New transmissions take away part of the driver's job—and do it better than most drivers can.

What You Should Know About Automatic Drives

By Devon Francis
Drawings by Ray Pioch

IF YOU are buying a new car this year, you are going to be forced into making a new decision.

You may have "the best left foot in the business." You may be able to make the old heap move as smoothly as a Diesel locomotive. But from now on *you will have to make a decision about automatic drives.* You will need to know them even to say "no" to the salesman. And unless you are a rich, bachelor hermit, your eventual answer probably will be "yes."

For the robot shifts are here to stay. Like the self-starter and the closed car, they are recognition of the plain fact that the automobile is a family utility, operated by drivers of varying skill. The new drives eventually will become standard equipment because they make things easy for the dub driver, giving him the effortless performance that a taxi pilot displays.

Most of these new transmissions are optional, at extra cost initially and—probably—in running expenses. But they promise the most important advance in driving since the introduction of no-clash shifting at the close of the 1920s.

With an automatic transmission, you set a lever, press on the gas pedal, and go. Your left foot has nothing to do. The innards of the new drives take care of all the problems of delivering push at the rear wheels with relation to engine speed and grades. The car makes like an old Stanley Steamer or Walker Electric.

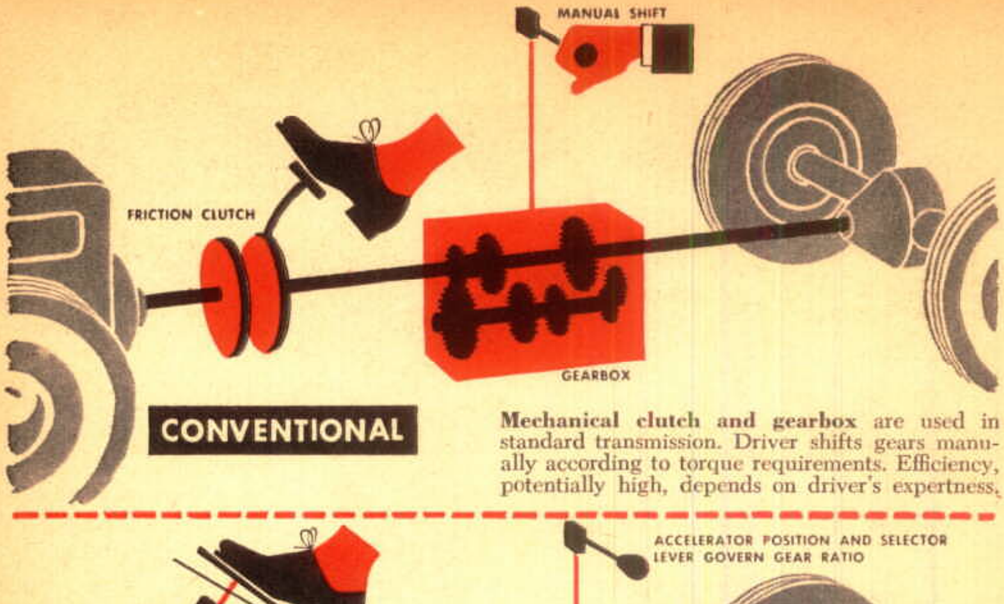
To give the car for many drivers this higher average driving ease, Detroit has performed nothing less than a little miracle. For all their complications, the new transmissions demand little or no more space or weight than a conventional transmission.

The new transmissions were pioneered before the war by Chrysler's fluid coupling and semi-automatic gear shifting and by Oldsmobile's Hydra-Matic. Now comes the confusion of Super-Matic, Ultramatic, Powerglide, Dynaflow, Prestomatic, and Gyromatic. Some others are so new that they haven't even been sales-named yet. But they all aim at the same thing: adapting the gas engine, weak in power and torque at low speeds, to the human driver who can best handle power with the press of a foot, just as he (or she) makes a radio louder with the twist of a wrist.

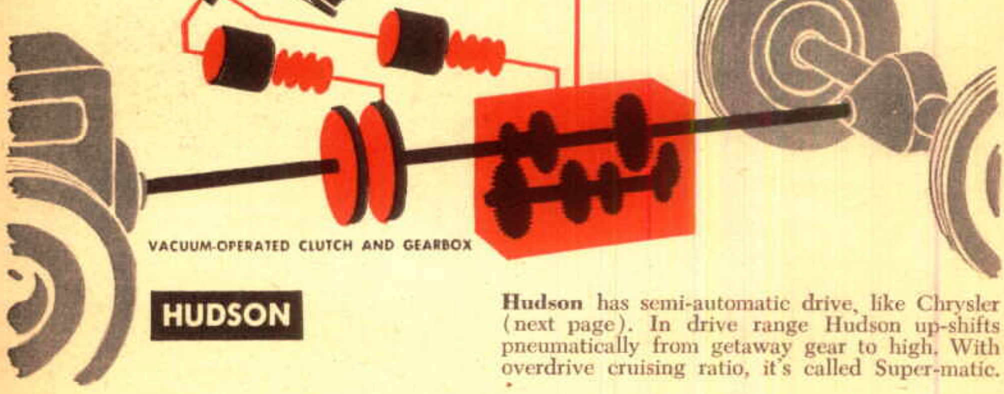
In these pages POPULAR SCIENCE presents a Who's Who of the new drives: how they work, how they differ, their advantages, disadvantages, and costs.

But They're Not Automatic

None of these new transmissions is actually "automatic." They are neither shift-free nor gearless. Even in the simplest, the selector quadrant on the steering column presents the driver with three choices, and most of them present five: (1) park, (2) neutral, (3) emergency low, (4) normal forward drive, and (5) reverse. Freedom from shifting exists only after the lever is flicked into the "drive" position. Even so, driving is not shift-free in snow, mud, or on steep hills. The very latest transmissions have those old solid gears for emergency low and reverse.



Mechanical clutch and gearbox are used in standard transmission. Driver shifts gears manually according to torque requirements. Efficiency, potentially high, depends on driver's expertness.



Hudson has semi-automatic drive, like Chrysler (next page). In drive range Hudson up-shifts pneumatically from getaway gear to high. With overdrive cruising ratio, it's called Super-matic.

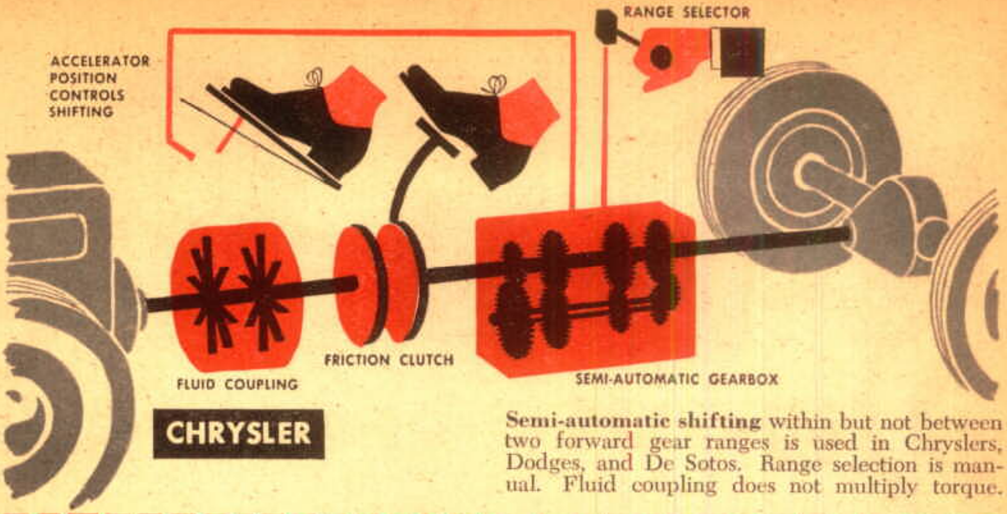
Some of the new drives use automatic gear trains as an adjunct to torque converters for an extra boost from a standing start. Hydra-Matic, oldest of the "self-shifting" transmissions, is a gear job throughout except for its fluid coupling.

The hydraulic torque converter, heart of several newer transmissions, is a fluid gearbox. It simply substitutes the hydraulic advantage of pump-powered turbines for the mechanical advantage or leverage of steel gears. It also gives an infinite number of ratios, compared to the three in a conventional low-second-high transmission.

