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CLUTCHES AND TRANSMISSIONS

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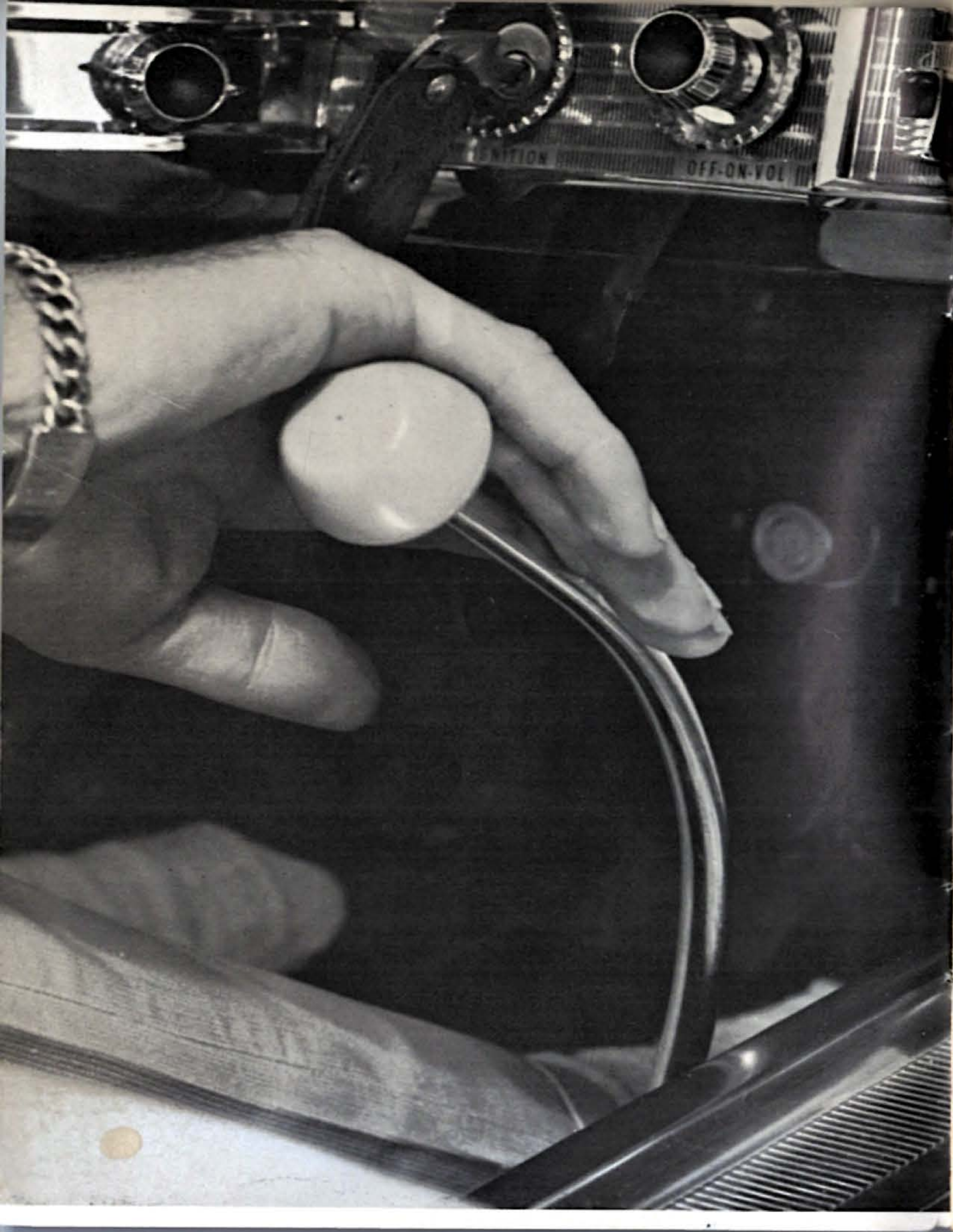
By JOHN LAWLOR



CONTENTS

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Cover photo by Bob D'Olivo shows, at top, a B & M Hydro Stick. Below that, a pair of Shift Master conversion kits. Next, an Offenhauser X-Shift case and adaptor. Bottom Left, a Velvetouch disc sandwiched between a Weber flywheel and clutch assembly. Bottom right, a complete Schiefer flywheel and clutch assembly.

WHAT'S GEARING FOR?

THE purpose of gearing in an automobile is to match the horsepower developed by the engine to the horsepower needed for specific driving conditions.

A car must operate over a broader range of speed than its engine can provide. A useful amount of power occurs within a relatively narrow range of engine speed. We use gearing to correct this problem, allowing the engine to run fast enough to develop plenty of horsepower, even when the car itself is traveling slowly. Let's review a few fundamentals to see how it's done.

Horsepower consists of two factors, force and the speed at which the force is developed. This force is what we call torque and is measured in pounds-feet or foot-pounds. Both terms mean the same thing. A theoretical unit of torque is simply a force of one pound acting on a lever one foot long.

A typical torque figure for a modern engine might be 300 lbs.-ft. This could be interpreted as a one-pound force acting on a 300-foot lever or a 300-pound force on a one-foot lever. For that matter, it could be a 150-pound force on a two-foot lever or any other combination of weight and leverage that multiplies to 300.

Torque, then, is merely a compound of force and the distance over which the force is applied. In order to accomplish anything, it has to occur at a definite rate, which in an engine is the number of crankshaft rpms.

We compute horsepower by multiplying the torque times the rpm and dividing the result by a numerical constant. The exact formula is:

$$\text{Horsepower} = \frac{\text{Torque X RPM}}{5252}$$

For the sake of economy, smoothness and overall flexibility, passenger car engines are usually set up to deliver maximum torque at fairly low rpm. But in an engine for racing, our main concern is maximum horsepower, not torque as such. In fact, many competition powerplants actually have less torque than passenger car units of the same displacement. But what they do produce occurs at much higher rpm, so the total horsepower is considerably greater.

The transmission enables us to vary torque and rpm to suit exact needs. In order to apply more of one, however, we have to sacrifice some of the other. If we want a strong amount of torque, we must give up speed. We can't increase both at the same time.

For example, we use first gear to increase torque so we can overcome the inertia of a vehicle's weight and set it in motion. To move a car from rest requires force but not much speed—at least initially.

We should be careful of our terms here. We may not need much speed to get a car going but we still need some. If there is motion, it must occur at a definite rate. In other words, both torque and rpm have to be applied; we can't separate them completely. This means we're still dealing with their combined product, horsepower, even when we discuss them individually.

To understand how gearing varies these two factors of horsepower, let's imagine a powerplant that develops 190 hp at 4,000 rpm. We can determine what this means in torque by switching our formula to:

$$\text{Torque} = \frac{\text{Horsepower X 5252}}{\text{RPM}}$$

A quick manipulation of a slide rule tells us we have approximately 250 lbs.-ft.

Suppose this engine is geared through a transmission with a ratio in first of 3-to-1 and in second of 1.5-to-1, while the rear axle ratio is 4-to-1. The specifications of actual cars are seldom such neat, round figures but these will simplify our math considerably.

In first gear, the overall reduction of the transmission and axle will be 12-to-1. When the engine runs at its horsepower peak, the 250 lbs.-ft. of torque will be multiplied to 3,000 lbs.-ft. at the axle. But, as the engine turns 4,000 rpm, the axle will hit only 333⅓ rpm. We've gained a bundle of torque but we've had to give up a lot of speed.

Actually, all 3,000 lbs.-ft. isn't going to reach the pavement because tire size is also a part of our gearing. If the tires were 24 inches in diameter, we would get the full amount. Each tire would have a radius of 12 inches and would act as the one-foot lever we mentioned in defining torque. But the average tire on a full-size car is about 28 inches in diameter. This is 14 percent more than a one-foot lever, so our final torque is reduced the same percentage. The figure applied to the road would be 2580 lbs.-ft. Of course, we gain 14 percent in speed over what we'd have with 24-inch tires.

To find the final speed in miles per hour, we have another formula:

$$\text{Miles Per Hour} = \frac{\text{Engine RPM X Wheel Diameter}}{\text{Gear Ratio X 336}}$$

We know the engine speed at the horsepower peak is 4,000 rpm, the wheel diameter is 28 inches and the overall gear ratio is 12-to-1. Applying the formula, we find that road speed is 27.75 mph.

When we shift to the 1.5-to-1 second gear, our overall gearing becomes 6-to-1. At an engine speed of 4,000 rpm, the torque at the axle becomes 1500 lbs.-ft. and speed of the axle 666-$^{2}/_{3}$ rpm. Road speed is now 55.5 mph. The gearing and torque have been cut in half but speed has been doubled.

The horsepower, though, hasn't changed during any of this. Gearing alters the relationship between the elements of horsepower but doesn't change the power itself. This can be seen clearly if we go back to the very first formula we discussed. Using the figures for torque and rpm at the axle in either first or second gear, we still come up with 190 hp! In actual practice, of course, friction and heat would absorb some of this; we wouldn't get the full amount to the axle. But this isn't the point. The important thing is that gearing can be used to increase torque or rpm but never power. When we shift gears, we're really shifting horsepower in relation to road speed.

From this point of view, we might reconsider that statement about first gear increasing torque to set a car in motion. Another way of looking at it is that first gear makes enough horsepower, which requires a high engine speed, available at a low road speed.

At one time or another, you've probably started your car in second gear. You had to rev the engine and slip the clutch to get enough power. You used the clutch to vary the relationship between engine and road speeds. But, because the slipping prevented a positive mechanical connection between the engine and transmission, it caused a lot of power to be wasted. You probably revved the engine much higher than you would have in first gear. A clutch doesn't make a very good substitute for a gear!

You obtained the power you needed to move the car with rpm, rather than torque. The point is that you needed power, not just rpm or just torque.

All gearing does is solve this problem for you. It modifies the factors of horsepower so that power itself can be applied conveniently and efficiently. ■

RATIOS

As WE'VE seen, the 3-to-1 first gear of our hypothetical transmission provides a road speed of 27.75 mph as the engine turns 4,000 rpm. Assuming that it's a conventional three-speed unit, it would have a direct 1-to-1 ratio in third gear, allowing the car to reach 83.25 mph at 4,000 rpm. This is the reason we refer to first as "low" gear and third (or fourth in a four-speed box) as "high." These terms describe the relative speeds the car can reach in the respective gears.

But 3-to-1, our low gear, is obviously a greater ratio than our 1-to-1 high. Some engineers feel the terminology should be switched—that first gear ought to be called "high" and third "low," in accord with their numerical values. Because this is contrary to established practice, the expressions "numerically high" and "numerically low" must be used for clarity.

We prefer to stick to common usage. When we discuss low gearing, we'll mean ratios of high numerical value that permit only relatively low road speeds. And high gearing will mean ratios of low numerical value.

We've seen what gearing does. How is it determined mechanically?

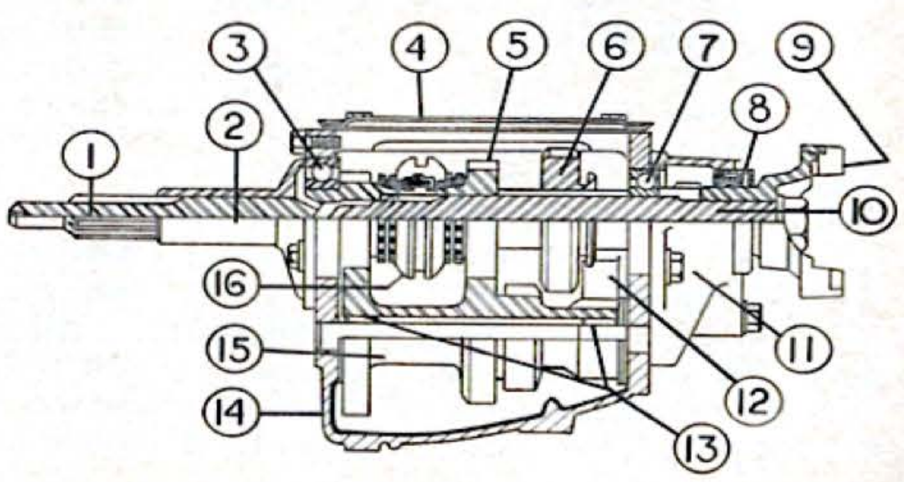
A gear is simply a form of pulley. The ratio between two gears is the relationship between their respective sizes. We'd obtain a 3-to-1 ratio if we had a gear six inches in circumference driven by a gear two inches around.

Normally, we describe the relative sizes of gears by the number of teeth on each component. Our 3-to-1 might be achieved by combining a 30-tooth cog with a 10-tooth one. To mate properly, the teeth on one gear are the same size as those on the other, so counting them provides us with an accurate relationship.

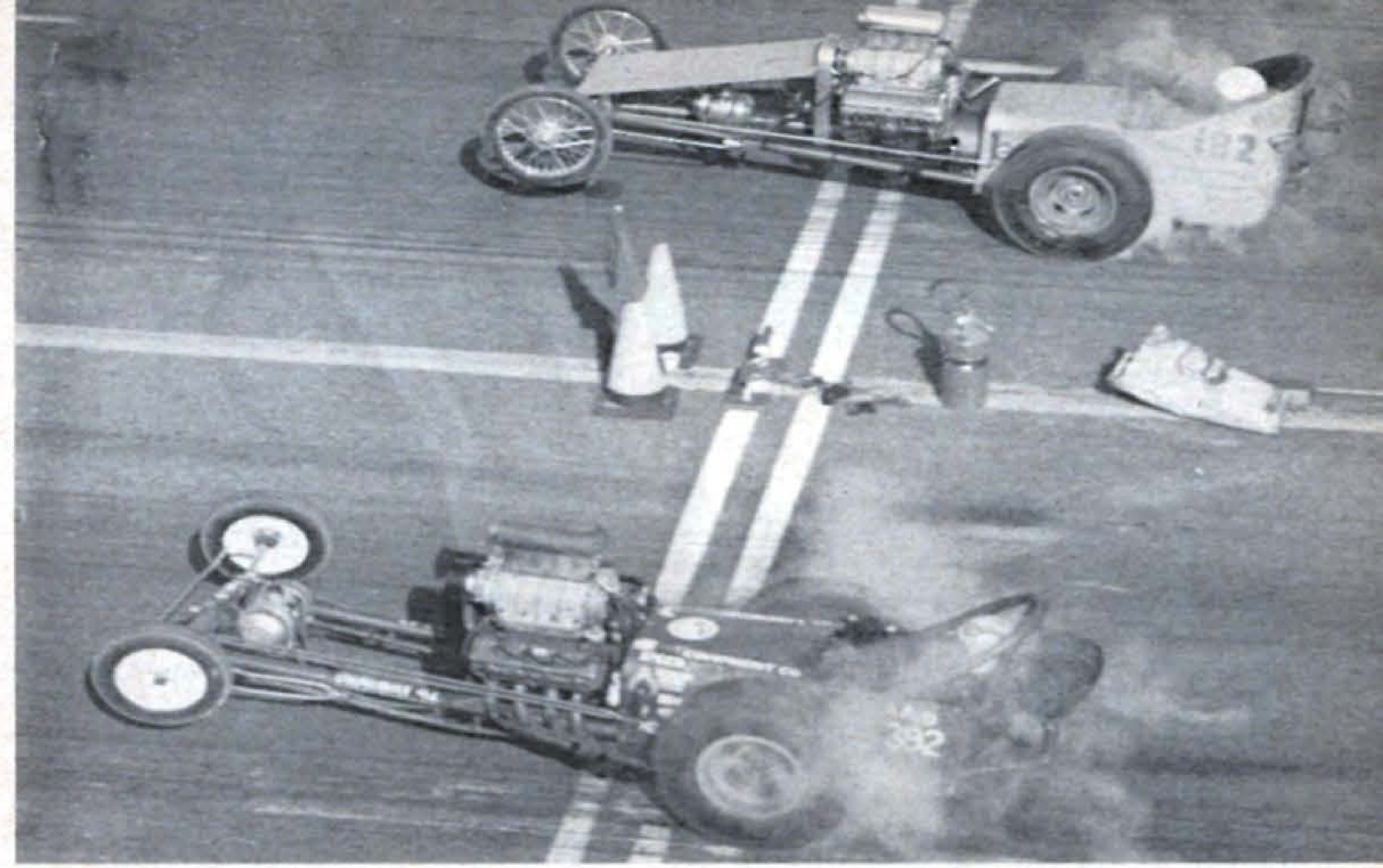
This also accounts for the rather odd figures we often find in gearing specifications. For example, if we have a 22-tooth gear driven by a 14-tooth, the ratio would be approximately 1.57-to-1. If we switched from 22 to 23 teeth, our gearing would become 1.64-to-1. These figures are both rounded off. We could carry either of them out to an indefinite number of decimal points.

An interesting sidelight here is that we can't obtain any ratio between 1.57 and 1.64 as long as we have either the 22- or 23-tooth unit as the larger gear in the set or the 14-tooth as the smaller one. To get 1.60, for example, we have to use an entirely different pair of cogs. (A combination of 24 and 15 teeth would do it.)

This means that we can't have every ratio we might want, even if we manufacture our own gearsets. But we can come close enough that this is pretty much a hypothetical problem. ■



Parts of typical 3-speed box: 1) Main drive pinion, 2) Front flange, 3) Pinion bearing, 4) Access cover, 5) Second gear, 6) First and reverse gears, 7) Mainshaft bearing, 8) Oil seal, 9) U-joint flange, 10) Mainshaft, 11) Rear flange, 12) Reverse idler gear 13) Countershaft bearings, 14)Case, 15)Countershaft gear cluster, and 16) 2nd and 3rd gear synchronizer assembly.



GEARING FOR COMPETITION

THE more horsepower a car can apply to the road at a particular speed, the faster the car will accelerate from that speed. Suppose we have two cars of equal weight traveling side-by-side at 50 mph. Car "A" is powered and geared to transmit 100 hp to the road at such a speed, while Car "B" can deliver 200 hp. We don't need a formula to see that, if the drivers of both vehicles floor their accelerators simultaneously, "B" will pull away ahead of "A."

For the quickest possible acceleration from any given speed, therefore, a car should be geared to apply all the horsepower it can at that speed. But, once a car begins to accelerate, it's no longer traveling at the "given" speed and, if maximum horsepower has been applied, the amount available has dropped.

In drag racing, this problem is carried to its ultimate extreme. A really good dragster can accelerate from zero to 180 mph or more in a ¼-mile and even the hotter stocks are hitting between 115 and 120 mph.

It's obvious that at any moment a car is racing down a ¼-mile strip, its speed is higher than it was the moment before. The ideal transmission for dragging would have an infinite range of ratios so that maximum engine power would be available at all road speeds. Unfortunately, nobody has devised a way to accomplish this with reasonable efficiency. Some torque converter automatics have infinitely variable ratios but, because they operate on an inherently inefficient hydraulic principle, they lose more performance than they gain.

If we can't have an infinite choice, it would seem the more ratios we do have, the more effectively we can apply power over a broad range of speed. This, by itself, is true. But the whole object of drag racing is to increase speed in the least possible time. And shifting from one ratio to another is a mechanical process that consumes time. It involves disconnecting the power train momentarily and, as we make the shift, no horsepower at all is reaching the rear wheels.

So we're faced with a contradiction. We want as many ratios but as few shifts as possible.

Fortunately, there are definite limits within which we are able to work. We can't use infinitely low gearing, for example, because it would mean applying full power without ever moving the car! Infinitely high gearing would be just as foolish. There's no point in using ratios which become effective beyond speeds the car has power to reach.

The key to the bottom limit is in a remark a few paragraphs back, "The more horsepower a car *can apply to the road* . . . the faster it will accelerate . . ." If we gear too low, the rear wheels will receive more horsepower than they can transmit to the pavement as the car is set in motion. The rear tires will break loose and spin furiously, wasting valuable power. (Besides gearing, such things as rear suspension behavior, differential action and type of tire all affect how much power we can get to the road, but that's getting beyond our immediate subject.)

A certain amount of wheelspin can be used to advantage, as we'll see a little further on. But we should gear for no more than is really useful and can be controlled. This, in effect, determines the lowest gearing we should have.

At the other extreme, the highest gearing we can use is the ratio which provides the highest top speed for our particular car. This isn't quite as simple as it sounds. The horsepower needed to propel a car increases as the speed becomes higher. The speed at which the power required coincides with the highest power the engine can deliver is the car's potential maximum. The overall ratio which makes top engine output available at that speed is our top gearing limit. If we gear too low or too high, the car will never be able to reach its maximum.

Even though we have these definite limits, they're still quite far apart. And, between them, we continue to have the problem of infinite gearing requirements. This means we'll have to settle for a much narrower operating range.

Maximum horsepower is produced at one specific engine speed. However, an engine develops *nearly* its maximum over a range of several hundred rpm, giving us some leeway. We should choose transmission ratios that will permit us to stay within this range.

It's impossible to do this with just a few ratios and cover the whole performance spectrum from bottom to top. In order to have:

1. First low enough for maximum acceleration without excessive wheelspin,
2. Overall gearing high enough to reach the car's top speed, and
3. Ratios close enough to stay within a few rpm of the engine's maximum power at all road speeds, a modern, high-performance V-8 would need at least eight or ten gears! The transmission would be so bulky that its weight alone would probably remove the car from serious contention in any kind of racing.

We have to determine what we want most, acceleration, top speed or highway flexibility. Our exact emphasis will be fixed by the rear axle ratio. But, first, we have to settle on transmission characteristics. ■

STOCK THREE-SPEEDS

THE closer our transmission ratios, the better chance we'll have to apply nearly maximum power over a broad range of road speeds. As we shift from a lower to a higher gear, the engine will lose less crankshaft speed. We'll keep rpm closer to the point of maximum power, so the average amount of power we get to the road will be greater and acceleration will be faster.

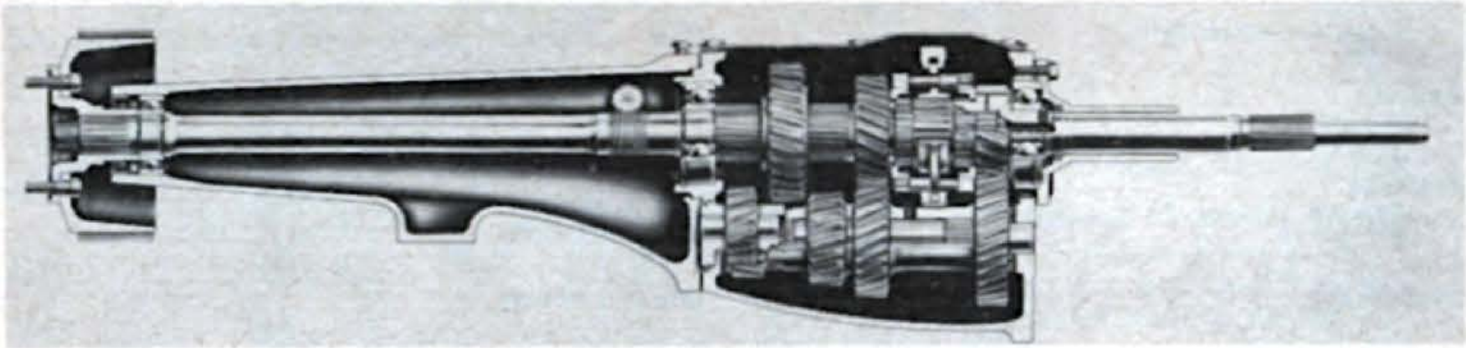
Closer ratios will also permit us to shift slightly faster, adding still further to performance. All manual transmissions for U.S. passenger cars incorporate synchromesh. Three-speed boxes generally have it on second and third gears and four-speeds on all four ratios.

Synchromesh consists of small clutches that adjust gear speed during a shift. As we move from second to third, for example, the system speeds up the third gear components so they'll engage smoothly. In other words, it synchronizes the meshing of the gears. If the ratios are fairly close, the difference in gear speed is less and the synchronizers don't have to make as sharp an adjustment. This allows them to function a little faster and enables us to engage the new gear a bit more quickly. Compared with a wide ratio transmission, the improvement in shifting time may be only a few thousandths of a second. But it allows just that much more of an edge in acceleration.

There's just one problem. The closer our ratios, the higher-geared our transmission will be. In first gear, we may not have enough power available for the quickest possible jump from the line.

Fortunately, this becomes less of a difficulty as power is increased or, to be technically accurate, when the amount of power relative to the total vehicle weight is increased. The better the power-to-weight ratio we have, the higher the transmission ratios we can afford. The reason is that greater power makes it more difficult to start in first without causing too much wheelspin. We're back to the problem of our bottom limit. Raising first gear avoids this and permits closer ratios throughout.

Detroit's application of this principle is apparent in Table I, a complete list



Chrysler, Dodge and Plymouth are available with this heavy-duty gearbox, the first really new 3-speed unit to come out of Detroit since before the Second World War.

of standard three-speed transmissions available in U.S. passenger cars. (Models not indicated, such as Cadillac, Imperial and Lincoln, aren't available with manual gearboxes.) Whenever several horsepower ratings are offered by a single manufacturer, a variety of transmissions are also available. And the higher the power, the higher and closer the ratios. Thus, when you buy a hot stocker, you usually get a higher-geared transmission.

The ratios usually aren't as close as they could be with the hottest engines because the one transmission has to be used with several different powerplants.

TABLE I. STANDARD 3-SPEED TRANSMISSIONS FOR 1962

	1st	2nd	O/D
BUICK			
Special	2.57	1.55	—
CHEVROLET			
Corvair	3.50	1.99	—
Chevy II	2.94	1.68	—
Biscayne, Bel Air, Impala			
Six, 170-hp V-8	2.94	1.68	.70
250- to 409-hp V-8	2.47	1.53	—
Corvette	2.47	1.53	—
CHRYSLER			
Newport, 300	2.55	1.49	—
DODGE			
Lancer, Dart Six	2.95	1.83	—
Dart V-8, Polara			
Standard	2.55	1.49	—
Optional	2.17	1.43	—
FORD			
Falcon, Fairlane Six	3.29	1.83	—
Fairlane V-8	2.78	1.61	.70
Galaxie			
Six	3.20	1.86	.70
170-hp V-8	2.78	1.61	.70
220- to 405-hp V-8	2.37	1.51	.70
MERCURY			
Comet, Meteor Six	3.29	1.83	—
Meteor V-8	2.78	1.61	.70
Monterey			
Six	3.20	1.86	—
170-hp V-8	2.78	1.61	—
220- to 330-hp V-8	2.37	1.51	—
OLDSMOBILE			
F-85	2.57	1.55	—
88	2.15	1.37	—
PLYMOUTH			
Valiant	2.95	1.83	—
Savoy, Belvedere, Fury			
Six	2.95	1.83	—
V-8	2.55	1.49	—
PONTIAC			
Tempest	2.94	1.68	—
Catalina	2.47	1.53	—
G.P., Star Chief, Bonneville	2.49	1.59	—
RAMBLER			
American, Classic Six	2.61	1.63	.70
Ambassador			
250-hp V-8	2.57	1.55	.70
270-hp V-8	2.49	1.59	.72
STUDEBAKER			
Lark Six	2.61	1.63	.70
Lark V-8, Hawk	2.57	1.55	.70

Note: All transmissions listed have direct 1.00-to-1 ratios in 3rd gear.

Nonetheless, they're an improvement over the gears used with the manufacturer's economy engines.

What if you start out with an engine that came from the factory with a relatively low power rating and wider transmission ratios? If you soup it, will you have to buy a different transmission in order to get better gearing?

Not necessarily. It may be that the particular transmission originally supplied with the engine is available in a close-ratio version for use with hotter stock powerplants. If so, all you have to do is pull the gearset itself out of the transmission you have and replace it with the higher-geared cluster.

Chevrolet offers a good case in point. In its full-size line, Chevy has a 2.94 first gear and 1.68 second or a 2.47 first and 1.53 second. These transmissions are identical except for the gearsets themselves. If you modified one of the lower-powered engines and improved the power-to-weight ratio enough to justify closer ratios, you could easily replace the 2.94/1.68 set with the 2.47/1.43.

Probably the best known example of gearset swapping is the use of Lincoln Zephyr gears in older Ford transmissions. From 1932 to 1948, inclusive, all Ford products used the same transmission design. In 1940, however, Lincoln adopted higher, closer ratios, as shown in Table II. The various gearsets were identified by the number of teeth on their driven clusters.

It didn't take rodders long to discover that these Zephyr gears slipped right into Ford transmissions and were the perfect complement for souped

TABLE II. FORD AND LINCOLN ZEPHYR GEARSETS

	1st	2nd
1932-48 FORD		
1939-50 MERCURY		
29-tooth	3.11	1.77
28-tooth	2.82	1.60
1940-48 LINCOLN		
26-tooth	2.33	1.58
25-tooth	2.12	1.43

Note: All transmissions listed have direct 1.00-to-1 ratios in 3rd gear.

Ford powerplants. The Zephyr cogs also fit the 1939-through-1950 Mercury gearboxes, though this car's slightly greater weight meant the engine output had to be raised a bit more than that of an equivalent Ford before the higher ratios could be used satisfactorily.

If power is increased much beyond any stock rating, it's advisable to replace the entire transmission. The original unit probably won't have the strength to cope with too much added power.

