CAR LIFE
Road Test

Willys 4wd Wagoneer

Holy Toledo—a 4-wheel-drive automatic transmission!

BY JOHN R. BOND

A LOOK BACK into automotive history reveals that the story of Willys-Overland has been a courageous fight. Though often near bankruptcy, the relatively small firm in Toledo has somehow always managed to survive and, despite the ups and downs of commerce and financial upheavals, there has never been any lack of engineering acumen. Willys-Overland narrowly missed being the Chevrolet to beat down Ford, with the low-priced Redbird in the early Twenties. It tried the Charles Knight principle (sleeve valves) in 1922 along with a European type car (the 1925 Whippet). In 1933 the Willys "77" featured pseudo aerodynamics. In 1937 it was the "Americar," styled by Amos Northrup. Then the war came along and Willys got the bulk of the contracts for building the Bantam Car Company's "Peep," better known now as the Jeep. After the war there was the astute but premature compact car called the "Aero Willys," then the tie-in with the Kaiser-Frazer Corp., which led nowhere insofar as cars are concerned, but did give Willys some financial security (Willys now is a division of Kaiser Industries).

The first Willys station wagon arrived in 1946, and the chassis featured independent front suspension for the first time (when ordered as a 2-wheel drive). This same special chassis was later used for the strange-looking Jeepster and was, in fact, built right up until the announcement last fall of a completely new chassis and engine.

The official designation of the 1963 Willys is the J-100 series, this being the 110-in.-wheelbase model. Three bodies are available: a 2-door wagon, a 4-door wagon and a panel delivery style. There is also a J-200 series with a wheelbase of 120 in. and a J-300 with a still longer frame, giving a wheelbase of 126 in. The two stretched-out models are built only as trucks and are advertised as the "Gladiator" models. The traditional Jeep "Universal" and the more recent "FC" (forward control) trucks are continued. Before describing the new J-100 "Wagoneer" model in detail it might also be mentioned that Willys currently produces four engines in its own plant.

No. Cyls	Head	Bore X Stroke	Cu. In.	Bhp @ Rpm
4	L	3.125 x 4.375	134.2	60 @ 4000
4	F	3.125 x 4.375	134.2	75 @ 4000
6	L	3.312 x 4.375	226.2	105 @ 3600
6	ohc	3.344 x 4.375	230.0	140 @ 4000

The Engine

The Wagoneer will use only the new overhead-camshaft powerplant which Willys calls the "Tornado OHC." This engine was described for *Car Life* readers in the July 1962 issue, but some additional details have been released by Willys Chief Engineer, A. C. Sampietro.

The OHC engine is obviously of the same family as the L-head engine

which Willys inherited from Kaiser-Frazer. However, though the bore centers, block height and length, etc., are identical between the L-head and the OHC unit, there are actually very few interchangeable parts. Connecting rods and flywheels are the principal parts common to both engines. The OHC model has its own block, head, pistons and even a special crankshaft. This latter component is dimensionally the same as used in the L-head engine (with four 2.375-in. main bearings) and is even forged from the same alloy (SAE-1045). But, because of the high rpm capability of the overhead camshaft engine, its crankshaft gets a newly developed heat-treating process called "Tufftriding." This patented process soaks the metal components in a liquid nitriding solution bath. This treatment imparts a high surface hardness to the journals as required for compatibility with heavy-duty bearing inserts. More important, the treatment improves the fatigue endurance limit by 50% and Willys engineers have this to say:

"Many hundreds of hours at rated speed, 4000 rpm, at 10% overspeed, i.e., 4400 rpm, and at the speed of maximum torque, later followed by thousands of miles of road work, confirmed the conviction that the Tufftrided crankshaft and tri-metal bearing will give long, trouble-free life under the most arduous of service conditions." Incidentally, we were told also that, as an extreme example, this engine has run briefly as high as 5600 rpm without blowing up.

