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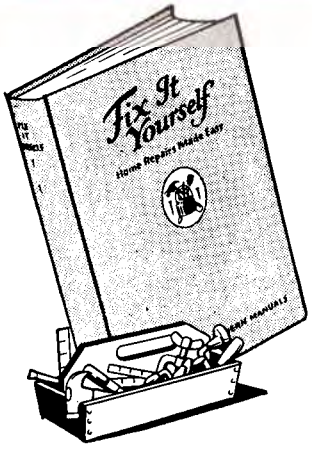

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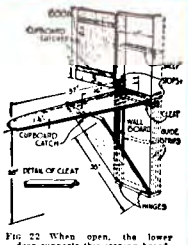

Fig. 22. When open, the lower door supports this ironing board.

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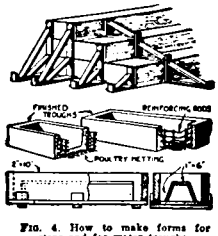

Fig. 4. How to make forms for steps and for water troughs.

SAVE a Stamp by Using the Postage-FREE Order Card on Back Cover Flap

YOUR CAR

How to Take Care of Your Car

POPULAR SCIENCE PUBLISHING CO., INC.
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YOUR CAR

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Tune Your Car for a Carefree Vacation

By R. P. STEVENSON

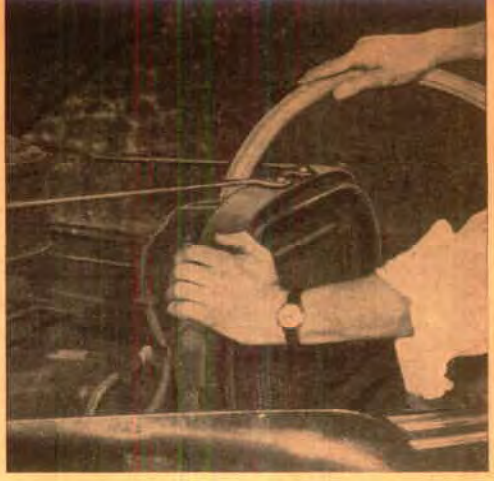
PSM Photos by ROBERT F. SMITH

VACATIONS always are more restful and interesting if free of the cares of your everyday life. For this reason, it will pay you to become a worry wart for a week or two ahead of time, if you are planning a motor trip this summer, and check over your car to see that it is in the best possible condition. For some of the more difficult jobs, you probably will want to take it to your serviceman, but there are many things you can do yourself, some of them minor and routine but all adding up to greater efficiency for your car and more travel comfort for yourself.

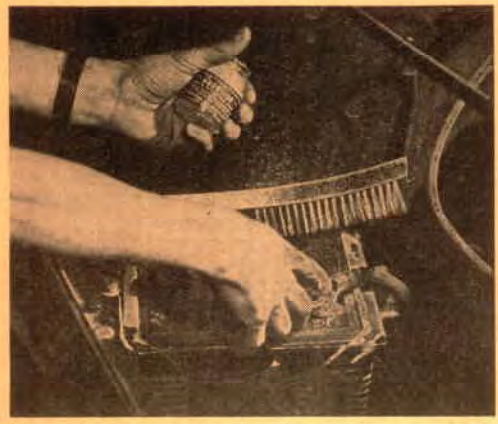
Such a pre-vacation checkup is particularly advisable if you are planning several days of steady driving, for minor defects that may not amount to much in short trips around home are apt to turn into major repair jobs under the stress of long runs. For example, you may have been getting along with brakes that are not quite equalized, or a grabbing clutch. On a long trip, bad brakes may damage your tires and it is possible that a grabbing clutch could magnify itself into a smashed transmission, rear end, or universal joint.

Before you set out, check the car thoroughly so it will not turn your trip into a series of garage stopovers. A can of motor oil stored with the luggage will help guard against burned-out bearings.

Hot weather and fast driving place a heavy burden on the cooling system. So tighten the hose clamps and adjust the fan belt, or replace it if frayed.



Also flush out the cooling system. Reverse flushing is more effective in cleaning out the corrosion, but a hose used in the old way will help a great deal.



With a wire brush, clean off the corrosion from the battery terminals. Then apply a light coating of petroleum jelly. Also check over the cables and be certain each one is making good contact.

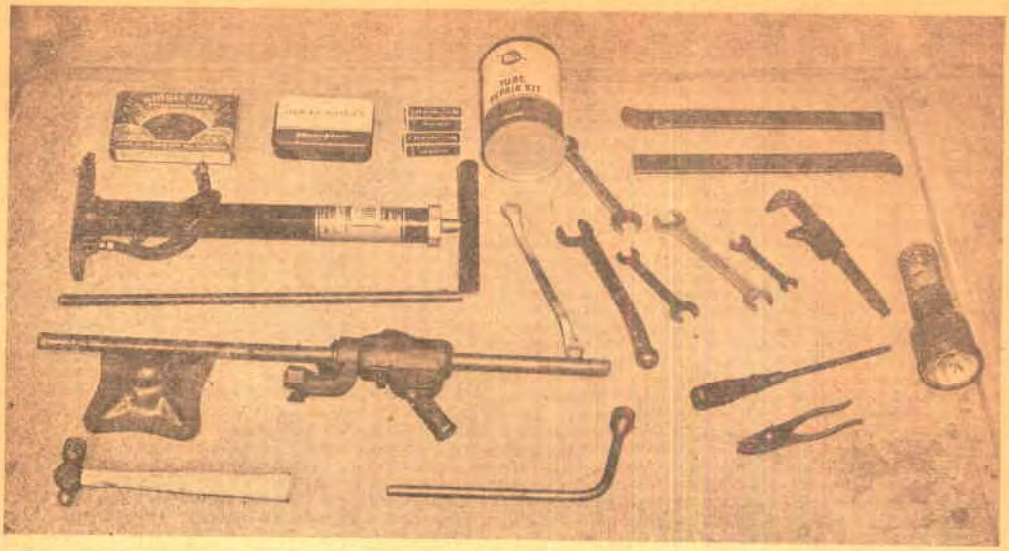
Remove the mesh filter from the air cleaner and wash the dirt from the filter with gasoline. Then dip it into a container of light oil and allow to drain for some time before returning to its place.

Before settling down to a consideration of the more serious jobs, like checking the brakes, adjusting the carburetor to give the best mixture for summer driving, cleaning the spark plugs, flushing the cooling system, and inspecting the tires, it would be well to give a thought to a few things that are so obvious that they could easily be overlooked.