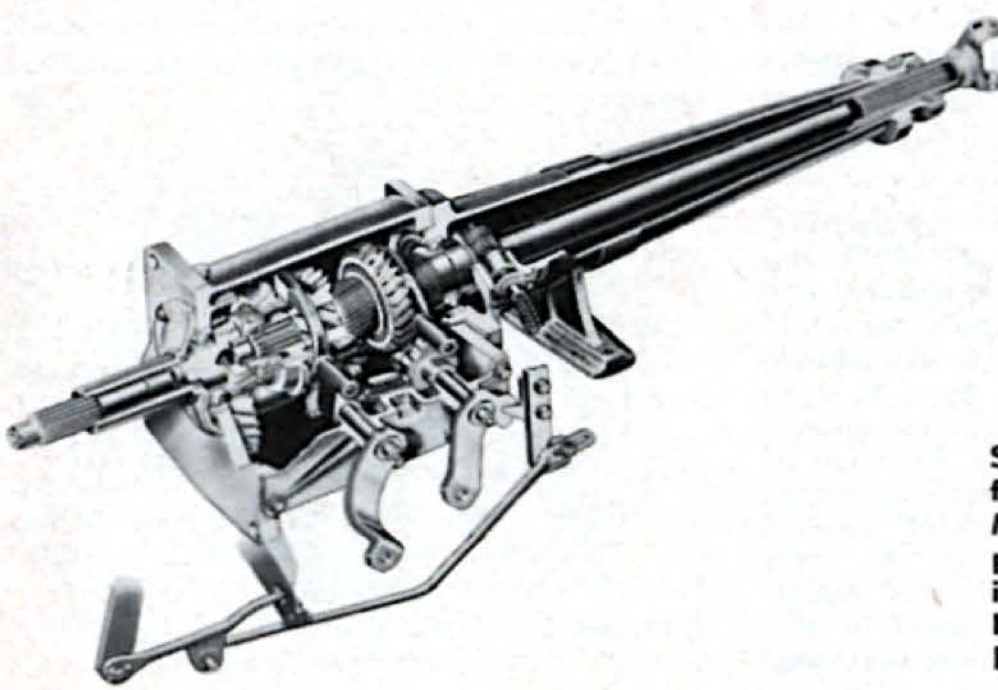
Some rodding enthusiasts are still tempted to use an older Ford transmission with Zephyr gears behind a modern, overhead valve V-8, especially if they're dropping the engine into one of Henry's 1932-to-48 cars. They'd best forget the idea. The newer engines will tear that old gearbox apart. The unit just wasn't built for the output of our modern powerplants.

Normally, most manufacturers provide beefed-up transmissions with their really hot engines. The Pontiac entry in Table I is an example. There isn't a significant difference between the ratios of the standard Catalina and the hotter models. The latter, however, have a much stronger box that's more capable of handling the tremendous power of Pontiac's hottest engines.

Detroit is just beginning to realize that rodders want extremely close ratios in gearboxes of adequate strength. Table I reveals that Dodge has announced an optional three-speed gearset with ratios almost the same as those of the 25-tooth Zephyr! We wouldn't be surprised to see some of the other manufacturers follow suit in the near future.

The basic Dodge transmission, incidentally, is shared with Chrysler and Plymouth. However, neither of these makes is currently available with an engine providing a power-to-weight ratio high enough to use the Dodge close ratio gears. To get off the line briskly, a Chrysler or Plymouth needs somewhat lower gearing than the hottest Dodge.

Chrysler Corporation introduced this transmission in 1961, acknowledging the demand among performance enthusiasts for an up-to-date manual gearbox. Several of those used by other makes were designed before World War II. The Chrysler unit, though, is all new. Engineered to transmit a terrific amount of power, it's one of the best three-speeds now being built. ■



Standard 3-speed gearbox for full-size Ford and Mercury has interlock to prevent rolling shifts into first or reverse. Long tailshaft is used to house optional overdrive.

OVERDRIVE

WITH a car of moderate power that can't use very close ratios, overdrive is a handy way to extend the operating range. It permits relatively low gearing in first while allowing good high speed characteristics as well. In other words, it stretches gearing closer to the bottom and top limits.

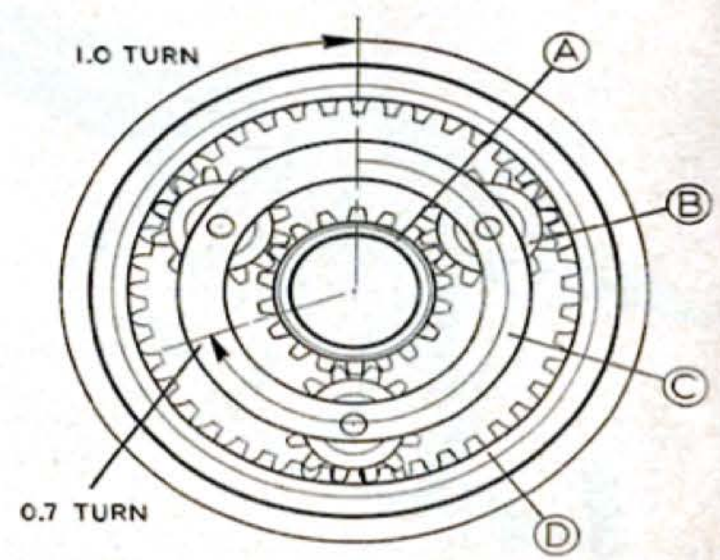
Overdrive is a supplementary gear of about .70-to-1. Note the decimal point. The ratio is lower numerically, hence higher in terms of gearing, than a direct 1-to-1 high gear.

Suppose we're running a car with a 4.50 rear axle and 30-inch tires. At 60 mph in third gear, the engine would turn 3224 rpm, an extremely high crankshaft speed for ordinary cruising. With overdrive, we can cut this to 2257 rpm. Not only will engine operation be smoother and quieter but fuel consumption will improve from one to three miles per gallon.

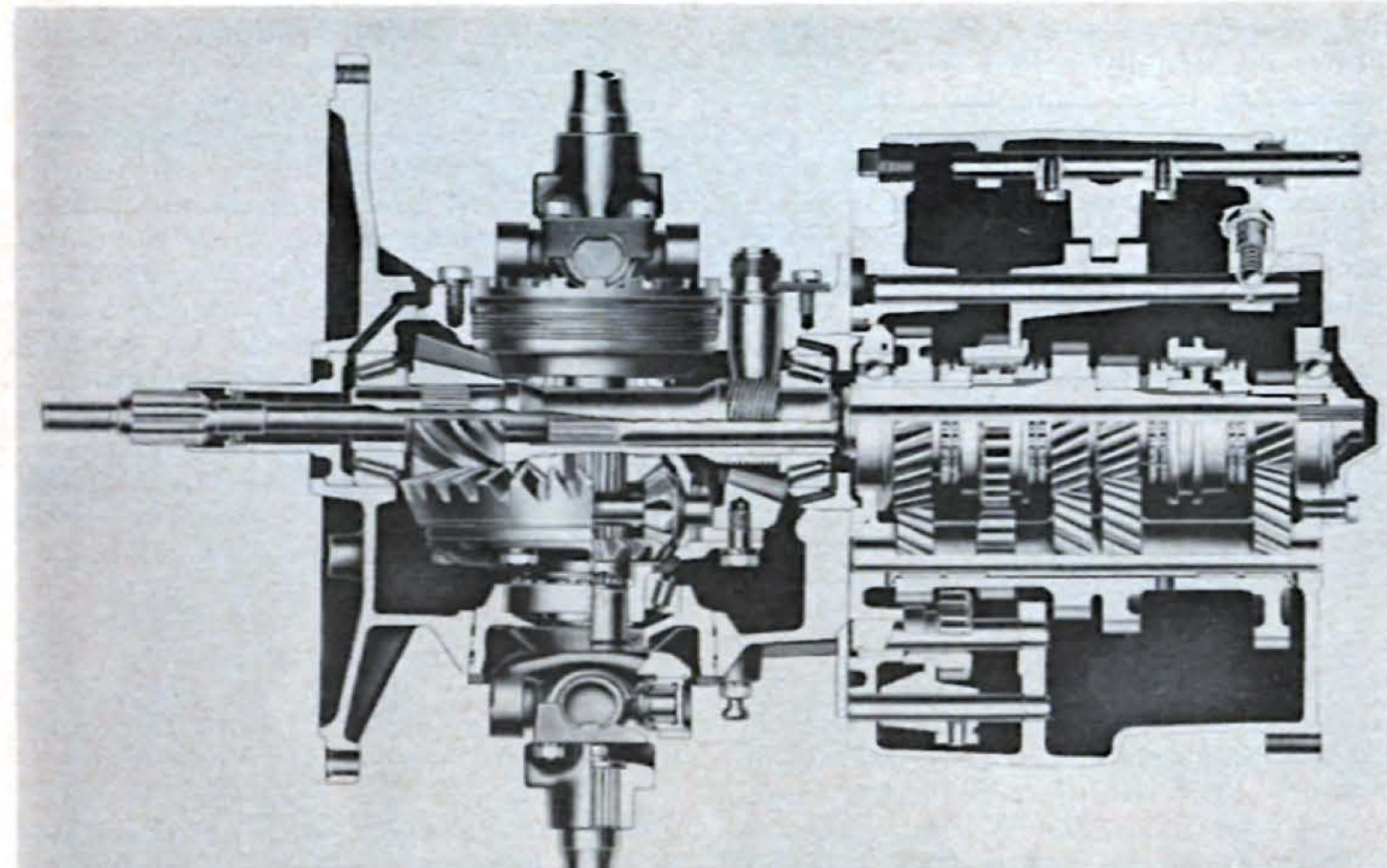
The idea of overdrive goes back to the old two-speed Columbia axles built for 1932-48 Fords. The modern system, though, is a part of the gearbox, rather than the axle. Primarily an economy device for moderate engine rpm at high road speeds, it's available on only a few present cars. Table I discloses that Rambler and Studebaker are the only makes offering it across the board. Ford will provide it on most models but Mercury, which uses many of the same mechanical components, installs it only on the Meteor V-8. Chevrolet is the only other make listing it and limits it to a couple of lower-powered jobs. All of these installations use the same overdrive system, which is manufactured by the Warner Gear Division of the Borg-Warner Corporation.

Overdrive can usually be engaged in either second or third gear, providing the effect of five speeds forward. However, it isn't suitable for dragging because it can't be used under full throttle. To put it into action, the driver has to lift his foot from the accelerator briefly. And, once he mashes it down again, the overdrive unit releases and drops the transmission back into normal gear. The object of the latter is to provide "kickdown" power.

For rodders, overdrive's biggest advantage is flexibility. Many competition cars have relatively low overall gearing, making them rough and noisy for ordinary street use. Overdrive's added high ratios reduce this problem considerably, easing normal driving and improving fuel economy for the fellow who can afford only one automobile for both drag racing and everyday transportation. ■



Overdrive incorporates planetary gearset. Sun gear, A, is held stationary while the planet pinions, B, are rotated around sun gear by transmission mainshaft, which is attached to planet carrier, C. As planet pinions turn, they carry ring gear, D, with them. The ring gear, in turn is connected to the overdrive output shaft. Because of ratios used, .70 of a revolution of transmission mainshaft and planet carrier causes one full revolution of the ring gear and the overdrive output shaft. The planetary idea is also used in the gearboxes of automatic transmissions.



Corvair and Tempest share this 4-speed gearbox, which is built in unit with rear axle.

STOCK FOUR-SPEEDS

THE quest for close ratios is a big reason four-speed gearboxes have become such a popular item. If we fill the gap between, say, a 2.50 low and 1.00 high with two additional gears instead of just one, our ratios will be closer all the way through.

The appearance of four-speed transmissions in U.S. cars was really something of an accident. If Chevrolet hadn't decided to turn the Corvette into an honest sports car, we might never have seen four-speed units in popular domestic makes.

As Table III shows, ten different 1962 cars are available with such transmissions. Eight of them, however, use variations of the original General Motors Corvette box.

This is something of an improvised transmission. Warner Gear, the same outfit that gave us overdrive, created the four-speed by converting an old three-speed it'd been building for years. The cogs for reverse were taken out of the main case and put in the tailshaft housing, leaving room within the case for four forward speeds.

The first version offered in the 1956 Corvette had a fairly close gearset. A year later, Chevrolet introduced the four-speed as an option in its regular line. Because the big car didn't have the Corvette's power-to-weight ratio, the gears were spread farther apart. These are usually called wide ratios to distinguish them from the sports car's set but the term is purely relative. Compared with the cogs in most other transmissions, they're still pretty close.

For 1962, most of the Super Stocks have more than 400 hp, bringing their power-to-weight ratios to new highs. Consequently, it's become practical to use the close Corvette gears in hot sedans and several makes now offer them.

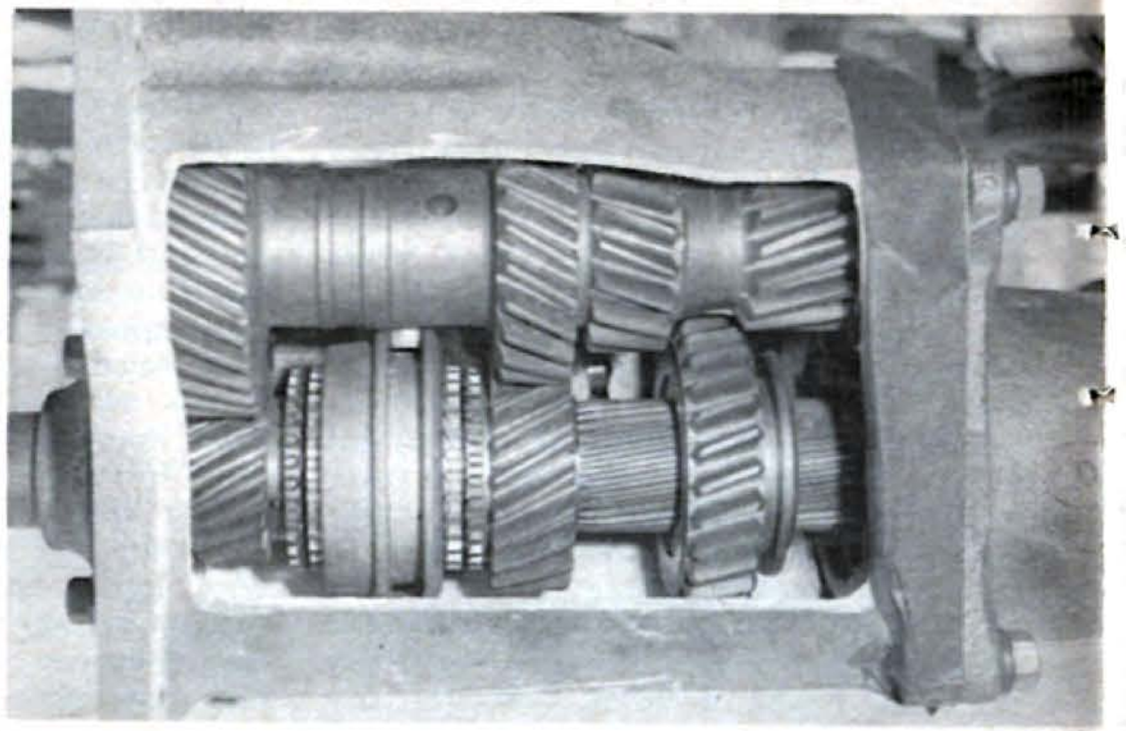
Ironically, though, the Corvette is now available with the wider gearset! Some owners of the Chevy two-seater have complained that the original ratios are *too* close for dragging, that first doesn't have enough dig. Despite all the engineering calculations in the world, gearing can still be a matter of opinion and personal driving technique!

Ford has stimulated further controversy by using the Warner box with a third series of ratios that fall between the other two. All three gearsets are interchangeable, by the way, so an enthusiast interested in a modified car with four speeds has plenty of room to experiment.

Generally, we're inclined to favor the closest set for racing. It requires a low rear axle ratio, though, to obtain low overall gearing in first. This brings us back to the problem of rough, noisy highway operation we mentioned in discussing overdrive. And no overdrive is available for the Warner four-speed. For this reason, the wider ratios might be a better choice for a dual purpose competition/transportation car.

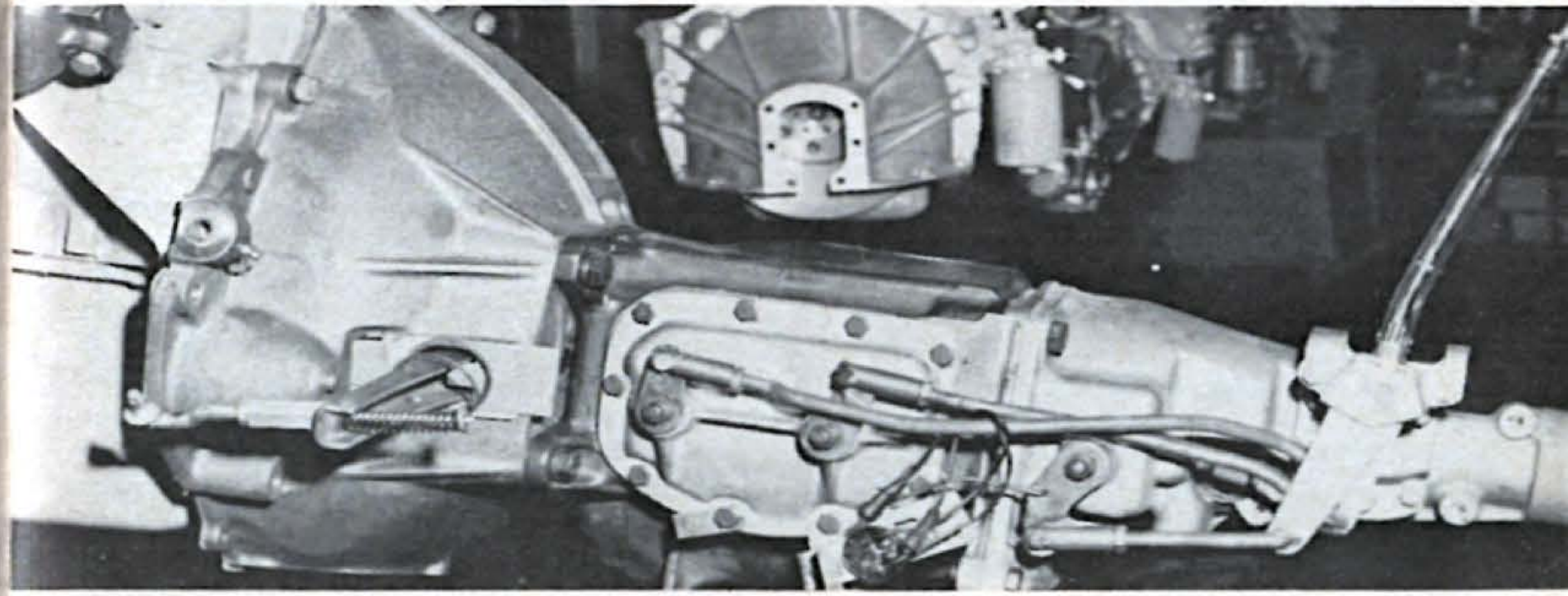
Still closer ratios were developed for the Warner box but they've never been released to the public. These were used in a factory Corvette entered in the 1957 Sebring 12-hour event. They're strictly road race gears, however, and forsake standing start acceleration for a tight operating range that enables the car to get in and out of corners as quickly as possible. They're definitely too high for dragging.

Gearing for the road, rather than all-out acceleration, is a normal practice in European cars. Unfortunately, most of the imports have mediocre power-to-weight ratios by our standards. They need very low first gears. To obtain adequate acceleration, yet have close ratios at road speeds, they



Ford 4-speed is based on same Warner box as Chevrolet unit shown on opposite page but uses special gearset with different ratios.

Warner 4-speed originally developed for Corvette is now offered on a total of eight different makes. Gears shown above are wider ratio set designed for big car use.

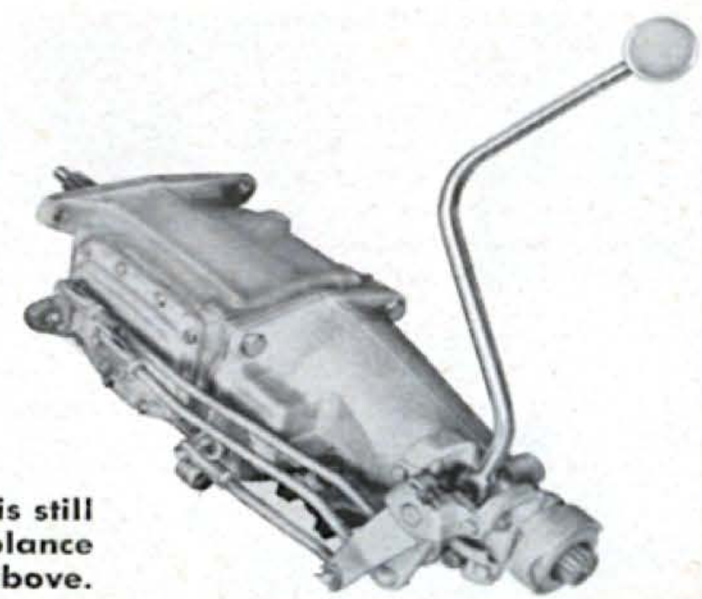


Pontiac was the first make after Chevrolet to offer the Warner box as regular factory option. Floor shift is standard equipment with all of Detroit's 4-speed installations.

TABLE III. 4-SPEED TRANSMISSIONS FOR U.S. CARS

	1st	2nd	3rd
WARNER			
Special (1957 Corvette Sebring SS)	1.87	1.54	1.22
Close Ratio (1956-62 Corvette, 1962 Chevrolet, 1962 Dodge, 1962 Pontiac)	2.20	1.66	1.31
Medium Ratio (1961-62 Ford)	2.36	1.78	1.41
Wide Ratio (1957-62 Chevrolet, 1958-62 Pontiac, 1961-62 Studebaker, 1962 Buick Special, 1962 Corvette, 1962 Oldsmobile F-85)	2.54	1.92	1.51
GM TRANSAXLE			
(1961-62 Corvair, 1962 Tempest)	3.65	2.35	1.44
PONT-A-MOUSSON			
(1960 Chrysler 300-F)	3.35	1.96	1.36

Note: All transmissions listed have direct 1.00-to-1 ratios in 4th gear.



Chevrolet adaptation of Warner unit is still one of the most popular. Note resemblance to the Pontiac 4-speed, shown above.

often have a low first combined with relatively high gearing in the other forward speeds.

The Pont-a-Mousson box in Table III exemplifies this idea. This is a unit developed for the Facel-Vega, a fairly heavy French luxury car, and offered briefly by Chrysler in its 300 series. Because of the sharp jump from first to second, it can't be considered as good a transmission for dragging as the Warner unit.

General Motors applies similar thinking in the Corvair/Tempest four-speed, which is the only such transmission besides the Warner now available in domestic cars. This unit has quite low gearing in first and second but a fairly high third. The object is to provide good acceleration at lower speeds with a rather modest engine output while allowing the use of third as a passing gear.

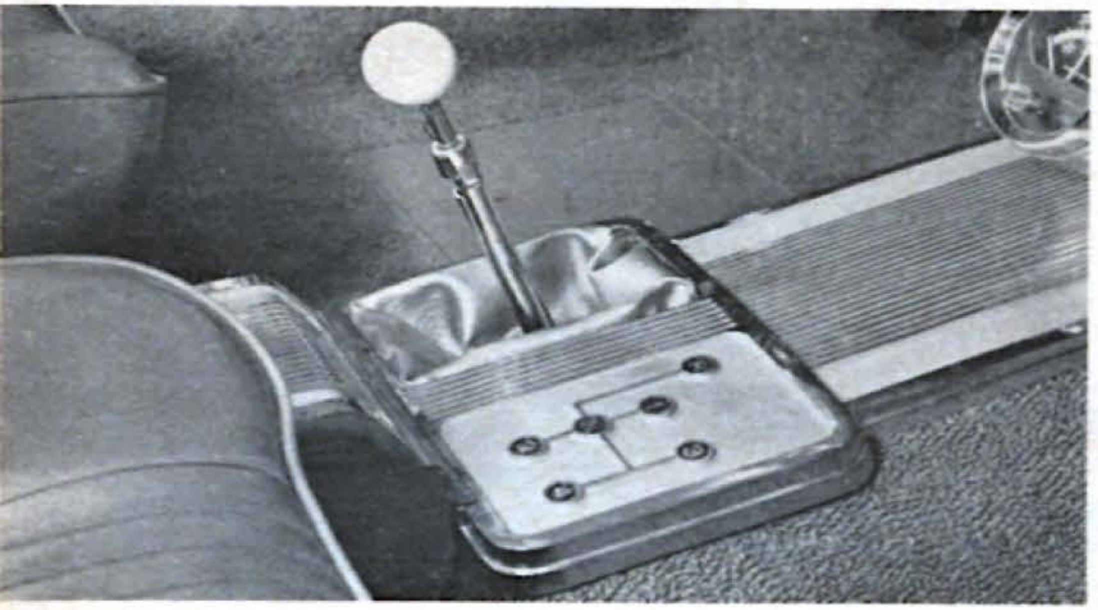
This is a transmission originated for the Corvair and recently adapted for the Tempest. It suits the little, rear-engined Chevrolet very well but we feel the Pontiac compact, with its greater power, should have closer, more evenly-spaced ratios.

A four-speed costs from $65 to $300, depending on make. Is it worth it? In terms of sheer driving fun, we'd say yes. For dragging, however, the question is debatable.

Theoretically, four speeds provide a definite performance margin over three, because of the close-ratio advantages of less drop in engine speed during a shift and slightly quicker gear engagement. But some drivers raise the issue of more ratios versus fewer shifts and argue for the latter. Several of the country's top Super Stock competitors are running with just three gears, though most of them admit they have to push the cars harder and calculate their shift points more carefully. The appearance of close-ratio three speeds, such as Dodge's new set, is sure to intensify the disagreement.

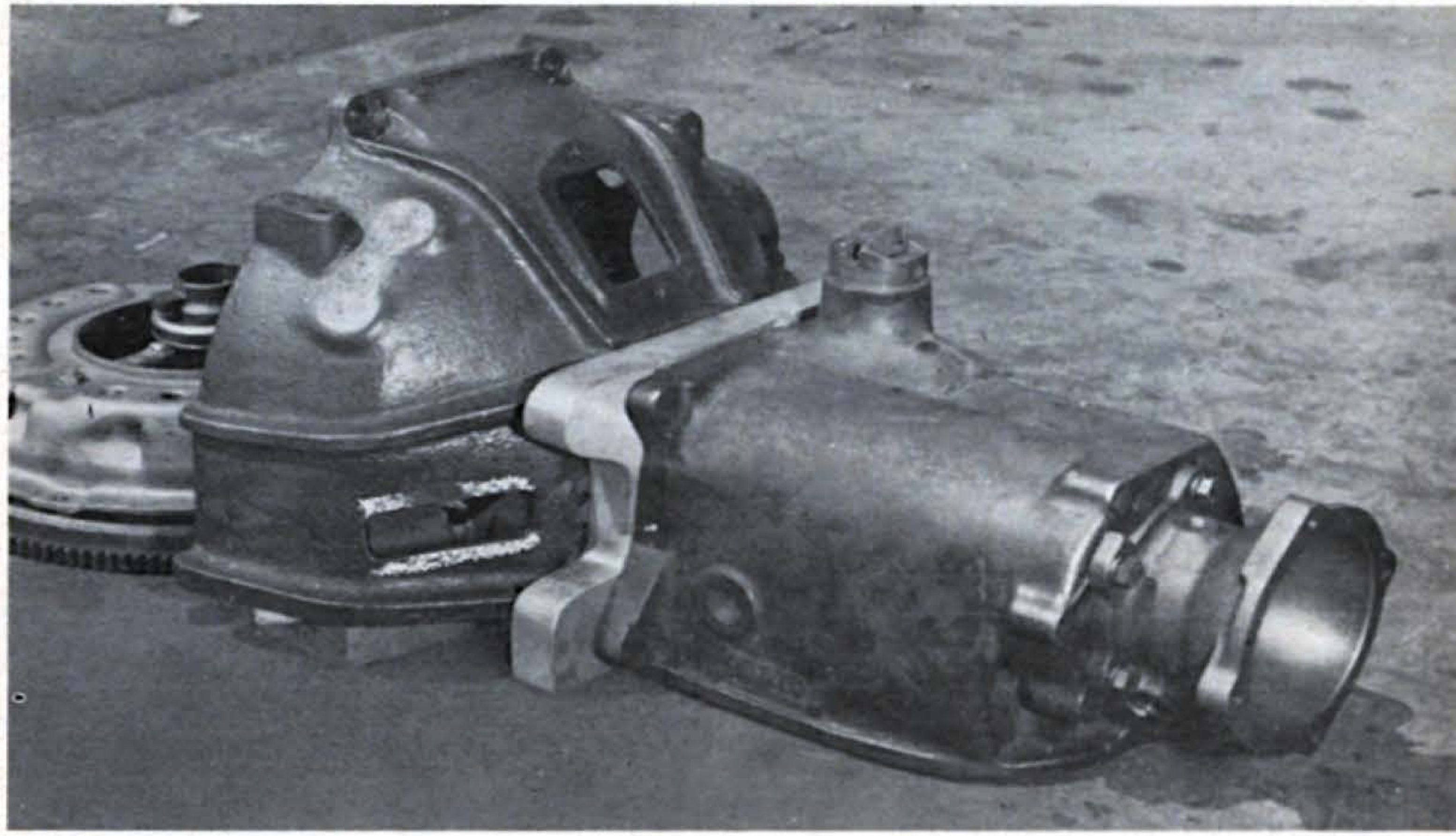
One important disadvantage of the Warner four-speed is beginning to show up. When the unit was first designed, nobody dreamed that upwards of 400 hp would be put through it. Today, this is happening in four different makes and the box shows signs of cracking under the strain. Several drivers running in the hottest stock classes report that the unit no longer holds up during a week-in, week-out racing schedule.

We know of two or three other makes that considered and rejected the idea of offering the Warner box. They felt its margin of strength wasn't good enough and decided to wait for a beefier four-speed. We certainly hope Warner accommodates them. ■



Luxurious finishing touch for 4-speed floor shift is shown in 1962 Pontiac Grand Prix, with special console housing for both gear lever, tachometer.

