How Overdrive Works

Here are some little-known facts you'll find valuable if your car is equipped with this semi-automatic transmission.

Drawings by Stewart Rouse

WHEN you first take the wheel of a late-model car equipped with overdrive, you'll soon discover that some of your old driving habits don't quite fit. For one thing, you are used to judging car speed by engine sound. So you may scare yourself on the first curve. Or collect a few speeding tickets.

There's a reasonable explanation for this. Overdrive cuts engine speed 30 percent. Compared to the job it usually has to do, the engine loafs. Naturally, it runs more quietly, and you're apt to underestimate the speed at which you're traveling.

Automatic overdrive was introduced 15 years ago. Since then, two and a quarter million units have been manufactured and installed on cars. Yet, despite its long history and expanding use, there's surprisingly little understanding of how it works or what you can do with it. Many drivers think of it solely as a fourth gear for open-road cruising. But that's just part of it.

Reduction of engine speed is the basic idea behind all overdrive equipment. From this, you get two direct benefits—better gasoline mileage and longer engine life. In addition, you have *two* extra forward speeds and many of the conveniences of an automatic transmission.

Gasoline is saved because of reduction in the total horsepower required to propel the car. Tests with a stock car have shown why.

It was determined that 12 hp. was needed simply to move the car at 40 m.p.h., either in conventional high or overdrive. However, engine friction and power losses in driving engine accessories demanded an additional 18 hp. while the car was in conventional drive. In overdrive, since the engine speed is reduced, this figure was cut to 11 hp.—a saving of 7 hp.

Except for a new type recently announced for dealer installation on Chevrolets, all overdrive units now in production for current-model cars are made by the Warner Gear Division of Borg-Warner Corporation. In the Warner units, there are slight variations in the electrical circuits and external housings from car to car, but essential components are virtually the same. The accompanying drawings show the working principles of a typical late-model unit. For clarity, some parts are exaggerated.

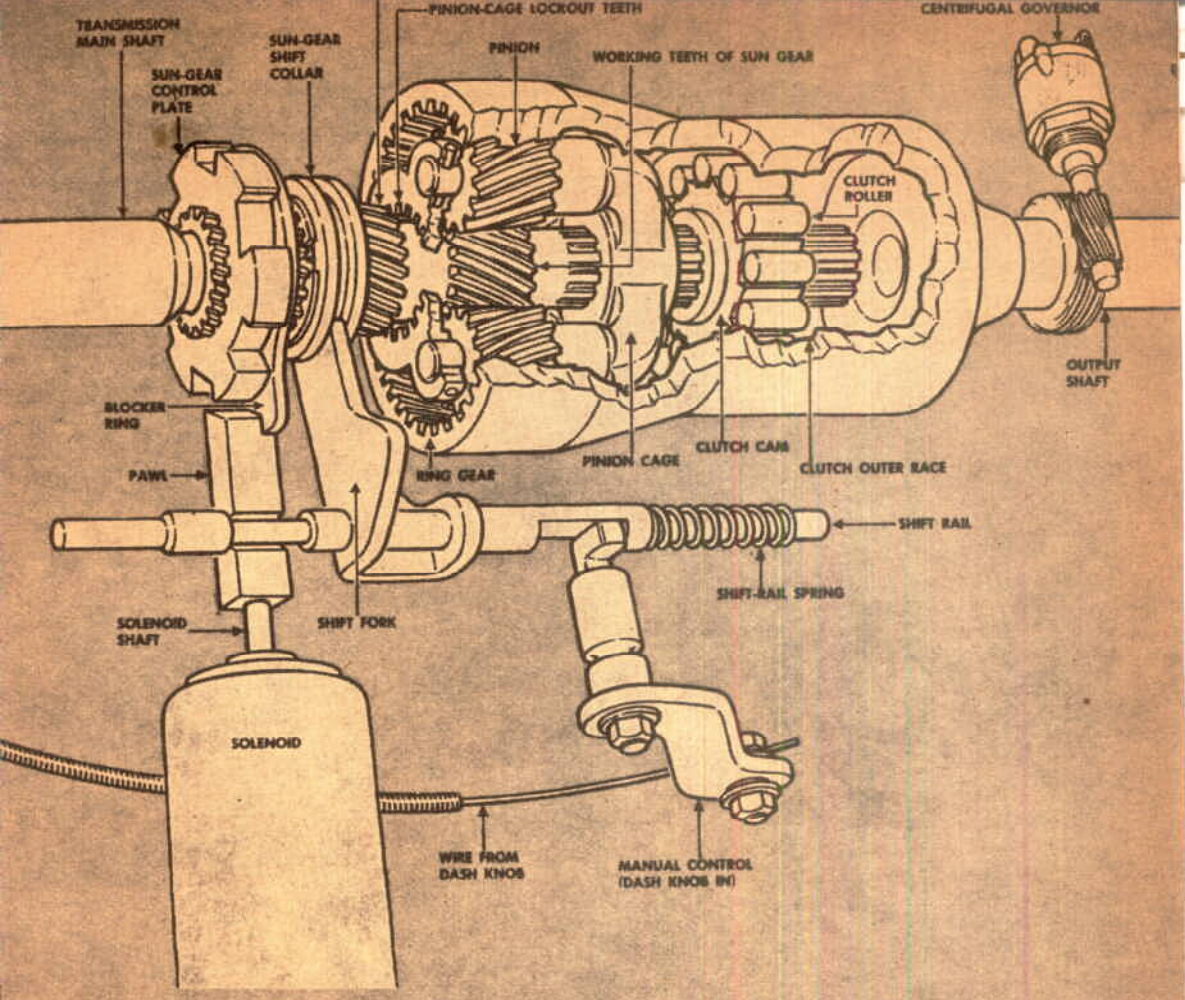
A modern overdrive unit is a supplementary two-speed transmission. It's mounted directly behind the normal three-speed trans-

DID YOU KNOW?

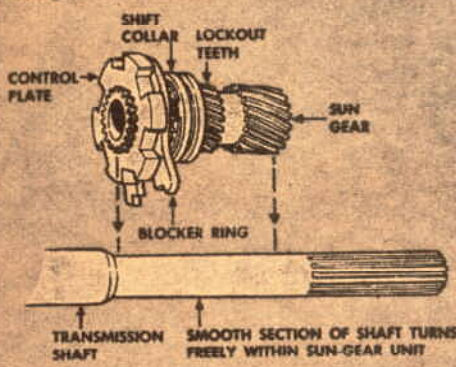
- Overdrive adds two extra speeds to your three-speed transmission—overdrive second and overdrive high.
- Overdrive second permits you to drive in traffic without touching clutch or shift lever. After engaging second, you can shift back and forth between second and overdrive second simply by manipulating the gas pedal.
- Below cut-in speed, after the car's once in low, you can shift at will without the clutch. In shifting up, release gas pedal briefly.
- You can engage overdrive (push in control knob) at any speed.
- You can lock it out (pull out control knob) at any speed. Before pulling the knob, kick down the gas pedal.

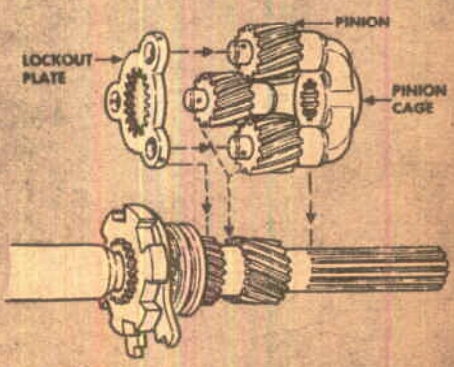
A FEW CAUTIONS

- Always lock out overdrive on slippery roads or when descending a long hill.
- Don't try to lock up into conventional drive below the cut-out speed without first feeding a little gas. You won't cause harm, but the unit will make an alarming buzz.
- Don't try to lock up above the cut-in speed without first kicking down from overdrive. Until you do, the dash knob won't pull out.
- In overdrive second, stay below 50 m.p.h. to avoid excessive gear velocities. With older cars, don't exceed 35 or 40 in overdrive second.
- Leave the car in reverse when parked on a hill.
- When being pushed for a dead-battery start, lock up into conventional high.

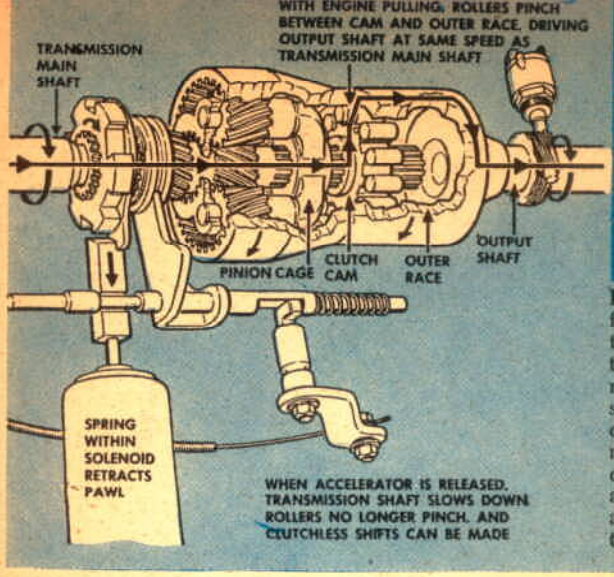


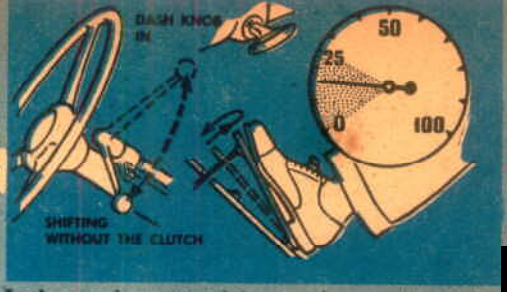
The parts of an overdrive unit are in the position above while car is at rest with dash knob in.



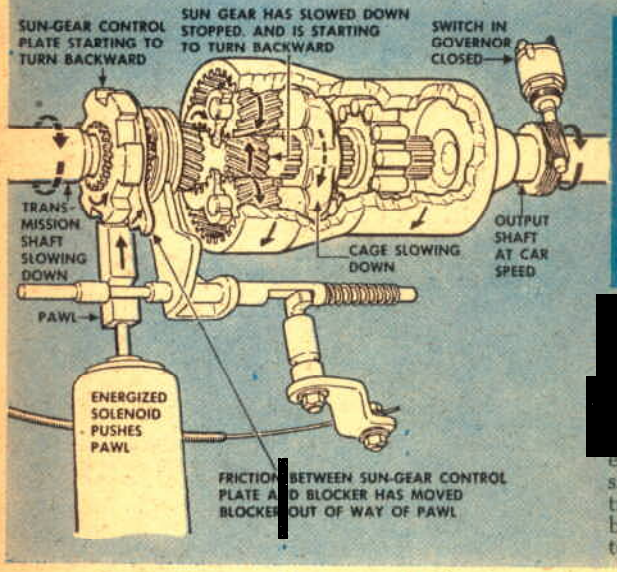


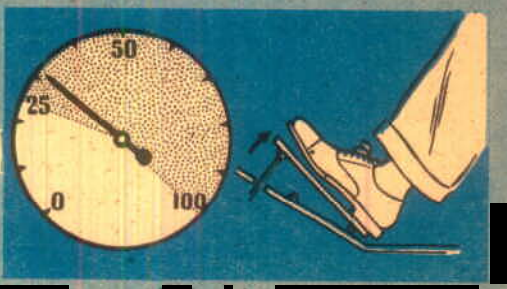
Planetary gears form the heart of overdrive. They give a ratio change that reduces engine speed in relation to car speed. The planetary set consists of a sun gear, three pinions that walk around it, and an outer ring gear. Entire sun-gear unit simply rests on smooth section of main shaft. There's no driving connection between the two. Pinion-cage hub is splined to shaft. Hence, the pinions are constantly carried in a circular path around the shaft. The pinions transmit power only when overdrive is in use. For this, sun gear is held stationary.





Let's see how overdrive works, starting out from standstill with dash control pushed in. Up to cut-in speed [redacted] m.p.h. the freewheeling main shaft ext[redacted] splined into the cl[redacted] cam. As [redacted] ma[redacted] shaft, roll[redacted] move o[redacted] into w[redacted] co[redacted] with ou[redacted] race, ca[redacted] tter to [redacted] and deliver power to wheels. Let up on the gas and roller clutch releases, allowing shifts without the regular clutch.