You may *think* you are adequately prepared to handle a task such as changing a tire on the road—but are you? Check to be sure you actually have a jack, tire pump, lug wrench, tire iron, and tube-repairing kit in the car. Such equipment has a habit of getting left in the garage or cellar after being used for other jobs. Even at the last moment, you better take a look at the tire pump again, since Junior may have borrowed it to inflate his bike tires or football.

While you are making sure of your tools, think about storing a gallon can of motor oil in the luggage compartment. It's sometimes a long distance between service stations—and that oil reserve could easily be the means of preventing your bearings from burning out. Incidentally, keep a close watch on the oil consumption for the first few hundred miles driven at good speed, for the car may have developed into an oil hog since your last long trip without showing it in routine day-to-day driving.

Before you set out, give your battery the same kind of check that you should anyway about every two weeks. See that the water level in each cell is at least ⅜" above the plates, adding distilled water if necessary;



Are you prepared for any emergency that might arise on the trip? Spread out your tools and equipment on the driveway and check them over to see that nothing essential is missing. In addition to the items seen here, a provident driver will take along chains, spare fuses, and extra bulbs for the accessory lights.

and take a hydrometer reading of each cell. Fully charged, the battery should have a specific gravity reading of 1.280 to 1.300. If the reading is below 1.250, have the battery recharged.

At the same time, clean any corrosion from the battery terminals with a wire brush, wash the posts and lugs with baking soda and water, and rinse with fresh water. A coating of petroleum jelly will help keep them clean. Go over the cables and be sure that they are in good condition, and that they make firm, low-resistance connections.

Unless you have done so quite recently, it would be well to change the crankcase oil and the transmission and rear-end lubricants, and have the car lubricated throughout. It's a good plan to refill the shock absorbers, too, and to replace any defective links. At the same time this is being done, make a painstaking inspection of the brakes, looking particularly for leaks in the hydraulic system. Have the linings replaced if you suspect they are worn to, or almost to, the rivets.

Go over each tire carefully for cuts, bruises, nails, and worn spots that may indicate unbalanced wheels, uneven brake action, or shimmy. Make this tire inspection after removing the wheels, and then transfer each to another position to get more even wear. On your pre-vacation visit to the service station be sure to have the wheels checked for alignment, for there is nothing that will ruin your tires more quickly than improper front-end alignment.

On a long trip at high speed, the cooling system must work at its best. Hence, the radiator should be flushed thoroughly to remove any corrosive deposits that might eventually work loose and clog the system. There is a difference of opinion whether the permanent antifreeze mixtures should be removed during the summer, but even if you want to leave the mixture in, it is a good idea to remove it temporarily, flush the system, and replace the mixture. While working on the cooling system, also adjust the fan belt to the proper tension. Replace the belt if it shows any sign of raggedness or is oil soaked.

While it may be best to have an expert set the carburetor for the most economical performance, there is one seasonal adjustment on many carburetors that anyone can make with ease. This is an adjustment that in winter causes the acceleration pump to shoot an extra charge of gasoline to your cylinders when you step on the gas. For summer, this should be set to pump a smaller amount.

If your car has an automatic choke, as it probably has, you will find a tiny wire-mesh air filter inside the choke housing. Remove this and clean with carbon tetrachloride—or if it looks hopeless, throw it away and get a

After scraping carbon from the spark plugs, check the gap on each with a wire gauge. If adjustment is necessary, bend only the side electrode.

new one. Also remove the filter from the air cleaner, wash out the dirt with gasoline, dip the filter in light oil, and drain before replacing. Clean the oil-filler cap in the same way. The sediment bowl in the fuel pump is still another cleaning job you should take care of.

Spark plugs are deserving of special attention. Before touching them, however, carefully brush away all dirt so it will not fall into the cylinders when the plugs are removed. If a plug is found to be cracked, badly worn, or oxidized, replace it. If it's still in good condition, scrape the accumulated carbon from the electrodes and check the gap with a wire gauge, bending the side electrode only if any adjustment is needed.

Next, turn to the distributor, inspecting the housing for cracks. If the points are pitted, smooth them with a coil file or replace, remembering that an accurate setting is required for smooth functioning of the engine. It is essential, too, that the timing (that is, the distributor vacuum-advance) be exactly right since this is a prime factor in good performance, and good performance will be especially important to your peace of mind during a vacation.

On a long trip, it is remarkable how annoying you may find a little squeak that you scarcely notice while driving around home. So locate it if you can—and tighten up the joint or apply a little oil. In any case, apply a little graphite lubricant to the wedge-plate and dovetail assemblies of the doors. You may be surprised at what a difference this makes in giving you a quieter ride.

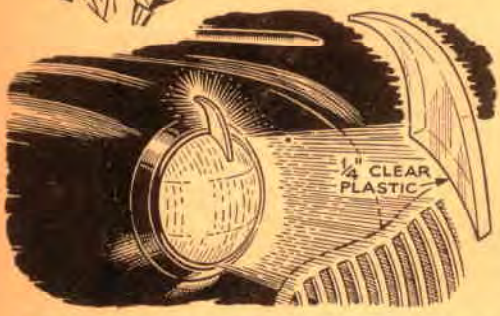
In addition to the tools and equipment previously mentioned, consider taking along a good set of chains—for on side trips in some rural areas you still may get bogged down in mud or sand. And speaking of weather, you undoubtedly are hoping that the sun will shine throughout the trip. However, it may not. So why not check the windshield-wiper hose for leaks right now—and be prepared?

A provident driver, especially if the trip is to be in lonely country, also would have on hand such things as flares, duplicate fuses, and spare bulbs for the taillight, backup light, and dash light. A duplicate set of keys—door and trunk or spare—is another good idea, but don't carry them yourself. Give them to a companion—or wire them to some inconspicuous place on the car that's accessible from the outside to someone who knows where to look.

