in the "heat range." Type numbers starting with "4" are 14 mm. thread size.

The last digit of the type number indicates the "Heat Range" position of the plug in the heat range system (Fig. 11-61). Read these numbers as you would a thermometer—the higher the last digit, the "hotter" the plug will operate in the engine; the lower the last digit, the "cooler" the plug.

PERIODIC SERVICE

Periodically (the actual time depending on operating conditions) the plugs should be removed for cleaning, inspection and regapping.

MINOR REPAIRS

INSPECT, CLEAN AND ADJUST SPARK PLUGS

When checking the condition of removed spark plugs, there are five principal points to observe:

1. Dirty—The lower end of the spark plug insulator becomes coated under operation with an oxide deposit. This deposit is a conductor of electricity (especially when heated), and when occurring in sufficient quantity, will cause missing. The deposit may occur at various mileages depending on operating conditions and is usually brown in color, although sometimes it is yellow or white. Plugs with this oxide coating on the lower end are not defective and replacing them is needless.

Fouled and dirty or oxide coated plugs can be thoroughly cleaned without injuring the insulator by use of the spark plug cleaner and indicator (Fig. 11-62) or similar equipment.

NOTE: Excessive cleaning of spark plugs to remove heavy deposits, will erode the insulator tip, and lower the heat range of the plug. Heavily coated plugs should be replaced.

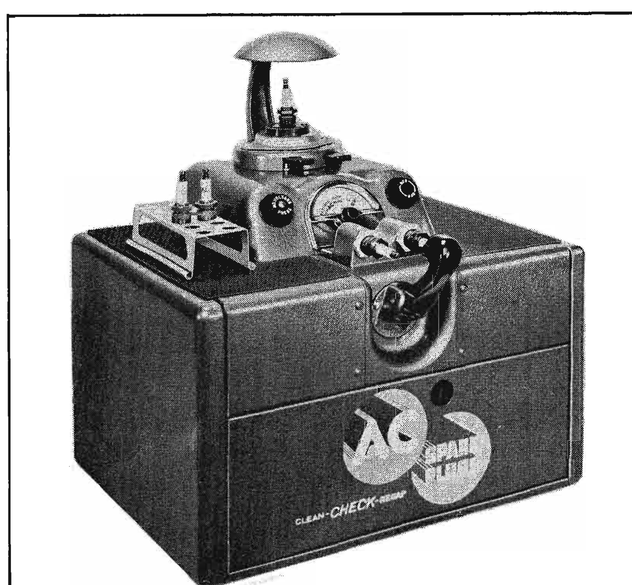


Fig. 11-62 Spark Plug Cleaner and Indicator

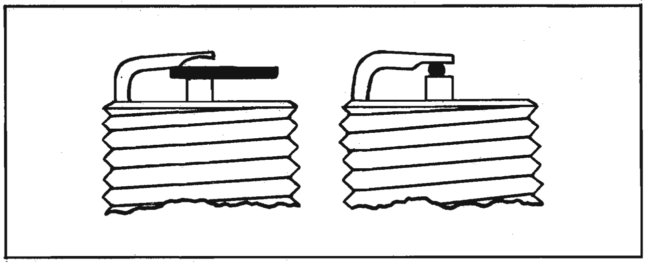


Fig. 11-63 Flat Feeler Versus Round Wire Gauge for Measuring Spark Plug Gap

Spark plugs should be cleaned following the instructions furnished with the cleaner. After cleaning, file the center electrode flat (to reduce the voltage required to fire the plug) and set the gap to .033″-.038″ using a round wire gauge (Fig. 11-63). Test the spark plugs following the instructions furnished with the spark plug cleaner and indicator.

2. Worn Out—Normal wear, electrodes consumed from long service. Replace plugs.

3. Wide Gap—Resulting from normal wear or rapid wear, requiring regapping of electrodes. When adjusting gap always make adjustment on the outer electrode, never on the center one, as this will break or crack the insulator. It is good practice to use new gaskets under the plugs when reinstalling them in the engine. Spark plugs should be tightened to not more than 25 lb. ft. torque. If a plug is installed in a location where a torque wrench cannot be used, turn the plug finger tight on a new gasket then tighten 3/4 of a turn with a wrench.

4. Broken Insulator—Breakage of the upper end by mechanical damage such as careless use of wrenches, or cracked insulator tips due to the plug having operated too hot. Replace plug.

5. Damaged Shell—Threads stretched or broken, or shell cracked due to mishandling or excessive tightening. Replace plug.

IGNITION COIL AND IGNITION RESISTANCE

The external coil resistance is an integral part of the wiring harness. It is composed of a stainless steel wire, plastic coated, and covered with a glass braid.

The ignition coil is an oil-filled, hermetically-sealed unit designed specifically for use with an external resistance in the 12-volt system. The combined action of the resistance and the primary windings of the coil provide a very rapid coil build-up. Rapid build-up assures maximum available voltage even at extremely high engine speeds. The resistance also prevents excessive primary current at all temperatures and thus reduces the tendency of the points to oxidize.

To obtain maximum starting performance at low temperatures, the resistance is by-passed during cranking, thereby connecting the ignition coil directly to the battery. This makes full battery voltage available to the coil and thus keeps ignition voltage as high as possible during cranking. The by-passing of the resistance during cranking is accomplished by means of a special terminal on the ignition switch which is connected directly to the coil.

SECONDARY IGNITION CABLES

All ignition cables in the secondary or high tension system (coil to distributor and distributor to plugs) are neoprene jacketed. These cables are resistant to the action of oil, grease, battery acid and road salt, and also offer resistance to corona breakdown. Ignition cables have a multiple, cloth thread core impregnated with a graphite solution to give the correct conductivity. These cables give proper resistance for suppression of radio and television interference.

No external suppressors should be used on the ignition system on car radio installation.

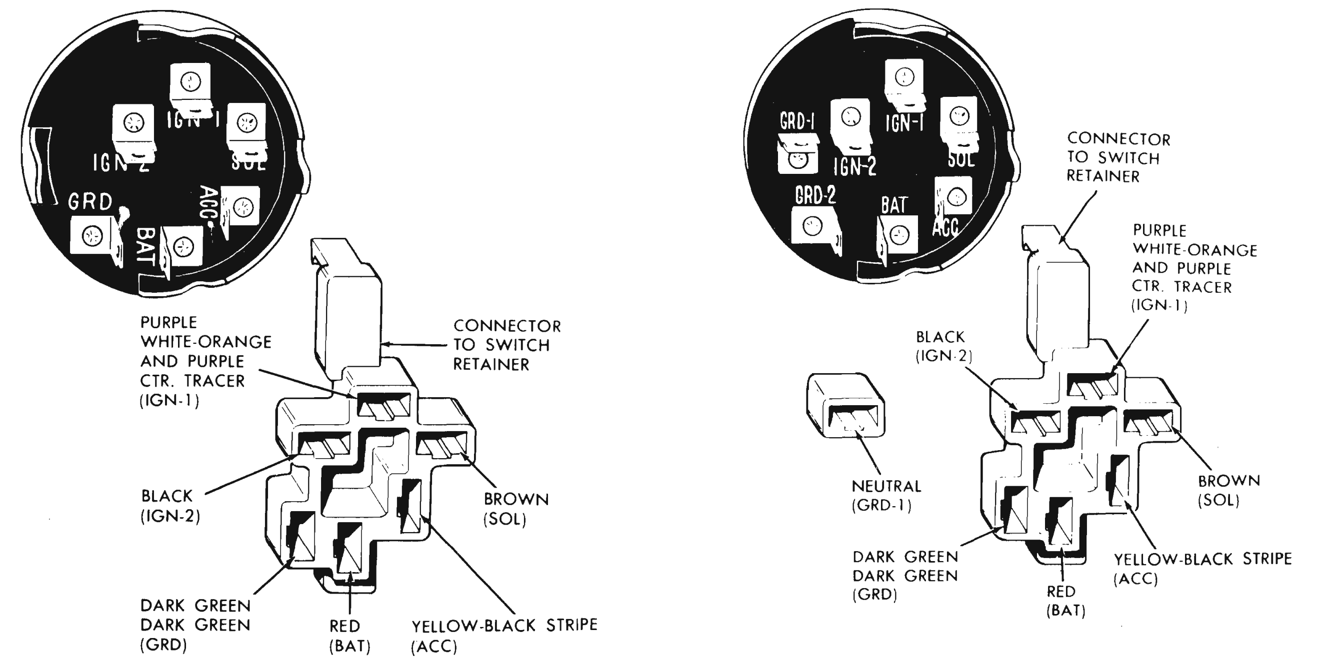
IGNITION AND STARTING SWITCH

The ignition and starting switch is key operated to close the ignition primary circuit and to energize the starting motor solenoid for cranking.

The ignition switch has four positions, "OFF" when the key is straight up and down, "ACC" (accessory) when turned to the left, "ON" when turned to the right until spring pressure is felt, and "START" when turned fully to the right against spring pressure.

With the switch in either the "ACC" or "ON" positions the following electrical circuits are activated: stop light, directional signals, parking brake warning light, radio, back-up lights, heater and defroster, electric windshield wiper, instrument, and rear window defroster. In the "ON" position the ignition primary circuit is also activated through the resistance.

There are six terminals on the back of the switch, used on all models without Circ-L-Aire Conditioning and seven terminals on cars with Circ-L-Aire Conditioning, Fig. 11-64.



All Models Except Circ-L-Aire Conditioning

All Models with Circ-L-Aire Conditioning

Fig. 11-64 Comparison of Back Side of Ignition and Starter Switch Assemblies

The terminal marked "BAT" is connected to the battery through the ammeter and supplies the power to the switch. The accessory terminal supplies power to the accessories when the switch is in the "ACC" or running positions. The "SOL" terminal supplies power to the solenoid to activate the starter in the start position. The terminal marked "GR" (ground) completes the test circuit for the temperature "HOT" indicator bulb when the switch is turned to the start position.

These circuits are all open when the ignition switch is in the "OFF" or "START" positions.

When the ignition switch is turned to the start position, the ignition primary circuit is activated directly, by-passing the resistance, and the starting motor circuit is activated to crank the engine.

Two ignition terminals, marked IGN-1 and IGN-2, will be found on the back of the switch. The IGN-1 terminal is energized when the ignition switch is in the normal operating position. It directs current to the ignition coil through the resistance. The IGN-2 position is energized when the ignition switch is turned to the starting position. It directs current to the coil around the resistance to provide full battery voltage to the coil when starting.

Figures 11-65 through 11-72 show circuit diagrams (viewing from the key end of the ignition and starter switch) for all models except cars equipped with Circ-L-Aire Conditioning as well as all cars equipped with Circ-L-Aire Conditioning.

IGNITION AND STARTER SWITCH ASSEMBLY—REMOVE AND REPLACE

1. Remove positive cable from battery to protect against short circuit.

2. Remove ignition switch ferrule by unscrewing with special spanner J-5893 (Fig. 11-73).

3. Remove ignition switch lamp housing brace screw from bottom flange of instrument panel.

4. Remove switch from back of instrument panel and disconnect wires after unlatching special locking terminal.

5. Replace switch by reversing above steps.

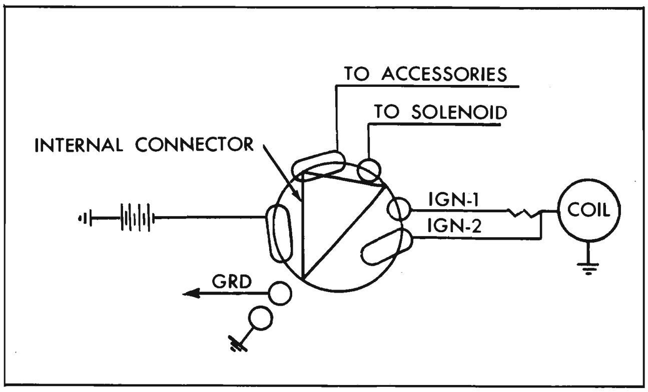


Fig. 11-65 All Except Circ-L-Aire AC—Circuit Diagram "Off" Position: No Current Flow—Switch Open

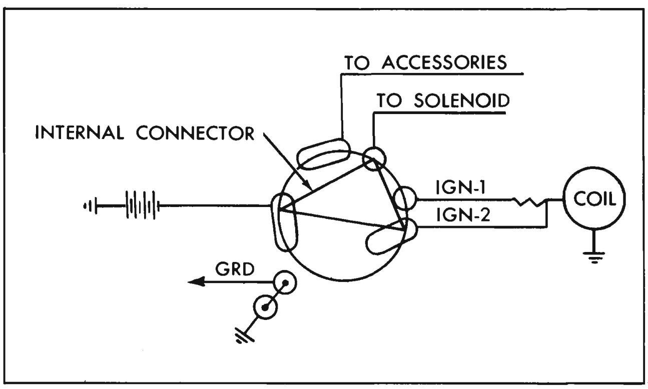


Fig. 11-66 All Except Circ-L-Aire AC—Circuit Diagram "Start" Position—Contactors are shown in "IGN-2" (start) position: current flows from the battery to and through the switch to the starter solenoid to operate engine electrical systems. No current flow through accessories circuit.

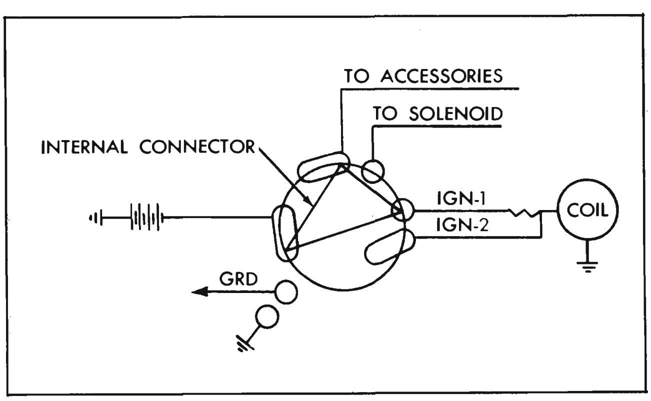


Fig. 11-67 All Except Circ-L-Aire AC—Circuit Diagram "ACC." Position—Contactors are shown in "ACC" 1" (run) position: Current flow is from the battery to and through the switch and to operate all engine electrical systems as well as all accessory circuits.

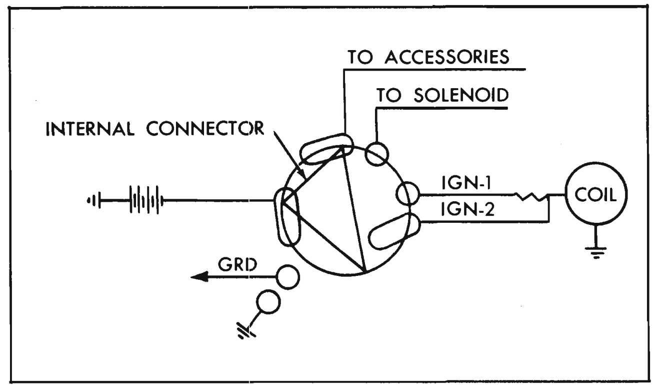


Fig. 11-68 All Except Circ-L-Aire AC—Circuit Diagram "ACC." Position—Contactors are shown in "ACC" position: Current flow is from the battery to and through the switch to operate accessories circuit only.

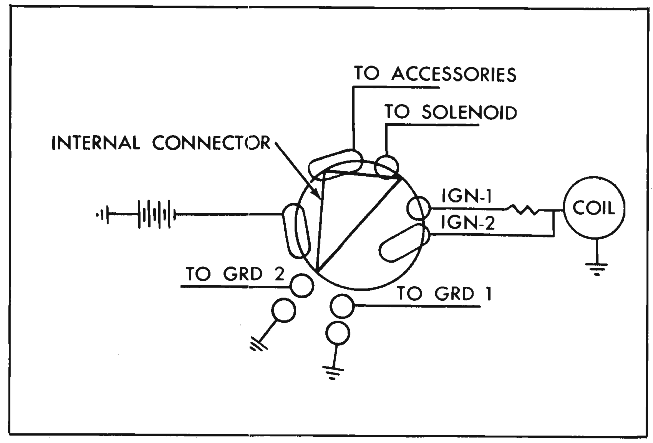


Fig. 11-69 All with Circ-L-Aire AC—Circuit Diagram "Off" Position: No Current Flow—Switch Open

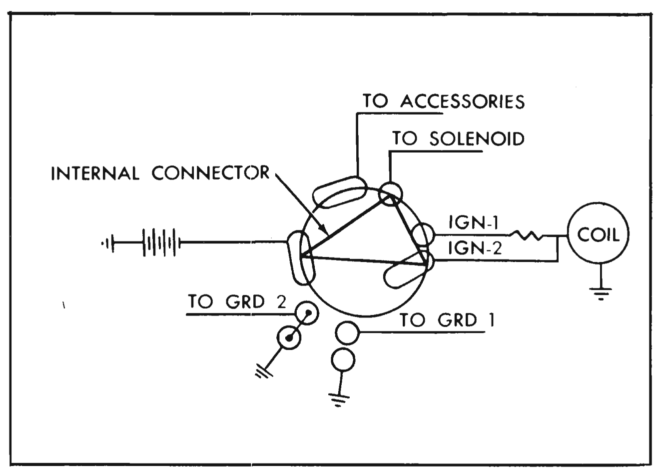


Fig. 11-70 All with Circ-L-Aire AC—Circuit Diagram "Start" Position—Contactors are shown in "IGN-2" (start) position: Current flows from the battery to and through the switch to the starter solenoid to operate engine electrical systems. No current flow through accessories circuit or Circ-L-Aire circuit.

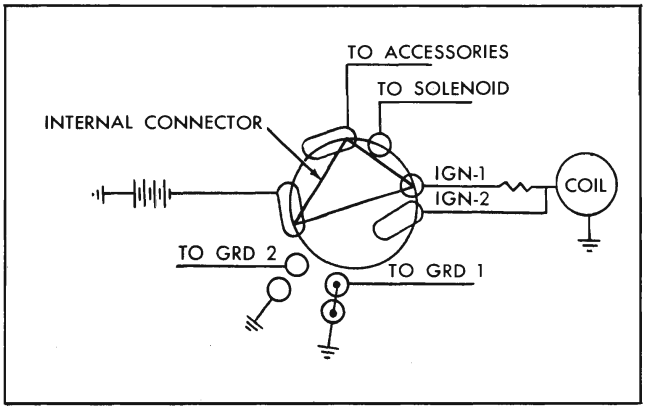


Fig. 11-71 All with Circ-L-Aire AC—Circuit Diagram "Run" Position—Contactors are shown in "IGN-1" (run) position: Current flow is from the battery to and through the switch to operate all engine electrical requirements as well as all accessories circuits.

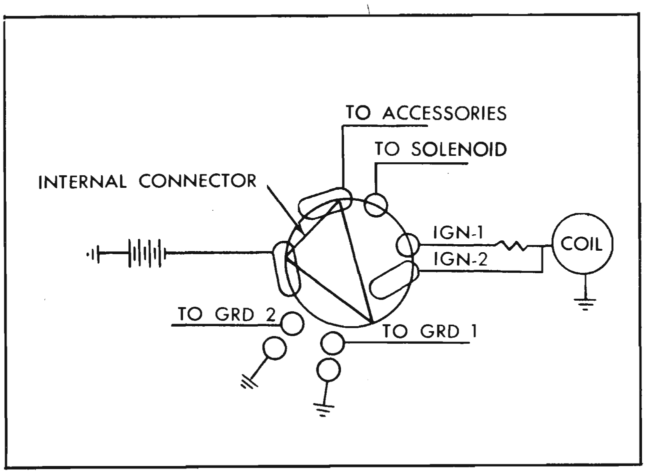


Fig. 11-72 All with Circ-L-Aire AC—Circuit Diagram "ACC." Position—Contactors are shown in "ACC" position: Current flow is from the battery to and through the switch to operate all accessories circuits except Circ-L-Aire Conditioning system. (The "GRD-1" connection inside the switch is open to prevent operation of the Circ-L-Aire Conditioning system.)

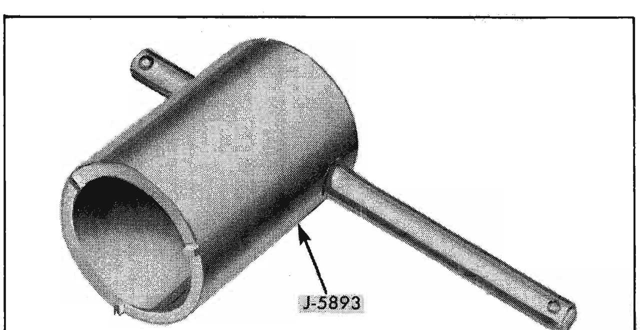


Fig. 11-73 Ignition Switch Ferrule Spanner

IGNITION SWITCH LOCK CYLINDER—REMOVE AND REPLACE

1. Place ignition key in lock and depress lock plunger by inserting small pin through hole in lock cap.

2. While holding plunger in, turn key approximately 20° counterclockwise to release lock cylinder and remove cylinder from switch.

3. To install lock cylinder, insert key in cylinder. Then, with key and cylinder turned about 20° counterclockwise, insert cylinder in lock and rotate clockwise to lock in place.

FREE UP STICKING IGNITION LOCK

Occasionally an ignition lock may stick, making it difficult to insert key and turn lock. In such case blow a very small quantity of powdered graphite into the lock key hole and operate lock several times until lock operates freely.

IGNITION SYSTEM TROUBLE DIAGNOSIS

QUICK CHECKS

If the engine does not run, the ignition system may be at fault if:

1. There is no spark, during cranking, when a spark plug wire is held ¼ inch from the engine.

2. The engine starts but immediately stops when the ignition switch is released from the "start" position.

If these checks indicate trouble in the ignition system, follow the procedure outlined below. This procedure may also be helpful in locating trouble in the ignition system if the car runs but not satisfactorily.

DIAGNOSIS PROCEDURE

If the checks outlined above indicate that the ignition system is at fault, the following checks may be made to help locate the difficulty. All checks are to be made with the lights and accessories off and in the sequence shown. Voltage readings referred to are indicated in Fig. 11-74.

Improper Operation of Ignition System

OPERATION	SPECIFICATION	CAUSE
Check all connections in primary and secondary circuit.		
Remove secondary coil lead from distributor cap. Hold ¼ inch from engine while cranking, and observe if spark occurs.		*If spark occurs:* Distributor cap. Rotor. Spark plug wiring.
Check voltage V-1 while cranking.	1 Volt Max.	Open circuit from battery side of coil to solenoid switch. Solenoid switch not closing ignition circuit. Ground in circuit from coil terminal to solenoid switch. Ground in coil.
Check Voltage V-2 ignition switch "ON", points open.	Normal Battery Voltage	Low battery. Points not open. Ground in circuit from coil to distributor. Ground in distributor. Ground in coil. Ground in circuit from coil to solenoid switch or to resistor.
Check Voltage V-2 ignition switch "ON", points closed.	5 to 7 Volts	*If over 7 volts check following:* Contacts not closed. Loose connection in distributor. Distributor not grounded to engine. Faulty contacts. Loose connection between coil and distributor. Resistance out of circuit due to shorted or incorrect wiring. Solenoid switch contacts stay closed. Wire resistor has too little resistance. Coil primary is open. *If under 5 volts, check following:* Loose connections between battery and resistor. Loose connections between resistor and coil. Resistor open or has excessive resistance.

Improper Operation of Ignition System—Continued

OPERATION	SPECIFICATION	CAUSE
Check Voltage V-3 ignition switch "ON", points closed.	0.2 Volts Max.	Contacts not closed. Loose connection in distributor. Distributor not grounded to engine. Faulty contacts—if faulty, recheck voltage V-2, ignition switch on, points closed.
Check Voltage V-4 ignition switch "ON", points closed.	0.7 Volts Max.	Loose connection from distributed resistance through ignition switch circuit to battery.

If these checks fail to find cause of trouble—remove distributor, coil, and resistance wire from engine and check to specifications. Also check wiring harness.

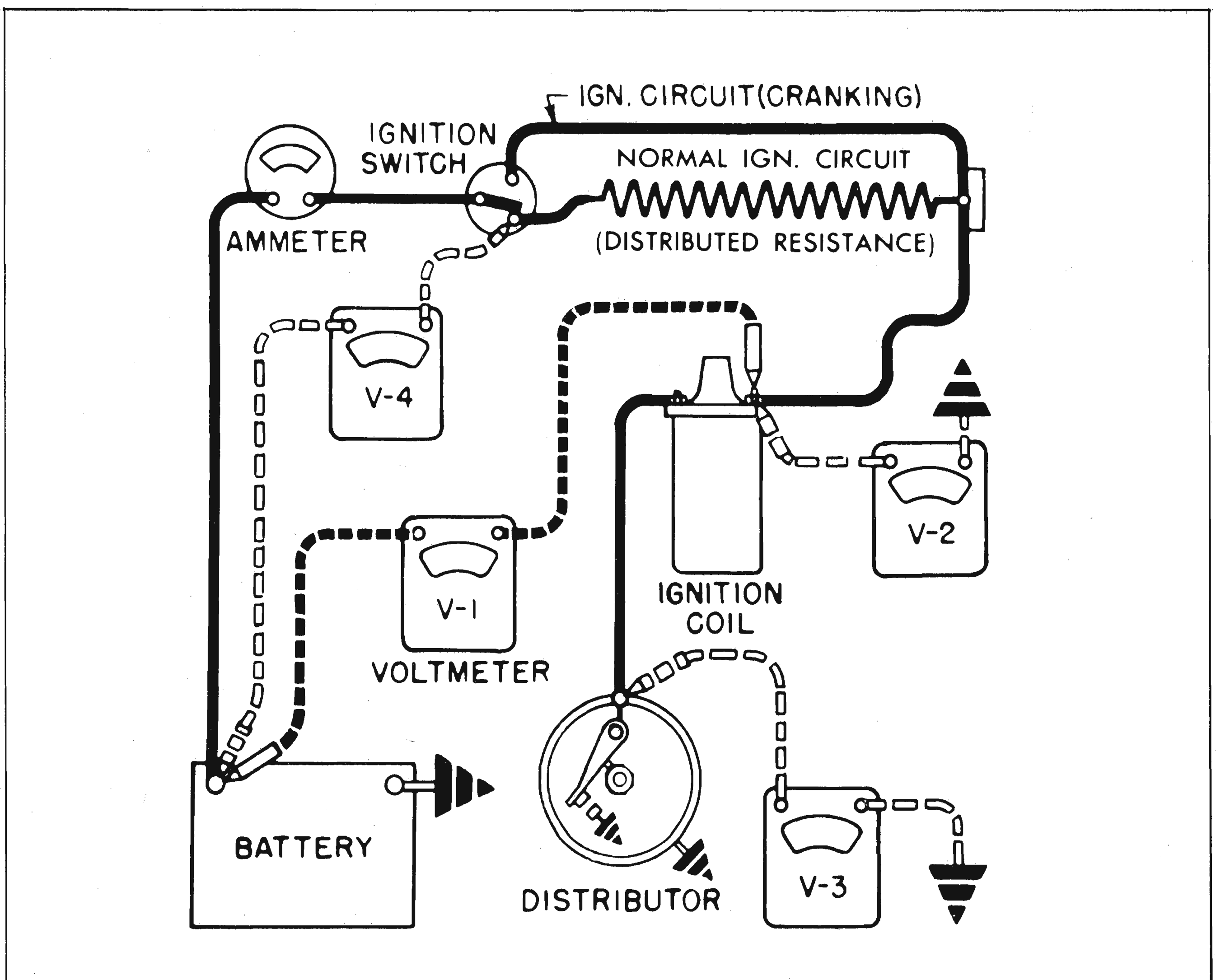


Fig. 11-74 Testing Diagram for Ignition Circuit

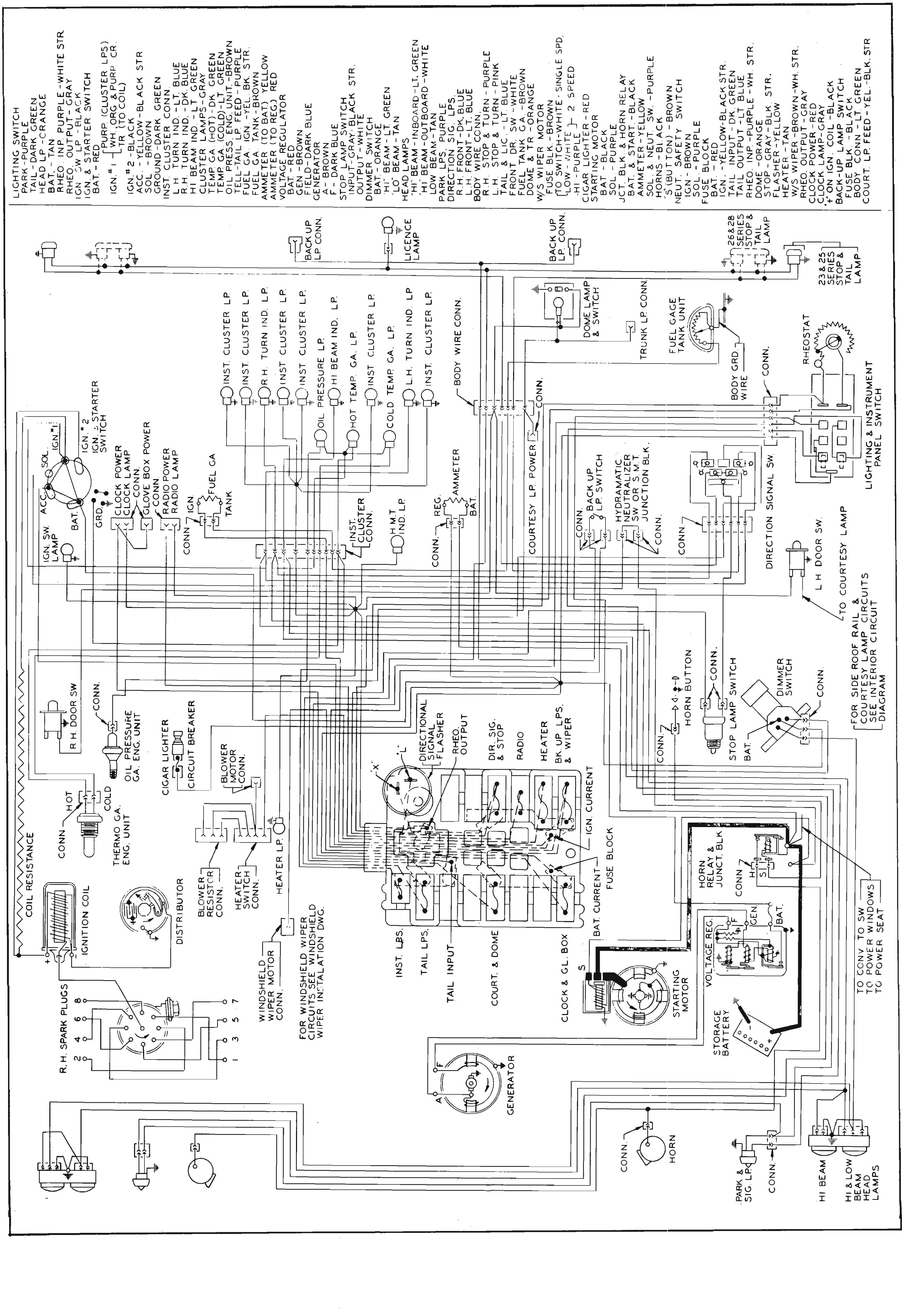


Fig. 11-75 Circuit Diagram—Wiring

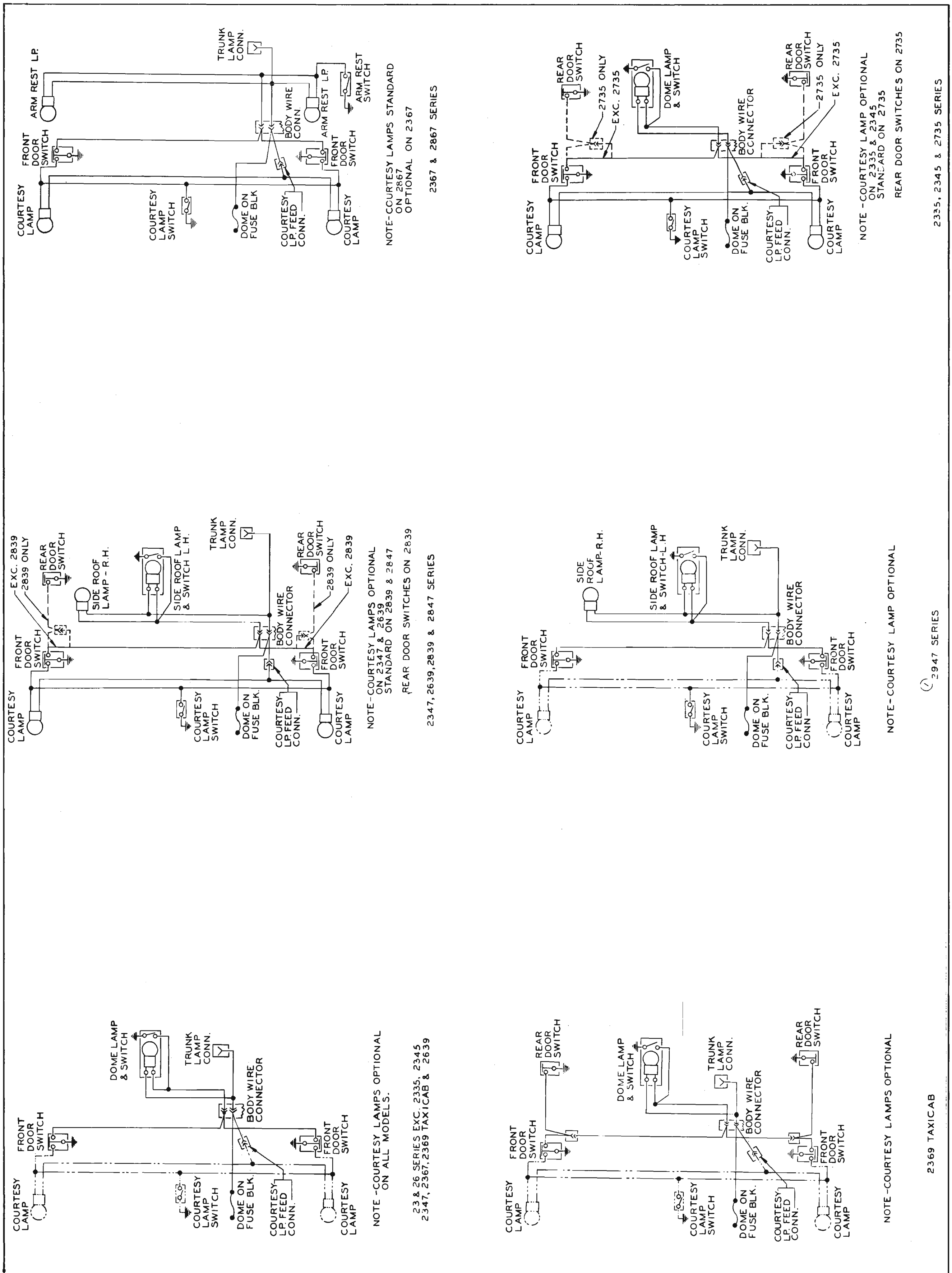


Fig. 11-76 Circuit Diagrams—Interior

WINDSHIELD WIPER AND WASHER

GENERAL

Electric windshield wipers are used on all models. The standard wiper on the Catalina and Ventura Series will be a single-speed tandem system (Figs. 11-77 and 78) (option) mounted in the engine compartment. All other series use a two-speed wiper motor (all two-speed are overlap—Fig. 11-79). When the washer option is elected on either system the washer unit is mounted on and driven by the wiper motor.

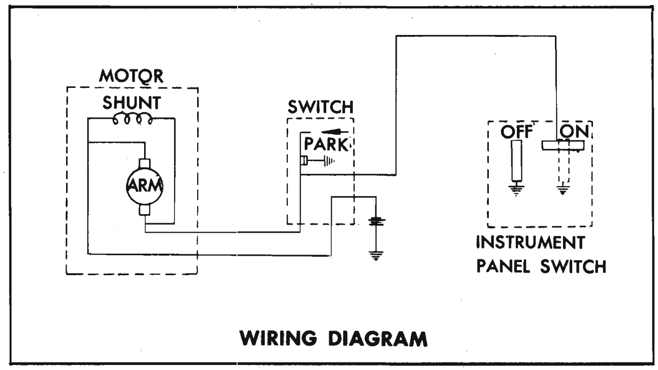


Fig. 11-78 Single-Speed Wiper Wiring Diagram

TWO-SPEED WIPER

GENERAL DESCRIPTION

The two-speed system is called the "overlap" type and is so called because the blades are offset and actually overlap in the park position. This overlapping action is accomplished by a double pin drive in the wiper transmission and longer arms and blades. Because of the great wipe area of the overlap system a 2″ stack wiper motor is used.

Overlap type windshield wipers feature a total of 3 feet of wiper blade action. The electric motor is driven for constant operation and has two distinct speeds. Wipers operate at approximately 65 and 80 cycles per minute respectively for each speed.

Wipe angle is approximately 91° and has an arm radius of 17 inches. The 18 inch long blades are in a depressed park position in proximity to the windshield moulding when the wiper is "OFF".