[redacted]car reac[redacted] cut-in [redacted] es solen[redacted] an[redacted] the [redacted] engagem[redacted] wi[redacted] engine is [redacted] ement. W[redacted] you let up on the gas, car [redacted] ntum tend[redacted] drive engine. Reverse torque [redacted]. In fracti[redacted] of second, roller clutch dis-[redacted] ges, sun gea[redacted] nd plate slow, stop, and make slight backward [redacted] rn. By means of friction, con-tro[redacted] plate carrie[redacted] horseshoe-shaped blocker ring ba[redacted] ward too. [redacted] is frees the pawl, allowing it to engage notched plate.

mission. Thus you have a total of five forward speeds.

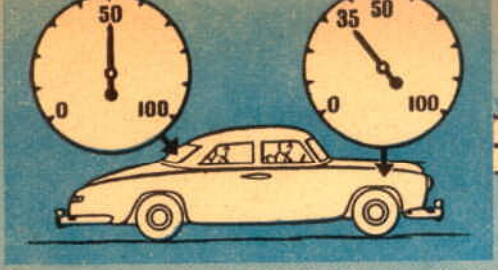
In order of gear ratio, these are low, second, overdrive second, high, and overdrive high. There's only a little ratio difference between overdrive second and high, but overdrive second is nevertheless a convenience that some owners don't know they possess—an automatic gear for easier traffic driving.

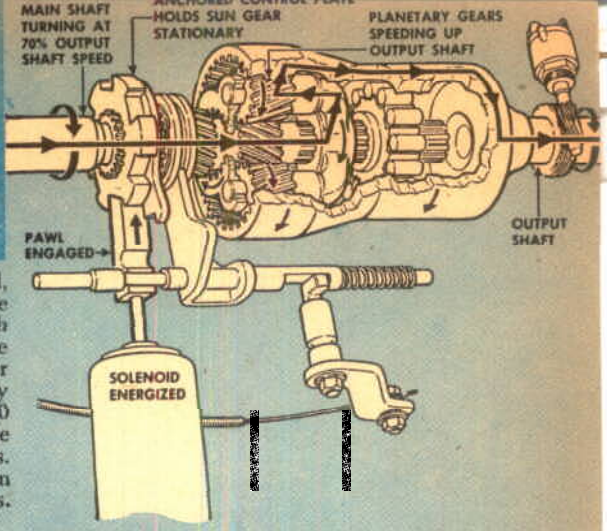
This is particularly true in the larger-engined cars with overdrive units set to cut in at relatively low speed. With such a car, you can do all your traffic driving in second and overdrive second—without touching the clutch or shift lever. Second provides all the power you need; overdrive second gives you the speed.

The things you do to operate overdrive are few and simple. To place the mechanism in readiness for automatic operation, you push in the dash knob. You can do this while the car is at rest—or at any speed.

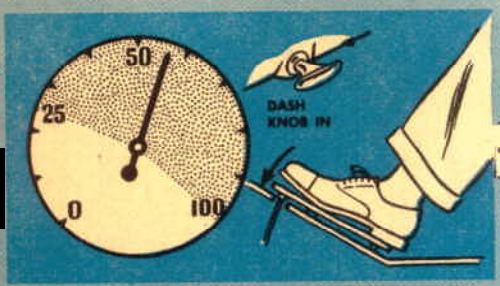
Starting from a standstill with the knob in, you shift into low in the usual way. From then on, *until you reach the overdrive cut-in speed*, you can shift into or out of any conventional gear without touching the clutch.

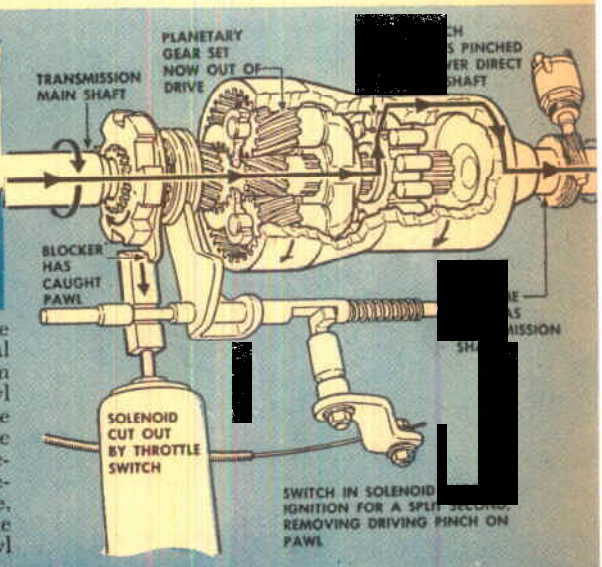
In shifting up, just release the accelerator momentarily while you change the gear lever. In shifting down, simply move the lever. A downshift from second to low is best done





Now you're in overdrive. With pawl engaged, control plate keeps sun gear from rotating. Drive is now from main sh[redacted] splines. This causes [redacted] sun gear, transmitti[redacted] ring gear, thence to [redacted] the outpu[redacted] rcent as f[redacted] ry gears. r, pinion cage makes only .7 revolution on its own axis.





Pushing gas pedal to floor shifts overdrive down to conventional gear. When down, pedal works kickdown switch, cutting current from solenoid. A spring then tends to withdraw pawl from sun-gear plate. However, the engine torque inches and holds pawl. To overcome this, the kickdown switch also interrupts ignition for fraction of second, slowing engine and causing reverse torque. This allows pawl to disengage, giving direct drive. When car slows below the cut-out speed, governor cuts solenoid, pawl withdraws, and freewheeling drive results.

with the clutch, however. Low is not a "synchronized" gear and you may cause clashing.

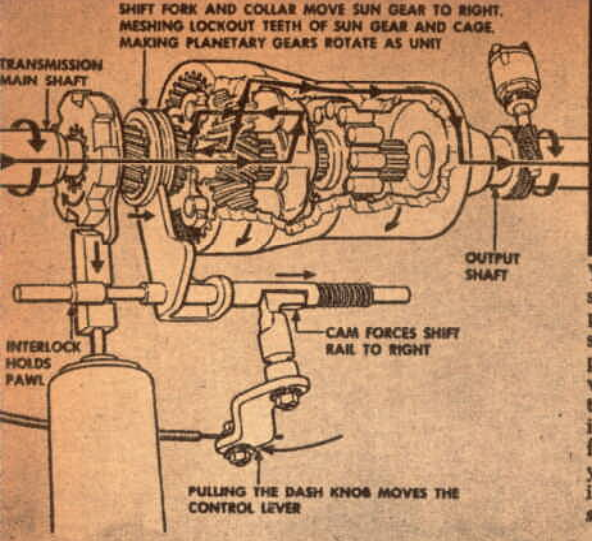
This clutchless shifting at low speeds is made possible by the freewheeling built into the overdrive unit. Each time you let up on the gas, the car freewheels. When you shift, the overrunning clutch within the unit automatically does the job of the regular clutch.

Overdrive cut-in speed is set at the factory. It varies with the make of car—somewhere between 18 and 32 m.p.h. After passing this speed, you lift your foot from the accelerator. The result is an automatic upshift into overdrive. If the regular transmission is in second, you go into overdrive second. If it's in high, you go into overdrive high.

When you need a quick burst of power, perhaps to pass another car, you simply jam the accelerator to the floor. This automatically downshifts to conventional gear.

At car speeds above the overdrive cut-in point, you must use the regular clutch to shift between conventiontional high and second gears. That's because the overrunning clutch doesn't have a chance to do the job it does below cut-in. As soon as you lift your foot from the gas pedal, the unit automatically upshifts into overdrive.

Unless you kick down to a conventional gear, the overdrive ratios continue to function until car speed drops to about 4 or 6 m.p.h. below the cut-in speed. At this point,



You can lock out overdrive while car is moving simply by kicking down accelerator and then pulling out dash knob. Pulling the knob moves shift rail and shift fork, bringing sun gear into position so that the teeth at right of shift collar will engage the corresponding internal teeth in the pinion cage. This makes entire group of internal working parts turn as a unit, eliminating freewheeling and overdrive. Before pulling knob, you must press gas pedal to kick down overdrive if engaged and cause meshing gears to turn at same speed.

the car automatically reverts to conventional gear, either second or high, when the governor cuts power from the solenoid.

You can lock out overdrive entirely at any speed. Just push down the accelerator momentarily and pull out the knob. It can be done so quickly that you get almost no acceleration—a point to remember if you are descending a hill and need to lock out to get engine braking.

Overdrive has passed through a series of engineering changes since its introduction in 1934. Early types were controlled by a speed-sensitive automatic clutch that required a driver to slow down to cut-out speed to reengage conventional drive. In 1939, an electric kickdown switch permitted shifting back to conventional drive above engagement speed.

In the latest overdrive, the governor and solenoid are the principal electric controls. The governor is operated by the car drive shaft. When the car reaches the cut-in speed, with the control knob in, the governor switch closes, sending current to the solenoid. Energized, the solenoid tends to push the engagement pawl toward the notched control ring attached to the sun gear. However, the blocker ring stops and holds the pawl.

This horseshoe-shaped ring rides on the hub of the control plate. Friction causes it to respond to movement of the control plate, through a small arc in either direction, until arrested by stops.

The sun gear and control plate are a single, splined unit that surrounds the transmission main shaft. This point is essential to understanding how overdrive works. Until an overdrive ratio is engaged, the sun gear merely idles. While the ratio is engaged, the sun gear is held stationary.

When you let up on the accelerator momentarily, the engine slows but the momentum of the car tends to drive it. The power flow is reversed. Torque reversal occurs.

In a fraction of a second, the sun gear and its control plate slow, stop, and then twist backward slightly. Friction carries the blocker ring along. Allowed to slip off the step of the ring, the pawl thrusts inward, engaging the notched collar and locking the sun gear.

When you kick down from overdrive to conventional gear, the notched control plate must be released by withdrawing the pawl. Engine torque, however, binds and holds the pawl. When you push the pedal to the floor, a switch opens the solenoid circuit. It also closes contacts that temporarily interrupt the ignition.

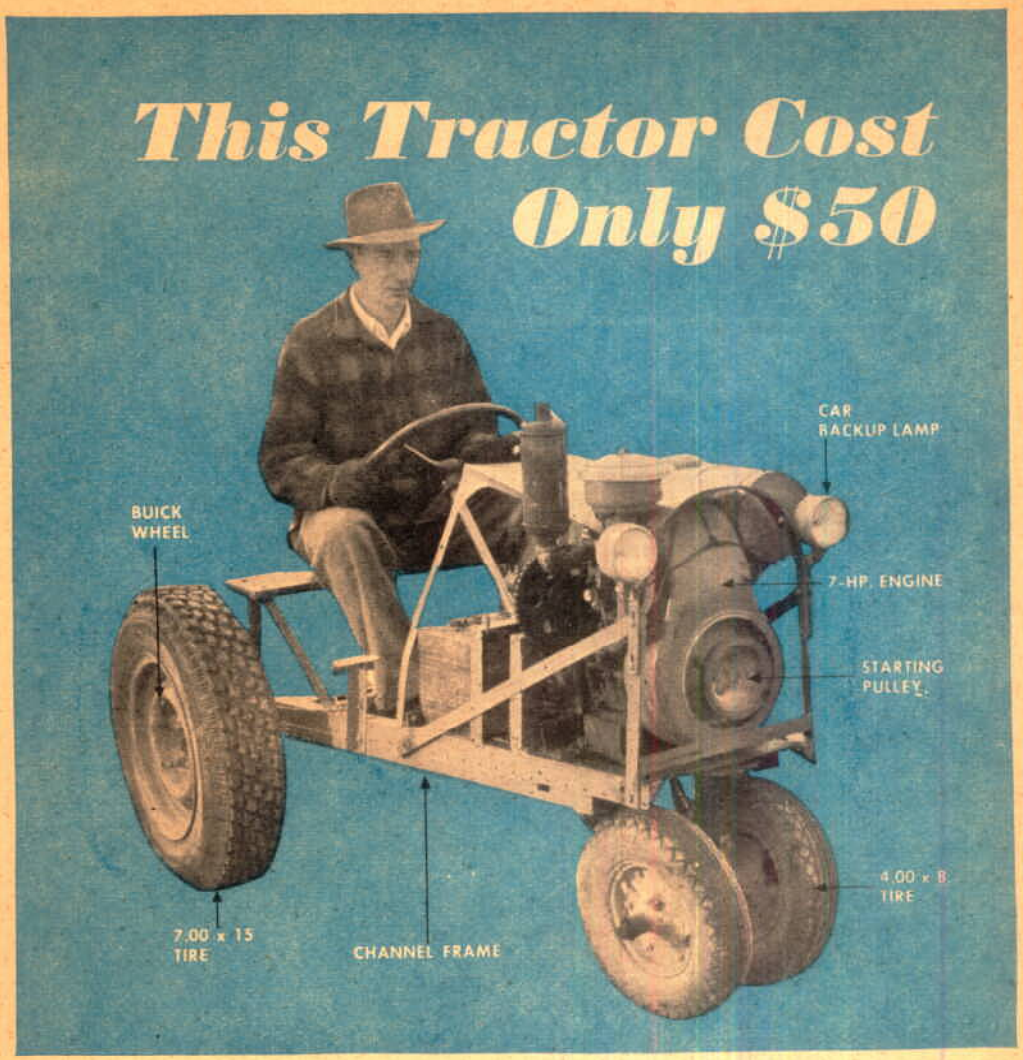
Interruption of the engine torque allows the pawl to be snapped out by a strong spring, whereupon the ignition and engine torque are restored. The entire sequence happens so fast that only a few explosions are missed.