BOXES WITH BEEF



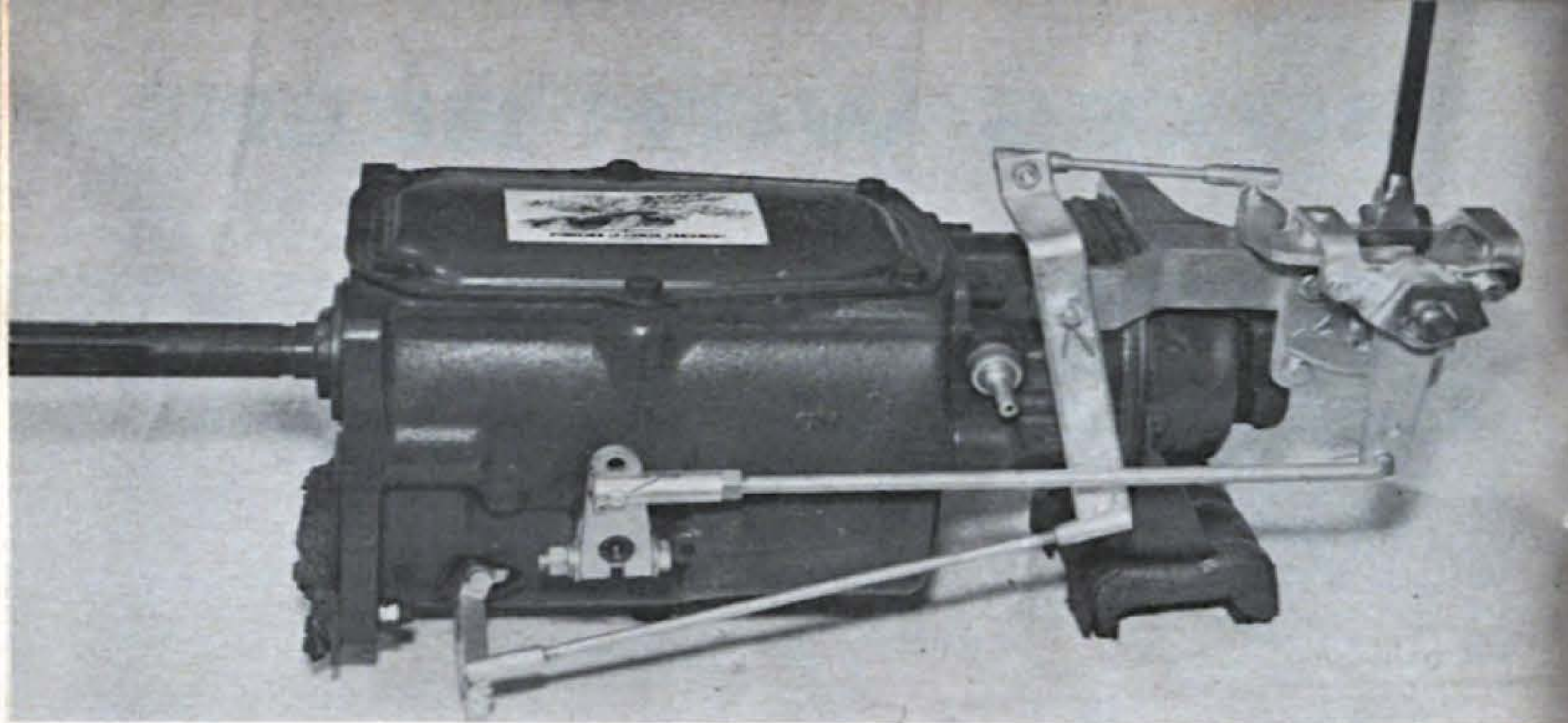
Installing a special gearbox isn't an easy task. This Cadillac-La Salle transmission has been reworked to fit an older Chevrolet with torque drive. Besides an engine-gearbox adaptor plate, unit requires a modified rear flange to mate with the Chev driveshaft.

GEARBOX strength becomes extremely critical when we get into highly modified cars. In fact, anyone building an all-out competition machine can forget most stock transmissions. They'll simply fly apart if they're attached to really hot engines.

There have been just a handful of gearboxes with enough beef for serious dragging. All of them were designed for expensive cars and, as a result, are far above average in strength.

The most sought-after of these is a unit introduced in 1937 by Cadillac and La Salle. Originally a floor shift transmission, it had a column lever from 1938 on. Cadillac used this box until 1953, when Hydramatic became standard equipment for the make, and Oldsmobile borrowed it in 1949 and 1950.

The Cad-La Salle box has fairly close ratios for a normal three-speed and is exceptionally well made. Gears, shafts and synchronizers are ruggedly designed and fabricated of very high grade steel. This is one transmission that should take just about any amount of power you can give it with an automotive engine. Adaptors are available from leading speed equipment firms to



Older Buick transmissions can be rebuilt into superb units for dragging but considerable work is necessary. This one's been finished off with an Ansen floor-shift conversion.

couple the Cad-La Salle to most popular V-8 engines and floor shift conversions for the 1938 and later units are easily obtained.

Cadillac and La Salle used an open drive shaft, so fitting the box to other cars with the same type of layout is fairly simple. Besides the correct adaptor, all you have to worry about is adjusting the drive shaft to the right length and fitting it with a front universal joint that will connect properly to the transmission.

Matching the Cad-La Salle box to a closed drive shaft, or torque tube, is somewhat more difficult. This kind of power train was used in older Fords and Chevrolets, among others, and is tricky to modify. Normally, the mainshaft of the transmission has to be shortened and equipped with a universal joint to match that of the torque tube. While such an installation takes time and trouble, most experienced rodding mechanics can handle it.

Actually, the biggest problem with Cad - La Salle boxes is the scarcity of the units themselves. Production stopped almost a decade ago and both rodders and classic car enthusiasts have cleaned them from almost every wrecking yard in the country. Some of the larger speed shops try to maintain a supply of them, both scrounged from junkers and traded in by rodders who have already raced them. However, because the demand is great, these merchants ask—and get—pretty stiff prices.

For this reason, many enthusiasts have turned to some of the other old big cars, in hopes of finding strong, close-ratio transmissions at lower cost. Buick and Packard units have been the most successful of these.

Buick boxes are probably the easiest to find because the make was quite popular during the 'thirties and 'forties and now occupies scrap heaps in great numbers. The design is quite sturdy and the ratios are identical with those of the Cad-La Salle. However, no one Buick transmission will do the job. Two of them have to be combined and some Oldsmobile parts are needed to finish the unit.

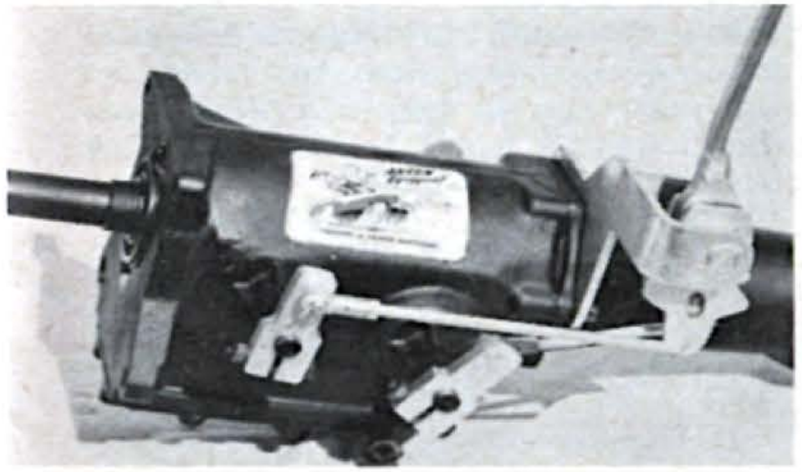
The 1936-38 Buick Century and Roadmaster had good, beefy transmissions with solid floor shift mechanisms. Unfortunately, Buick was among the advocates of torque tube drive and these older boxes were engineered for it. This means installation problems just the opposite of those with a Cad-La Salle!

Several modifications are necessary to get a Buick gearbox into a car with an open drive shaft. The usual procedure is to use the transmission mainshaft, together with the rear bearing retainer and other minor parts, from a 1951-56 Oldsmobile. However, the Olds mainshaft won't work with the first and reverse gears of the 1936-38 Buick. To get a proper fit, cogs from a 1941-48 Buick Roadmaster must be used.

All this is complicated but the total effect is a fine transmission that, even with the extra parts necessary, should cost much less than a Cad-La Salle.

The Packard box is also available in sufficient quantity that the price is modest. It has even huskier gears than the Cad-La Salle, though the overall gearbox strength isn't as great. This is especially true of the 1936-38 floor shift version, which had a rather poorly-built case. In 1939, the unit was converted to a column shift and the change resulted in much better overall construction.

One big disadvantage remained, though, right through the last Packard transmission in 1954. The mainshaft

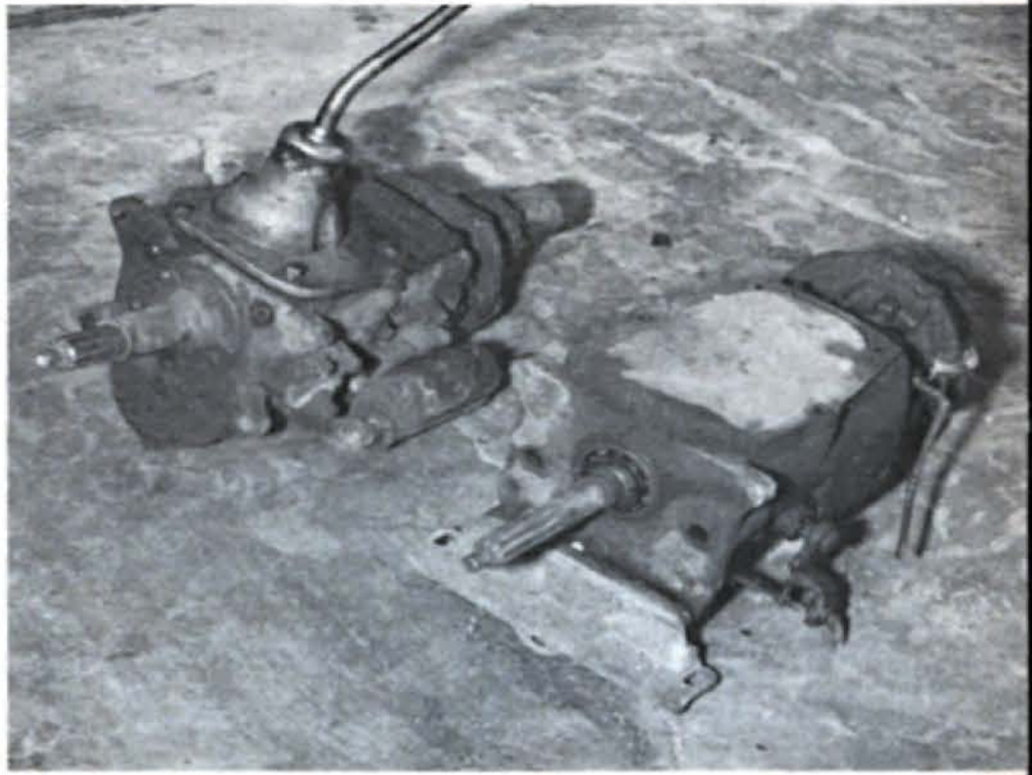


Later model Cad-La Salle boxes are ideal for racing. Shift conversions, such as the Ansen unit shown here, make it unnecessary to use the earlier, hard-to-find Cad boxes with floor levers.

TABLE IV. HEAVY-DUTY 3-SPEED TRANSMISSIONS

	1st	2nd
BUICK		
(1936-38 Century or Roadmaster with 1941-48 Roadmaster gearset)	2.39	1.53
CHRYSLER		
(1961-62 Chrysler, Dodge and Plymouth)	2.55	1.49
(1962 Dodge)	2.17	1.43
CADILLAC-LA SALLE		
(1937-53 Cadillac, 1937-40 La Salle, 1949-50 Oldsmobile)	2.39	1.53
PACKARD		
(1936-54 all models)	2.43	1.53

Note: All transmissions listed have direct 1.00-to-1 ratios in 3rd gear.



Two Buick gearboxes, the 1936-38 and 1941-48 units, must be combined with a few Olds parts to build one good transmission for drag racing. Ratios are same as the Cad-La Salle's.

was quite small and has proven difficult to adapt to the universal joints on larger drive shafts. This has turned a good many rodders away from what's an excellent gearbox in most other respects.

The Packard ratios are similar to those of the Cad-La Salle and Buick. First is slightly lower, though not enough to make much difference, and second is the same as in the other two boxes.

Two features make the Packard a desirable transmission for dual purpose racing/street rods. The first and most unusual is that it's one of the very few three-speed units with a synchromesh first gear. Usually, it's necessary to go to a four-speed to get this advantage.

Synchronizers are much easier to apply to pairs of gears than to a single ratio. In most passenger cars, first is engaged only to move the car from a dead stop. This circumstance doesn't require synchromesh, so few car makers have ever bothered to use it in the first of three gears. The Packard, in fact, is the only three-speed mentioned in this book that's so equipped. In a four-speed, however, there are two pairs of gears and, since three of these have to be synchronized anyway, it's easy to extend the device to first.

A synchromesh first can make a car with a fast-revving, competition powerplant much easier to operate in traffic because it eliminates the problem of lugging in second. Low gear is readily available without either double-clutching or stopping, so engine speed can be kept up at all times.

The other big advantage of the Packard for road use is the availability of overdrive. This was an option from 1941 on and is often found as a part of the later units. It can complicate an installation but, as we've seen, it's mighty useful for ordinary driving.

In many ways, the Packard is the most appealing of the three. If only that mainshaft were a little huskier. . . .

One more transmission should be mentioned here, the new Chrysler-Dodge-Plymouth three-speed. It's been in production less than two years, so the only way to get it is fresh from the factory. It hasn't had time to show up in the junkyards yet!

Chrysler begins with a small, light but extremely rigid case, then fills it with sturdy gears and shafts. As a finishing touch, the synchronizers are virtually the same as the very rugged ones used in the Cad-La Salle box.

If Chrysler builds this unit in sufficient numbers, especially with the closer ratios, we expect to see it in as great demand among tomorrow's rodders as the Cad-La Salle has been among our own generation. ■

The original Cad-La Salle unit has an extremely long tail shaft that must be cut down to fit most other cars. Compare this box with the Cad-La Salle modified for a Chevy, shown on page 15.

FLOOR SHIFTS

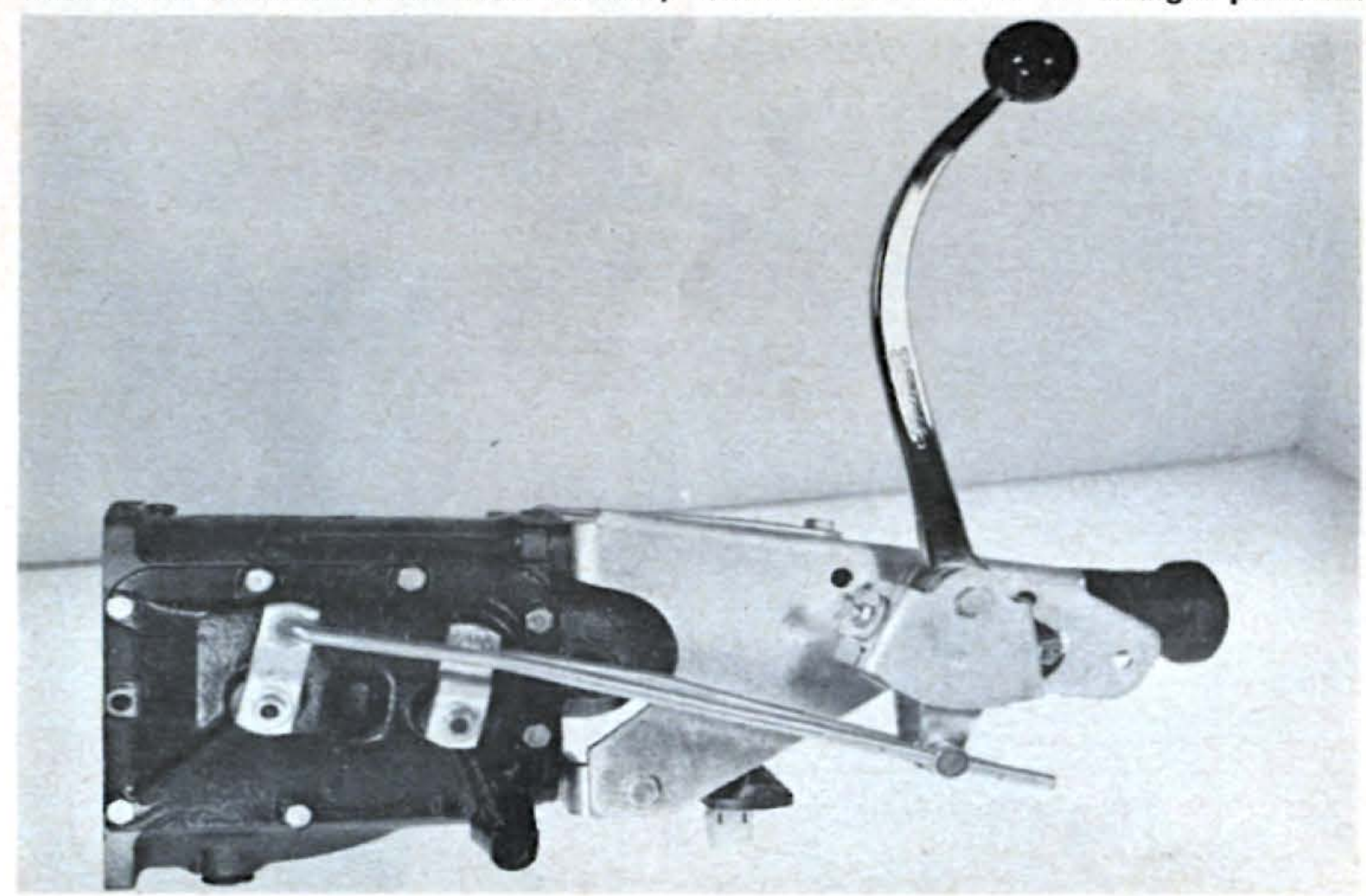
A FEW years ago, most rodders were busy replacing floor shift levers with modern column set-ups. Today, they're just as busy putting the levers back on the floor!

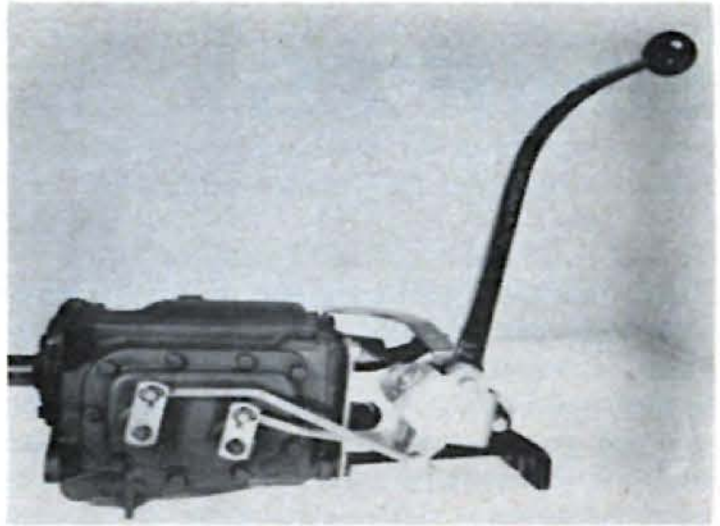
As drag racing has become more and more competitive, we've learned that a control going directly through the floor to the transmission can save up to half a second in shifting time, compared with a linkage detouring along the steering column. And half a second can mean half a dozen car lengths at the end of a ¼-mile drag.

This doesn't mean the floor lever is a magic wand. We pointed out earlier that a close-ratio box can be shifted faster because the synchronizers can adjust gear speed more quickly. But no matter how close the ratios are, the synchronizers still need time to work. While this may be only a few thousandths of a second, it sets a definite physical limit on the speed of a shift.

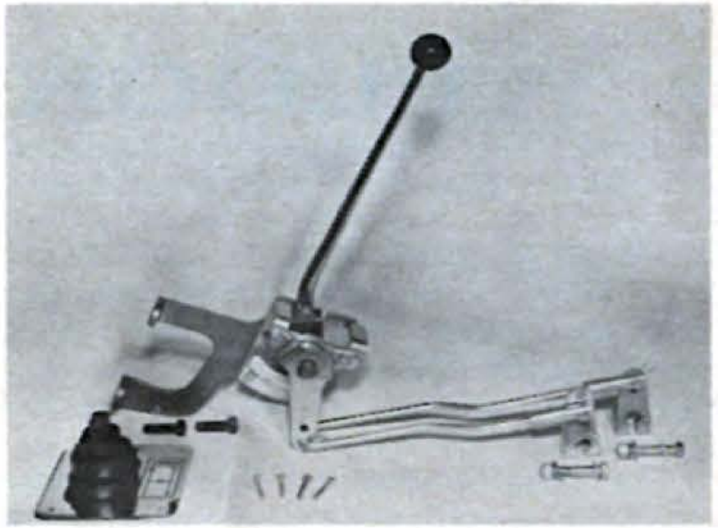
A column linkage usually allows so much slack that it can't approach this limit. A floor shift is direct and precise but, even so, it can't be operated any

Hurst conversion for '49-thru-'62 Ford 3-speed transmissions is one of most popular kits on the market. Unit is "Dual Pattern," can be shifted in "H" or straight patterns.



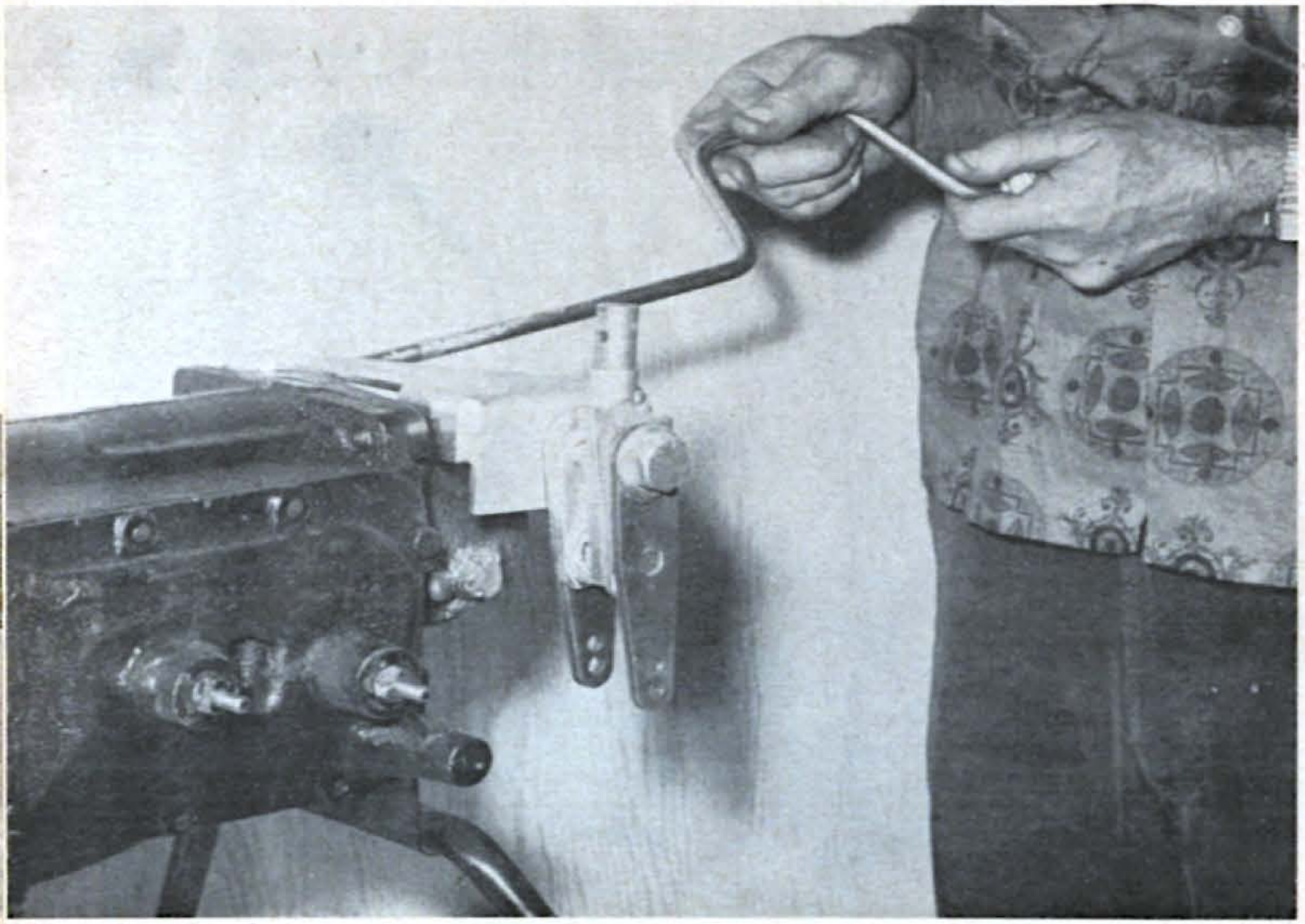


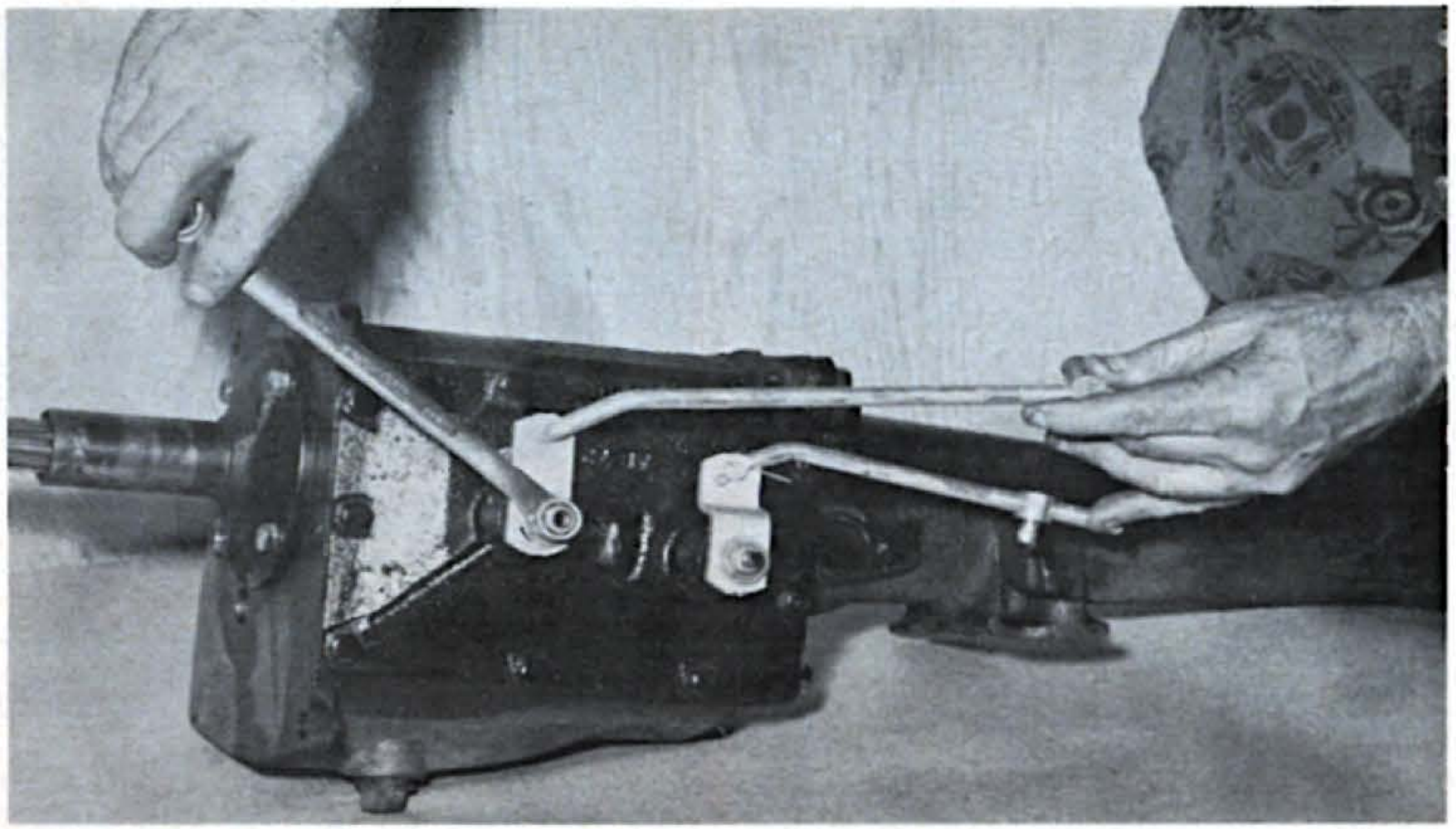
Pontiac authorizes the Hurst floor shift as a dealer option for both 3- and 4-speed gearboxes. 3-speed unit is shown above.



Ansen "Posi-Shift," by Ansen Automotive of Los Angeles, was one of the first conversion kits to be placed on market.

The first steps in installing a "Posi-Shift" are to remove the standard linkage, then to mount the special bracket, supplied with the kit, at the rear of transmission housing.





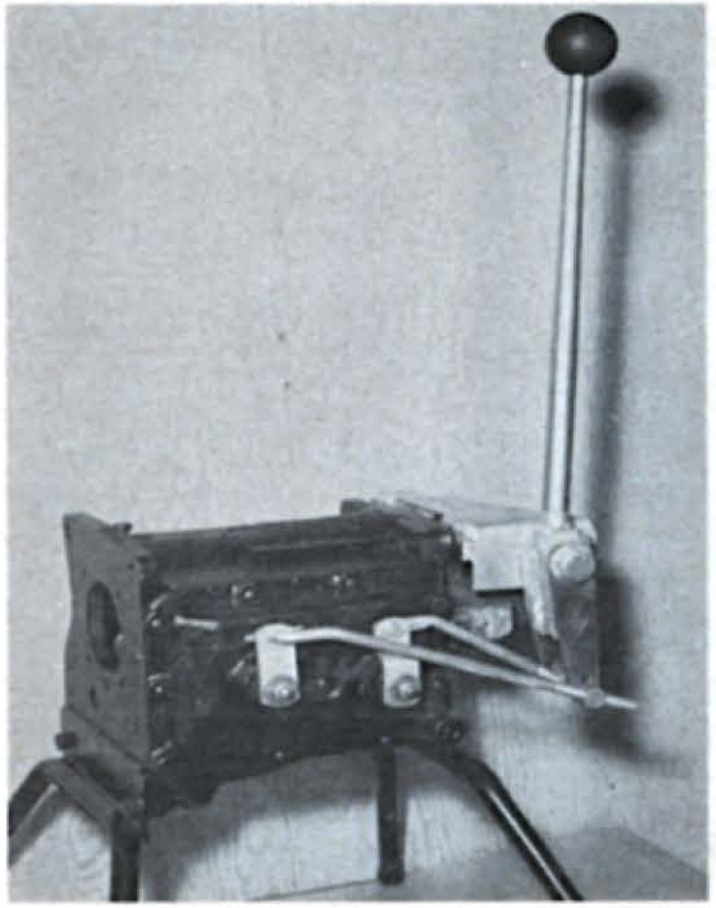
The shifting rods to connect with the floor lever are simply bolted in place. For fast action, they must be adjusted carefully.

faster than the synchronizers permit.