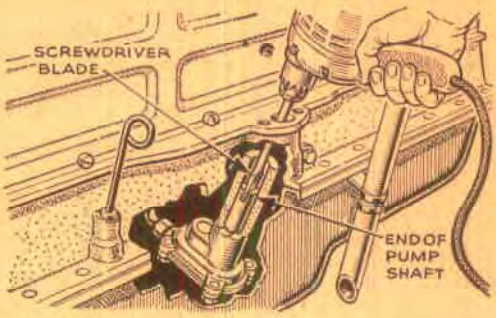
Lastly, if you are like most other people, your glove compartment probably could stand some attention. Clean out the mixture of bobbie pins, gum drops, old envelopes, and other debris that probably finds a haven there, and replace with insurance papers, several up-to-date maps, a flashlight, some spare matches and cigarettes, and any other personal items that will help bring you back alive and in good spirits. END

On a pre-vacation visit to your service station, have the wheels aligned. It is estimated that a tire ½" out of line is dragged sideways 87' each mile, reducing life of the tire 20 to 50 percent.

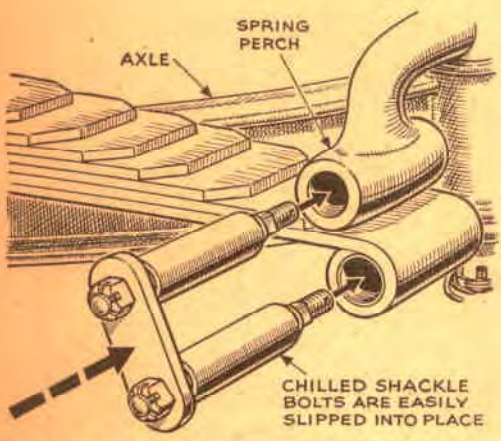
Hints From the Model Garage



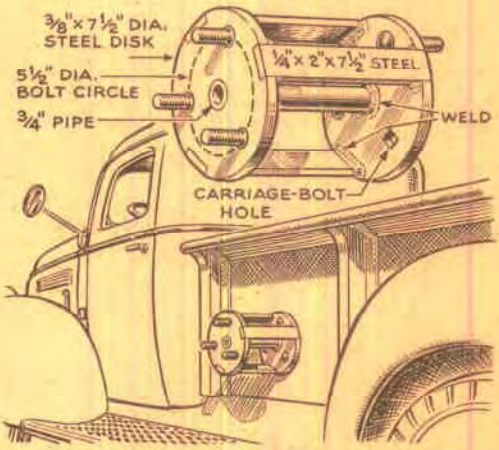
Plastic Shows Lights Are On. If a headlight burns out, you'll know it without leaving the car. Edge-lighted along the lower surface, a horn-shaped indicator cut from plastic carries the illumination up where you can see it. A good cement job will hold it on, or a metal strip screwed to rear corner can be clamped by lamp rim.



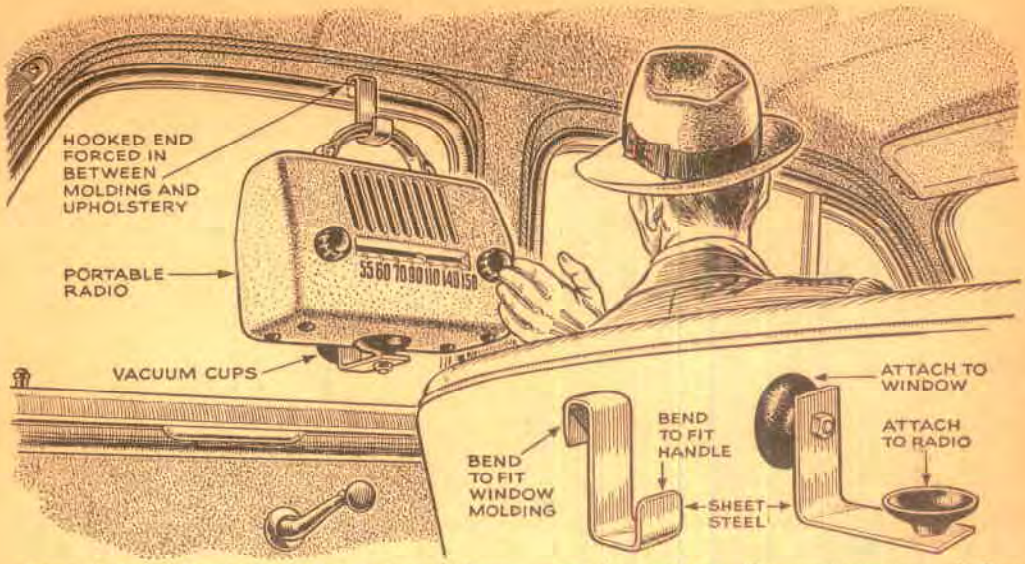
Drill Primes Pump. When an engine is started after an overhaul, oil pressure must come up fast to protect dry, tight wearing surfaces. Reader George Pedley, working on a Chevrolet engine, used an electric drill to run the pump until the oil gauge showed pressure. Then he finished assembly, timed the engine, and started it.



Cold Shackle Goes in Easily. Since cold contracts metal and hardens rubber, Robert Douglas, of Rochester, N. Y., suggests that you take advantage of this when installing Ford or similar spring shackles. Put the new ones into the freezing compartment of a refrigerator and leave for about half an hour. Then you'll find they have contracted enough to go into place with much less difficulty.

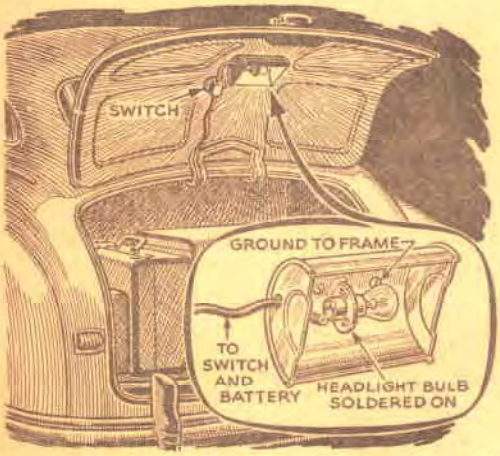


Carrier for Truck Tire. When Edward S. Barrows, of Philadelphia, bought a pickup, the spare-tire carrier was missing. He remedied this by building the one illustrated from scrap materials. He writes that he finds this more convenient than the usual carrier under the box and that it doesn't interfere with any use of the truck. Should you want to carry an extra spare, a carrier like this might be the answer.