Upon release of the pawl, the engine speeds up. When its speed reaches the value corresponding to direct drive, the roller clutch engages and you operate in conventional gear. This continues until the driver no longer needs full power and lets up on the pedal. As he does, overdrive again engages.

What about reverse? That's taken care of, too. Since the roller clutch will not drive the car backward, the transmission reverse-shift mechanism automatically locks out overdrive. There's no need to touch the control button.

END

This Tractor Cost Only $50



A powerful midget, it shows what you can do with junk-yard bargains, a hacksaw, and a welding outfit.

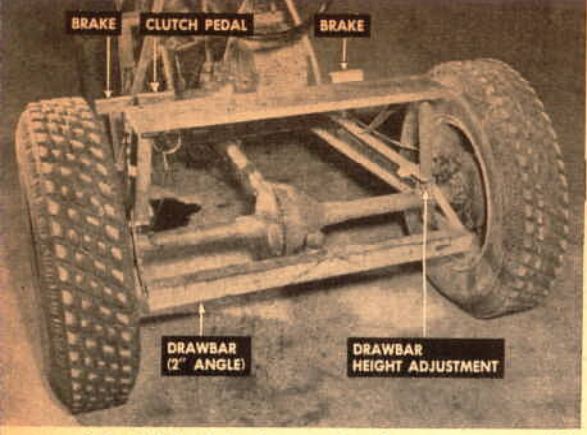
PS photos by W. W. Morris

SOON after Paul E. Matous completed his $50 tractor, a friend's automobile got stuck in the mud.

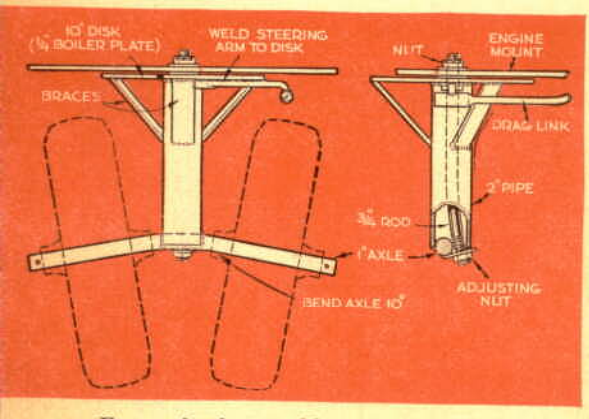
"As a gag, he yelled to me to come and pull him out," says Matous, a building contractor at Orangeburg, N. Y. "He thought I couldn't possibly move the car."

Matous was doubtful too. After all, a tractor with a 7-hp. engine is no road-building giant. Another car already had failed to budge the stuck car, even with the

It weighs 450 lbs. One man can easily tip it over. But don't let that fool you about its stability. The builder reports it never "rears up."



Individual brakes make short turns possible. Axle is hooked in notched frame, but U bolts, as in drawing at bottom of page, would be better.



Front-wheel assembly pivots on a boiler-plate "fifth wheel." A ¾" rod through the 2" pipe ties assembly to boiler-plate engine mount.

help of a couple of well-muscled pushers. As Matous hooked on, the pushers winked at each other. But the little tractor buckled down and dragged the car free.

Matous then turned to the others. "You guys certainly can push," he grinned.

"Push!" one of them said. "We weren't pushing! We were *riding!*"

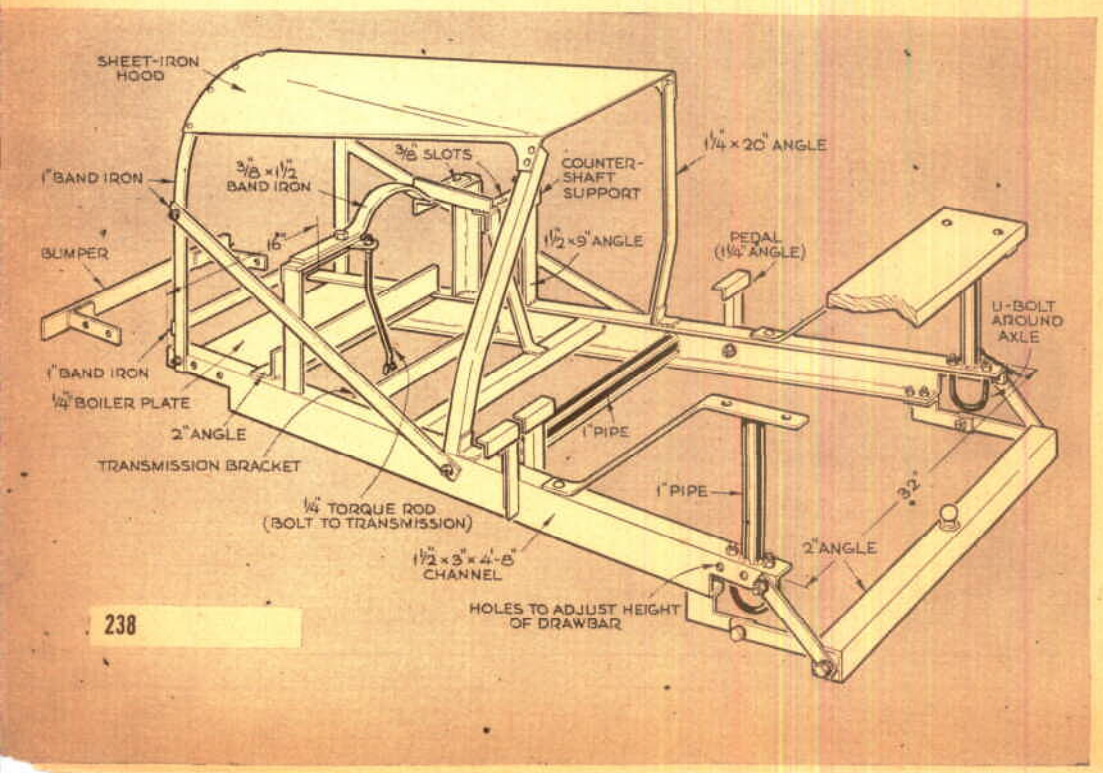
Matous is a shrewd bargainer, as well as a good craftsman. Otherwise, he couldn't have kept the cost of his doodlebug so low. He paid only $35 for a surplus engine—a single-cylinder, air-cooled, four-cycle Briggs & Stratton. A Ford transmission, Ford steering gear, pre-war Austin rear end, and other parts came from a junk yard.

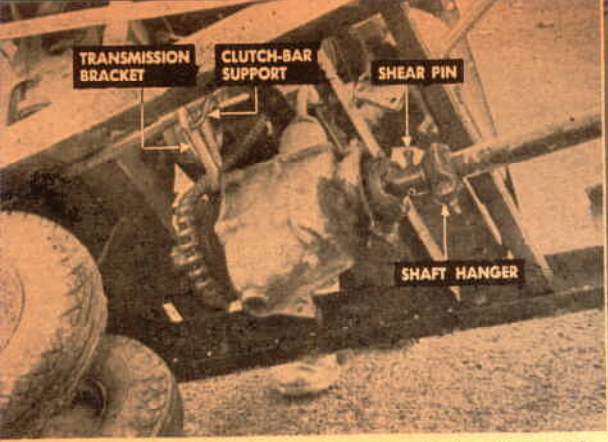
In assembling these, Matous worked mostly with a hacksaw and welding outfit. No machining was required.

The Matous tractor doesn't compare in looks with some of the commercial jobs, but its builder offers to bet it will easily outperform at least two famous makes. On that score, Matous argues with some authority. His main job several years ago consisted of repairing agricultural tractors.

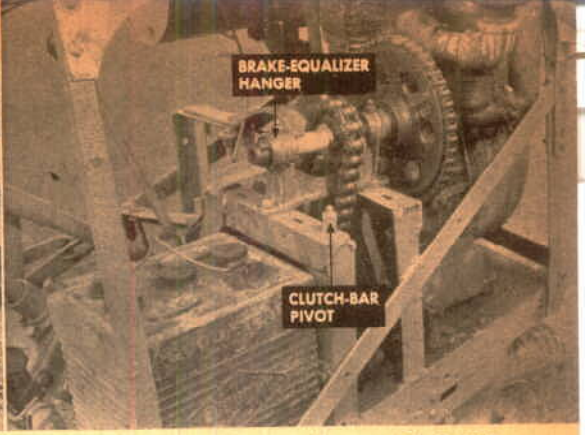
Matous is proud of the tractor's stability. By experimenting, he produced a nice balance between traction and power. For easy maneuvering, the wheelbase was kept short. But so far Matous has not found a situation that will cause the front wheels to leave the ground.

Good weight distribution explains this. The engine rests as far forward on the frame

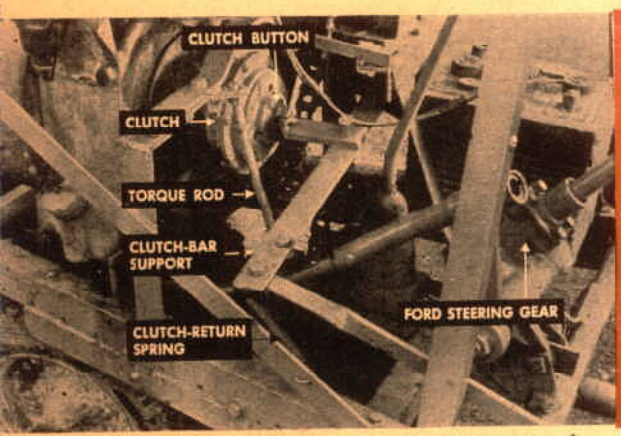




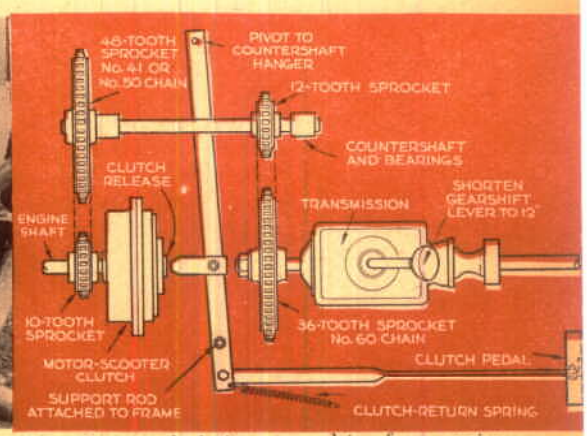
A shear pin protects power train. Universal joint was kept only to make assembly easier. Since rear is unsprung, it could be omitted.



A brake-equalizer hanger from a Ford V-8 supports the countershaft. Drive-chain tension is adjusted by moving the hanger in and out.



Clutch linkage is simple. When you press the pedal, a transverse bar pivots forward. Short arm depresses the button, disengaging clutch.



Sprockets and chains carry drive from engine to transmission. Sketch shows power train and clutch linkage from viewpoint directly above.

as he could get it. This shoves the balance point ahead, but there is no loss of traction. The operator's weight helps here. For some jobs, Matous adds about 100 lb. by filling the rear tires with water.