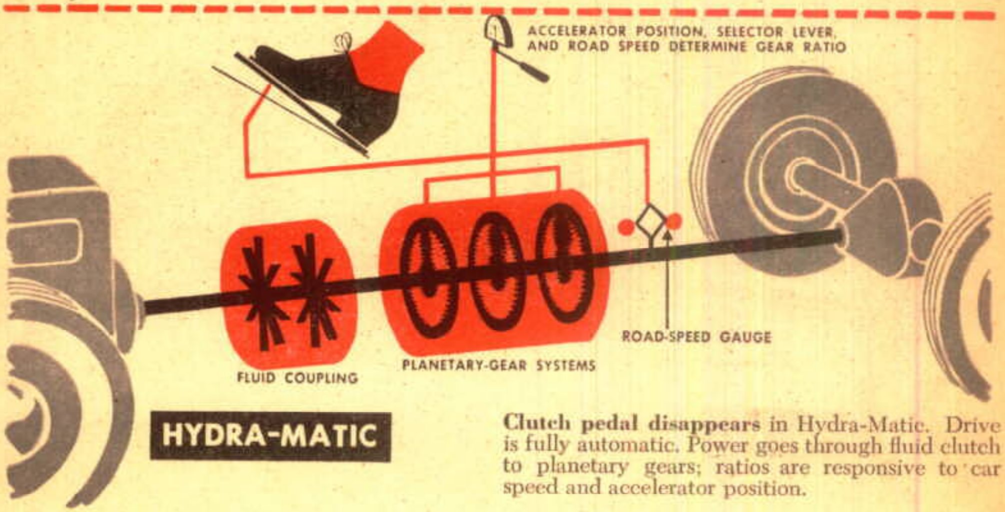
Make Them Shift for Themselves

In engineering an automatic transmission, the aim of the auto makers was to get that familiar H-type shift and clutch pedal out of the driving compartment. They have accomplished this in two ways. The first, and most obvious, way was to make the gears shift themselves (PS, Dec. '45, p. 142). Overdrive (PS, Apr. '49 p. 180) is a small semi-automatic transmission giving an extra high gear tacked on a conventional one. Shifting within but not between the low and high ranges is automatic in some Chrysler Corp. transmissions. All ordinary forward driving with Hydra-Matic is automatic.

The second way is the torque converter, trade-marked Dynaflow on its first introduction to the American private-car market (PS, Feb. '48, p. 113). A new combination of gears plus torque converter is the latest in automatic transmissions. PS readers know that Dynaflow and Packard's Ultramatic (PS, June '49, p. 139) have in common not only torque converters but several other features as well. So do Chevrolet's Powerglide and the automatic transmissions of Studebaker, Ford, and Mercury. It is the



Semi-automatic shifting within but not between two forward gear ranges is used in Chryslers, Dodges, and De Sotos. Range selection is manual. Fluid coupling does not multiply torque.



Clutch pedal disappears in Hydra-Matic. Drive is fully automatic. Power goes through fluid clutch to planetary gears; ratios are responsive to car speed and accelerator position.

way the individual manufacturers combine these basic principles that makes them different.

The new transmissions are neither simple in construction nor simple to understand. They are almost literally built like a watch. No Sunday mechanic can tear one down, put it together, and drive it Monday morning. They're complex because they have to perform a lot of functions that heretofore were performed by hands and feet made dexterous by habit. They must also, within themselves, mend some of their own inherent faults. This explains in part why the automatic transmission took so long to move out of the luxury price bracket.

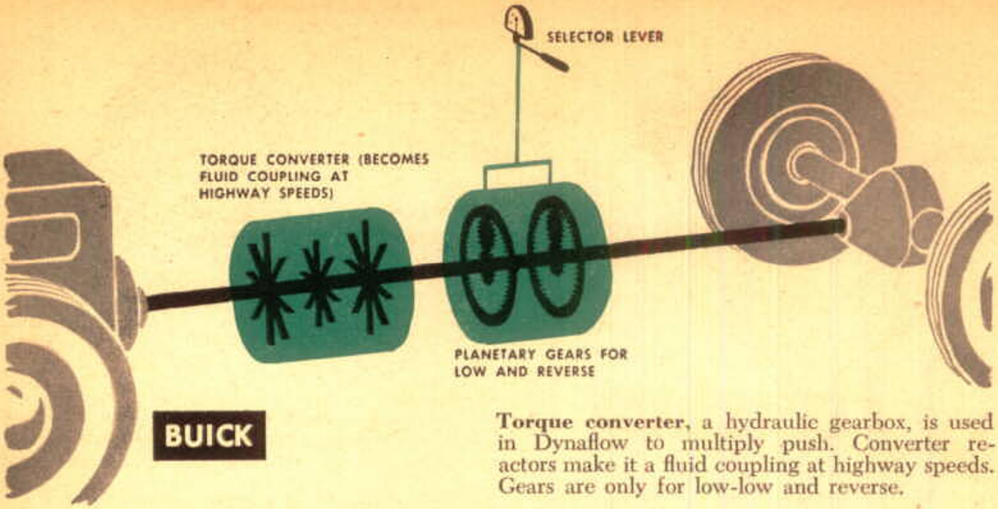
Here are some of the complicating elements that are packed into the new drives:

- The hydraulic torque converter.
- One or more planetary-gear systems (borrowed from the Model-T Ford.)
- Gear-action oil pumps.
- One or more multiple-disk clutches.
- A series of band-type transmission brakes.
- A hydraulic valve block assembly.
- A master-plumber's nightmare of pipes carrying oil under high pressure.

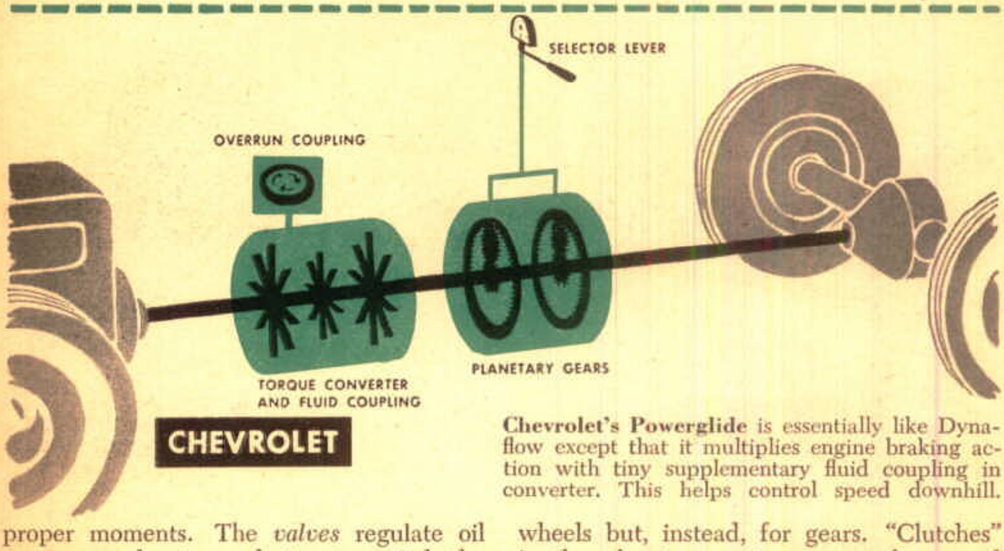
The torque converter and the planetary gears drive the car by transmitting and multiplying engine torque. What elements do *what* and *when* depends on speed, load conditions, and what brand of transmission you are driving.

Controlling the Controls

All the rest of the stuff in an automatic transmission comprises the *regulation* and *control* systems. The *pumps* maintain pressure in the plumbing. The *clutches* change gear ratio and direction of rotation by seizing and releasing planetary parts at the ➡



Torque converter, a hydraulic gearbox, is used in Dynaflow to multiply push. Converter reactors make it a fluid coupling at highway speeds. Gears are only for low-low and reverse.



Chevrolet's Powerglide is essentially like Dynaflow except that it multiplies engine braking action with tiny supplementary fluid coupling in converter. This helps control speed downhill.

proper moments. The *valves* regulate oil pressure and act as *selectors* to switch the power train through the transmission.

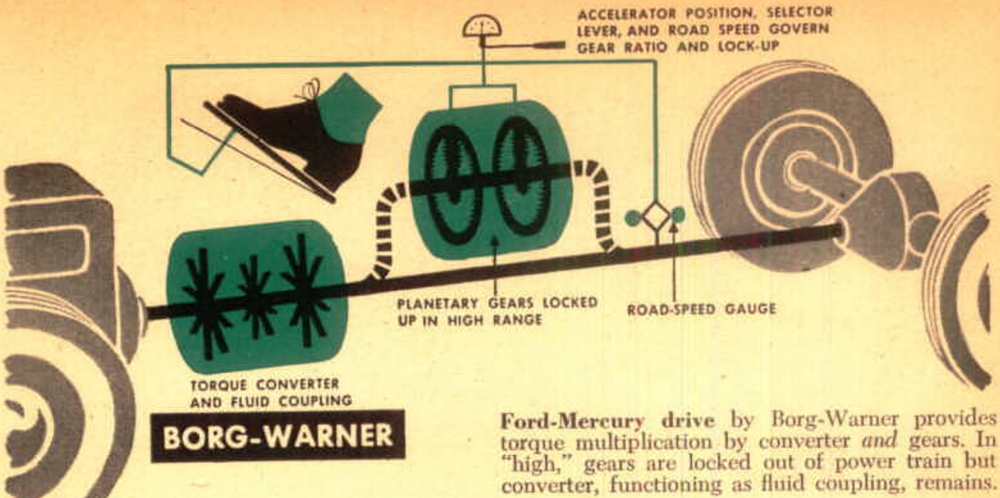
Most of the new drives have, besides the items listed above, a centrifugal *governor*. This is half of a team in the control system. The other half is the driver's accelerator pedal. Between them, they interpret the torque and speed you demand and go around or through the elements in the transmission accordingly.