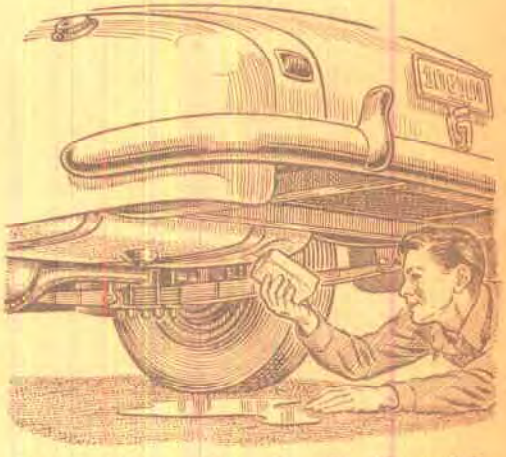


Portable Used in Car. Installed as shown, a good portable can double as a car radio. You'll notice that it can be quickly dismounted to serve in its original function.

With some sets two lower brackets may be necessary to provide firm support. Be sure to moisten the suction cups before applying to the glass. Most portables will not equal the performance of a good car radio, of course, but an installation like this has been found perfectly satisfactory in areas where stations are not too distant.



Light Works Automatically. If your luggage compartment hasn't a light, here's one that you can install at little expense. Mount a mercury switch under the lid to close the circuit and turn on the light automatically when you lift the lid. Drop the lid, and it goes off. Tap a taillight wire for the hot lead, and provide a good ground contact from the reflector to the car. A tin can cut in half makes a good reflector.



Soap Stops Gas Leak. If carefully applied, a bar of soap will make an emergency roadside repair for a small leak in your gas tank. After locating the hole, wipe off surrounding dirt and grease and rub the soap firmly over the spot several times. Since gasoline will not readily dissolve soap, this temporary fix will usually last until you can get to a garage and have the tank repaired or replaced.

HOW TO TOUCH UP DAMAGED SPOTS OR APPLY A NEW COLOR COAT OF LACQUER OR ENAMEL

Repainting Your Car

AUTO refinishing today is a most diversified business. The actual space and equipment needed for the work, as well as the requisite heat and light, are readily available, but other things are also essential. These are skill in matching colors, knowledge of how to do the work, and the proper technique in handling spray guns, abrasive papers, and rubbing compounds. All require experience, and unless a car owner has some ability along these lines, it is better by far to have the work done by a reputable painter and finisher. For successful refinishing, you should preferably have portable spray equipment and, of course,

Spraying on the finish coat. The windows and all chrome-plated trim or other bright work must be masked by using masking tape and newspapers

At right, the preliminary coats of primer-surfacer, which have been sprayed on, are being rubbed with waterproof paper and water

suitable materials for the work. A warm, bright day is necessary, and a clean garage. If you do not have a sprayer, you can still do the work satisfactorily provided you have good, clean brushes that have been properly kept in liquid brush keepers. You can then use the new four-hour, synthetic-resin type auto enamels and turn out a good job at considerable saving in cash. Don't attempt it, however, unless your garage is not only clean and well lighted, but can also be kept free of flies on a warm, bright day.

If your car was originally finished in lacquer, the same type of finish can be used again. A simple way to test the old finish is to sand a small section with dry sandpaper. If the paper gums up, the finish is lacquer, if not, it is enamel. If you decide to refinish with lacquer, it will have to be sprayed on, not brushed. Lacquer is a hard drying and relatively inflexible coating with powerful solvents that attack the undercoats, so it can be used only over lacquer-base coatings. Enamel, which is made on an oil-resin base, can be applied over any sound, tight base coating, whether lacquer, enamel, or varnish.

If the first finish on your car was enamel, then that alone should be used for the new coat. As conditions warrant, it may be applied with either the gun or brushes, except that in the latter instance a special thinner must be purchased to slow up the initial set of the enamel to allow the brush marks to flow out properly.

What you Save

Materials required for a typical touch-up lacquer job on a damaged car door:

2 sheets No. 180 abrasive paper	$0.10
3 sheets No. 280 abrasive paper	.15
1 tack rag	.35
½ pt. primer-surfacer	.40
1 pt. colored lacquer	1.00
1 pt. first-grade thinner	.35
1 lb. No. 2 rubbing compound	.40
Owners' Cost	$2.75
Average price quoted by five garages	$6.75
Owner Saves	$4.00

Materials for a typical recolor job in lacquer:

7 sheets No. 280, and 3 No. 320	.50
1 pt. primer-surfacer	.75
¼ lb. glazing putty	.25
1 tack rag	.35
2 qt. body color (for 2 coats)	4.00
2 lb. No. 2 rubbing compound	.75
1 qt. fender body color (for 2 coats)	2.00
1 package 1" masking tape	1.25
2 qt. thinner	.75
Owners' Cost	$10.60
Average price quoted by five garages	$35.00
Owner Saves	$24.40

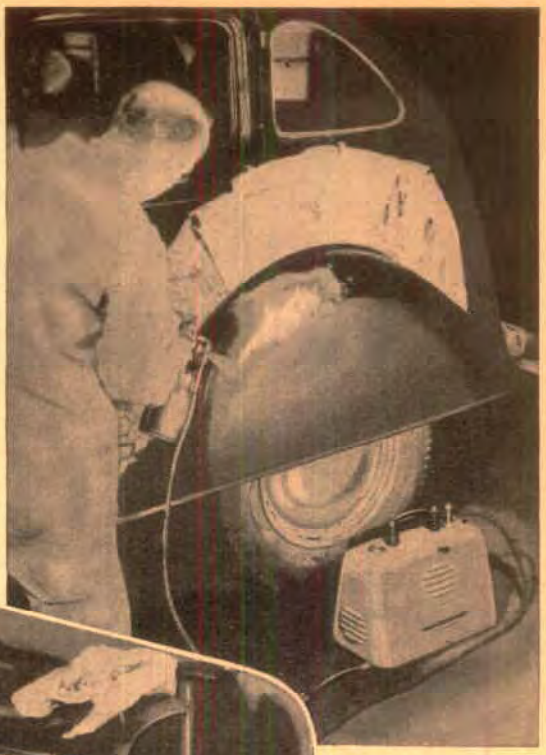
Materials for a typical recolor job in enamel:

7 sheets No. 280, and 3 No. 320	.50
¼ lb. glazing putty	.25
1 pt. primer-surfacer (if needed)	.75
1 tack rag	.35
2 qt. body color (for 2 coats)	2.50
1 qt. fender body color (for 2 coats)	1.25
1 package 1" masking tape	1.25
4 qt. special thinner	1.15
Owner's Cost	$ 8.00
Average price quoted	$25.00
Owner Saves	$17.00

STEPS IN TOUCHING UP A DAMAGED DOOR

In each instance it is necessary to mask all windows and chromium-plated or other bright work as shown in the photos.