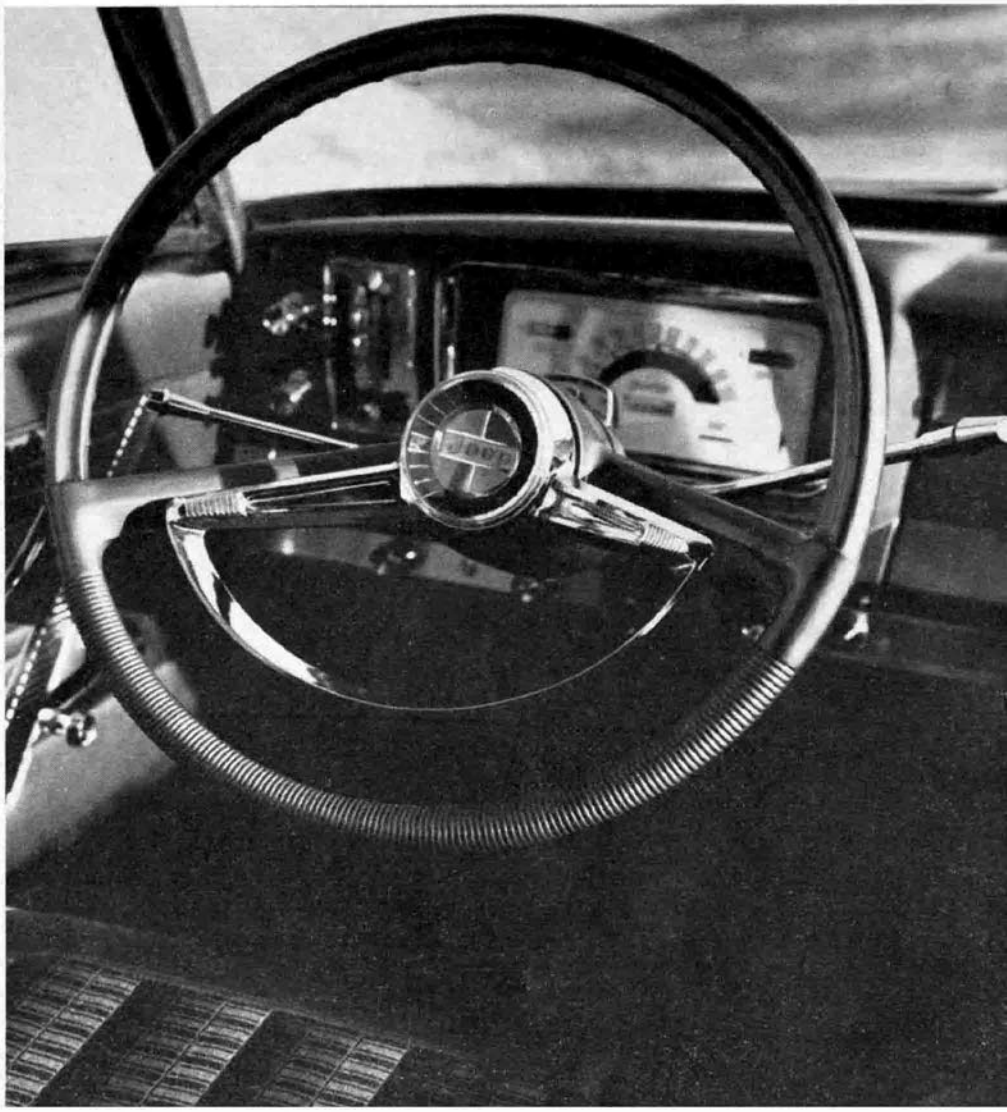
Placing the camshaft in the head eliminates the usual long pushrods, and the rocker-arm system employed also eliminates the tappets. But driving this camshaft requires a very long chain, because the distance between sprocket centers is 16.68 in. Willys uses a standard ½ in. pitch x 0.88 in. wide silent chain (supplied by Morse) with a fixed chain guide damper on the tight side and a rubber-coated spring blade tensioner on the slack side. The nominal valve timing sequence is 15-55-55-15, and new engines are set up so that this sequence is obtained after the chain stretches, which occurs during the first few hours of running.

Summed up, the engine used in the Wagoneer is one of the most interesting being built today. We also feel strongly that the company policy on horsepower and torque claims is most commendable.

The following figures show both gross and net bhp. Willys advertises only the net figures, while nearly all other firms give the unrealistic and often unattainable gross figures.

	Net	Gross
Bhp	140 @ 4000	155 @ 4000
Torque	210 @ 1750	230 @ 2200

MARVIN LYONS PHOTOS



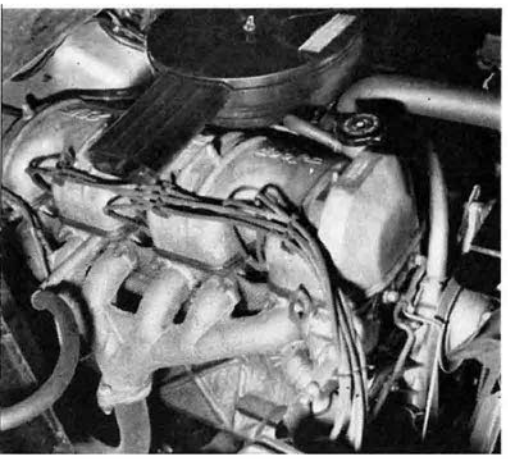
POWER STEERING and a pleasant easy-to-read instrument panel help make the Wagoneer a comfortable car. Automatic transmission indicator quadrant is on steering column.