Studebaker and Packard have a single-plate disk clutch not unlike the clutch in a car with a conventional transmission. This is used to lock up everything in the transmission and provide a direct *mechanical* connection between engine and differential, eliminating hydraulic "slip."

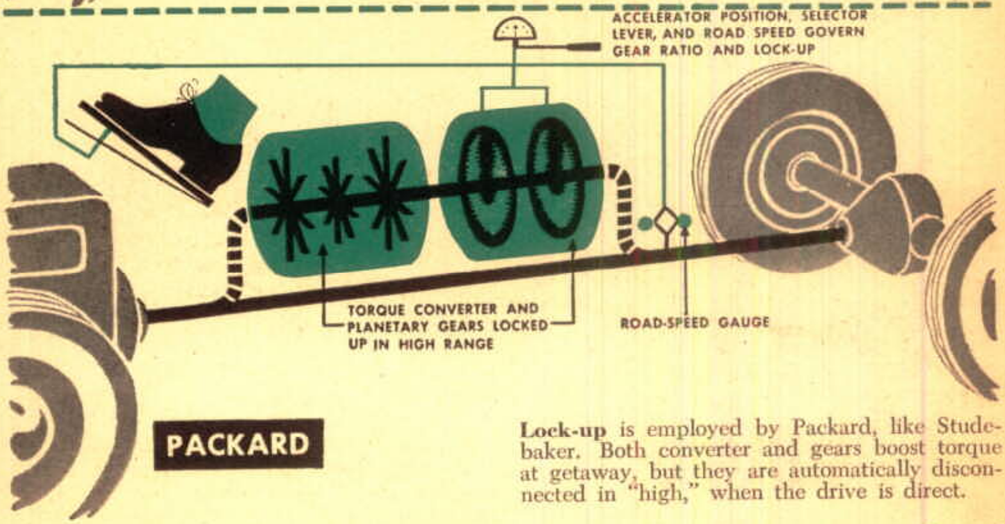
Old automotive words have taken on new meanings. In the new transmissions, "brakes" and "bands" are not those for the car's wheels but, instead, for gears. "Clutches" in the planetary systems are only second cousins to the clutch that responds to the pedal under the left foot. "Valves" have not to do with the engine's cylinders but with the hydraulic system. "Free-wheeling" can mean *gear*-wheeling, not coasting on the highway.

The Manufacturer Says . . . .

Once you get past the torque converter, the most fascinating parts of the new transmissions are the planetary-gear systems and the pipe lines that cause them to deliver, or help multiply, engine torque to the rubber on the road. Here, for example, is the factory's explanation of what happens in the Studebaker in "emergency low"—and if you understand it readily, you will be doing better than most of the engineers in the industry itself:



Ford-Mercury drive by Borg-Warner provides torque multiplication by converter *and* gears. In "high," gears are locked out of power train but converter, functioning as fluid coupling, remains.



Lock-up is employed by Packard, like Studebaker. Both converter and gears boost torque at getaway, but they are automatically disconnected in "high," when the drive is direct.

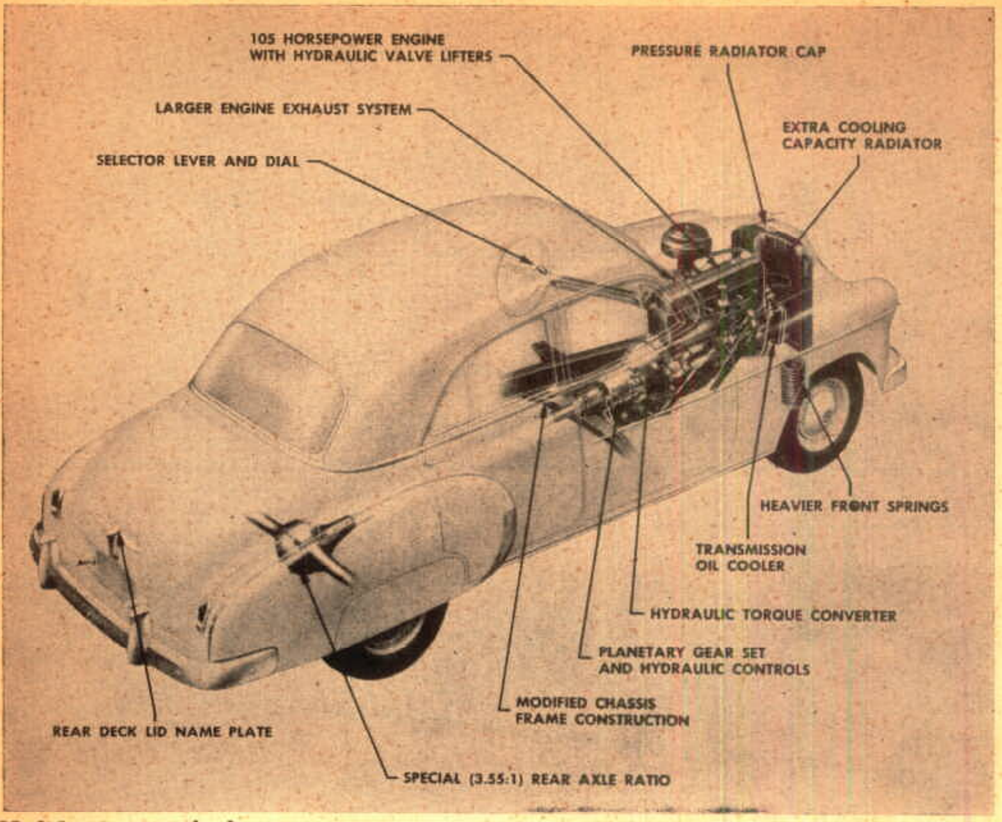
A *lockup band* and *forward drive band* are applied through their *hydraulic servo mechanisms*. The *lockup band* holds the *sun gear* of one of two *planetary* sets stationary, while the *forward band* holds stationary the *sun gear* of a *second planetary* set through a *free-wheel unit* fitted with *sprags* to prevent *counter-rotation*. The *power flow* is from the *turbine* shaft of the *torque converter* to the *ring gear* of the *first planetary set*. In a simple *planetary-gear system*, a forward ratio drive is effected through the *planet carrier* when the input is through the *ring gear* and the *sun gear* is held *stationary*. The two *planetary sets* function alike, but the second one effects a different ratio due to different numbers of teeth. The total gear ratio in first gear is the product of these two ratios in the planetaries, or 2.308 to 1. The *combination* of this *gear reduction* and the *torque multiplication* in the *converter* as the car starts gives a maximum ratio of 4.96 to 1 at the rear axle.

But you actually get a torque effort of better than 17½ to 1 in emergency low. How come? Well, you multiply the *gear reduction* in the planetaries times the *torque boost* in the converter *times* a rear-axle ratio of 3.54 to 1.

Gas Economy? Servicing? Performance?

No, the new transmissions are not simple. And the differences among them are going to supply no end of argument around the gas pumps for many years. Bear in mind that these differences reflect honest divisions of opinion among design engineers. One engineer is a nut on servicing economy, another on gas economy. Still another wants getaway performance. In the end every engineer has to compromise, and it is the differences in the compromises that produce the differences in drives.

Dynaflow, which has no torque multi-



Modifications involved in putting a torque converter in new Chevrolet are shown here. More power, transmission oil cooler, and change from 4.11-to-1 rear-axle ratio are important ones.

plication by gear when the car is in the driving range, has the great virtue of relative simplicity. But Dynaflow requires more engine power if the rear-axle ratio is to be kept within economical limits. Chevrolet's Powerglide is like Dynaflow except that it incorporates an extra gizmo in the torque converter to afford extra engine *braking* power in going downhill. Chevvy must pay for that advantage in forward-driving efficiency, if ever so slightly.

They're All Different

In the interests of simplicity, Ford and Mercury will have no mechanical lock-up, as Packard and Studebaker do, to by-pass the torque converter for direct, mechanical drive once the car gets rolling.

Who's right—Ford, or Packard and Studebaker? Oldsmobile and its licensees (Cadillac, Pontiac, Nash, Lincoln, Kaiser, Frazer) cling to automatic gear drive without fluid torque multiplication. Who's right? Chrysler and Hudson as yet haven't given complete "automatic" drive a tumble. Who's right, for whom, for how much?

What has been gained, now that the new automatic transmissions are here? Their drawbacks are plain. In ordinary driving, even the best of them give slightly less gas mileage than conventional gearboxes.

Heat Is a Problem

It takes extra gas to move that extra machinery, and heat energy is built up inside the torque converter that is dissipated into the air. In fact, some of the new transmissions have a special radiator to get rid of the heat. On sizzling days some torque converters over-heat. The oil in them froths. The air content cuts the density and reduces the amount of torque transmitted to the rear wheels.

Almost all of the new drives "creep" at the stoplight, especially when the engine is cold and is kept at a fast idle by the automatic choke. A firm foot must be kept on the brake pedal until the light turns green.