Car refinishing naturally divides itself into three classes: Touch-up jobs, recolor jobs (top coat only), and the hand-brushed auto enamel finish. The necessary materials are listed in the tabulation marked "What You Save." Prices may vary to some extent. The estimates mentioned were obtained from five garages which specialize in auto painting and are located in the writer's home city, Syracuse, N. Y.



Above, spraying metal primer on a mud guard which had been so badly scratched in places that it was necessary to wet-sand part of it down to the bare metal

The final coat, if lacquer, is allowed to dry for half a day, then rubbed carefully with No. 2 rubbing compound

TOUCH-UP JOBS

1. Sand all chipped or scratched areas to the bright metal with fine abrasive papers, preferably No. 180 or 5/0 waterproof abrasive paper and water. Sponge clean. Polish the surrounding areas with No. 2 rubbing compound, or any standard abrasive liquid polish (such as No. 7) to bring up the color.

2. Feather the edges of the paint down with No. 280 or 8/0 waterproof abrasive paper and water. Sponge clean. Dry.

3. Wipe quickly with a clean cloth dampened but *not wet* with denatured alcohol, or use the commercial cleaning solution supplied by the maker of the lacquer you are using. Do not touch any surfaces with the hands after this alcohol wipe, and do not use gasoline at any time.

4. Prime with spray coats of primer-surfacer. This material protects the metal, insures adhesion, and builds up a level surface. When sprayed on in *light*, successive coats, the primer-surfacer allows cutting down with abrasive papers to a true surface. Let each coat dry until flatted, or free

of gloss from the thinners. Apply at least two coats. Dry for half an hour.

5. Wet-sand lightly with No. 280 or 8/0, or No. 320 or 9/0, waterproof paper—just enough to cut down any dust nibs. Level and feather out all edges. Avoid cutting through to the metal. If this occurs, recoat as needed.

6. If the old finish is lacquer, recoat with lacquer color to match. This can usually be obtained from auto refinishing stations if you give the make and color of the car and the year of manufacture. If the old finish is enamel, use a similar new material instead. Wipe off the surfaces carefully with a purchased or homemade tack rag before applying any finish coats. A tack rag is merely a lintless cloth which has been rendered slightly tacky with varnish so that it will pick up the dust.

7. Spray a light, even coat and let it dry in order to judge the color match. Tint the color, if necessary, by using japan or lacquer colors, which can be purchased in tubes or 1-lb. cans as needed. For very small areas that require matching, you can use artists' tube colors. It is often best to spray an entire fender or door rather than try to match perfectly a small patch. If this is done, any small difference in color is not likely to be noticed.

8. Apply a mist coat. Let this set from five to ten minutes, and then give a double coat (one up and down, the other from left to right) just wet enough to obtain a good flow and level out properly, but not enough to cause any sags. Watch this very carefully in the case of enamel coats.

9. Let dry half a day in summer, or at 75 to 80 deg. F. in winter, then rub out with No. 2 compound for lacquer coats. Do *not* rub enamel, but leave in full gloss.

RECOLOR JOBS

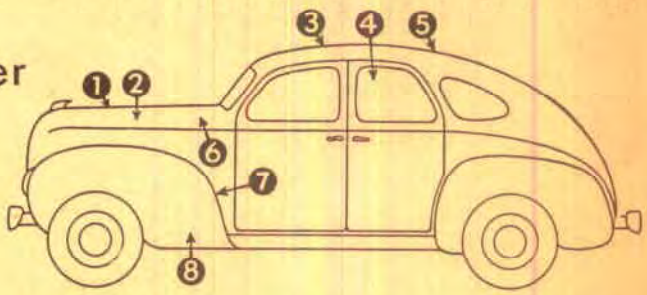
1. Wash the car clean with warm water and a half cupful of trisodium-phosphate powder to a pail of hot water. Hose off clean.

2. Sand all scratches and defects down to the bright metal. Cut the entire finish down dull, using water and No. 280 or 8/0 waterproof paper to level out all parts of the surface. Now apply spot putty on all dents and abrasions not cut down by the sanding. These auto-glazing putties are specially prepared and cannot very well be made at home. They are sold in tubes or cans and can be purchased locally or directly from finishing manufacturers. Keep all putty spots thin and light, and rely on successive coats for building up a dent rather than one heavy application, which might shrink on drying. Dry hard between applications, then water-sand down level.

3. Spray all puttied spots and bare portions with primer-surfacer in successive light coats. Dry thirty minutes and sand level with No. 320 or 9/0 waterproof paper and water. Dry carefully.