OPERATION (FIG. 11-80)

The nylon gear is driven by a worm on the end of the motor armature shaft. The drive plate containing the drive shaft (and having the crank arm on the other end) extends through the nylon gear in a hole placed off center of the gear. The drive pawl and lock pawl are located by the drive plate pivot pins, the

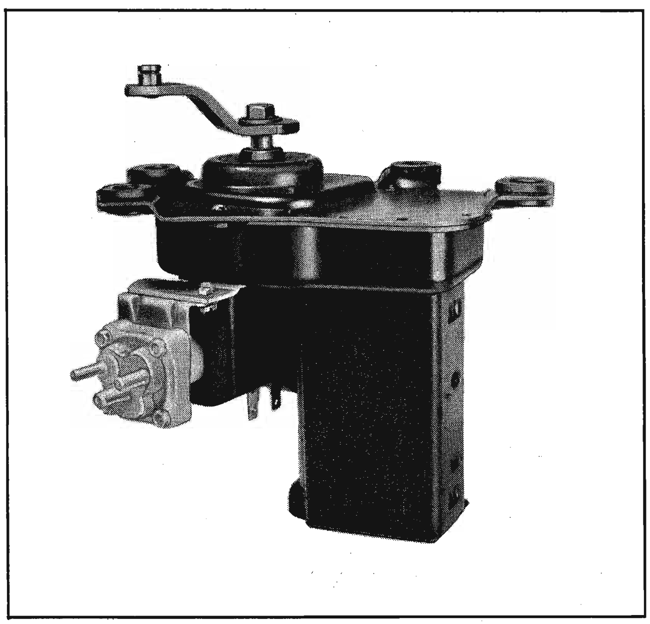


Fig. 11-77 Single-Speed Tandem Windshield Wiper

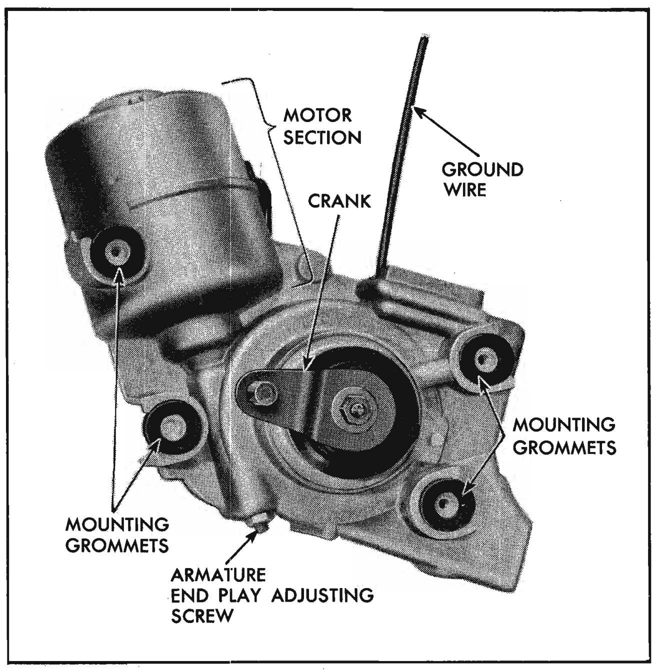


Fig. 11-79 Two-Speed Overlap Windshield Wiper

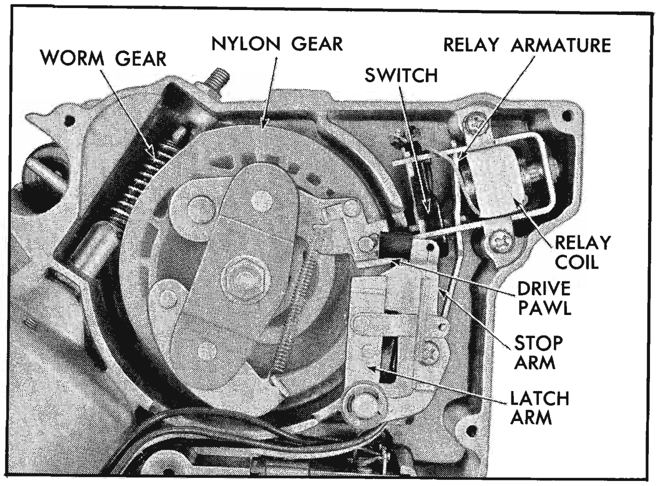


Fig. 11-80 Wiper Drive Mechanism

nylon gear cam slots, and the spring. Controlling the starting, operating, stopping and parking of the unit are the latch arm, stop arm, relay and switch assembly.

WIRING

To operate the wiper, it is only necessary to turn the control knob on the dash to the "Lo" or "Hi" speed position.

When the control is in the "Lo" position (Fig. 11-81), the relay coil and shunt circuits are connected to ground at the dash. The relay armature pulls in, completing the series circuit to ground in the motor. This causes the motor to rotate at a relatively slow speed since current flow in the shunt winding is relatively high.

Placing the control in "Hi" (Fig. 11-82) opens the shunt circuit to ground at the dash control switch. The shunt field circuit is then completed to ground through the resistor located on the wiper unit terminal board. This greatly reduces current flow in the shunt winding permitting motor speed to increase, Fig. 11-83.

STARTING

As the relay armature is pulled in, it pulls the latch arm out of the normal path of the gear assembly drive pawl (Fig. 11-80). As the wiper starts, only the nylon gear and eccentric shaft start to rotate. The drive plate assembly, however, is held from rotating by the drive pawl pressure against the stop arm.

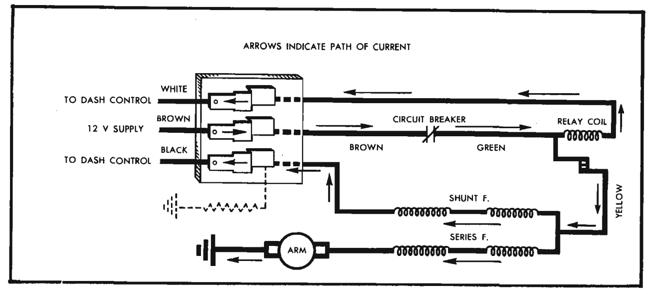


Fig. 11-81 Wiring Circuit—"Lo" Speed Operation of Two-Speed Overlap Windshield Wiper

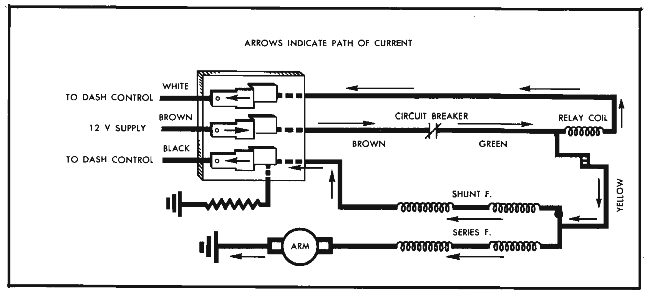


Fig. 11-82 Wiring Circuit—"Hi" Speed Operation of Two-Speed Overlap Windshield Wiper

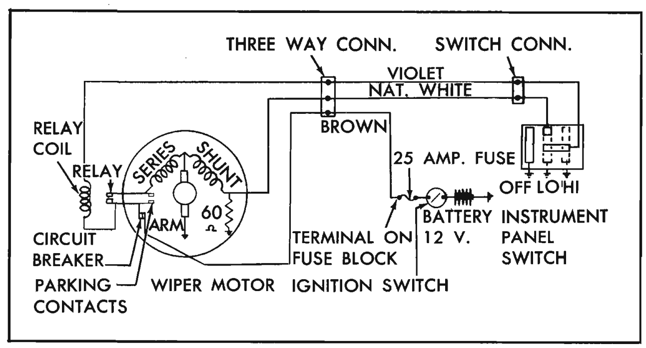


Fig. 11-83 Wiring Diagram—Two-Speed Overlap Windshield Wiper

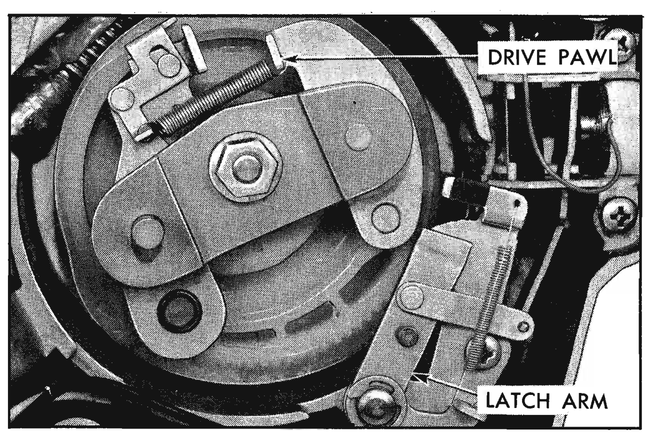


Fig. 11-84 Latch Arm in Path of Drive Pawl

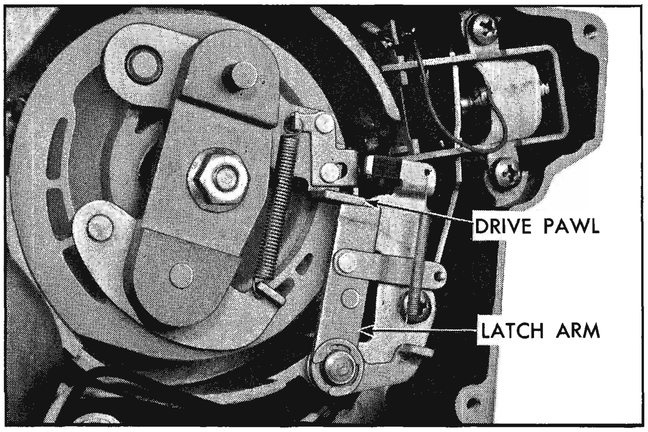


Fig. 11-85 Drive Pawl Contacting Latch Arm

After the nylon gear and eccentric shaft assembly have rotated approximately 180° the guide pins of the drive and lock pawl assemblies snap into their respective pockets in the nylon gear. This allows the drive pawl to clear the stop arm and the entire drive gear assembly then rotates as a unit. The wiper unit is now in its normal operating position.

STOPPING AND PARK

Turning the control to the off position at the dash opens the relay control coil circuit, which allows the spring loaded latch arm to move into the path of the drive pawl (Fig. 11-84).

NOTE: The circuit to the motor is still closed mechanically in the relay control switch during this period of the parking cycle.

When the drive pawl comes against the latch arm (Fig. 11-85), the drive plate, drive pawl and lock pawl are held from rotating; whereas the gear and eccentric shaft continue to rotate. The cam type action between the eccentric shaft and the drive plate shaft moves the drive plate and related parts in a direction toward the relay control switch. This causes the drive pawl to push against a relay control switch tab, which opens the circuit to the motor.

WASHER OPERATION (FIG. 11-86)

During normal operation of the wiper, the washer unit pumping mechanism is held in an idling position by a relay mechanism located in the washer assembly housing.

Pushing the washer button on the dash control closes the washer relay circuit and mechanically operates the dash control switch to the "Lo" speed position.

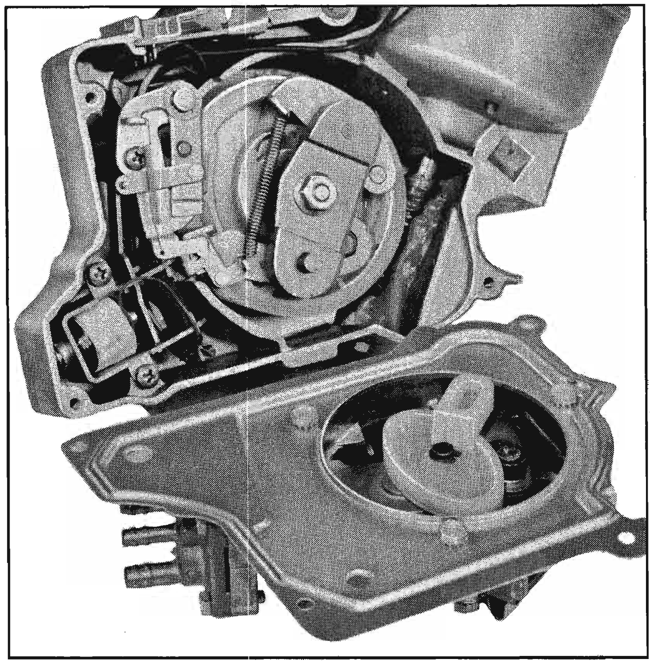


Fig. 11-86 Wiper Unit Removed from Washer

NOTE: If the wiper is turned on prior to pushing the washer button the wiper will operate at whatever speed the dash control was set at during the wash cycle.

When the washer relay armature pulls in, the pumping mechanism is released from its idling position and starts to pump water. As the pumping mechanism starts to pump water it also starts to rotate a 21 tooth ratchet wheel. When the ratchet wheel has been rotated through the 21 teeth it returns the pump to its idling position.

At the completion of a wash cycle the wiper must be turned off manually at the dash control.

WIPER MOTOR AND GEAR ASSEMBLY—REMOVE

In order to remove the motor assembly from the car, the following procedure should be followed:

1. Remove wiper arm and blade assemblies.
2. Remove both retaining nuts, cam parts, washers and escutcheon assemblies J-6592-02.
3. Remove ventilator grille.
4. Remove link retainer.
5. Disconnect all electrical connections and washer hoses.
6. Remove four attaching screws and motor and gear box assembly.

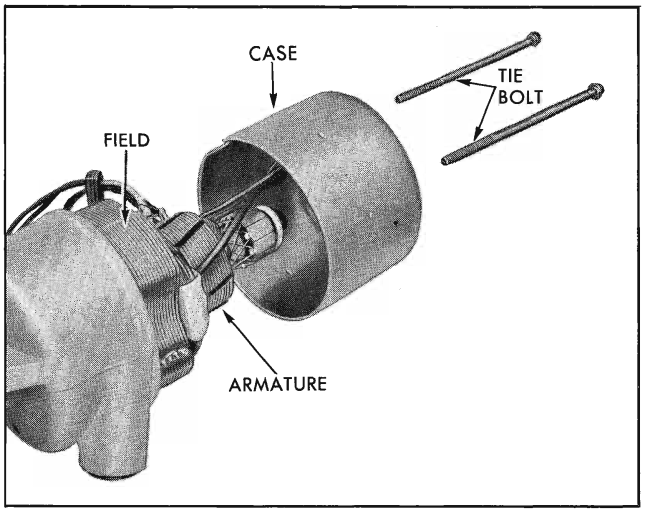


Fig. 11-87 Motor Case Removed

DISASSEMBLY AND ASSEMBLY

The overhaul procedures for the wiper are broken down into three major areas: The motor section, gear box section and washer pump section. Each section may be serviced independently of the other.

DISASSEMBLE MOTOR (FIG. 11-87)

1. Remove the two motor tie bolts.

2. Remove the armature end-play adjusting screw.

3. Strike steel case lightly with mallet to partially loosen it from die cast housing and motor field.

4. Insert a tool through the armature adjusting screw opening and push against the end of the armature shaft to back off the case. This will retain the armature commutator in position between the brushes until ready to separate the armature from the case, avoiding damage to the parts.

5. Pull the armature out of the case and remove the brush springs, felt washer, thrust washer, thrust plate, and rubber thrust disc (Fig. 11-88) from the case assembly bearing as required.

6. The field assembly is pressed into the housing and should not be removed unless replacement is necessary. If replacement is necessary, proceed as follows:

a. Cut the black and yellow leads that extend through the case assembly rubber grommet in a location convenient for splicing.

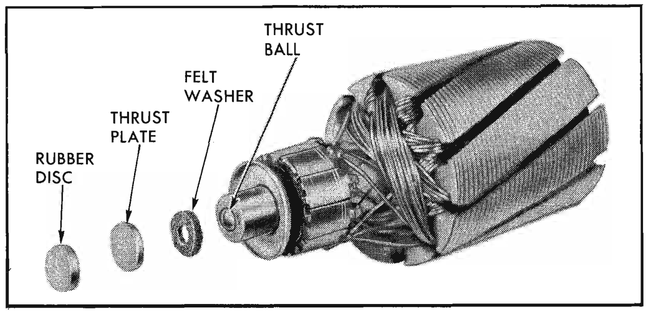


Fig. 11-88 Exploded View Armature Thrust Parts

b. Cut the internal field lead enclosed in black plastic tubing approximately two inches from the brush holder to which it is attached (Fig. 11-89).

c. Scribe a reference line along the side of the housing and field for reassembly purposes.

d. Install puller J-2623 or J-7844 and remove field from case.

ASSEMBLE MOTOR

1. Install field assembly as follows if removed for replacement.

a. Scribe a reference line on the replacement field in the approximate same location as the one scribed on the original field (step 6c under DISASSEMBLE MOTOR).

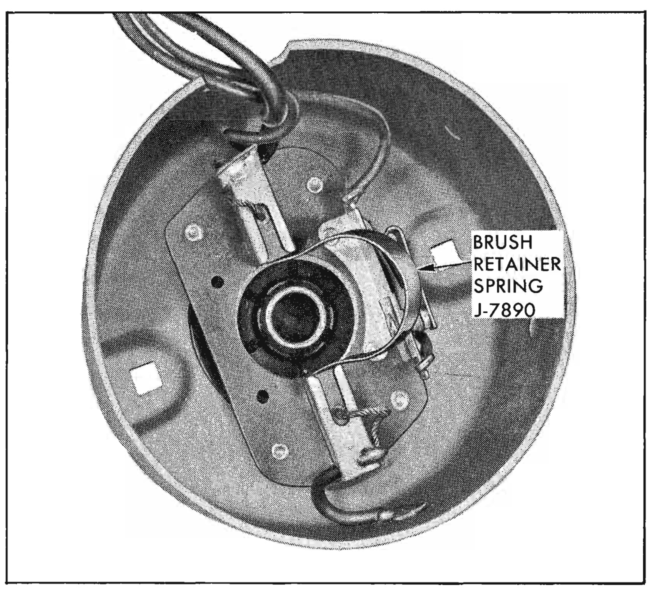


Fig. 11-89 Retainer Holding Brush in Place

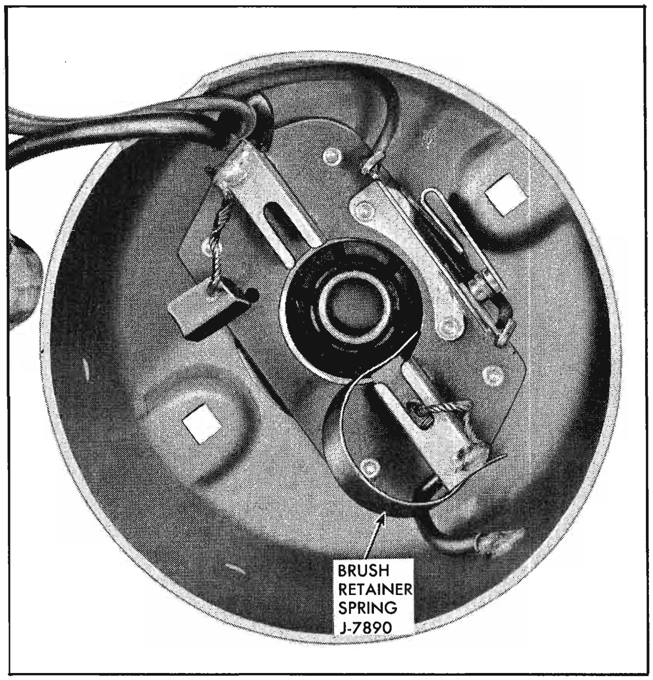


Fig. 11-90. Retainer in Position for Armature Installation

b. Align the field and housing according to the reference lines and start the field in the housing.

c. Push the field in the housing until it bottoms against the machined ridge.

d. Shorten as required and splice the replacement field leads to those leads cut in steps 6a and 6b under DISASSEMBLE MOTOR.

2. Assemble rubber disc, thrust plate, and felt washer into the case as shown.

NOTE: Thrust ball (located in end of armature shaft) is retained by grease. If it came out during disassembly, reinstall it into the end of the shaft using a heavy grease as a retainer.

3. Install brush spring in brush guide.

4. Compress spring with pencil or similar pointed tool on one side.

5. Insert brush in guide.

6. Install brush retainer spring (Fig. 11-89) over entire length of guide to retain brush.

7. Install opposite brush spring in brush guide.

8. Compress spring with pencil or similar pointed tool.

9. Insert brush in guide.

10. Insert second brush retainer spring (Fig. 11-90) between brush faces and remove retainer spring previously installed.

11. Be sure steel thrust ball is located in commutator end of armature shaft, lubricate armature shaft and thrust ball with a high melting point grease and install armature shaft in case assembly bearing.

12. Remove the brush retainer spring.

13. Maintaining the armature in its assembled position in the case, start the armature worm shaft through the field and housing bearing until it starts to mesh with the worm gear.

NOTE: It may be necessary at this point to rotate the armature slightly before the worm will engage with the worm gear.

14. Rotate the case as required to align the holes in the case with those in the housing.

15. Being very careful not to pinch any of the motor leads between the case and edge of the field, push the case onto the field until it butts against the housing.

16. Secure the case to the housing with the two tie bolts.

17. Install end-play adjusting screw finger tight, back off ¼ turn and tighten lock nut.

DISASSEMBLE GEAR BOX (FIG. 11-91)

The gear box section is subdivided into two areas, (A) The relay control and latching mechanism and (B) The drive gear mechanism.

A. RELAY CONTROL AND LATCHING MECHANISM:

DISASSEMBLY:

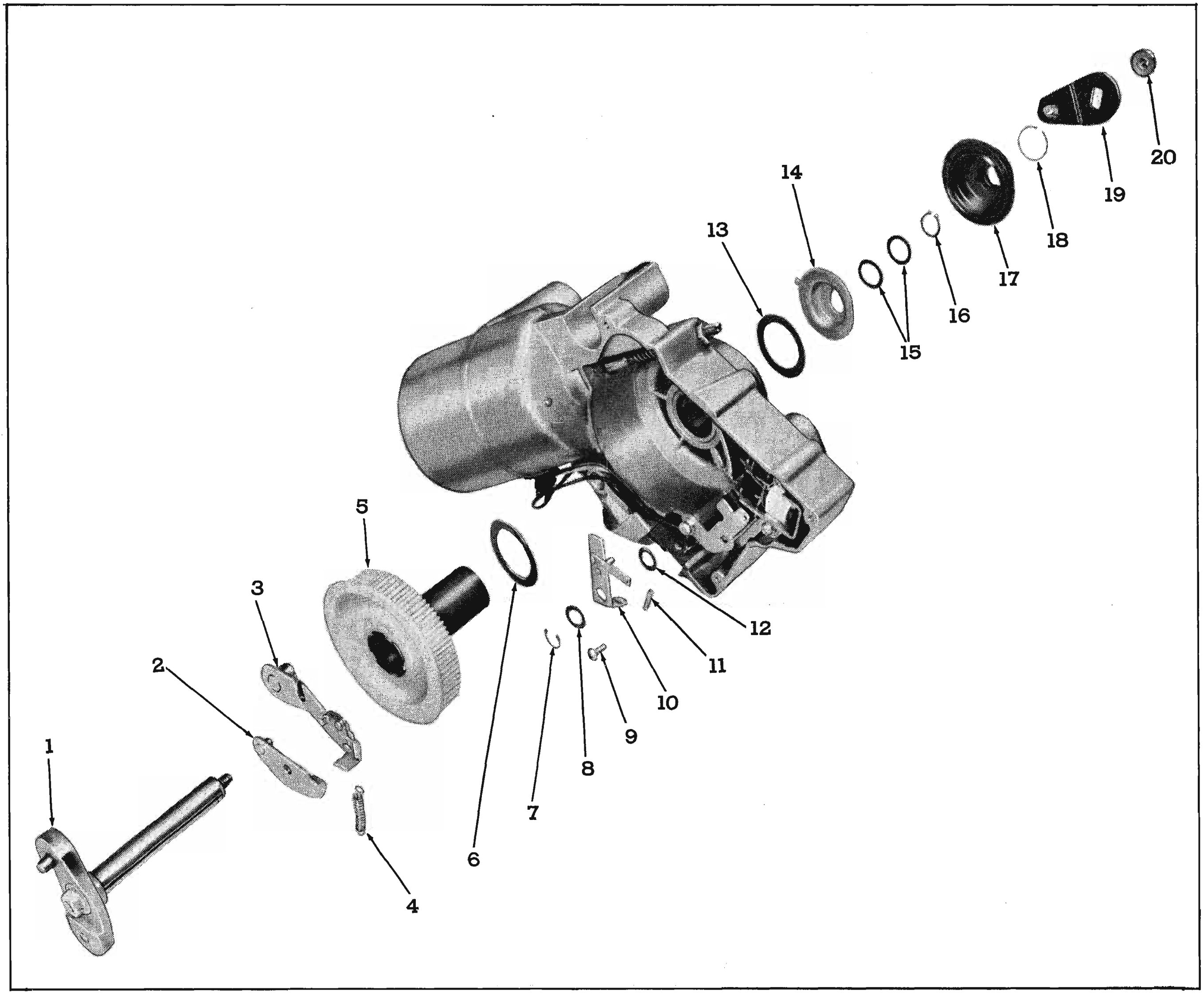
1. Remove the four screws which secure the gear box cover or washer pump assembly to the gear box.

2. Disconnect coil spring, remove E-ring and lift the latch and follower assembly off the pivot pin and relay armature.

3. Remove the stop assembly retaining screw. This will permit the stop assembly to be moved as necessary to allow clearance for removing the relay control assembly.

4. Remove the two screws that secure the relay control assembly.

5. Lift the relay control assembly out of the gear box and unsolder leads as required.



1. Drive Plate and Shaft Assy.	6. Spacer Washer	11. Spring	16. Retaining Ring
2. Lock Pawl	7. E-Ring	12. Spacer Washer	17. Seal Cap
3. Drive Pawl	8. Spacer Washer	13. Spacer Washer	18. Snap Ring
4. Spring	9. Retaining Screw	14. Shield	19. Crank Arm
5. Gear and Eccentric Shaft	10. Latch Arm	15. End Play Washers	20. Nut

Fig. 11-91 Two-Speed Overlap Windshield Wiper Drive Mechanism—Exploded View

ASSEMBLY:

Solder existing green and yellow wiper leads to relay control switch and solder the relay coil lead to the wiper unit terminal board and reverse disassembly procedure.

B. DRIVE GEAR MECHANISM

DISASSEMBLY:

1. Remove the crank arm retaining nut.
2. Remove crank arm, snap ring, and rubber seal.

3. Remove the retaining ring, end play washers, shield, and spacer washer.

4. Follow steps 1 through 3 under RELAY CONTROL AND LATCH MECHANISM DISASSEMBLY.

5. Remove gear mechanism from the gear box and slide spacer washer off the gear assembly eccentric shaft.

6. Slide the drive plate and shaft assembly out of the gear assembly, remove the lock and drive pawls, and remove the coil spring.

ASSEMBLY:

1. Assemble lock and drive pawls to the shaft and drive plate assembly.

2. Install the assembled parts in the gear and eccentric shaft.

3. Hold the gear and drive plate assembly in this relative position until installed in housing since no retainer is used and accidental disassembly can easily occur.

4. Connect the coil tension spring between the lock and drive pawls.

5. Reinstall spacer washer on eccentric shaft of gear.

6. Reinstall gear mechanism in the housing as shown.

7. Reassemble parts removed in Steps 1 through 4 under drive gear disassembly.

NOTE: The crank arm is installed so that it "points" to the side of the drive plate OPPOSITE to that on which the coil spring between the lock and drive pawls is located.

End play should be .005" max. End play washers should be added as required.

WINDSHIELD WASHER PUMP—REPLACE

The washer pump assembly is serviced as a complete unit. To replace the washer pump assembly proceed as follows:

1. Remove wiper unit from car.

2. Remove the four (4) screws that secure the washer pump and cover assembly to the gear box.

3. Install washer pump and cover assembly so that the slot in the washer pump cam arm fits over the pin on the wiper unit drive plate.

4. Reinstall the four screws that secure the washer pump assembly to the wiper gear box.

WIPER OPERATIONAL CHECKS ON CAR

Testing the wiper while installed on the car consist of checking out the body wiring, dash control and wiper linkage.

BODY WIRING

1. Make sure body wiring is properly connected to the wiper unit and dash switch.

2. Check the wiper unit ground strap making sure it is securely connected under wiper unit cover screw and to body.

3. With ignition switch turned on, check for 12 volts at center or No. 2 terminal of wiper unit terminal board. If unit is equipped with washer pump, check also for 12 volts at the brown lead terminal which connects to washer pump.

DASH SWITCH

1. Check dash switch mounting. Loose mounting can cause an intermittent operating condition when using the wiper.

2. To determine if dash switch or power is faulty, try operating wiper independently of dash switch as follows:

Connect 12 volt supply to center or No. 2 terminal of wiper terminal board and connect a jumper wire from terminal No. 1 (next to cover) to ground. Wiper should operate in "Hi" speed.

To check "Lo" speed operation, connect an additional jumper wire from terminal No. 3 to ground.

3. To determine if washer pump unit or the button is faulty, operate washer pump independently of washer switch as follows:

Operate wiper unit as explained in Step 2 above and connect 12 volts to either of the washer pump terminals. Connect a jumper wire from the other terminal to ground.

WIPER LINKAGE

Remove necessary body parts to gain access to wiper unit crank arm and transmission link rods. Disconnect transmission link arms from crank arm and manually operate each wiper transmission to locate either a binding condition or faulty transmission.

INSTALLING DRIVE ARM

The slotted hole in drive arm must engage rectangular shoulder on the wiper transmission shaft to ensure the park position, wipe pattern and synchronization of wiper arms will be correct. If drive arm does not fully engage shoulder on motor shaft it will only be held temporarily by friction of the retaining nut, and wipers will operate only through a few cycles before nut becomes loose.

Check installation of drive arm. Nut must be from flush to one thread below end of wiper transmission shaft.

NOTE: Drive (crank) arm must be installed with motor in park position (link end of arm toward driver side).

WIPER OPERATIONAL CHECKS ON BENCH

RELAY CONTROL—LATCH MECHANISM

Remove gear box cover or washer pump assembly to gain access to relay control and latching mechanism. To prevent motor from running, disconnect yellow lead from relay control switch.

Manually operate the relay armature to check that latch arm and attaching parts move freely.

RELAY CONTROL ASSEMBLY

1. Circuit to Relay Coil—Connect 12 volt supply to wiper as follows: (+) to center of No. 2 terminal and (−) to housing. Check for 12 volts at switch terminal to which the green lead is attached. No voltage indicates an open lead circuit breaker or a broken brown or green lead.

2. Relay Coil—If circuit to relay coil checks out leave 12 volt supply connected as explained in Step 1 above and connect a jumper wire from terminal No. 1 to housing. Failure of relay armature to pull in indicates a weak or open relay coil. (Recheck for a binding condition in the latching mechanism.)

3. Relay Switch—If steps 1 and 2 above check out correctly, proceed as follows:

a. Leave battery and jumper wire connected as described in Steps 1 and 2 and check for 12 volts at switch terminal to which the yellow lead attaches. If relay pulls in properly and no voltage reading is obtained a defective switch is indicated.

b. Disconnect jumper wire between terminal No. 1 to ground and check that relay armature moves away from coil pole.

NOTE: If wiper gear mechanism is in full park position, disconnect the coil spring that connects between the gear assembly drive and lock pawls to release the pressure of the drive pawl switch actuator against the switch tab. Check for 12 volts at switch terminal to which yellow lead attaches. No voltage reading indicates a defective relay switch.

c. Leave voltmeter connected as described in Step b above and manually push the switch stop tab toward the relay coil. If voltage reading is still obtained a defective switch is indicated.

MOTOR CHECKS

For the motor checks disassemble the motor but leave the field assembly in the housing.

ARMATURE

Ground, Open or Shorted—Checking adjacent commutator bars with test prods from a 12 volt source and noting variations in reading should locate trouble in the armature.

CASE AND BRUSH ASSEMBLY

Inspect the case and brush assembly for the following items:

a. Brushes worn or binding in their respective holders

b. Defective brush springs

c. Loose solder joints

d. Dirty or defective circuit breaker contacts

FIELD ASSEMBLY

Open Test—Disconnect yellow lead from relay control switch and connect an ohmmeter between the yellow lead and the brush holder to which the internal field lead connects. No reading indicates an open series field.

Next connect an ohmmeter between the yellow lead and the terminal to which the black motor lead attaches. No reading indicates an open shunt field.

OPERATING WIPER—BENCH

CAUTION: Be sure brass ground strap is connected to wiper housing.

"Lo" Speed—Connect 12 volt supply to center or No. 2 terminal and ground housing. Connect jumper wires from terminals 1 and 3 to ground.

"Hi" Speed—Disconnect jumper wire from terminal No. 3.

Stop—Reconnect jumper from terminal No. 3 to ground and disconnect jumper from terminal No. 1.

TWO-SPEED WINDSHIELD WIPER TROUBLE DIAGNOSIS

CONDITION	POSSIBLE CAUSE	REMEDY
Wiper inoperative	1. No power supply (12 V) at wiper.	1. Check circuit from power source to wiper.
	2. Wiper ground strap loose or disconnected.	2. Connect ground strap securely to body.
	3. Inoperative dash switch.	3. See dash switch checking procedure.
	4. Wiper unit latching mechanism binding.	4. See wiper latching mechanism checking procedure.
	5. Inoperative relay control.	5. See relay control checking procedure.
	6. Inoperative wiper motor.	6. See wiper motor checking procedure.
	7. Drive shaft siezed in eccentric gear shaft.	7. Free up shaft or replace parts.
Wiper will not shut off.	1. Wiper unit latching mechanism binding.	1. Free up latching mechanism and lubricate as required.
	2. Relay control switch inoperative. (Relay coil grounded.)	2. See relay control checking procedure.
	3. Drive pawl tab broken.	3. Replace drive pawl.
Excessive speed in "Hi" speed range but operates normal in "Lo" speed.	1. Loose solder connection between motor black field lead and wiper terminal board.	1. Repair as required.
	2. Resistor on wiper terminal board open, or rivets loose.	2. Replace terminal board assembly.
Wiper operates in "Lo" speed only.	1. Inoperative dash switch.	1. See dash switch checking procedure.
	2. Black lead between dash switch and wiper terminal board grounded.	2. Check body wiring to locate grounded condition and repair as required.
	3. Wiper motor black lead internally grounded.	3. Disassemble wiper as required to locate and repair grounded condition.
Wiper operates in "Hi" speed only.	1. Dash switch inoperative.	1. See dash switch checking procedure.
	2. Repair black lead as required.	2. Black lead between dash switch and wiper unit open.
Transmission noise.	Add end play washers to obtain .055" max. end play.	Excessive end play in idle shaft and/or reversing link shaft.
Blades don't park, stop any place.	Replace relay switch assembly.	Inoperative relay switch.

SINGLE-SPEED TANDEM WIPER

GENERAL DESCRIPTION

The one-speed tandem wiper consists of a rectangular-shaped shunt wound 12 volt motor attached to a gear box containing a gear and shaft assembly and parking switch (Fig. 11-92). These wipers operate at approximately 48 cycles per minute and have an automatic park position. The parking switch contacts are located in the gear box so that a mechanical type washer pump, similar to that used on two-speed overlap wipers, could be adapted to the one-speed tandem wiper systems.

The tandem system, which could be described as a wiper team working in unison, has a wipe angle of 107° and an arm radius of 14.7 inches. Wiper blades are approximately 15 inches long.

WIPER OPERATION

The single-speed tandem wiper operates with two switches—a dash switch and a parking control switch —to control the starting and stopping of the wiper. The parking switch contacts are located internally in the wiper unit gear box.

When the wiper is turned "on" at the dash switch, current flows through the motor field and armature to the dash switch to ground.

When the wiper is first turned "off", the wiper motor circuit to ground is opened at the dash switch. However, the parking switch contacts, which are

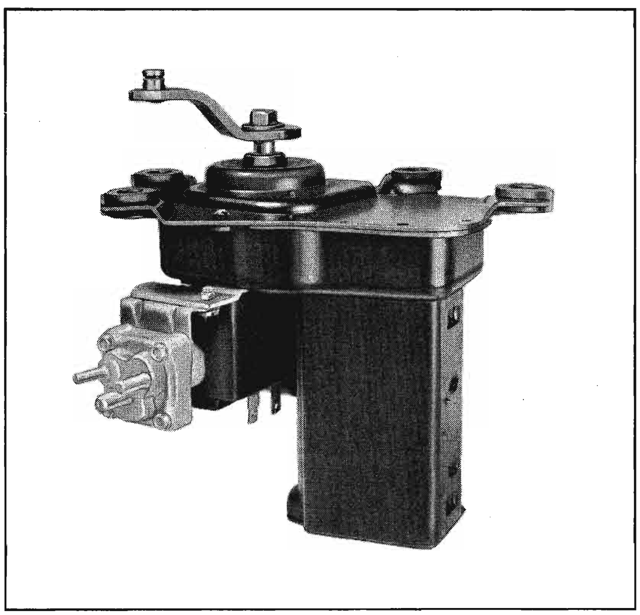


Fig. 11-92 Single Speed Windshield Wiper

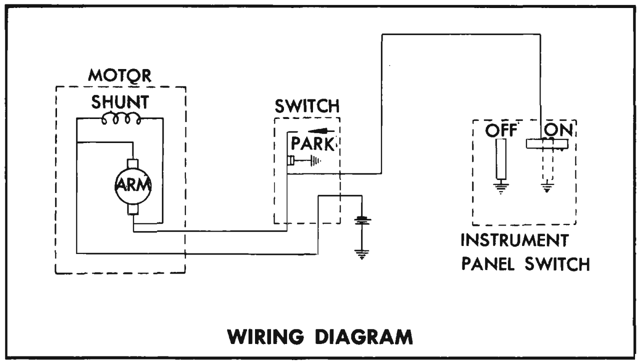


Fig. 11-93 Single-Speed Wiper Schematic

closed to ground by a ring on the wiper gear keep the motor circuits closed to ground until the wiper reaches the park position. As the wiper reaches the park position a hump on the wiper gear is reached. This allows the parking switch contacts to open which in turn opens the motor circuits to ground.

WIPER ADJUSTMENTS

ARMATURE END PLAY

Armature end play is automatically adjusted by proper assembly of end play washers (Fig. 11-94).