The first price of an automatic transmission is higher. It will come down, but it probably will be years before it is as cheap as a conventional shift. For a long time, servicing is bound to cost more.

Although designed to make the dub a smooth driver, the new transmissions will require even the experts to re-school themselves for best performance or best gas mileage. They must be pushed briskly—18 or 20 m.p.h.—when the battery won't start the engine, and shouldn't towed to start, unless you want to risk smacking the towing car when the engine catches. Snow-driving must be relearned. The selector lever must be treated with the same caution as the old clutch pedal and shift lever.

But the "disadvantages" of the new drives are outweighed by their advantages. Efficiency may be below that of an *ideally* manipulated manual shift, but it'll be a lot better than that turned in by the dub—or the lazy expert. Moreover, the cushioning fluid absorbs a lot of driving stresses, with consequent long-run savings. Eventually, automatic drives will let the driver forget his car and concentrate on the road. That ought to make driving a lot safer. And then there's another advantage:

You'll Give In Eventually

You may say no to the salesman this year when he suggests an automatic drive. But be wary if the man who lives across the street buys a car without a clutch pedal. As sure as shooting, his wife is going to tell *your* wife about shift-free driving.

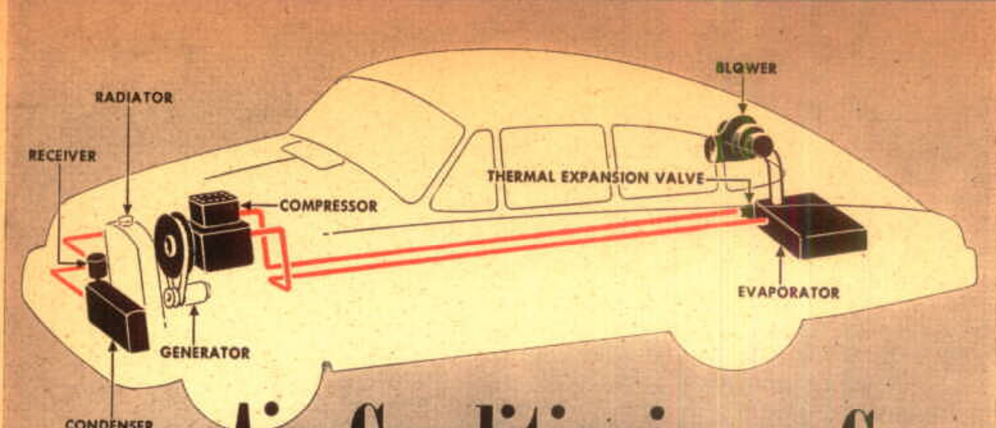
An automatic transmission is a great advantage if it only keeps peace in the household. END

BOX SCORE OF AUTOMATIC DRIVES

This chart shows the availability and prices of factory-installed automatic and semi-automatic drives and overdrives on 20 U. S. cars. Where models are not specified, the notation applies to all of that make. Prices are those recommended to dealers and are listed only where the drive is optional equipment. They do not include excise or sales taxes.

CAR	DRIVE	STANDARD/OPTIONAL	PRICE	OVERDRIVE	PRICE
BUICK	Dynaflow	Standard on Roadmaster only	$160	Not offered	
CADILLAC	Hydra-Matic	Standard on 62 Series and 60 Series Special only	174.25	Not offered	
CHEVROLET	Powerglide	Optional on DeLuxe only	150	Not offered	
CHRYSLER	Prestomatic	Standard except on Royal	120	Not offered	
CROSLEY		Not offered		Not offered	
DE SOTO	Tip-Toe Shift	Standard on Custom only	120	Not offered	
DODGE	Gyromatic	Optional	94.60	Not offered	
FORD	Borg-Warner	To be optional	150 (est.)	Optional	$ 96.90
FRAZER	Hydra-Matic	Optional	*	Optional	91
HUDSON	Super-matic Drive-master	Optional Optional	189.50 99.50	Optional	90
KAISER	Hydra-Matic	Optional	*	Optional	91
LINCOLN	Hydra-Matic	Optional	174.25	Not offered	
MERCURY	Borg-Warner	To be optional	150 (est.)	Optional	100
NASH	Hydra-Matic	Optional on Ambassador only	158.50	Optional	Statesman 93.50 Ambassador 99.80
OLDSMOBILE	Hydra-Matic	Optional	158.50	Not offered	
PACKARD	Ultramatic	Optional on Custom only	185	Optional	92
PLYMOUTH		Not offered		Not offered	
PONTIAC	Hydra-Matic	Optional	158.50	Not offered	
STUDEBAKER	Borg-Warner	Optional on Land Cruiser and Commander only	*	Optional	Land Cruiser 93 Commander 93 Champion 87
WILLYS		Not offered		Standard on 4- & 6-cyl. station wagons and Jeepsters; not otherwise offered	

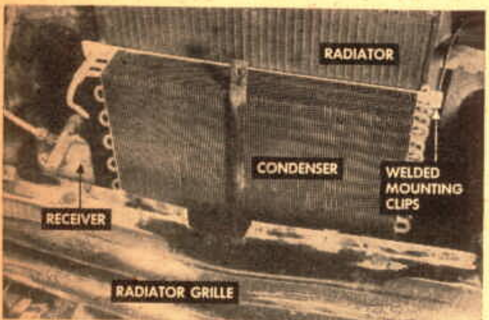
*To be announced



Air-Conditioning a Car

A home-installed mechanical cooling system keeps passengers in this 1948 Oldsmobile comfortably cool, even in the hottest midsummer weather.

By Walter B. Moses, Jr.

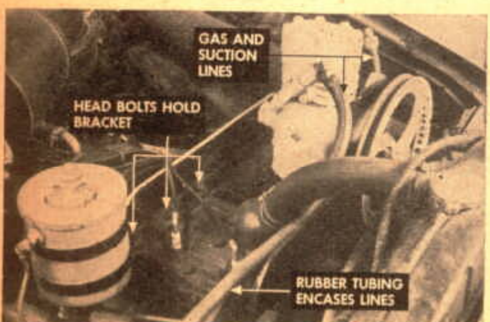


Though bolted directly in front of lower part of the radiator, the condenser has been found not to interfere with cooling of the engine.

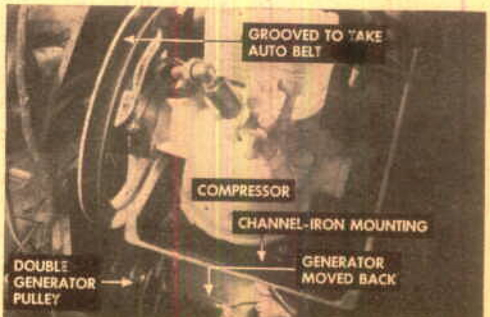
PITY the poor motorist who must drive on a heat-soaked highway under a broiling sun, cooped up in an upholstered steel box, and propelled by a gasoline-fired heat engine. It's about time we did something to cool him as well as his engine.

Of course you can buy an evaporative-type window cooler, good on long, fast trips in dry country, but it won't help much where heat is accompanied by high humidity—which it is in most of the country. Here mechanical refrigeration, the kind that's custom-installed in high-priced cars, must be used. I've put it in my 1948 Oldsmobile and it keeps the car comfortably cool on the hottest midsummer days in Louisiana.

The actual heat load on a car is tough to calculate, depending as it does on many variables, including window area, speed, outside temperature and humidity, tightness of windows and doors, and insulation in the roof, firewall, and floor. However, it seems



Cylinder-head bolts hold the cut-away piece of channel on which compressor is mounted. Note sponge-rubber insulation on the tubing.



Compressor is aligned with the rear one of two pulleys on the generator shaft. Front channel flange is trimmed to clear boss on compressor.

safe to say that the average car generally requires from one to two tons of mechanical refrigeration. (This means that it needs provision for removing as much heat as would melt from one to two tons of ice every 24 hours.)

A cooling system this size is several times larger than the ordinary room air-conditioning unit for home use. The compressor and condenser in my car are both nominally rated at ½-ton capacity, but they work fine. This is because the compressor runs faster than before when the car is driven at normal highway speeds, and because the volume of air passing through the condenser is much greater than in fixed applications. I keep the belt on the compressor at all times during the cooling season, handling day-to-day variations with the blower fan.

Three major pieces of equipment comprise the system: (1) the compressor, which changes the Freon® refrigerant from a gas to a liquid and which needs belt power; (2) the evaporator, which absorbs heat from the air inside and which has an electric blower; and (3) the condenser, which discards the heat extracted and which needs a flow of outside air. These parts might be taken from old commercial refrigerators.

Other parts include a receiver to hold the condensed Freon, a thermal expansion valve by the evaporator, and a drain to discharge water removed from the air into a fender well. Installing this equipment isn't too easy, since it involves numerous problems of support and clearance. Most of the work has to be planned on the car itself rather than at the drawing board.