4. After carefully dusting car with a brush, go over it again with a commercial

Here's the Order to Follow When Using Lacquer



1. Sand from top down on hood, cowl, and right side complete.

2. Repeat on left side. Blow the dust out of the window frames and all body seams.

3. Wash top with special cleaning fluid or diluted alcohol.

4. Mask all windows and chrome trim.

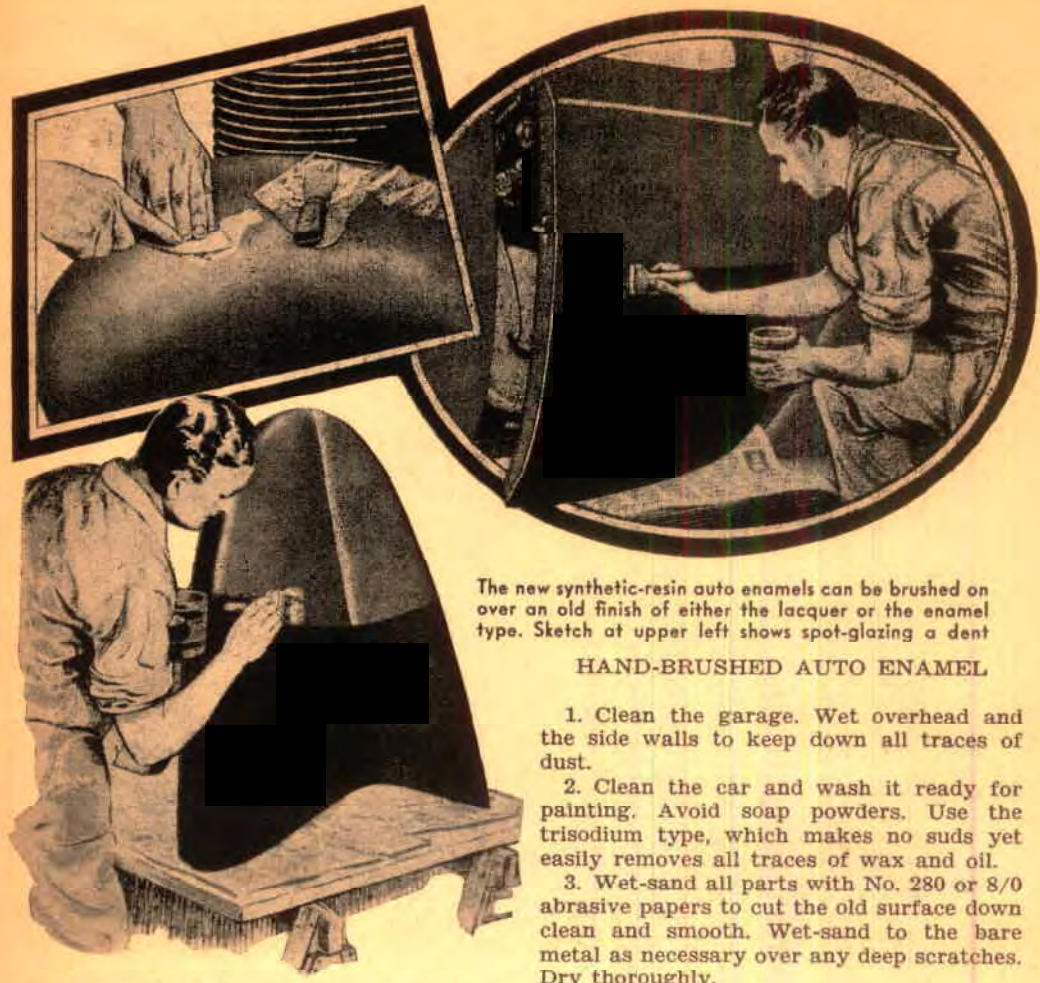
5. Dust off turret top with tack rag. Start to spray on front right corner to belt lines, across and over. Repeat immediately on left side. Give two coats, one following the other.

6. Clean spray dust off of the cowl, lower part of body, and rear fenders. Wipe with tack rag. Spray these sections.

7. Clean spray dust off front fenders and hood, use tack rag, and spray the finishing coat on rear fenders and lower part of body.

8. Spray cowl, front fenders, and hood. Let set fifteen minutes, then apply the finishing coat.

9. Let harden half a day, and then rub with No. 2 compound and polish.



The new synthetic-resin auto enamels can be brushed on over an old finish of either the lacquer or the enamel type. Sketch at upper left shows spot-glazing a dent

or homemade tack rag to insure the complete removal of all traces of dust.

5. Spray on an undercoat of light to medium weight on the spot-sanded areas only, just as for a new finish, whether lacquer or enamel. Dry thirty minutes for lacquers and four hours for enamel undercoatings. Water-sand lightly to remove any nibs, using No. 320 paper and water. Dust off and tack-rag again.

6. Spray two good, wet coats without inducing any sags or drips. For enamels, let set not less than from ten to fifteen minutes, and then spray on a full-bodied coat within an hour, so as to give good anchorage, coverage, and body, but without inducing sags, especially on vertical surfaces. For lacquer coatings, let set half a day and then rub out with No. 2 compound. Finish with an abrasive liquid polish, if available, and dry cloths. (No. 2 and No. 7 serve about the same purpose and either will do.) Wax the finish, if desired, to obtain an extra bright gloss.

HAND-BRUSHED AUTO ENAMEL

1. Clean the garage. Wet overhead and the side walls to keep down all traces of dust.

2. Clean the car and wash it ready for painting. Avoid soap powders. Use the trisodium type, which makes no suds yet easily removes all traces of wax and oil.

3. Wet-sand all parts with No. 280 or 8/0 abrasive papers to cut the old surface down clean and smooth. Wet-sand to the bare metal as necessary over any deep scratches. Dry thoroughly.

4. Prime the exposed metal surfaces with an oil-base metal primer, which is the only type that can be brushed. Dry four hours, then sand with No. 280 or 8/0 and water. Dry off and tack-rag, then recoat. Dry hard and resand with No. 320 or 9/0 paper and water. Cut down level, and feather out all edges. Dry thoroughly.

5. Spot with glazing putty as needed. Dry hard. Sand level with No. 280 or 8/0 paper and water. Dry thoroughly.

6. Apply a brush coat of primer-surfacer to all the putty spots. Dry hard and wet-sand with No. 280 or 8/0.

7. Inspect the entire job and spot-sand as required. Before starting the enamel work, sprinkle the garage floor again. It pays to keep walls dampened down, too. Dust off and tack-rag just ahead of the brush work.

8. Use brushes freshly cleaned in pure turpentine or special thinner made for reducing the enamel to brushing consistency. The special thinner must be obtained in any

case, since the enamel itself, if made for auto finishing, is made to be used in the spray gun and, therefore, has too fast an initial set or surface hardening to flow out readily under the brush unless mixed with the thinner. Thin the enamel and work the brushes in a small portion of it until the bristles are satisfied and all traces of the thinner have left the heel of the brush. Then discard this small amount of paint.