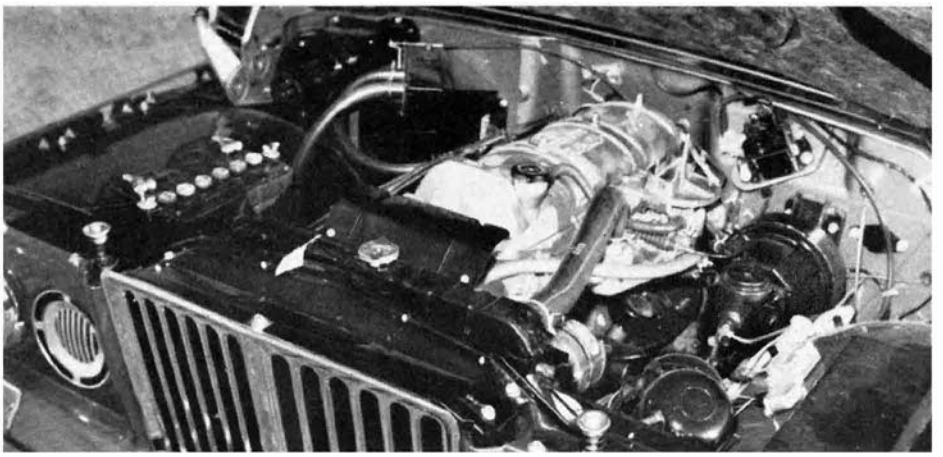
The Chassis

Because the Wagoneer was designed for both a 2-wheel and a 4-wheel drive, the frame is relatively high off the ground. This, in turn, avoids some of the design headaches associated with very low passenger cars. The Willys frame consists of two channels 5.5 in. deep. In plan view, the two rails come together at the front to provide for steering clearance. The top-of-frame line is 16.7 in. above the ground and hence the kick-ups at each end, for axle clearance, are modest. There are five cross members and the front member is cleverly arranged so that it provides the center mounting point for the independent front suspension as well as a mounting on each side for the upper wishbone pivot.

While the rear suspension is a conventional Hotchkiss arrangement with leaf springs, the front suspension (and drive) options merit some discussion. On the 2-wheel drive Wagoneer, a new independent system with torsion bar springs is standard equipment. If you order 4-wheel drive, you get a solid front axle with leaf springs, but the independent system with torsion bars is optional. You can also get a conventional tubular front axle with leaf springs on certain truck models, but not on the wagon. Thus, with one frame and a minimum number of special parts, Willys offers a choice of four front-end arrangements. (See illustration, page 56.)

The reason for the independent suspension is that it allows a softer ride, more nearly comparable to that of a conventional passenger car. This is easily shown by the fact that the leaf-spring front end has a ride rate of 150 lb./in. (per wheel), while the independent front end has a ride rate per wheel of 110 lb./in.; 27% softer. Complete suspension data for the two systems are as follows: ▶





POWERPLANT IS Willys' new Tornado overhead cam 6-cyl. Note accessible location of spark plugs. Engine compartment is big enough to allow easy service.

Wagoneer

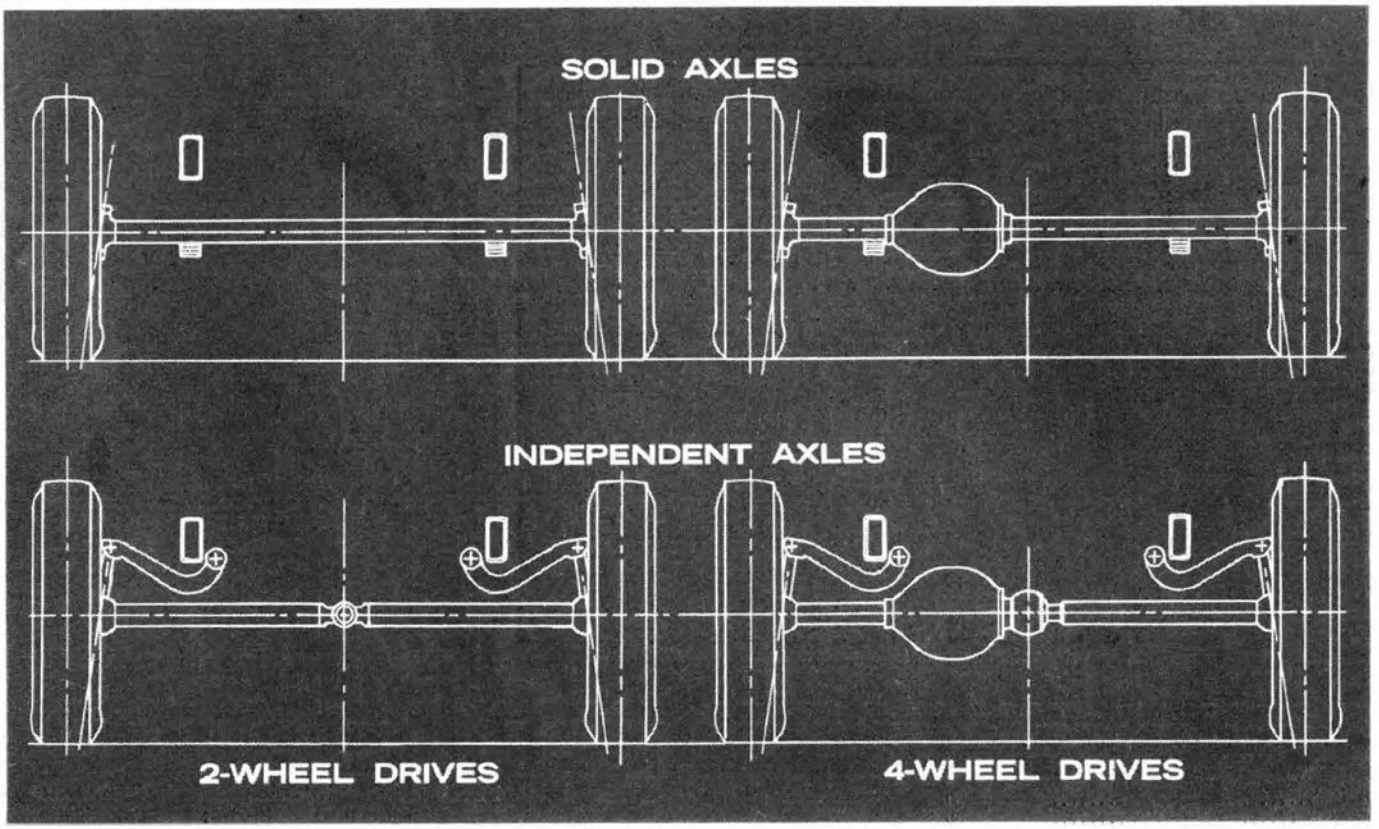
	I.f.s.	Solid Axle
Front ride rate	110	150
Rear ride rate	140	140
Front jounce	4.0	4.0
Front rebound	4.5	4.5
Rear jounce	4.5	4.5
Rear rebound	6.0	6.0