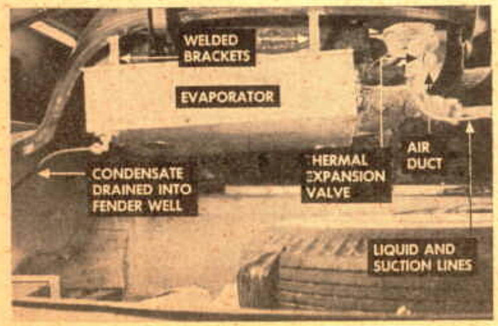
I mounted the compressor on a cut-down piece of 10" channel iron bolted to the head with the existing bolts. Rather than use a single belt on the engine, water pump, generator, and compressor, I drive the compressor from a special double pulley attached to the generator. This permits removal of the extra belt when cooling isn't needed. The generator was moved back 1⅜", the width of the pulley, and a second pulley was silver-soldered to the first while both were aligned on a mandrel. The pulley on the compressor was grooved out on the lathe to take a standard auto V belt.

The condenser is mounted in front of the bottom half of the radiator by angle clips welded to the radiator frame, to which are bolted matching clips welded to the condenser. Brass bolts hold the assembly in place. Even in extremely hot weather I have been able to detect no increase in engine operating temperature due to air obstruction from the condenser. The receiver is secured by a bolt running up through the dust pan in front of the radiator.

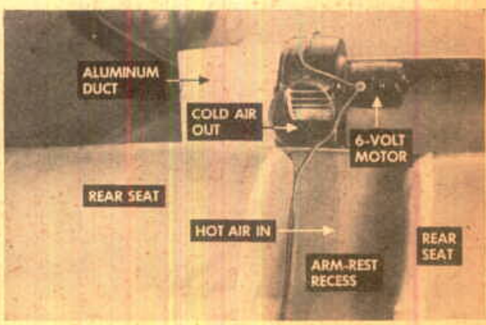
Located to minimize obstruction of trunk space, the evaporator is bolted under the deck behind the rear seat. Air entering the trunk around the seat and through the center arm rest is drawn through the evaporator to be cooled and dehumidified. The moisture it gives up is piped out the left fender well. The air is then drawn up through an aluminum duct and discharged toward the front of the car by the 6-volt fan.

Normal infiltration of outside air is more than adequate to handle ventilation. The blower, connected through a SPDT switch to the regular heater switch, effects a one-minute recirculation of air inside.

The refrigerant lines are mainly ½" soft copper and are fitted at several points with necessary flexible connections. I covered them with "spaghetti" insulation of sponge rubber and ran them back inside the right frame channel. END



Where the coolth is produced. Air entering the trunk around rear seat is drawn through the evaporator and ducted upward and forward.



Blower on rear deck directs air toward front of car. All windows and ventilators are kept shut when air-conditioning system is working.

When mounted, aluminum visor compares favorably with a commercial job—and costs less.

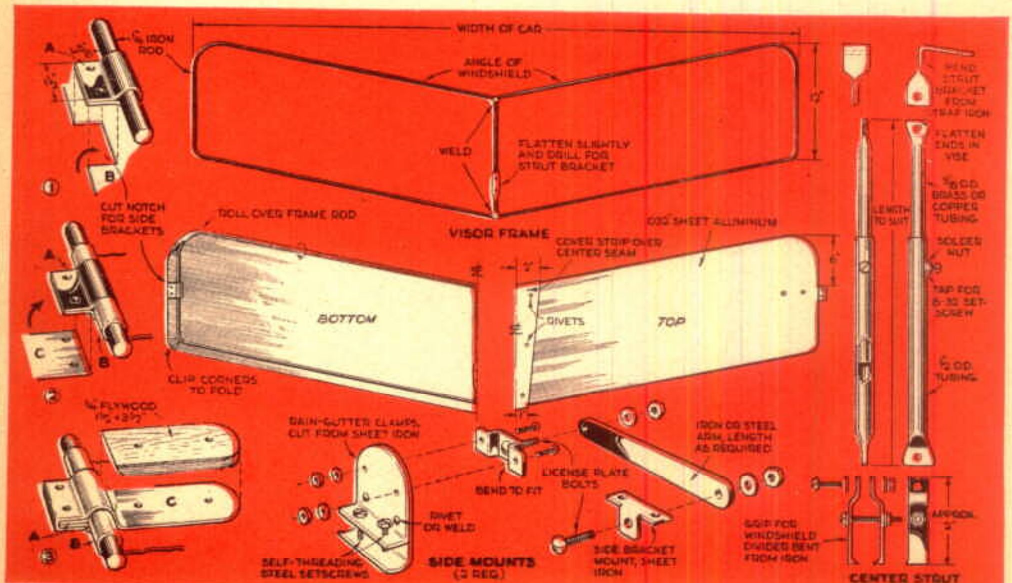
Homemade Visor Costs Only $4

By Roland Cueva

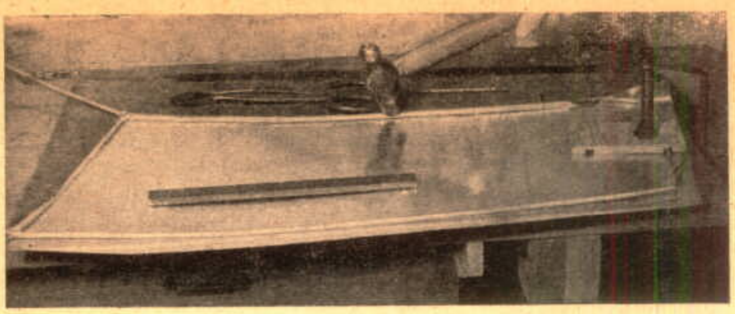
THE day I installed my aluminum visor, a friend wanted to bet it was too flimsy. I wish now I had taken the bet. Months later, the visor still is rigid. It has not shown the slightest sign of a wobble.

Even if you buy all materials, a visor like this usually can be built for less than $4. Material at hand may reduce the total cost.

Frame. Measure the car width across the windshield posts and take the sweep-



Side-bracket details are seen from below in Figs. 1 to 3. Roll the notched aluminum (B) around the rod. Bend stiffener strip (C) up and over bracket (A). Rivet through plywood.



Aluminum rolls easily over the ¼" rod frame. Pound it down as shown here and then smooth the rolled inner edge with an iron bar like the one in foreground. Notice side bracket on the rod at the right.

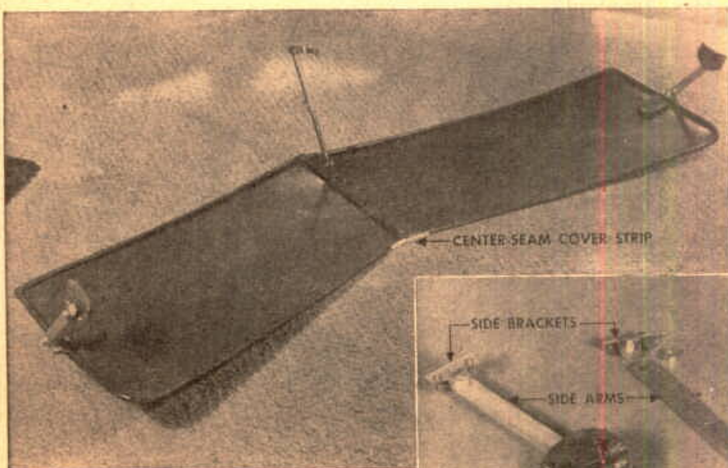
back angle. Then cut a cardboard pattern 12" wide for half the visor, transfer it to plywood, and saw it out.

Nail the wood pattern to your workbench or shop floor. Starting at the center back, form the ¼" aluminum or iron rod around it. Clamp or nail the bent rod in place. When you reach the center front, pry up the pattern, flop it over, renail it, and continue bending the rod to the starting point. Cut off the excess rod and weld a piece 11½" long across the frame center. With a hammer, flatten a part of this member and drill two ⅜" holes for the strut bracket.

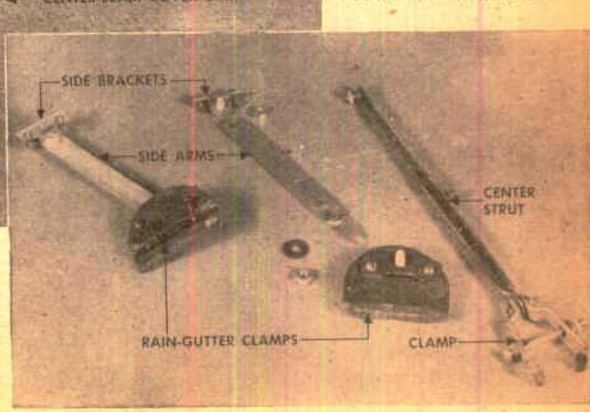
Covering. Use .032" aluminum for this. A sheet 18" wide and 5½' long will do the job. Put down the pattern and mark around it 1¼" from the edge except at the center line, which you mark flush. Snip out this panel. Then turn the aluminum over. Use the same center line to mark and cut the opposite panel.

Clamp the frame to the aluminum and roll the sheet over the rod. Clip the corners so they will pound down smoothly. When you install the side brackets, stiffen each, as shown, with an aluminum strip rolled over it and sandwiched between the cover sheet and a plywood block. Fasten by rivets through this sandwich. Make the center strut bracket and attach it with machine screws. An aluminum cover strip is riveted over the center seam and the ends rolled over the frame. Take the visor to the car. Bend it down gently over a sawhorse until it conforms to the roof curve.