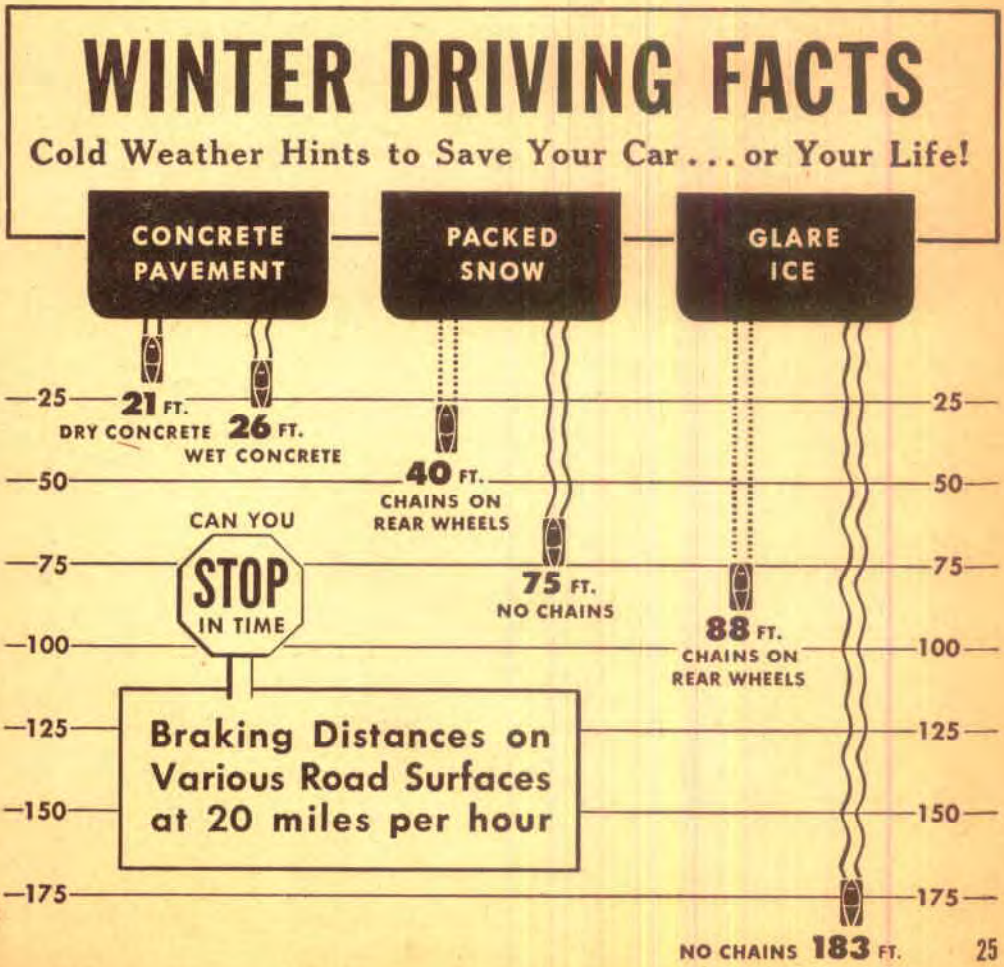
9. Apply coatings of the thinned enamel solidly and evenly to the car. Do the portions farthest away first, and fenders and the like last. Plan the work carefully before starting and use a tack rag on separate areas just ahead of the brush. Avoid sags on the vertical areas. Be sure to sudy the accompanying illustrations carefully before starting work.

10. Keep all coated work clean by lifting out any lint or bristles. For this work use a ball of burnt varnish on the end of an applicator stick or wire to touch the lint while the enamel is still wet and flowing. To prepare the picking stick, cook six to eight parts of brown rosin and one part of varnish in a clean vegetable can until a hot droplet falls on a cold glass plate cools and forms a stiff pill. Take a ball of this about the size of a shoe button, shape it round with wet fingers, and apply it to any specks of lint in the still wet enamel coating. The enamel flows together again as the lint is lifted out.

11. Dry hard and wet-sand with No. 320 or 9/0 paper and water if a second coat is needed to obtain full depth and color. Dry thoroughly after washing clean. Tack rag off and recoat as needed.

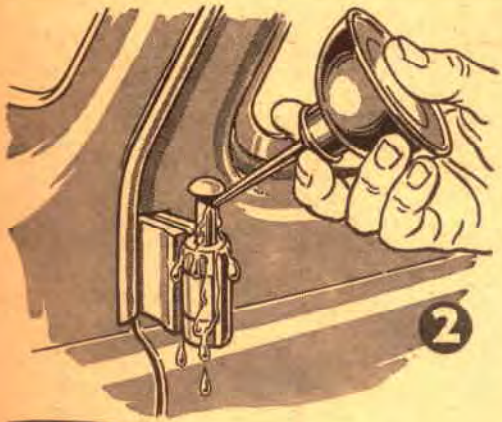
12. Allow the final coat two days to dry before putting car in service.

13. Wheels can be washed, sanded wet, dried, and brush-coated or sprayed as needed. For this work they are removed, and some method of supporting them about 36" from the floor should be used in order to see better the progress of the work and also eliminate tiresome bending over.



Hints From the

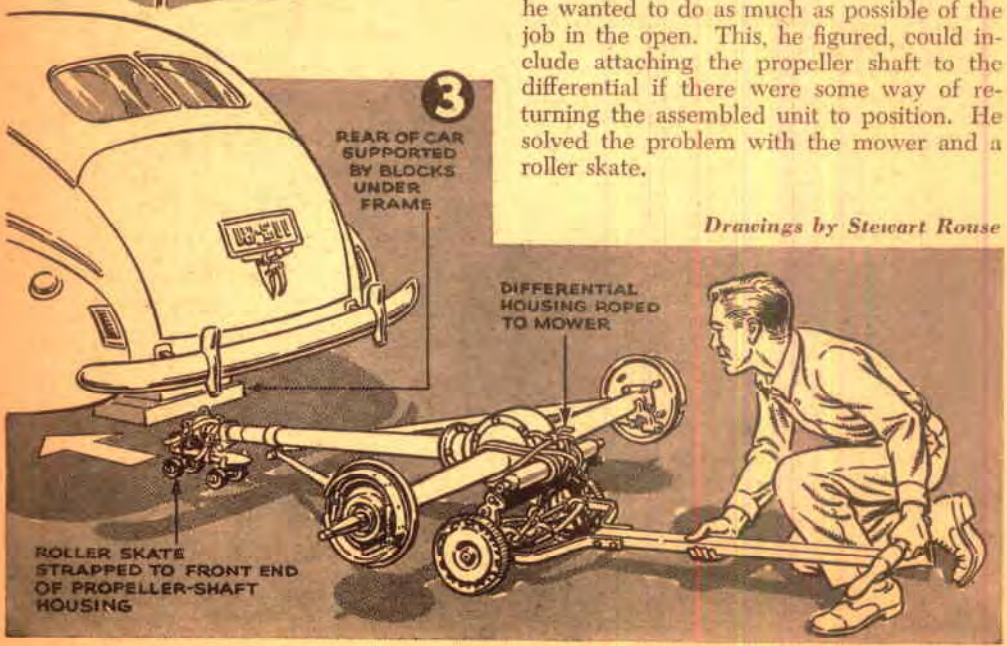
1. A flashlight is handy for repairs at night, but it may force you to work with one hand. A chap who stopped in the Model Garage had solved the problem neatly by keeping a heavy rubber band on the light. With this, he can strap the light to his forearm, freeing both hands for work. He also keeps a supply of tape wrapped around the light—so he needn't hunt for it in the dark.