As mentioned earlier, the i.f.s. system uses a torsion bar for a spring. This type of spring was selected more for convenience than anything else; it has nothing whatever to do with the softer ride and it obviously would be difficult to find room for a coil spring on the 4-wheel drive models. The torsion bar installation is very neat, and because the two "axle" halves act as lower wishbones, a simple float level gauge can be used to adjust for correct standing height via a bolt at each torsion bar anchorage. (Readers will please note that this adjustment does not and cannot affect the ride in any way.) The torsion bar is driven by the short upper arm because this member rotates through a much larger angle than does the long lower arm. This in turn allows a smaller diameter bar, actually about ¾ in. with an effective length of 34.5 in. The bar is well protected in this location, an important advantage.

The geometry of this suspension is like any other short and long arm (wishbone) system, but raised several inches. The wheel travel, up and down, given in the prior tabulation is quite ample and one of the *Car Life* staff made an unofficial study of the geometry, with these results:

	4.0-in. Jounce	4.5-in. Rebound
Camber angle	5.2° neg.	1.0° neg.
Tire scrub	1.05 in.	0.1 in.

WILLYS OFFERS four different front end systems for the J-Series, two independents for easy-riding applications, two solid axles for rough duty.



GLADIATOR VERSION (left) of new J Series utilizes many of the same body panels as the Wagoneer, offers the same power and suspension options.

The camber angles shown were measured from a true vertical line. The static setting is 1° positive and the scrub figures (in inches) are for one wheel; the actual track change is double the amount given. It is also notable that the kingpin axis is inclined at 8° and does not give true centerpoint steering by 1.5 in. measured at the tire contact patch. The front roll center is commendably high, about 8.0 in. by our study, but it drops to ground level during the rebound travel. This and a rear roll center approximately 10.0 in. above the ground should insure moderate roll angles in a corner.

All suspension and steering joints are designed to retain lubricant for 30,000 miles but, contrary to passenger car practice, grease fittings are supplied. It should also be mentioned that front end alignment adjustments are provided for camber, caster and toe-in and no special tools are required to do the job. However this statement does not apply to the solid front axles with leaf springs.

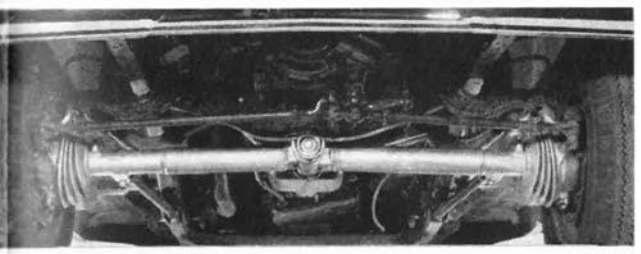
The steering system looks a trifle complicated and there are 3 links, 6 ball ends and one idler lever. But the option of 4-wheel drive means these links must be forward of the axle and the long lower suspension arms require the idler lever for accurate steering. Power steering via a linked cylinder is an option, by the way.