Modern floor shifts differ somewhat from those used in older stock cars. In the early 'thirties, standard transmissions were built with the shift lever projecting right from the top of the case. When Detroit began taking the lever off the floor, the shifting controls were moved to the side of the transmission, where they could be connected easily to the steering column linkage. Because the case had to be redesigned for this arrangement, it usually isn't practical to adapt an old floor shift to a modern transmission. Too much reworking of the entire box is necessary.

The current floor shift popularity dates from the 1955 Corvette and Thunderbird. Chevrolet and Ford adapted their standard gearboxes for these models by simply attaching a floor lever to the regular side-shift controls, rather than going back to the old practice of thrusting the lever through

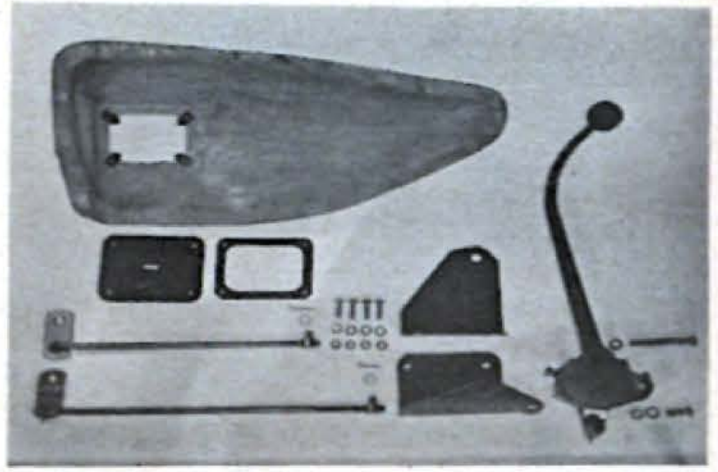
Finished unit is simple, rugged. Though transmission is shown out of car, normal installations are made right in the vehicle.



the top of the case. Virtually all the conversion kits now on the market use the same principle. A good many of them, in fact, even use Corvette parts.

Many kits preserve the normal "H" shifting pattern, though they narrow the neutral slot to allow a faster move from first to second. There are some, however, with a straight line pattern, similar to that of a motorcycle. This is supposed to minimize the necessary lever movement and provide the quickest possible shift. One unit, the Hurst Dual Pattern, incorporates *both* arrangements. A simple adjustment within the linkage converts the unit from "H" to straight and back again.

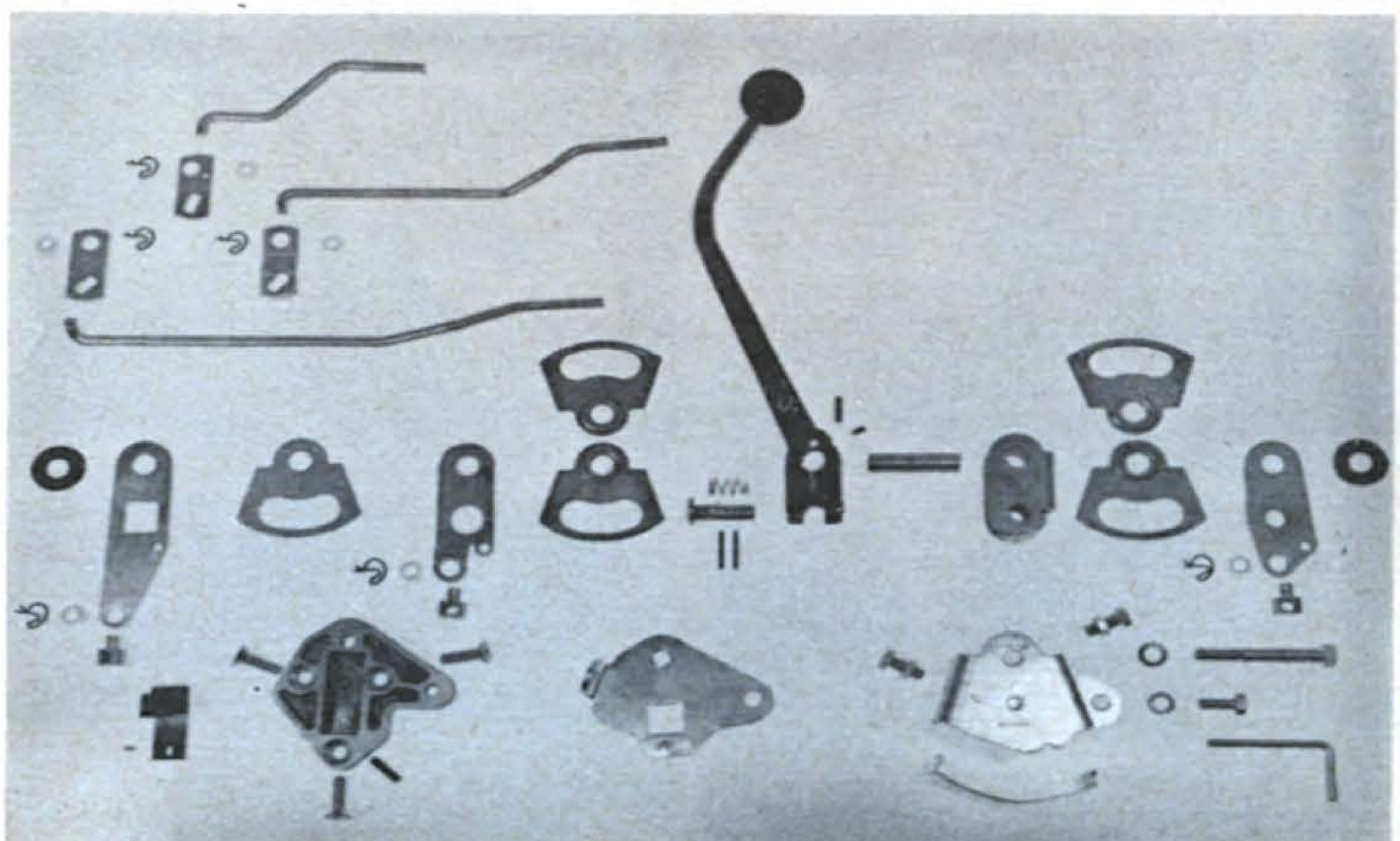
We've tried both set-ups and we've talked to lots of drivers who have also sampled both. Frankly, we haven't come up with any proof that the straight line is faster than a tight "H." So you pays your money and takes your choice.

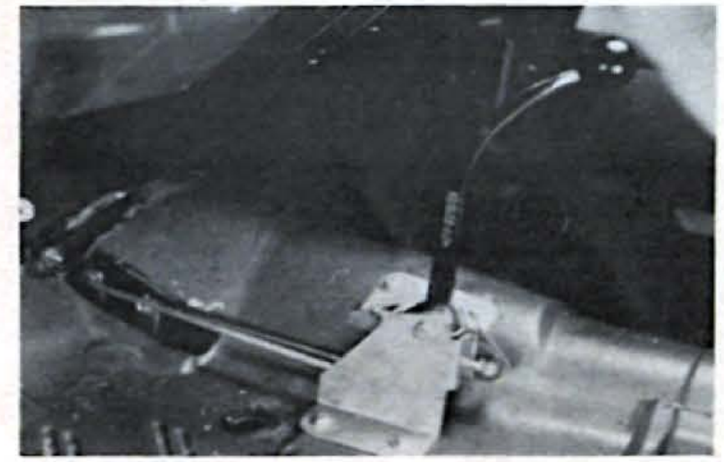


Boot is part of Hurst kit for Dodge, covers section of linkage placed above floor because of slim clearance underneath car.

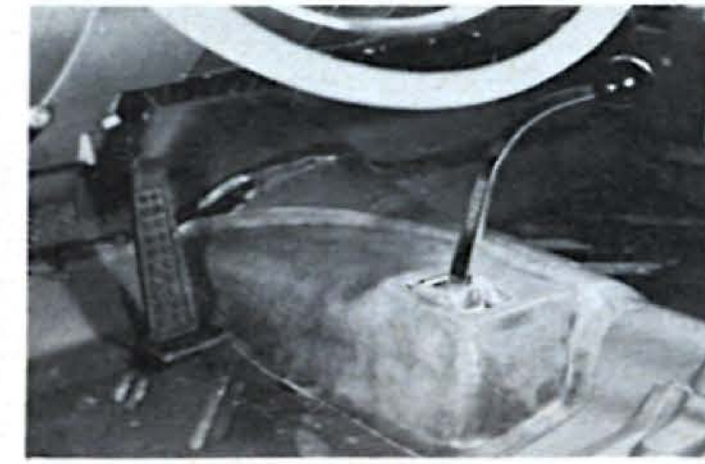
Installing a floor shift is a fairly easy task. Pull up the rug in the front passenger compartment and cut a two-inch hole in the floor, just above the transmission. The instructions with your particular kit will tell you where the hole should be. Then, disconnect

Hurst offers this special kit for Warner 4-speed box, replacing factory floor shift. Unit is designed for rugged use, is recommended by Pontiac for cars raced regularly.

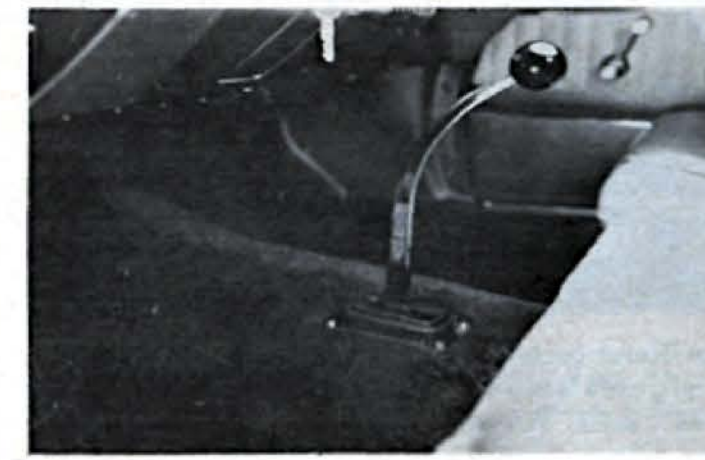




Dodge's '62 model doesn't allow sufficient room between the floor and transmission. Hurst linkage installs above floor panel.

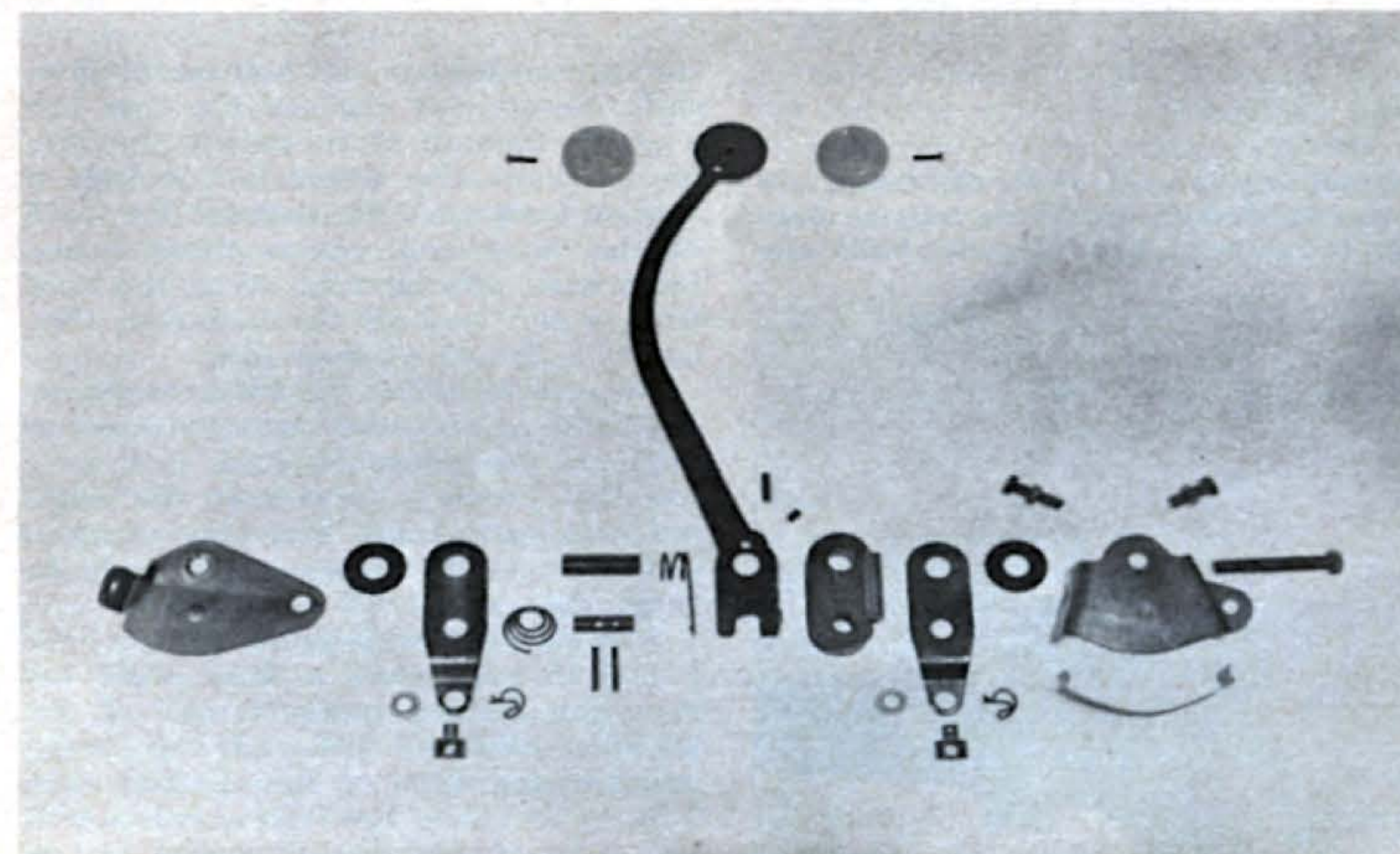


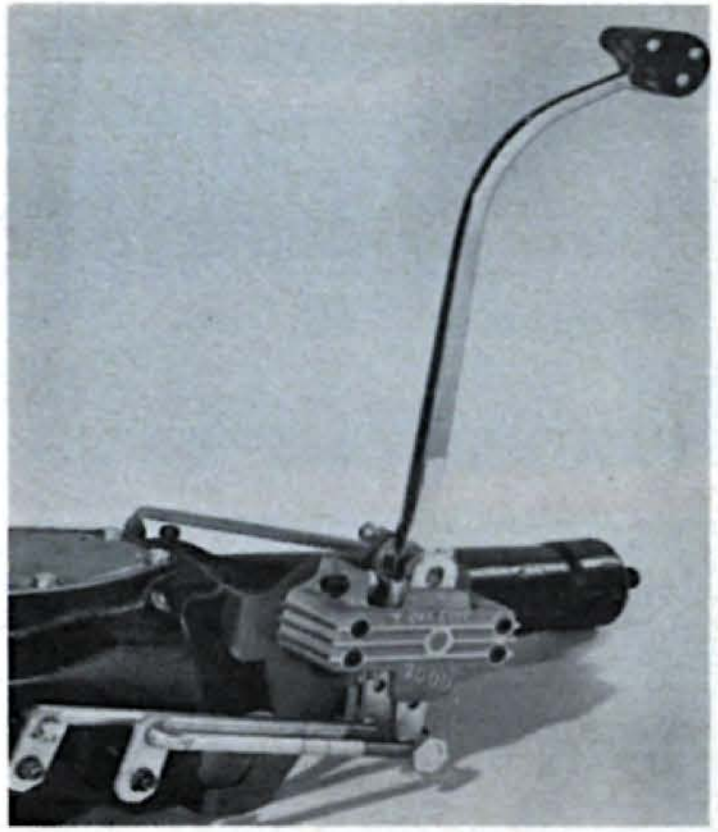
Boot is designed to conceal shift linkage, reduce possible noise. Molded from fiberglass, it fits normal contour of floor.



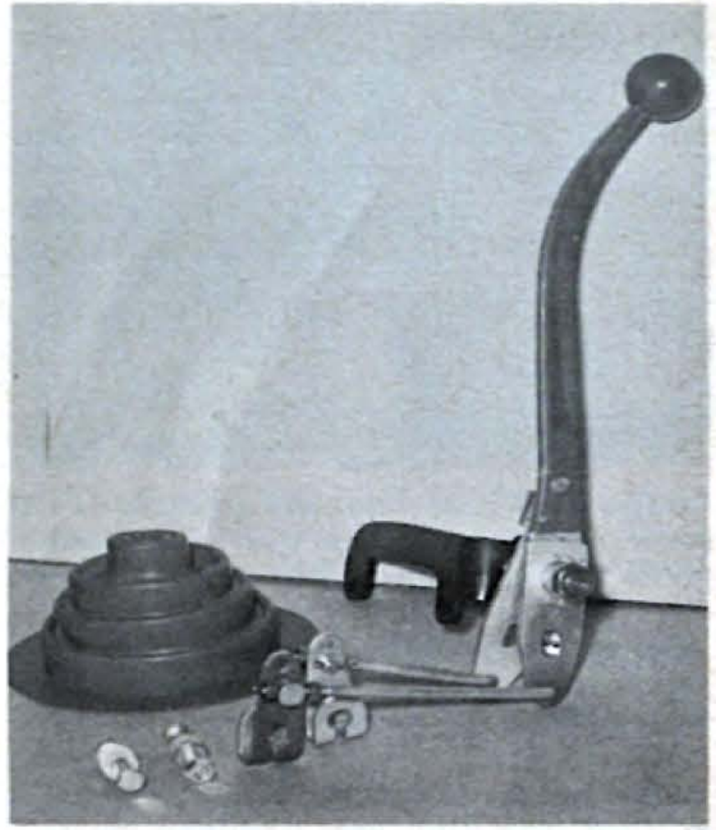
Carpeting fits over boot, provides factory-finished look. Unit was designed for new Dodge but also applies to '62 Plymouth.

Hurst makes conversions for most popular 3-speed transmissions in current use, works closely with auto manufacturers.



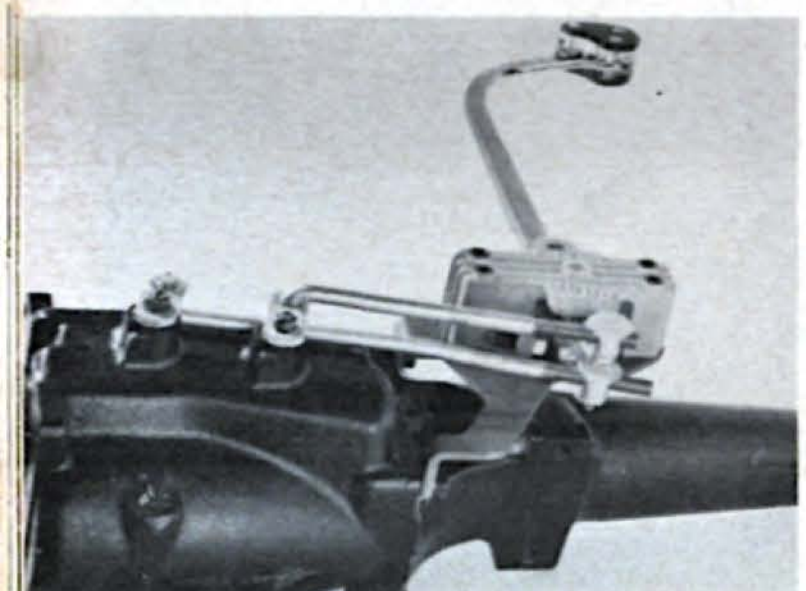


Contrast is seen here in Cal-Equip's 7000, designed only for competition. Maker says unit will function under full throttle.



At other extreme is Ansen's new economy kit for those who want a moderate cost floor shift just for sheer driving pleasure.

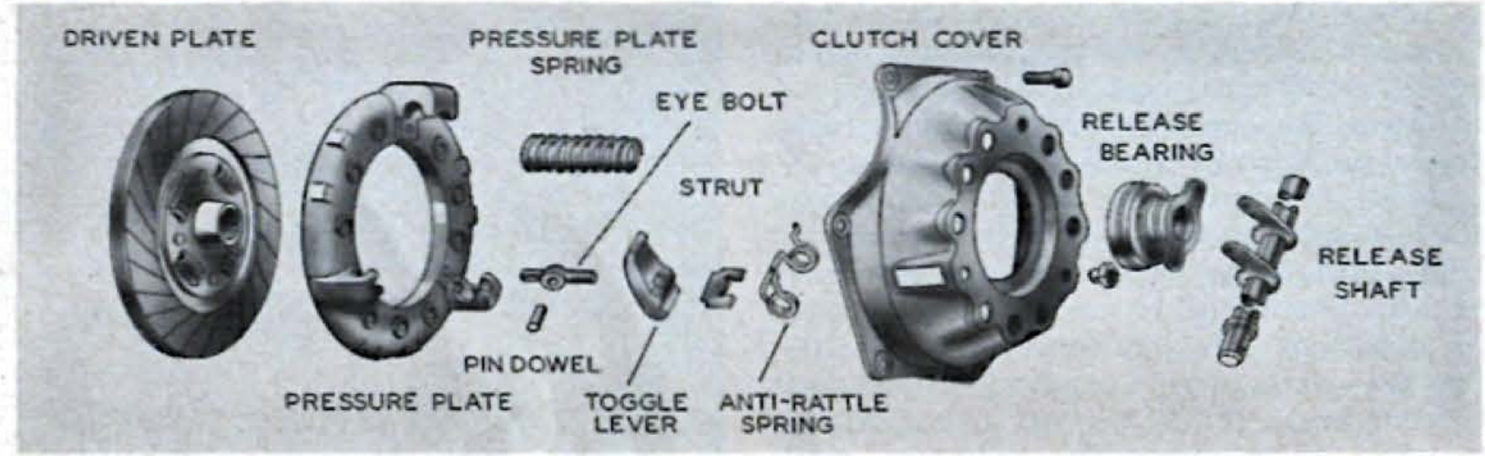
Rugged engineering of the Cal-Equip unit is exemplified by half-inch rods in linkage to minimize flexing under hard use.



the column linkage and bolt on the floor shift. Before you replace the rug, cut a small hole in it to match the one in the floor. The better kits include a rubber boot that fits around the base of the lever and covers these holes. Otherwise, you have to adapt the boot from a car, such as the Corvette, that comes with a stock floor shift.

Be sure to follow the kit instructions carefully. Even the best conversion made is just so much junk if it isn't installed properly. And save the original column linkage. You may want to put it back on when you're ready to trade the car.

Kits vary in price from $30 to over $100. If you want a floor shift for everyday driving pleasure, one of the cheaper units will suffice. But if you're going racing, plan on spending at least $50 or $60. The few extra dollars will buy a lot of added ruggedness. ■



Main components of a clutch assembly are shown in this drawing. Multiple parts, such as springs, toggle levers, bolts, nuts and pins, are shown just once for sake of clarity.

CLUTCHES

THE clutch is probably the weakest link in the whole drive chain. On one hand, it should be small and light, so it can be operated smoothly and quickly to allow the fastest possible shifts. On the other, it has to be strong enough to withstand terrific amounts of friction and pressure or it will literally blow up.

Achieving the right balance of light weight and strength is no easy trick. The contradictions and compromises we find throughout an automobile are nowhere more evident than they are here.

Two sub-assemblies are involved in a normal clutch design. The clutch disc or driven plate is attached to and rotates with the transmission input shaft, while the flywheel, pressure plate and cover all revolve as a unit with the engine crankshaft. When the clutch is engaged, the pressure plate forces the disc against the flywheel, creating a simple friction contact that locks up the whole power train.

The lighter these components are, the easier the operation of clutching and shifting will be. For this reason, Detroit tries to keep clutch size and weight as low as possible.

But the lighter they are, the more likely they will burst. As engine output becomes greater, the clutch must be enlarged and strengthened to accommodate the added load.

To prevent slippage with a fast revving powerplant, the pressure holding the disc and flywheel together must be increased. Slippage causes power to be wasted in the form of heat. The temperature of the clutch rises and, if allowed to go too high, it may cause some components to explode.

Greater pressure, in turn, means a stronger assembly. We can't take a disc and flywheel designed for a pressure of 1500 pounds per square inch, then slam together at 3000 pounds and expect them to last very long.

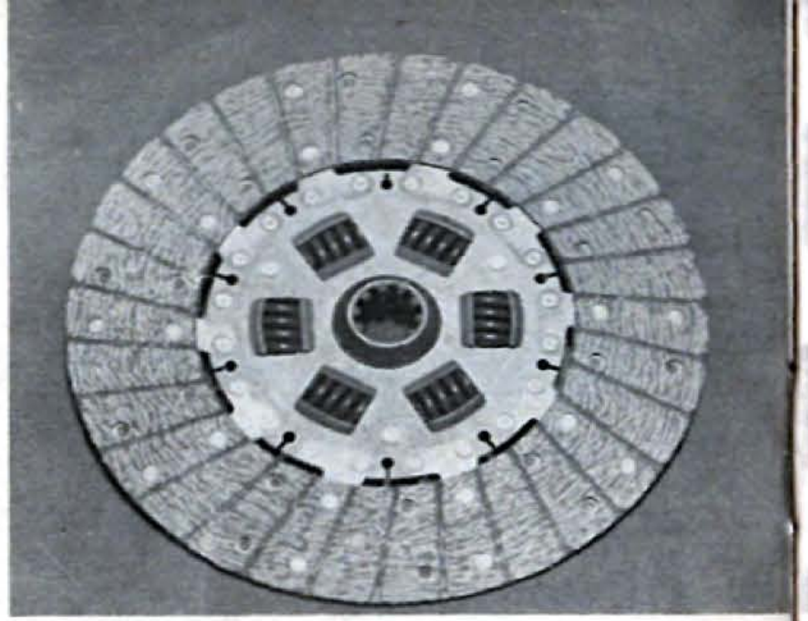
As we raise pressure, the clutch becomes harder to release. The pedal stiffens and becomes extremely tiring to use in traffic. Fortunately, this is one clutch problem that's solved fairly easily. High-powered stock cars have centrifugal weights on their pressure plates that allow relatively light springs for easy clutch operation at low speeds. As rpm goes up, centrifugal force causes these weights to increase clutch pressure. This is what's known as a semi-centrifugal clutch, distinguishing it from the conventional type which relies on springs alone for pressure.

Why *semi*-centrifugal? Because there's such a thing as a fully centrifugal clutch with no spring pressure at all. The weights are its only source of pressure. This, however, is suitable for use with only a limited amount of horsepower. It shows up occasionally on small motorcycles, scooters and some of the smallest foreign cars.

At high speed, a semi-centrifugal clutch becomes quite stiff, as you probably know if you've tried a fast shift in any of the cars listed with one in Table V. But it's never any harder to release than a conventional clutch of equivalent pressure and, usually, it's much easier. It's probably the ideal type of clutch for a dual purpose rod.

Slippage, as we've seen, is most undesirable at higher speeds. But there are times when we have to allow a certain amount of it.

The most important is when starting a car from rest. The rear axle and wheels have to be set into motion progressively; they can't suddenly rotate at even the reduced rpm provided by first gear. The clutch should be engaged gradually, permitting the axle to accelerate to the speed potentially available from the transmission.

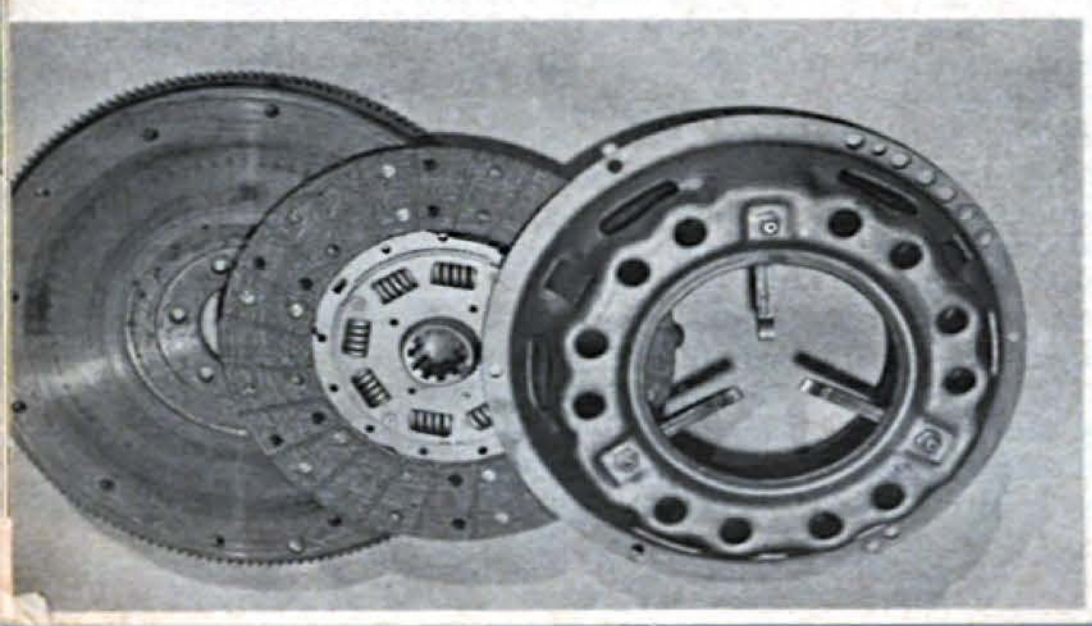


The clutch disc is one of the most punished components in an automobile. This is a Borg and Beck 11" unit used by Chevy and is typical of discs in passenger cars.

In other words, the clutch should be slipped. If it isn't, there'll be a sudden jolt through the whole drive train as power is applied. This will have one of two effects. In a car of moderate output, the engine will simply stall, while in a hotter vehicle, the rear wheels will break traction and spin without providing any forward thrust. In either case, the car will just sit there, looking rather silly.

That old bugaboo wheelspin has reared up again. Here, it's doing what we should've allowed the clutch to do, providing slippage.

The clutches in ordinary passenger



Shown, left to right, are a flywheel, clutch disc or driven plate and cover. The pressure plate is housed within the cover.