Fittings. Details of these are illustrated but they must be made to fit your particular car. Shape the gutter clamps to match the gutter, and use nonrusting stock. END



Finished visor, seen at left, can be lacquered to match car. In this case, the middle cover strip on the top surface was left bright. Note how side mounts and strut are attached.



Adjustable fittings used are pictured at right. Instead of making side arms as shown, you could use casement-window adjusters. The strut clamps to base of windshield divider.

Engineering Your Own Midget Car

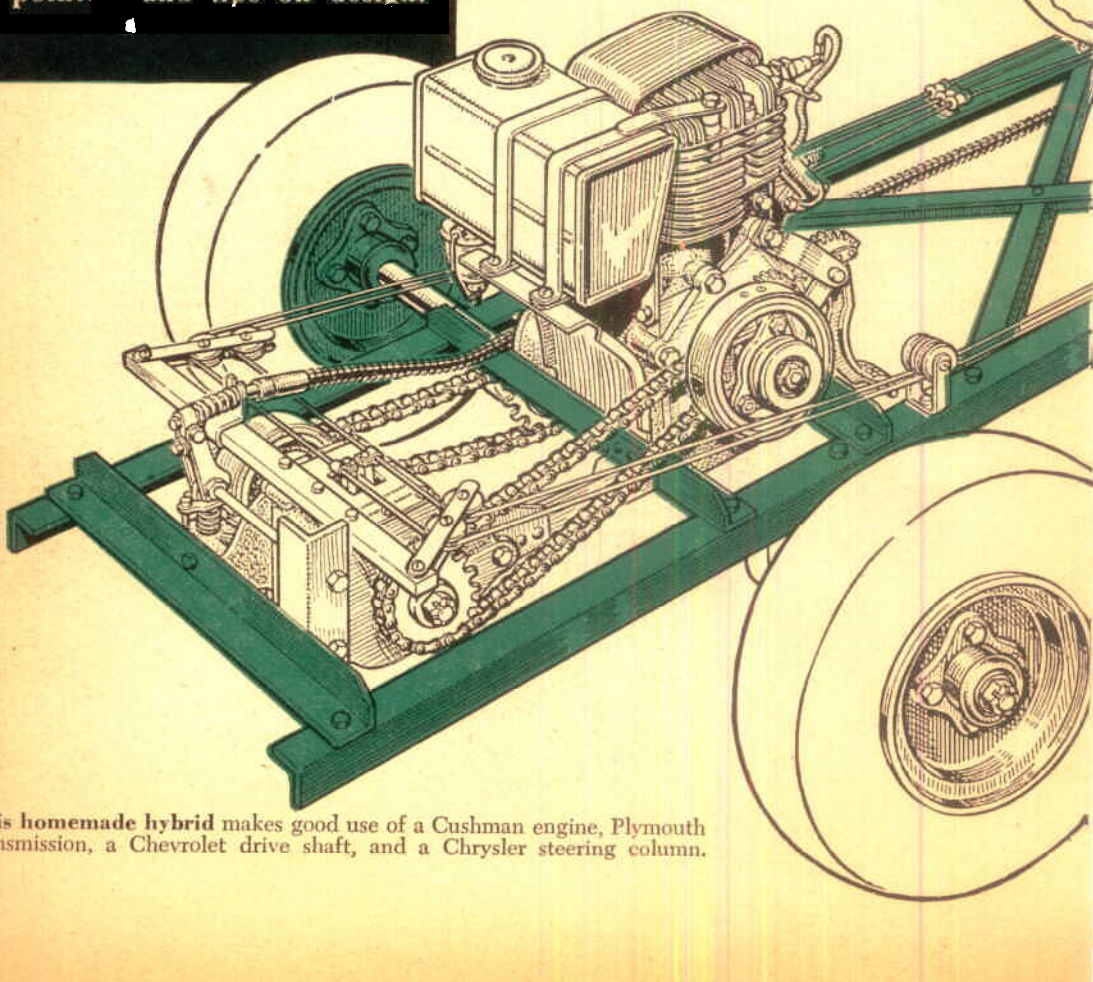
Tempted to build a tiny car around an air-cooled engine? This article gives practical pointers and tips on design.

IT'S not easy to look at one of the small air-cooled engines you can buy fairly cheaply these days without dreaming of building a midget car around it.

If you try it—and plenty of people have—you may end up with anything from an overgrown motorized coaster wagon of practically no utility to a slick little trick that'll do you proud on the highway. Which you get depends on a lot of factors, among them the time, tools, pocketbook, construction skill, and design sense you bring to the task. This article won't give plans for a specific car, since so much depends on the engine you use and the service desired. But it *will* give design pointers that the writer learned the hard way.

Your first, highly important job is some hard thinking about what you want. If the car is simply for casual jaunts in a spacious back yard or along level private roads, you can get by with a primitive design—say, a fixed pulley ratio, and perhaps no clutch.

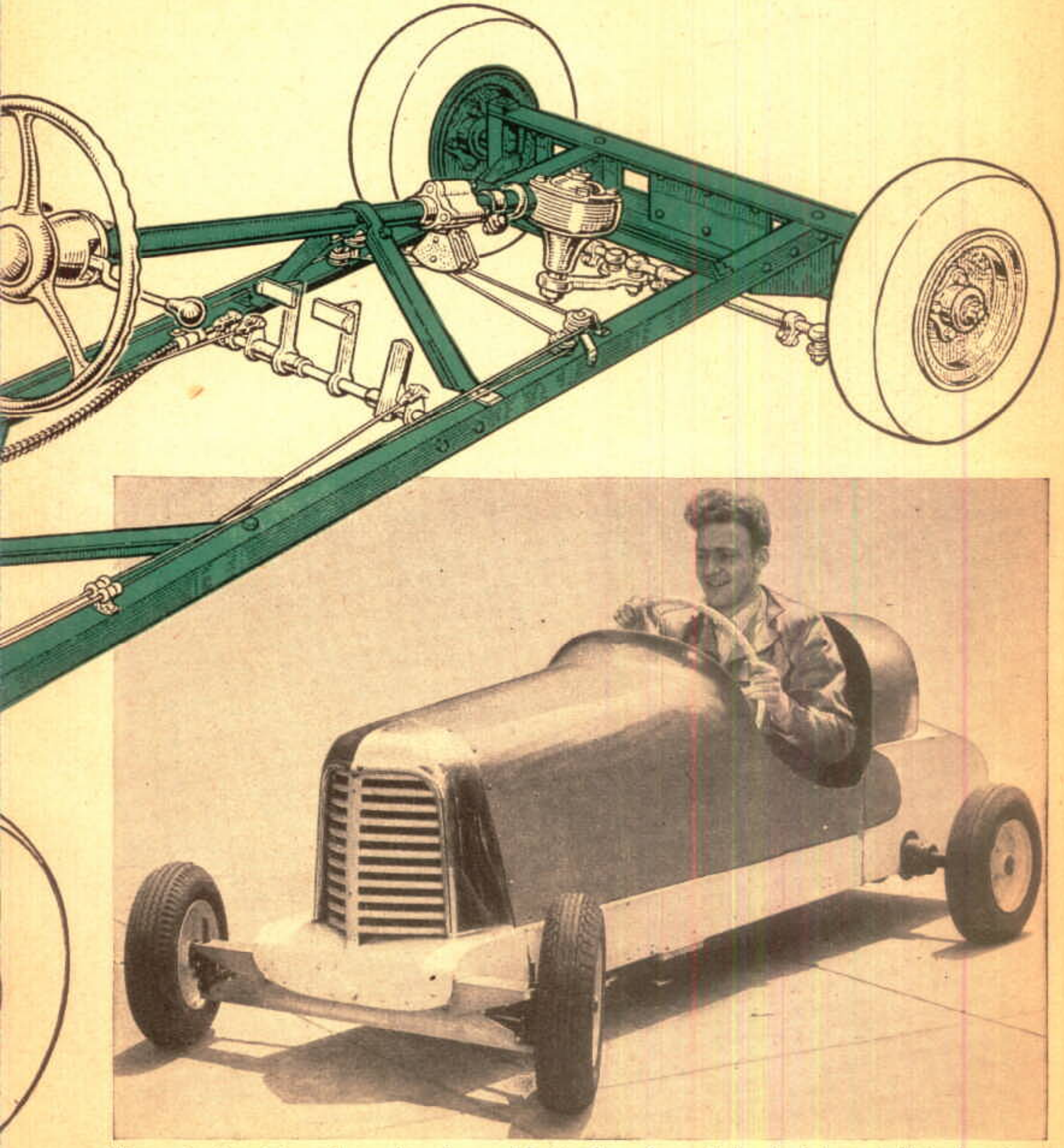
But if you're going to venture out on the



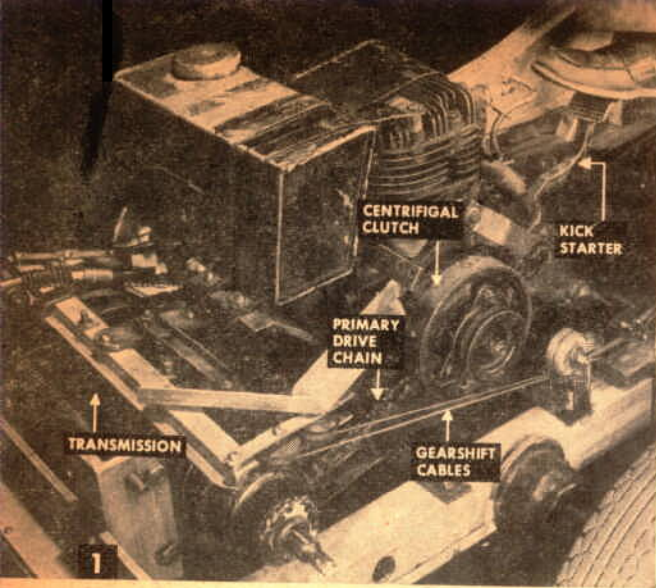
This homemade hybrid makes good use of a Cushman engine, Plymouth transmission, a Chevrolet drive shaft, and a Chrysler steering column.