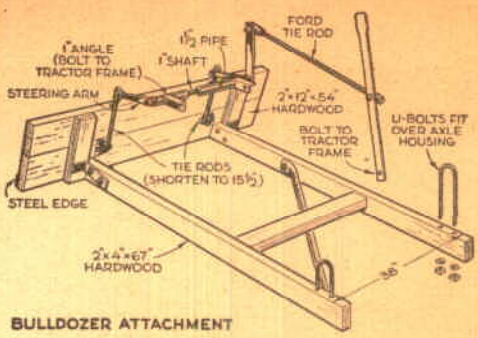
Sprockets, countershaft, and chains carry the drive to the Model-A transmission. Speeds are about 10 m.p.h. in high, 4 m.p.h. in second, and 1½ m.p.h. in low.

A brake-equalizer hanger from a Ford V-8 provided a readymade countershaft bearing. The shaft itself is a 9″ length of ⅞″ rod, tapped ¼″ deep for setscrews that secure the sprockets. Each of the two bearing points was drilled and tapped for a grease fitting. Bolted through slots to its angle-iron mount, the countershaft hanger can be moved to adjust chain tension.

When Matous set out to build the tractor, he intended to cut down a Ford rear end. But he decided to forego this job on finding that an available Austin unit had the 44″ tread he wanted. He installed this with considerable misgivings. But despite its lightness it has stood up well.

Buick wheels at the rear take 7.00 by 15 mud-grip tires. Inflated to less than 10 lb., these put a large area of rubber on the ground. For some jobs, Matous puts on tire chains.

The front tires are 4.00 by 8 (the wheelbarrow type), standing 16″ high. These roll on a 1″ axle, bent 10° for the proper camber. Welded to the center of the axle is a length of 2″ pipe, welded and braced at the upper end to a 10″ disk of ¼″ boiler plate. In operation, this disk bears against a sheet of ¼″ boiler plate that ties together the front end of the channel-iron frame. A ¾″ threaded rod, running down through the 2″ pipe, holds the wheel assembly to the frame boiler plate. At the lower end, this rod is



BULLDOZER ATTACHMENT

Homemade bulldozer attachment hangs on rear axle of tractor. As the sketch shows, Matous made generous use of junked auto parts when building bulldozer as well as the tractor itself.

bent toward the rear to clear the axle. A nut on its end provides adjustment.

The steering assembly came from a Ford V-8. After shortening the shaft to 24", Matous reversed and centered the steering arm. Then he attached the drag link to another steering arm welded to the disk.

For the frame, Matous welded together bed-spring angles in channel form. The engine is bolted to the boiler plate that brackets the front end of the frame. For easy starting, the engine is located with the starting pulley overhanging the plate. The tractor has no bumper, but one could easily be added, as suggested in the drawing.

At the present time, the lights draw juice directly from a 6-volt battery. The headlamps are back-up lights fitted with 32-candlepower bulbs. Future plans for the tractor include installation of a generator high up under the rear part of the hood. This part is flat, and for a reason: it makes a convenient spot to lay tools or the gas-can cap.

A remote control for varying the tension of the governor spring from the driver's seat is another proposed improvement. A third is a conveniently located toggle switch to stop the engine by shorting out the magneto.

About the time Matous built the tractor he also bought a tract of rolling woodland. On this tract, which he refers to as his private Aberdeen proving ground, Matous has made the tractor a real workhorse. Among other jobs, he has used it to snake heavy logs, drag a heavily loaded trailer, and level off the ground with a homemade bulldozer blade.

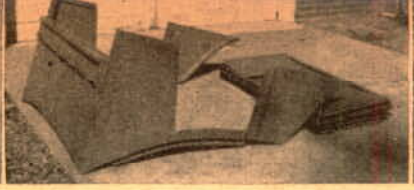
He hasn't yet gotten around to setting it to the routine small-farm and garden chores —plowing, cultivating, mowing, and the like—but he feels confident the machine will take all these jobs in good stride. END

PIPE DIMENSIONS

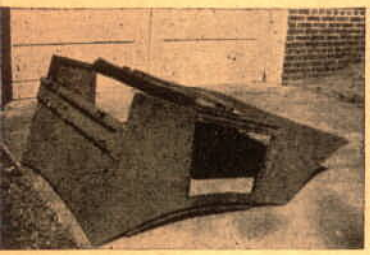
Nominal Inside Dia.	Actual Outside Dia.	Actual Inside Dia.	Nominal Inside Dia.	Actual Outside Dia.	Actual Inside Dia.
⅛	0.405	0.270	3	3.5	3.067
¼	0.540	0.364	3½	4	3.548
⅜	0.675	0.494	4	4.5	4.026
½	0.840	0.623	4½	5	4.508
¾	1.05	0.824	5	5.563	5.045
1	1.315	1.048	6	6.625	6.065
1¼	1.66	1.38	7	7.625	7.023
1½	1.9	1.61	8	8.625	7.982
2	2.375	2.067	9	9.625	8.937
2½	2.875	2.468	10	10.75	10.019

Note: Dimensions above are in inches, and are for standard steel and wrought-iron pipe.

FOR YOUR POPULAR SCIENCE INFORMATION FILE



As these steps in assembly suggest, this compactly folded compartment can be installed in short order



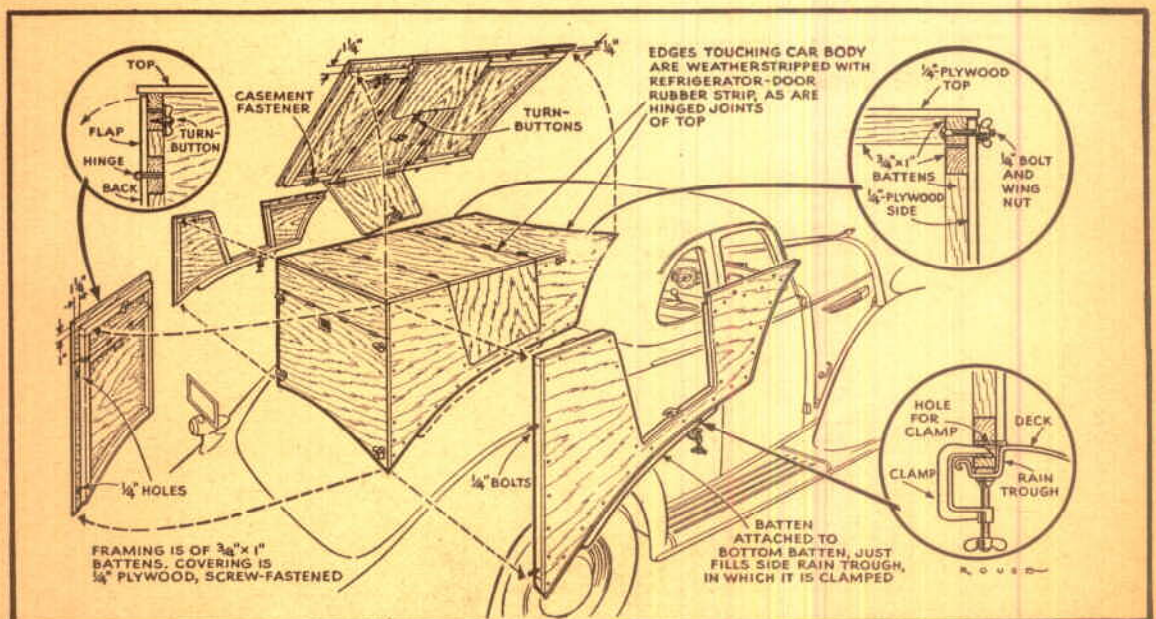
HINGED PLYWOOD PANELS ADD COMFORT FOR EXTRA PASSENGERS

Rumble-Seat Enclosure

EXTRA weatherproof space is provided for a coupe with this rumble-seat enclosure. Once built to suit your car, it can be put into place or removed in three to five minutes, and when not in use it stores inside the closed rumble seat. If the rear window opens and the car has a heater, you can keep the compartment warm in winter.

The enclosure consists of four sections—two sides, the back, and the top, all made of ¼" plywood attached with screws to ¾" x 1" battens. The top hinges at two places, the rear pieces folding forward over the front piece. This sectional top not only facilitates access to the seat but provides a variable degree of exposure above on sunny days. The side flaps, hinged to the top batten, swing up and in, and turn buttons above hold them open. If you wish, glass can be installed in these flaps for a side view when they are closed.

The contoured edges touching the car are weatherstripped with refrigerator-door rubber, as are the hinged joints of the top. A batten on the lower edge of each sidepiece fits snugly into the rain trough, and clamps placed through holes in these battens and under the troughs hold the entire unit in place. A coat of linseed oil cut with turpentine serves as an undercoat for the plywood. Finish off the unit with paint matching the car.



preferably a noninflammable one, on flat and pile fabrics. Soap and water may sometimes be used in general cleaning of pile, but be sure that the soap is nonalkaline and always have more suds than water. Badly pressed-down pile can be refreshed by steaming with a hot flatiron touched lightly to a damp cloth laid over the surface of the fabric, or by the repeated applications of steaming hot cloths. While the upholstery is still damp, brush it lightly with a whisk broom, and brush it again when it has dried.

Leathers may be washed with thin suds of lukewarm water.

Helping Auto Upholstery

WHAT TO DO ABOUT UNSIGHTLY STAINS THAT CAN'T BE AVOIDED

MANY a car owner is like the proverbial housewife who swept dirt under the carpet. In the case of the car owner, scrupulous care is often given to the motor and the body is kept spotlessly washed and polished, but once the door is opened the auto has somewhat the appearance of an unmade bed.

Granted that keeping the mechanical parts of a car in good condition is more important and that all the attention in the world to the upholstery won't make the engine run better, yet you may be surprised at the uplift in spirits a clean car interior can bring—as well as the sizable reduction it can make in your personal cleaning bill at the tailor's.

Use of a whisk broom is all that is necessary most of the time, but occasionally a more thorough job should be done with a vacuum cleaner or an old-fashioned carpet beater. Seats should, of course, be removed when a carpet beater is used to knock out the dust. This isn't always necessary with a vacuum cleaner, but even then removal of the seats will permit better cleaning of the corners under them.

Flat-woven cloth, pile fabrics, and leathers are generally the basic types of fabrics used for automobile upholstery. If dirt is imbedded too deeply for removal by a vacuum cleaner, apply a volatile cleaner, Use a nonalkaline soap. The surface should then be wiped with a damp cloth containing no soap and finally wiped dry with a soft, dry cloth.

On occasion the upholstery may be soiled in spots by some matter other than ordinary dirt and dust. These various accidental stains require special treatment and should be removed as quickly as possible after they have been noted. A number of specific cleaning instructions are contained in booklets published by several automobile manufacturers. In some instances, especially when water is required, there may be discoloration of the upholstery involved in the cleaning, but often this will be preferable to allowing the stain to remain. Always use clean cloths, change frequently to clean parts of the cloth, and use as many cloths as necessary.

Battery Acids. Soak the spot with household ammonia for about a minute so that the acid will be neutralized, and then wash off the place with a clean cloth and cold water. If the acid is allowed to remain on the fabric, it will eat away the fibers.

GREASE

Blood. Rubbing with a clean cloth and cold water is often sufficient. If some of the stain remains, apply a little household ammonia and water and, after a minute or so, rub again with a wet cloth. If this is not sufficient, apply a paste of corn starch and cold water. Pick and brush off the starch when it has dried. Several applica-

tions may be necessary. Never use hot water or soap on blood spots, for they will set the stain and make removal virtually impossible.

Candy. Stains from candy other than chocolate should be rubbed with a cloth dipped in very hot water. If any of the stain remains after the fabric has dried, sponge with carbon tetrachloride. Chocolate spots are rubbed with lukewarm water, and then sponged with carbon tetrachloride after the upholstery has dried.

Chewing Gum and Tar. Moisten the gum or tar with carbon tetrachloride and scrape with a dull knife before it dries.

Fruit, Liquor, and Wine. Try rubbing first with lukewarm water, scraping, if necessary, with a dull knife. If this does not remove the stain, use hot water, but remember

Rub the iron-rust soap in the spot with the fingers and, after a minute, wipe it off with a dry cloth, repeating until the wiping cloth no longer shows a stain; then rub with cold water. In applying ink eradicator, always use the No. 1 solution, since the No. 2 will change the color of the fabric. Put ink eradicator, oxalic acid, or sodium bifluoride on the upholstery with an eye dropper and blot with blotting paper, repeating until a clean portion of the blotting paper shows no stain; then rinse by rubbing with cold water.