TABLE V. STANDARD CLUTCHES FOR 1962

	Diameter	Pressure	Remarks
BUICK			
Special	9.5	1230	
CHEVROLET			
Corvair	8.0	1050	
Chevy II			
90-hp	8.0	1250	
120-hp	9.12	1250	
Biscayne, Bel Air, Impala Six	9.5/10.0	1775/2000	
170-hp V-8	10.0	1875	
250- to 300-hp V-8	10.5	2100	
380- to 409-hp V-8	10.5	2400	†
Corvette	10.0	2300	†
CHRYSLER			
Newport, 300	10.5/11.0	1790/2350	†
DODGE			
Lancer			
101-hp	9.12	1158	
145-hp	9.25	1445	
Dart			
Six	9.25	1445	
230-hp V-8	10.0	1640	†
305-hp V-8	10.5	1790	†
310- to 410-hp V-8	10.5	2235	†
FORD			
Falcon, Fairlane Six	8.5	1200	
Fairlane V-8	9.5	1230	†
Galaxie			
Six	9.5	1230	†
170-hp V-8	10.0	1278	†
220-hp V-8	11.0	1575	†
300- to 405-hp V-8	11.0	1710	†
MERCURY			
Comet, Meteor Six	8.5	1200	
Meteor V-8	9.5	1230	†
Monterey			
Six	9.5	1230	†
170-hp V-8	10.0	1278	†
220-hp V-8	11.0	1575	†
300- to 330-hp V-8	11.0	1710	†
OLDSMOBILE			
F-85	9.5	1565	†
88	11.0	2386	†
PLYMOUTH			
Valiant			
101-hp	9.12	1158	
145-hp	9.25	1445	
Savoy, Belvedere, Fury			
Six	9.25	1445	
230-hp V-8	10.0	1640	†
305-hp V-8	10.5	1790	†
PONTIAC			
Tempest	9.25	1477	
Catalina, Star Chief, Bonneville	10.5/10.4	2087/2430	†
Grand Prix	10.5/10.4	2313/2430	†
RAMBLER			
American			
90-hp	8.0/8.5	1269/1350	
120-hp	8.5/9.25	1440/1533	
"E" Stick	9.13	1200	*
Classic	8.5/9.25	1440/1533	
Ambassador	10.5	1893/2050	
STUDEBAKER			
Lark			
Six	8.5	1024	
180- to 195-hp V-8	10.0	1582	
Hawk, Lark 210- to 225-hp V-8	10.5	1640	
Hawk, Lark 4-Speed	10.25	1465	†

† Semi-centrifugal
* Automatic

Note: Diameter is indicated in inches and pressure in pounds per square inch. Figures separated by a slash (/) show standard specification on the left and optional heavy-duty on the right.

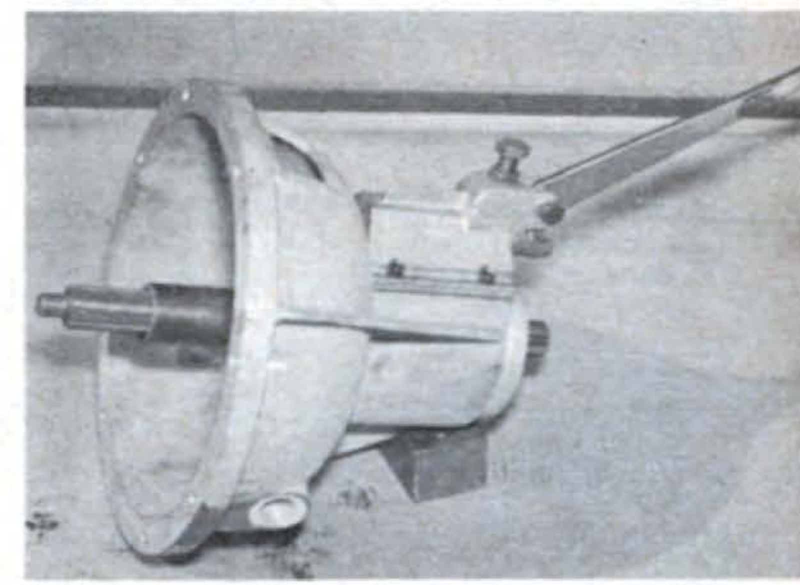
cars are supposed to be slipped. Smooth starts aren't possible otherwise. But a racing engine operates at very high rpm. If we slip the clutch of a competition car very much, we'll have that high-speed heat problem. The rear wheels help us avoid such difficulties by providing us with another source of slippage.

Remember? We said earlier that a certain amount of wheelspin could be used to advantage.

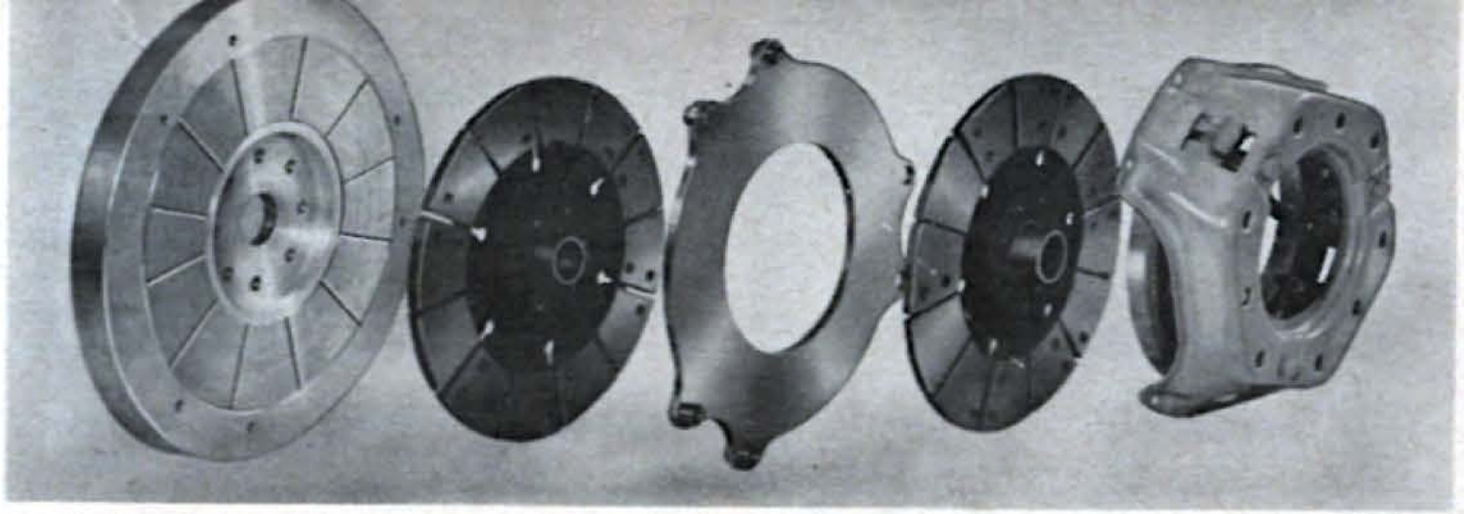
We can't forget clutch slippage altogether and simply let the wheels spin. This sacrifices the control and traction we need to get moving quickly. But we can combine both types of slippage, reducing each of them to levels we can keep in check.

Most experienced ¼-mile competitors agree that a fast, efficient jump from the line is essential for a low elapsed time. As one of them expressed it, "Drags are usually won at the start, not the finish." The proper balance of clutch slippage and wheelspin is the secret of a winning start.

The technique is simple, though it takes a little practice to get the proper



"In-and-out" box is popular for racing. It is a transmission that provides neutral and direct drive only. It consists merely of a splined shaft and contains no gearing.



Dual-disc clutches, such as this Schiefer unit, are often used in dragsters for greater clutch area without increased size. Such assemblies are too stiff for street use, though.

feel with any particular car. And "feel" is the right word. Skillful competition driving is more of an art than a science.

Here's how to do it. Rev the engine between 2,000 and 3,000 rpm. When you get the green flag, let in the clutch enough to break the rear wheels loose but not so much that they don't provide forward thrust. Then, as you get under way, you'll feel the tires digging in. When you're sure they're beginning to bite, though they may not be absolutely firm yet, pop the clutch all the way.

You've held clutch slippage at a minimum and avoided the problem of excessive heat, yet you've kept wheelspin under control so you didn't lose too much traction.

In a broad sense, this involves the same principle as a second gear start. You're using slippage to keep rpm high so that plenty of power is available.

If a car's power-to-weight ratio is good enough, you can take advantage of slippage and actually get faster ¼-mile acceleration with a start in second or even third gear. This might seem unreasonable but two important factors are involved. You keep engine speed higher and you save shifting time. The key is enough power and enough slippage to break from the line quickly.

The hottest dragsters are usually built to be driven in this manner. A good rail job will have a fantastic power-to-weight ratio. This means the transmission ratios can be spaced so closely there isn't any point in using more than one! The advantage of two, three or four extremely close gears would be lost in the time required to shift them. Since there's one ratio provided by the rear axle, the conventional gearbox can be forgotten.

A vestigial transmission, the so-called "in-and-out" box, is often used for a choice between neutral and direct drive. This can't be called a gearbox, however, because there's no gearing to it. It simply uses a splined shaft that can be disconnected. In-and-out boxes are also popular in cars built for track racing.

The power of one of these dragsters is enough to blow most clutches to bits. If even a slight amount of slippage is necessary, the problem is compounded. Obviously, a really brutal assembly must be used.

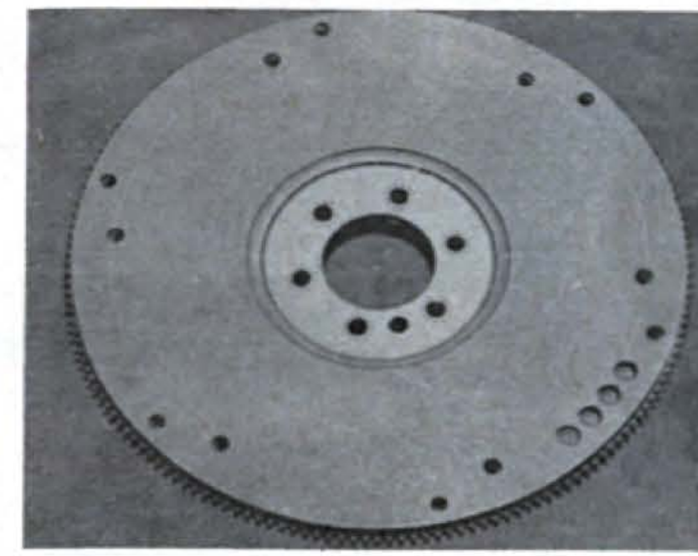
The usual type for such installations is a clutch with *two* discs, doubling the friction area. A floater plate is set between the discs so they have something to grip besides each other. Because a dual-disc clutch is heavy, it requires extreme effort to operate and simply won't allow fast, easy shifts. Consequently, it isn't practical to use one with an ordinary transmission. But it serves the needs of a non-shifted dragster very well. ■

CLUTCHING FOR THE QUARTER

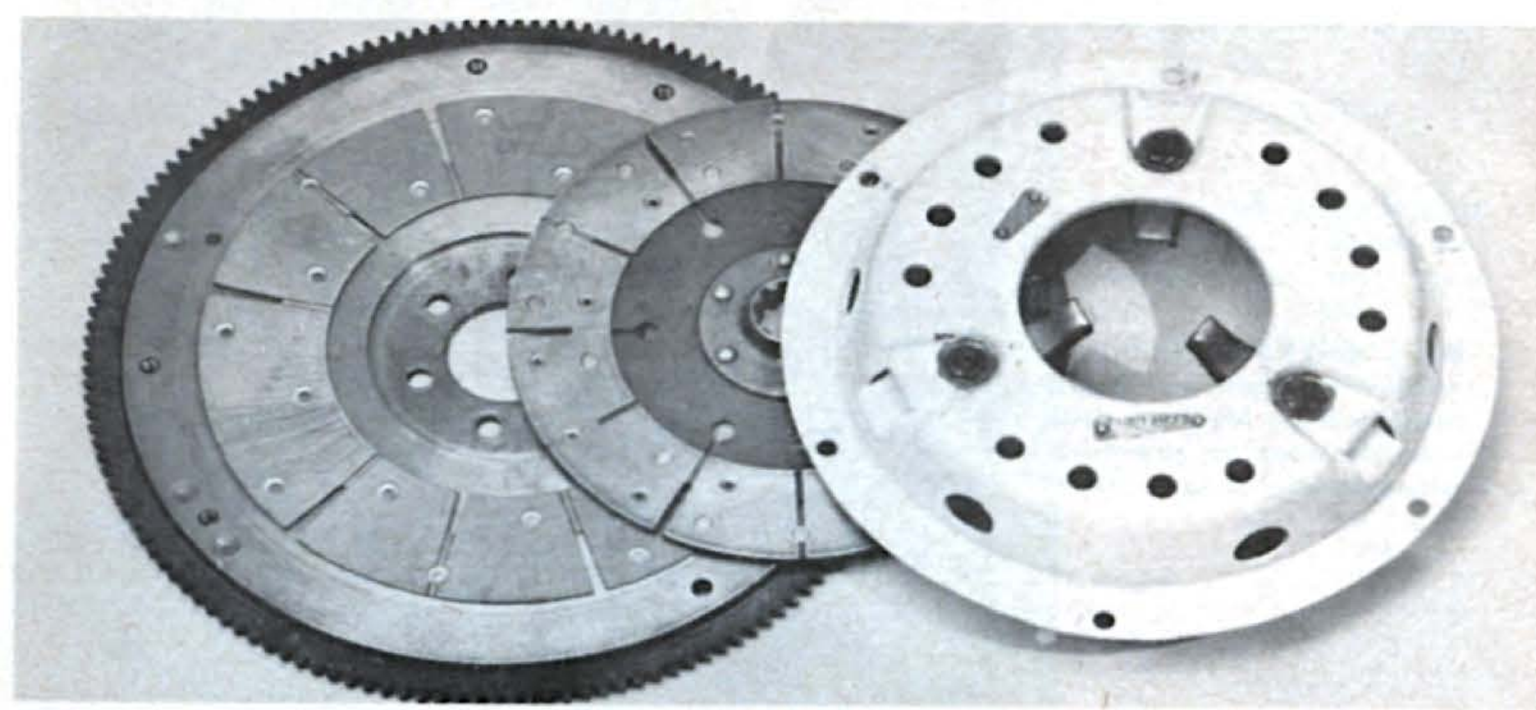
IF YOU'RE planning to drag race in a stock class, see if your make is available with a heavy-duty clutch. If so, get one, even if you have to talk the dealer into supplying it from his list of police or taxi options. A Super Stock will have a beefed clutch as standard equipment but one has to be specially ordered for a normal showroom model.

If, on the other hand, your taste runs to modified cars, use the hairiest clutch assembly you can afford and are willing to drive on the street.

Lightweight aluminum flywheel, right, is by McGurk Engineering, has friction surface toughened by the Sanford technique.

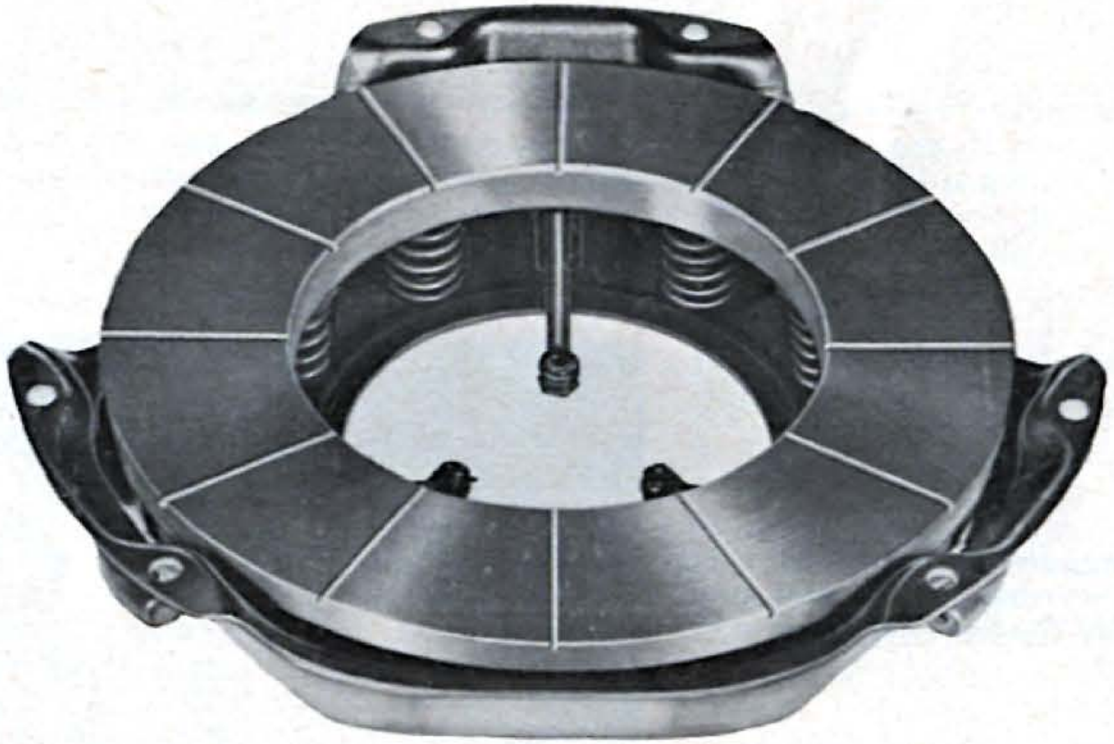


Hays "Challenger" clutch assembly features extensively modified pressure plate and metallic Velvetouch surfacing on disc.

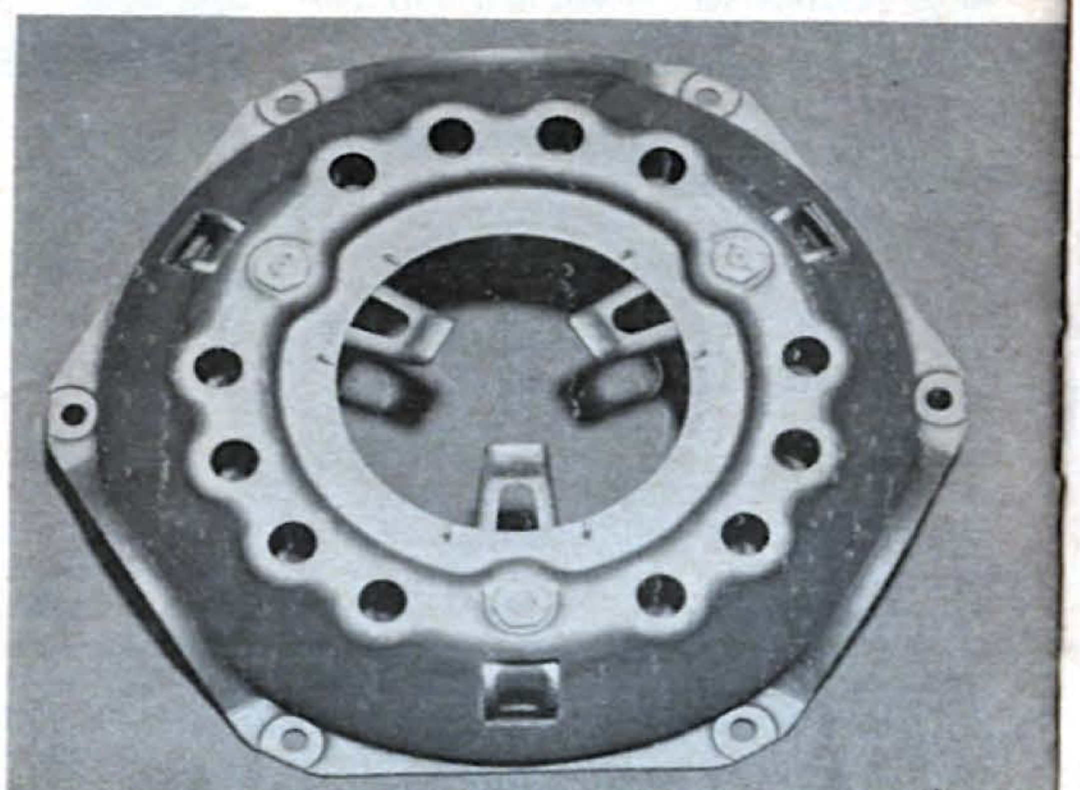


In both cases, the principle is the same. Get the strongest equipment you can because it'll save money and grief in the long run. A clutch designed for normal road use simply won't hold together under the strain of frequent dragging. To avoid the expense of eventual replacement, install a unit of proper quality to begin with.

Obviously, the man with a modified has more leeway on this point than the one who prefers a stocker. Starting



Schiefer pressure plate, above, is fabricated of aluminum but surface is sprayed with a molten mix of bronze and steel.



Borg and Beck assembly shown at right has been modified by McGurk and incorporates a pressure plate made of cast steel.

with flywheels, let's check some of the equipment he can use.

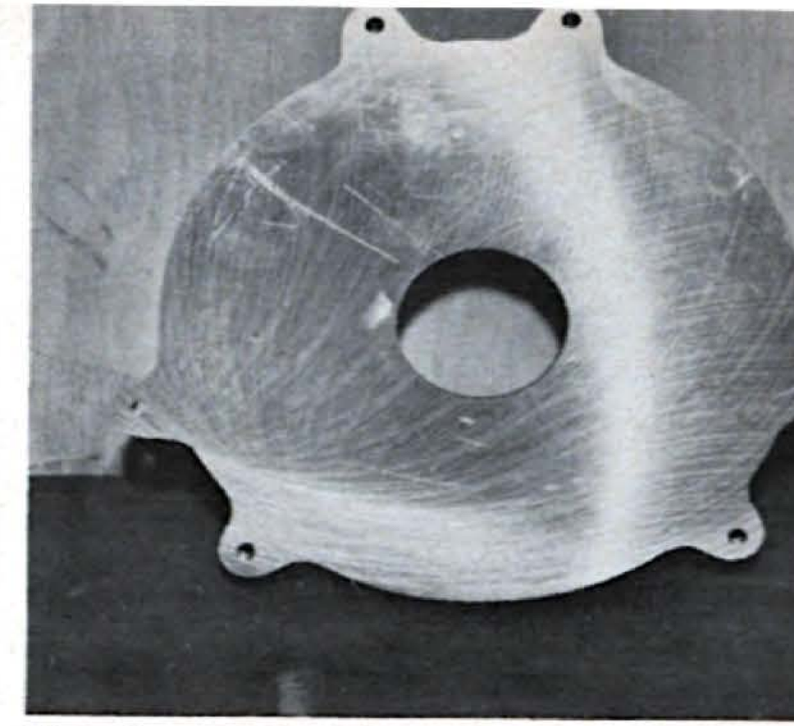
The flywheel should be as light as possible, consistent with strength. If its weight is kept down, the crankshaft is supposed to accelerate faster and the 'wheel itself stands a better chance of holding together. The reason for the latter is that centrifugal force acts on the metal itself. The heavier the metal, the greater the force and the greater the chances of a blow-up.

In the heyday of the flathead Ford, chopping the flywheel was popular. This was a method of lightening the unit by reducing its thickness. However, chopping also reduces strength and isn't recommended with our extremely powerful modern engines.

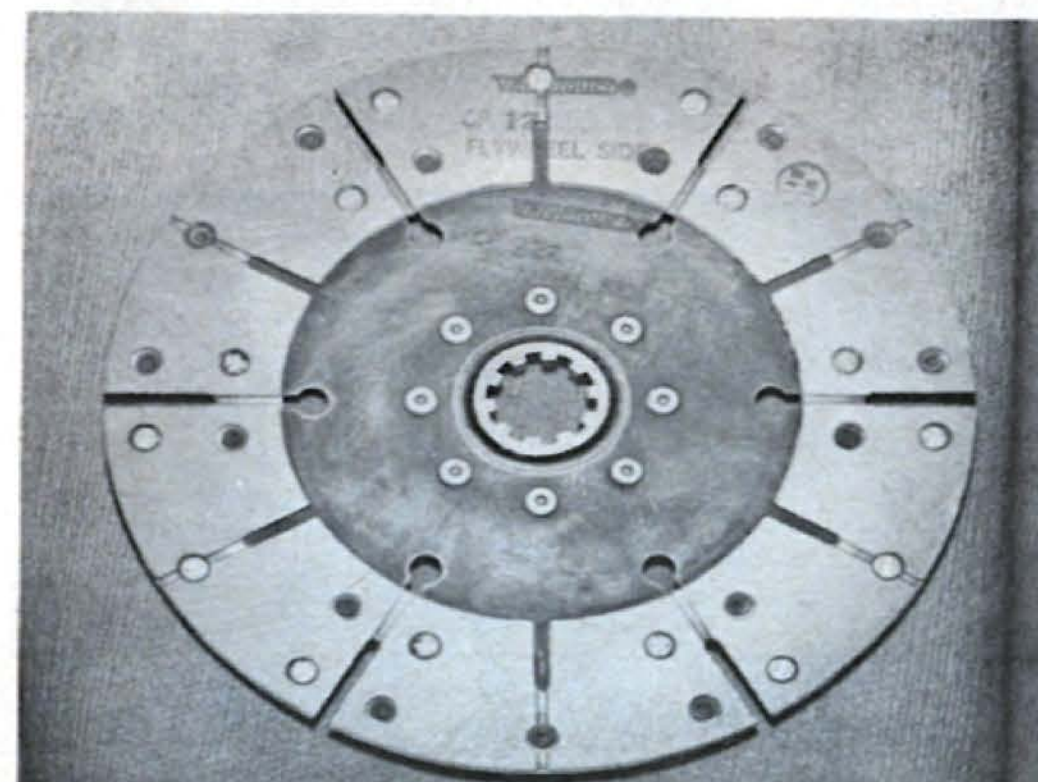
The best bet is a good steel or aluminum 'wheel designed expressly for competition. Steel is heavier but aluminum requires special treatment for a proper friction surface.

Three methods are used to toughen the face of an aluminum 'wheel. First is the Sanford technique, a simple hardening of the metal itself. Next comes the use of a steel insert, bolted or riveted in place. Finally, there's a treatment developed by the Schiefer Manufacturing Company which involves spraying a molten mixture of bronze and steel onto the aluminum.

The disc is the next item to consider. Again, light weight is desirable. If the



Though aluminum flywheels are lighter, steel units are used by many drag race competitors because they are stronger. Unit above is made by C-T Automotive.



Velvetouch surfacing on clutch discs is great for competition but has too much "bite" for use in passenger cars.

disc is too heavy, it'll continue to rotate the transmission shaft after it's disengaged, preventing a smooth shift.

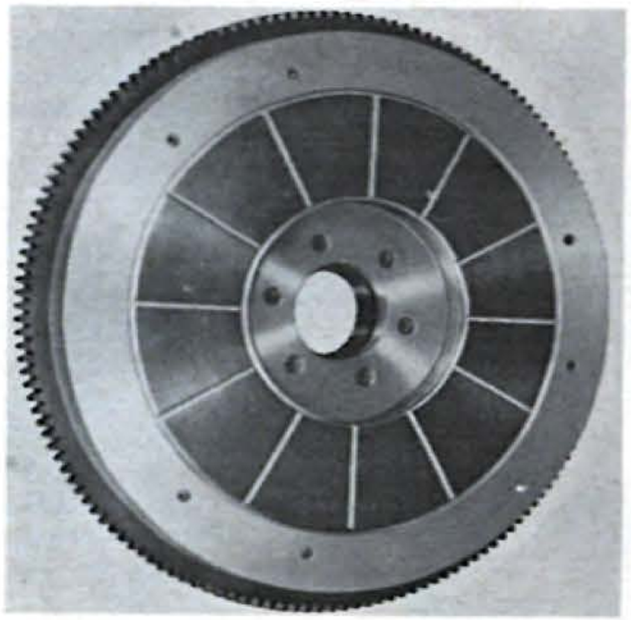
In stock cars, discs are usually surfaced with asbestos or a similar material. Dual purpose rods usually retain asbestos but competition machines often scrap it in favor of a metallic surface, such as Velvetouch, for a better grip at high rpm. Metallic disc coverings cause pretty fierce clutch action, however, so forget them if you're going to spend any time on the street.

Pressure plates for racing are usually designed to fit stock covers and may be either conventional or semi-centrifugal. As we've noted, the latter has advantages for a car that'll be used on both the strip and the street. Some plate assemblies for competition have nothing more than heavier springs for increased pressure. Others employ aluminum for the plate itself, surface-treated with either the Sanford or Schiefer methods described for flywheels.

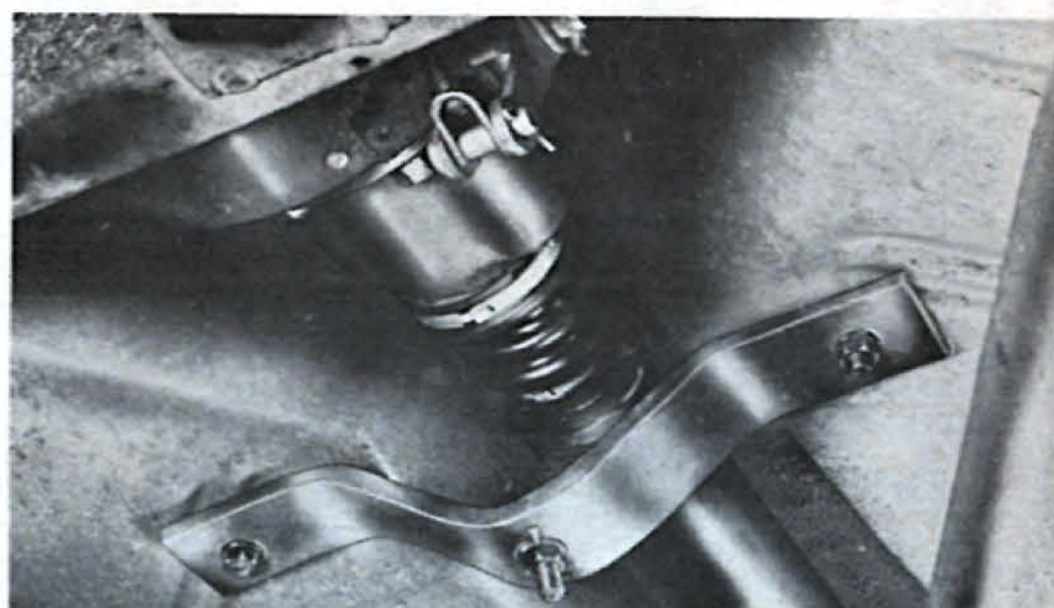
Generally speaking, assemblies are available as complete packages from most of the competition clutch manufacturers. In such cases, they're specifically engineered to replace the standard Borg and Beck assemblies used with General Motors and Chrysler engines or the Long units used with Ford powerplants.