WIPER UNIT CHECKING PROCEDURES—SINGLE SPEED

CHECKING THE WIPER INSTALLED IN CAR

1. Check to see that ground strap connection is tight at both the wiper and car body.

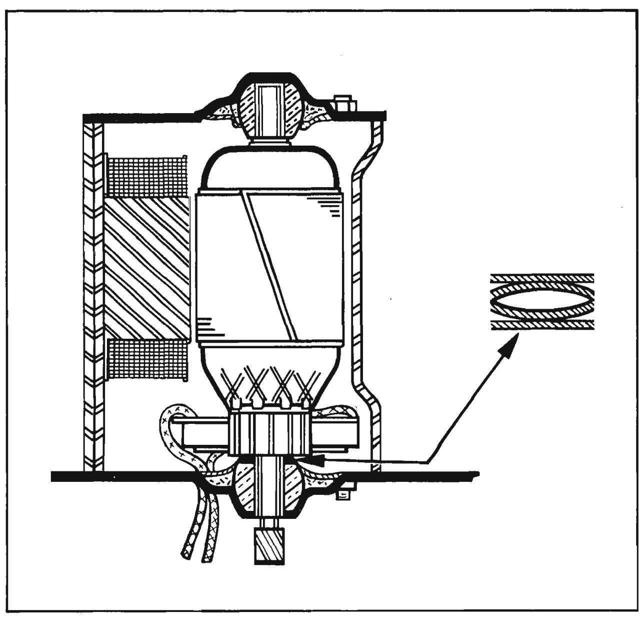


Fig. 11-94 Armature End Play Washers

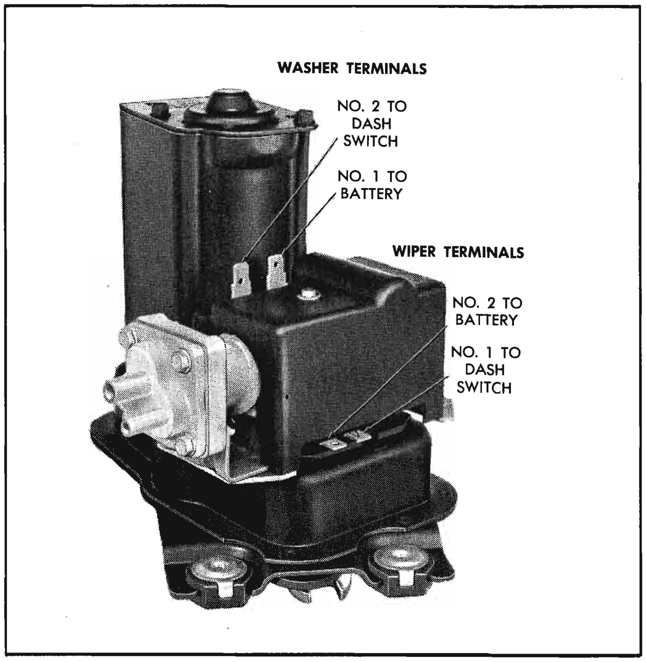


Fig. 11-95 Wiper and Washer Terminals

2. With ignition on, check for 12 volts at feed wire terminal that connects to the No. 2 wiper terminal (Fig. 11-95). If no voltage reading was obtained, check car wiring.

3. If correct voltage is obtained in step 2, connect a jumper wire from the No. 1 terminal (Fig. 11-95) to ground. If wiper operates, an inoperative dash switch or broken wire to dash switch is indicated.

4. If wiper fails to operate in step 3 remove body parts as necssary to gain access to the wiper transmissions and linkages. Disconnect transmission arms from wiper crank arm and recheck to see if wiper will operate. If wiper operates correctly, trouble is located in the transmissions. If wiper fails to operate, remove wiper from car for bench check.

CHECKING WIPER REMOVED FROM CAR

There are four basic reasons for removing the wiper unit from the car for repairs (1) wiper inoperative (2) wiper blades fail to park (i.e., blades stop anywhere on glass when wiper is turned off) (3) wiper fails to shut off (4) intermittent operation.

WIPER INOPERATIVE

Connect wiper to 12 volt system as shown in Fig. 11-96 and note current draw. The following ammeter readings will indicate the type of trouble to look for.

Current Draw—0

No reading indicates an open motor circuit. Check solder connection at terminal board and all splice connections in motor.

Current Draw—2-3 amps

Disassemble motor and check for

a. Open armature

b. Sticking brushes

c. Improperly positioned brush springs

d. Loose pigtail connections at splice joints (Fig. 11-97)

Current Draw—10-12 amps

a. Open field circuit

b. Broken gear

WIPER RUNS SLOWLY AND VIBRATES—CURRENT DRAW 7-9 AMPS

Check for binds in the gear train.

Check for shorted armature using a growler.

WIPER BLADES FAIL TO PARK

This condition is caused by parking switch contacts being dirty or broken. To inspect and/or clean contacts, disassemble gear box.

WIPER FAILS TO SHUT OFF

a. Check to see that wiper motor lead that connects to the No. 1 terminal (Fig. 11-95) is not grounded.

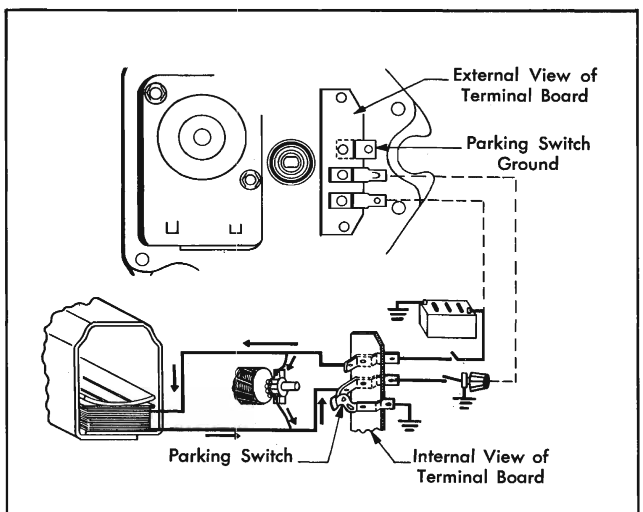


Fig. 11-96 Wiper Wiring

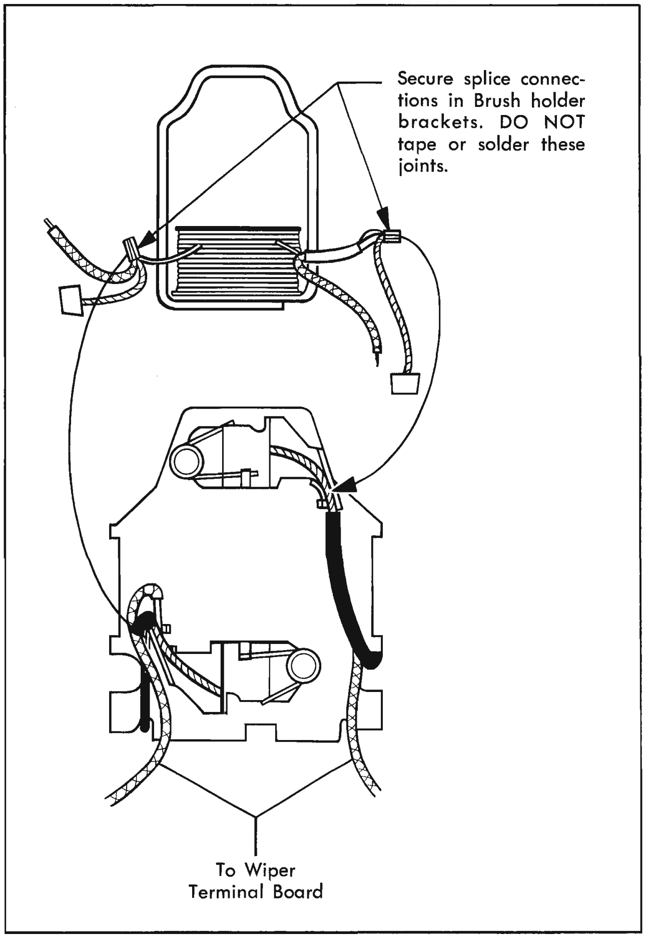


Fig. 11-97 Wiper Internal Wiring

b. Disconnect wiring from dash switch. If wiper shuts off, replace dash switch.

c. Check to see that parking switch contacts are not frozen, bent or burnt together.

INTERMITTENT OPERATION

Check for loose ground strap, loose dash switch, loose connection.

SINGLE SPEED WIPER—DISASSEMBLE

GEAR BOX

1. For wipers equipped with a washer pump remove the two washer pump mounting screws and lift washer pump off wiper.

2. Remove washer pump drive gear (Fig. 11-98). The gear is pressed on the shaft but can be wedged off by using two screwdrivers between gear and plate.

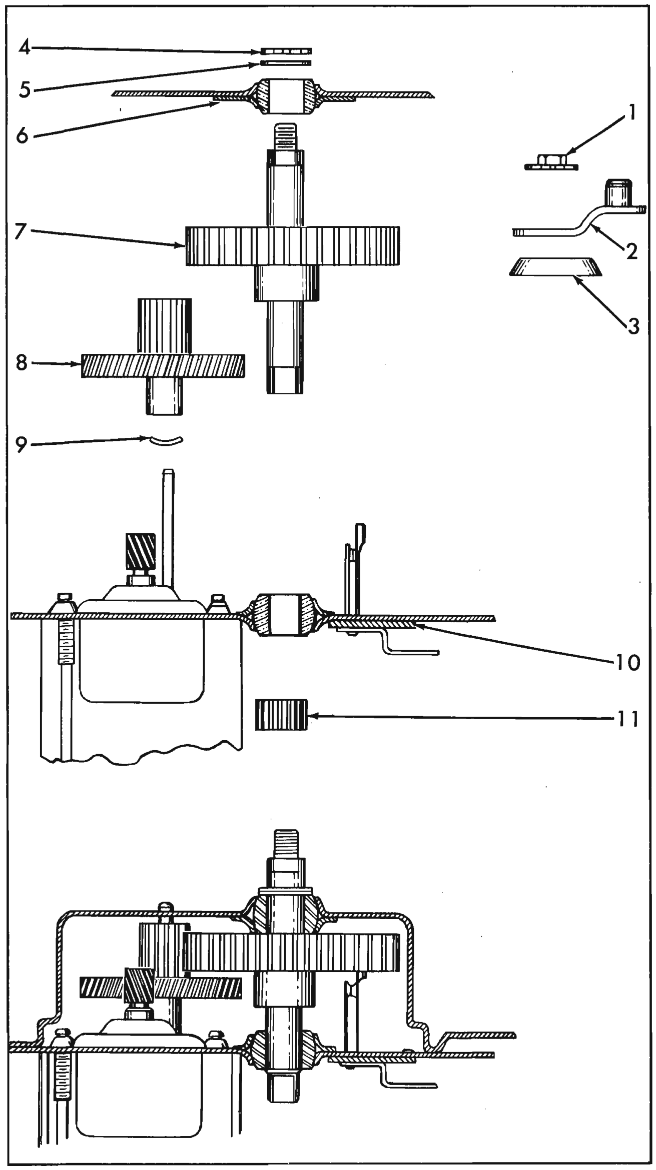
3. Clamp crank arm in a vise and loosen crank arm retaining nut.

4. Remove seal cap, retaining ring and end-play washers.

NOTE: Seal cap should be cleaned and re-packed with a water proof type grease before re-assembly.

5. Drill out the gear box cover retaining rivets and remove cover from gear train.

CAUTION: Mark ground strap location for re-assembly purposes.



1. Nut
2. Crank Arm
3. Seal Cap
4. Retaining Ring
5. Washer
6. Gear Box Cover
7. Output Gear and Shaft Assy.
8. Intermediate Gear
9. Spring Washer
10. Parking Switch and Terminal Board Assy.
11. Washer Pump Drive Gear

Fig. 11-98 Gear Box X-Section

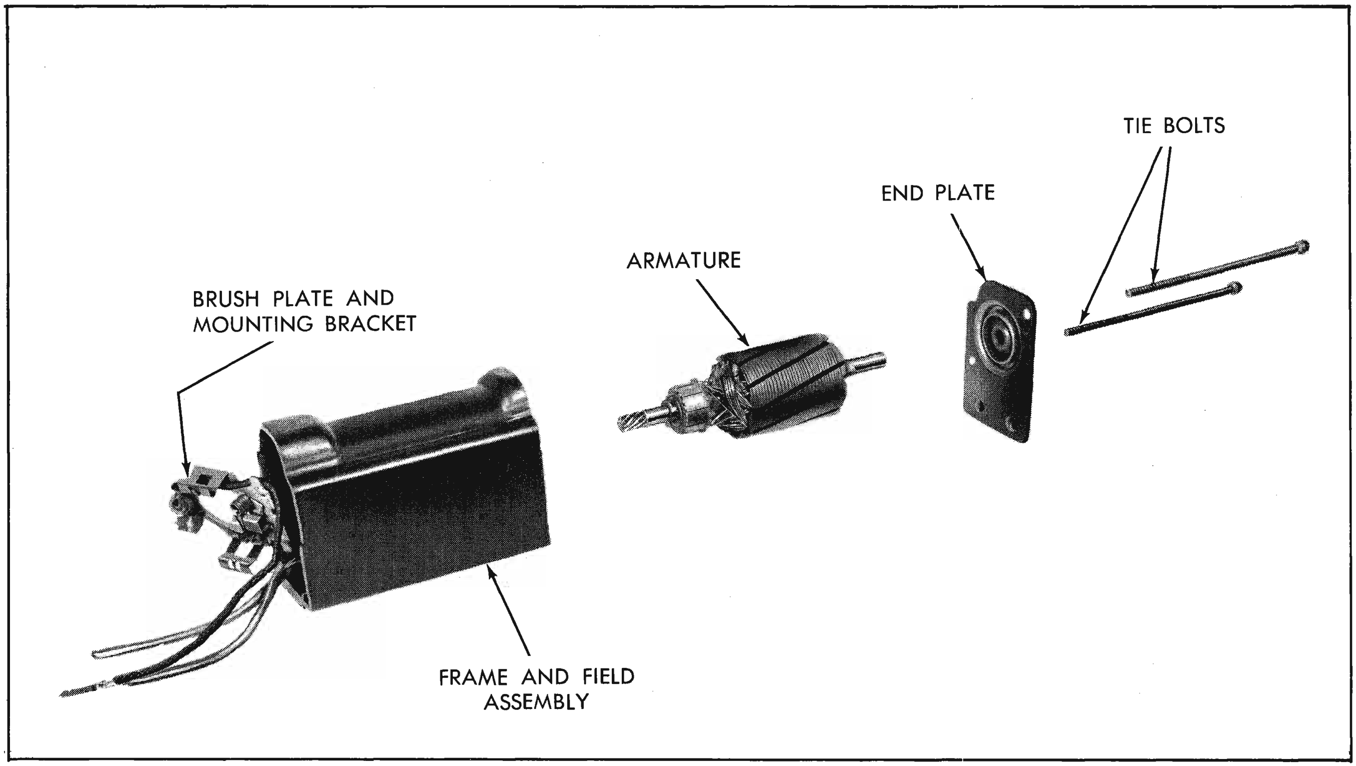


Fig. 11-99 Wiper—Exploded View

NOTE: Screws, nuts and lockwashers for re-assembling cover to wiper are contained in the service repair package.

6. Remove output gear and shaft assembly (Fig. 11-98), then slide intermediate gear and pinion assembly off shaft.

7. Remove terminal board and park switch assembly, if necessary, as follows:

a. Unsolder motor leads from terminals. Coding of these leads on single speed wipers is not necessary.

b. Drill out rivets that secure terminal board and park switch ground strap to plate.

NOTE: Screws, nuts and washers for attaching a replacement terminal board-park switch assembly are included with the replacement assembly.

GEAR BOX—ASSEMBLE

Reverse steps 1 thru 7 except as noted:

1. **INSTALL GEAR BOX COVER.** Be sure cover is located properly over locating dowel pins and be sure to re-install ground strap.

2. **INSTALL CRANK ARM.** Operate wiper to park position and install crank arm on output shaft so that identification marks line up with those in the cover (Fig. 11-100). Clamp crank in vise before securing the retaining nut.

MOTOR—DISSASEMBLE

Refer to Fig. 11-99.

1. Follow steps 1 thru 7 under gear box disassembly.

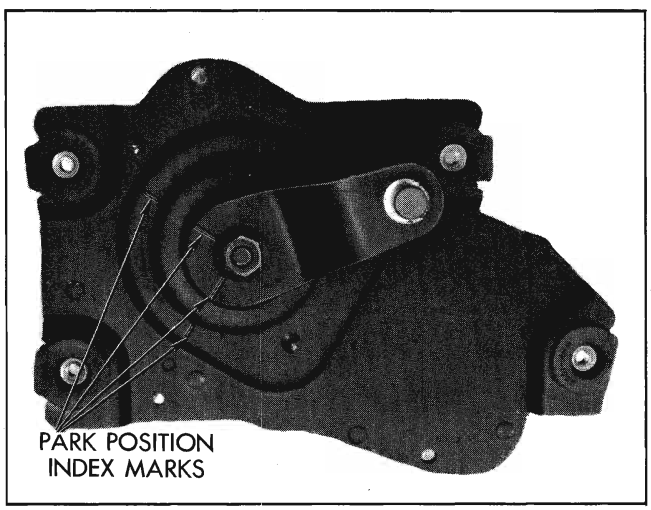


Fig. 11-100 Crank Arm Position

2. Release brush spring pressure against brushes as shown in Fig. 11-101.

3. Move brushes away from armature and slide armature out of frame and field assembly. Pull end cap assembly off armature.

4. Remove end play adjusting washers.

To assemble motor, reverse steps 1 thru 4.

WIPER SPECIFICATIONS

Operating Test Voltage	12 VDC
Crank Arm Rotation (looking at arm)	CCW
Current Draw (Amps.)	
No load	3 Max.
Dry windshield	3.5 Max.
Stall	11.0 Max.

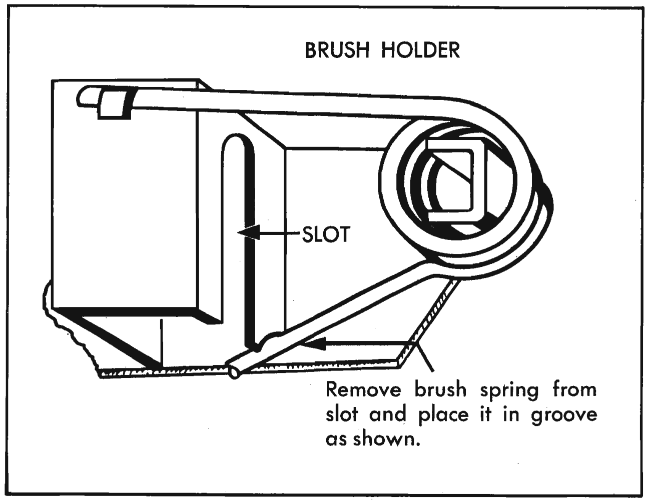


Fig. 11-101 Motor Brush Spring

WINDSHIELD WASHER PUMP—TWO SPEED WIPER

GENERAL DESCRIPTION

The windshield washer pump used with the two-speed wipers is equipped with a four lobe rotor cam. It consists of a relay, pump assembly, valve assembly and related parts assembled in a casting which attaches directly to the wiper gear box.

OPERATION

When the washer pump assembly is mounted on the wiper correctly a pin on the gear fits into the slot of washer rotor cam (Fig. 11-102).

Thus when the wiper is operated this rotor cam is always turning with the wiper gear.

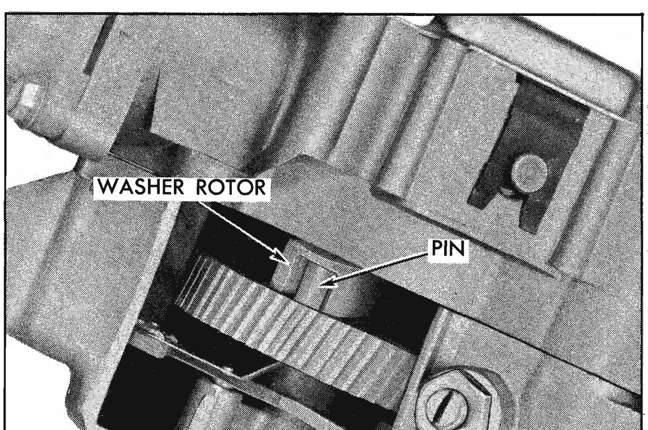


Fig. 11-102 Washer Rotor

WIPER ON—WASHER OFF

As the rotor cam rotates, it actuates a spring loaded lever and pin assembly to which a ratchet arm is attached (Fig. 11-103).

The lever arm pin extends into the slot of a spring loaded plunger arm. The spring loaded plunger arm which is attached to the pumping bellows, is held in a retracted position (spring compressed) by an eccentric on the ratchet wheel when the pump is idling (Fig. 11-104).

Thus while the pumping mechanism is idling the lever arm pin can move freely back and forth in the plunger arm slot and no pumping action occurs. The

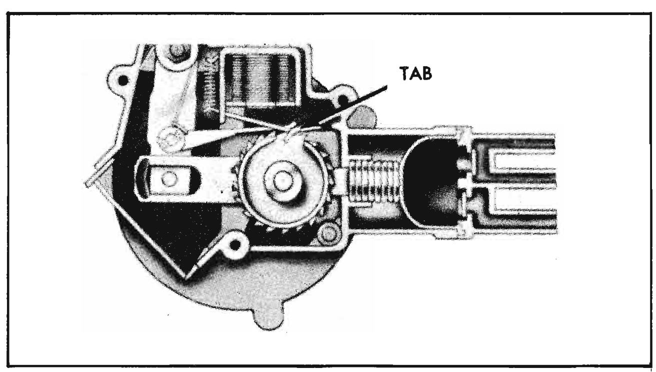


Fig. 11-103 Pump Tab

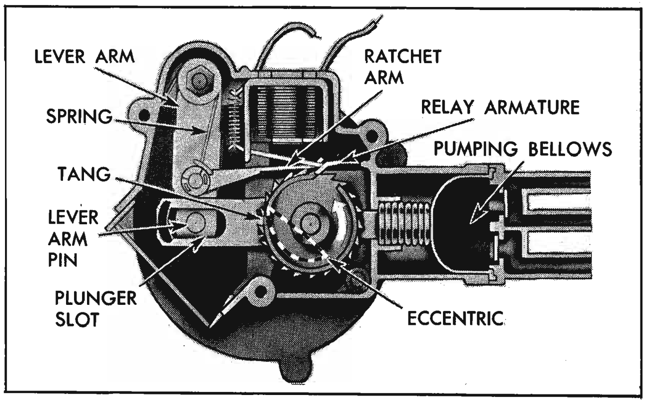


Fig. 11-104 Engaged Position

ratchet arm, which extends through an opening in the relay armature, is prevented from rotating the ratchet wheel by the relay armature.

WIPER ON—WASHER ON

When the washer button on the dash is pushed in to start the washer the circuit to the washer pump relay coil is closed to ground. The relay armature then pulls in and is held in the energized position by a wire stop (Fig. 11-105).

The ratchet arm, which previously was moving freely back and forth through the armature opening now drops out of the opening and starts to rotate the ratchet wheel.

As the ratchet wheel is rotated, the eccentric is moved away from the plunger arm tang releasing the plunger arm for pumping action (Fig. 11-106).

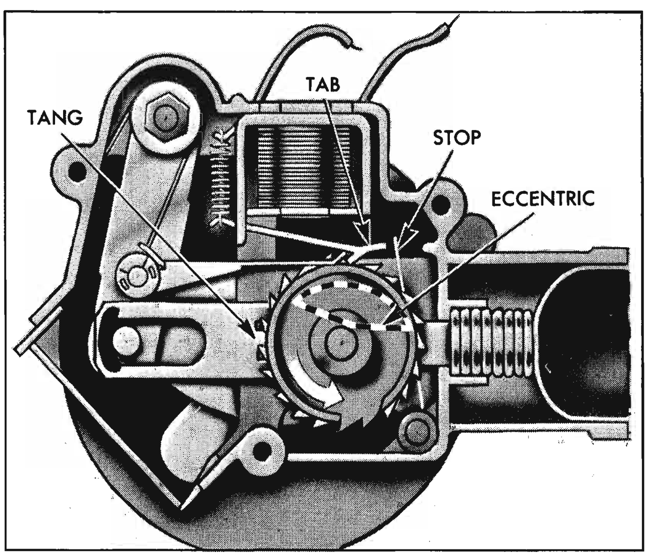


Fig. 11-105 Pump Stop

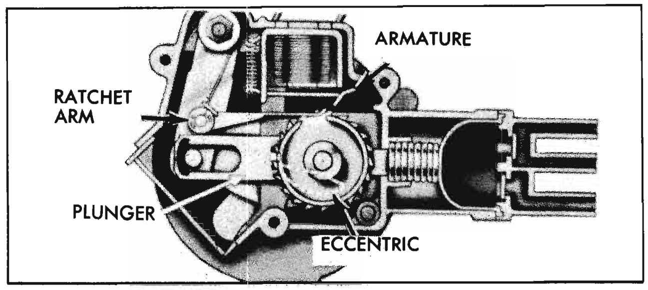


Fig. 11-106 Plunger Arm Release

The plunger arm being spring loaded, now moves in a direction toward the bellows and collapses the bellows forcing the water in the bellows out through the outlet valves to the nozzles (exhaust stroke). See Fig. 11-107. At the same time the edge of the plunger arm slot moves up tight against the lever arm pin. As the rotor cam is turned each lobe (4) actuates the lever arm which in turn pulls the plunger arm back compressing the spring. While the plunger arm is being pulled back (suction stroke) water is drawn in through the inlet valve (Fig. 11-108). As the high point of each lobe is passed, the plunger arm spring pulls the plunger arm toward the bellows. This collapses the bellows and forces water out through the outlet valve (exhaust stroke).

Thus for each revolution of the wiper gear and/or rotor cam there are four pumping strokes. For each pumping stroke the ratchet wheel is actuated or turned one tooth by the ratchet arm.

As the ratchet wheel turns the eccentric (Fig. 11-109) pushes the wire stop out of the way of the relay armature. This allows the armature to partially drop so that the armature tab rests against the edge of the ratchet wheel.

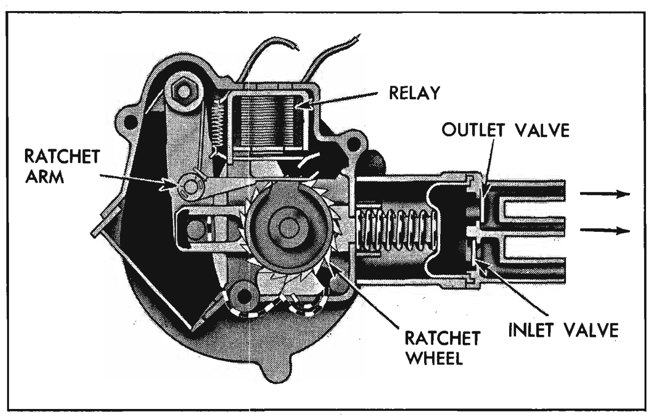


Fig. 11-107 Exhaust Stroke

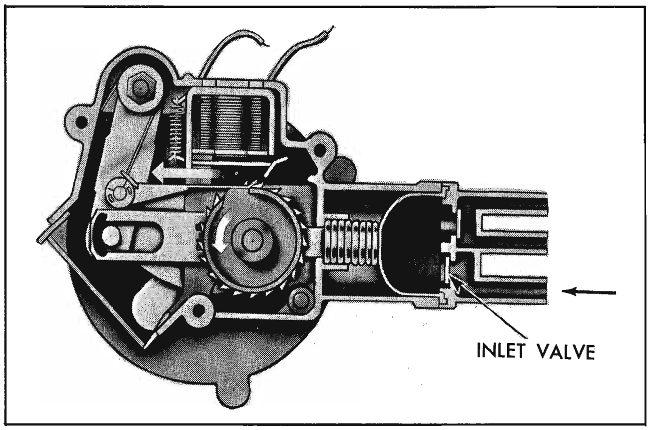


Fig. 11-108 Suction Stroke

After the ratchet wheel has been rotated about 12 teeth, the ratchet wheel eccentric starts to interfere with the plunger arm tang (Fig. 11-104). This results in shorter pumping strokes and thus smaller "squirts" out the nozzles.

When the ratchet wheel has been turned through 360° or 21 teeth, two simultaneous functions occur as the wash cycle is completed. (1) Relay armature tab drops into the ratchet wheel slot allowing the ratchet arm to enter the armature opening preventing further ratchet wheel rotation. (2) The ratchet wheel eccentric has moved into a position which holds the plunger arm in a retracted position preventing further pumping action. The pump is now back idling.

CHECKING PROCEDURES

CHECKING THE WASHER PUMP ON THE CAR

WASHER PUMP INOPERATIVE

1. Inspect all washer hoses and hose connections. Check screen at end of jar cover tube and see if adequate supply of washer solution is in jar.
2. If items in step 1 check out, start wiper motor first then push washer button and listen for "click" as washer relay pulls in. If no "click" is heard, check power supply (12 V) at washer pump wiring connector. No voltage indicates shorted or inoperative car wiring.
3. If correct voltage reading was obtained in step 2, start wiper first then connect 12 volt supply to one wiper terminal and ground the other. If washer relay "click" is heard, an inoperative dash switch is indicated.
4. If washer relay click is not heard in step 3, a faulty washer pump relay coil is indicated.

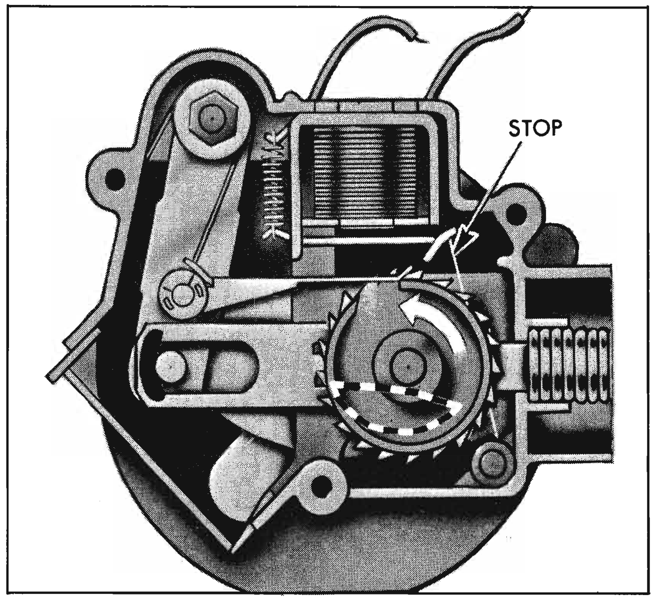


Fig. 11-109 Pump Eccentric

5. If relay click was heard in step 3 and pump still does not pump water, an inoperative valve assembly is indicated.

   NOTE: Listen for soft clicking as washer pump ratchet wheel is rotated through a cycle.

WASHER PUMPS CONTINUOUSLY WHEN WIPER IS "ON"

1. Disconnect wiring from washer pump. If pump shuts off, trouble is located in the wiring or switch.

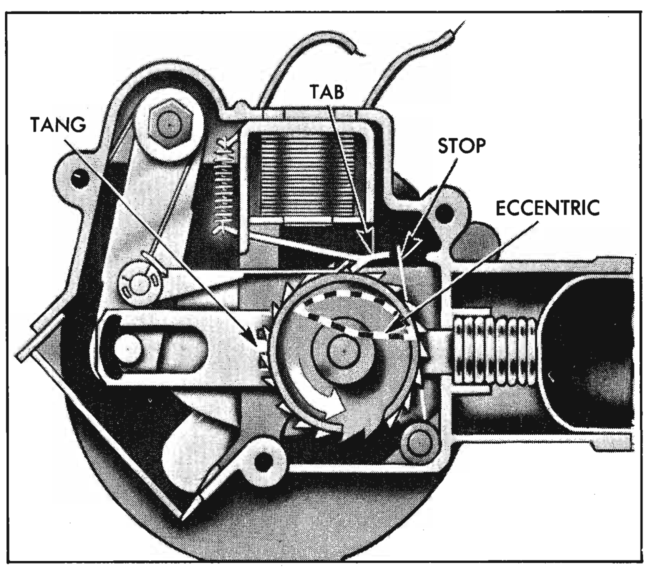


Fig. 11-110 Pump Stop

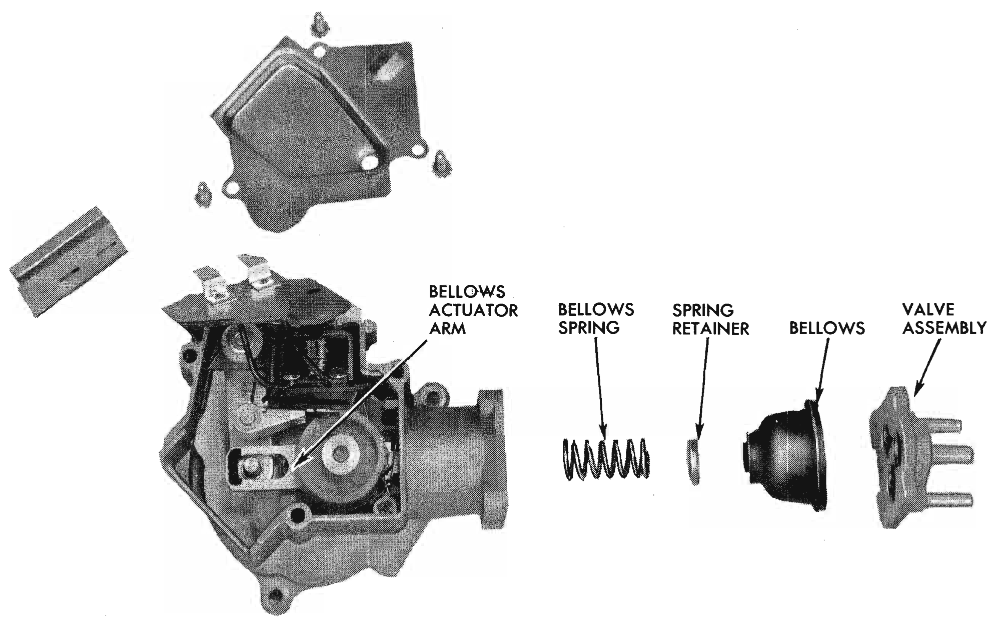


Fig. 11-111 Washer Pump—Exploded View

2. If pump fails to shut off in step 1, remove pump assembly from car for further checking. (See below.)

CHECKING DETACHED WASHER PUMP

1. Connect 12 volt supply to one washer terminal and ground the other. Manually rotate the rotor cam and observe if relay armature pulls in (Fig. 11-110). Failure of relay to pull in indicates an open relay coil or poor solder connections.

2. If relay pulled in in step 1, manually rotate the rotor cam (CCW looking at rotor) through a complete cycle (ratchet wheel rotated through 360° or 21 teeth) carefully observing if performance matches that as explained under washer operation.

   Binds or any other type of malfunction can usually be located in this manner.

WASHER PUMP DISASSEMBLY PROCEDURES

RELAY TERMINAL BOARD ASSEMBLY

1. Remove relay terminal board cover.

2. Slide spring clip off relay mounting stud.

3. Rotate nylon rotor cam to free ratchet pawl from relay armature and lift out relay terminal board.

4. Save terminal insulator for reassembly.

5. To reinstall relay assembly, hold relay armature against the coil pole and position the coil mounting stud in the casting slot.

6. Reinstall spring clip on mounting stud.

7. Assemble insulator over terminal and position terminal board.

8. Manually rotate washer pump nylon cam through a cycle (ratchet rotated 21 teeth) to check if pump is operating correctly as explained under pump operation.

VALVE ASSEMBLY

1. Remove the four screws that secure the valve assembly to the housing (Fig. 11-111) and gently pry the bellows lip out of the valve body.

BELLOWS REPLACEMENT

1. Remove valve assembly.

2. If pump is in idling postion, release it as follows: Push relay armature toward relay coil so that wire stop spring engages it (Fig. 11-110) then manually rotate nylon rotor cam until pumping action can be felt. The bellows should now extend partially out of the housing.

3. Place an obstruction (small block of wood) between cam lever arm and housing.

4. Push in against bottom of bellows and turn bellows approximately 90°. This should release bellows from pumping arm.

5. Reassemble by reversing the above procedure.

WINDSHIELD WASHER PUMP—SINGLE SPEED WIPER

GENERAL DESCRIPTION

The windshield washer pump used with the single speed wipers is equipped with a three lobe rotor cam. It consists of a relay, pump assembly, valve assembly and related parts assembled in a unit which attaches directly to the wiper gear box (Fig. 11-112).

OPERATION

The washer pump assembly is mounted on the wiper gear box and driven through gears by the wiper motor (Fig. 11-113).

Thus when the wiper is operated the rotor cam is always turning with the wiper gear.

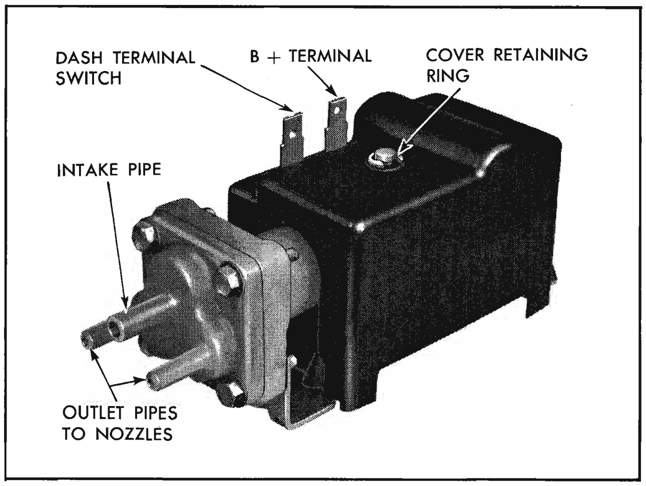


Fig. 11-112 Washer Unit—Single Speed Wiper

WIPER ON—WASHER OFF

As the rotor cam rotates, it actuates a spring loaded roller and plunger arm assembly to which a ratchet arm is attached (Fig. 11-113).