HAIR

Lipstick. Apply carbon tetrachloride to the spot

Keep That New-Car Look

that hot water itself may cause some discoloration. After the fabric has dried, sponge with carbon tetrachloride if any stain still remains. Do not use soap, as it may set the stain.

Grease and Oil. Scrape first with a dull knife, and then sponge and rub with carbon tetrachloride. Dirt contained in the grease may remain on the fabric and can be removed with lukewarm soapy water, which should then be rinsed off with a clean damp cloth.

FRUIT

Ice Cream. Treat first as a fruit stain, which may be sufficient. In persistent cases, follow by rubbing with warm soapsuds, and then rinse out the soap. When this has dried, sponging with carbon tetrachloride will remove any fatty matter that remains.

ICE CREAM

Ink and Iron Rust. Iron rust requires initial rubbing with warm soapsuds and rinsing with cold water. When the fabric has dried, it is treated the same as ink. For this use iron-rust soap, ink eradicator, a saturated solution of oxalic acid, or a two-percent solution of sodium bifluoride. These are usually efficient in the order listed. The composition of writing inks varies, however, and it is impossible to find an agent equally effective for all. Ink rarely can be completely removed from velvets and flat fabrics without injuring the material.

and blot with blotting paper, repeating until the stain is removed.

Mildew. Rub vigorously with warm soapsuds and then rinse. Old mildew may leave a stain that cannot be completely removed. Try soaking with a 10-percent solution of oxalic acid, removing the acid after a minute by alternate blotting and pouring on of hot and cold water.

Nausea. Sponge with cold water before the stain has had a chance to dry; then wash with lukewarm suds and rinse. Use carbon tetrachloride on any remaining stain.

Paint. Rub with turpentine or a half-and-half mixture of denatured alcohol and benzene before the paint has dried. Saturate dry stains with the alcohol-benzene mixture and work out as much paint as possible with a dull knife. Repeat this several times; then rub with lukewarm suds and rinse.

Shoe Polish. Use carbon tetrachloride on black or tan polish. White polish can often be brushed off; if not, use cold water, let it dry, and brush again.

Urine. Sponge with lukewarm soapsuds and rinse with cold water; then rub the surface with a solution composed of one part household ammonia and five parts water. Let this remain for a minute, and then rinse with a clean wet cloth.

GUM

Water spots. Sponge the entire panel of upholstery with cold water; then rub with carbon tetrachloride.

How to Get the Most Out of SYNTHETIC TUBES

By Walter E. Burton

THAT much of the nation's motor traffic rolls on air in synthetic-rubber tubes is proof enough that these tubes are practical. But to many a motorist they are as much a mystery as the H-bomb. He isn't quite sure how to mount these new inner tubes, is a little doubtful on the care they require, and often is at a complete loss when he has to repair a puncture or other leak. Some facts, straight out of the laboratories and factories where synthetic tubes were developed, may create a closer acquaintance.

There are four main kinds of inner tubes in use—natural rubber, GR-S, butyl, and neoprene. Many natural-rubber tubes date from prewar make. GR-S tubes are going out of the picture. Butyl tubes are the most widely made and may be the leading tubes of the future, no matter how plentiful natural rubber becomes. Neoprene tubes are not yet made in large quantities.

The initials GR-S stand for Government Rubber—Styrene. During the war this synthetic was made in Government plants by the copolymerizing of butadiene and styrene and was widely used for tires. Contrary to some belief, it is not highly resistant to oil. GR-S tubes are marked with a red stripe on the rim area.

Butyl rubber made in Government plants was known as GR-I. It is a synthetic formed by copolymerizing isobutylene with small quantities of isoprene or butadiene. Butyl tubes are marked with a blue stripe.

Neoprene produced in Government plants was known as GR-M. It is made by polymerizing chloroprene (monochlorobutadiene) and has good oil resistance. The identification stripe is yellow.

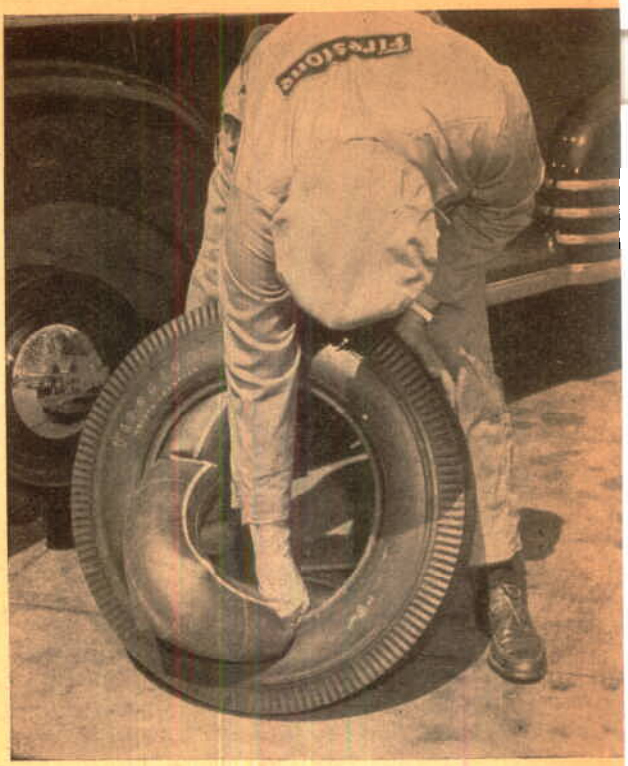
This is about how the picture shapes up now: Passenger tubes of all sizes and truck tubes up to 8.25" cross section are to be made from butyl; larger tubes and special-purpose passenger tubes, such as Life Guards, Puncture Seals, and Life Protectors, of natural-rubber compounds.

Why tire and tube technicians believe butyl tubes are here to stay is revealed by a comparison of the properties of GR-S, butyl, and natural rubber. These comparisons, and other data given here, are based on information compiled by inner-tube tech-

Vegetable-oil soap is brushed on the exposed area of the inserted tube and for 2" down in the tire.

Mount the tire on the rim, inflate to recommended pressure to seat the beads, deflate, and reinflate.

Make sure there is no grit on the tube or inside the casing. Insert the tube, inflate until it is nearly rounded out, and replace the valve cap.
Photos by Firestone



nicians of The Firestone Tire & Rubber Co., B. F. Goodrich Co., and Goodyear Tire & Rubber Co.

In tensile strength butyl is but slightly inferior to natural rubber, while GR-S is only half as strong. Butyl can be stretched 14 percent farther than natural rubber, GR-S 10 to 15 percent less. Resistance to tear by butyl is essentially equal to that by natural rubber, while GR-S has but 55 to 60 percent of the resistance. Air diffusion or loss through GR-S is half as rapid as through natural rubber; through butyl it is only 5 to 10 percent as rapid.

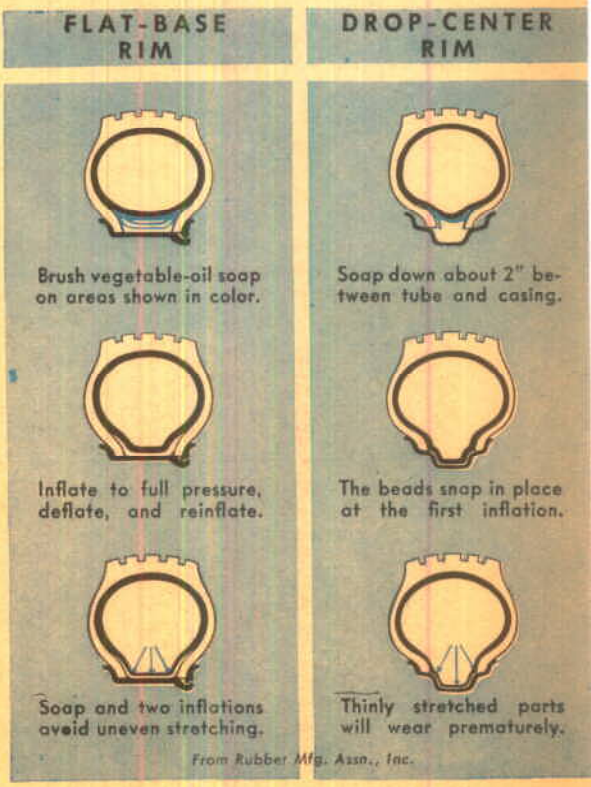
You may have heard that, because butyls hold their air so well, they need not be inflated with the regularity or frequency of natural-rubber tubes. Tire technicians warn, however, that pressure should continue to be checked every week or so because of the possibility of leaks for other reasons. Synthetic tubes are more likely to be damaged by pinching and other underinflation evils than natural rubber, and it is even more important that leaks be discovered and repaired as early as possible.

One secret of getting maximum service from synthetic tubes regardless of type is proper mounting in the casing so they won't be stretched too thin at the rim and tire bead. Proper lubrication with a vegetable-soap solution and an inflation-deflation routine are the methods recommended by the Rubber Manufacturers Association, Inc., and tube manufacturers. Follow their suggestions yourself, and if a serviceman does the job watch to see, for instance, that he doesn't skip deflation and reinflation.

Here are the six steps recommended:

1. Remove the valve core and use the valve cap to hold air in the tube. After making sure that the inside of the casing and the outside of the tube are free of grit and other foreign material, insert the tube in the casing. Inflate until the tube is nearly rounded out and replace the valve cap.

2. Dissolve enough neutral vegetable-oil soap to make a decidedly "soapy" liquid and apply it with a brush or cloth to the visible portion of the tube and for about 2" down the sides of the tube inside the casing. Soap also the inside of the casing for the same distance and soap both surfaces of the flap used with flat-base rims. Do not use so



WAFFLE-RIBBED surfacing is put on the new synthetic butyl inner tubes of the United States Rubber Company. The extra butyl is said to crowd around a puncturing nail and thus to reduce the rate of air escape. This allows a car to be driven farther before stopping for a repair.

much soap that it runs down into the tire.

3. Center the tire on the rim, keeping the beads out of the rim well of a drop-center rim. Inflate to partial pressure, supporting the tire with the hand so it will not hang loosely on the wheel.

4. Manipulate the valve stem until it is centered in the hole. Pull it firmly against the rim and hold it there while the tire is being inflated to recommended pressure.

5. Deflate the tire completely by simply removing the air hose. Then replace the valve core in the stem.

6. Reinflate to recommended pressure. You need not worry about centering the casing on the rim. The first inflation forces the beads to seat themselves. But during this step the tube is often stretched unevenly, and a second inflation is necessary to give it a chance to adjust itself.

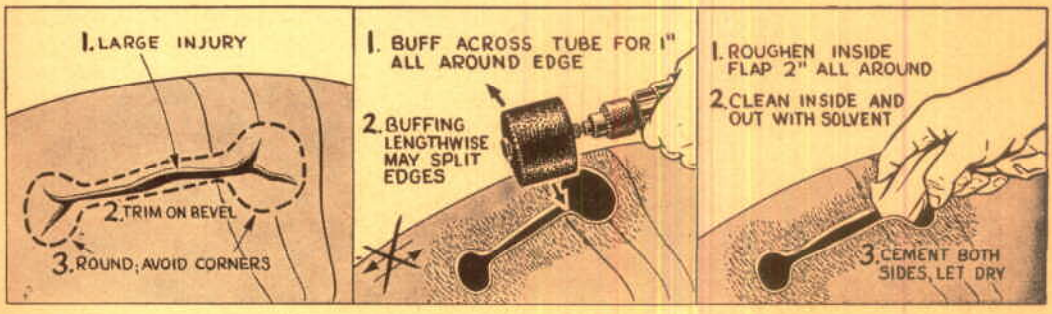
Warning: When the core has been removed from the valve, inflation with a high-pressure air line that has no pressure-regulating device may prove dangerous. The sudden entrance of air at high pressure may snap the beads against the rim with such force that they will be damaged and later on may cause a blowout. Sudden inflation has also been known to cause a tire to explode. Though removal of valve cores is common practice, it may be better for the novice to leave them in as a safeguard to restrict the valve opening if he uses an air hose having no pressure control.