The finishing touch for the whole clutch assembly is a combination bell housing and scattershield strong enough to contain the flying pieces if the unit does explode. This is a safety precaution required for dragging all types of cars but the weakest stockers. According to the rules of the National Hot Rod Association, the scattershield should be at least a quarter inch thick and cover the entire clutch.

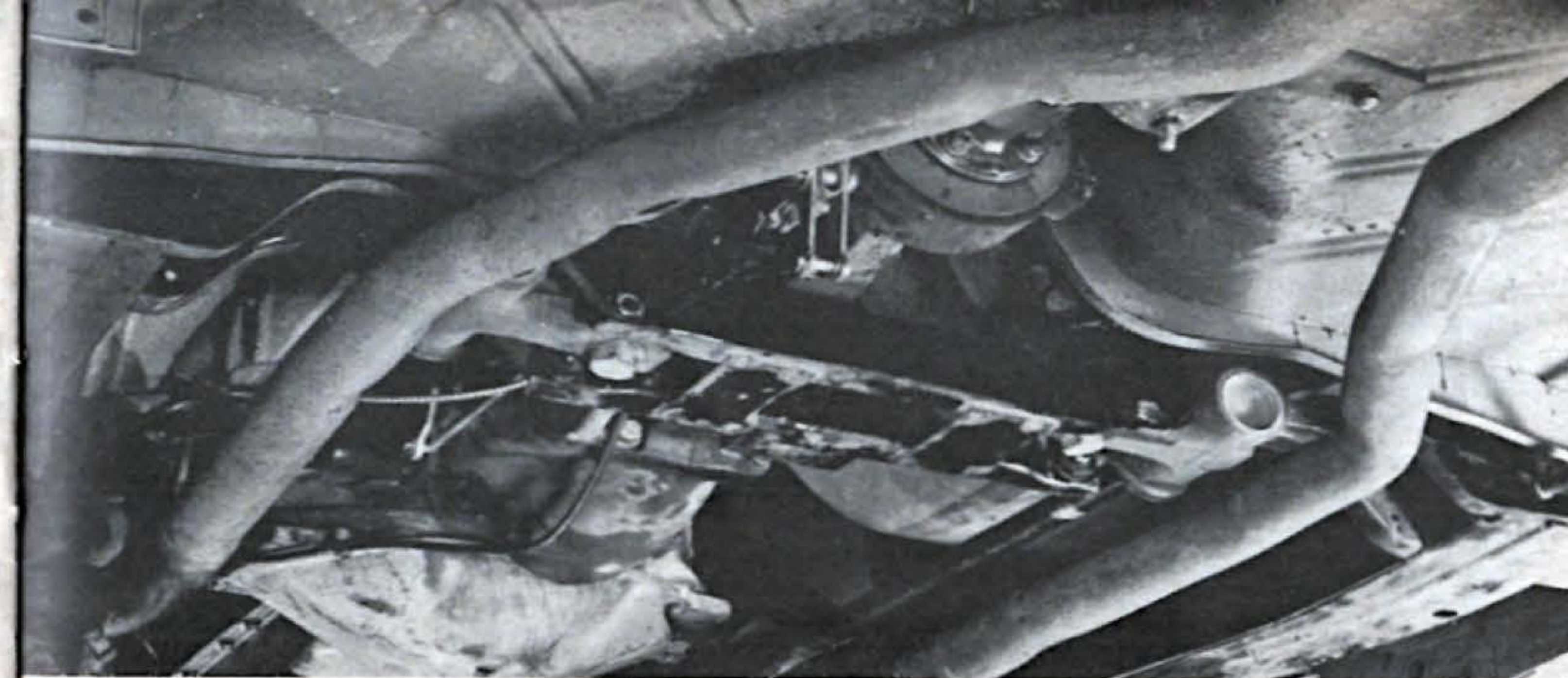
Again, don't compromise on quality. A good scattershield means more than just passing technical inspection at the local strip. It could save your life. ■



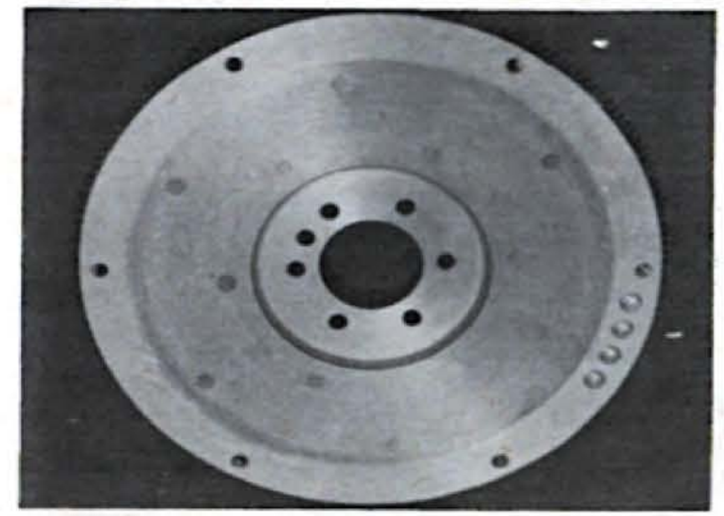
Schiefer also uses spray of bronze and steel to surface flywheels, shown above. Grooves are to speed cooling process.

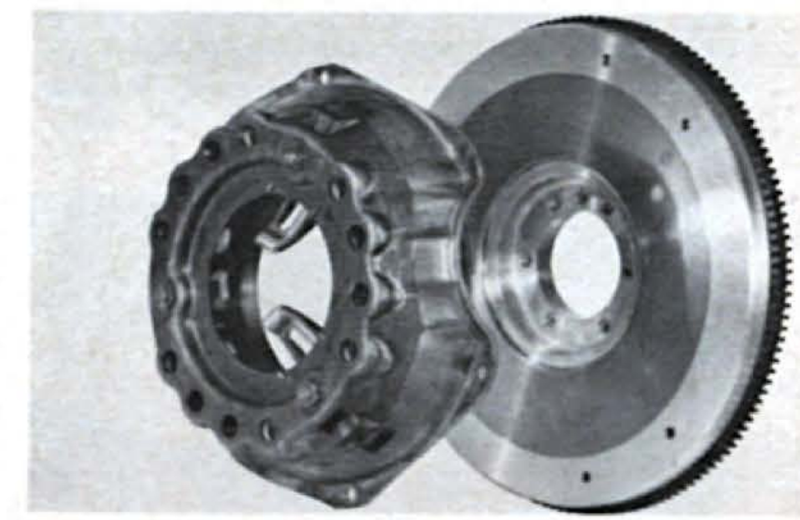


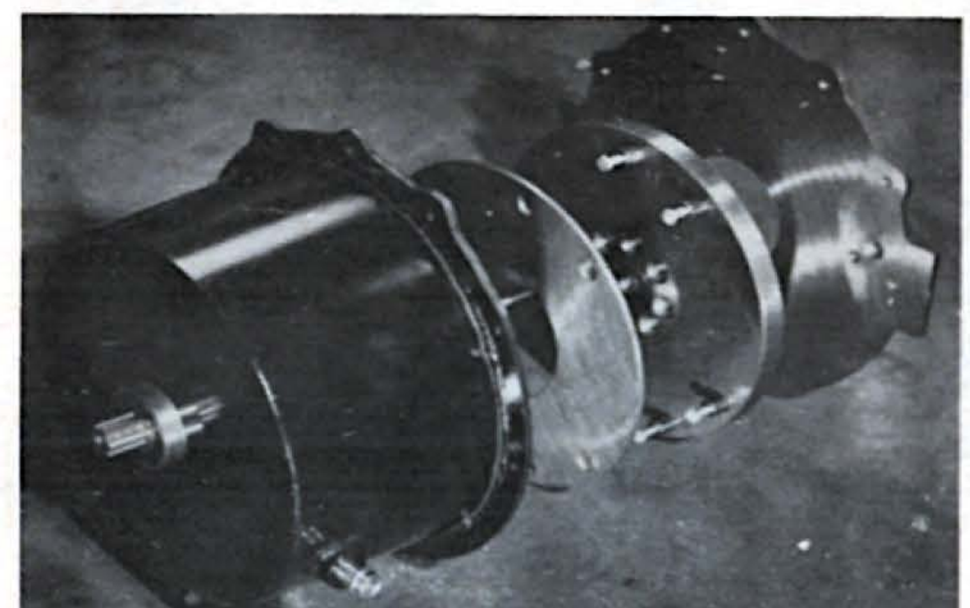
Safety loop, right, can be made of strap iron, is intended to keep drive shaft in place in event universal joint unglues.



The underside of this Dodge conforms with safety rules in its drive train. The clutch is housed in a heavy scattershield, while a safety loop is just visible behind exhaust.







ABOVE, LEFT—Still another method of providing a tough friction surface on an aluminum flywheel is to rivet an insert of steel to unit.

ABOVE — Least expensive way to modify clutch is to stiffen springs in pressure plate assembly. This Weber "Maxitorq" is case in point.

LEFT—At the other extreme, this Ansen design combines a dual-disc clutch, in-and-out box and safety scattershield all in one assembly.

HOW ABOUT AUTOMATICS?

"IT'S BRUTAL but it works!" No, that isn't something we heard in the pits at the local strip. Emile Levassor, an early French automotive engineer, said it in 1895. He was describing the world's first three-speed, sliding gear transmission.

His words are just as appropriate in 1962 to characterize even the best of our manual shifts. The Cad-La Salle and Chrysler three-speeds and the Warner four-speed are all brutal. At best, the manual gearbox is a pretty crude mechanism that requires considerable skill to manipulate for top performance. It breaks easily and the device that connects it to the engine, the clutch, is literally explosive.

The automatic transmission gets away from all this. Shifting is much smoother and easier, even when we override the hydraulic brain under the floor boards and select the gears ourselves. For those running hot powerplants in road cars, an automatic simplifies driving immensely. Not only can shifting be forgotten but the hydraulic coupling or converter soaks up a lot of the uneasiness of a sensitive, high-revving engine, making things easier on both the driver and the drive train.

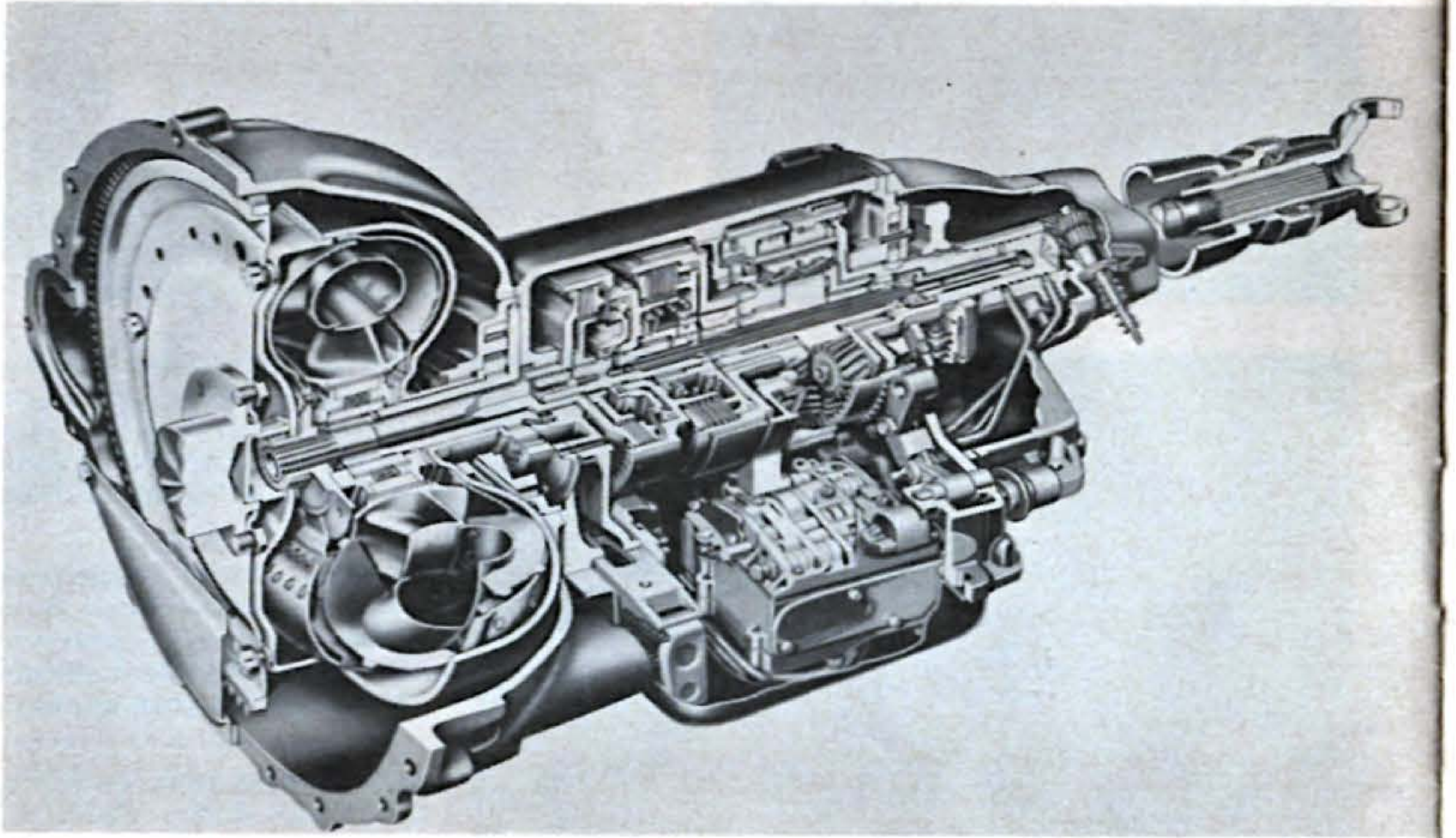
Best of all, the automatic eliminates those miserable clutch problems forever. There's little chance of an automatic ever blowing up, so a scatter-shield is completely unnecessary.

A few years ago, the thought of dragging with an automatic would've been regarded by rodders as a mild form of insanity. Acceleration with a self-shifter was far behind what could be obtained with a manual setup.

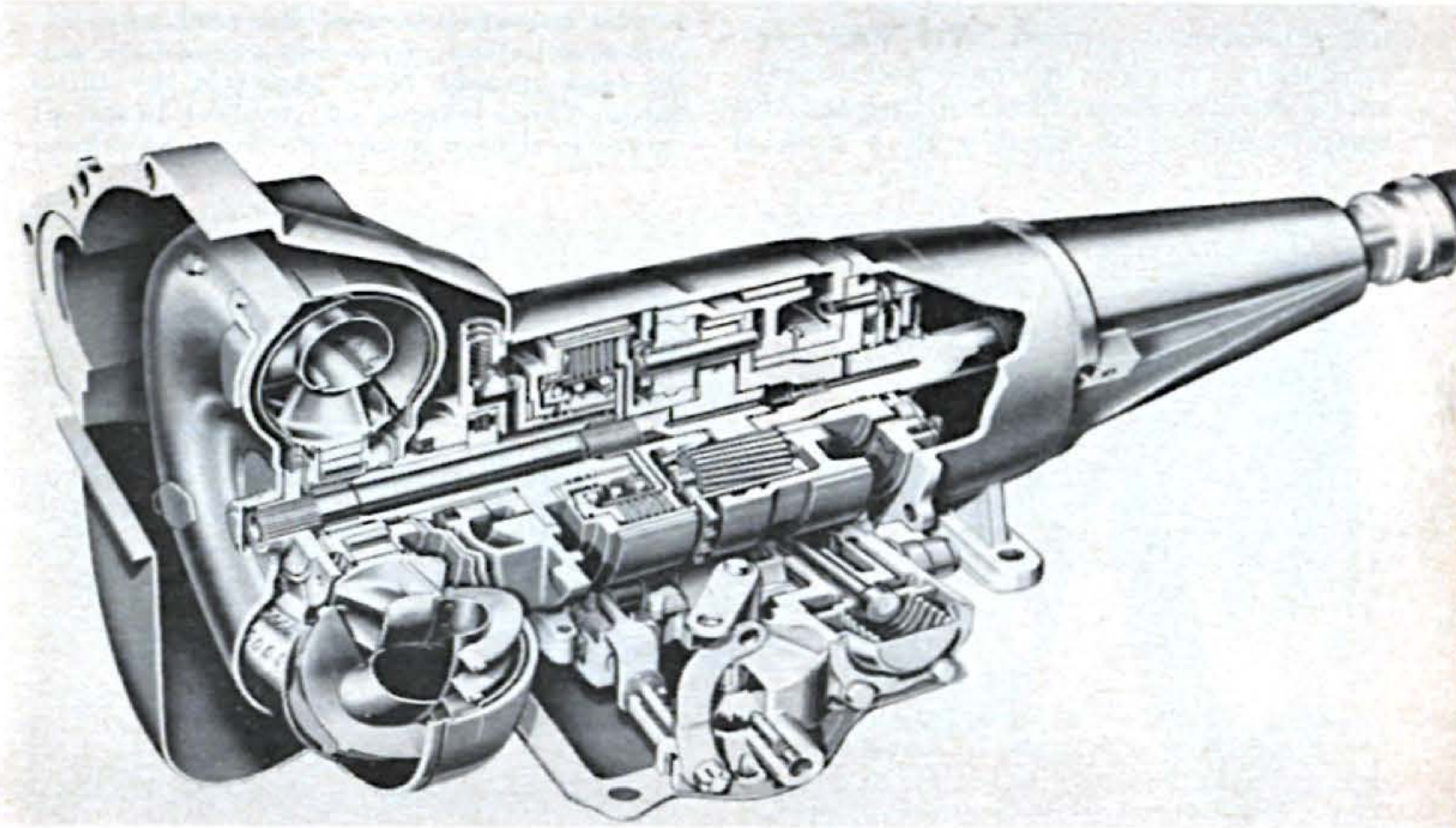
The automatic still hasn't closed the gap but it's narrowed it down considerably. Today's hydraulic box is a remarkably efficient device and there's good reason to believe tomorrow's will actually surpass the manual.

If you're racing a stocker with an automatic, the slight sacrifice in performance won't mean anything to you. You'll be running in a special class with other automatics, where the competition will be fair and square.

Even in the modified classes, you'll find you aren't spotting your opponents much of an advantage. There's one automatic that's especially prepared for dragging and does a terrific job. All else being equal, it takes an exceptionally deft hand with a stick shift to beat it.



Ford's Cruiseomatic combines a torque converter with 3-speed gearbox. Transmission is made by Borg-Warner and is similar to units supplied to Rambler and Studebaker.



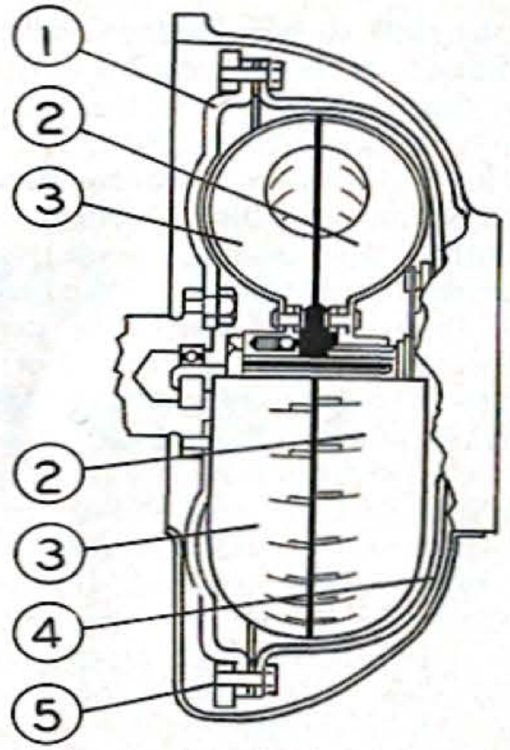
Fordomatic is a simpler, 2-speed unit aimed at the economy market. It is also built by Borg-Warner, is lighter and cheaper than Cruiseomatic. Mercomatic is similar design.

Actually, a driver who knows how to get the most out of a hydraulic box can often beat one who hasn't got just the right touch with a manual. And it takes much less time to master the correct technique with an automatic.

Let's put it this way. A car fitted with an automatic isn't likely to take the top or middle eliminator trophy during an afternoon's racing. But it stands a very good chance of capturing its own class and, when the clocks are turned off for the day, it can be driven home with an absolute minimum effort.

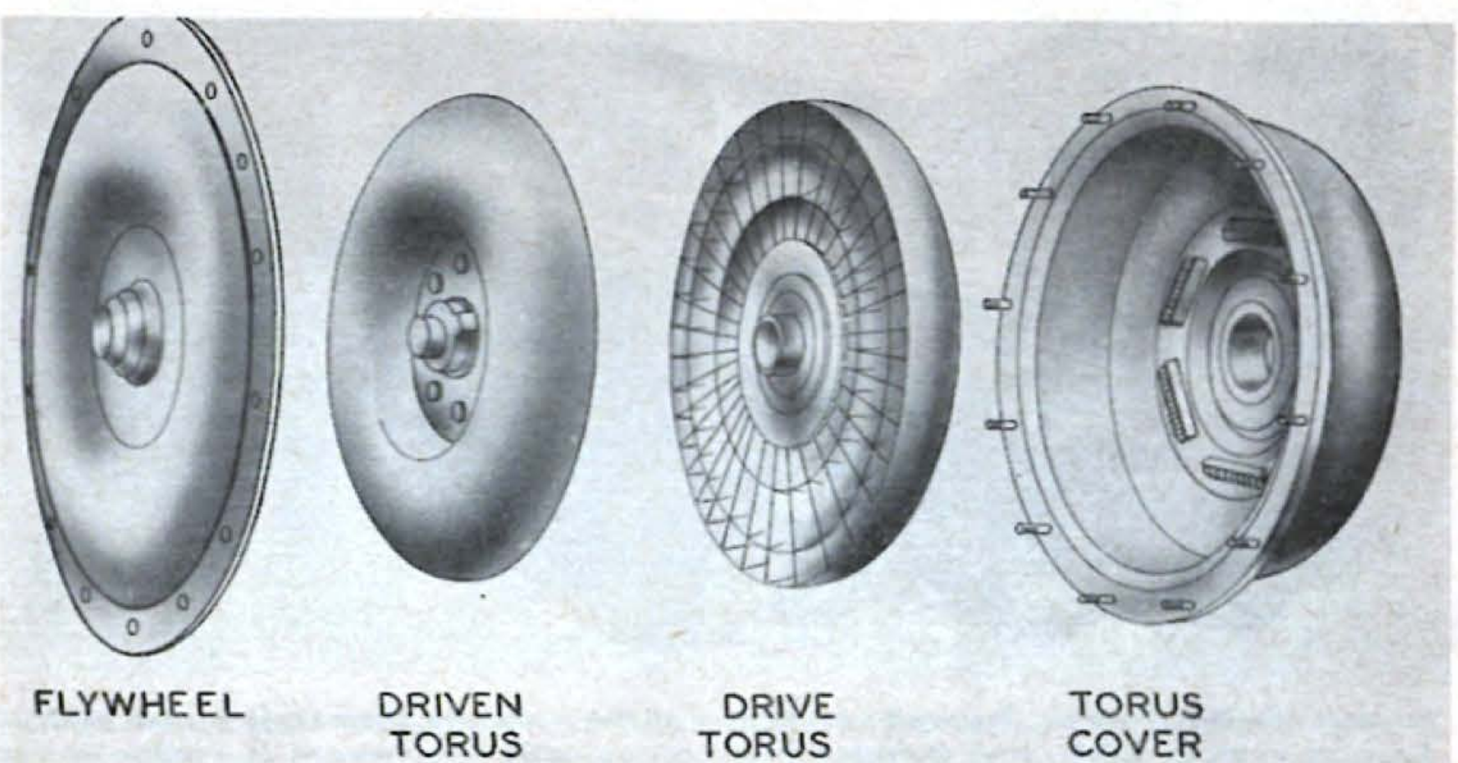
Automatics can be divided into two categories, Hydramatic and others. We're not putting it that way out of any particular favoritism for General Motors. Hydramatic embodies an important difference from other hydraulic boxes and this difference happens to make it especially suitable for racing.

With Hydramatic, the normal plate clutch is replaced by a hydraulic coupling. This consists of two revolving components called torus members, which are concave in shape and contain small radial vanes. The housing for the torus members is filled with a special



The components of a hydraulic coupling are: 1) Flywheel assembly, 2) Drive torus, 3) Driven torus, 4) Torus cover, and 5) Cover retaining bolts. Power is transmitted by splashing oil from one torus to the other.

In the drawing below, internal and external structure of the torus members can be seen clearly. Note vanes in the drive torus. These throw oil against identical vanes in driven torus, causing it to rotate.



oil. The first, or driving, torus is connected to the flywheel and, as it turns, its vanes splash oil against the vanes of the second, or driven, torus. The driven torus, in turn, rotates the mainshaft of the transmission.

The coupling serves the same purpose as a clutch. It merely conveys engine output to the transmission but it does it hydraulically instead of mechanically. This means considerable slippage but, because oil is the actual connecting medium, heat never becomes a serious problem.

The hydraulic coupling is an exclusive feature of Hydramatic. All other automatics use a torque converter, which not only serves as a clutch but also provides gearing effect.

In the converter, the job of the driving torus is performed by the pump, or impeller, and that of the driven torus by the turbine. The vanes in the turbine are slanted in relation to those in the impeller. This deflects the path of the oil in such a way that the torque reaching the gearbox from the turbine has been multiplied. The rpm drops off, of course, in accord with the fundamental relationship between the two factors of horsepower.

To prevent the increased torque from reacting against the impeller and cancelling itself, a third component must be added. Known as the stator, it has curved vanes to control the oil flow from the turbine back to the impeller.

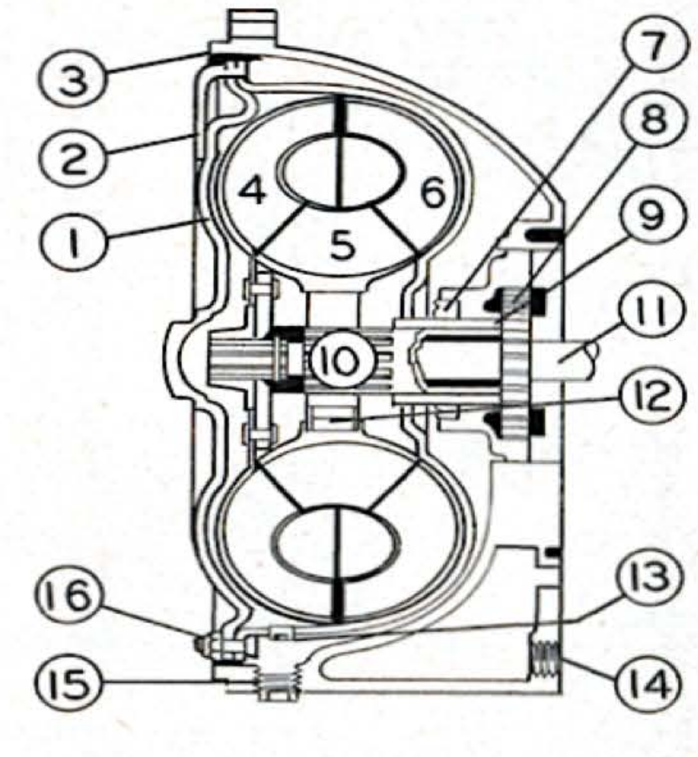
Three elements, then, are the minimum for a converter. Still more can be added. Buick, for example, uses two turbines, one reacting against the other to provide still further torque multiplication.

The degree of gearing provided by a converter will vary according to the load on the unit. The lowest ratio is usually between 2- and 2.5-to-1 and is called the maximum stall ratio because it represents the point at which the turbine will stall. In other words, no further load can be applied to it.

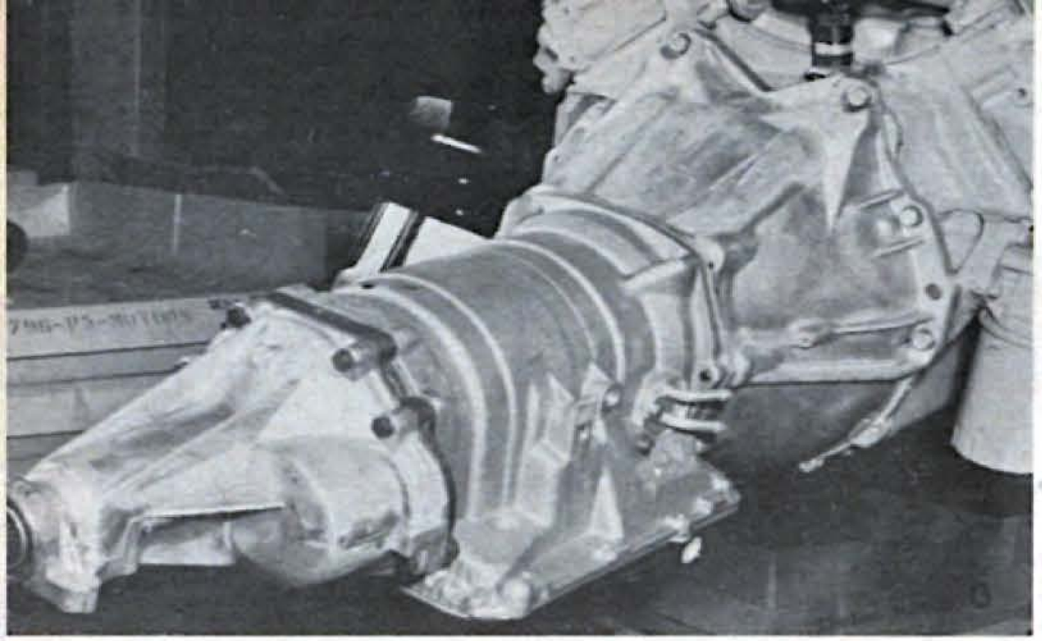
The highest ratio is a 1-to-1 direct drive, the same as high gear in a conventional transmission. When a converter reaches this point, it's really functioning as a hydraulic coupling.

The converter would appear to have all the advantages. At moderate speeds, this is quite true. The converter can supplement the gearbox and provide broader gearing. But, as the unit approaches direct drive, its efficiency drops 'way off and slippage occurs. The oddly-shaped vanes necessary for low rpm torque multiplication prevent the converter from performing the coupling's job as well as the coupling itself.