The lever arm pin extends into the slot of a spring loaded plunger arm. The spring loaded plunger arm

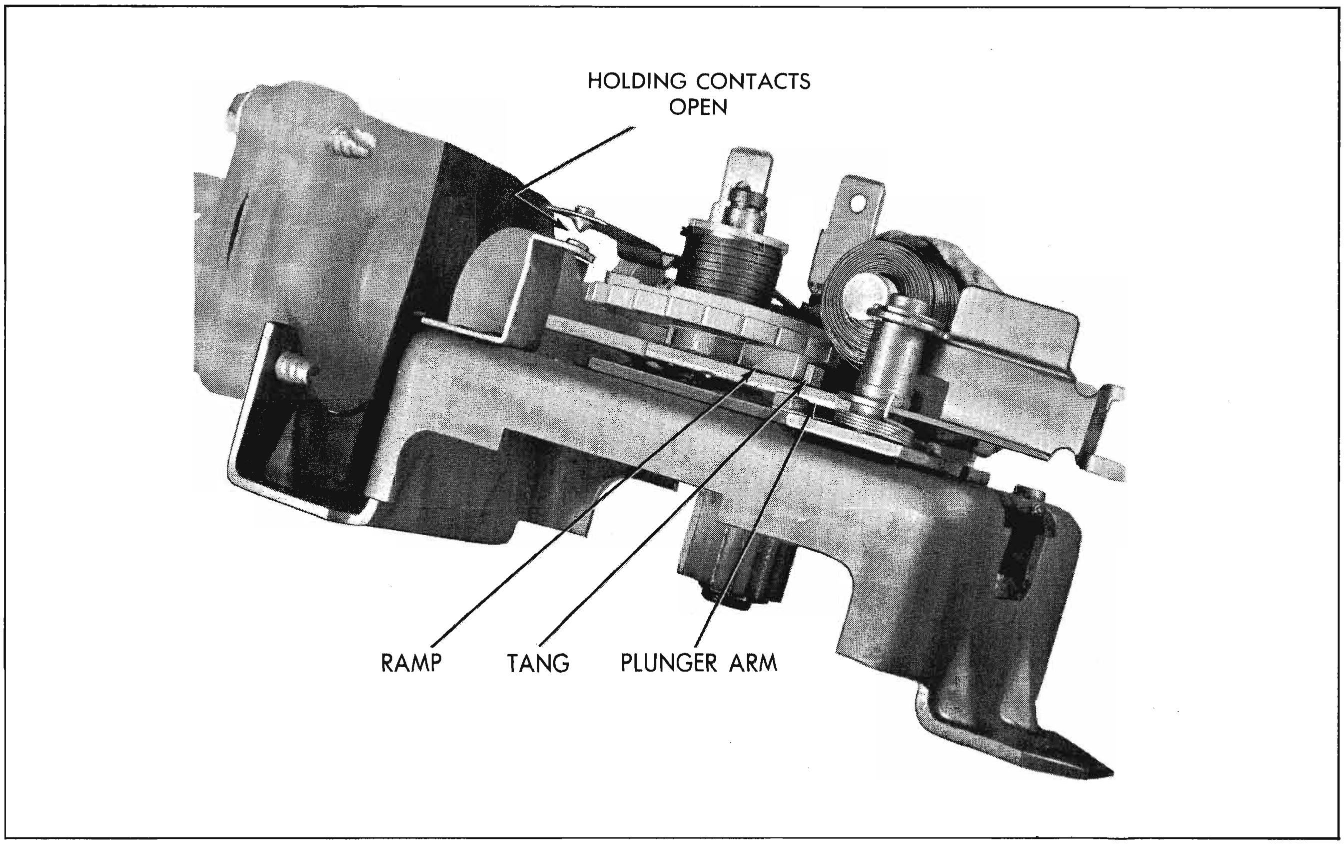


Fig. 11-113 Washer Unit—Cover Removed

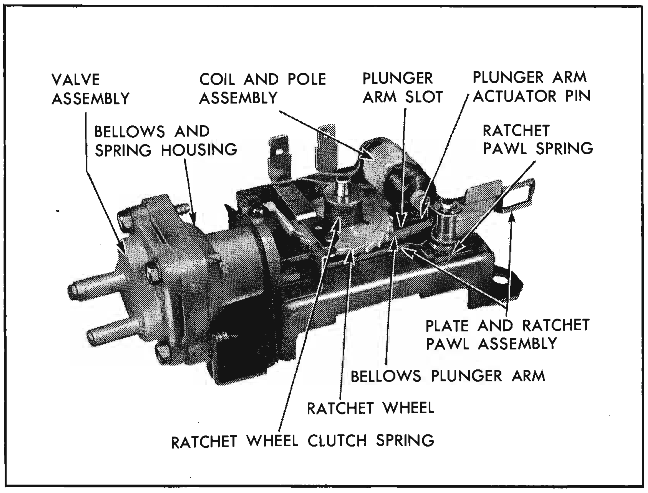


Fig. 11-114 Washer Pump Mechanism

which is attached to the pumping bellows, is held in a retracted position (spring compressed) by an eccentric on the ratchet wheel when the pump is idling (Fig. 11-114).

Thus while the pumping mechanism is idling the lever arm pin can move freely back and forth in the plunger arm slot and no pumping action occurs. The ratchet arm is prevented from rotating the ratchet wheel by a spring which prevents engagement when the relay coil is not energized.

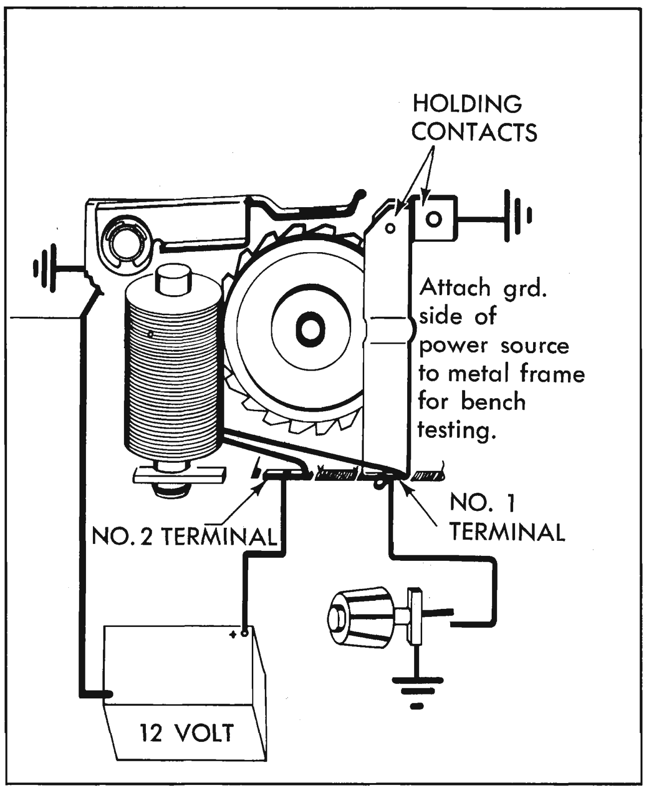


Fig. 11-115 Washer Pump Schematic

WIPER ON—WASHER ON

When the washer button on the dash is pushed in to start the washer the circuit to the washer pump relay coil is closed to ground (Fig. 11-115). The relay then pulls the ratchet arm in against the ratchet wheel.

The ratchet arm, which previously was moving freely back and forth now starts to rotate the ratchet wheel (Fig. 11-116).

Also, a cam or "hump" allows the contact points to close which provides a ground circuit after the switch is released. As the ratchet wheel is rotated, the eccentric is moved away from the plunger arm tang releasing the plunger arm for pumping action.

The plunger arm being spring loaded, now moves in a direction toward the bellows and collapses the bellows forcing the water in the bellows out through the outlet valves to the nozzles (exhaust stroke) (Fig. 11-117). At the same time the edge of the plunger arm slot moves up tight against the lever arm pin. As the rotor cam is turned each lobe actuates the lever arm which in turn pulls the plunger arm back compressing the spring. While the plunger arm is being pulled back (suction stroke) water is drawn in through the inlet valve (Fig. 11-118). As the high point of each lobe is passed, the plunger arm spring pulls the plunger arm toward the bellows. This collapses the bellows and forces water out through the outlet valves (exhaust stroke).

Thus for each revolution of the rotor cam there are three pumping strokes. For each pumping stroke the ratchet wheel is actuated or turned one tooth by the ratchet arm.

After the ratchet wheel has been rotated about 12 teeth, the ratchet wheel eccentric starts to interfere with the plunger arm tang (Fig. 11-113). This results in shorter pumping strokes and thus smaller "squirts" out the nozzles.

When the ratchet wheel has been turned through 360° or 21 teeth, two simultaneous functions occur as the wash cycle is completed. (1) A cam on the ratchet wheels opens the contact points thus opening the relay ground circuit. This lets the ratchet arm disengage from the wheel and move back and forth freely. (2) The ratchet wheel eccentric has moved into a position which holds the plunger arm in a retracted position preventing further pumping action. The pump is now back idling.

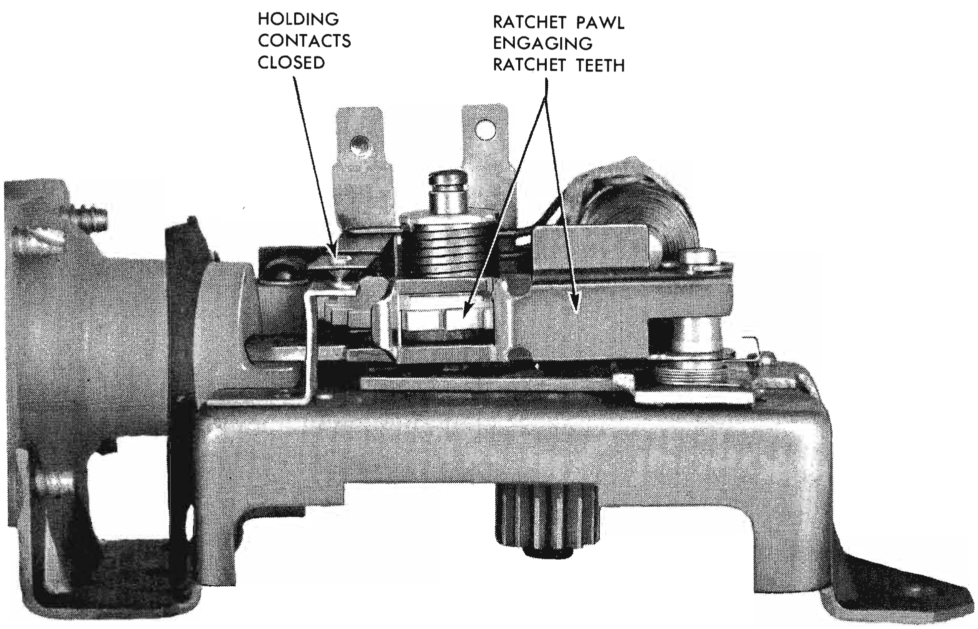


Fig. 11-116 Washer Rachet Pawl

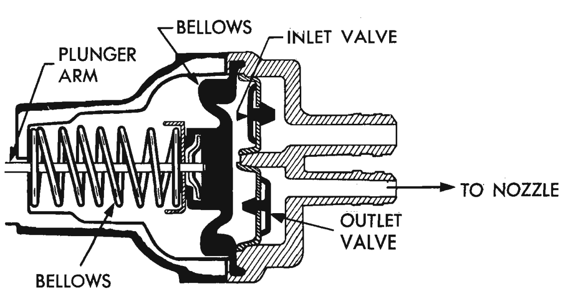
CHECKING PROCEDURES

WASHER PUMP ON CAR

WASHER INOPERATIVE:

1. Check the following items:
   (1) Jar has adequate quantity of water solution.
   (2) Hoses are not damaged and hose connections are tight.
   (3) Screen at end of jar cover hose is not plugged.
   (4) Electrical connections to washer pump and dash switch.
   (5) Nozzles are not plugged.
2. If these items check out, start wiper motor only, then push washer button and listen for "click" as washer relay pulls in. If no "click" is heard, check for 12 volts at terminal No. 2 Fig. 11-119.

   No voltage indicates defective wiring. If "click" is heard, proceed to step 4.
3. If correct voltage was found in step No. 2, connect a jumper wire from terminal No. 1 to ground (Fig. 11-119) and operate wiper. If washer relay "click" is heard and pump functions correctly, a defective dash switch or an



NOTE: View shows only one outlet valve.

Fig. 11-117 Washer Bellows—Exhaust

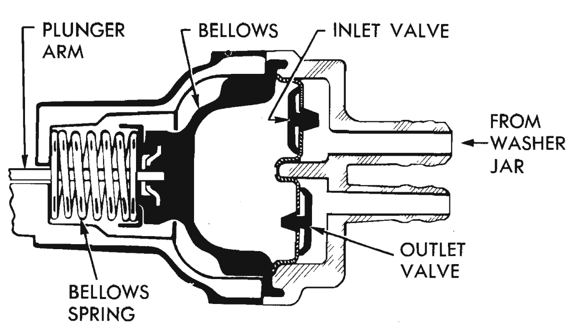


Fig. 11-118 Washer Bellows—Intake

open circuit between washer pump and dash switch is indicated—"No Click" indicates an open relay coil.

4. If relay "click" is heard in Step 2, listen for the soft clicking as the pump ratchet wheel is rotated.

   If soft "clicking" is not heard, the pump mechanism is faulty and should be removed from the wiper motor and checked.

   If soft clicking is heard but no pumping action occurs, replace the valve assembly and recheck pump.

WASHER PUMP DETACHED

CHECK PUMP OPERATION AS FOLLOWS:

1. Remove washer pump cover and connect 12 volt power supply to washer pump as shown in Fig. 11-115. Connect jumper wire from terminal No. 1 to ground. Turn ratchet pawl to the position shown in Fig. 11-115. Ratchet pawl should be pulled toward relay pole and engage ratchet teeth. Failure to do as described above indicates an open relay coil.
2. If relay and ratchet pawl perform correctly in Step 1, manually rotate the 3 lobe cam one lobe in a clockwise direction (looking at the cam). Observe if relay holding contacts close and the pump plunger arm is released from its lock-out position. Fig. 11-114 shows plunger arm in lock-out position.

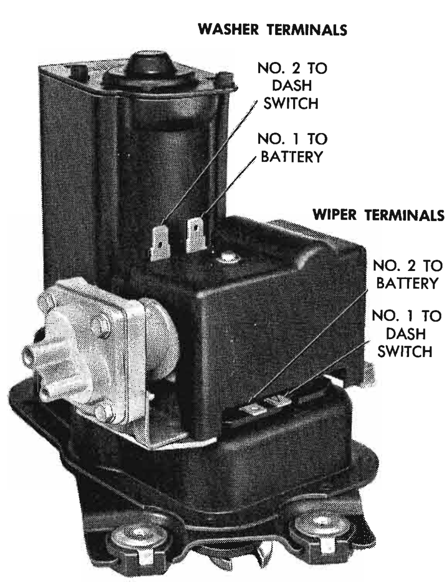


Fig. 11-119 Washer Terminals

3. Disconnect jumper wire from terminal No. 1. Relay coil should remain energized and hold ratchet pawl against ratchet wheel. Failure to do so indicates open or dirty holding contacts.
4. If pump performs correctly in Step 3, continue to manually rotate the 3 lobe cam until the ratchet wheel has been turned through 360° or 21 teeth. After the ratchet wheel has been rotated 21 teeth, the holding contacts should be opened by a "hump" on the wheel and the pump plunger arm should be in the "lock-out" position (Fig. 11-114).

CHECK VALVE ASSEMBLY AS FOLLOWS:

1. Attach a hose to the large (intake) pipe. You should be able to blow through it but not draw through it.
2. Attach a hose individually to each of the small or exhaust pipes. You should be able to draw through them but not blow through them.

   If any of these valves allow air to pass in both directions, the valve assembly is defective.

WASHER PUMP—DISASSEMBLY—ASSEMBLY

RELAY

1. Remove washer pump cover.
2. Unsolder coil leads from terminals. (Note: No polarity is necessary when resoldering coil leads)
3. Remove coil retainer clip and slip coil assembly out of mounting bracket.

RATCHET PAWL

1. Remove washer pump cover.
2. Disengage spring from ratchet pawl. (CAUTION: Be sure spring is properly assembled before replacing washer pump cover.)
3. Remove "E" ring and slide ratchet pawl off shaft.

VALVE ASSEMBLY

1. Remove the four screws that secure the valve assembly to the bellows housing.

   CAUTION: It is sometimes necessary to carefully pry the bellows lip out of the valve body groove.

BELLOWS

1. Remove valve body.

2. Manually operate pump to release pump from "lock-out" position so plunger arm moves its maximum distance toward the valve body.

3. Hold bellows plunger arm from moving, then push in against bottom of bellows with thumb and twist bellows 90° to release bellows and bellows spring.

SPECIFICATIONS

Number of "squirts" at full pressure	12
Pressure (PSI)	11-15
Coil Resistance (ohms)	20

LIGHTING, HORN, AND ACCESSORY POWER CIRCUITS

DESCRIPTION

FUSE BLOCK

The fuse block (Fig. 11-120) is located on the dash shroud at the left side just above the front edge of the floor mat, Fig. 11-121, and has replaceable fuse clips which are serviced separately. An efficient tool for fuse clip removal can be made from a cotter pin approximately 2½ inches long. Cut off long leg even with short leg. File a bevel on the outside of both legs. Spread the pin wide enough to span the fuse clip.

To remove fuse clip, insert cotter pin over center of fuse clip and push in to disengage locking ears on both sides of clip. Continue pushing after ears disengage and fuse clip will come out through fuse block.

NOTE: Fuse and lamp applications can be found in the specification tables at the end of this section.

WIRING HARNESS

The wiring harness routing is positioned to reduce the possibility of damage to the harness. Particular attention should be given toward making sure that the wiring is not pinched, stretched, or positioned so as to contact any movable parts under the instrument panel. This includes the hand brake, foot brake, ash trays, accelerator linkage, etc.

In the engine compartment the following routing should be checked: wires to generator, wires in clip retainer opposite the carburetor choke heat tube, around regulator, horn relay, battery, starter solenoid, large dash clips, and the large dash grommet.

WIRING CONNECTORS

Wiring connectors have a locking design to insure a tight fit and to prevent them from separating.

NOTE: When servicing the new connector, insert a thin bladed screwdriver between the male and female section to unlock the assembly before pulling it apart.

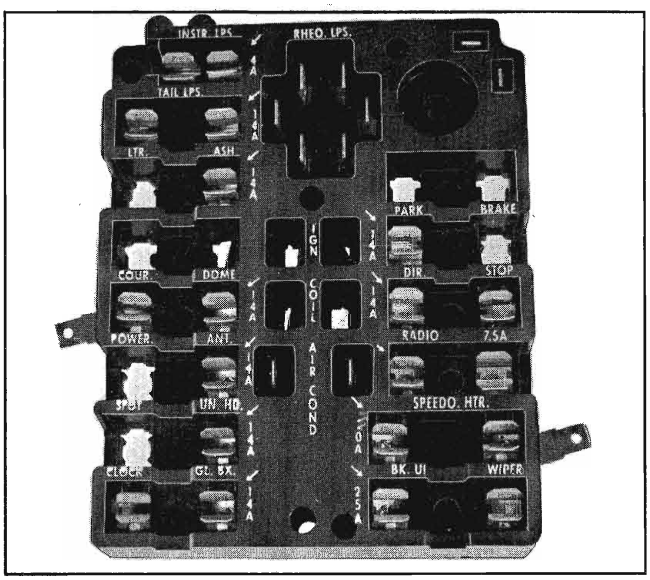


Fig. 11-120 Fuse Block

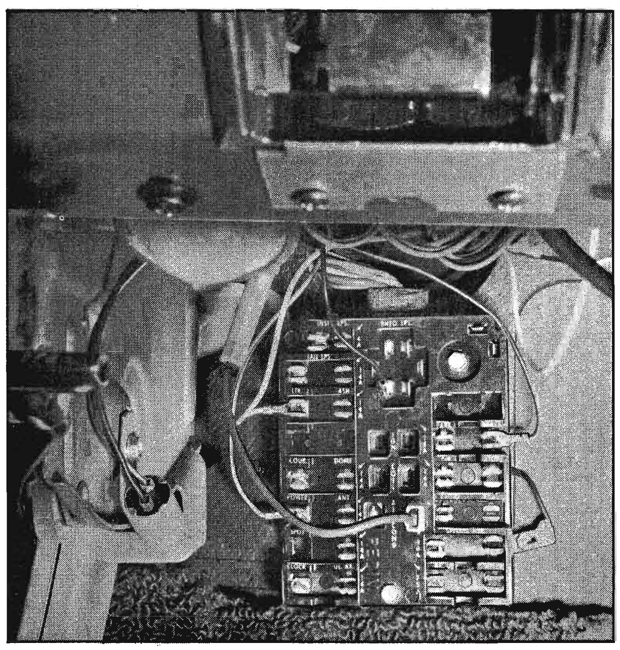


Fig. 11-121 Location of Fuse Block

TAIL LIGHTS

The tail lamp bulb is a double filament bulb which acts as a stop light, tail light and turn signal light. The bulb can be removed from the inside of the trunk.

STOP LIGHT SWITCH

The stop light switch must be checked whenever the brake pedal height has been changed. Adjustment is made by positioning the switch and bracket in relation to the pedal arm.

NOTE: Make sure that the switch doesn't restrict pedal action.

LIGHTING—HEADLIGHTS

The headlamp wire is an integral part of the chassis wiring harness. It is a one piece wire direct from the dimmer switch to the headlamp connector.

GENERAL DESCRIPTION

Headlamps are of sealed beam construction so that the light source, reflector, lens, and lens gasket are all assembled in one sealed unit. When the filament burns out or the lens is cracked or broken, the entire unit is readily replaceable with a new unit.

The filaments used in twelve volt headlamps are very fragile. These headlamp units must be handled carefully, therefore, to prevent breakage.

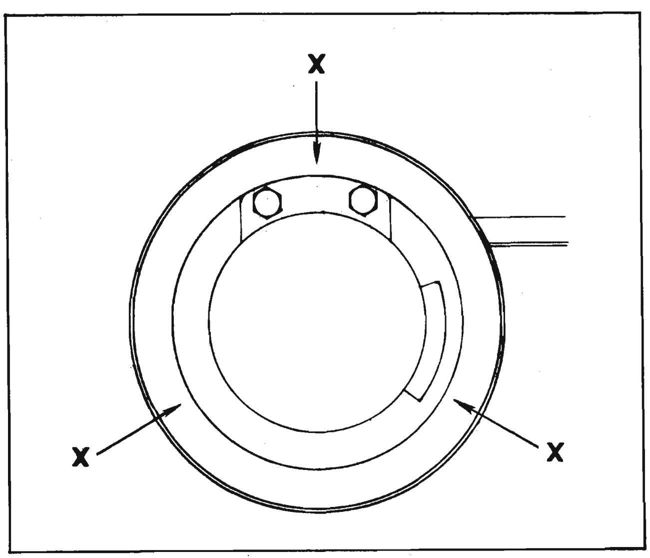


Fig. 11-122 Inner Ring of Aimer

OPERATION

The dual headlight system consists of four headlights paired horizontally. Each pair of lights consists of a sealed beam unit (inner unit with No. 1 embossed on the lens) with one filament which provides an upper beam only, and the other sealed beam unit (outer unit, with No. 2 embossed on the lens) with 2 filaments which provide both an upper and a lower beam. The sub-body is also identified.

Since the No. 2 headlight lens is designed to provide maximum illumination on lower beam and the upper beam filament is not at the focal point of the No. 2 lamp, the major portion of the upper beam illumination is supplied by the No. 1 unit. The upper beam is supplied by all four headlamps.

When the lower beam is desired, the No. 1 lamps are turned off, the upper filament of the No. 2 lamps are turned off and the lower filaments of the No. 2 lamps are turned on.

ADJUSTMENTS ON CAR

AIM DUAL SEALED BEAM HEADLAMPS WITH T-3 AIMER

NOTE: This device meets the SAE specifications for mechanical aimers.

1. The following general procedure should be followed before actual headlamp aiming is performed.

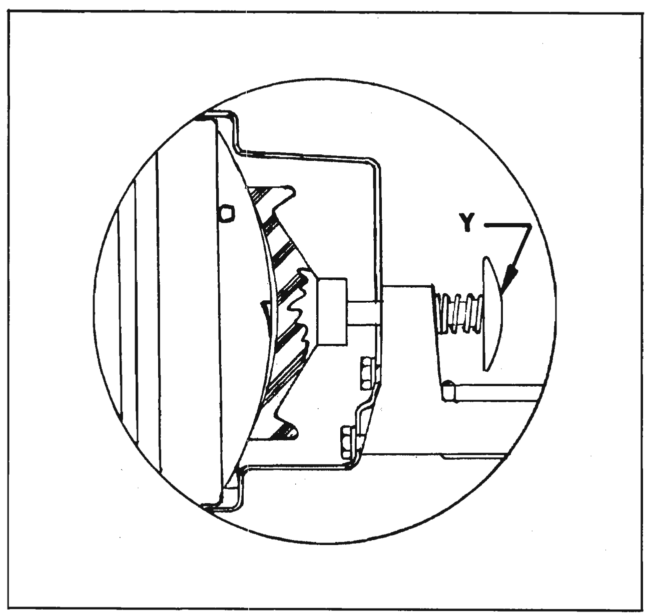


Fig. 11-123 Cross Section of Aimer Installed

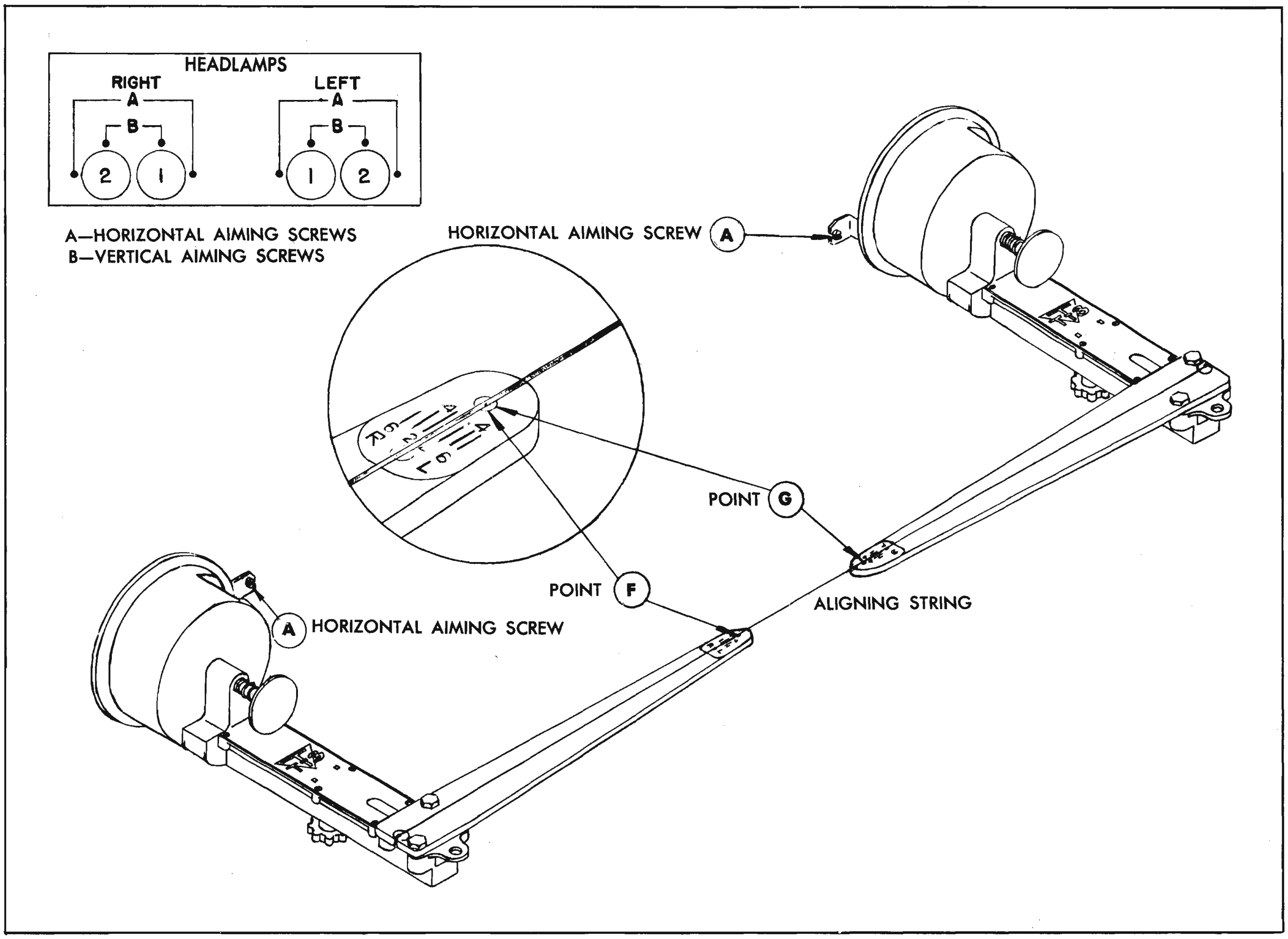


Fig. 11-124 Horizontal Aim Adjustment

a. Locate car on a known level surface or recalibrate aimers for a selected unlevel surface.

b. Tire pressures should be equalized to recommended pressure.

c. Car should be unloaded—no extreme load in trunk and no passengers.

d. Car should be rocked sideways to equalize springs.

e. Turn on headlamp units to determine if all filaments burn.

f. Replace any burned out unit.

g. Proceed with headlamp aiming.

2. Remove headlamp doors from each headlamp.

3. Position T-3 Safety-Aimer on headlamp so that guide points engage smooth inner ring of aimer at points "X" shown in Fig. 11-122 and the cross arm on aimer points toward center of car.

4. Secure aimer to headlamp unit by pressing knob "Y" (Fig. 11-123) firmly. Rotate cross arm to approximately horizontal position.

5. Repeat steps 3 and 4 on corresponding headlamp on other side of car.

6. With aimers in place, position knot on string in slot on right-hand aimer.

7. Adjust horizontal aim as follows:

a. Rotate aimers around headlamp units so that points "F" and "G" (Fig. 11-124) just clear string.

b. Turn screw "A" on left-hand lamp until the string is positioned directly over center line on aiming dial at point "G". Turn screw clockwise in making final adjustment to take up play in headlamp mechanism.

c. Repeat same operation on right-hand unit to make point "F" center under string.

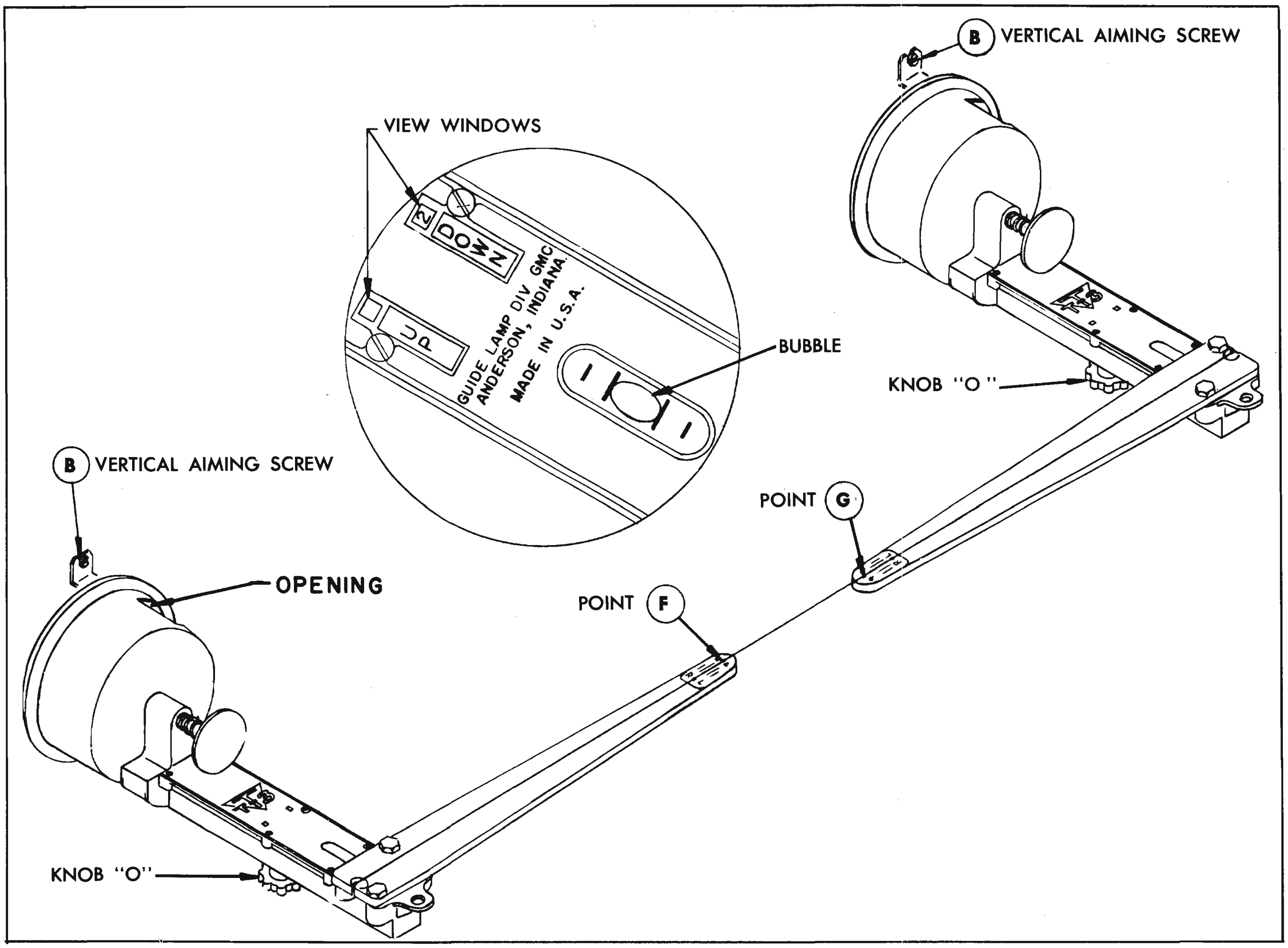


Fig. 11-125 Vertical Aim Adjustment

8. Adjust vertical aim as follows:

a. Loosen knob "O" (Fig. 11-125) and move slider until numeral "2" appears in DOWN view window. Tighten knob.

b. Turn headlamp vertical aim screw "B" counterclockwise until bubble is at end of vial toward T-3 unit. Then turn screw clockwise until bubble is centered.

c. Repeat same operation on other headlamp unit.

d. Recheck string at points "F" and "G," and bubbles for centered position.

e. Pull on suction cup tabs through opening in aimer. Remove aimers and mount on remaining pair of headlamp units. Repeat horizontal and vertical aiming procedure.

f. Reinstall headlamp doors.

SELECTION OF AIMING AREA

Select an area for headlamp aiming which you believe to be level. Drive car onto the selected area and install the T-3 Safety-Aimers on either both outer or both inner pair of headlamp units so that the cross arm on each aimer points toward center of car. Loosen knob "O" and move slider until numeral 2 appears in "DOWN" view window. Turn vertical lamp aiming screws to center level bubbles. Mark all four wheel positions on the floor, turn car end for end making sure that all four wheels are resting on the marked positions on the floor. If the level bubbles are still centered, the selected aiming area is level, and T-3 Safety-Aimers can be used as they come from the factory with the car in this position.

If the level bubbles are not centered after the car has been turned end for end, the selected area is not level and T-3 Safety-Aimers must be recalibrated as follows:

1. Loosen knob "O" on aimer (Fig. 11-126) and move slider until bubble is centered.

2. Record numeral in view window. (This numeral used only for recalibration.)

3. Move slider to a position half-way between the above recorded numeral and the numeral 2 in "DOWN" view window. (This numeral used only for recalibration and not in headlamp aiming procedure.)

4. Turn car end for end to original position. Leave slide in position arrived at in step 3.

5. Recalibrate aimer by turning screw "T" until bubble is centered. The T-3 Safety-Aimer is now calibrated for the selected area. ALL FUTURE AIMING MUST BE DONE WITH CARS PLACED IN THE SAME AREA AND FACED IN THE SAME DIRECTION AS THE CAR WAS WHEN AIMERS WERE RECALIBRATED.

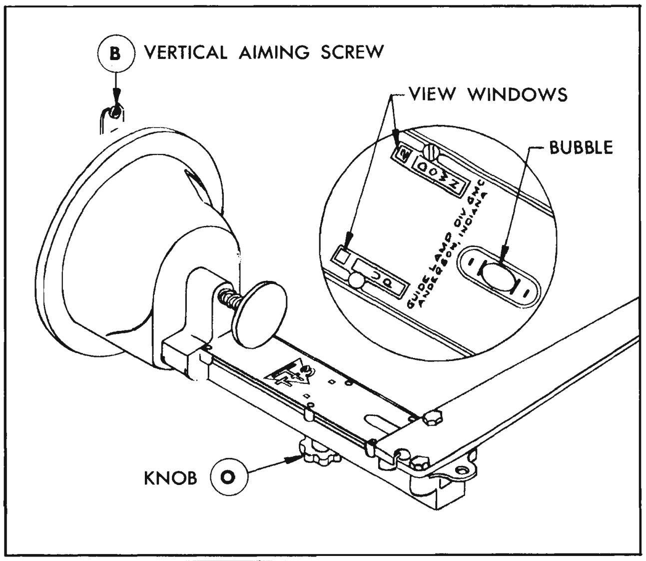


Fig. 11-126 Calibrating for Unlevel Surface

HEADLIGHT AIMING—SCREEN METHOD

Preparation of car for aiming operation includes:

1. Make sure car is in good horizontal and vertical alignment with aiming test equipment.

2. Jounce car to equalize suspension.

3. Make sure the aiming is performed with car at curb height.

4. Tires should be inflated uniformly to recommended pressure.

Aiming screen data is contained in Fig. 11-127. When aiming upper beam the pattern of only the inboard upper beam units is to be used.