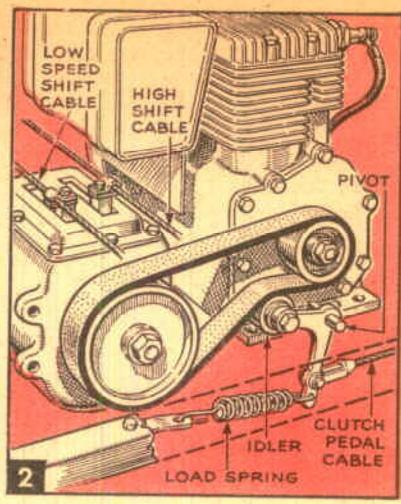
highways, where the car may mix it up with its big brothers from Detroit, you'll have to work harder. Not just because of the licensing requirements, either. You'll need good brakes, good lights, and reliable, flexible performance. Otherwise, the car won't be useful—or safe. If it's to go on the highway, it's just plain *got* to meet highway standards.

Most midgets are built around the engine, so let's begin there. Chances are you'll be using one of the common four-cycle, single-cylinder engines ranging from ⅝- to 9-hp. Here's a table that'll help you estimate the power needed, depending on the minimum top speed and hill-climbing ability you're willing to accept. (It assumes an overall weight of 450 lb., and allows for a 10



Clean sheet-metal work won't make a midget run better, but it will take a job out of the soap-box class. Galvanized iron, judiciously pieced with junk-yard parts, produced this slick body.





percent power loss in the drive system.)

% Grade	Horsepower Needed, Speed in m.p.h. 10	15	20	25	30	35	40
0 (level)	.6	1	1.6	2.2	3.1	4.3	5.8
5	1.2	2	2.9	3.9	5.0	6.6	8.5
10	1.9	3	4.2	5.5	7.1	8.9	
15	2.5	4	5.5	7.2	9.1		
20	3.2	5	6.8	8.8			

Next, you're ready to calculate the overall drive ratio to give most effective use of the engine's power. The problem is to select a ratio that will bring the engine to the speed where it gives greatest power when the car is traveling at the top speed obtainable from that horsepower. Figuring this calls for knowing (besides horsepower and road speed) the size of the drive wheel to be used and the r.p.m. at peak power. This latter figure, incidentally, is generally a bit less than peak r.p.m. Here's a table for an engine having a power peak at 2,800 r.p.m. and a drive wheel of the common 4 by 8 pneumatic wheelbarrow type:

Drive Ratios						
Speed in m.p.h.	10	15	20	25	30	35
Overall ratio (to 1)	13.4	8.9	6.66	5.33	4.45	3.8

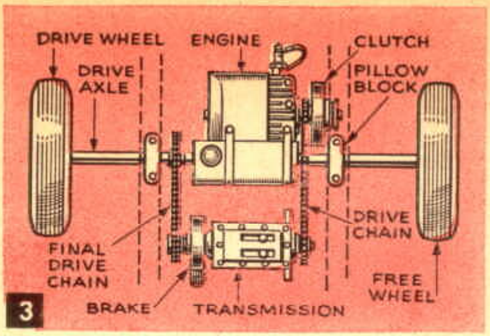
Let's assume you have a 3-hp. engine. The first table indicates it will drive a 450-lb. load at about 30 m.p.h. on a level road. The second table indicates the engine-to-wheel ratio in high gear should be about 4.45 to 1. And to take the same car up a 20 percent grade at 10 m.p.h., a ratio of 13.4 to 1 will be needed.

Obviously, variable gear ratios are needed for all but the most primitive cars, since a fixed one is necessarily a compromise between speed and power. This in turn means you'll need some kind of transmission and, in most cases, a clutch as well.

For a clutch, a commercial centrifugal one of the type shown in Fig. 1 is very useful. Employed on many motor scooters, it automatically disengages at idling speed, and applies power smoothly as the engine is revved up. Lacking such a clutch, you may be able to get by with idler-pulley or slack-belt clutch, such as is shown in Fig. 2. However, it'll need careful adjustment and will give trouble if allowed to get oily or wet. It may also slip under heavy loads.

A V-belt primary drive would give you less trouble with slippage, but you'll find it tough to get good clutch action with V-belts. They have a tendency to transmit power even when very slack, unless the outside of the belt system is caged to concentrate the slack over one pulley. Also the clutch may have a tendency to grab.

The power train shown in Fig. 3, incorporating a standard auto transmission, has much to recommend it. Being mounted transversely, the transmission acts as a countershaft. It permits the total 4.45 to 1 ratio to be divided into a 2.2 to 1 ratio from engine to transmission and a similar ratio between the transmission and rear axle. The attached parking brake provides a good means of stopping the car, and the lower gear ratios are valuable for starting and hill climbing. The reverse gear, though not absolutely necessary, will often be handy.



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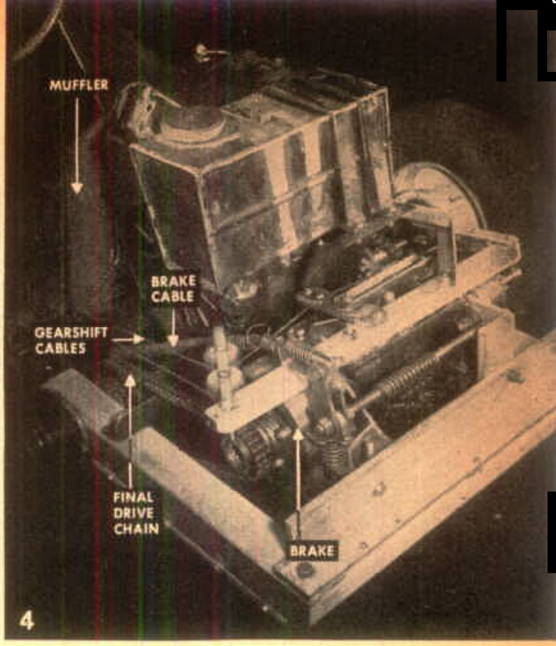
Figures 1 and 4 give details on such a setup. Note that the transmission is controlled by cables clipped to the shifter forks.

If you're willing to dispense with reverse gear, a motorcycle transmission may be the answer. It incorporates a clutch, and it's lighter and smaller than a car transmission. You'll have to devise a separate braking system as in Fig. 5.

A regular auto differential is far too clumsy for most midgets, and yet some arrangement is necessary to let the rear wheels "corner" at different speeds. One answer is to drive the left wheel only. On the car shown here a 1⅜" drive shaft running in ballbearing pillow blocks acts as a live rear axle. Splines at the left drive that wheel through a welded sleeve; the other wheel floats on ¾" roller bearings.

As for springing, much depends on the roads the car will use and the type of wheels employed. In the writer's experience, 4 by 8 pneumatic wheels provide all the "springing" needed on smooth roads at modest speeds. But if springing is desired, study the details sketched in Figs. 6 and 8. Experiment with the stiffness of the coil springs in the rear and the number of leaves in front to produce the best ride. If you employ springs, be sure to allow for the effect of axle movement on the final-drive chain in the rear, and on the steering linkage in the front. Also make provision for braking thrust and torque.

Steering geometry and front-end construction may be simplified by a study of Figs. 7 through 12. The most important consideration is to have the inner wheel on a turn cut in at a sufficiently sharper angle than the outer wheel. (This is necessary because the inner wheel travels a smaller circle than the outer one, and it must reach and maintain this lesser radius if it's to avoid sidewise tire drag and wear.)