The Transfer Case

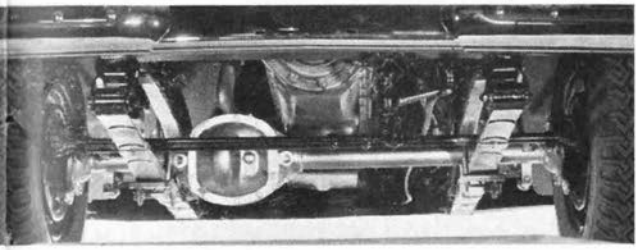
All 4-wheel drive models have a new "silent-type" transfer case of interesting design. In prior 4-wheel drive vehicles by Willys, the transfer case was bolted to the rear of the standard transmission and all power was conveyed sideways via 3 gears. The drive gear was at the engine centerline, then there was an idler gear, and finally the driven gear. This 3rd or driven gear, being outboard far enough to clear the engine, was then used for both the front and rear propeller shafts. And anyone who has ever ridden in a Jeep knows that the gears whine at all times.

To obviate this, the Wagoneer de- ▶

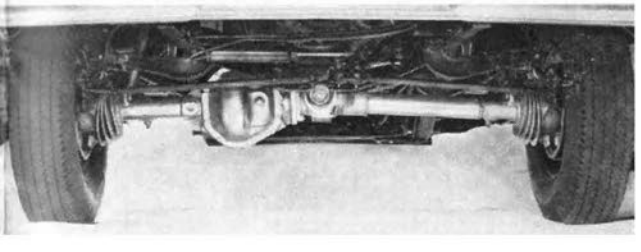
INDEPENDENT front has pivot point in center, torsion bars.



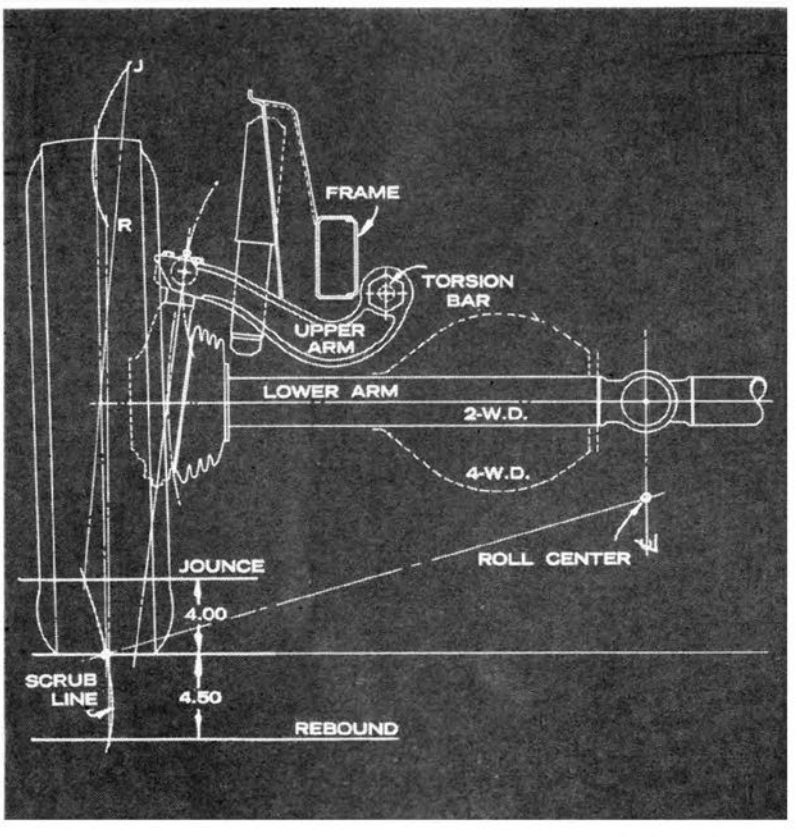
RUGGED DUTY front end has 4-wheel drive, leaf-springs.



INDEPENDENT 4wd has U-joint at center pivot, torsion bars.



GEOMETRY OF swing axle front-wheel-drive and location of components.



Wagoneer

sign drives the rear wheels directly—i.e., the rear propeller shaft runs down the center of the chassis rather than being off to one side. The result is that driving along in 2-wheel drive is as quiet as in any conventional automobile. However, if you engage the dog clutch for 4-wheel drive, the same old gear whine comes back. In 2-wheel drive the transfer gears merely freewheel, in 4-wheel drive they run under load. This is not a perfect solution but it's a big improvement.

With a Borg-Warner automatic transmission available for the first time with 4-wheel drive, the buyer who wants the all-wheel drive feature will be happy to find quieter running on the highway.