The hot spot of each light shall have relationship to the vertical and horizontal center line of the individual light unit within the limits and conditions shown in Fig. 11-127 at a distance of 25 feet.

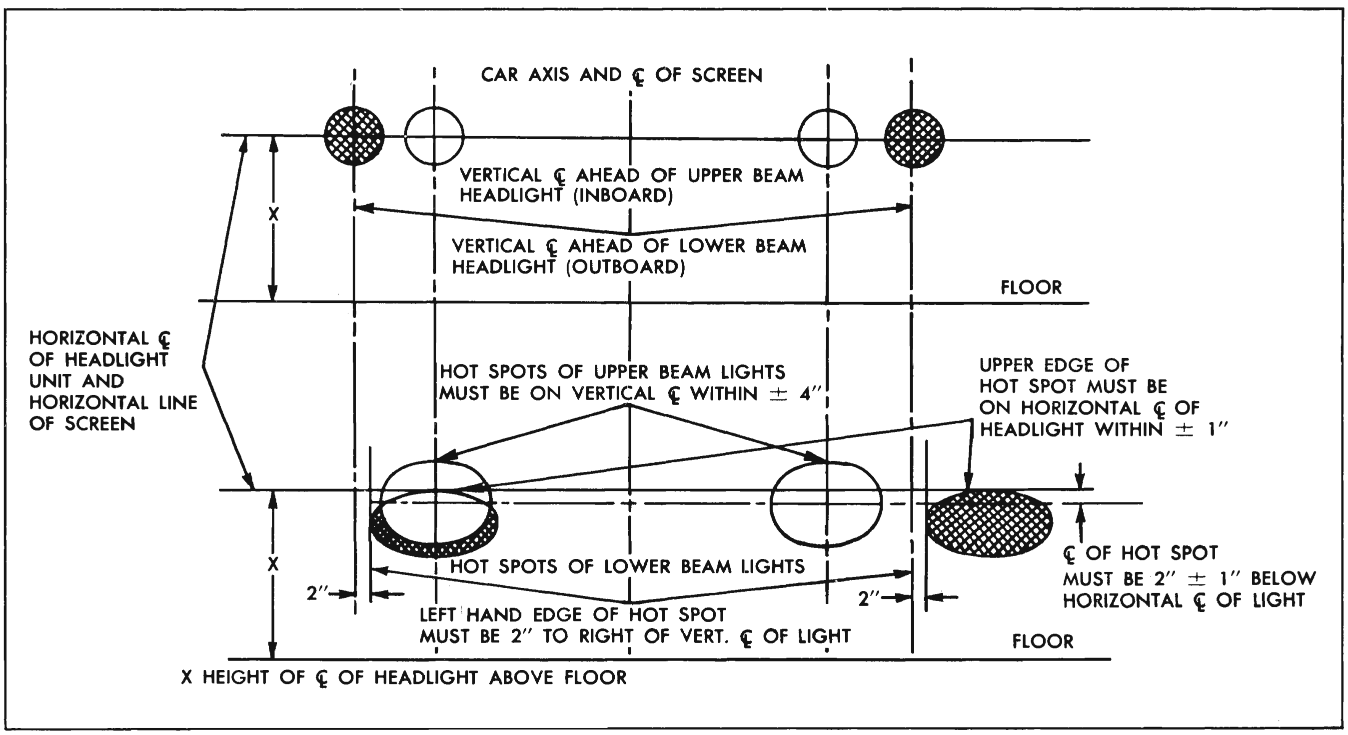


Fig. 11-127 Headlight Aiming Screen Chart

MINOR REPAIRS

REMOVE AND REPLACE HEADLAMP SEALED BEAM UNIT

1. Remove headlamp door.

2. Remove retaining ring and sealed beam unit from mounting.

3. Pull connector from rear of beam unit and separate sealed beam unit from retaining ring and mounting ring.

4. Assemble new sealed beam unit into mounting ring and retaining ring and plug sealed beam unit into connector.

5. Install beam unit and retaining ring.

6. Check headlamp aiming and readjust if necessary.

7. If headlamp door rubber seal is worn, remove seal and cement new seal securely to door.

8. Replace headlamp door.

LIGHTING SWITCH

The instrument panel main lighting switch which has two "ON" positions or notches, the first for parking, tail and license lamps, and the extreme "OUT" position for the headlamps, tail, and license lamps. Rotating the lighting switch knob operates a rheostat for dimming the instrument panel lamps. When the rheostat is rotated counterclockwise to the extreme left position the instrument panel lamps are completely off.

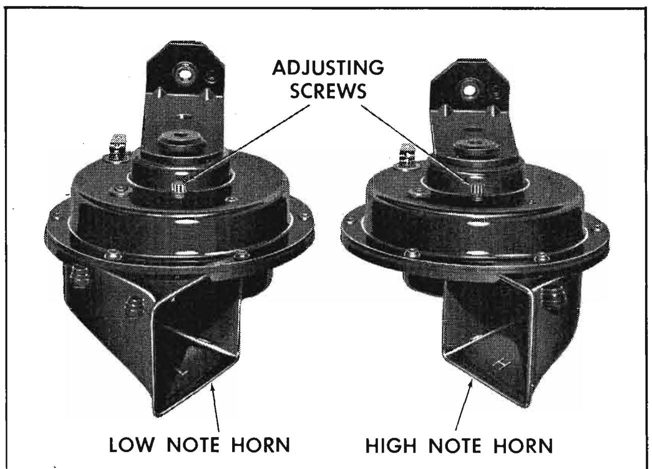


Fig. 11-128 Low and High Horns

REMOVE AND REPLACE LIGHT SWITCH

1. Remove one battery cable from battery post.

2. Pull switch knob to headlight "ON" position, push latch button on side of switch assembly and pull out switch knob assembly.

3. Unscrew bushing from switch assembly and remove switch assembly.

4. Remove "push-on" connector with leads from light switch and connect to new switch.

5. Position new switch in instrument panel, and start bushing through ferrule into switch assembly. Tighten bushing securely.

6. Insert knob assembly into switch assembly until end of rod engages catch.

7. Install cable on battery post.

HEADLIGHT DIMMER SWITCH

The headlight beam switch (foot operated) controls the headlamp country (bright) beam or traffic (dim) beam is on when the main lighting switch is pulled out. A red indicator lamp on the speedometer shows when the headlamp country beam is on.

NOTE: Advise owner to always see that the red indicator light is out, indicating that the traffic beam is on, when meeting cars.

PARKING LAMP

Parking lamps use a two filament bulb. One filament is for the direction signal and the other is for the parking lamp.

HORNS

The two horns installed on the car are designed to give a blended tone when operated together (Fig. 11-127). Each of these horns utilizes a solenoid actuated diaphragm to develop a resonating air column in the horn projector.

A relay is inserted in the horn circuit because of the high current required to operate horns. The relay reduces the length of heavy gauge wire required and provides a more direct connection between the horns and the battery. Consequently, higher voltage is available at the horns and better performance is obtained by eliminating the voltage drop which otherwise would be in the horn button wiring circuit.

CIGAR LIGHTER

Two different makes of cigar lighters are used, "Casco" and "Rochester".

The chief functional difference between the two lighters is that the Rochester lighter is protected by a manual reset circuit breaker while the Casco lighter is protected by a replaceable fuse. Both protective devices are part of the lighter socket assembly.

The lighters release automatically (usual time for release is 10 to 14 seconds) which means that if the plug assembly is held in by the operator's hand a sufficient length of time (60 to 90 seconds) the fuse will blow or circuit breaker contact button will release. This may, in some cases, account for a blown fuse or released circuit breaker contact button when lighter is functioning perfectly.

If temperature of the element shows indication of incorrect timing (too hot or too cold), the socket assembly containing the bi-metal hold-in fingers must be replaced.

The lighters have a safety feature in the form of two retaining fingers which prevent the knob and element assembly from falling out or "popping" out of the socket onto the floor. If these fingers do not keep the knob and element assembly from falling out onto floor the socket assembly should be replaced.

CIGAR LIGHTER

REPLACE FUSE–CASCO

1. Remove wire connector from rear of lighter base.
2. Unscrew fuse from lighter base assembly.
3. Screw on new lighter fuse.
4. Reconnect connector to lighter base.

REPLACE ELEMENT–CASCO

Remove knob and metal knob flange from element assembly and install knob and flange on new heating element assembly.

REPLACE ELEMENT–ROCHESTER

Replace complete plug assembly.

REPLACE LIGHTER SOCKET OR WELL

1. Remove wire connector from rear of lighter socket.
2. Loosen clamping shell (use 1" deep socket if necessary), unscrew lighter socket and remove socket from instrument panel. If equipped with light, remove bulb.
3. To install, reverse above procedure, seeing that clamping shell is turned up FINGER TIGHT ONLY on lighter socket.

RESET CIRCUIT BREAKER–ROCHESTER

1. Remove connector and contact from back of lighter base.
2. Remove cover from reset button.
3. Push circuit breaker reset button back into socket assembly.
4. Replace reset button cover.
5. Replace connector on lighter base.

DIRECTION SIGNAL ASSEMBLY

DESCRIPTION

The turn signal circuit consists of the switch, flasher, two lamps in the instrument cluster, the stop lamp filaments in the rear lamps, and the turn signal filaments in the parking lamps

The direction signal actuator mechanism is located in a housing just below the steering wheel (Fig. 11-129). The electrical switch is mounted on the steering column jacket just below the steering column to instrument panel bracket (Fig. 11-130). It is actuated by a rod inside the steering column jacket.

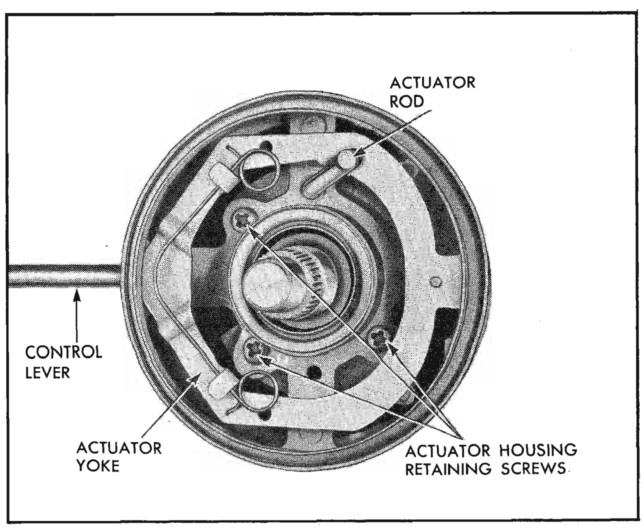


Fig. 11-129 Direction Signal Control

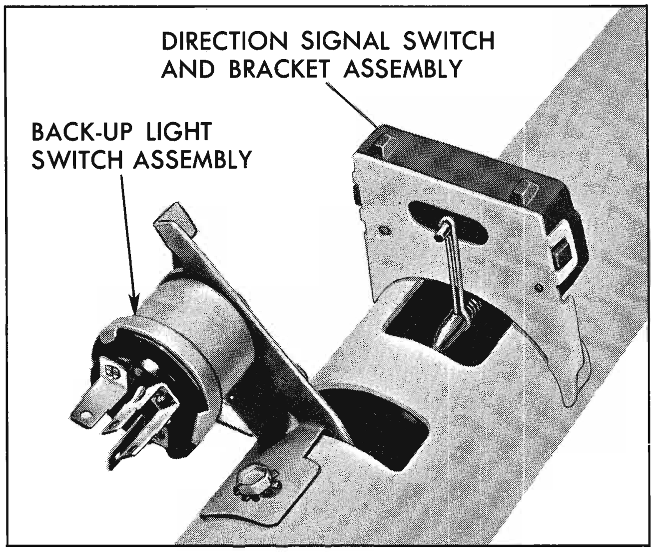


Fig. 11-130 Direction Signal Switch

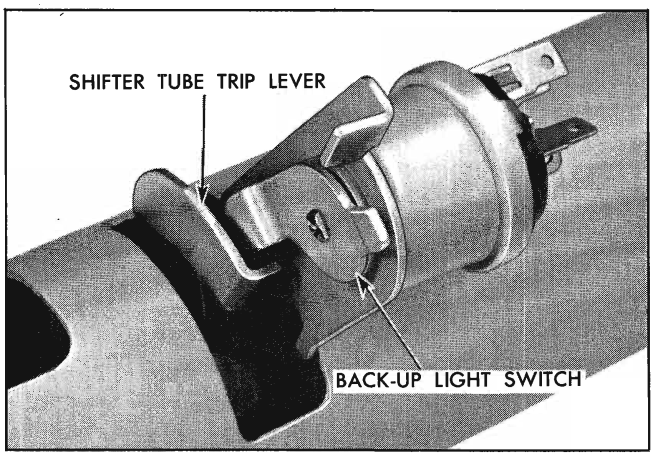


Fig. 11-131 Location of Shifter Tube Trip Lever

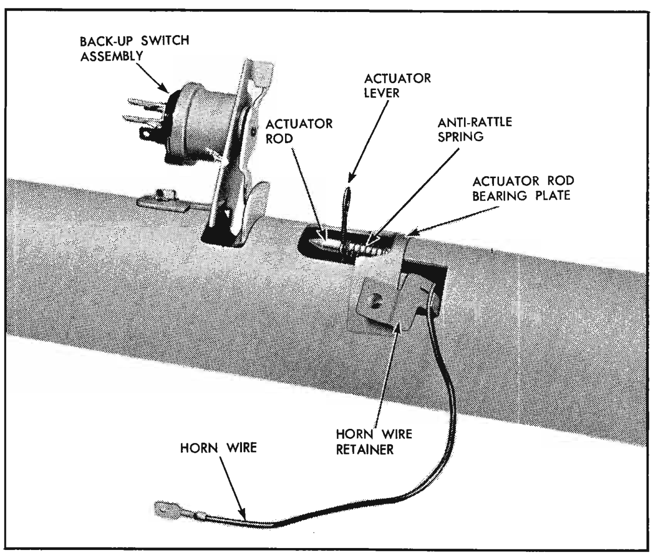


Fig. 11-132 Details at Lower End of Actuator Rod

Two flasher units for two and three bulbs respectively can be identified by the first number, "2" or "3", after the "AP . . ." number on the flasher unit. The flasher, which is mounted on the fuse block, consists of two sets of points, a coil, and resistor. One set of points controls the flashing of the instrument panel lamps and the other set controls the flashing of the front and rear lamps. The frequency of the turn signal is 80 to 100 flashes per minute.

DIRECTION SIGNAL AND BACK-UP LIGHT ASSEMBLIES—REMOVE AND REPLACE

REMOVE

1. Disconnect horn cable from terminal.

2. Remove wire connectors from back-up light and direction indicator switch terminals.

3. Remove screws and star washers securing back-up light switch assembly and remove switch from steering column housing.

4. Remove shifter tube trip lever retaining screw and washer and remove lever in opening of steering column housing (Fig. 11-129).

5. Remove two screws and star washers and remove direction signal switch assembly and hold wire retainer from steering column housing.

6. Hold actuator rod anti-rattle coil spring and bearing plate and remove hair-spring type actuator lever from actuator rod (Fig. 11-132).

NOTE: A length of steering column insulator felt stuffed into the opening below the actuator rod will prevent loss of actuator spring.

7. Remove anti-rattle spring and bearing plate.

8. Pull actuator rod out from top end of steering column.

9. Remove horn connector assembly and horn wire from end of upper bearing support plate.

10. Remove three screws which retain actuator housing and remove housing (Fig. 11-133).

11. Actuator can be removed from housing by removing control lever and pressing out shield.

REPLACE

1. Install horn wire and contact assembly in end of bearing support (Fig. 11-134), snaking wire through outer slots of bearing support lock plate and

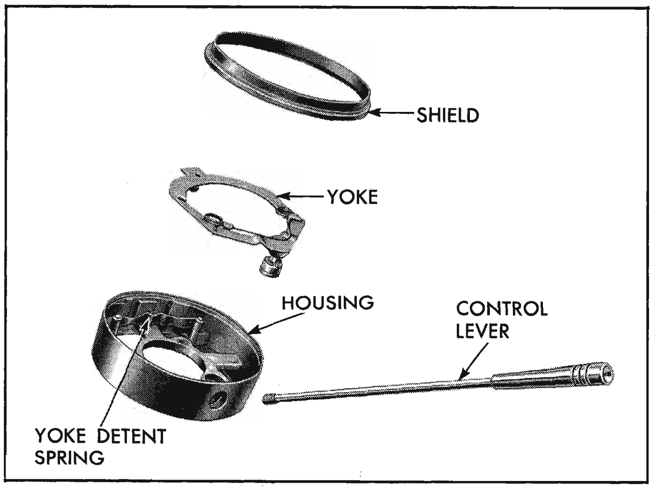


Fig. 11-133 Direction Signal Control—Exploded

retainer plate and between steering column housing and shifter tube.

NOTE: Attaching a suitable firm wire to end of horn wire will simplify installation of wire into steering column.

2. Pull end of horn wire out appropriate opening in steering column housing.

3. Install actuator housing over upper bearing support and insert three retaining screws. Torque to 10-35 lb. in.

4. Install actuator rod bearing plate, direction signal switch and horn wire retainer in appropriate position on housing (Fig. 11-132).

5. Insert two screws and star washers, but do not tighten.

6. Insert actuator rod through opening in actuator housing and engage lower end of rod in retaining hole of bearing plate.

7. Engage top end of actuator rod in slot of actuator housing.

8. Install anti-rattle spring on lower end of actuator rod, exercising extreme care to prevent spring from falling inside steering column housing.

9. With direction switch carrier in neutral, insert .090"-.093" dia. gauge into two holes in switch bracket and install actuator lever, engaging lever on prong of switch.

10. Torque two direction signal switch retaining screws to 10-35 lb. in.

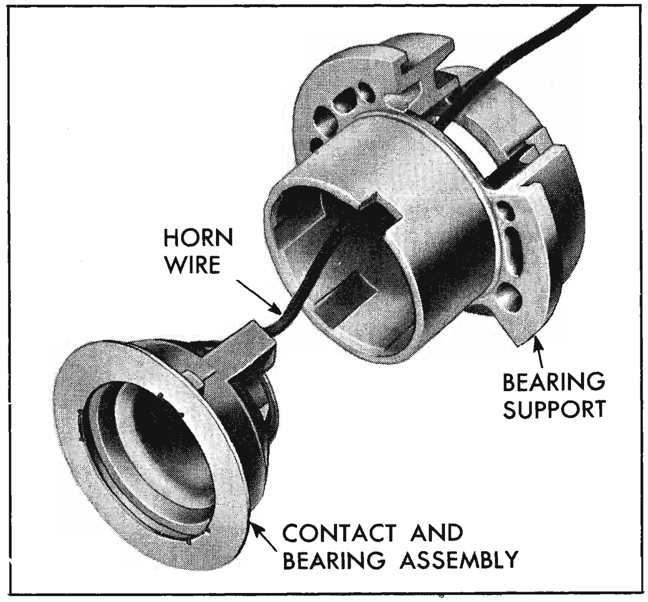


Fig. 11-134 Horn Contact and Bearing Support

NOTE: There should be no tension on actuator rod when screws are tightened.

11. Insert horn wire through wire retainer.

12. Install back-up light trip lever through lower opening in steering column housing and position on shifter tube. Insert retaining screw and star washer and tighten securely.

13. Install back-up light switch assembly on steering column housing and insert retaining screw and star washer. Tighten securely.

NOTE: When upper shift lever is placed in "reverse" position and released, trip lever must hold back-up light switch lever in "on" position. If necessary, bend trip lever to obtain this condition, making certain the movement of upper shift lever to "second" position does not actuate switch.

14. Connect horn cable to terminal.

15. Engage wire connectors to back-up light and direction indicator switch terminals.

DIRECTION SIGNAL SWITCH

The electrical switch can be removed from the steering column jacket without disturbing the actuator mechanism. After removing the two screws which retain the switch and control rod bearing plate to the jacket, the switch can be disengaged from its actuating lever. Servicing is simplified by the use of "push-on" type connectors.

When installing the direction signal switch it is very important that it be centered properly on the steering column. Improper positioning can result in an inoperative stop lamp.

The actuator mechanism can be removed as follows after removing the steering wheel.

1. Remove direction signal switch from steering column jacket and actuating lever.

2. Hold actuator rod anti-rattle coil spring and bearing plate and remove hair spring type actuator lever from rod.

NOTE: A rag or steering column insulator felt stuffed into the opening below the actuator rod will prevent loss of the spring.

3. Remove anti-rattle spring and bearing plate.

4. Pull actuator rod out from top of steering column.

5. Remove three screws which retain actuator housing and remove housing.

6. Actuator yoke can be removed from housing by pressing out shield (Fig. 11-133).

Replace rod by reversing the above steps. Fasten horn wire retainer on top of direction signal switch bracket.

DIRECTION SIGNAL WIRING

Direction signal schematic wiring diagram is shown in Fig. 11-75.

LIGHTING AND ACCESSORY TROUBLE DIAGNOSIS

Troubles in the lighting and accessory power circuits are caused by loose connections, open or shorted wiring, or blown fuses. In each case trouble diagnosis requires following through the circuit until the source of difficulty is found. To aid in making an orderly point-to-point check, refer to the schematic wiring diagram (Figs. 11-75 and 11-76).

HEADLAMP AND/OR AMMETER FLICKER

CAUSE	REMEDY
Normal if regulator points are clean.	Neither headlight flicker nor ammeter pointer fluctuation is necessarily indicative of an inoperative regulator. Flicker is normal in most cars, particularly during winter months when the electrical loads and charging circuit voltages are higher. Since the charging system voltage is controlled by the vibrating contact points, the contact points work much harder resulting in a greater degree of contact oxidation during winter driving than occurs in the warmer months of the year. Regulator contact points are normally self-cleaning, but when operating rapidly the self-cleaning feature may not be sufficient to remove all the oxide accumulation and, therefore, the points will not conduct properly. Thus, regulated system voltage drops momentarily until the contact points do clean themselves, and it is during this time that the operator notices the car headlights flicker, the ammeter pointer flutters or both. Before replacing a voltage regulator which is assumed to be inoperative because of headlight flicker or ammeter pointer flutter, make sure:

HEADLAMP AND/OR AMMETER FLICKER—Cont.

CAUSE	REMEDY
Normal if regulator points are clean.	a. Battery cable and other electrical connections in the charging circuit are clean and secure. b. That apparent malfunction is not merely due to a light oxide accumulation on the contact points. c. Voltage regulator is properly cleaned and adjusted. Cleanin', regulator contact points minimize headlight flicker or ammeter pointer flutter temporarily the same as installing a new regulator; but, under cold weather operation conditions, neither cleaning of points or installation of a new voltage regulator will assure that flicker or pointer fluctuation will not recur.

STOP LAMP INOPERATIVE ON ONE SIDE

CAUSE	REMEDY
Improperly centered direction signal switch.	Center direction signal switch.

DIRECTION SIGNAL FAILS TO OPERATE

CAUSE	REMEDY
Blown fuse.	Replace fuse.
Defective flasher unit.	Replace flasher unit.
Loose connection circuit.	Check and tighten connections.
Failure of direction signal in left or right parking lamp or stop lamp.	Replace lamp.

INDICATOR LAMP FLASHES EXTREMELY FAST

CAUSE	REMEDY
Loose connections in circuit.	Check and tighten connections.
Failure of parking lamp.	Replace parking lamp.
Failure of stop lamp.	Replace stop lamp.

HORNS WILL NOT OPERATE

NOTE: To locate the trouble, connect a jumper lead to the first and last terminals of the relay. (NOTE: Terminal numbers are stamped on the relay base.) If the horn blows, the trouble is in the relay, horn button, or wiring. (To determine whether the relay, horn button, or wiring is at fault,

HORNS WILL NOT OPERATE—Continued

ground the No. 2 terminal of the relay. If the horn blows, the horn button or wiring is at fault.) If the horn does not blow and the wiring between the battery and relay is not defective, connect a voltmeter between the horn terminal and the horn mounting nut. Again connect the jumper lead to the first and last terminals of the relay and note the voltmeter reading.

If no voltmeter reading is obtained, the wiring between the relay and horn is open or the horn is not grounded. If the voltmeter reading is less than 7.0 volts, the trouble is due to high resistance connections in the wiring or a faulty horn. If the voltmeter reading is above 7.0 volts, the trouble is due to faulty horn.

CAUSE	REMEDY
Loose connections in circuit.	Check and tighten connections. Be sure to check ground strip in power steering coupling.
Defective horn switch.	Replace defective parts.
Defective horn relay.	Replace relay.
Defects within horn.	Replace horn.

HORNS HAVE POOR TONE

CAUSE	REMEDY
Low available voltage at horn.	Check battery and charging circuit.
Defects within horn.	Although the horn should blow at any voltage above 7.0 volts, a weak or poor tone may occur at operating voltages below 11.0 volts. If the horn has a weak or poor tone at an operating voltage of 11.0 volts or higher, remove the horn and replace.

HORNS OPERATE INTERMITTENTLY

CAUSE	REMEDY
Loose or intermittent connections in horn relay or horn circuit.	Check and tighten connections.
Defective horn switch.	Remove button or ring and replace defective parts.
Defective relay.	Replace relay.
Defects within horn.	Replace horn.

INSTRUMENTS

GENERAL DESCRIPTION

Instruments consist of a fuel gauge, temperature indicator (thermo-gauge), charge indicator, oil pressure indicator, and speedometer. Service on the instruments can be obtained through authorized branches. However, a knowledge of instrument circuit checks must be had to determine if operating difficulties lie in the instrument itself or in its allied circuit.

FUEL GAUGE

DESCRIPTION

An electric fuel gauge is used at the instrument panel (dash unit) and fuel tank on all models. The fuel gauge indicates the quantity of gasoline in the tank only when the ignition switch is turned on or to the accessory position.

When the ignition is turned off or to start, the pointer may come to rest at any position. The letters "E" and "F" on the fuel gauge are used to point out direction of indicator travel only.

Gauge readings are made from five markings on the gauge face. The left hand line indicates empty. The center line half-full and the right line full.

The dash unit of this instrument consists principally of two coils spaced 90° apart, with an armature and pointer assembly mounted at the intersection of the center lines of the two coil end pieces (Fig. 11-135). Silicone liquid in the armature bearing prevents vibration of the pointer on rough roads.

One end of the left coil (at the instrument panel) is connected to the left gauge terminal which is connected directly to the battery (through the ignition switch). The other end of the left coil and one end of the right coil are connected to the right gauge terminal at the instrument panel which is connected directly to a rheostat which is the fuel gauge tank unit. The other end of the right coil and the tank unit are grounded.

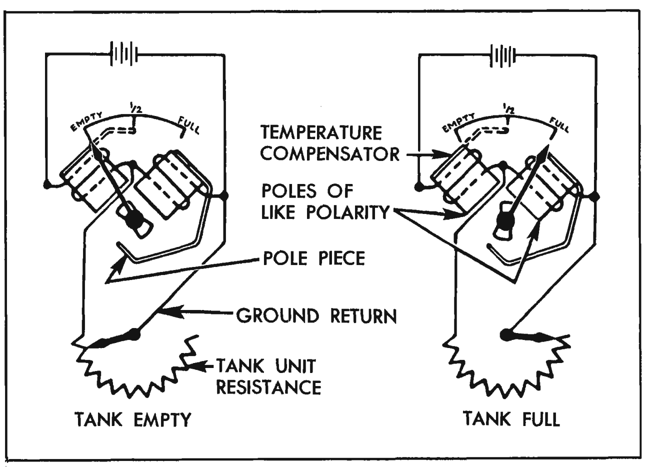


Fig. 11-135 Fuel Gauge Diagram

Resistance allows more current to flow through the right hand coil as the tank fills up, causing the right hand coil to balance the constant magnetism of the left hand coil, bringing the pointer and armature assembly to rest somewhere between the two coils, the exact position depending on the relative magnetic strength between the two coils.

The fuel gauge tank unit consists of a float, with linkage connecting to a movable contact arm and a rheostat. As the float rises, due to filling the tank, the contact arm moves over the rheostat cutting in resistance and allowing more current to flow through the right-hand "full" coil of the panel unit.

Four fuel tank gauge units are released for service:

One tank unit is for all cars equipped with Circ-L-Aire Conditioning and Safari.

One tank unit is for all cars with Circ-L-Aire Conditioning except Safari.

One tank unit is for all Safari models except Circ-L-Aire Conditioning.

One tank unit is for all Safari models with Circ-L-Aire Conditioning.

Circ-L-Aire Conditioned cars are equipped with a vapor separator system, therefore, a special fuel tank gauge unit is required to accept the vapor return line to the tank.

TEMPERATURE INDICATOR

The engine temperature indicator lights are controlled by a thermal switch which senses coolant temperatures, Fig. 11-136.

When the ignition switch is turned to the "START" position a TEST CIRCUIT IS CLOSED TO INDICATE WHETHER THE RED LIGHT IS FUNCTIONING PROPERLY.

The engine thermostat is calibrated to control the coolant temperature within certain limits at atmospheric pressure. With the installation of either the standard 13 lb. pressure radiator cap or a 15 lb. cap,

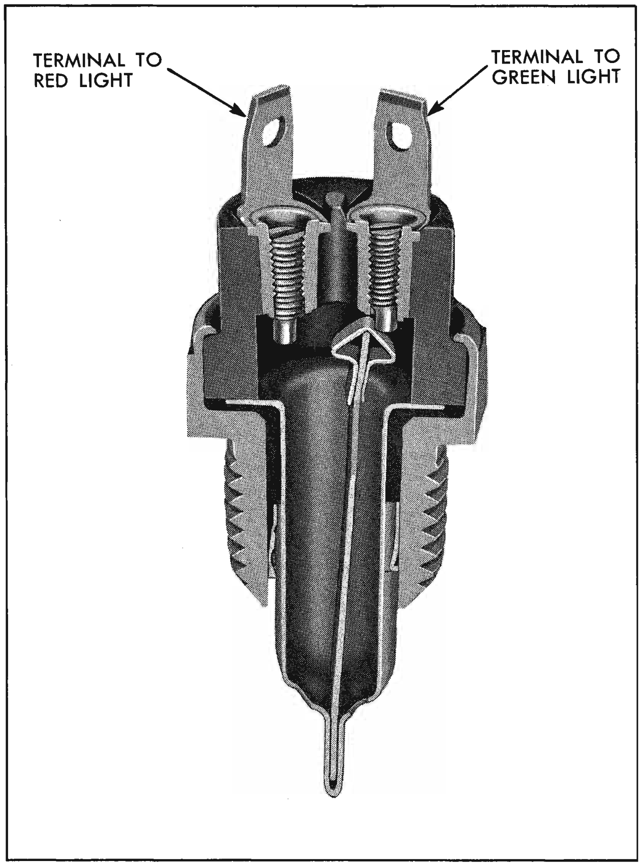


Fig. 11-136 Cross Section of Engine Temperature Indicator Switch

as used on air conditioned and/or 425E engine cars, the boiling point of the engine coolant is raised approximately 2.5°F. for each pound of pressure increase. Thus, at atmospheric pressure, the boiling point of the coolant (if only water) will increase from 212°F. to approximately 245°F. at sea level; similarly, the use of the 15 lb. cap raises the boiling point of the coolant (if water only) from 212°F. to approximately 250°F. at sea level.

The coolant pressure and temperature will vary during the car's operation. As an engine warms up from a cold start, heat energy absorbed by the coolant (circulated by the water pump) causes the coolant to expand with a resultant increase in cooling system pressure. When the car is stopped, as at an intersection, the temperature of the coolant will increase because the coolant circulation is reduced and air flow through the radiator is at a minimum. When the car moves forward again, the engine coolant is cooled due to recirculation through the radiator and added air flow across the radiator. This rising and lowering of temperature and pressure is a normal function of our cooling system.

The engine thermostat control temperature also varies as the coolant anti-freeze mixture varies. Pontiac specifies the use of 180°F. thermostat with glycol type anti-freeze; however, if an owner insists on the use of alcohol type anti-freeze, a 160°F. thermostat is essential. Such installation is considered owner maintenance.

The instrument panel heat indicator is designed to light up (green light) any time the engine coolant temperature is below 113-120° F. Upon starting a cold engine there will be a period of time before the coolant reaches its normal operating temperature and the thermostat will remain closed until the thermostat control temperature is exceeded; then the thermostat will open. When the coolant temperature exceeds 113-120° F., the green light heat indicator (a bimetallic switch) opens the circuit to the green light and the light goes out. If the coolant temperature reaches 236-240° F. (for cars without air conditioning) and 242-246° F. (for cars with air conditioning and/or 425E engine) the circuit to the red light will be closed causing warning lamp to be illuminated.

If the cooling system should not hold pressure due to pressure cap being left loose, or accident such as puncture of radiator, rupture or disconnection of a hose, or use of low boiling point anti-freeze, the calibration temperature of the red light heat indicator may not be reached, in spite of boiling.

The chart in Fig. 11-136 is a typical engine coolant temperature curve for a 170° F. thermostat when the engine is operated at a constant speed of 25 mph and 0° F. air as the ambient temperature. Therefore, should a thermostat be removed from a car while the engine is still very hot, the valve would be open but closes rather quickly as the thermostat cools below the valve control temperature. A bench check would show that a 170° F. thermostat would start to open between 167° F. and 172° F. and, if continued to be warmed, it would have a minimum opening of .380" at 192° F.

It is to be noted that a higher temperature thermostat (e.g. 180° F.) will *not* provide faster warm-up. Since either a 170° F. or 180° F. thermostat remains tightly closed until their control temperatures are reached, *rate* of warm-up is unaffected by the thermostat. Sensible heat is obtained from the heater at about 113° F. water temperature at 0° F. ambient.

CAUTION: Low boiling coolants will not operate light.

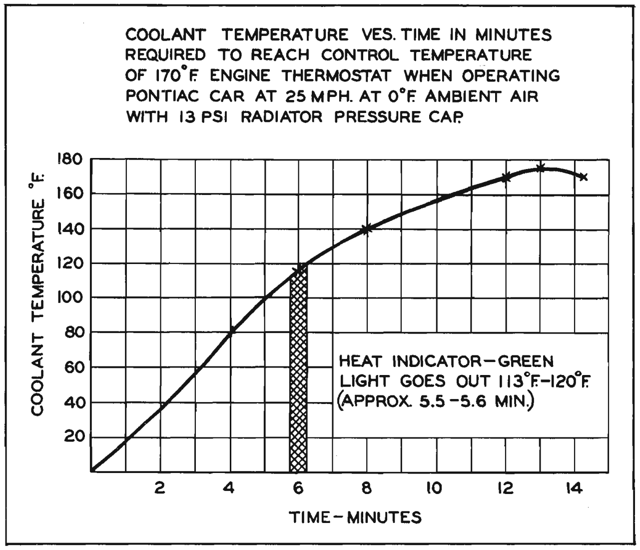


Fig. 11-137 Coolant Temperature versus Time in Minutes Required to Reach Control Temperature of 170° F. Engine Thermostat when Operating at 25 mph at 0° F. Ambient Air with 13 psi Radiator Pressure Cap.

GENERATOR INDICATOR

The generator indicator (sometimes referred to as ammeter) consists of a frame to which is attached a soft iron pole piece. The frame also supports a permanent magnet armature and pointer assembly.

When no current flows through the generator indicator, the magnet holds the pointer armature and pointer so it indicates 0. When current passes in either direction through the indicator the resulting magnetic field attracts the armature opposing the effect of the permanent magnet and giving a reading proportional to the current flow.

NOTE: The charge indicator is marked "D" on one side and "C" on the other since it only indicates flow of current and does not show how much current is flowing. No attempt should be made to interpret the reading in amperes current flow.

ENGINE OIL PRESSURE INDICATOR

The engine oil pressure indicator light is controlled by a pressure operated switch located in the oil filter pad. When the engine is running, the light operates only when the oil pressure is not satisfactory. This light should come on when the ignition is turned "on" and the engine is not running.

The oil pressure switch breaks contact at 5$\pm$ 1.5 psi on increasing pressure and makes contact at 5 $\pm$ 1.5 psi on decreasing pressure.

SPEEDOMETER

The speedometer incorporates a speed indicating mechanism and an odometer to record total mileage. A flexible cable, which enters the speedometer driven gear in the transmission on one end and the speedometer head at the other, rotates both mechanisms whenever the transmission main shaft, propeller shaft and wheels rotate.

The speed indicating portion of the speedometer operates on the magnetic principle. In the speedometer head is a permanent magnet which rotates at the same speed as the cable. This magnet exerts a pull on a speed cup causing it to move in direct ratio to the revolving magnet speed. A pointer is attached to the speed cup spindle to indicate speed on the speedometer dial. A finely calibrated hair spring (also part of the speed cup assembly) opposes the magnetic pull on the speed cup so the pointer indicates true speed; it also pulls the cup and pointer to zero when the car stops.

The odometer is driven by a series of gears from a worm gear cut on the magnet shaft. Odometer discs are so geared that as any one disc finishes a complete revolution, the next disc to the left is turned one-tenth of a revolution.

PERIODIC SERVICE

No periodic service or lubrication of instruments (except for the speedometer cable) is required.

Never attempt to lubricate the fuel gauge tank unit; adequate lubrication of this unit is provided by splash of the gasoline.