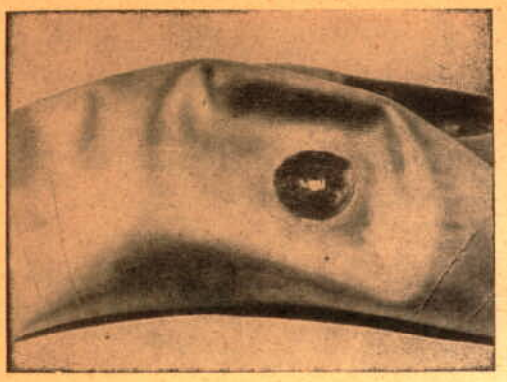
When a synthetic tube is inflated out of the casing, as in testing for a leak, be careful not to admit so much air that the tube will be stretched beyond its original size. Once so stretched, a synthetic tube hardly ever comes back to size.

The care given a natural-rubber tube is also required for one of synthetic rubber. That is, inflate to recommended pressure, always use a cap on the valve, and check pressure regularly.

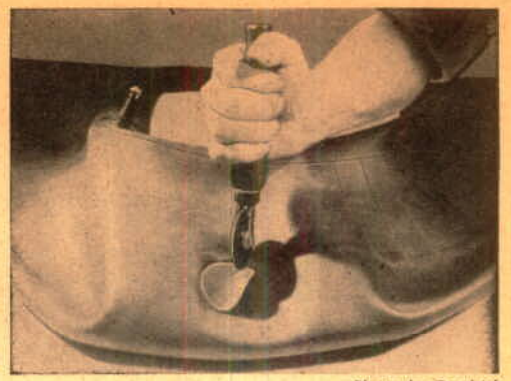
Patches are made on synthetic tubes in the same manner they are on natural-rubber tubes, except that for injuries 1″ or more long GR-S tubes require a reinforcement patch on the inside. Both hot and cold patches can be applied successfully. Tire manufacturers recommend heat-vulcanized patches for permanency. Motorists who still have on hand hot or cold patches made of prewar rubber should not use them on synthetic tubes, but save them for repairs on tubes of natural rubber.

For GR-S as well as butyl tubes having punctures or holes less than ½″ long, trim the





After a small hole is trimmed, an area is buffed ½" larger than the patch, and cement is applied.



Photos by Goodrich

When the cement has dried, a beveled-edge patch is centered over the hole and rolled down hard.

edges to remove sharp corners where a tear might start and roughen an area about ½" larger around than the patch will be. Always buff at right angles to the grain of the tube, which runs parallel to the large circumference, to avoid the possibility of starting a split. Remove the surface glaze, but do not cut or scratch the tube deeply.

Clean the roughened area with solvent or cold-patch rubber cement worked in with a knife blade. Wipe or scrape off excess cement. Spread more cement over the area and let it dry.

For nail holes and the like a prepared round patch with a beveled edge can be used. For other holes cut a patch to extend 1" beyond the edge in all directions, and bevel the outer edge of the patch at about a 45-deg. angle. Center the patch over the hole and roll it into good contact with a roller, fruit jar, tin can, or the edge of the repair kit.

A method of applying an inside as well as an outside patch to a large injury in a GR-S tube is shown in the drawings below. Note the dumbell appearance of the trimmed hole to avoid sharp corners at the ends.

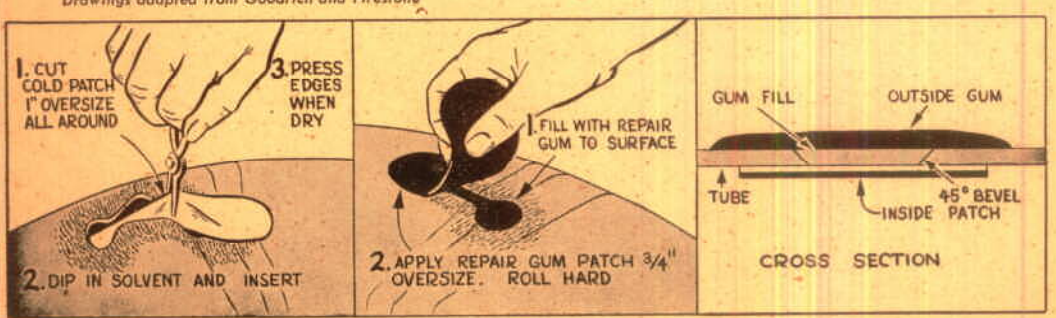
The inside of the tube is roughened as well as the outside, washed clean with solvent, and coated with vulcanizing cement. A cold patch 1" larger than the injury in all directions is dipped in solvent, inserted, and pressed down on all edges when dry.

Next, the injury is filled with quick-cure repair gum, and a sheet of quick-cure gum is applied on top and rolled down firmly. This final patch should be ¾" larger than the hole in all directions. As the final step the repair is **vulcanized.**

The same method may be followed for holes larger than ½" on butyl tubes and for those between ½" and 1" on GR-S tubes, omitting the inside patch and gum fill.

Though it may be preferred to take vulcanization jobs to a service station, a motorist can get satisfactory results with a vulcanized-patch kit. He should specify in purchasing it whether the patches are to be used for synthetic or natural-rubber tubes. When the largest patch won't cover the injury, two or more may be applied in succession. After the first is placed, roughen part of its outer surface, and apply the second patch to overlap it ½" or more.

Drawings adapted from Goodrich and Firestone



Automobiles still kill tens of thousands: they'll go on doing it until you and the rest of the buying public are willing to pay the price of safety.

Cars Can Be Safer

By DEVON FRANCIS

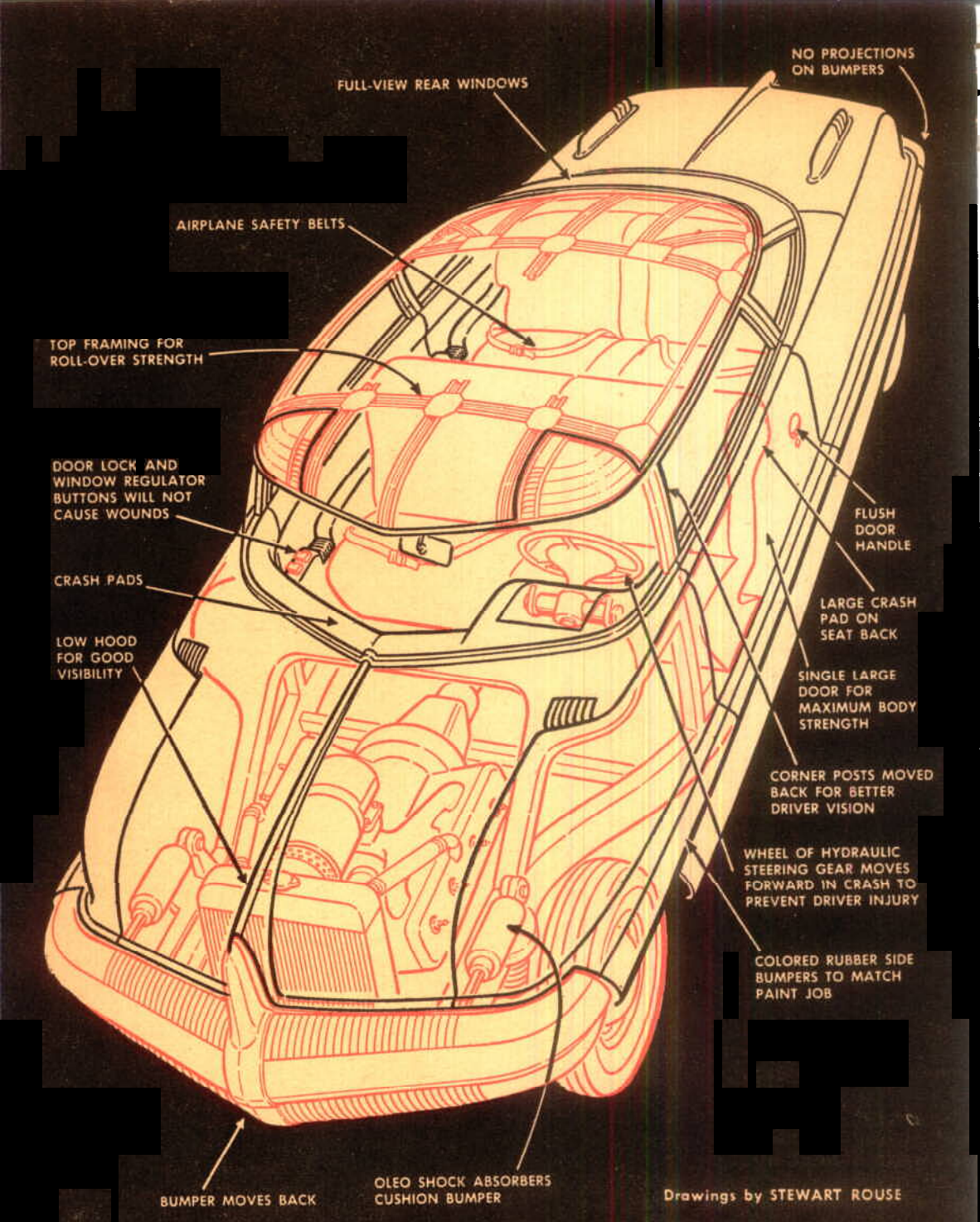
YOU have left the outskirts of town and are rolling on the highway, the speedometer comfortably short of 50. Your car is fresh-tuned for spring; tires are newish, brakes sharp; there is not a squeak or rattle to spoil the purr of the engine. Suddenly, a car comes toward you. It is not going very fast. It veers slightly. It rolls with agonizing slowness across the freshly painted white line, toward you . . . toward you. You jam on the brakes, but you are still doing 15 or 20 when it hits you. . . .

You are washing the car in your driveway. The grade of the driveway is slight, barely enough to make an egg roll. Your kid is playing in the front seat. You bend down to wring out the chamois, look up and realize the car is moving. You scrabble for the doors, but the windows are closed. By the time you get a door opened, the car —moving all of five miles an hour—has smashed into the corner of the garage. The bumper breaks. The child screams. The doctor bill for hurts suffered by the youngster when he was pitched into assorted knobs on the instrument panel is $10. The repair bill on your radiator is $40.

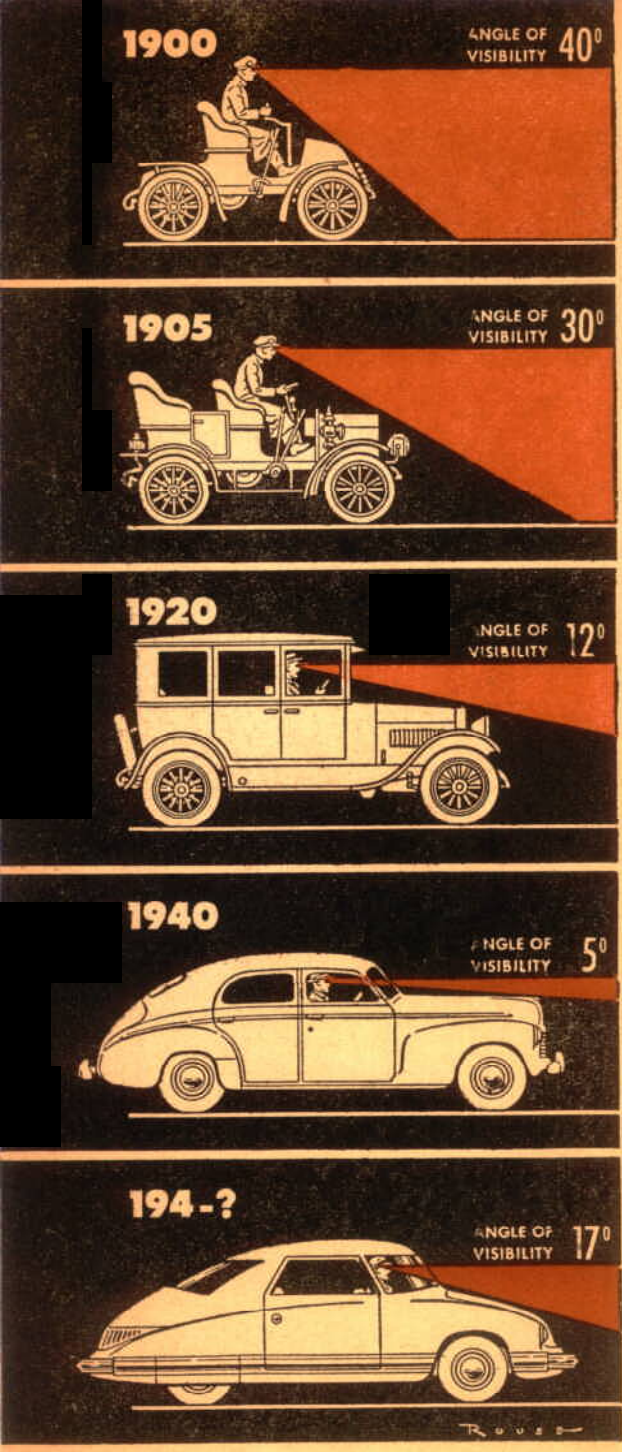
You may be the best driver on the insurance companies' records, but if you don't carry the scars of an accident as you read this, you can thank your good luck as well as your skill.