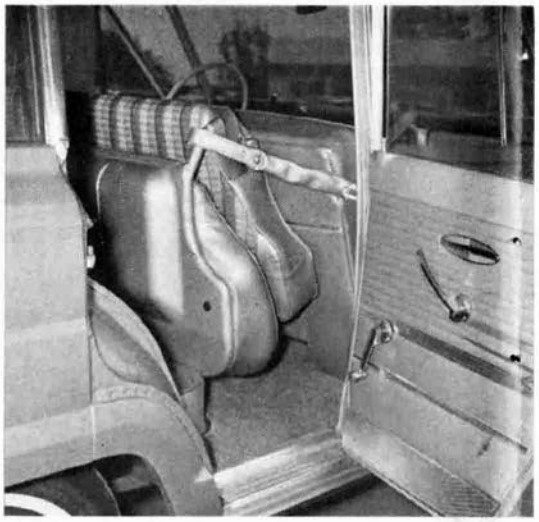
For special service, the Wagoneer can be ordered with a 3- or 4-speed manual transmission. When a manual transmission is specified with 4-wheel drive you get yet another transfer case. This 2nd type is similar to the other and is quiet when using 2-wheel drive only. But it has some additional sliding gears, which can be shifted for an extra low low. A separate lever is provided for this and the 4-position sequence, fore and aft, is: 4WD-High, 2WD, Neutral and 4WD-Low. The extra-low ratio is 2.03:1, with "high" being 1:1. In short, this special transfer case, in low, doubles the pulling power and halves the vehicle speed. The reason it cannot be used with the automatic transmission is because the shift into low is by sliding spur gears and this requires a manual clutch.

The automatic transmission is similar to that used on Rambler and Studebaker V-8 models. First gear is 2.40, 2nd 1.47, with a converter multiplication of 2.15 available at stall.

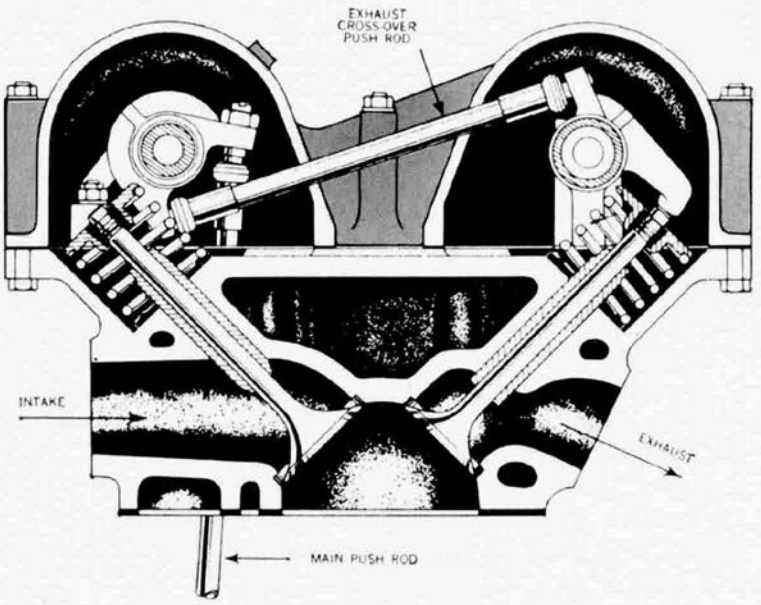
A Warner Gear 3-speed manual transmission (Model T-86) as used on several passenger cars is standard with 2WD and has a 2.57 1st gear and 1.55 2nd. This 2WD model can also be ordered with overdrive.

On 4-wheel drive models the standard 3-speed transmission is a WG T-90 which is similar to the above except that low is 2.80:1 and you can't get overdrive. Specifications of the 4-speed transmission were not available to us but it is a truck type and not the all-synchromesh WG T-10.

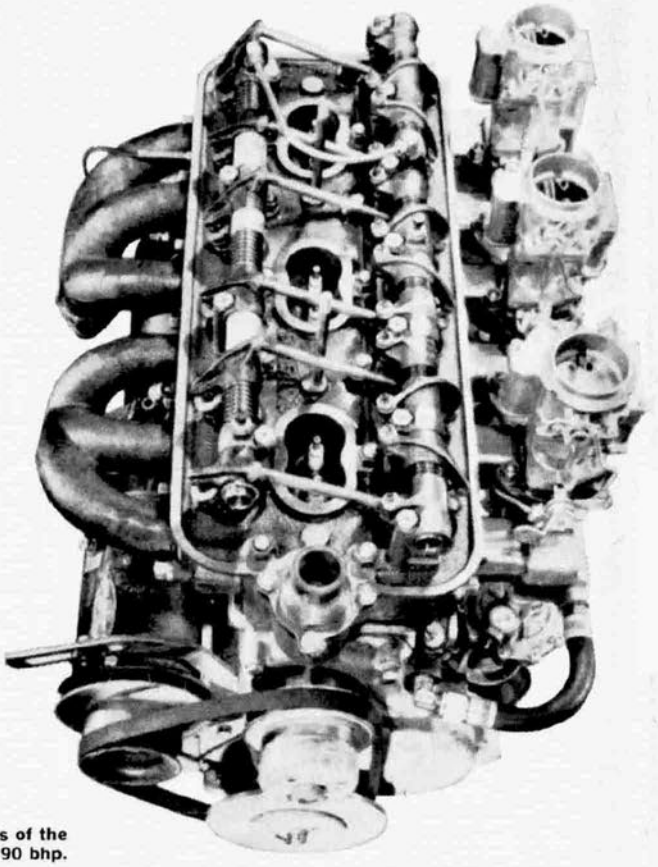
Driving axles are all made by Spicer and have hypoid gears. The automatic transmission gets a 3.73 ratio, while 4.09 is the standard ratio for all manual transmissions except when overdrive is specified (2WD only), on which the 4.27 ratio is supplied. Powr-Lok differentials are optional. The



STRAP HOLDS folded rear seat.