In some cases the speedometer cable becomes noisy or the speed indicator wavers or is erratic. This may be due to a dry cable which should be lubricated using special speedometer grease as outlined in the GENERAL LUBRICATION SECTION. When the cable is removed for lubrication, check it for erratic operation. To do this, take the ends of cable (after removing it from casing) one end in each hand, and slowly turn the cable (Fig. 11-138). If it is kinked, the loop will "flop"; in such a case replace the cable.

MINOR REPAIRS

INSTRUMENT CLUSTER—REMOVE AND REPLACE

1. Disconnect battery.

2. Disconnect cluster wire at chassis wiring harness connection below plenum chamber.

3. On cars with Circ-L-Aire Conditioning, remove instrument cluster pad and trim plate (retained with clutch head screws). Remove radio knob and retaining nut. Push cluster toward front seat to gain access to speedometer cable and wire connectors.

4. Using a spin wrench or deep socket, remove four ⅜ x 10-24 nuts and four lock washers.

5. Disconnect speedometer cable.

6. Remove wire connector from ammeter terminals and other electrical connections on back side of cluster.

7. On all cars less Circ-L-Aire Conditioning, push cluster toward front of car. Turn cluster upside down and remove cluster assembly.

8. Remove cluster.

9. Replace by reversing the above procedure.

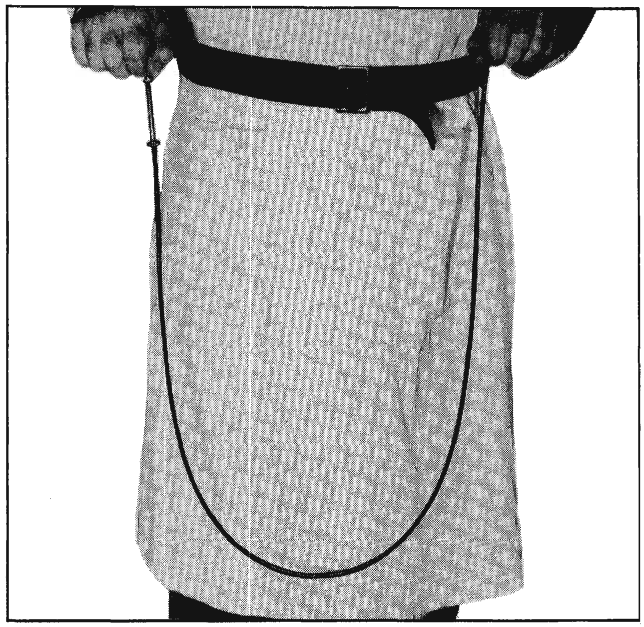


Fig. 11-138 Testing Speedometer Cable for Kinks

SPEEDOMETER—REMOVE AND REPLACE

1. Disconnect Safeguard control cable on cars so equipped (pull straight out).

2. Remove speedometer cluster assembly.

3. Remove cluster face plate and lens by unsnapping face plate from housing.

4. Remove three screws on back of cluster at speedometer cable fitting area.

5. Remove speedometer and instruments carefully. If car is equipped with Safeguard speedometer, disconnect ground wire at clip terminal and also the wire retaining clip. Carefully note routing of wires before removing ground wire.

6. Remove two screws retaining numeral plate and remove speedometer head assembly.

7. Replace by reversing the above procedures being careful so as not to damage instruments.

FUEL GAUGE AND AMMETER—REMOVE AND REPLACE

1. Disconnect battery.

2. Remove wire connector and cluster illumination light.

3. Remove two gauge bracket to cluster screws.

4. Remove gauge assembly.

5. Replace by reversing the above steps.

IGNITION SWITCH—REMOVE AND REPLACE

1. Remove retaining ring from front of panel.

2. Remove switch from and drop below panel.

3. Release terminal retainers on accessory terminal and then pull connector off switch.

4. Replace—push connector onto switch and reverse steps 1 and 2.

HEAT CONTROL ASSEMBLY—REMOVE AND REPLACE

1. Remove heater control housing to instrument panel screws at bottom of heater control assembly.

2. Disconnect wire connectors at heater control.

3. Disconnect vacuum connector on Circ-L-Aire heater vacuum switch.

4. Back out upper retaining screws approximately $5/16''$.

5. Replace by reversing the above procedures.

6. Check adjustment of heater control valve cable(s).

FUEL GAUGE TANK UNIT (ALL EXCEPT SAFARI)—REMOVE AND REPLACE

NOTE: Before removing tank unit be sure it is actually inoperative; see TESTING section.

1. Clean away any dirt that has collected around tank unit and tank unit terminal so it will not enter tank and also because dirt, particularly if calcium chloride, causes an electrical leak that will cause error in gauge reading.

2. Disconnect lead from terminal on tank unit, disconnect fuel line, remove five screws holding unit to tank and remove unit from tank.

3. Install new tank unit, first checking for float arm freedom of movement by raising it to various positions and seeing if it will always fall to "empty" position.

4. Install attaching screws and tighten securely.

5. Securely install wire to terminal or tank unit and see that boot on wire connection is properly installed so as to seal connection.

6. Reconnect fuel pipe.

SPEEDOMETER CABLE—REMOVE AND REPLACE

1. Disconnect speedometer cable casing from speedometer head.

2. Slide old cable out from upper end of casing, or if broken from both ends of casing.

3. Take a short piece of speedometer cable with a tip to fit the speedometer and insert it in the speedometer socket. Spin the short cable between the fingers in the direction that higher speed is indicated on the speedometer dial and note if there is any tendency to bind. If binding is noted, there is trouble inside the head and the speedometer should be repaired.

4. Inspect cable casing, especially at transmission end, for sharp bends and breaks. If breaks are noted, replace casing.

5. Spread a generous coating of speedometer cable grease over the lower two-thirds of new cable and a thin coating over the upper one-third of the cable.

6. Insert cable into upper end of casing, lower end first.

7. Seat upper cable tip in speedometer and tighten casing connector to speedometer case as tightly as possible with fingers.

NOTE: Insufficient tightening of connector will result in connector loosening, causing speedometer indicator to waver.

8. See that there are no sharp bends in casing.

FUEL TANK GAUGE UNIT (SAFARI MODELS)—REMOVE AND REPLACE

NOTE: Before removing tank unit be sure it is actually inoperative. See TESTING section.

1. Remove fuel filler cap and drain fuel tank.

2. Disconnect ground screw at inside of frame just forward of luggage well compartment.

3. Disconnect waterproof tank gauge wire connector between frame and luggage well compartment.

4. Disconnect wire from clamps at frame.

5. Disconnect fuel lines.

6. Remove fuel tank front splash shield.

7. Disconnect fuel tank strap and remove tank.

8. Remove gauge from tank.

9. Replace by reversing the above procedures making sure a new fuel gauge tank unit gasket is installed.

INSTRUMENT TROUBLE DIAGNOSIS

GASOLINE GAUGE DOES NOT REGISTER WITH IGNITION ON

CAUSE	REMEDY
Break in line between instrument panel unit and iginition switch.	Check line and connections to switch and panel unit.
Inoperative panel unit.	Check and replace.

GASOLINE GAUGE SHOWS FULL UNDER ALL CONDITIONS

CAUSE	REMEDY
Break in line between tank and instrument panel unit.	Check and repair.
Inoperative tank unit.	Check and replace.
Tank improperly grounded.	Remove paint under tank unit mounting screws and tighten screws. Ground tank to chassis and check gauge operation.

GASOLINE GAUGE SHOWS EMPTY UNDER ALL CONDITIONS

CAUSE	REMEDY
Lead to tank unit grounded.	Make necessary repair.
Inoperative tank unit.	Check and replace if necessary.
Inoperative panel unit.	Check and replace if necessary.

THERMO-INDICATOR INOPERATIVE

Test thermo-gauge

SPEEDOMETER NOISE AND/OR INDICATOR OSCILLATING

CAUSE	REMEDY
Cable dry.	Lubricate cable.
Kinked cable.	Replace cable. Re-route casing so that bends have no less than 6″ radius.
Inoperative speedometer head.	Replace or have repaired at authorized service station.
Casing connector loose on speedometer case.	Tighten connector.

INSTRUMENT TESTING

FUEL GAUGE TANK AND INSTRUMENT PANEL UNITS

In order to isolate trouble in the fuel tank or instrument panel unit, use either an extra tank unit, which is known to be good, or a reputable gas gauge tester.

CAUTION: In process of testing fuel guage panel unit NEVER place full battery current on terminal to which wire to tank unit is normally attached. To do so will burn out resistance coil in tank unit even though the terminal is touched only momentarily.

To test, remove lead to tank unit from instrument panel unit and then use one of the following methods:

TESTING WITH EXTRA TANK UNIT

Engine must be operating at 1500 rpm when testing the gasoline gauge to insure adequate voltage (14.5 volts) at the gauge.

1. Attach a wire lead from the terminal on the extra tank unit to the tank unit terminal on the panel unit and connect a second wire from body of extra tank unit to car chassis.

2. Turn on ignition and move float on extra tank unit to full and empty positions. If panel unit indicates corresponding reading, it is satisfactory and trouble is in tank unit or wire lead from panel unit to tank unit.

3. Check wiring to tank unit by disconnecting lead from tank unit in car and connecting to test unit. With test unit grounded to chassis move float to full and empty positions and see that instrument panel unit reads correctly. Incorrect reading indicates defect in wiring.

4. Check tank unit by removing from tank, reconnecting the lead and operating unit in same manner as the test unit (tank unit must be grounded

while testing). If instrument panel shows correct reading, trouble was caused by poor connection of lead to tank unit or poor ground. If instrument panel does not give correct reading, install a new tank unit.

TESTING WITH GAS GAUGE TESTER

The calibration limits of the fuel gauge dash unit are 30 ohms—full, 15 ohms—½ full and 1 ohm empty.

1. Remove lead to tank unit from instrument panel unit. Attach red wire of tester to the tank unit terminal on panel unit and ground the tester by connecting the black wire to a good ground.

2. Turn on ignition switch and move lever on tester through its full travel. If panel unit reads "empty" and "full," it is satisfactory and trouble is in tank unit or possibly wire lead from instrument panel unit to tank unit.

3. Check wiring to tank by disconnecting lead from tank unit in car and connecting to tester. Ground tester and move lever on tester through its full travel. If instrument panel unit shows "empty" and "full," tank unit is probably defective and should be checked as in step 4 above.

SPECIFICATIONS

	Synchro-Mesh	Hydra-Matic	Ex-Duty
	(1980458)	(1980558)	(1980570)
Battery Model	2SMR53	558	3SMR72
Capacity at 20 hr. rate, amp.-hr.	53	61	72
	Standard	Heavy Duty & Circ-L-Aire Conditioning	Heavy Duty (Low Cut In)
Generator Model	1102303	1102220	1105143
Brush Spring Tension, Oz.	28	28	28
Cold Output	35 amps., 14 V. 2540 Gen. r.p.m. 925 Eng. r.p.m.	45 amps., 14 V. 2520 Gen. r.p.m. 1025 Eng. r.p.m.	45 amps., 14 V 2520 Gen. r.p.m. 1125 Eng. r.p.m.
Field Current Draw	1.69-1.70 amps. 12 V., 80°F.	2.66-2.86 amps. 12 V., 80°F.	2.66-2.86 amps. 12 V., 80° F.
Regulator Model	1119668	1119623	1119623
Paint Code Identification (daub)	Yellow	none	none
Cutout Relay:			
Air Gap, In.	.020	.020	.020
Point Opening, In.	.020	.020	.020
Closing Voltage, volts	11.8-13.0	11.8 - 13.0	11.8 - 13.0
Voltage Regulator:			
Air Gap, In.	.067	.067	.067
Upper Contact Opening, In.	—	.016	.016
Normal Range (125°F) volts	13.8-14.8	13.8 - 14.6	13.8 - 14.6
Lower Contact Setting		.1 - .3V Lower	.1 - .3V Lower
Current Regulator:			
Air Gap, In.	.075	.057	.057

SPECIFICATIONS (Cont.)

	Regular Fuel	Premium Fuel
Cranking (Starter) Motor Model	1107791	1107781
Brush Spring Tension, oz.	35	35
Free Speed:		
Volts	10.3	10.6
Amperes	75	80 - 120
RPM	6900	3900-5400
Resistance Test (Armature Locked):		
Volts	5.8	2.0
Amperes	435	290 - 370
"E" Engine and Circ-L-Aire Conditioning Uses		1107781
Solenoid Switch Model	1114257	1114257
Hold-in Winding (at 10 volts)	15.5 - 17.5 amps.	15.5 - 17.5 amps.
Both Windings (at 10 volts)	47 - 54 amps.	47 - 54 amps.
Distributor Model	1110997	1110996
Rotation	C-C	C-C
Cam Angle, set to	30°	30°
range	28°-32°	28°-32°
Condenser Capacity, mfd.	.18-.23	.18-23
Centrifugal Advance (Dist. Degrees)	Deg. RPM	Deg. RPM
Start	0-2 450	0-2 400
Intermediate	6-8 1050	4-6 750
Intermediate		7-9 1000
Maximum	9-11 1800	8-10 1450
Vacuum Control—Model		
Inches of Mercury to start advance	6-8	8-10
Inches of Mercury for full advance	13-15	15-17
Maximum Advance (Dist.)	10°	10°
Ignition Coil Model	1115133	1115133
Primary Resistance, Ohms	1.81-1.95	1.81-1.95
Secondary Resistance, Ohms	7200-9500	7200-9500
Spark Plugs	A.C.	A.C.
Size	14 MM	14MM
Type	45S	45S
Gap	.035"	.035"
Torque	25 lb. ft.	25 lb. ft.
Ignition Resistor Wire		
Resistance at 80°F. Ohms	1.32 ± .04	1.32 ± .04

Horns	Model	Type	Ampere Draw
All	9000397	Low Note	7 - 12 amp. 12V
	9000398	High Note	7 - 12 amp. 12V

Relays

Delco	Application	Type	Air Gap Point Closed	Point Opening	Closing Voltage, V
537722	Air-Cond.	Control	.015"	.020"	7-9
1116970	All	Horn	.020"	.018"	1.5-9.5

PONTIAC FUSE CHART

CATALINA, VENTURA, STAR CHIEF & BONNEVILLE SERIES	FUSE TYPE	FUSE CAPACITY AMPS.	STANDARD (S) OPTIONAL (O)
Tail Lamps	SFE	14	S
License Lamp	SFE	14	S
Instrument Lamps	SFE	4	S
Console Courtesy and Compartment Lamps	SFE	14	S and O
Dome and/or Quarter Lamps (Exc. Conv.)	SFE	14	O
Courtesy Lamps	SFE	14	S and O
Clock Power	SFE	14	S and O
Clock Lamps	SFE	4	S and O
Compass Lamp	SFE	4	O
Tachometer Lamp	SFE	4	S and O
Electric Windshield Wiper Motor & Pump	3AG or AGC	25	S
Ignition Key Lamp	SFE	4	S
Lighting Control Rheostat	SFE	4	S
Stop Lamps	SFE	14	S
Direction Signals and Indicator	SFE	14	S
Ash Tray Lamp	SFE	14	O
Cigar Lighter Lamp	SFE	14	O
Windshield Washer	3AG or AGC	25	O
Circ-L-Aire Conditioner Control Lamp	SFE	4	O
Circ-L-Aire Conditioner Power and Blower Motor	3AG or AGC	30	O
Heater Control Lamp	SFE	4	O
Heater Blower Motor	SFE	20	O
Parking Brake Warning Lamp	SFE	14	O
Hydra-Matic Indicator Lamp	SFE	4	O
Glove Box Lamp	SFE	14	O
Luggage Compartment and Utility Lamp	SFE	14	O
Underhood and Underhood Utility Lamp	SFE	14	O
Safe Guard Speedometer Circuit and Low Fuel Lamp	SFE	20	O
Back-Up Lamps	3AG or AGC	25	O
Radio Dial Lamp	SFE	4	O
Radio Power	SFE	7.5	O
Power Antenna	SFE	14	O
Spot Lamp	SFE	14	O

Cigar lighter fuse or circuit breaker is located on forward end of lighter housing. Capacity is the result of heat from the heater element and the amps. used.

Electric windshield wiper motor has an internal circuit breaker (2 Speed Only).

Lighting switch circuit breaker will carry a 22 amp. load continuously. Will open with 35 amps. within 30 to 60 seconds.

Fuse block is located on passenger side of dash, left side of car.

Circ-L-Aire Conditioning Power—One 30 amp. fuse inline fuse holder above fuse block. On and off with ignition switch.

Power window motors, seat motors, and tailgate window motors—40 amp. circuit breaker on junction block on l.s. fender skirt; direct connection to battery. Only one circuit breaker required for any combination.

LAMP USAGE

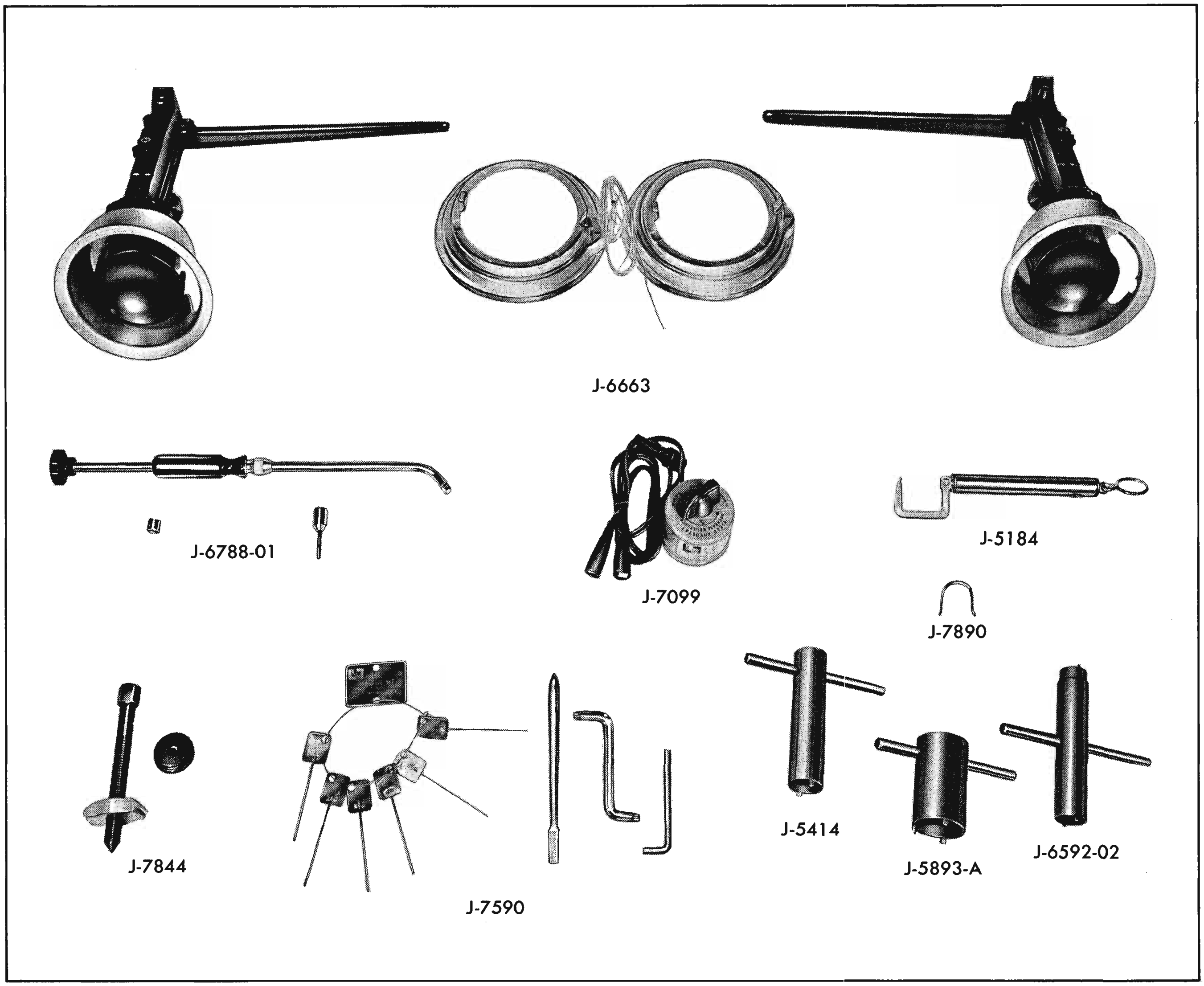
	LAMP	TRADE NO.	DOMESTIC: Cat. Sedans & H. T. Cpe.	Catalina Sta. Wgns.	Catalina Conv. Cpe.	Star Chief Sedan	Star Chief H. T. Sed.	Bonneville Hardtops	Bonneville Sta. Wgn.	Bonneville Conv. Cpe.	Bonneville H. D. Chassis	Grand Prix	EXPORT: Right Rule of Road	Left Rule
STANDARD EQUIPMENT	Head (37.5W)	Type 1 SB	2	2	2	2	2	2	2	2	2	2	2	
	Head (37.5-50W)	Type 2 SB	2	2	2	2	2	2	2	2	2	2	2	
	Head (37.5-40W)	Type 2X XB												2
	Park and Direction Signal	1034	2	2	2	2	2	2	2	2	2	2		
	Tail, Stop and Direction Signal	1034	2	2	2	4	4	4	2	4		4		
	Direction Signal Indicator (Catalina)	57	2	2	2									
	Direction Signal Indicator (All Others)	1816				2	2	2	2	2	2	2		
	License	67	1	1	1	1	1	1	1	1	1	1		
	Instruments (Illumination) (Catalina)	57	6	6	6									
	Instruments (Illumination) (All Others)	1816				6	6	6	6	6	6	6		
	Oil Pressure Indicator (Catalina)	57	1	1	1									
	Oil Pressure Indicator (All Others)	1816				1	1	1	1	1	1	1		
	Temperature Gauge (Catalina)	57	2	2	2									
	Temperature Gauge (All Others)	1816				2	2	2	2	2	2	2		
	Headlamp Beam Indicator (Catalina)	57	1	1	1									
	Headlamp Beam Indicator (All Others)	1816				1	1	1	1	1	1	1		
	Ignition Key	53	1	1	1	1	1	1	1	1	1	1		
	Clock	57				2	2	2	2	2		2		
	Dome or Side Roof (Hard tops)	90					2	2				2		
	Dome (except with reading lamp)	211	1	1		1			1					
	Courtesy (Entrance)	89			2			2		2				
	Console Compartment	57										1		
	Console Courtesy	89										1		
	Rear Seat Arm Rest	68			2					2				
	Tachometer	57										1		
SPECIAL ORDER EQUIPMENT	Circ-L-Aire Conditioner Control	57	1	1	1	1	1	1	1	1	1	1		
	Ash Container	53	2	2	2	2	2	2	2	2	2	2		
	Back-Up	1073	2	2	2	2	2	2	2	2	2	2		
	Compass	53	1	1	1	1	1	1	1	1	1	1		
	Courtesy (Entrance)	89	2	2		2	2		2			2		
	Courtesy (9 Pass. Sta. Wgn. R.)	90		1										
	Dome (with reading lamp)	1004	1	1		1			1					
	Heater Control	57	1	1	1	1	1	1	1	1	1	1		
	Hydra-Matic Indicator	57	1	1	1	1	1	1	1	1	1	1		
	Inst. Panel Compartment	57	1	1	1	1	1	1	1	1	1	1		
	Luggage Compartment and Utility	1003	1		1	1	1	1		1		1		
	Underhood and Utility	93		1					1		1			
	Underhood	93	1		1	1	1	1		1		1		
	Parking Brake Warning	57	1	1	1	1	1	1	1	1	1	1		
	Radio Dial	57	1	1	1	1	1	1	1	1	1	1		
	Spot Lamp	4404 SB	1	1	1	1	1	1	1	1	1	1		
	Cigar Lighter	53	1	1	1	1	1	1	1	1	1	1		
	Safeguard Speedo Dial Warning	57	1	1	1	1	1	1	1	1	1	1		
	Low Fuel Warning	55	1	1	1	1	1	1	1	1	1	1		
	Clock	57	2	2	2									
	Reading Lamp	94 IF	1	1		1			1			1		
	Console Compartment	57								1				
	Console Courtesy	89								1				
	Tachometer	57	1	1	1	1	1	1	1	1	1			

Lamp No.	Design			Lamp No.	Design			Lamp No.	Design		
Trade	Volts	Amps.	C. P.	Trade	Volts	Amps.	C. P.	Trade	Volts	Amps.	C. P.
53	14.4	.11	1	941F	12.0	—	15	211	12.0	1.17	15
55	7.0	.45	2	1003	12.8	1.05	15	4404 SB	12.8	2.34	30W
57	14.0	.25	2	1004	12.8	1.05	15	Type 1SB	12.8	3.14	37.5W
67	13.5	.53	4	1034	12.8	2.10	32	Type 2SB	12.8	3.14	37.5W
68	13.0	.41	3	1034	14.0	.56	4	Type 2SB	—	4.19	50W
89	13.0	.63	6	1073	12.8	2.05	32	Type 2X XB	12.8	3.14	37.5W
90	13.0	.63	6	1816	13.0	.33	—	Type 2X XB	—	4.19	50W
93	12.8	1.15	15	1881	15.5	.24	2	—	—	—	—

WRENCH TORQUE SPECIFICATIONS

TORQUE	SIZE	APPLICATION
		Instrument Panel Instruments and Clock
20-25 Lb. Ft.	1/4-20	Screw and L/W Assy.—Speedo. Driven Gear and Sleeve Assy. Trans. Case
20-30 Lb. In. 40-50 Lb. In.	(Meter End) (Trans. End)	Cable Assembly—Speedometer
8-12 Lb. Ft.	5/16-18	Screw—Speedometer Cable to Frame Clip
30-56 Lb. In.	10-24	Nut—Instr. Cluster to Trim Plate
30-50 Lb. In.	10-24	Nut—Instr. Cluster to Retainer
35-50 Lb. In.	1/4-20	Screw—Speedometer Driven Gear Retainer to Trans.
30-50 Lb. In.	10-24	Screw—Instr. Panel Cluster Retainer to Trim Plate
		Chassis Wiring, Clips, Switches, Etc.
10-35 Lb. In.	10-24	Screw and L/W Assy.—Dimmer Switch Assy. (To Body)
10-35 Lb. In.	10-16	Screw—Direction Signal Switch Assy. to Strg. Col. Jacket
15-35 Lb. In.	10-16	Screw—Neutralizer Switch and Back-Up Lamp Switch Assy. to Strg. Col.
15-40 Lb. In.	1/2-20	Nut—Stop Light Switch Assembly
10-35 Lb. In.	10-24	Screw—Main Wire Assy. Clip to Parking Brake Anchor
10-35 Lb. In.	10-24	Screw—Main Wire Assy. Instr. Cluster Conn. to Dash
35-45 Lb. In.	14-10	Screw—Main Wire Assy. to Dash Clip
10-35 Lb. In.	10-12	Screw—Main Wire Fuse and Terminal Block to Dash
		Battery and Leads
20-35 Lb. Ft.	3/8-24	Nut—Battery Ground Cable Assy. to Cylinder Head

SPECIAL TOOLS



J-5184	Armature Brush Tension Scale
J-5414 or J-8653	Instrument Panel Nut Wrench
J-5893-A	Ignition Switch Spanner Wrench
J-6592-02	W/S Wiper Transmission Wrench
J-6663	T-3 Headlamp Aimer
J-6788-01	Carburetor and Distributor Adjusting Tool
J-7099	25 OHM Rheostat
J-7590	Generator Regulator Service Set
J-7844	W/S Wiper Field Coil Puller
J-7890	W/S Wiper Brush Retainer

Fig. 11-139 Electrical and Instruments Special Tools

ACCESSORIES

CONTENTS OF THIS SECTION

SUPER DELUXE RADIO

DESCRIPTION

The All-Transistor Super Deluxe Radio (Fig. 12-1) offers numerous advantages over previous push button models. The Pontiac owner will welcome the following outstanding features of these entirely new radios:

1. Instant performance when radio is turned on—no vacuum tubes to warm up.

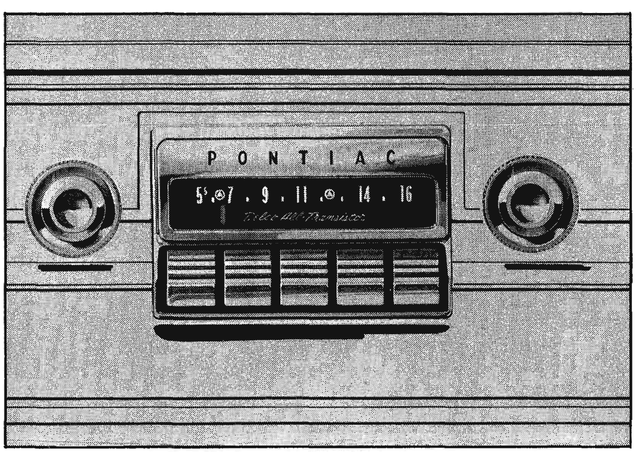


Fig. 12-1 Super Deluxe Radio

2. Low battery current drain. This radio requires less than half the current of previous models.
3. Although less current drain, station pick-up ability and power output remains as good or better than previous models.
4. Longer life and less maintenance due to all transistors and lower current drain.

The Super Deluxe Radio allows the Pontiac customer manual tuning, push button tuning, automatic volume control (regardless of variations in signal strength) and a tone control which enables the owner to select a high fidelity tone of his or her choice.

PRE-REMOVAL TROUBLE DIAGNOSIS

The proper operation of the radio depends not only on the radio itself, but on a number of components that are external to the radio. A failure of one of these external components will cause a radio complaint just as a failure inside the radio.

Most radio complaints usually fall into one of three categories; the radio is either dead, weak or noisy. Before removing a radio from the car, a few simple checks can be made in a very short time. In some cases the radio will not need to be removed at all.

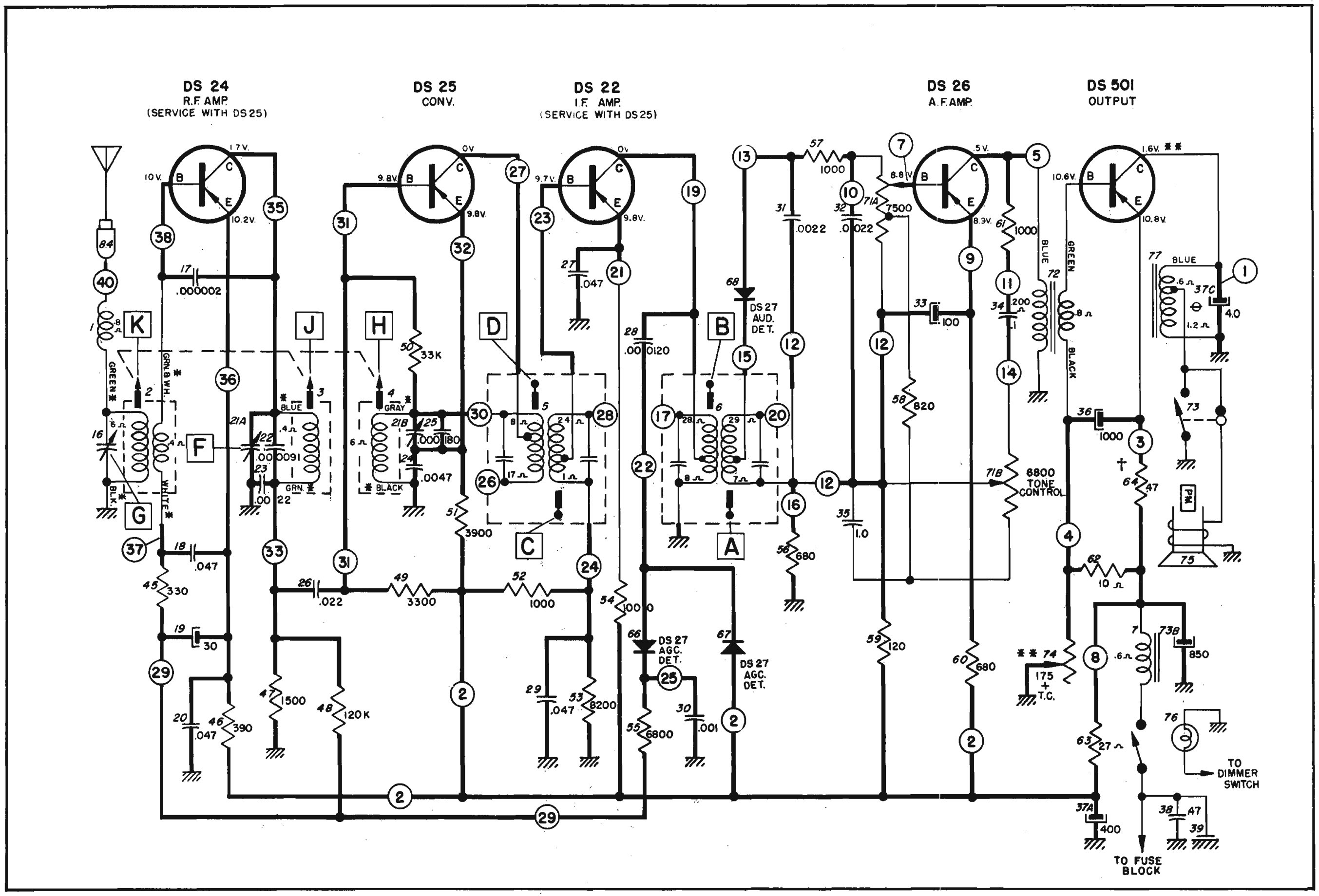


Fig. 12-2 Schematic of Super Deluxe Radio

COMPONENT PARTS OF SUPER DELUXE RADIO

ELECTRICAL PARTS

Coils

DESCRIPTION

Illus.
No.

1. Choke, antenna series
2. Antenna, tuning
3. R.F., tuning
4. Oscillator, tuning
5. 1st I.F.
6. 2nd I.F.
7. Choke, "A" supply, input

Capacitors

16. Antenna Trimmer
17. .000002 mfd., 100 V., disc ceramic
18. .047 mfd., 75 volt, tubular
19. 30 mfd., 6 V., electrolytic
20. .047 mfd., 75 volt, tubular
21. Dual Trimmer
    21A. R.F. Section
    21B. Oscillator Section
22. .000091 mfd., 100 volt, disc ceramic
23. .0022 mfd., 100 volt, dipped mica
24. .0047 mfd., 100 volt, disc ceramic
25. .000180 mfd., 100 volt, ±5%, disc cer.
26. .022 mfd., 75 volt, tubular
27. .047 mfd., 75 volt, tubular
28. .000120 mfd., 100 volt, ±5%, disc cer.
29. .047 mfd., 75 volt, tubular
30. .001 mfd., 100 volt, disc ceramic

31. .0022 mfd., 100 volt, disc ceramic

32. .0022 mfd., 100 volt, disc ceramic

33. 100 mfd., 3 volt

34. 0.1 mfd., 75 volt, tubular, vert. mtg.

35. 1.0 mfd., 3 volt, disc ceramic

36. 1000 mfd., 1 volt, electrolytic

37. Electrolytic—3 section
    37A. 400 mfd., 16 volt
    37B. 850 mfd., 16 volt
    37C. 4 mfd., 11.5 R.M.S.

38. .47 mfd., 100 volt, tubular

39. Spark Plate

Resistors

45. 330 ohm, ½ watt

46. 390 ohm, ½ watt

47. 1500 ohm, ½ watt

48. 120,000 ohm, ½ watt, ±5%

49. 3300 ohm, ½ watt

50. 33,000 ohm, ½ watt

51. 3900 ohm, ½ watt

52. 1000 ohm, ½ watt

53. 8200 ohm, ½ watt

54. 1000 ohm, ½ watt

55. 6800 ohm, ½ watt, ±5%

56. 680 ohm, ½ watt

57. 1000 ohm, ½ watt

58. 820 ohm, ½ watt

59. 120 ohm, ½ watt

60. 680 ohm, ½ watt

61. 1000 ohm, ½ watt

62. 10 ohm, ½ watt

63. 27 ohm, ½ watt

64. .47 ohm, Fuse Resistor

Tubes & Transistors

DS501 Transistor, output

66. DS27 Diode, AGC-Det.
    DS22 Transistor, I.F. Amp.
    DS24 Transistor, R.F. Amp.
    DS25 Transistor, converter
    DS26 Transistor, audio driver

67. DS27 Diode, AGC-Det.
    Insulator Kit, transistor mtg.

68. DS27 Diode, Audio Det.

Miscellaneous Electrical

71. Control, vol., tone & switch
    71A. Volume
    71B. Tone
    71C. Switch

72. Transformer, input

73. Switch, speaker inter-lock

74. Rheostat, 175 ohm, T.C.

75. Speaker, 4 x 10″, P.M., slotted

76. Lamp, dial light, #57

77. Transformer, output

MECHANICAL PARTS

Chassis

80. Connector Assembly, "A" lead

81. Dial Light Assembly

83. Radiator Pkg., transistor heat
    Insulator Pkg., radiator mtg.

84. Socket, antenna connector

Tuner Parts

91. Backplate, pointer
    Bearing Plate, manual shaft, rear

92. Bell Crank Pkg., pointer
    92A. Spring, pivot

93. Bushing, manual shaft

94. Clutch disc, adjustable
    Set Screw, slab head

95. Core Bar

96. Core, tuning

97. Drive Shaft & Worm Pkg., manual

98. Escutcheon Assembly
    98A. Backplate, dial
    98B. Dial, calibrated

99. Finger Bar Pkg., declutching

100. Gear & Bushing, clutch anti-backlash

101. Grommet, ant. & R.F. coils mtg.

102. Grommet, osc. coil mtg.

103. Housing, tuning coils
Sleeve, ant. & R.F. coils

104. Lever Pkg., clutch operating
Roller, clutch oper. lever

105. Link, core bar connecting

106. Link, pointer calibration adjustment

107. Pointer Assembly Package

108. Spring, pivot

109. Pushbuttons, frt. bear. plate & slides (set of 5)
109A. Pushbutton, ind. (5 req'd)

110. Set Screw & Nut Pkg., treadle pivot

111. Spring Pkg., clutch operating

112. Spring, core bar connecting link

113. Spring, driver shaft retainer

114. Spring, pointer calibration link

115. Spring Pkg., pushbutton return (set of 5)

116. Spring Pkg., treadle bearing

117. Treadle Bar

Installation Parts

Capacitor, generator

Capacitor, voltage regulator

Ferrule, covers mtg. nuts (2)

Fuse, 7.5 amp., type SAE

Knob, control (2)

Knob, dummy

Knob, tone control

Nut, radio bushing (2)

Spring, control knob (2)

Washer, knob anti-rattle (2)

109B. Pushbutton, individual (5 required)

Refer to the RADIO TROUBLE DIAGNOSIS before removing radio.