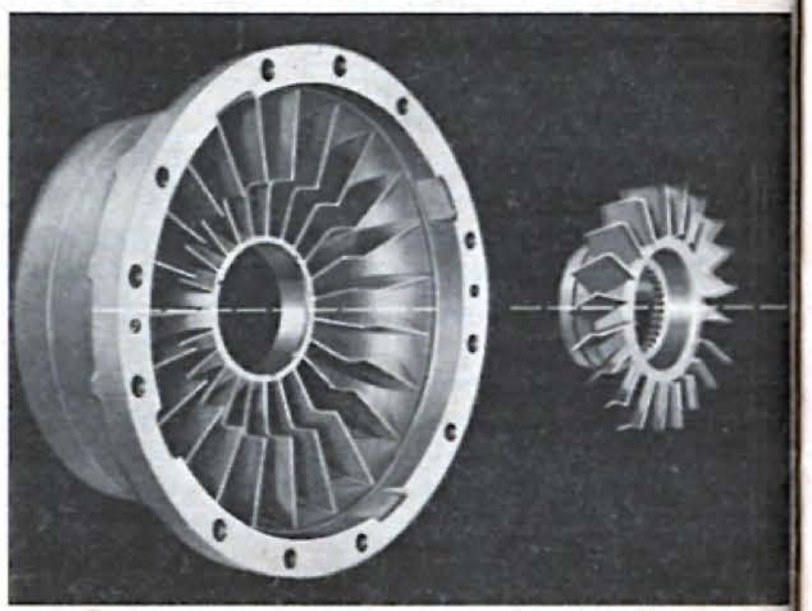
It's true that the coupling allows excessive slippage at lower speeds. As it gains rpm, however, this decreases. And as the unit approaches the point where the converter is slackening off,



The torque converter consists of: 1) Cover, 2) Flywheel, 3) Housing, 4) Turbine, 5) Stator, 6) Impeller, 7) Oil seal, 8) Oil pump, 9) Impeller hub, 10) Reactor shaft, 11) Input shaft, 12) Stator clutch, 13) Converter drain plug, 14) Gearbox drain plug, 15) Bell housing drain plug, 16) Ret. bolts.



The bulkiness of Hydramatic is evident in this Pontiac installation. The 4-speed version, preferred for best performance, is shown here.



Oldsmobile calls this device an "Accelerotor" but it is really a form of converter to assist the rather feeble 3-speed Hydramatic box.

TABLE VI. AUTOMATIC TRANSMISSIONS FOR 1962

	Maximum Overall Ratio	Converter Stall Ratio	1st	2nd	3rd	4th
BORG-WARNER						
Fordomatic, Mercomatic (Ford Falcon, Fairlane; Mercury Comet, Meteor)	4.20	2.40	1.75	1.00	—	—
Fordomatic, Mercomatic (Ford Galaxie; Mercury Monterey)	4.55	2.60	1.75	1.00	—	—
Cruiseomatic, Mercomatic Multidrive (Ford Galaxie, Thunderbird; Mercury Monterey)	5.06	2.10	2.40	1.47	1.00	—
Turbodrive (Lincoln)	4.98	2.10	2.37	1.48	1.00	—
Flashomatic (Rambler)	5.09	2.12	2.40	1.47	1.00	—
Flightomatic (Studebaker)	5.16	2.15	2.40	1.47	1.00	—
CHRYSLER CORPORATION						
Torqueflite (Chrysler, Dodge, Imperial, Plymouth)	5.39	2.20	2.45	1.45	1.00	—
GENERAL MOTORS						
Buick Dual Path Turbine Drive (Special, Skylark)	3.80	2.50	1.52	1.00	—	—
Buick Turbine Drive (Le Sabre, Invicta, Electra)	6.19	3.40	1.82	1.00	—	—
Chevrolet Powerglide (Corvair)	4.73	2.60	1.82	1.00	—	—
Chevrolet Powerglide (Chevy II)	4.55	2.50	1.82	1.00	—	—
Chevrolet Powerglide (Biscayne, Bel Air, Impala Six)	3.82	2.10	1.82	1.00	—	—
Chevrolet Powerglide (Biscayne, Bel Air, Impala V-8; Corvette)	3.70	2.10	1.76	1.00	—	—
Pontiac Tempestorque (Tempest)	3.64	2.00	1.82	1.00	—	—
Hydramatic (Olds F-85)	3.64	1.20	3.03	1.58	1.00	—
Hydramatic (Olds 88, 98; Pontiac Catalina, G.P.)	3.56	1.20	2.97	1.56	1.00	—
Hydramatic (Cadillac; Pontiac Star Chief, Bonneville)	3.97	—	3.97	2.55	1.55	1.00

the coupling becomes almost as effective as a direct mechanical connection.

In a drag between two cars of similar power, weight and axle gearing, one with a converter should get the initial jump on one with a coupling. But the suggestion that "races are won at the start" probably wouldn't hold up in this case. Between the converter's loss of efficiency at high rpm and the coupling's gain, the latter vehicle should catch and pass its rival in a ¼-mile.

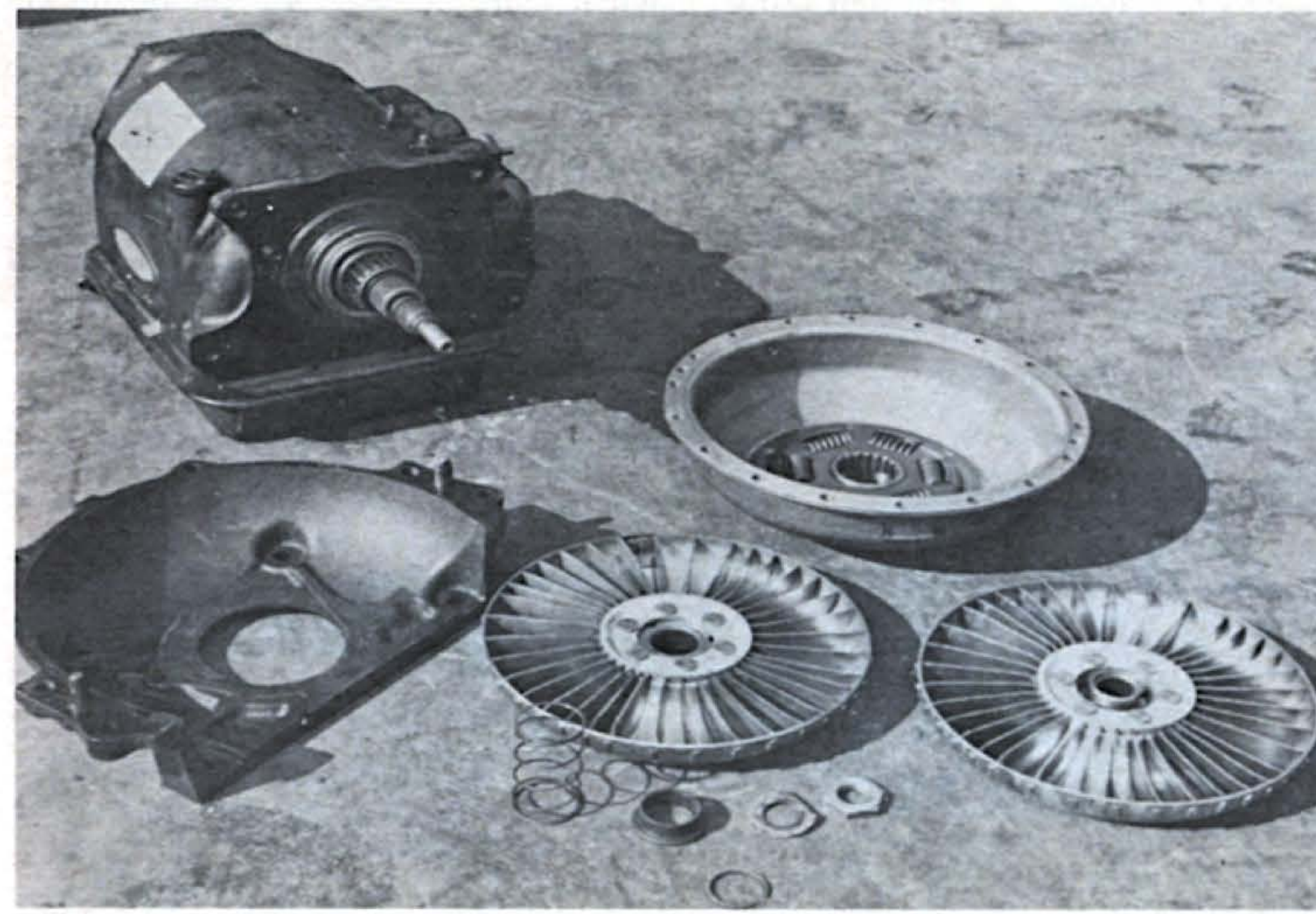
When we get into the modified classes, we're dealing with very high revving engines and, as we've seen, we want some slippage at low rpm but as little as possible at faster speeds. Here, the hydraulic coupling looks much better suited for our needs than the torque converter.

Regardless of the hydraulic system, most automatics also employ a gearbox. There've been a few attempts to use a torque converter without supplementary gearing, notably Buick Dynaflow and Chevrolet Turboglide, but none of them have been too successful. They're complicated and expensive and don't provide the response obtained with even a token mechanical assist.

Only three firms in this country build automatics for passenger cars. Borg-Warner, the outfit we discovered earlier in the overdrive and four-speed business, builds hydraulic boxes for Ford and its affiliated makes and also for Rambler and Studebaker. Chrysler Corporation and General Motors, on the other hand, produce their own units.

Table VI breaks the automatics down, first, according to who makes them and, second, according to the number of gearbox speeds.

Because the torque converter can multiply first gear by the stall ratio, some of these units have extraordinary overall ratios. Even with only two speeds, the maximum gearing can be fierce. Note Buick's 6.19, for example. And keep in mind that this is further amplified by the rear axle! A Buick with a 3.23 axle would have a total gearing potential of 20-to-1! However, such a ratio occurs just momentarily at the stall point. This, combined with slippage in the converter, prevents the car from spinning the rubber right off



Compare torus members of this dismantled Hydramatic with "Accelerotor" on opposite page. Normal torus is ideal for racing because it has low speed slipping qualities.

the rear wheels. Similar gears in a manual box would demolish a pair of tires every time the car took off!

Hydramatic's coupling doesn't provide any multiplication, so the unit is built with a four-speed transmission. This permits it a first gear strong enough to overcome its even greater low rpm slippage, together with three moderately close ratios for use once the car's underway.

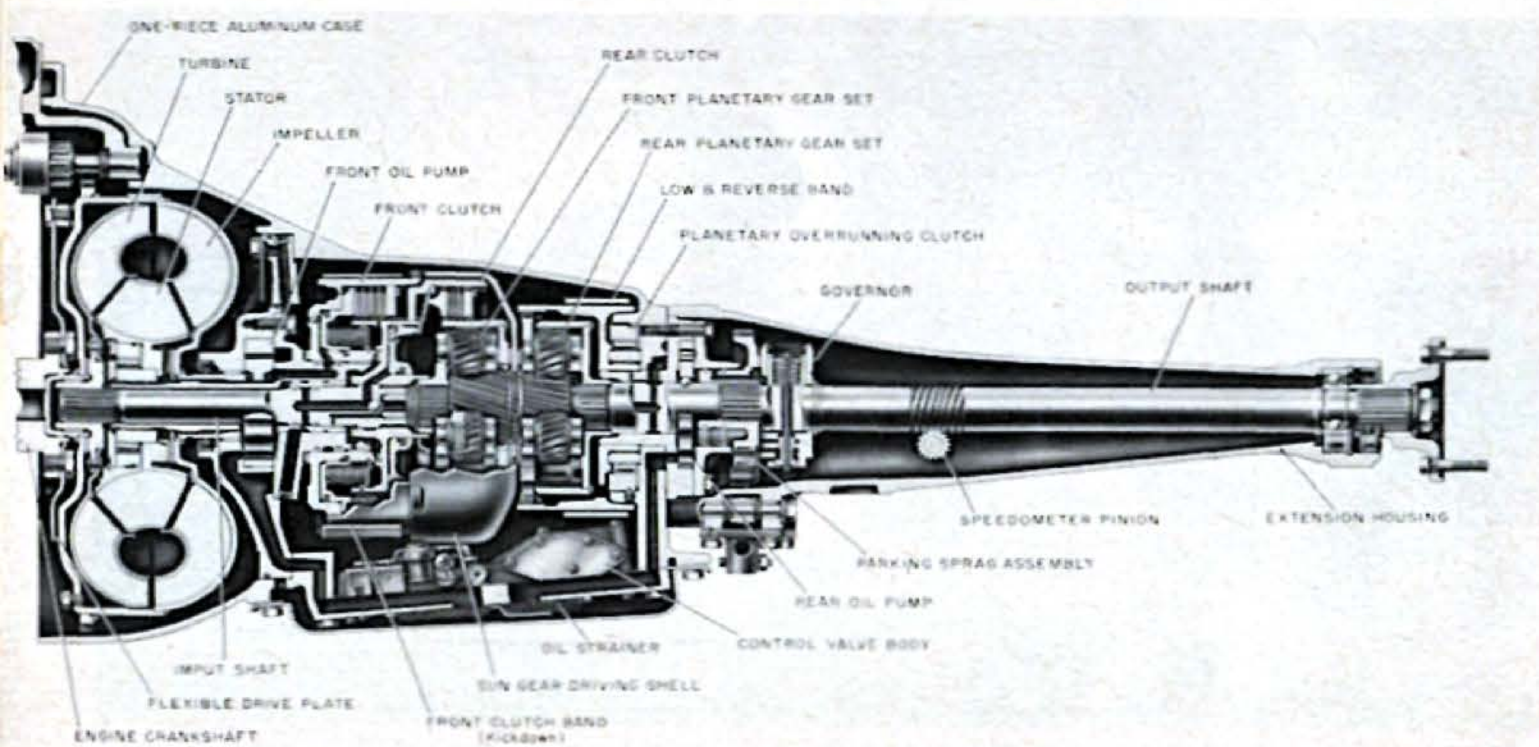
Last year, Oldsmobile and Pontiac introduced a new Hydramatic with only three speeds. To make up for the lost gear, they incorporated a small stator in the coupling, turning it into a mild torque converter. The added multiplication is slight, however, and this particular transmission isn't as flexible or as responsive as competitive torque converters with three speeds or the earlier Hydramatic with four ratios. Fortunately, the latter is still available in the Cadillac and the biggest Pontiacs.

Next to hydraulic slippage, the biggest problem of racing with any automatic is that it does what it's supposed to do—it shifts automatically! A system of small clutches and valves within the transmission responds to variations in load and speed and selects the proper gear. However, all this is set up for normal highway use and doesn't serve the gearing requirements for maximum acceleration. Under full throttle, an automatic will hold its lower gears longer than usual but not long enough for serious dragging.

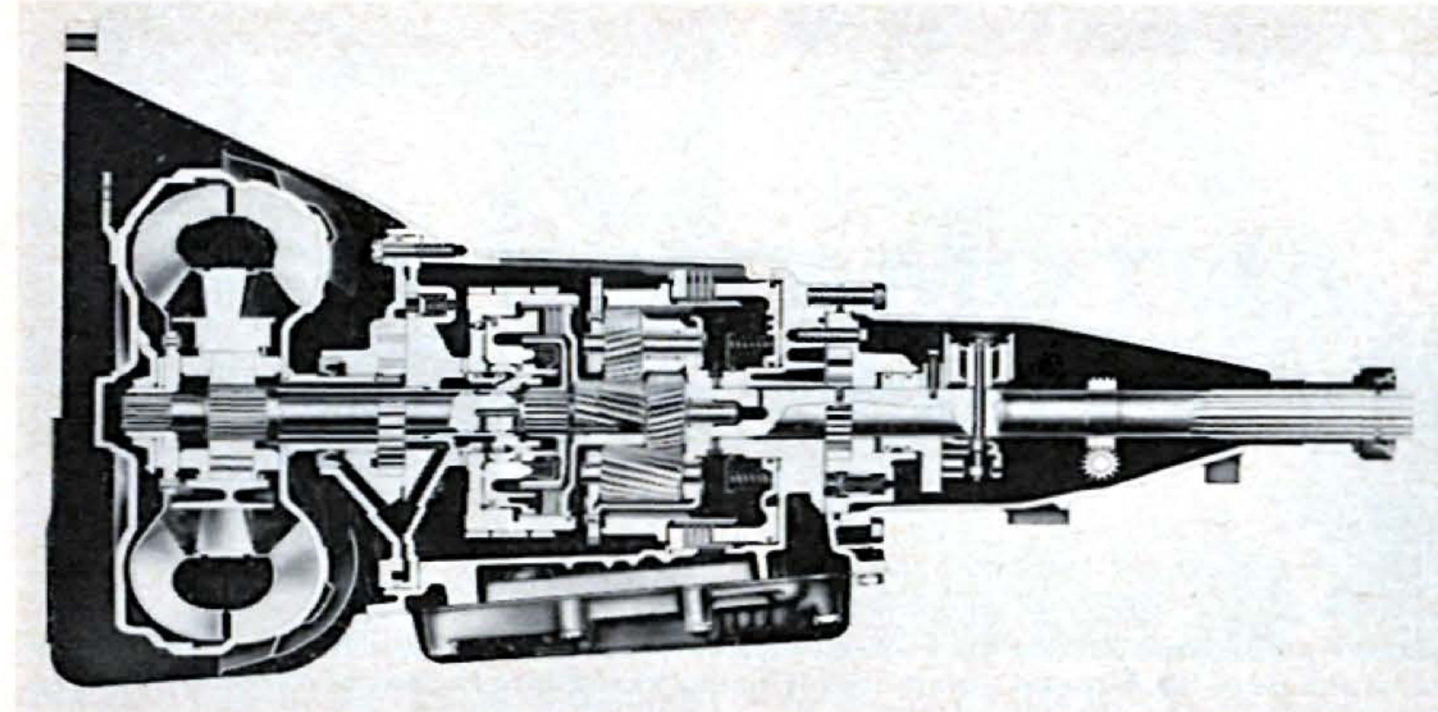
However, all of them have a low and one or two drive ranges. These can usually be exploited for controlled shifts.

Two-speed units are the easiest (if not the fastest!). You simply hold them in low as long as you want and they won't shift out of first. When you're ready for second, flick the lever to drive. It's best to make the move a few hundred rpm before you want the actual shift because the plumbing in the transmission won't respond immediately.

Chrysler's Torqueflite and the new three-speed Hydramatic can be handled in a similar manner. The low position, marked "1" in a Chrysler product and



Torqueflite, offered by Chrysler, Dodge and Plymouth, is one of the finest 3-speed units. "1-2-3" push-buttons provide complete control over upshifts with this transmission.



Chevrolet's Powerglide is built in different forms for the Corvair, Chevy II and normal full-size models. This sample, designed for Chevy II, shows converter and 2-speed box.

"L" in a General Motors car, will hold first indefinitely. Shift to the intermediate range and second will engage. And drive will provide third.

The Borg-Warner three-speed requires a somewhat trickier technique for proper results. If you shift from low into either the intermediate or drive positions, the transmission will skip second and go directly from first to third. To prevent this, move the lever from low to drive, then immediately pull it back into low. This will force a shift to second. Then, when you're ready for third, move into drive and stay there.

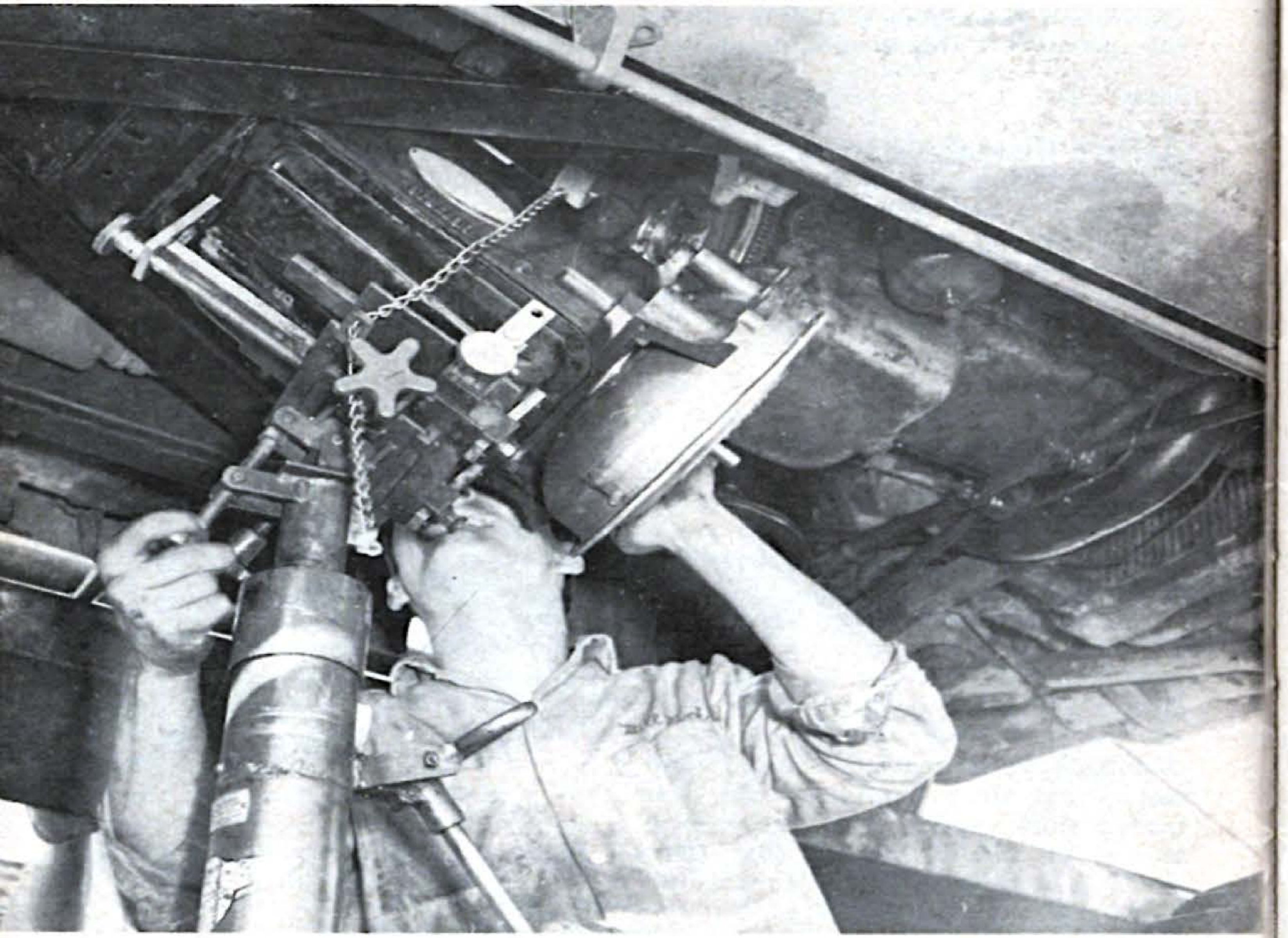
Hydramatic four-speed has the big advantage of a hydraulic coupling and looks like the best bet for racing. As always seems to happen when we're on to something, though, there's a drawback. Hydramatic is the one automatic that doesn't permit fully controlled shifts. It has low, intermediate and drive ranges but all four gears function in all three ranges. Low simply holds first and second at higher rpm than the other positions, while intermediate holds third at a faster speed. But in any range, upshifts will occur too soon for the quickest possible acceleration. The best you can do is try a low-intermediate-drive sequence and stay in the lower ratios as long as the box will let you.

Among the stockers, the advantage of Hydramatic's coupling are largely defeated by this lack of shifting control. It still has a theoretical edge on the Borg-Warner and Torqueflite three-speeds but not enough for us to put money on the Hydramatic every time it comes to the starting line. If you want to stick with production equipment, don't let the potential superiority of General Motors' four-speed scare you away from Ford or Chrysler products. In stock form, it isn't that good.

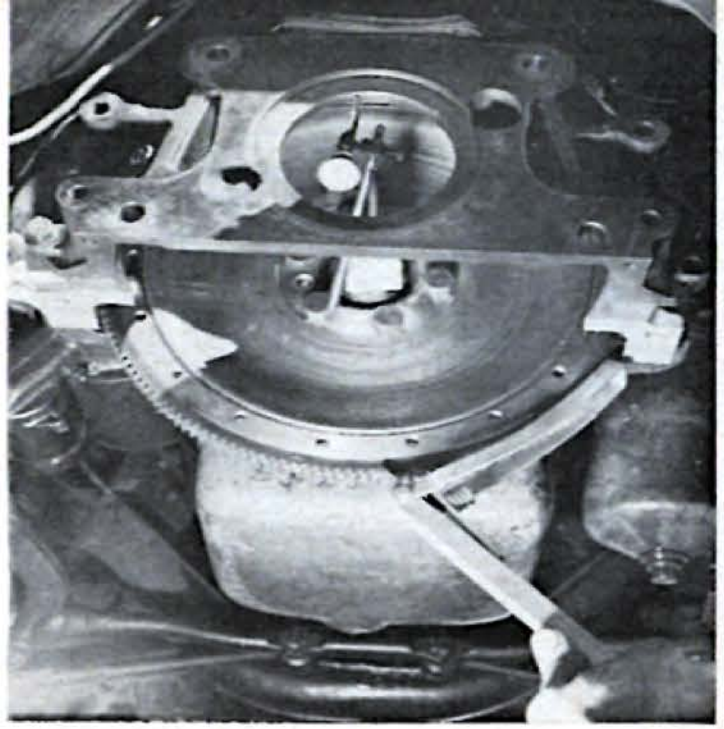
But, if you're thinking of Hydramatic for a modified car, you won't have to worry about that shifting problem. There just happens to be something on the market that's custom-built for your needs. ■

AUTOMATICS FOR COMPETITION

Beefed Hydramatics are the lazy man's equivalent of Cad-La Salle boxes. In this photo, one of the popular 4-speed automatics is being eased into chassis of a modified Chevy.



The first step in the actual installation of an automatic transmission is to apply a torque wrench to the bolts on flywheel.



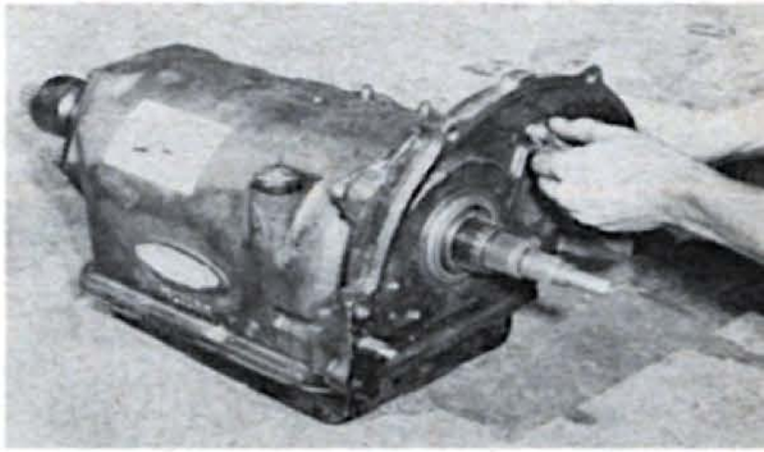
To assure proper mating of components, it is vitally important that the flywheel and housing be checked for concentricity.

FOR THE hotter classes, Hydramatic is the only automatic to consider. The coupling works beautifully with a really powerful engine, the unit can be beefed to transmit extremely high outputs and, yes, it can be modified for full manual control.

The best Hydramatics for competition are those built between 1953 and 1956, inclusive. The 1953 units were the first to have an intermediate range. This meant that extra clutches had to be incorporated within the automatic controls to allow selection of the new range. And these bring the total number of clutches within the unit high enough that it becomes possible to arrange positive control.

From 1956 on, one of the most important of these control clutches was replaced by a miniature hydraulic coupling to provide smoother shifting characteristics. The transmission became something of a Hydramatic within a Hydramatic! However the coupling can't be reworked for external control.

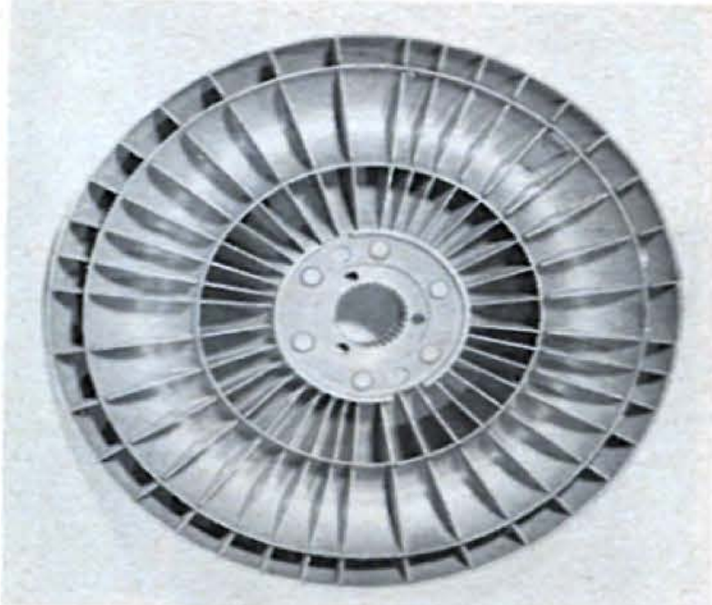
The transmission should also be one from a heavier car. During the early 'fifties, Hydramatic was borrowed from



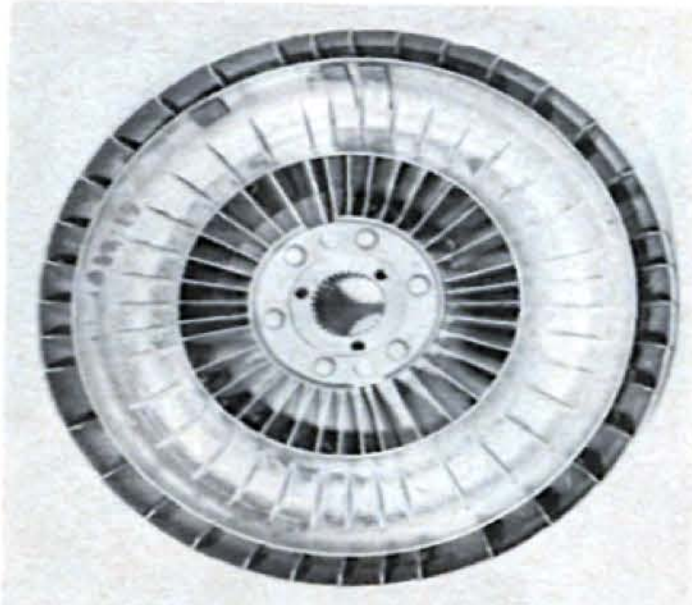
This Hydramatic is being prepared for the installation in a Chevy shown opposite. Note the special adaptor that is required.