EXPERIMENTAL 250-cu in. ohv 6-cyl. engine head was designed and tested by Willys in the hope of achieving a workable hemispherical head with the camshaft in the conventional crankcase.



THREE CARBURETORS, split exhaust headers were features of the experimental head. On stock block it produced 190 bhp.

WAGONEER has a huge cargo capacity.

4-WHEEL DRIVE conquers tough terrain.

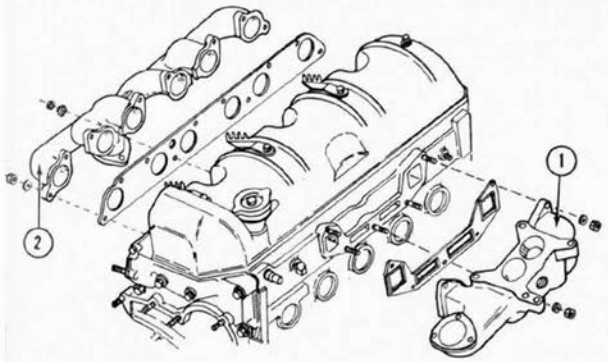
maximum load capacity for these axles is 2500 lb. front, 3000 lb. rear, for either 2WD or 4WD.

The brakes are hydraulic, with cast iron drums. All drums are 11 x 2 in., giving a swept area of 276 sq. in. and a net lining area of 161 sq. in. A vacuum booster is optional. Wheels are mounted on five studs, with 15 x 5.5K rims. Standard tires are 6.70-15 with 7.10-15 optional. There is ample clearance for chains on all four wheels.

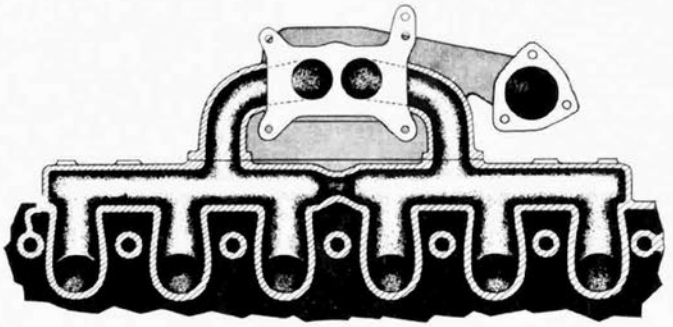
A 20-gal. gas tank is mounted amidships and under the floor, while the spare tire is also under the floor, but at the rear. Other miscellaneous items include a transistorized voltage regulator (used with an alternator), an easy-to-service instrument cluster which uses a printed circuit on the back, and a single plug-in terminal there and in numerous other places.

DRIVING THE WAGONEER

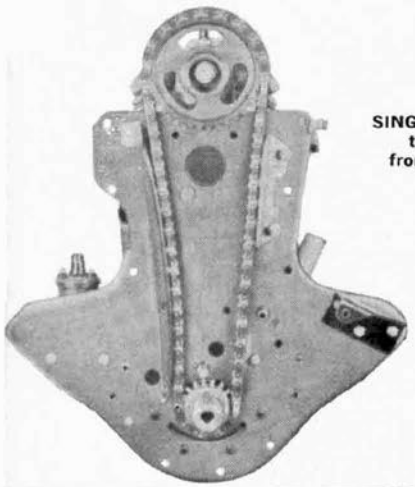
INTRODUCED in November 1962, the Willys station wagon is one of the most interesting vehicles to come out of Toledo in many a year. This wagon, which Willys describes as a "Wagoneer," looks like what it is—an honest, extra-heavy-duty station wagon that has been designed to do a wagon's work. Styled by Brooks Stevens Asso- ▶



INTAKE (1) and exhaust (2) manifolds of production unit.

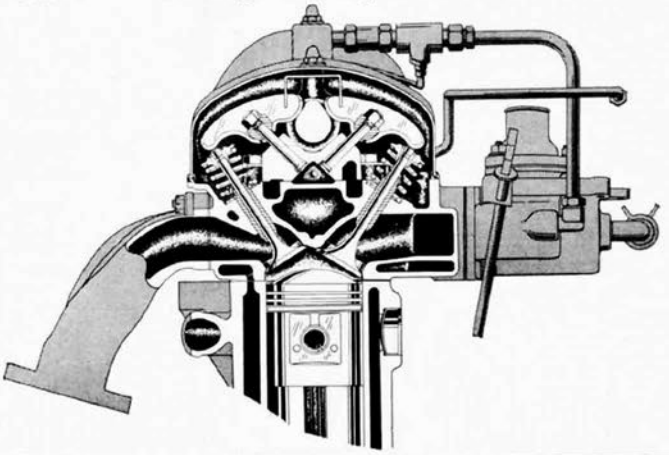


CYLINDER HEAD gallery and inlet manifold.