If all the diagnosis checks fail to turn up the problem, the condition is in the radio itself. The radio should be removed from the car and sent to an authorized service station. Include all pertinent information that might help the radio technician repair the radio as quickly as possible.

REMOVE AND REPLACE RADIO

1. Remove glove compartment.
2. Remove control knobs.
3. Remove large hex nuts.
4. Remove nut and washer from radio support bracket on left side of radio.
5. Remove radio to fuse block connector, antenna lead-in wire and speaker leads.
6. Remove radio through glove compartment door.
7. Reverse procedure to install.

REMOVE AND REPLACE SPEAKER

1. Remove radio.
2. Remove four nuts holding speaker to upper panel.
3. Remove speaker.
4. Reverse procedure to replace.

ADJUST ANTENNA TRIMMER

In order to make the antenna trimmer adjustment, the car should be outdoors and as far removed from electrical disturbances as possible. Extend the antenna to its full height. Tune in a weak station between 600 and 1000 kilocycles where it is possible to turn the volume control on full. This is necessary in order to offset the action of the automatic volume control. Using a screwdriver turn the trimmer adjusting screw clockwise until the station fades out. Turn the screw counterclockwise until the station peaks in volume and starts to fade. Then adjust the trimmer screw between these two extremes for maximum volume. The trimmer screw is accessible at the rear of the radio through the hole toward back of the glove box.

The antenna trimmer adjustment should be made on new car pre-delivery inspection and also after a set has been removed from the car and worked on by a radio repair man. The reason for trimming the antenna after service work has been performed is that the radio repair man will undoubtedly have adjusted the trimmer to match his antenna so that it no longer matches the antenna in the car from which it was removed. Trimming the antenna is especially important with the Electramatic Wonder Bar Radio as this will directly affect the sensitivity control of the selector bar.

ELECTRAMATIC WONDER BAR RADIO

DESCRIPTION

The Electramatic Wonder Bar Radio (Fig. 12-3) is equipped with a "selector bar" and five push buttons to provide manual tuning of all available stations in any locality. The push buttons are preset to the owner's favorite stations while the selector bar provides tuning to all stations transmitting in the area.

When the selector bar is depressed and released the tuner will automatically move to the right and stop, accurately tuned, when it reaches the next station having adequate strength to stop it. When the tuner reaches the right end of the dial it flies back to the left and again starts moving to the right until it reaches a station having sufficient strength to stop it.

Two control knobs flank the radio dial. The left hand knob is the OFF-ON switch and volume control. The tone control is mounted behind the left knob. The right knob is the manual tuner. Directly under the selector bar is the three position "sensitivity" control that limits signal strength.

When the control is moved fully to the left only the strongest stations are picked up by the selector bar. Movement of the sensitivity control to the right to the second and third positions will increase the signal pick up ability of the selector bar to all listenable stations.

PRE-REMOVAL TROUBLE DIAGNOSIS

See SUPER DELUXE RADIO

REMOVE AND REPLACE RADIO

See SUPER DELUXE RADIO

ADJUST ANTENNA TRIMMER

See SUPER DELUXE RADIO

RADIO TROUBLE DIAGNOSIS

Generator Noise

Connect capacitor from the armature terminal on the generator to ground or the frame of the car.

Voltage Regulator Noise

Place capacitor between the battery terminal of the regulator and chassis.

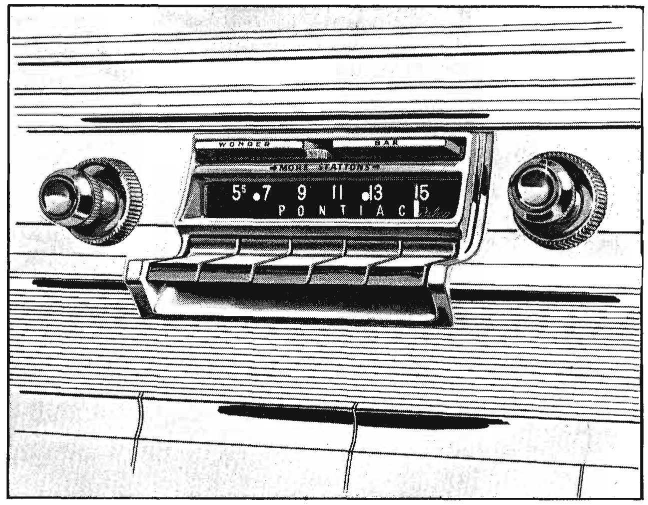


Fig. 12-3 Electramatic Wonder Bar Radio

Ignition Interference

Eliminate by inserting a resistance type rotor in the distributor cap, using resistance wiring harness and installing a capacitor from the "A" connection of the ignition coil to ground.

Ignition Interference Through Hood to Radio Antenna

Eliminate by installing a hood grounding clip.

Ball on End of Antenna Rod

Ball eliminates the sharp point and reduces the effect of corona discharge. Curb feelers bent too close to ground will cause noise in the auto radio.

Noise from Wheels and Tires of Car

Noise caused by friction both between the wheels and axles and between the tires and the road surfaces.

Wheel Static

Caused by voltage being developed as the wheel rotates on the axle. Noise is eliminated by placing wheel static collectors in the two front wheels; button end of spiral spring must ride snugly in hole on end of axle.

Tire Static

Caused by electrical charge being built up inside tire due to friction between tire and road. Noise is eliminated by inserting tire static powder into tires using a special injection gun.

CAUTION: Inject powder carefully or powder will backfire in face.

MOST AUTO RADIO COMPLAINTS FALL INTO ONE OF THREE CATEGORIES

DEAD, WEAK OR NOISY

A. Radio is dead.

1. Thump check radio—turn radio on and listen intently for a distinct "thump" from the speaker which should be heard as current builds up through the power transistor.

   a. If "thump" is heard, go to check (3).

   b. If no "thump", check fuse.

      (1) Wonder Bar radio must be fused by a 7.5 ampere fuse. If push button radio fuse (4 ampere) is used with Electra-matic radio, fuse will blow when wonder bar turning is used. If radio plays, after replacing fuse, tap radio with rubber mallet or heel of hand and race the engine; if another fuse blows, remove radio for repair.

      (2) If fuse is OK, check all radio interconnecting cables for secure connections. If still no thump, remove radio for repair.

      (3) Check antenna by substitution; simply unplug regular antenna and plug in a spare. If radio is still dead, remove for repair.

B. Weak

1. Check to see if antenna trimmer is peaked by tuning to a weak station and grasping antenna rod with hand. If volume drops considerably the trimmer is peaked properly; if the volume remains same or increases slightly, antenna trimmer needs adjusting. Use procedure outlined under "Adjust Antenna Trimmer".

2. If radio is still weak, trimmer does not peak, check antenna by substitution.

3. Plug speaker in securely. Make sure speaker is plugged in securely at radio. If radio is still weak, remove the receiver for repair.

C. Noisy

1. Noisy all the time complaint is almost always due to a defect inside the radio but could be caused by a bad antenna. Check with a substitute antenna.

2. Noisy when tapped or jarred, caused by loose antenna connection to the radio, a poor connection to car's power, poor speaker connection, or a loose part or connection inside the radio.

3. Noisy only when engine is running due to faulty noise suppression equipment.

   a. Check by substitution per instructions in "Noise Suppression".

   b. Engine noise can also be caused by some leads or cables laying too close to transistor cooling fin on engine side of firewall. Antenna lead-in shielding must be grounded both at antenna base and at radio. Poor connections at either of these points can result in engine noise getting into radio.

4. If noise is present only while car is moving, problem is either wheel or tire static.

   a. To check, drive car on a macadam road until noise is noticed; then apply brakes; if noise disappears, it's wheel static; if noise persists, it's tire static.

   b. Check for correct installation of static collectors in front wheels or insert tire static powder in tires as required.

5. Noisy when car equipment is operated such as directional lights, brake lights, power seat, or power windows.

   a. Check for defective antenna lead-in wire or loose mounting at antenna base.

If all the above checks fail to turn up the problem, the condition is in the radio itself. The radio should be removed from the car and sent to an authorized service station. Include all pertinent information that might help the radio technician repair the radio as quickly as possible.

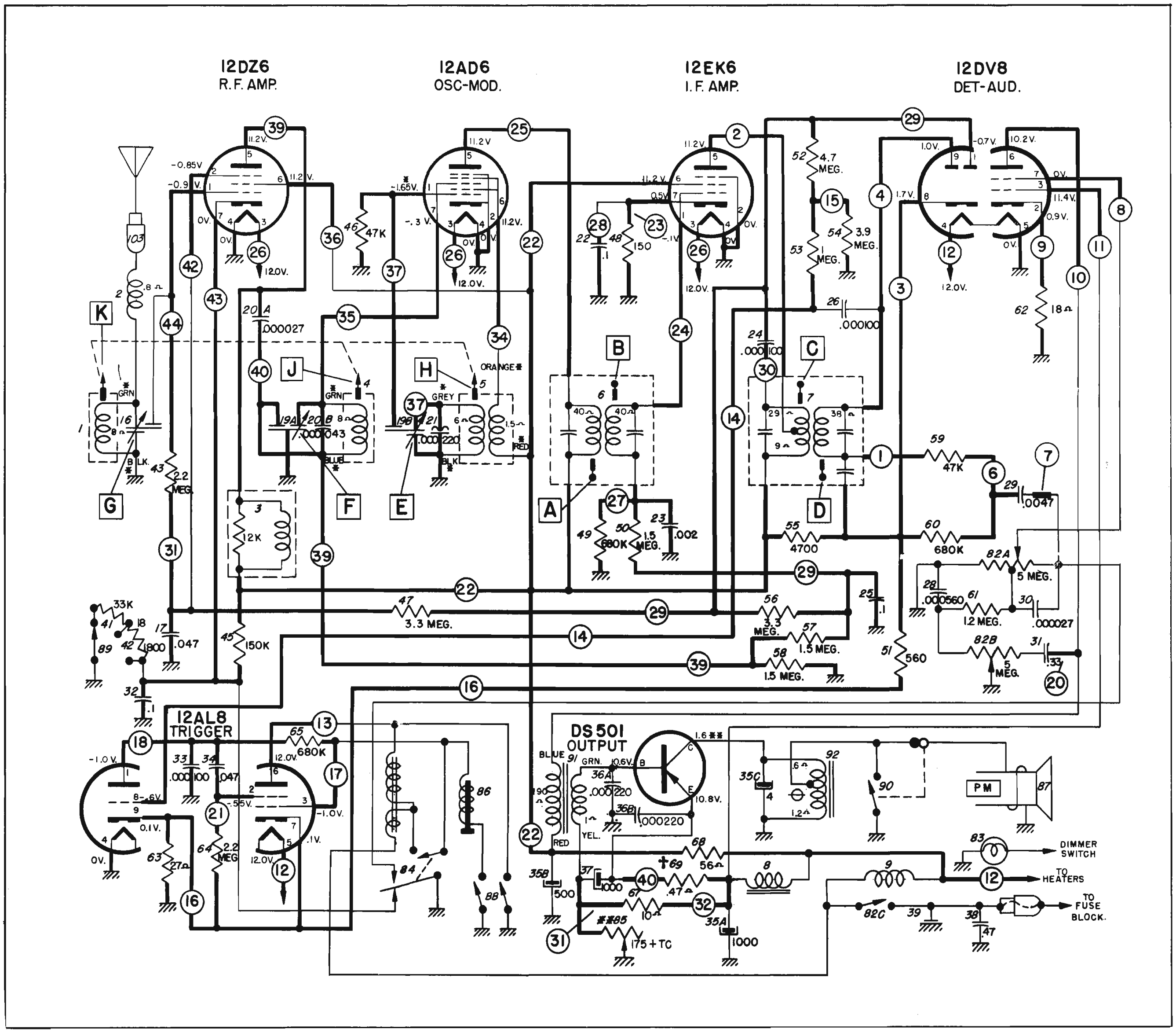


Fig. 12-4 Schematic of Wonder Bar Radio

COMPONENT PARTS OF WONDER BAR RADIO

ELECTRICAL PARTS

Coils

Illus.
No.

1. Antenna tuning
2. Choke, antenna series
3. Choke, R.F. plate
4. R.F. tuning
5. Oscillator tuning
6. 1st I.F.
7. 2nd I.F.
8. Choke, "A" supply
9. Choke, hash

Capacitors

16. Trimmer, antenna
17. .047 mfd., 75 volt, tubular
19. Dual Trimmer
    19A. R.F. Section
    19B. Osc. Section
20. Capacitor dual ceramic
    20A. .000068 mfd., 500 volt
    20B. .000043 mfd., 500 volt
21. 0000220 mfd., dipped mica ±5%
22. .1 mfd., 75 volt tubular
23. .002 mfd., 500 volt, ceramic
24. .000100 mfd., molded mica ±5%

25. .1 mfd., 75 volt, tubular
26. .000100 mfd., 500 volt, dipped mica ±5%
27. .000047 mfd., 100 volt, mica
28. .000560 mfd., 500 volt
29. .0047 mfd., 200 volt, tubular
30. .000027 mfd., 500 volt
31. .33 mfd., 100 volt, tubular
32. .1 mfd., 75 volt, tubular
33. .000100 mfd., 500 volt, ceramic
34. .047 mfd., 100 volt, tubular
35. Electrolytic, 3 section
    35A. 1000 mfd., 16 volt
    35B. 500 mfd., 16 volt
    35C. 4 mfd., 32 volt
36. Dual Ceramic
    36A. .000220 mfd., 500 volt, ceramic
    36B. .000220 mfd., 500 volt, ceramic
37. 1000 mfd., electrolytic
38. .47 mfd., 100 volt, tubular
39. Spark plate

Resistors

41. 33,000 ohm, ½ watt
42. 1800 ohm, ½ watt
43. 2.2 megohm, ½ watt
44. 10,000 ohm, ½ watt
45. 150,000 ohm, ½ watt
46. 47,000 ohm, ½ watt
47. 3.3 megohm, ½ watt
48. 150 ohm, ½ watt
49. 680,000 ohm, ½ watt
50. 1.5 megohm, ½ watt
51. 560 ohm, ½ watt ±5%
52. 4.7 megohm, ½ watt ±5%
53. 1 megohm, ½ watt
54. 3.9 megohm, ½ watt ±5%
55. 4700 ohm, ½ watt ±5%
56. 3.3 megohm, ½ watt
57. 1.5 megohm, ½ watt
58. 1.5 megohm, ½ watt
59. 47,000 ohm, ½ watt
60. 680,000 ohm, ½ watt
61. 1.2 megohm, ½ watt
62. 18 ohm, ½ watt
63. 27 ohm, ½ watt ±5%
64. 2.2 megohm, ½ watt
65. 680,000 ohm, ½ watt
67. 10 ohm, ½ watt
68. 56 ohm, ½ watt
69. .47 ohm, Fuse Resistor

Tubes and Transistors

DS501 DS501 Transistor, output
12DZ6 12DZ6 R.F. amp. tube
12AD6 12AD6 Osc.—Mod. tube
12EK6 12EK6—I.F. amp. tube
12DV8 12DV8 Det.—Audio tube
12AL8 12AL8 Trigger tube

Miscellaneous Electrical

82. Control, volume, tone and switch
    82A. Volume
    82B. Tone
    82C. Switch
83. Lamp dial light, No. 57
84. Relay, tuner operating
85. Rheostat, 175 ohms, T.C.
86. Solenoid and plunger assy.
    86A. Clip, plunger stop
87. Speaker, 4″ x 10″ P.M., slotted mtg. holes
88. Switch, push bar and solenoid
89. Switch, sensitivity (includes push bar)
90. Switch, speaker inter-lock
91. Transformer, input
92. Transformer, output
93. Switch, push bar, F-4 Tuner
94. Switch, solenoid, F-4 Tuner

MECHANICAL PARTS

Chassis

101. Dial Light Assy.
     Felt Pad, tube
102. Radiator, transistor heat
     Insulator, heat radiator
     Shield, tube, 12AD6
103. Socket, antenna connector
     Socket, tube, 7-pin miniature
     Socket, tube, 9-pin miniature

Tuner Parts

110. Arm Pkg., power
111. Arm Pkg., treadle return, F-3 Tuner
112. Arm Pkg., treadle trigger, F-3 Tuner
113. Backplate, pointer
114. Ball Bearing Pkg., (13 ± retainer cup)
115. Bearing Plate, manual shaft, rear
116. Bell Crank Pkg., pointer
     Spring pivot
117. Bracket Pkg., treadle trigger, F-3 Tuner
118. Bushing, manual shaft
119. Clutch Disc, adjustable, F-3 Tuner
     Set Screw, slab head
120. Core Bar
121. Core, tuning
122. Drive Shaft, worm and rack pkg.
123. Escutcheon Assy.
124. Finger Bar Pkg., declutching

125. Gear and Bushing, clutch anti-backlash
126. Governor Gear Train
127. Grommet, R.F. and ant. coil mtg.
128. Grommet, osc. coil mtg.
129. Housing, tuning coils, F-4 Tuner
    Sleeve, ant. and R.F. coil
130. Lever Pkg., clutch operating
    Roller, clutch operating lever
131. Lever and Shaft Pkg., solenoid return
132. Link, core bar connecting
133. Link, pointer calibration adjustment
134. Link Pkg., solenoid
135. Pointer Assy. Pkg.
136. Spring, pivot
138. Pushbuttons, front bearing plate and slides
    (set of 5)
139. Pushbuttons, individual
140. Retaining Ring Pkg., mech., linkage
    (10 in Pkg.)
141. Set Screw and Nut Pkg., treadle pivot
142. Spring Pkg., clutch operating
143. Spring, core bar connecting link
144. Spring, pointer calibration link
145. Spring, power
146. Spring Pkg., pushbutton return (set of 5)
147. Spring, treadle bearing
148. Treadle Bar
150. Arm Pkg., Sliding, solenoid, act. sw. F-4
151. Arm Pkg., Treadle Return, F-4 Tuner
152. Clutch disc, adj., F-4 Tuner
153. Lever Assy. Power Arm to Treadle, F-4 Tuner
154. Spring, treadle return, F-4 Tuner

Installation Parts

Capacitor, generator
Capacitor, voltage regulator
Ferrule, covers mtg. nuts (2)
Fuse, 7.5 Amp., type SAE
Knob, control (2)
Knob, dummy
Knob, tone control
Nut, radio bushing (2)
Spring, control knob (2)
Washer, knob anti-rattle (2)

REAR SEAT SPEAKER

DESCRIPTION

The radio rear seat speaker system employs a single speaker. The speaker is concealed below the package shelf cover on Catalina, Star Chief, Bonneville and Grand Prix Sedans. The speaker is centered in the seat back of Catalina and Bonneville Convertible Coupe Models.

Control of the speaker features a circuit design whereby switching a choke coil and condenser in and out of the circuit causes the lower frequency tone to be accentuated in the rear and the high frequency tones in the front.

Operation of control for ideal sound selection is as follows:

1. Front speaker—full response.
2. Front and rear—Sepra-Phonic sound.
3. Rear speaker—full response.

MANUAL ANTENNA

The manual antenna is mounted on the right front fender, in approximately a vertical position.

PERIODIC SERVICE

ANTENNA MAINTENANCE PROCEDURE

Many antenna troubles can be prevented by cleaning the antenna mast at periodic intervals (at least once a month). This is easily performed by wiping the extended mast with a soft cloth when the car is being lubricated or washed.

During the winter months the mast should be lubricated also by wiping it with a cloth containing a light oil.

ELECTRIC ANTENNA

DESCRIPTION

The semi-automatic antenna (Fig. 12-5) works at the discretion of the operator by means of a switch located on the instrument panel. To raise the antenna the switch is rotated in a clockwise direction; to lower it is rotated counterclockwise. When the knob is released, it returns automatically to the "off" position. The antenna can be raised or lowerd to any height by releasing the switch when the desired position is reached.

NOTE: The ratcheting of the clutch can be heard in the full travel positions of the antenna.

The station wagon antenna is mounted on the right front fender; other models have rear mounting.

PERIODIC SERVICE

ANTENNA MAINTENANCE PROCEDURE

Many antenna troubles can be prevented by cleaning the antenna mast at periodic intervals (at least

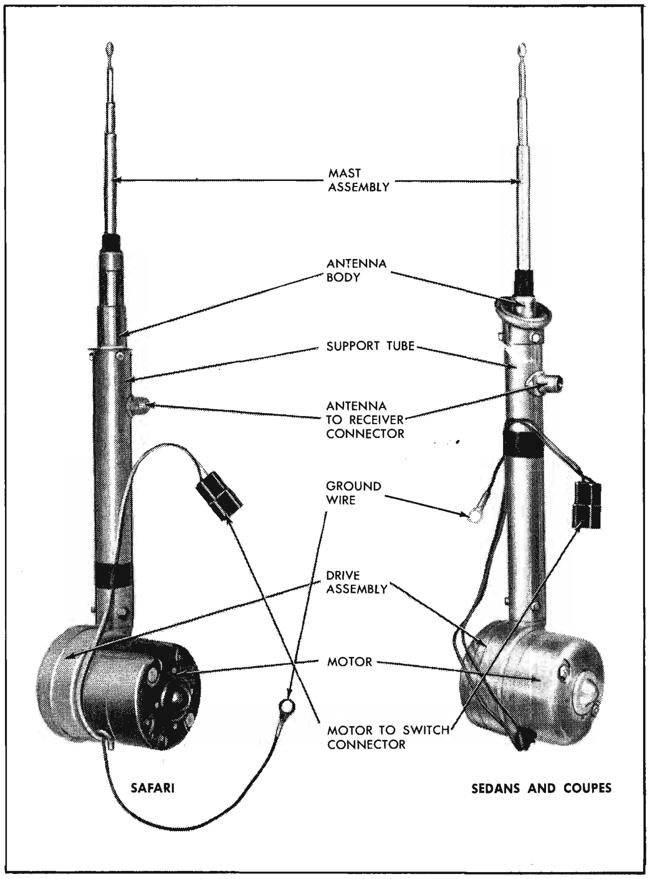


Fig. 12-5 Tenna Antenna

once a month). This is easily performed by wiping the extended mast with a soft cloth when the car is being lubricated or washed. During the winter months the mast should be lubricated also by wiping it with a cloth containing a ligh oil.

REMOVE AND REPLACE ELECTRIC ANTENNA

1. Fully lower antenna.
2. Remove dome nut, "O" ring, fender adapter and rubber pad from top of antenna.
3. Disconnect ground wire, power wires and lead-in (Fig. 12-6).
4. Remove two screws securing the antenna to the wheel house flange and remove antenna.
5. To install antenna, reverse removal procedure making sure antenna is properly mounted onto the wheel house flange. Adjust nut to provide support and tighten lock nut. Proper support adjustment is finger tight plus four full turns.

SERVICE AND REPAIR PROCEDURE

Before removing antenna from car, determine whether fault is in the antenna drive or in the switch and wiring circuit. This is done as follows:

1. Disconnect motor cable at antenna end.
2. Connect antenna to a 12 volt D.C. power source.

Negative lead of the power source should be grounded to antenna motor case. Touch positive lead to each terminal individually on motor cable of antenna. If antenna does not operate, the fault is in the antenna drive. If antenna does operate, the fault is in the switch and wiring circuit.

Replace drive assembly, mast assembly, or support tube assembly (Fig. 12-6) as follows:

CAUTION: Before attempting replacement of any of the three major sub-assemblies listed above the hook-up wire should be removed from the pin and insulator assembly to prevent this wire from being broken where it is soldered to .400 tube section of mast

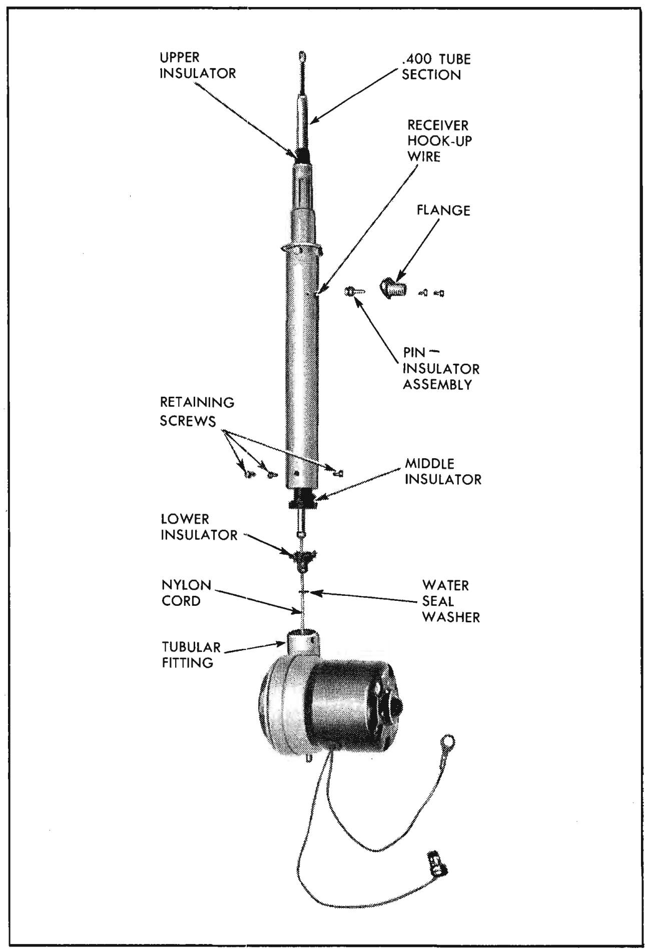


Fig. 12-6 Tenna Antenna—Exploded View

1. Remove two (2) screws holding flange to support tube.

2. Remove flange from pin and insulator assembly.

3. Unsolder hook-up at pin.

NOTE: Do not overheat pin by slow soldering as this will destroy pin insulator. Use needle nose pliers to hold pin while soldering.

4. Remove pin and insulator assembly with gasket.

If replacement of drive assembly, support tube assembly, or mast assembly is indicated:

5. Remove three (3) screws which hold support tube to drive assembly.

6. Holding drive assembly in one hand and support tube in other hand, pull (applying back and forth rotary motion at same time) until support tube is removed from antenna.

To replace support tube assembly:

7. If only replacing a damaged support tube assembly, apply the reverse of steps 1 through 6 making sure that hook-up wire is extended through proper hole in support tube.

If replacement of drive assembly or mast assembly is indicated:

8. Holding drive assembly in one hand and mast assembly in other hand (grasp near bottom of mast assembly), rock mast assembly back and forth and pull at same time. This will remove insulator bushing and .400 tube section from tubular fitting on drive assembly.

9. Apply 12 volts D.C. (up directon of mast) to power leads until entire length of nylon cord has been expelled from drive assembly. To prevent kink or bend in nylon cord, keep it taut by pulling on mast.

NOTE: If drive assembly is inoperative it will be necessary to manually remove nylon cord from drive assembly. To remove nylon cord from disabled drive assembly, place the assembly in a vise so the normal plane of the nylon cord is parallel with the floor. Then, using both hands, pull on .300 diameter mast tube until nylon cord is removed completely from the drive assembly.

CAUTION: DO NOT attempt service on components of drive assembly. This must be serviced as a complete unit.

10. Remove bottom insulator and water seal washer from tubular fitting using wire hook or long nose pliers.

11. Thread nylon cord through bottom insulator with small diameter end down. Then thread nylon cord through water seal washer.

12. Apply 12 volts D.C. (down direction of mast) to power leads and feed nylon cord into drive assembly. Do not allow bend or kink to occur in nylon cord.

NOTE: Push water seal washer and bottom insulator all the way down into tubular fitting before nylon cord completely disappears into drive assembly. Remove power if necessary in order to seat these parts.

13. Push .400 tube section down into tubular fitting on drive assembly. *Make sure that upper edge of flange on insulator bushing is below center of 3 holes in tubular fitting.*

14. Install support tube assembly (minus flange, pin and insulator assembly) in proper position making sure hook-up wire is extended through proper hole in support tube.

15. Install three (3) screws to hold support tube to drive assembly.

16. Solder hook-up wire to pin and insulator assembly.

CAUTION: Do not overheat by slow soldering.

17. Assemble flange over pin and insulator assembly and install two (2) screws.

ANTENNA TROUBLE DIAGNOSIS

WEAK RECEPTION OF FADING

CAUSE	REMEDY
Moisture in the support tube.	Remove antenna, disassemble, clean, dry and reassemble. Check drain holes in the drive housing.

ANTENNA WILL NOT RAISE OR LOWER

CAUSE	REMEDY
Blown fuse.	Replace fuse.
Loose electrical connections.	Check at fuse panel, switch, or antenna.
Bent antenna.	Straighten or replace.
Defective part.	Disassemble and repair, according to service procedure.

SLOW OPERATING MAST

CAUSE	REMEDY
Dirt or foreign material on mast.	Clean and wipe with light oil.
Bent antenna mast.	Straighten or replace.

ELECTRIC CLOCK

The electric clock is operated by current from the car battery so that hand winding is eliminated. Automobile clocks operating on direct current from the car battery must not be compared too closely for accuracy to the home electric clock operating on alternating current. The cycles per second of alternating current used in the home are controlled and periodically corrected at the power house, thereby eliminating accumulation of errors.

With the direct current system such as used in a car, no such control is possible; therefore, automobile electric clocks will accumulate errors day by day the same as hand wound, spring operated clocks.

The electric clock provides automatic regulation of the rate when the position of the hands is changed. Movement of the hands forward or backward automatically adjusts the length of the hair spring to make the clock run faster or slower. The amount of change in rate depends upon the amount the hands are changed. Maximum rate change is approximately 20 seconds per day and is obtained when the hands are moved five minutes. If the clock is reset less than five minutes the change in rate is proportionally less than 20 seconds.

SETTING CLOCK

When setting clock to correct for errors in time, pull reset stem out, move hands counterclockwise to correct time if clock is running fast, or move hands clockwise to correct time if clock is running slow, then allow reset stem to return to its normal position. This will automatically adjust the rate of the clock to run slower if it is running fast, or faster if it is running slow.

Owners should be advised to set the clock to the correct time once a week at regular intervals to ensure maximum accuracy.

REMOVE AND REPLACE

1. Remove glove box.
2. Remove power and lamp leads at rear of clock.
3. Remove two retaining nuts and washers.
4. Remove clock from back of instrument panel.
5. Replace by reversing procedure.

READING LAMP

The new reading lamp is a combination reading-dome light. The rear portion of the unit is the dome light and the forward half has a swivel plate containing a spot type light.

The frosted lens on the dome light is retained by three tabs which fit into slots. To remove the lens for bulb replacement, insert a thin blade screwdriver at the center of the large end of the lens and disengage the tab. The lens can then be readily lifted off.

BACK-UP LAMPS

The back-up lamp switch on Hydra-Matic equipped cars is incorporated in the starter neutralizer switch. This switch is located on the steering column on column shift Hyda-Matics and in the console on floor shift Hydra-Matics.

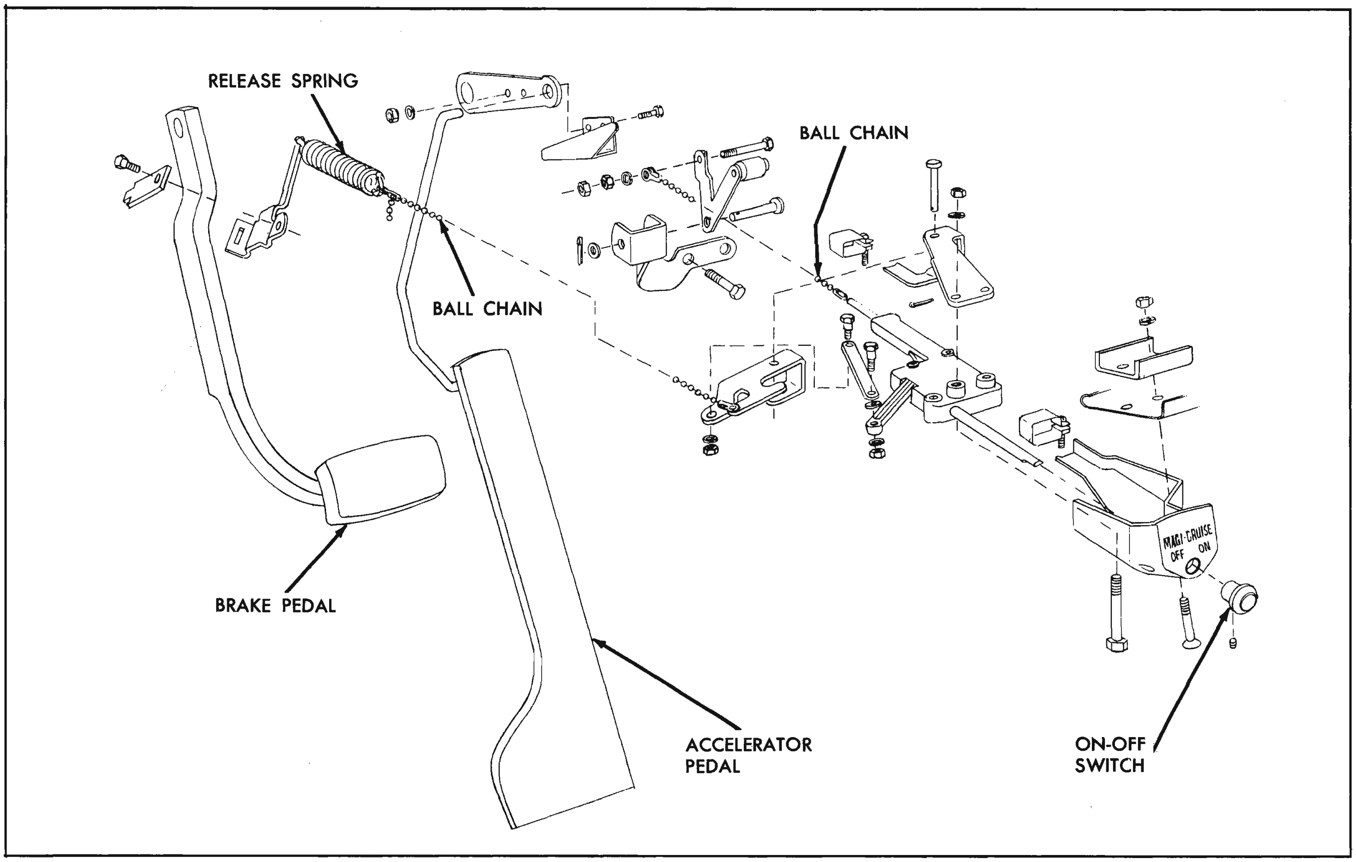


Fig. 12-7 Magi-Cruise—Exploded View

The back-up lamp switch used with vehicles equipped with column shift synchro-mesh transmissions is mounted on the steering column. Moving the shift lever to the reverse position causes the switch actuating pin in the gearshift lower lever to close the switch, completing the electrical circuit anytime the ignition key is in the "ON" or "ACC" position.

The actuating pin should be adjusted to clear the switch by 1/8" when the gearshift lower lever is moved into second gear position.

MAGI-CRUISE THROTTLE CONTROL

DESCRIPTION

The Magi-Cruise is an accessory which holds the throttle at any position selected by the operator. It has a manual "on-off" switch on the instrument panel. In the "on" position it releases the holding lever and allows it to operate and lock the accelerator rod in any desired position (Fig. 12-7).

The control rod is connected to the accelerator pedal linkage by a chain. The locking lever is connected to the brake pedal by a chain and spring. Any time the holding lever is released it allows the spring loaded control rod to seek its innermost position.

When the accelerator pedal is depressed, the chain will become loose until the brake pedal is tapped at which time holding lever is actuated releasing the control rod to its inner position governed by the chain. This holds the accelerator pedal in whatever position it was in at the time the brake pedal was tapped. Whenever the brake is tapped or applied the Magi-Cruise unit is released. The unit can also be released by turning the "on-off" switch on the instrument panel to the "off" position.

ADJUSTMENTS

1. Turn control to "on" position and lock control shaft in a position extended 1 1/4".

NOTE: Carburetor must be in normal hot idle position.

2. Insert chain in connector to fit without slack.

3. Install chain between the control lever and bracket assembly and the control shaft.

CAUTION: Do not cut off excess chain.

NOTE: On cars with four barrel carburetor, move throttle control return spring to bottom hole in anchor plate.

4. With control in "on" position, install release spring in hole of the brake pedal release bracket.

NOTE: Engine must be running on cars equipped with power brakes.

5. Install bead chain between the release spring and the release lever on the control leaving approximately two beads of slack (Fig. 12-7).

CAUTION: Do not cut off excess chain.

6. Manually lock throttle in an open position.

7. Slowly depress brake pedal. Accelerator pedal must release before the brake is actually applied.

a. If this does not happen, there is too much slack in the chain. Move the spring to the rear hole in the brake pedal release bracket and adjust one ball shorter in connector. This provides ½ ball length adjustment. If there is still too mush slack, move spring to the front hole of the brake pedal release bracket.

b. Repeat this procedure until proper adjustment is obtained.

NOTE: Enough slack must be provided so that brake pedal moves approximately ½" or more before control rod is released.

c. If chain is too tight, unit will have tendency to slip when driving over rough roads.