For in the last 25 years—during which every reader of this magazine has been driving or riding in a motor vehicle—some 500,000 Americans have been shoveled under tombstones because they were involved in automobile accidents. Uncounted millions have been maimed and bruised. Additional millions have had so many close shaves on the highway that they are calloused to the statistics of daily disaster.

The spring starts the annual American open season on motorists and pedestrians



Here is an artist's conception of what a safer car might look like. It's no dream; eventually, automobiles will include many of the items illustrated. This one could be built now, without waiting for a solution of the problems of weight and balance that make rear-engine design a thing of the future.



A substantial part of the highway accidents that killed 34,000 persons last year could be attributed to poor visibility from the driver's seat. As the drawings above show, visibility has been progressively reduced for years by the longer hoods, lower seats and shallower windshields that found favor with the public. Now visibility is gradually being increased from its hazardous minimum.

alike. Tens of thousands will die in traffic accidents during 1947. *You* may be one of them.

A lot *has* been done to cut down this carnage. More *can* be done. What is it?

I went to Detroit to find out, after some preliminary investigation in Boston, Washington and New York. I knew the automobile makers were sensitive about safety. Making automobiles is a blue-chip business. Any mistake in figuring what you, the motorist, will buy, can mean millions of dollars in losses. Even the most altruistic manufacturer could no more afford to make cars you *ought* to like than Hart, Schaffner & Marx could make suits without lapels. And lapels on a man's suit haven't been used for their original purpose—buttoning up the neck against the weather—for a century.

What Price Visibility?

U. S. buyers have made the auto makers very cautious about safety innovations. One manufacturer reduced the size of the grip on his steering wheel, not so many models back, to give you a better view of the road and of your instrument panel. What happened? You stopped buying that model until the grip had been fattened up by a fraction of an inch. That fraction of an inch didn't increase its strength a particle.

Another courageous pioneer rounded off the hood so you could get a better look at where you were going—and paid for it by losing customers. Another deepened the windshield. Nobody liked it. Drivers complained that they felt "exposed." They were satisfied, though, when the manufacturer blanked out the bottom of the windshield and reduced the visibility.

Nowadays, when you climb into an airplane, you fasten your seat belt as a matter of course. But the motor-car makers are afraid to put seat belts on their vehicles, even though 70 miles an hour is 70 miles an hour, whether you are in a plane or an automobile.

The Canvas-topped Killer

You insist on convertibles, which are a standing order to the undertaker. Even the manufacturers don't like convertibles. Every Detroit big shot I talked with about those canvas-topped killers said, "Not for my boy!" Some said there ought to be a law about them.

So automobiles are what they are for a perfectly logical reason: the collective pur-

A wide corner post can completely block out another car at a critical moment. The public put the corner post in the driver's eye by crowding three in front. It's still there, although seats have been widened and corner supports narrowed. A slimmer steering wheel would also increase visibility.

chasing power and *buying desires* of millions of people, you included.

In Detroit I asked a double-barreled question: *What has been done, what can be done, to make automobiles safer containers for people in motion?*

I found out that much had been done—in spite of you, the buyer. Safety glass and solid tops that will take the impact of a roll-over were only two items in a long list of improvements in the last four decades. The self-starter was introduced as early as 1911, the steel frame as early as 1914.

Safety Aids Galore

Here is an incomplete list of other safety innovations:

Tilt-beam headlights, prism lenses, windshield wipers, stop lights, indirect lighting of instruments, adjustable seats, balloon tires, four-wheel brakes, bumpers front and rear, heaters, hydraulic brakes, synchromesh transmissions, the foot dimmer switch, carburetor silencer and flame arrester, independent front-wheel suspension, the "turret" top, sealed-beam headlights, steering column gear shift and the 50-mile-an-hour warning light on the speedometer.

A lot of these changes were sneaked in by the back door so as not to disturb the customers. Many that were discussed couldn't be made. You have yet to see a car maker put a crash pad on the dash so a passenger wouldn't bash his head on it in a quick stop.

Faults by Inheritance

The automobile is what it is because it grew from a buggy with a back door. Today's car is a lineal descendant of the old side-winder of the early 1900's, a not-so-horseless carriage. Unlike the helicopter, which had to be engineered fresh and clean, the automobile inherited the ills of its ancestors. People insist, for example, on more doors in their automobiles than in their houses, even though the getting-in and getting-out time is piffling compared with the greater safety of structure that fewer doors would provide.

What would a car be like if the designers didn't have to keep thinking about what the public would and would not buy?

I found in Detroit that it is perfectly possible to build a safer car with existing components, without waiting for rear en-

gines or magic-strength materials. And I discovered, too, that the kind of a car Detroit would *like* to build for you actually *is* being built—little by little.

Little is the right word: Changes come slowly because the earnest engineers can't start from scratch; they have to begin with innovations that you, your aunt and your next door neighbor think are proper.

Advancing the Driver

Year by year, for a decade, car design has moved the driver forward. Now and then the hood got too long, but nonetheless the driver went forward in the chassis. The long hood, once expressive of power and the egotism of the driver, has been shortened perceptibly. It is going to be shortened more.

Experience with buses and cab-over-engine trucks has shown a decided advantage for this forward position. The driver, key man on the safety team, can see better. Moreover, with his own carcass right out in front, he is a little less likely to rely on the false safety of all that iron between him and disaster.

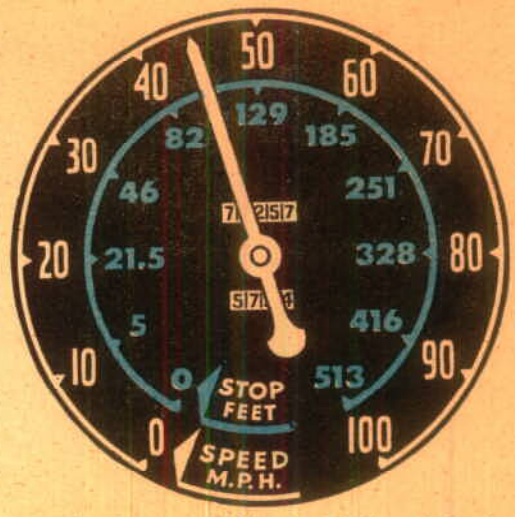
With the hood rounded down, the much-touted rear engine awaits a new day of lighter, more efficient engines. To transport people, a car must also transport luggage, and today's engines take less room than today's bags. So the best place for the engine is still in front.

What else? Not much, to the eye. But under the sleek roof, frame members will weld body to running gear. This is called "unitized construction." It's in some of today's cars. Whatever footage is ahead of you will be steel, not air under a glamorous hood.

Supports May Move

Corner posts are being thinned down for better visibility. They may be moved back, out of the driver's eye.

Cars also will be engineered to take a punch with less damage to flesh and metal. Today's bumper is only a bar to push a car around. It will fold or snap at anything over four miles an hour. Yet airplanes, engineered for bumps, hit runways every day with foot-pounds of wallop that would make an accordion of a car. My editor tells me he has seen 10-ton Grummans hit a flight deck on one wheel, with the oleos (oil-cushioned shock absorbers) in the landing gear taking up the whole shock. As a



A safety feature would be the inclusion of stopping distances on the speedometer dial, reminding the driver how they shoot up as speed increases. The distances shown are for optimum conditions—halting the car on dry concrete. Slippery pavement or faulty brake action could skyrocket the figures.

flier myself, I know that the oleos absorb the concussion of a lot of pilot error.

So why not have bumpers with oleos? And why not admit, on the drafting tables, that cars must operate in traffic? With bumps inevitable, shock-mounted front and rear bumpers would sop up the abuse. Rubber side bumpers, colored to match the paint job, would save many a wrinkled side panel.

Helpful Headlights

The most dangerous driving, everyone knows, is at dawn, dusk and during the hours of darkness. Sealed-beam headlights already have helped to lessen the danger. Some engineers are thinking about putting the headlights higher, on the roof corners, to afford a greater angle against the road and keep them out of the eyes of the fellow passing you in the opposite direction. The same men who worked out the sealed-beam lights are now experimenting with polarized light. When it comes, the glaring beams that light the whole road will be a couple of dim discs to you.

Death on the road is shocking enough, but there are far more injuries than fatalities. Many of these less-than-fatal accidents have been avoided by better *inside* engineering and design. There are fewer cracked kneecaps because legs have been better

accommodated in the front seat. There are fewer broken noses because the backs of front seats have been padded for the benefit of rear-seat riders.

Problems of Impact

The safer car to come will present a smooth, soft surface to bodies that are involuntarily catapulted forward in sudden stops. That brings up another story which makes you, the customer with the dollar in his pocket and his neck out, look a little foolish. One company actually designed a leather-covered, crash-padded dash. Then the vice-presidents in charge of engineering and profits got cautious. They feared the impact on the market of a car that confessed the realities of danger in driving. So they substituted a nice decalcomania of leather-covered dash right on the steel!

Aside from such reluctance, and the public attitude that causes it, the advantages of crash padding are obvious. A 2,500-pound automobile develops 302,000 foot-pounds of energy at 60 m.p.h.—enough to do a lot of damage if anything gets in its way. A braking action of 4/5 gravity, which is common, throws a person forward with a force of 4/5 his own weight; if an automobile structure in a collision will withstand an impact of four times gravity, a passenger is bound to get hurt unless there is something in front of him to soften his landing.

The problem of safety in impact is simply one of controlling the rate of deceleration. Hit a steel plate with your fist and you skin your knuckles; hit a pillow, and your hand is unhurt. For this reason, automobile makers regard the "crumple rate" of fenders, body and framework as a safety factor in collisions.

In terms of impact, because of its sheer weight as a projectile, a heavy car is more dangerous than a light one—so cars are being lightened. Hundreds of pounds are being stripped off with all-welded construction, and further weight reduction is being explored by cutting down mechanical friction.

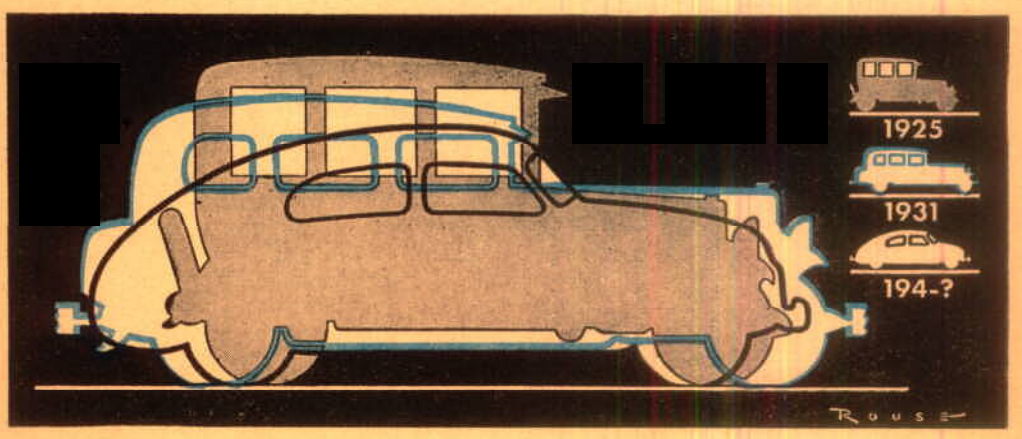
Even a medium tank cocooned with foam rubber would not be as safe—if it hit another medium tank—as a car on a pedestal, with an empty gas tank, in the Smithsonian Institution. But cars will be made safer as soon as the American people give the manufacturers the green light.

Safety Isn't Gratis

Already an automobile is the second largest collective investment (a home costs more) of the typical American family. Safer cars are likely to cost more. You can't put welds and ribs into a frame for free. And auto makers cannot bet against your whims.

You won't get a really safe car, soundly engineered and sensibly designed for modern traffic, until you are willing to pay the price of safety. That price will mean a few more payments and fewer foolish notions about what a car ought to look like standing still.