SINGLE ROW chain drives the overhead camshaft from the crankshaft, has tensioner at left.

PRODUCTION sohc design needs only six cam lobes.



all the better for it. Certainly, there's no truck-like ride here and the Wagoneer feels stable and controllable over roads that make lesser vehicles wobble, wander and weave.

Our test car had optional power steering and power brakes. These also rate very high by our standards—perhaps the efforts involved in operating them are just a little higher than in a typical sedan, but there is a good sense of steering control from the power system and the brakes didn't throw us into the windshield the first time we applied them.

In the performance department, it might be well to bear in mind that the Wagoneer is not light. The Willys catalog says its 4-door, 4-wheel drive model has a shipping weight of 3566 lb. and a curb weight of 3701 lb.

Our test car, with some weighty options, showed 3910 lb. on certified scales, with full tanks, of course. The test weight, with driver and observer was therefore well over 2 tons: 4160 lb. to be exact. This heft and a frontal area of 27.0 sq. ft. will inhibit performance and economy, and we were very surprised to show a zero to 60 time of 15.9 sec. (remember, that's with automatic), and one trip at 60 mph got us a 17.0 mpg average. Even town driving with moderate traffic gave us 14.5 mpg, which certainly demonstrates the remarkable efficiency of the OHC engine.

We also got a real surprise during the speedometer checks—the instrument on this particular car proved to be 5% slow. At a steady 80 mph, the timed runs showed a true speed of 84 mph and we feel certain that the honest top speed would be at least 88 mph, with 90 mph available under favorable conditions. We didn't try, however, because the engine had only 1200 miles on it and was probably a little too tight to give conclusive results. Road feel and stability at high speed seemed excellent, though we did not have the car long enough to try it under crosswind conditions.

The brakes were adequate, even though they are not overly large for the weight they have to control. We tried the 4-wheel-drive system briefly, but not conclusively, and discovered a remarkable ease of operation. Being used to the more military types of 4wd, the Willys' smoothness and lack of gear rumbles caught our fancy. Pull up on the lever to shift in the front wheels, push down on the throttle, and it just picks its own path over the mud and tough terrain.

The Wagoneer lists for $2546 (fob Toledo) in its least expensive, 2-door, 2wd form; the 4wd system adds nearly $700 to the price and a custom 4-door like our test vehicle begins at $3526—automatic transmission, radio, etc., are extra. It all adds up to an expensive package, but one seemingly well planned for many functions. ■

CAR LIFE ROAD TEST

1963 WILLYS
Wagoneer 4-Wheel Drive

SPECIFICATIONS

List price (4-w.d.)	$3526
Price, as tested	3926
Curb weight, lb	3910
Test weight	4160
distribution, %	54/46
Tire size	6.70-15
Tire capacity, lb	4460
Brake swept area	276
Engine type	6-cyl., sohc
Bore & stroke	3.34 x 4.38
Displacement, cu in	230.0
Compression ratio	8.50
Carburetion	1 x 2
Bhp @ rpm	155 @ 4000
equivalent mph	83.6
Torque, lb-ft	230 @ 2200
equivalent mph	46.0

DIMENSIONS

Wheelbase, in	110.0
Tread, f and r	57.0
Over-all length, in	183.7
width	75.6
height	64.2
equivalent vol, cu ft	515
Frontal area, sq ft	27.0
Ground clearance, in	7.75
Steering ratio, o/a	24.1
turns, lock to lock	4.25
turning circle, ft	38.3
Hip room, front	59.0
Hip room, rear	45.0
Pedal to seat back, max	40.0
Floor to ground	17.5
Luggage vol, cu ft	107
Fuel tank capacity, gal	20.0

EXTRA-COST OPTIONS

Automatic transmission, power steering, power brakes, radio, wsw tires.

GEAR RATIOS

3rd (1.00)	3.73
2nd (1.47)	5.48
1st (2.40)	8.95
1st (2.40 x 2.15)	19.2

PERFORMANCE

Top speed (4200), mph	88
Shifts, rpm-mph (auto.)	
3rd ( )	
2nd (3650)	52
1st (3600)	31

ACCELERATION

0-30 mph, sec	4.8
0-40	7.9
0-50	11.4
0-60	15.9
0-70	21.6
0-80	31.2
0-100	
Standing ¼ mile	20.2
speed at end	68

FUEL CONSUMPTION

Normal range, mpg 14-17

SPEEDOMETER ERROR

30 mph, actual	31.7
60 mph	63.0
80 mph	84.0

CALCULATED DATA

Lb/hp (test wt)	26.9
Cu ft/ton mile	91.7
Mph/1000 rpm	20.9
Engine revs/mile	2870
Piston travel, ft/mile	2090
Car Life wear index	60.0

PULLING POWER

70 mph, maximum gradient, %	6.8
50	11.5
30	26.0
Total drag at 60 mph, lb	310