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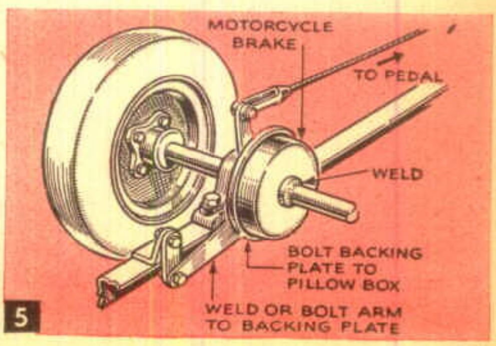
The correct angles will be approximated at all times if the steering is designed as in Fig. 7, with the two steering-knuckle arms pointing to the center of the rear axle when the front wheels point dead ahead. Be sure the king pins and their tie-rod ball joints are at that time accurately aligned with the center of the rear axle.

A wheel spindle may be built up by driving a turned steel shaft into a turned or tapped steel block. The resultant knuckle assembly must be permanently strong, so use a heavy drive fit that's pinned and peened or welded. The ends of the block may be either drilled and tapped, as in Fig. 8, for a sprung front end, or turned to give kingpin studs, as in Figs. 9 and 12. Steering-knuckle arms could be angle sections bolted and welded in place, or steel shafting driven into the blocks and secured in the same way as the wheel spindles.

Accurate and reliable steering control



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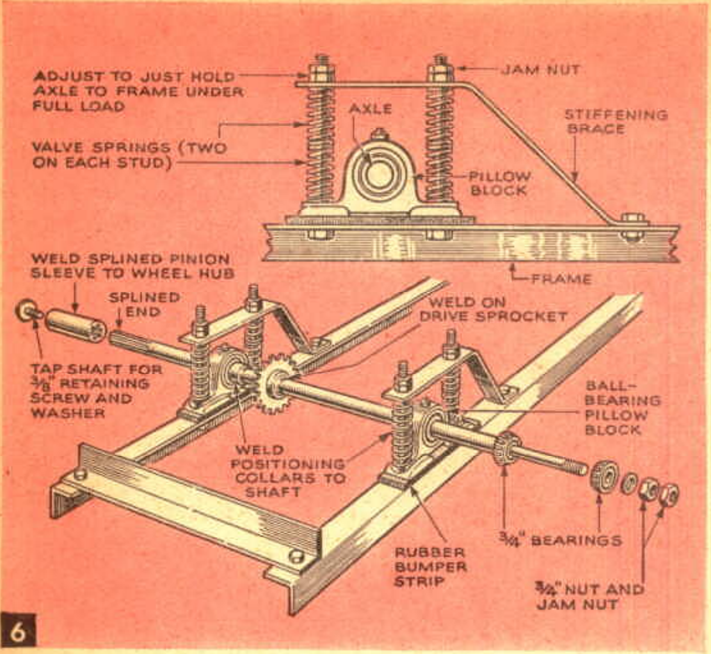

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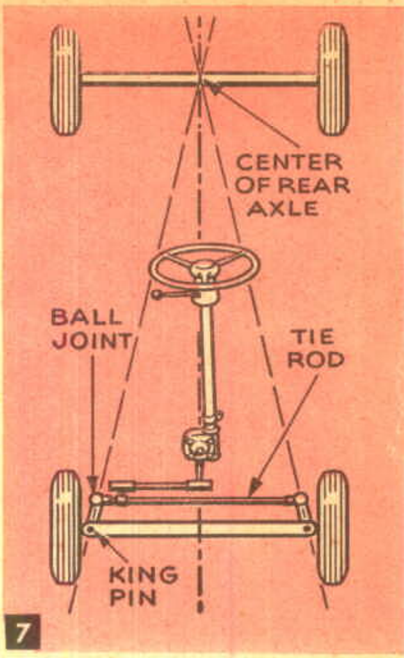

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calls for a cut-down steering post and gear from a regular car, preferably of the type that uses a drag link parallel to the axle. Try to obtain one that's fitted with a shift lever, since this will simplify transmission control. Methods of mounting and bracing the gear are suggested in Figs. 10 and 11. And don't skimp on the job of safetying the entire linkage, preferably with castle nuts and cotter pins.

Throughout the construction of the car (and especially if you choose a sprung front end), you'll run smack into clearance headaches. For instance, the steering drag link

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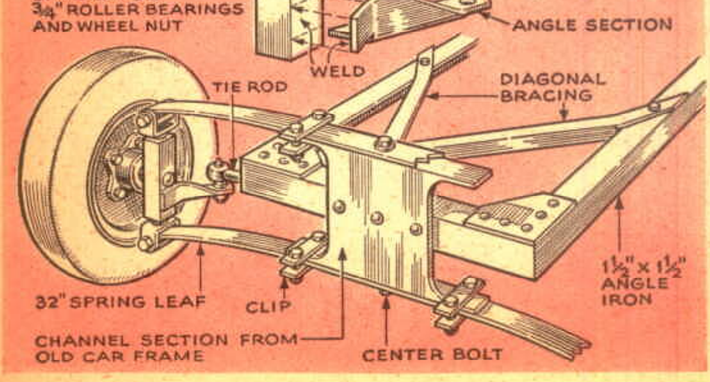

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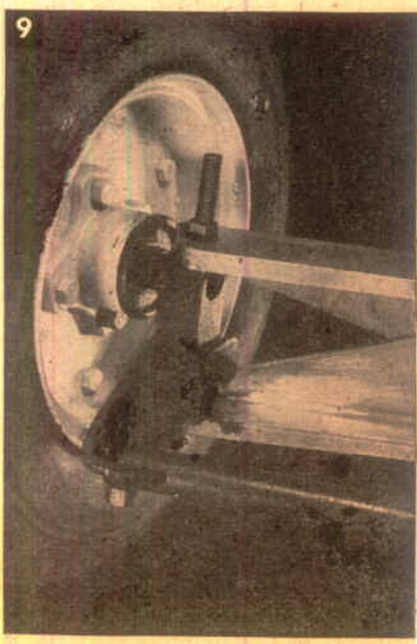

must obviously clear the frame in all steering positions and all loads. It is a good plan to dope out clearances on paper as far as possible ahead of time. Another good scheme is to prop up the parts in approximate position before you weld, cut, drill, or otherwise commit yourself.

Light structural-steel angle stock with welded joints will make an excellent chassis, as will somewhat larger aluminum-alloy angle. With steel you will need to strike a nice balance between insufficient rigidity and excessive weight; with aluminum the problem will mainly be to get secure bolted or riveted joints. Try to employ angle stock in the ways that will give maximum stiffness; the paired pieces that make up the front axle in Figs. 9 and 12, for instance, act almost as a box or channel section and combine lightness with strength.

The location of the engine is up to you, but rear mounting has much to recommend it. Simplicity, compactness, and less heat and noise are among its advantages. Don't let the wheelbase and tread creep beyond modest dimensions. One way to determine the shortest wheelbase that will serve is to prop up the engine, transmission, and other major parts in approximate position on the shop floor. Then measure off what's needed to make a comfortable driver's compartment, chalking off the area occupied. You can now make a good estimate of the shortest wheelbase that will still fit everything in. As for the tread, the proportions will be about right if it is approximately half the wheelbase.

A nicely engineered chassis deserves a good body. You'll simplify things if you hold compound curves to a minimum. Either sheet aluminum or galvanized sheet iron will serve. Such compound curves as are necessary can be had by cutting and piecing sections trimmed from big-car fenders.

It's probably evident by now that you'll gain by a familiarity with local auto graveyards. Other good supply sources are war-surplus outlets; 3/32" flexible steel aircraft cable, for instance, is fine for transmission controls. Motor-scooter and motorcycle shops will also help out, especially for horns and lighting systems.

Finally, keep in mind the "little things"; if you neglect them, they won't seem so little. Be sure the engine will get enough cooling air. Provide easy access to the fuel tank and oil plug. Leave enough space for the kick starter or pull rope. Protect drive chains or belts from gritty puddle splash, and don't forget that unfendered front wheels can sling a mean mud bath. Use a muffler that really muffles—a noisy engine will set your nerves on edge. And be certain that all chains, belts, and hot tailpipes are shielded from stray fingers.—*Roy M. Howell, St. Albans, N. Y.*

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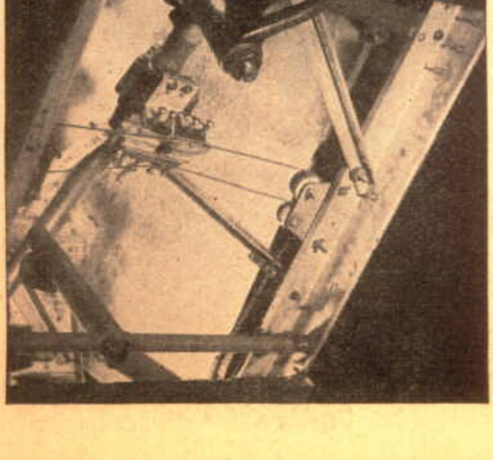

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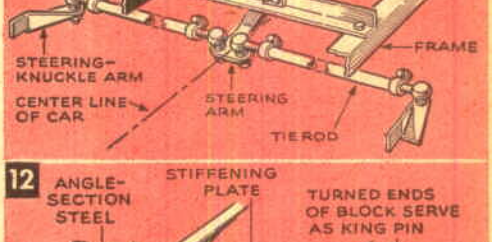

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