NOTE: Release spring must be installed with hook ends down and end with connector toward rear of car.

LOW FUEL INDICATOR

DESCRIPTION

Low fuel indicator is only available with the Safeguard speedometer. This indicator operates in conjunction with the fuel gauge (Fig. 12-8).

When the pointer on the dash unit reaches a position showing approximately ⅛ of a tank of fuel, the indicator light should come on. At this time the fuel gauge (tank unit) resistance is 1 to 4 ohms. A thermister is used (delay unit) to close circuit to make light go on. It illminates ¼ dim at 0° F full on after 5 minutes. (Temperature conditions vary current flow due to varying resistance as temperature changes.)

The low fuel indicator circuit is between the ignition terminal of the fuel gauge (dash unit) and ground. It consists of a magnetic switch which completes the circuit when fuel gage pointer is in approximately the ⅛ full fuel position. A dampener in this circuit or delay unit prevents light flicker caused by gasoline movement when the tank is between ¼ and full. This unit however, will not prevent flicker as the ⅛ tank position is approached.

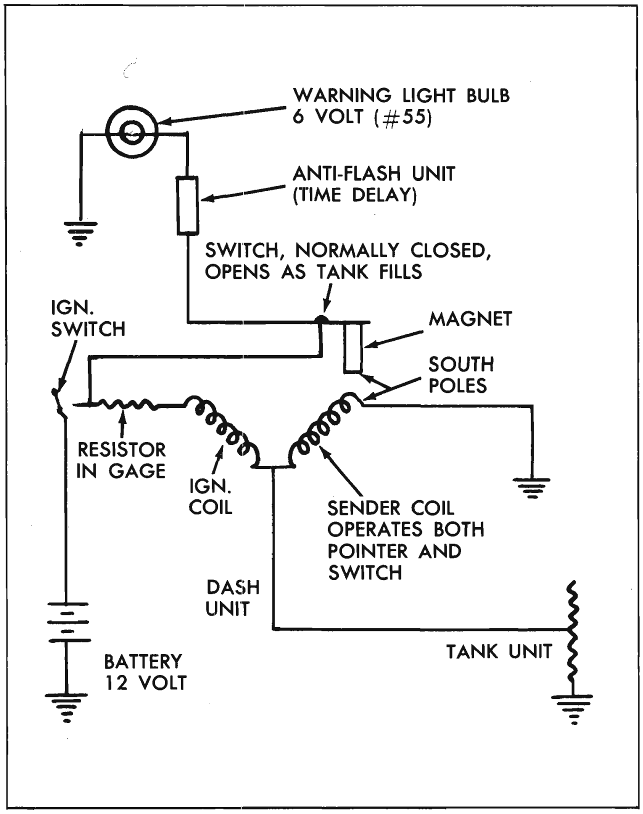


Fig. 12-8 Low Fuel Indicator Circuit

Due to the fact this is not a precision instrument and factors such as capacity of fuel tank and tolerances of instruments, it is difficult to definitely determine exact number of gallons of fuel that are remaining in the fuel tank when the fuel gauge reads ⅛ or the exact time the low fuel indicator bulb become operative. The instrument is standard, if the light comes on with as high as 7 gallons of gasoline remaining in 25 gallon gasoline tank. No adjustments should be attempted on this unit.

SAFEGUARD SPEEDOMETER

The Safeguard speed unit is built into the speedometer and affords an audible as well as a lighted warning signal at the pre-selected speed setting. It provides infinite speed selection from 15 to 100 miles per hour.

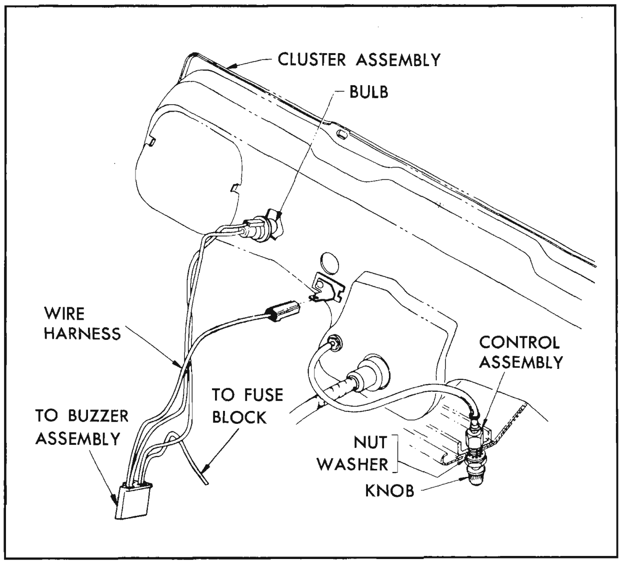


Fig. 12-9 Schematic of Safeguard Speedometer

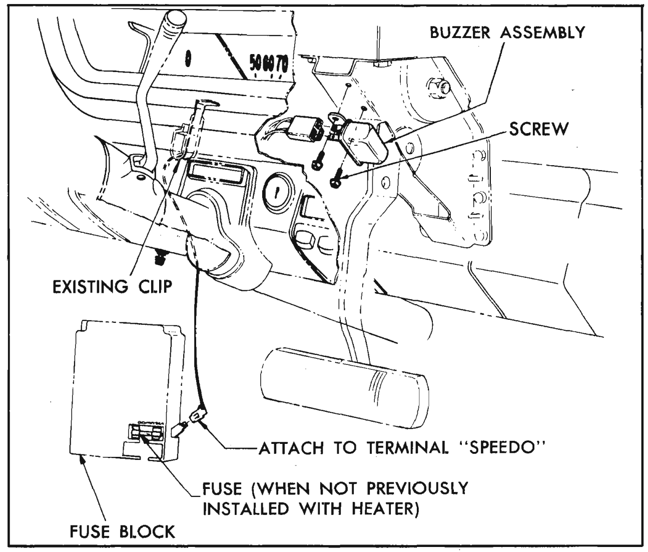


Fig. 12-10 Connections to Speedometer

The warning mechanism includes a "setting" knob (Fig. 12-9) located below the dash. The setting knob has a cable running to the speedometer. The control permits settings from 15 to 100 miles per hour.

The speed warning pointer is connected to the re-set knob shaft. A silver alloy contact hair spring is also connected to the same shaft and moves with the pointer when a desired speed is being selected.

The speedometer pointer has a silver alloy contact which contacts the speed setting pointer at any speed as desired by the driver.

Assuming that the reset knob is set for 40 miles per hour, when the speedometer reaches this set speed, electrical contact is made for the buzzer and light signals begin and continue until the speed is reduced below 40 miles an hour.

SWITCH AND WIRING ASSEMBLY— REMOVE AND REPLACE

1. Remove connector from buzzer (Fig. 12-10).
2. Remove wire from ground and fuse block.
3. Remove wiring assembly from clip.
4. Remove lamp sockets from housing.
5. Remove two buzzer mounting screws, and re-move buzzer.

To install reverse steps 1 through 5.

INSIDE NON-GLARE (TILTING) MIRROR

The mirror has a tongue and groove type joint that enables much greater range of vertical position-ing. By means of the greater range of travel at this point and an added zone of travel available by turn-ing the curved ball stud over in the joint, the needs of every driver should be satisfied. Maximum upward position can be obtained by rotating mirror so that the "Day-Night" tab is at the top.

NOTE: If objectionable reflections are noted with the mirror in this position at night turn the mirror to the normal position (tabs at bottom) for night use.

GUIDE-MATIC

DESCRIPTION

The Guide-Matic is an electronic device which provides automatic switching of headlamps between upper and lower beam in response to light from an approaching vehicle.

The system (Fig. 12-11) consists of a phototube unit, amplifier unit and a combination dimmer-override type foot switch.

The phototube unit (Fig. 12-12) mounted on top of the instrument panel, is the light sensing device which converts light into an electrical signal for use by the amplifier unit. A control is located on the rear of the unit which allows the driver to limit the amount of sensitivity of the unit.

The amplifier unit receives and amplifies the signal from the phototube unit. The amplifier incorporates a power relay with heavy duty contacts for switching headlamp beams.

The dimmer-override foot switch provides auto-matic control of the headlamp beams in one position,

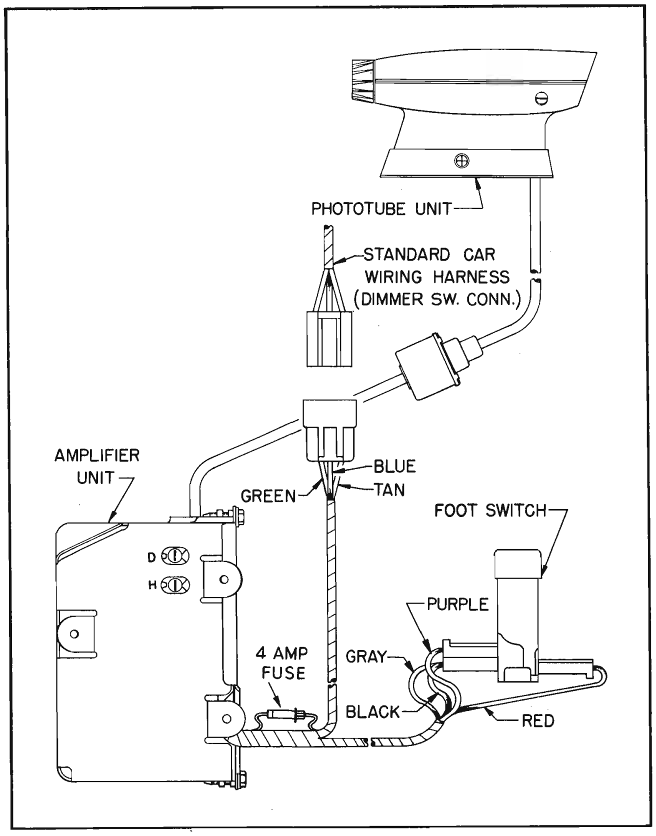


Fig. 12-11 Guide-Matic System

and manual low beams in the other position. In automatic position, a spring load momentary contact type switch is also provided. Depressing the foot switch slightly provides an overriding upper beam condition regardless of light on the phototube unit. This permits the driver to signal if an approaching

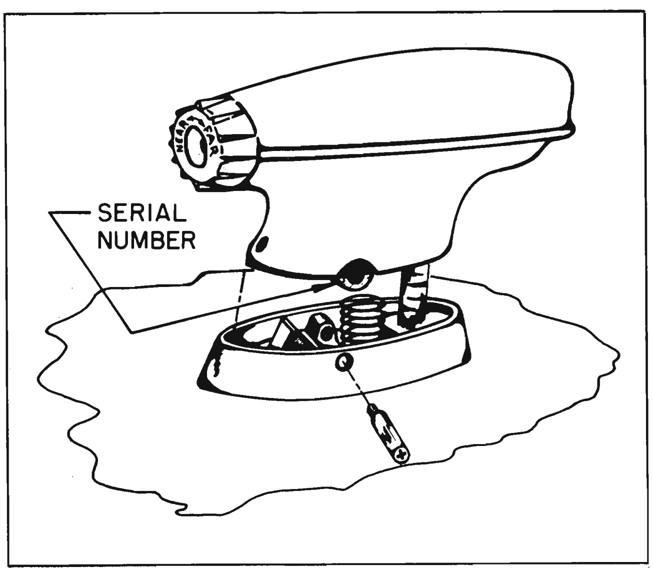


Fig. 12-12 Phototube Unit

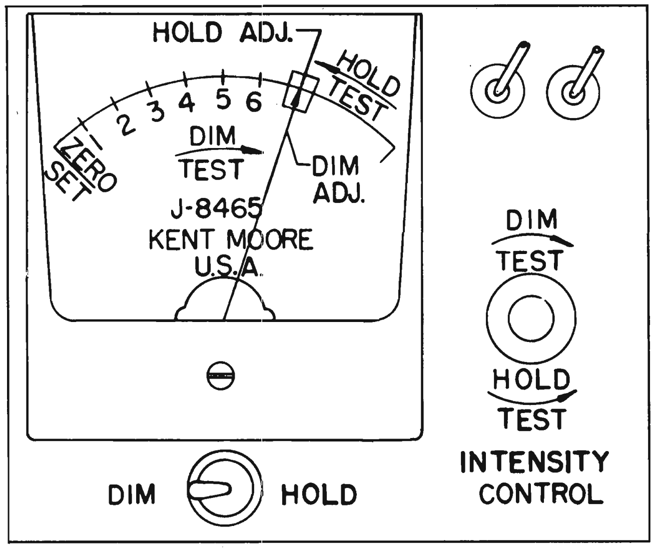


Fig. 12-13 J-8465 Tester

vehicle fails to switch to low beam promptly, and also, in a lighted area provides a simple test for "automatic" position of the foot switch.

The Guide-Matic is connected to turn on with the headlamps. After approximately 30 seconds warm-up period, the Guide-Matic will provide complete automatic switching of the headlamp beams. Street lights and other extraneous lights encountered in the city are sufficient to maintain its vehicle headlamps on low beam. Occasionally, when trailing an older model car with poor lighting on the rear, or due to some other unfavorable condition, it may be desirable to change the foot switch position to manual low beam. The Guide-Matic is disconnected from its vehicle headlamps in this position, but is not turned off. It continues to function as long as vehicle headlamps are turned on.

ADJUSTMENTS AND TESTS

TESTING EQUIPMENT

A new tester J-8456 is required for installing, checking or adjusting the Guide-Matic. The tester includes a vertical aiming device No. 6 and a sensitivity test lamp (Fig. 12-13).

PHOTOTUBE UNIT VERTICAL AIMING PROCEDURE

Proper performance of the Guide-Matic power headlight control requires that the phototube unit be accurately aimed vertically. If the unit is amined too low, back reflections from the headlamps which are being controlled will lock the amplifier on lower beam. However, the unit must be aimed as low as

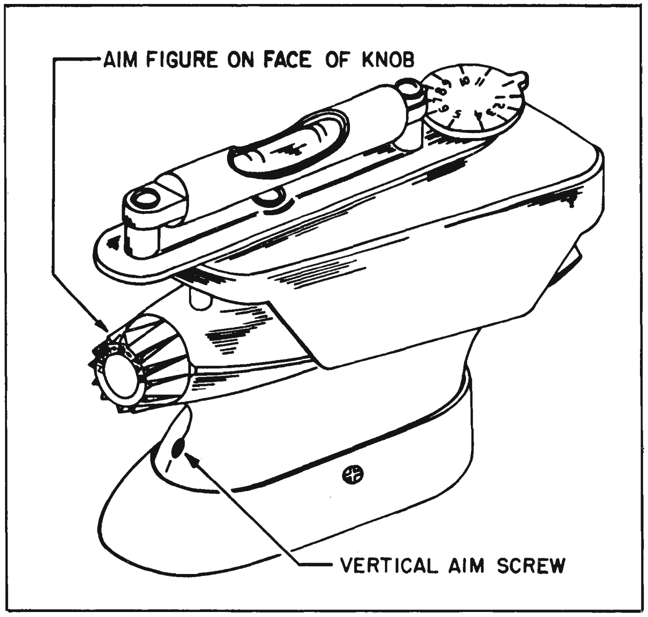


Fig. 12-14 Aiming Device Installed

possible to provide maximum tolerance for car loading.

NOTE: Due to normal settling of front and rear springs, it is recommended that the aiming procedure outlined below should be made with the 2,000 mile inspection.

1. Phototube unit vertical aiming should be done with car unloaded, trunk empty except for spare tire, gas tank at least half full, and with tires at correct pressure.

2. Locate car on a level floor (level within ¼″ fore and aft of car).

3. Rock car sideways to equalize springs.

4. Set aiming device No. 6 on top of phototube unit (Fig. 12-14).

NOTE: (1) the three points on aiming device must be resting on top of phototube unit.

(2) The aiming device must be touching front of phototube unit.

5. Observe number stamped on driver control knob. Adjust aiming dial until corresponding number is under pointer.

6. Adjust vertical aiming screw until bubble is centered in level.

DIM AND HOLD SENSITIVITY TEST PREPARATION FOR TEST ON CAR

CAUTION: Phototube unit must be covered with a black cloth during test. Tests or adjustments on the

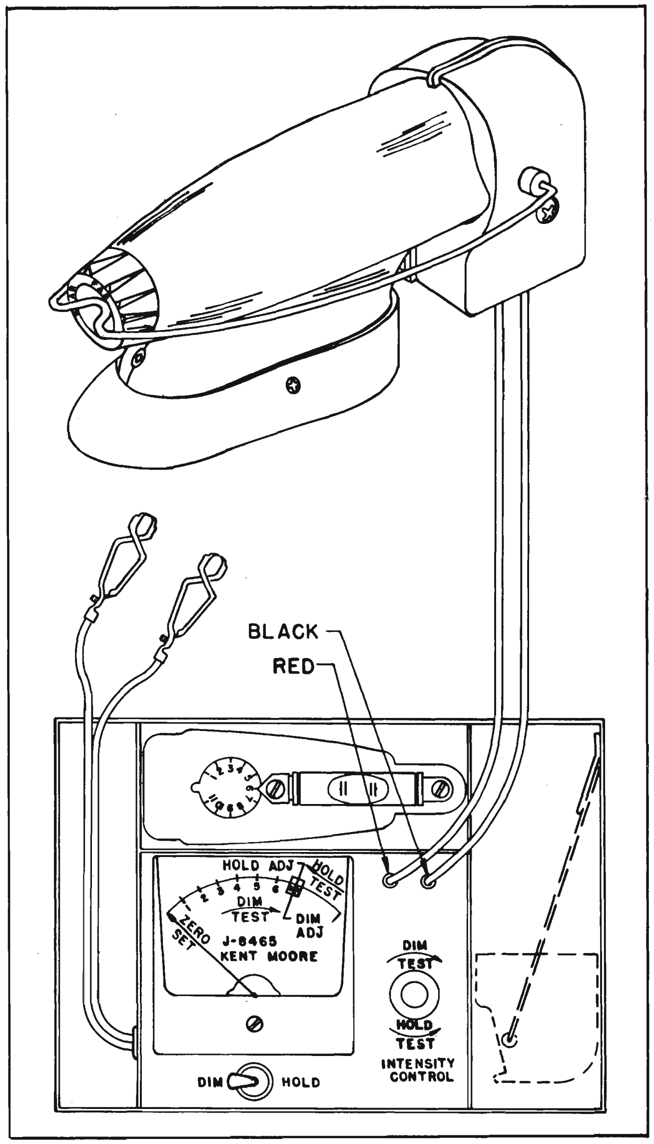


Fig. 12-15 Dim and Hold—Test Equipment Installed

Guide-Matic should be made with the phototube unit below 100° F. If the car has been in the sun immediately prior to checking allow it to cool in a covered place for approximately one hour before the check is actually made.

PREPARATION FOR TEST

1. Set drive control to "detent" position.
2. Install tester lamp (Fig. 12-13).
3. Start engine and operate at fast idle while making adjustments.
4. Turn headlamps on and wait at least five minutes for amplifier unit to stabilize. Place foot switch in "automatic" position.
5. Turn zero corrector on face of meter until meter pointer is on zero set line (Fig. 12-15).

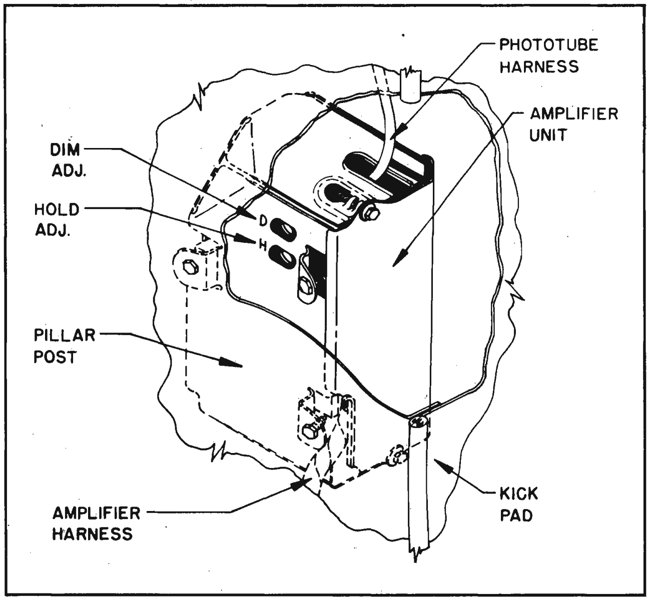


Fig. 12-16 Dim and Hold—Adjustment Screw Location

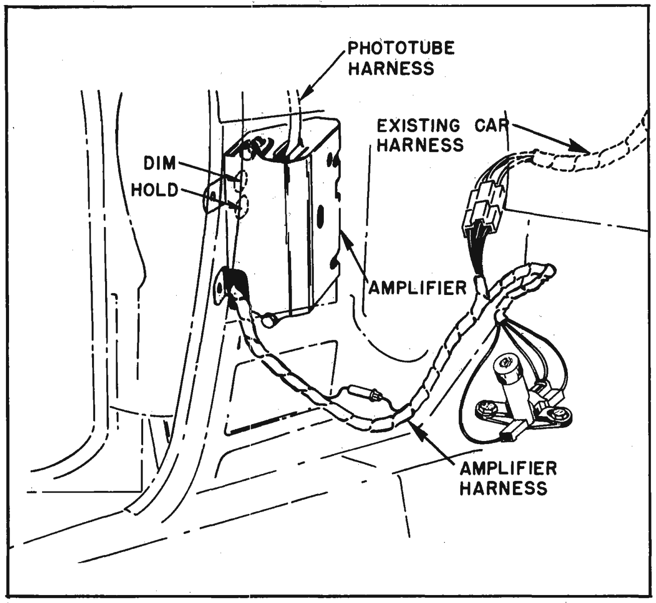


Fig. 12-17 Amplifier Harness

6. Turn tester intensity control counterclockwise.

7. Connect battery leads of Guide-Matic tester to battery terminals.

DIM SENSITIVITY TEST

1. Rotate tester intensity control completely counterclockwise.

2. Turn selector or dim-hold switch to "hold" position and then back to "dim" position. Headlamps should be on upper beam.

3. Turn tester intensity control clockwise slowly just to point where headlamps switch to lower beam. The meter pointer should now read in the black dim sensitivity range on the meter scale (Fig. 12-16). If not, preceed to "hold" sensitivity adjustment on car.

HOLD SENSITIVITY TEST

1. Rotate intensity control clockwise.

2. Place dim-hold switch in dim position and back to hold position. Headlamps should be on low beam.

3. Rotate intensity control slowly counterclockwise to point where headlamps switch to upper beam. The meter pointer should be in the green hold sensitivity range on meter scale. If not, proceed to hold sensitivity adjustment on car.

HOLD AND DIM SENSITIVITY ADJUSTMENT ON CAR

CAUTION: Hold sensitivity must be properly adjusted before adjusting dim sensitivity. Phototube unit must be covered with a black cloth during adjustments.

Preparation for adjustment same as for dim and hold sensitivity test on car.

HOLD SENSITIVITY ADJUSTMENT ON CAR

1. Hold and dim sensitivity controls are slotted for screwdriver adjustment and are located at the side of the amplifier unit. When installed on the car they are available through the left front door post after removal of the hinge cover and the dust and moisture protective plug (Fig. 12-17).

2. Rotate the amplifier hold control completely clockwise.

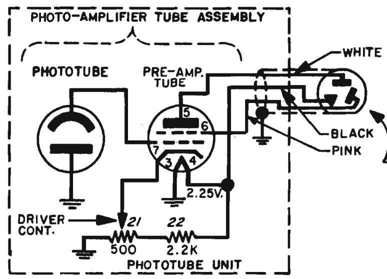
3. Rotate tester intensity control completely clockwise.

4. Place dim-hold switch momentarily in dim position to obtain low beam and then place the switch in hold position.

NOTE: If lights do not switch to lower beam, the amplifier dim control must be turned completely clockwise and then readjusted after hold adjustment is correct.

5. Adjust intensity control slowly counterclockwise until meter pointer is on hold sensitivity adjustment line.

6. Turn amplifier hold control slowly counterclockwise just to the point where headlamps switch to upper beam. Do not go beyond setting.



ALL VOLTAGES ARE MEASURED FROM TERMINALS TO CHASSIS (EXCEPT WHERE STATED OTHERWISE) WITH A VACUUM TUBE VOLTMETER. DRIVER CONTROL IN CENTER DETENT POSITION. TOLERANCES ON VOLTAGES ±10%. ILLUSTRATION NUMBER ABOVE OR TO LEFT AND VALUES BELOW OR TO RIGHT OF COMPONENTS. A+ VOLTAGE ADJUSTED TO 13 V.D.C. ENCIRCLED NUMBERS ON SCHEMATIC CORRESPOND TO WHITE NUMBERS ON PRINTED CIRCUIT BOARD DRAWING.

POWER RELAY-ILL.NO.2

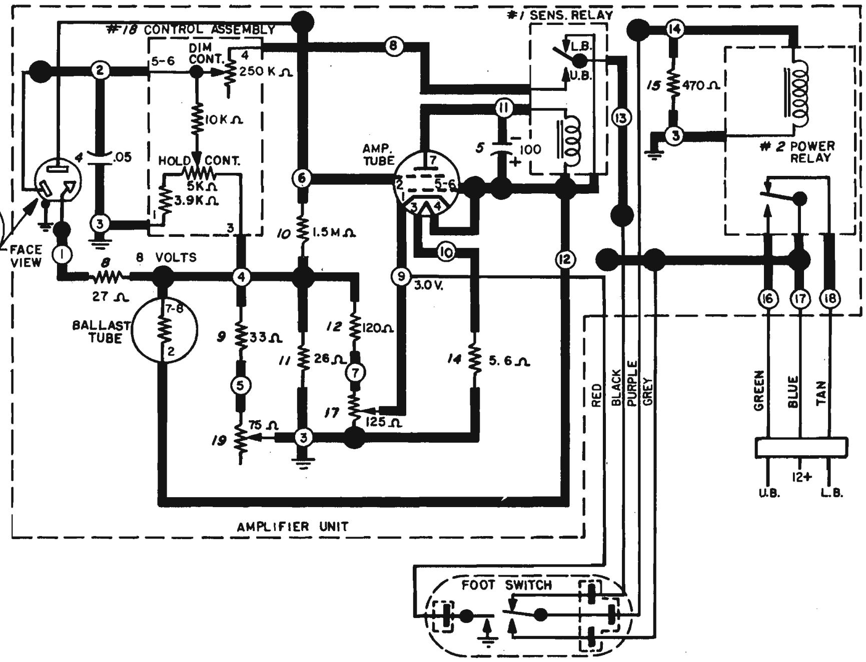
VOLTS	COIL RESISTANCE
12 V.D.C.	45 OHMS

SENSITIVE RELAY-SPDT-ILL. NO. 1

COIL	VOLTS	RESISTANCE
U.B.	L.B.	410 OHMS ± 10%
3.0 6.5	0.0 0.5	

SENSITIVE RELAY OPERATING POINTS

HOLD	MAX. OF 3.5 V.	COIL VOLTS
DIM	MIN. OF 1.0 V.	



TUBE VOLTAGES

TUBES	PIN NUMBERS 1		2		3		4		5		6		7		8		9	
	U.B.	L.B.	U.B.	L.B.	U.B.	L.B.	U.B.	L.B.	U.B.	L.B.	U.B.	L.B.	U.B.	L.B.	U.B.	L.B.	U.B.	L.B.
PREAMP.	0	0	0	0	0	0	2.0	2.0	3.0 3.5	.2	3.0 7.0	4.0 7.5	.25	.25				
AMP.	3.0	2.8	3.0 3.5	.2	2.2	2.2	13.0	13.0	13.0	13.0	13.0	13.0	8.0 9.5	13.0				
BAL.	0	0	13.0	13.0	4.0	3.0 6.5	0 4.5	3.0 6.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	0 4.5	3.01 6.5

Fig. 12-18 Guide-Matic Circuit Diagram

7. Recheck sensitivity as shown in steps 1 through 3 under hold sensitivity test.

8. Reinstall button plug and hinge cover.

DIM SENSITIVITY ADJUSTMENT ON CAR

CAUTION: Dim sensitivity should not be adjusted until after hold sensitivity is properly adjusted.

1. Rotate amplifier dim control completely counterclockwise (Fig. 12-16).

2. Momentarily place dim-hold switch on hold then back to dim to obtain upper beam.

3. Adjust tester intensity control until meter pointer is at dim sensitivity adjustment line.

4. Slowly rotate amplifier dim control clockwise just to the point where headlamps switch to lower beam.

NOTE: Do not go beyond this setting.

5. Recheck sensitivity as shown in steps 1 through 3 under dim sensitivity test on car. If sensitivity is not correct, repeat adjustment procedure.

6. If adjustment is correct, turn off headlamps and remove tester.

7. Reinstall dust and moisture protective button plugs.

REMOVE AND REPLACE

NOTE: If the diagnosis indicates the phototube unit must be removed for repair by an authorized warranty repair dealer, the amplifier unit should also be removed and sent with the phototube unit. If the amplifier unit must be removed for repair. the Phototube unit need not be sent with it if the diagnosis indicates it is functioning properly.

Manual switching of the headlights may be obtained by removinng the fuse from the fuse holder behind the left kick pad in the event the Guide-Matic can not be repaired immediately.

PHOTOTUBE UNIT

1. Disconnect the phototube unit harness from the amplifier harness.

2. Remove cross recess head pivot pin from right side of phototube unit.

3. Lift unit off base and remove phototube unit and harness.

AMPLIFIER UNIT

1. Disconnect foot switch harness.
2. Remove left front kick pad.
3. Disconnect phototube and amplifier harness.
4. Remove hinge cover.
5. Remove amplifier attaching screws at the door post and remove amplifier.

To install, reverse the procedure. After installing the amplifier unit, check the dim and hold sensitivity adjustments.

TROUBLE DIAGNOSIS

Turn Guide-Matic on and allow at least one minute warm-up. In a lighted area, the headlamps should be on low beam in both positions of the foot switch. If not, refer to Headlamps Stay On Upper Beam. With a black cloth over the phototube unit, the headlamps should be on upper beam in one position of the foot switch. If not, refer to Headlamps Stay On Lower Beam.

If customer complains of the Guide-Matic dimming too late or too soon, refer to Sensitivity Adjustment.

PREPARATION FOR TROUBLE DIAGNOSIS

NOTE: If car has been in the sun immediately prior to checking, allow to cool in a covered area for about one hour before checking.

1. Turn on headlamps.
2. Allow minimum of one minute warm-up.
3. Follow steps progressively under the specific complaint until trouble is located.

HEADLAMPS STAY ON LOW BEAM

1. a. Cover phototube unit with block cloth.

b. Depress foot switch ¼″. If upper beam is not obtained, cycle switch several times and again depress foot switch ¼″.

c. If upper beam is not obtained, go to step 2. If upper beam is obtained, go to step 3.

2. a. Remove amplifier harness from foot switch.

b. Remove standard car harness from amplifier harness and plug onto foot switch.

c. Cycle foot switch several times.

d. If headlamps do not switch beams, trouble is in standard car harness on foot switch.

e. If headlamps do switch beams, trouble is in Guide-Matic amplifier. Remove for servicing.

3. a. Place dim and hold controls in their approximate center of rotation.

b. Place foot switch in automatic position (upper beam is obtained when foot switch is depressed ¼″).

c. If upper beam is obtained, only adjustment is needed.

d. If upper beam is not obtained, go to step 4.

4. a. Disconnect phototube unit from amplifier unit.

b. If headlamps go to upper beam trouble is in the phototube unit. Remove amplifier and phototube units for detailed servicing.

c. If headlamps do not go to upper beam, trouble is in the amplifier unit. Remove amplifier unit for detailed servicing.

HEADLAMPS STAY ON UPPER BEAM

1. a. Cycle foot switch several times.

b. If headlamps remain on upper beam in both positions of foot switch go to step 2.

c. If headlamps go to lower beam in one position of foot switch, check the fuse. Replace if blown, go to step 3 if okay. If fuse blows again, remove for repair.

2. a. Check wire color coding of three-way connector on foot switch (Fig. 12-17).

b. Check foot switch and car harness.

3. a. Remove red wire from foot switch.

b. If headlamps go to low beam, trouble is in foot switch.

c. If headlamps remain on upper beam, go to step 4.

4. a. Disconnect phototube unit from amplifier unit.

b. Ground white wire to amplifier harness (Fig. 12-17).

c. If headlamps switch to low beam, trouble is in phototube unit. Remove amplifier and phototube units for detailed servicing.

d. If headlamps remain on upper beam, trouble is in amplifier unit. Remove for detailed servicing.

NO OVERRIDING HIGH BEAM

1. Check to see if red wire is connected to foot switch. If not, make connection.
2. If red wire is connected, remove red wire and place a jumper from red wire to ground. If override is obtained, replace foot switch.
3. If override is not obtained, trouble is in the amplifier. Remove for detailed servicing.

MISCELLANEOUS INFORMATION

DECIMAL EQUIVALENTS

1/64........015625	17/64........265625	33/64........515625	49/64........765625
1/32........03125	9/32........28125	17/32........53125	25/32........78125
3/64........046875	19/64........296875	35/64........546875	51/64........796875
1/16........0625	5/16........3125	9/16........5625	13/16........8125
5/64........078125	21/64........328125	37/64........578125	53/64........828125
3/32........09375	11/32........34375	19/32........59375	27/32........84375
7/64........109375	23/64........359375	39/64........609375	55/64........859375
1/8........125	3/8........375	5/8........625	7/8........875
9/64........140625	25/64........390625	41/64........640625	57/64........890625
5/32........15625	23/32........40625	21/32........65625	29/32........90625
11/64........171875	27/64........421875	43/64........671875	59/64........921875
3/16........1875	7/16........4375	11/16........6875	15/16........9375
13/64........203125	29/64........453125	45/64........703125	61/64........953125
7/32........21875	15/32........46875	23/32........71875	31/32........96875
15/64........234375	31/64........484375	47/64........734375	63/64........984375
1/4........25	1/2........5	3/4........75	1........1.

WEIGHTS AND MEASURES

LINEAR MEASURE

1/12 foot (ft.)........................=1 inch (in.)
12 inches.................................=1 foot
3 feet..........................=1 yard (1 yd.)

AREA MEASURE

1/144 square foot (sq. ft.)...=1 square inch (sq. in.)
144 square inches..................=1 square foot
9 square feet..............=1 square yard (sq. yd.)

LIQUID MEASURE

1/16 pint (pt.)....................=1 ounce (oz.)
1 pint.................................=16 ounces
2 pints..................=1 quart (qt.)=32 ounces
4 quarts.........................=1 gallon (gal.)
31½ gallons.......................=1 barrel (bbl.)

DRY MEASURE

½ quart (qt.)........................=1 pint (pt.)
2 pints..........................=1 quart (qt.)
8 quarts.........................=1 peck (pk).
4 pecks........................=1 bushel (bu.)
105 quarts...............................=1 barrel

CUBIC MEASURE

1,728 cubic inches...................=1 cubic foot
27 cubic feet.........................=1 cubic yard

COMMON WEIGHT

16 ounces...................................=1 pound
100 pounds..............=1 hundred weight (cwt.)
2000 pounds..............................=1 ton

COMMON U.S.A. EQUIVALENTS

LENGTH

1 inch.......................=25.4001 millimeters
1 millimeter.......................=0.03937 inches
1 foot.........................=0.304801 meters
1 meter..........................=3.28083 feet
1 yard.........................=9.914402 meters
1 meter.........................=1.093611 yards
1 mile.......................=1.609347 kilometers
1 kilometer.......................=0.621370 miles

LIQUID CAPACITY

1 quart.........................=0.94633 liters
1 liter.........................=1.05671 quarts
1 gallon.........................=3.78533 liters
1 liter.........................=0.26418 gallons

DRY CAPACITY

1 quart..........................=1.1012 liters
1 liter..........................=0.9081 quarts
1 peck...........................=3.310 liters
1 liter..........................=0.11351 pecks

DRILL SIZES

Letter Sizes	Drill Diam. Inches	Wire Gage Sizes	Drill Diam. Inches	Wire Gage Sizes	Drill Diam. Inches	Wire Gage Sizes	Drill Diam. Inches
Z	0.413	1	0.2280	28	0.1405	55	0.0520
Y	0.404	2	0.2210	29	0.1360	56	0.0465
X	0.397	3	0.2130	30	0.1285	57	0.0430
W	0.386	4	0.2090	31	0.1200	58	0.0420
V	0.377	5	0.2055	32	0.1160	59	0.0410
U	0.368	6	0.2040	33	0.1130	60	0.0400
T	0.358	7	0.2010	34	0.1110	61	0.0390
S	0.348	8	0.1990	35	0.1100	62	0.0380
R	0.339	9	0.1960	36	0.1065	63	0.0370
Q	0.332	10	0.1935	37	0.1040	64	0.0360
P	0.323	11	0.1910	38	0.1015	65	0.0350
O	0.316	12	0.1890	39	0.0995	66	0.0330
N	0.302	13	0.1850	40	0.0980	67	0.0320
M	0.295	14	0.1820	41	0.0960	68	0.0310
L	0.290	15	0.1800	42	0.0935	69	0.0292
K	0.281	16	0.1770	43	0.0890	70	0.0280
J	0.277	17	0.1730	44	0.0860	71	0.0260
I	0.272	18	0.1695	45	0.0820	72	0.0250
H	0.266	19	0.1660	46	0.0810	73	0.0240
G	0.261	20	0.1610	47	0.0785	74	0.0225
F	0.257	21	0.1590	48	0.0760	75	0.0210
E	0.250	22	0.1570	49	0.0730	76	0.0200
D	0.246	23	0.1540	50	0.0700	77	0.0180
C	0.242	24	0.1520	51	0.0670	78	0.0160
B	0.238	25	0.1495	52	0.0635	79	0.0145
A	0.234	26	0.1470	53	0.0595	80	0.0135
		27	0.1440	54	0.0550		

INDEX

A

B

C

D

E

W