General Motors by a variety of other car makers from Rambler to Rolls-Royce. The units built for smaller cars were lightly stressed and need considerably more work before they can be attached to hot powerplants.

The primary changes required are within the valve body, the component that governs shifting. By re-routing certain valve passages, it's possible to block upshifts. The idea is to modify for the kind of control offered with

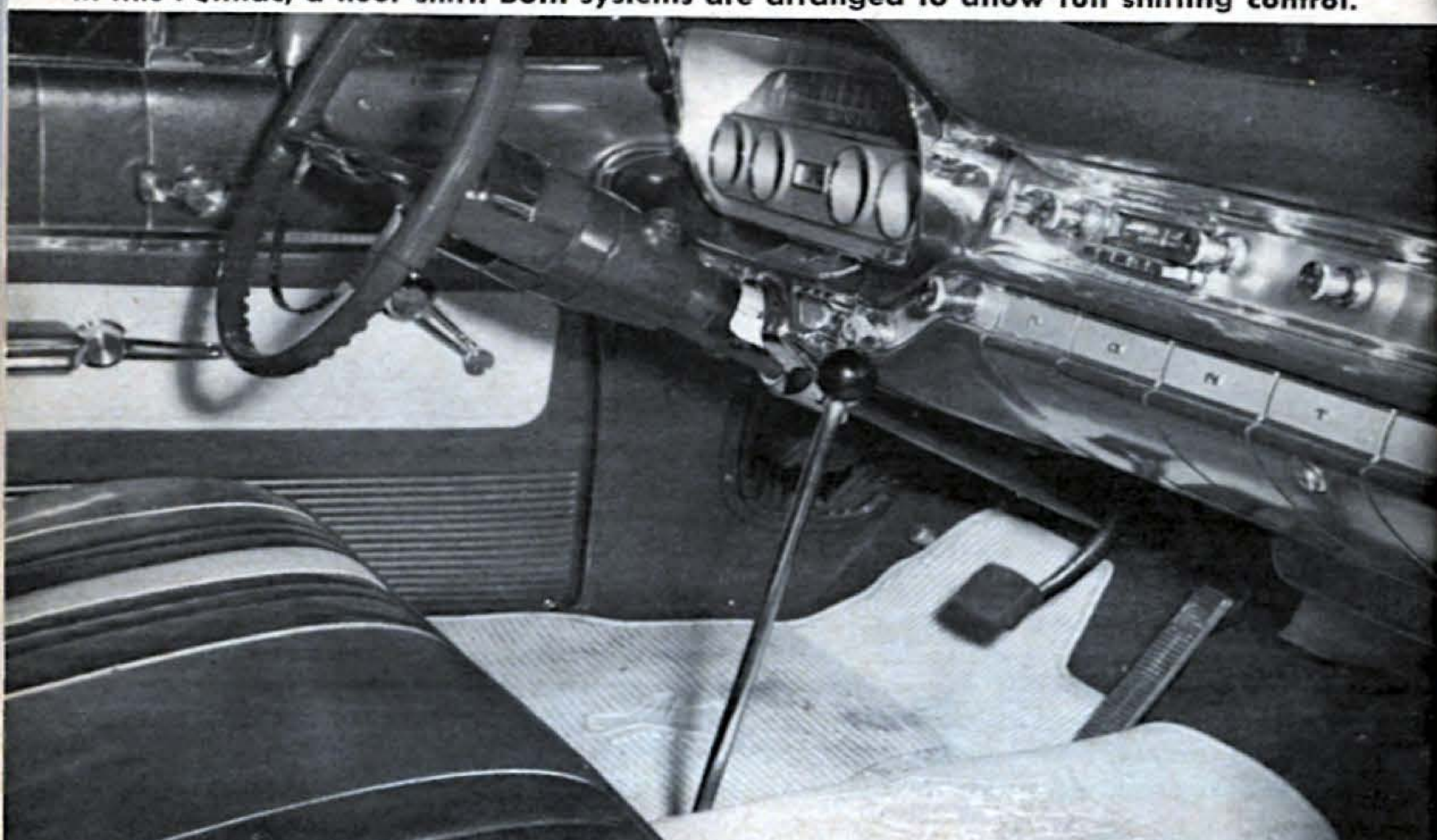


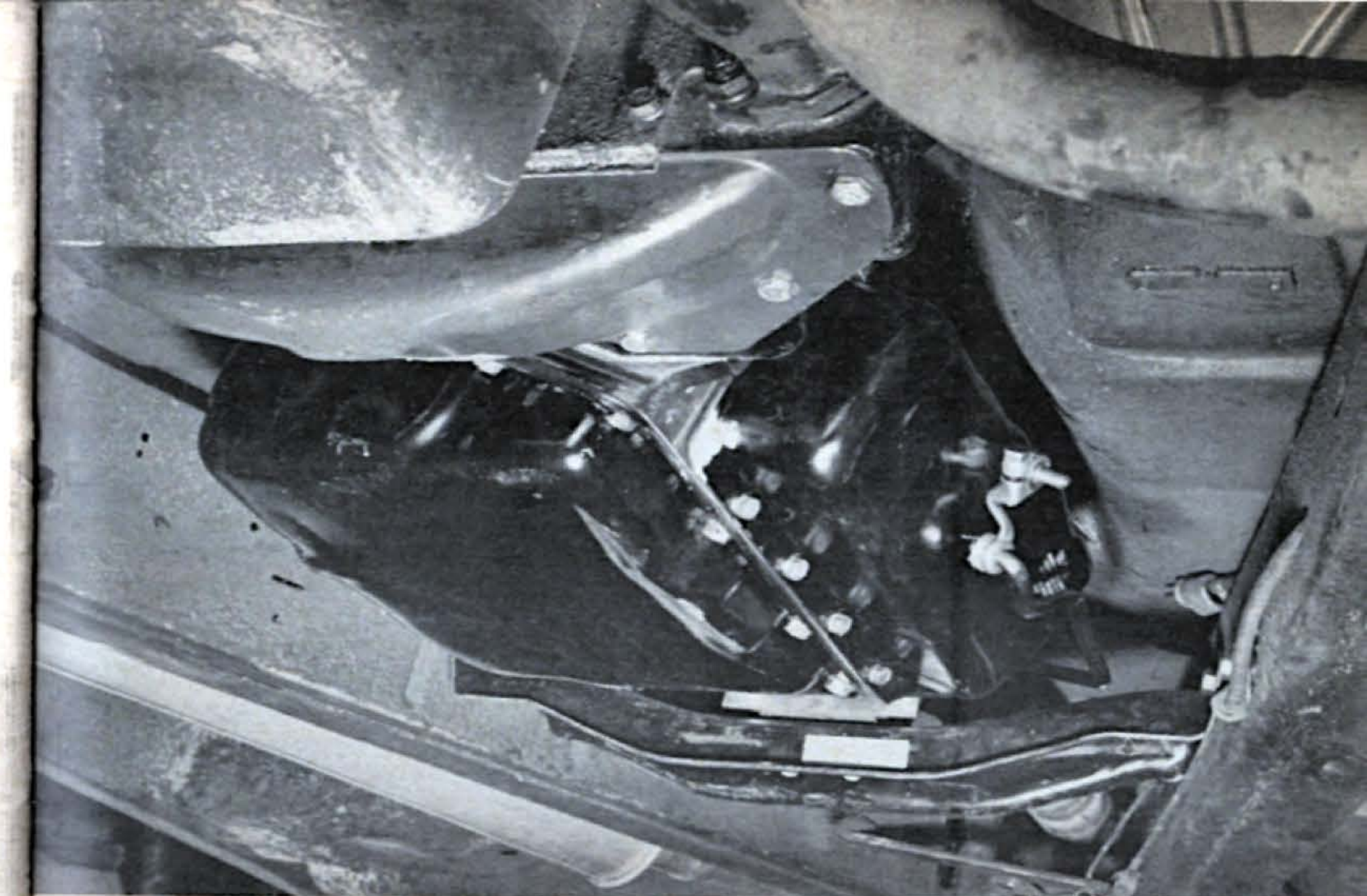
B and M's Hydro-Stick conversion is fitted with deeply-vaned torus members for normal street use; good response at low rpm.



In competition versions of the Hydro-Stick, the vanes are noticeably shallower. This is to allow greater slippage at low speed.

Hydro-Stick can be equipped with either a conventional column lever or, as displayed in this Pontiac, a floor shift. Both systems are arranged to allow full shifting control.





Installation of Hydro-Stick in cars originally built with Hydramatic is an easy task, while a full line of adaptors are available to fit the unit to most other popular makes.

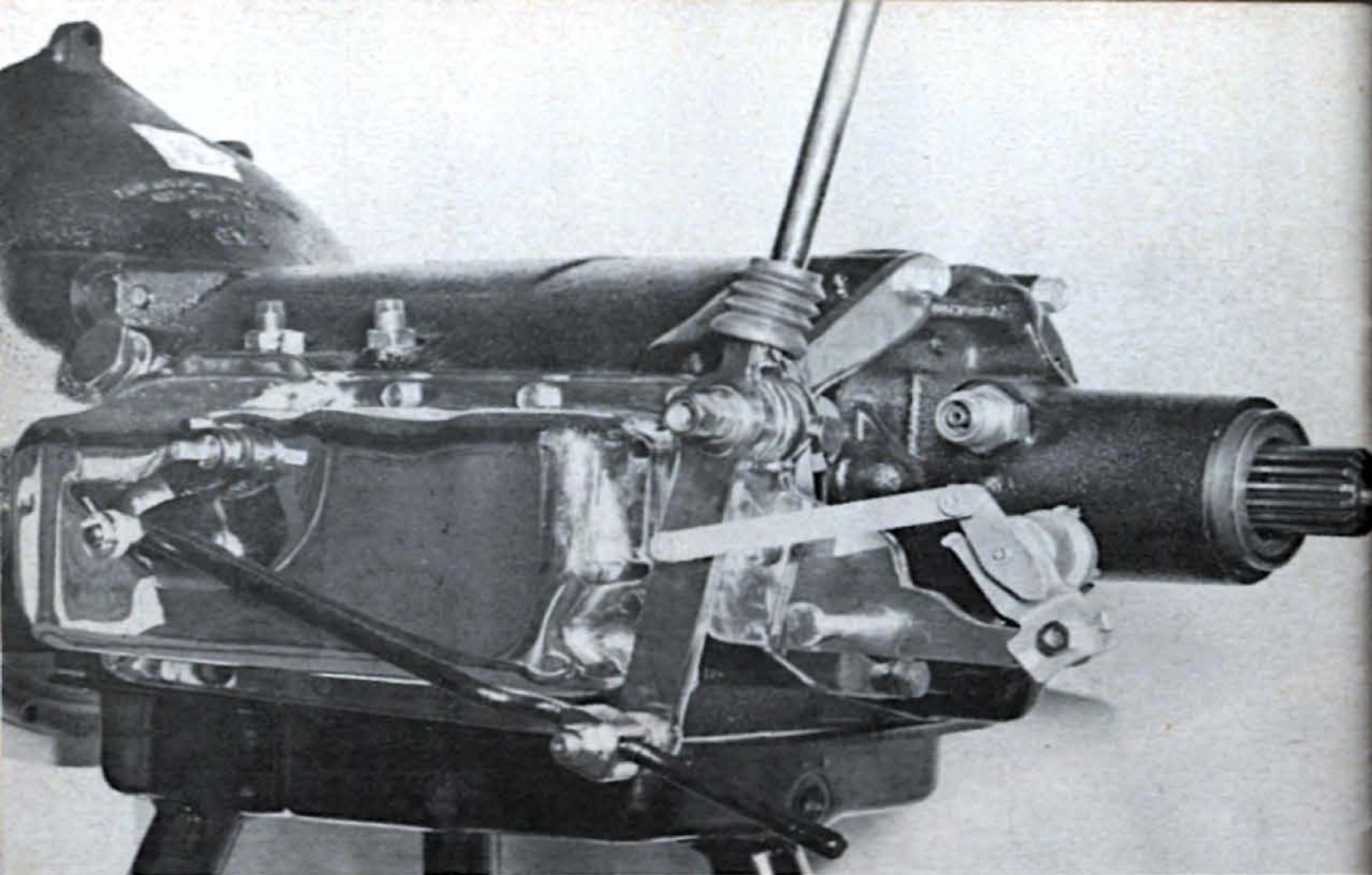
Torqueflite or Hydramatic three-speeds. For the older Hydramatic, this would mean four forward positions, one to hold the unit in first, another in second and so on. To assure quick, positive shifts, the oil pressure through the valve body should be increased. Stock Hydramatics are designed for smoothness, not fast action, and the latter is a necessity in competition.

From this brief description, it's obvious that rebuilding a Hydramatic isn't a job for the backyard rodder. All automatic transmissions require the touch of a skilled mechanic and certainly one that's being built for racing deserves particularly careful treatment.

One outfit that does a really superb job is B and M Automotive of Van Nuys, California, producers of the famous Hydro-Stick. They start with Hydramatics of very specific makes and years, rebuild them completely and add a good many unique refinements of their own. The valving is reworked to provide controlled upshifts into all ratios. From right to left with a column shift or front to rear with a floor lever, the positions and the gears available in each of them are:

R: Reverse,
1: First,
2: First and Second,
3: First, Second and Third,
4: First, Second, Third and Fourth, and
N: Neutral.

In other words, the numerical designation of each range indicates the highest gear provided in that range.



The control linkage on a Hydro-Stick looks very much like a floor shift conversion on an ordinary manual transmission. B & M builds the unit for durability under rugged use.

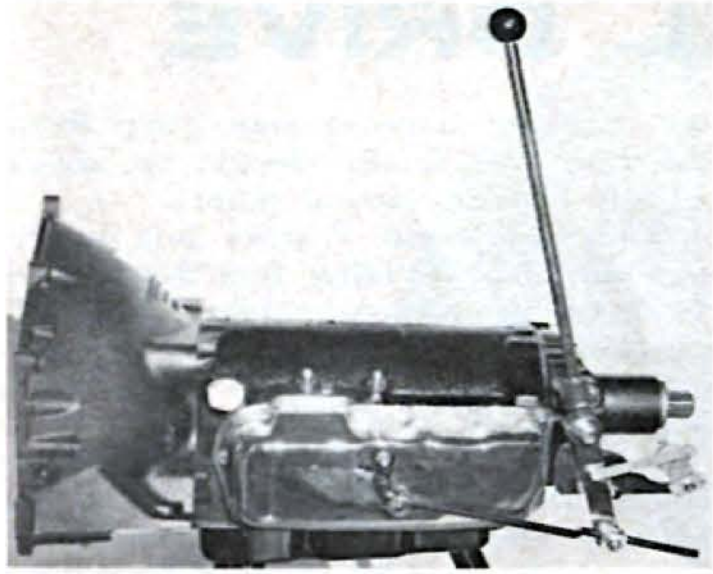
You can run as far as you want in first by merely holding "1," then engage second by moving the lever to "2," and so on up the line. Yet all four ratios are available in "4." If you're in a lazy mood, throw the lever into that position and the Hydro-Stick will behave just like any other Hydramatic, shifting automatically through all four speeds.

Well, maybe it won't be *just* like the original. For crisp gear changes, B and M boosts the oil pressure through the valving from the stock range of 70 to 90 pounds per square inch to 185 pounds. This provides a really solid action. In fact, it may be a bit too hairy for some tastes, so each Hydro-Stick is delivered with instructions for reducing the pressure to obtain greater smoothness.

The Hydro-Stick is available in three models. Lowest priced is a unit for cars of stock power. Next is a moderately beefed job for modified but unblown engines. Topping the line is an especially rugged version intended for supercharged powerplants.

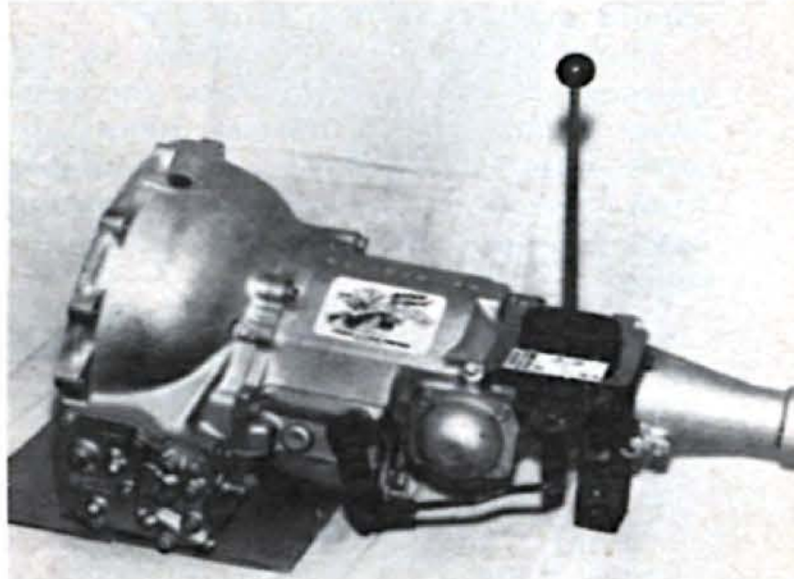
An example of the differences among them is found in the torus members. A stock torus design with deep vanes is provided for street use. This, surprisingly, doesn't provide enough slippage for the hottest competition engines, so the Hydro-Stick for racing is supplied with shallow torus vanes. And, of course, the units for faster cars are strengthened all the way through.

B and M back up their intriguing product with a 90-day or 4000-mile guarantee and a full year's guarantee against defects in workmanship. In addition, they'll overhaul and rebuild one of their transmissions for its original



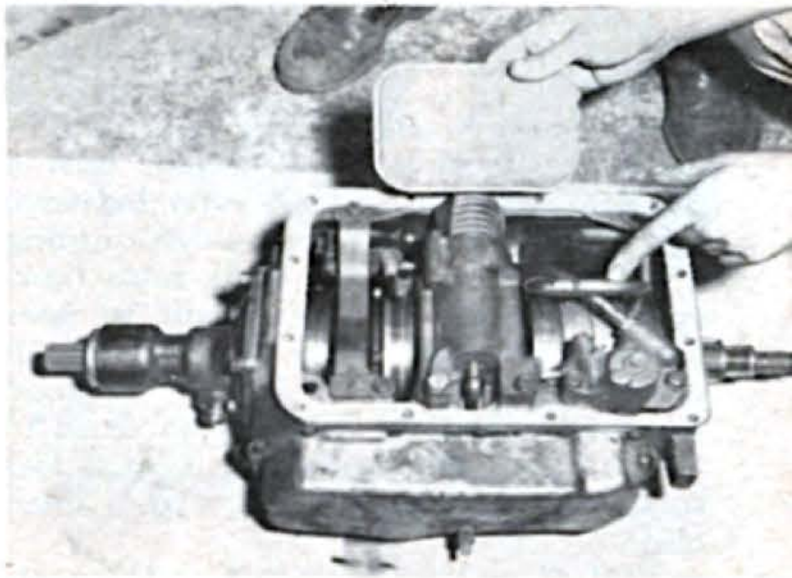
ABOVE—Hydro-Stick has won fame on basis of its good performance in hands of top drag race drivers across the country.

ABOVE, RIGHT—Another beefed Hydramatic is Ansen Powermatic, a reworked unit; is manually shifted with floor lever.



RIGHT—Ansen has experimented with beefed Powerglide but torque converter with 2 speeds is not suited for dragging.

BELOW, RIGHT—If you are thinking about beefing your own Hydramatic, take a close look, it is not a job for the unskilled.



owner for only $75. And the second owner can get the same service for $100. This shows remarkable confidence in a product that, by its very nature, is going to receive the hardest possible use.

The Hydro-Stick is for automatic enthusiasts what the old Cad-La Salle gearbox has been for stick shift fans. And the very reason the Cad-La Salle went out of production should assure a good supply of this exciting automatic for some time to come. Cadillac dropped its manual transmission to standardize on the very Hydramatic design the B and M considers best adapted to reworking! ■

THE FINAL DRIVE

A DETAILED analysis of differential and rear axle problems would be out of place in a discussion of clutches and transmissions but any attempt to define gearing must take the rear axle ratio into consideration.

This final element in the drive train will determine the exact performance characteristics of a car. For acceleration, the axle should be geared low so that, combined with first gear, it will provide an overall ratio as close to the bottom limit as possible. For maximum speed, on the other hand, the choice should aim at the top limit.

These are the two extremes in requirements and several Detroit factories have given the enthusiast plenty to work with. Here are the axles available from the four makes concentrating most intensely on performance equipment:

Chevrolet: 3.08, 3.36, 3.55, 3.70, 4.11, 4.56, 4.88, 5.14 and 5.43;

Dodge: 2.76, 2.93, 3.15, 3.23, 3.31, 3.36, 3.42, 3.55, 3.58, 3.73, 3.91, 4.10, 4.30, 4.56, 4.89, 5.12, 5.38, 5.57, 5.83 and 6.17;

Ford: 3.00, 3.10, 3.22, 3.40, 3.56, 3.89, 4.11, 4.29, 4.57, 4.71, 4.86, 5.14, 5.43, 5.67 and 5.83;

Pontiac: 2.56, 2.69, 2.87, 3.08, 3.23, 3.42, 3.64, 3.90, 4.10, 4.30, 4.55, 4.88, 5.38, 5.57, 5.86 and 6.14.

So where do we start? Well, experience at the drags has shown that a stocker needs an overall ratio between 10- and 15-to-1. Suppose we're running a hot Chevy with the wide ratio four-speed Warner box. We want to gear toward the higher end of the 10-to-15 spread in hopes of having a good terminal speed. If we get too close to 15-to-1, our axle ratio may be too low to get us through the traps at a good clip.

Still, if we try for 10-to-1 on the nose, we may not have enough jump from the line. We finally decide on about 11.5-to-1 as a starting point.

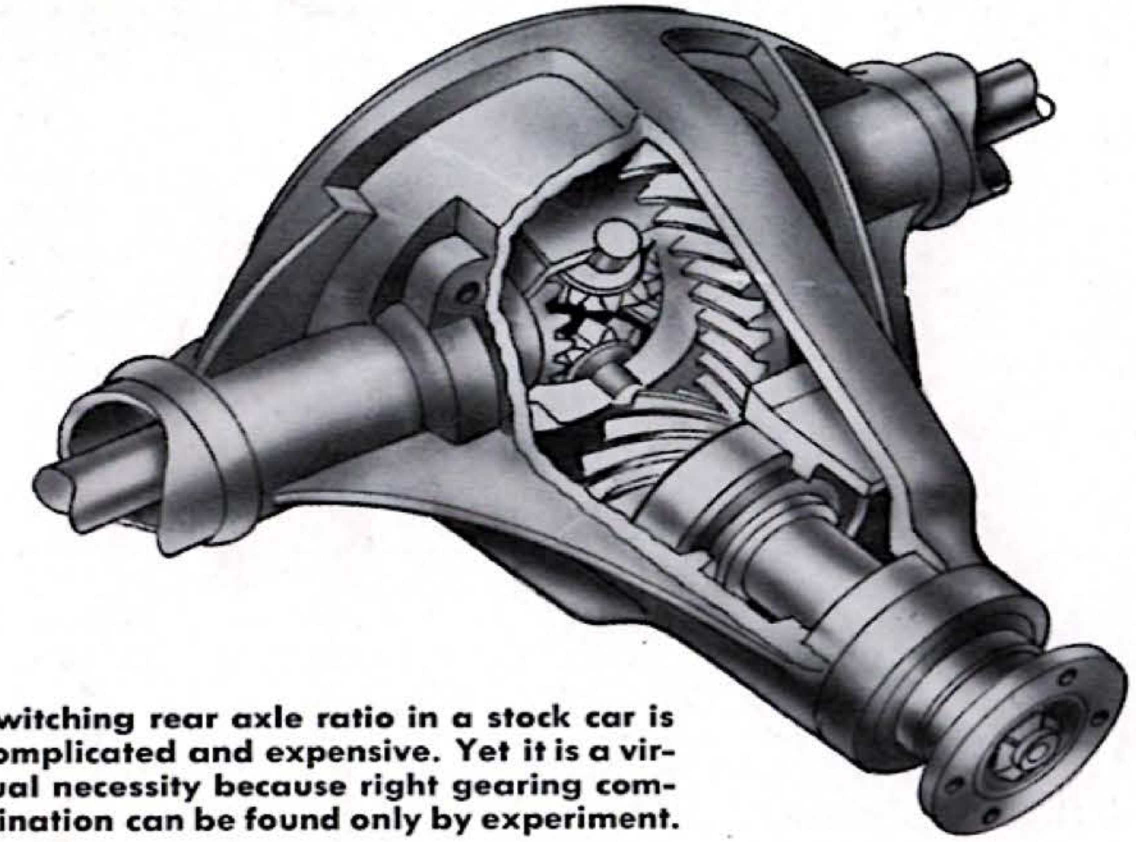
The wide ratio Warner box has a first of 2.54. Dividing that figure into 11.5, we get approximately 4.54. And checking Chevy's list, we find that we can come mighty close to this with a 4.56.

Actually, it's next to impossible to select an axle ratio quite so scientifically. The hotter stocks generally run from 4.56 to 4.89, but determining what's just right for your particular car is pretty much a matter of experimenting with what can be fitted. Too many variables are involved to set down specific rules that will work out every time.

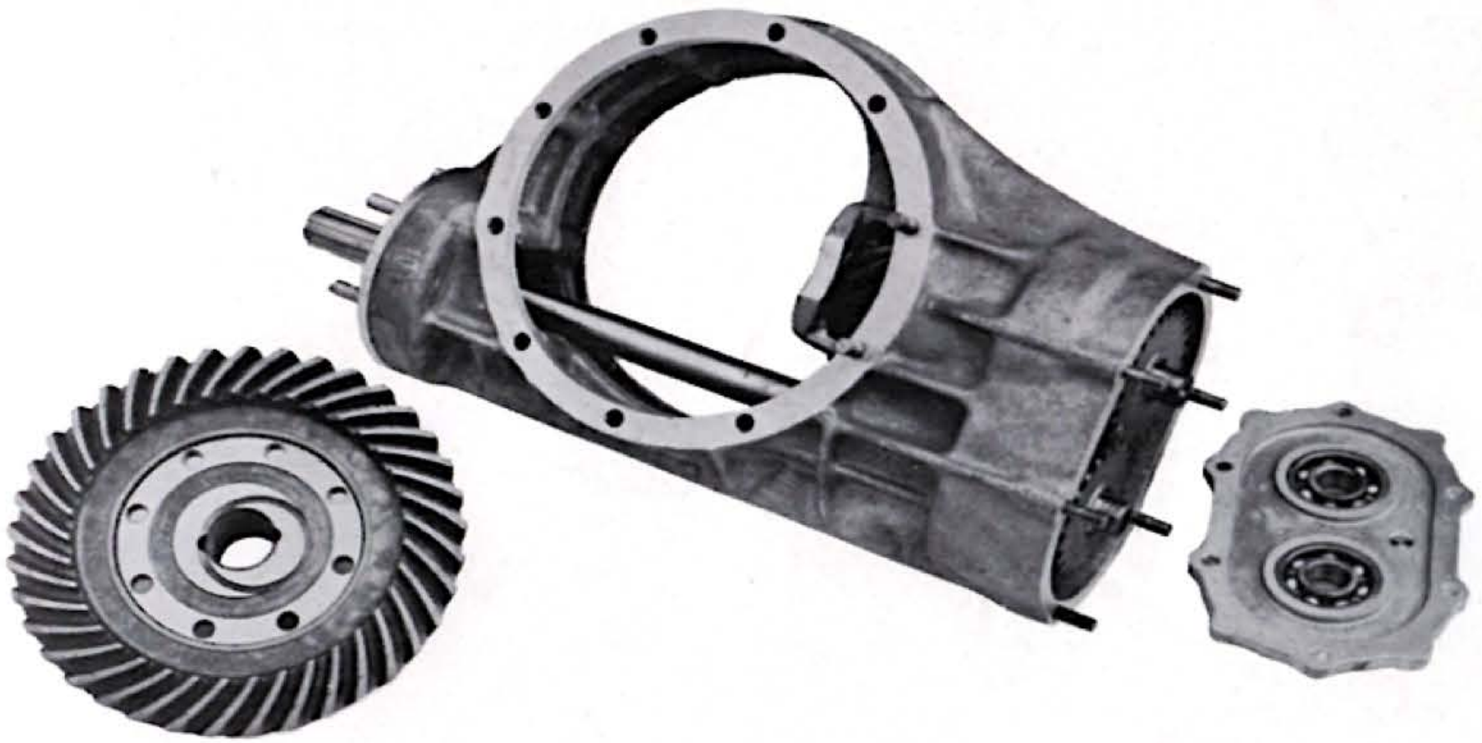
In modified cars, it becomes even more difficult. You may be dealing with an extreme power-to-weight ratio and, when you first build the car, you have no way of determining what the best overall ratio in first should be or what the ratio for the best speed at the end of the ¼-mile might be. However, you can conduct experiments at considerably less expense than the fellow with a stocker. He has to change the whole rear end every time he wants to try a new axle ratio. With a modified, you can install a Halibrand quick-change rear end and put gear sets in and out as often as you please. And each change takes only a few minutes. Your latitude is greater, too, since Halibrand offers ratios from 2.20 to 8.60.

The exact combination for the best possible times at your local strip cannot be calculated by a formula. There are so many variable factors that you can find the right gearing for your car only by experiment.

So we can't tell you just what you should have. At best, we hope we've pointed you in the right direction. How far you want to go is pretty much up to you. ■



Switching rear axle ratio in a stock car is complicated and expensive. Yet it is a virtual necessity because right gearing combination can be found only by experiment.



Halibrand quick-change rear end is a valuable component for all types of competition cars. It is designed to permit changes in the rear axle ratio with the least possible time and effort.