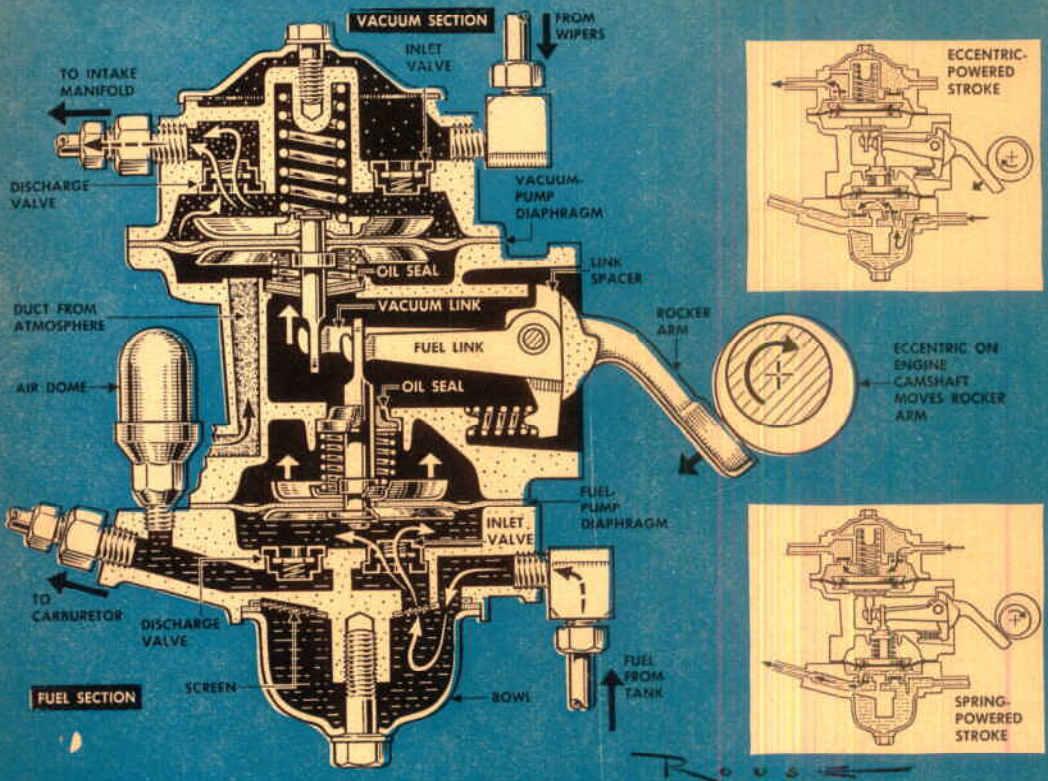
END



Once high and short, then long, cars are getting more compact and closer to the road. Other changes involve weight, which is being reduced, but engineers are restricted by the rough necessity of a 50-50 front and rear balance. Incorrect weight distribution could multiply the hazards of applying brakes on a curve, for example, because of "slippage," or normal side-skid.

Common trouble sources in a fuel pump include, left, rust and sludge choking the filter bowl and screen; and at right, a ruptured pump diaphragm.

Inside of combination pump is shown below. This is AC's type AJ, used on several recent cars. Vacuum side works wipers if engine vacuum drops.

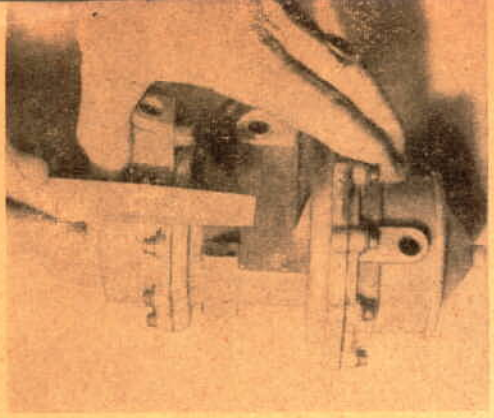


How to Overhaul a Fuel Pump

By E. F. Lindsley

SOME mechanics say an ordinary guy should keep his mitts off a fuel pump. An overhaul, they argue, is a specialist's job. But I've done it, very successfully, and I'm no specialist.

Although mechanical fuel pumps come in various shapes and sizes, they all work on the same principle. Some simply pump gas to the carburetor. Others, like the type above, also have a vacuum section to keep the wipers operating when the manifold vacuum drops. The simple pumps, naturally, are easier to overhaul. But patience and reasonable care will keep you on top of



File a mark on diaphragm flange before taking a pump apart, so you can reassemble it same way. Wash dirt off with suitable solvent.

Lay out parts neatly in order of disassembly. This makes it easier to put pump back together properly after you have fixed it.

even the more complicated ones. Service procedures are roughly similar for all types.

What are the trouble signs? A fuel pump is faulty if it pumps too much or too little gas.

Gasoline dripping from the carburetor, rough idling, and hard starting may point to a pump that's delivering too much fuel.

But the trouble is quite likely to be outside of the pump. A defective automatic choke, punctured carburetor float, defective needle valve, improper carburetor adjustment, or loose carburetor assembly screws may all deliver too much fuel to the engine. If none of these troubles is found, however, the pump probably needs overhauling.

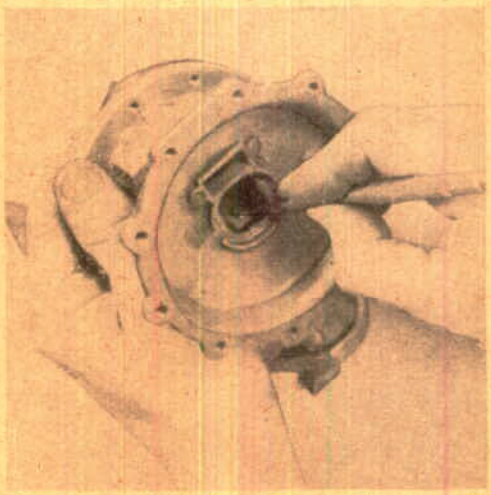
Dying out, poor acceleration, hard starting, low power, and popping back in the intake manifold may be symptoms of too little gas—although some of these might also result from a leaking or plugged fuel line, or carburetor trouble.

High oil consumption often is traceable directly to a ruptured fuel-pump diaphragm pumping oil from the crankcase. On the vacuum side of a combination pump, this may show up as blue oil smoke in the exhaust.

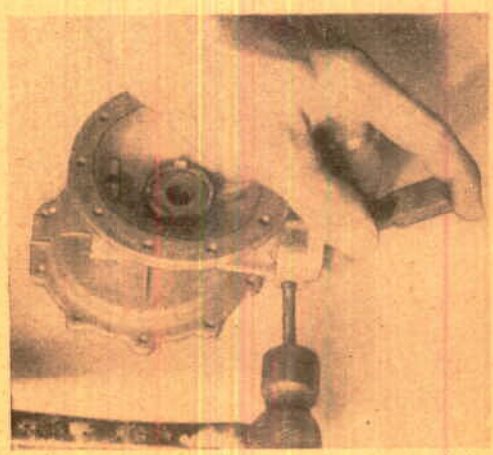
One of the surest signs, of course, that something's wrong with the vacuum pump is slow action of the wipers while you're climbing a hill or accelerating.

Checking for leaks. When the pump seems to be weak, make sure there's gas in the tank and go over the lines for leaks. Then disconnect the fuel line at the carburetor, slip the end into a clean bottle, and have someone step on the starter—ignition off. A good pump should spurt fuel vigorously.

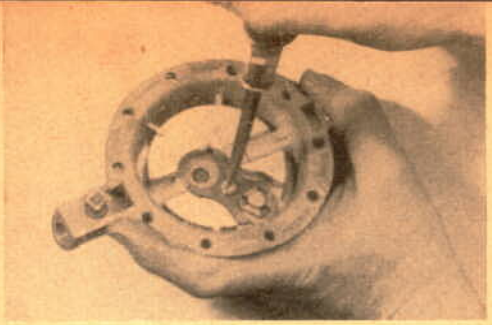
If a pump's delivery is weak, check for diaphragm-flange leaks by applying a



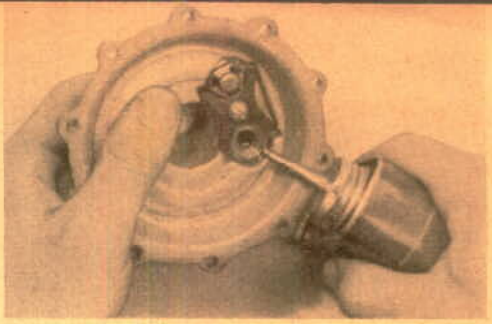
Diaphragm pull rod in this pump hooks on the rocker link. Some engage in a different way. Attaching one may require patience and care.



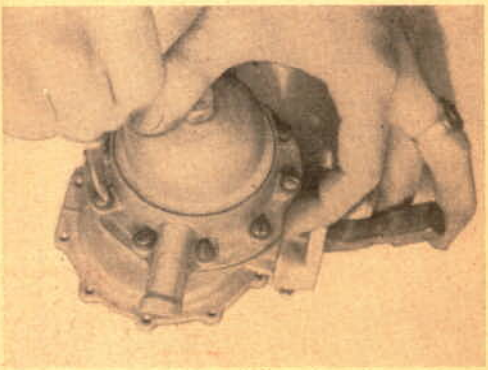
Keep rocker arm aligned with pivot-pin hole, or use a drift, when installing the pin. Stake pin with a punch to keep it from working out.



Install new valves and gaskets exactly as old ones came out. Watch whether large or small end of each valve cage goes down or up.



A drop of light oil aids new valve. To avoid mistakes, leave the old valves in place until ready to install new ones. Keep valves clean.



Flex diaphragm to its full stroke when tightening the flange screws. For square seating, alternately tighten screws directly opposite.

Test pump manually before completing the job. Here, thumb over the inlet checks the suction. Make the test before installing vacuum side.

little saliva—or heavy oil, if you're fastidious—and watching for bubbles. Should you find a leak, tighten the cover screws alternately on opposite sides. Continued leaking indicates a bad diaphragm.

If the diaphragm flange is okay, check for a leak around the bowl gasket. Also remove and clean the bowl and screen. This should always be done anyway at least twice a year. It's frequently neglected.

Removing the pump. If tightening and cleaning fail to revive a pump, it should be removed and overhauled or replaced. Some pumps have a thick pad under them to locate the rocker arm properly against the camshaft eccentric. Do not lose this.

Clean away all traces of the old gasket and be sure to use a new one.

A rupture in the diaphragm may be the only trouble. Other defects such as a broken rocker arm, worn or defective linkages, or a broken spring may be discovered, however, while the pump is being taken apart.

While tearing down the pump, notice how the diaphragm pull rod engages the rocker link. Some take only a half turn to right or left to disengage, others hook on, and many have link pins retained by spring clips.

The spring-clip setup permits replacement of diaphragm sheets without removing the pull rod. To do this, soak the sheets in kerosene, slip them over the pull rod, and hold them aligned with a few flange screws through the edge holes. To avoid wrinkles, tighten the top nut while keeping the lower alignment washer from turning.

When you finally assemble the diaphragm sandwich between the cover and the body, the diaphragm should be flexed to full stroke before completing the screw tightening. If clamped when stretched flat, the diaphragm couldn't work without tearing.

It's easier to install the rocker-arm pin against spring pressure if you make a drift out of a rod or nail about the same size as the pin. File the point to a taper and use it to line up the hole. END

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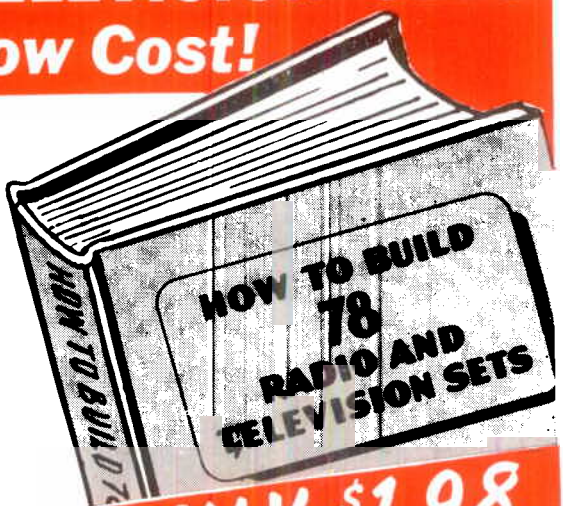

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