2. Drive Out Hinge-pin to Oil. In the older cars with exposed hinges, Marion L. Rhodes, of Knightstown, Ind., finds it's best to drive the pin out halfway when oiling. Then apply a penetrating oil and allow to soak about five minutes. Unless the pin is loosened, even excessive oiling may not stop a persistent squeak.

3. Mower Used as Dolly. While doing a rear-end job in his backyard, G. A. Miller, Jr., of Atherton, Calif., found an unexpected use for his lawn mower. Since there was little room to work under the car, he wanted to do as much as possible of the job in the open. This, he figured, could include attaching the propeller shaft to the differential if there were some way of returning the assembled unit to position. He solved the problem with the mower and a roller skate.

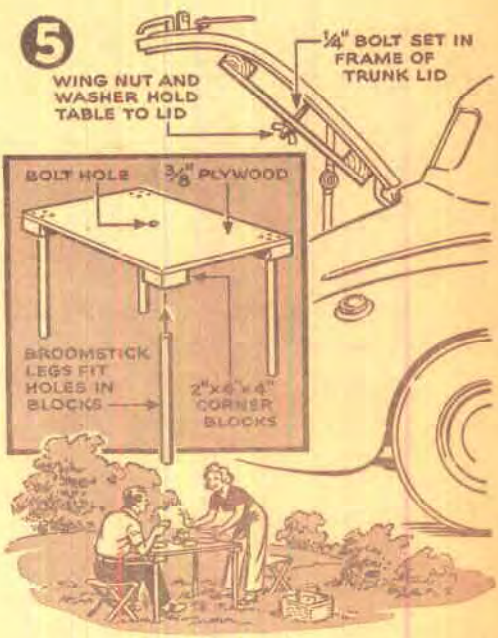
Drawings by Stewart Rouse



Model Garage

4. Paint the Hood Inside. Heat from the sun and engine may cause the finish on the hood to deteriorate. As a precaution, W. Van Sandt, of Long Branch, N. J., recommends making use of the fact that light colors reflect heat. White enamel or silver paint applied inside the hood will reflect part of the engine heat and keep the hood cooler.

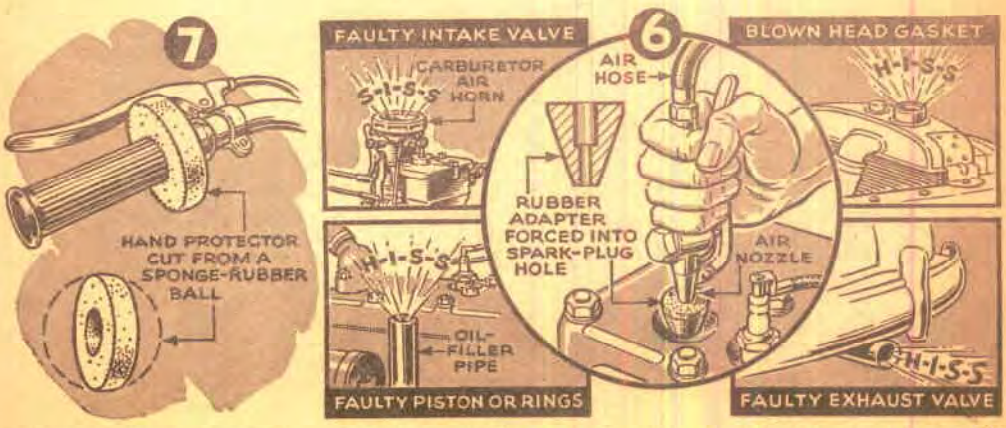
5. Table Always With You. Now that picnic time is here again, you may want to follow in the footsteps of H. C. Marhoff, of Chicago, and build this convenient table. When not in use, it takes up little space.



6. Air Spots Compression Leak. When an engine loses compression on one cylinder, Robert Brunt, of Lakewood, Ohio, diagnoses the trouble with an air hose. After removing the plug and setting the piston on firing position, he applies air to the spark-plug hole. If air hisses from the carburetor air intake, the trouble's in the intake valve; if from the exhaust pipe, in the exhaust valve; if from the oil filler, it's the piston or rings; if from the radiator, a blown gasket.

7. Cushions Rider's Hand. On long runs, the front-brake lever may chafe a motorcyclist's hand. A sponge-rubber disk slipped over the grip will prevent this.

Gus Wilson



HOW TO FORM GOOD DRIVING HABITS

AT MODERN highway speeds you may not have time to think about the *right* way of meeting an emergency. You must rely on habit, carefully formed, to do the right thing for you. Good driving habits can save you and your car from serious damage in a tight spot. And the right kind of habits can save you time, trouble and money every time you roll out of your garage.

According to suggestions furnished through the courtesy of General Motors, there are seventeen habits you can form that will stretch your gasoline mileage and help prolong the useful life of your car.

Starting the Engine. Always keep the clutch pedal pressed down when starting the engine. This lets the engine turn over without turning the transmission gear; it saves the battery extra work and provides faster starting—thus cutting gasoline waste. Besides, it's a fine way to avoid accidents that may happen if you start with the transmission in gear.

Hand Choke. If you have one, use it sparingly! Too much choking can waste enough gas to drive your car for several blocks—and may dilute your crankcase oil with gasoline to boot. Choke just long enough for the engine to begin firing smoothly; then push it all the way in.

Warm-up Period. Don't race the engine until it is warm—it takes time for the oil to circulate and lubricate the moving parts.

Clutch. A good rule to remember: Keep your feet off the clutch pedal unless you want to shift gears. Some drivers have the bad habit of "riding" the clutch, a surefire way to wear away the clutch lining rapidly. Others "slip the clutch"—let the pedal part way up to keep the car from rolling backwards on a grade. Both habits can involve you in unnecessary clutch repairs.

Gear Shifting. Shift into second, and from second into high, as soon as you have attained speed. On a level, you can shift from low to second in a single car length; most good drivers shift from second to high before they have reached 25 miles per hour. Prolonged driving in low gears wastes gas and rubber, and subjects your engine to unnecessary wear.

Starting on Ice. This is the exception to the general rules of starting. On slippery surfaces, don't use low gear at all! Start in second, and go easy on the accelerator. And when you want to stop on icy roads, shift into second and let the engine help you do your braking.

Acceleration. When you step on the gas, a charge of raw gas is squirted into the intake manifold, and much of it is wasted. Your car probably has

plenty of quick pick-up—but you'll save money if you don't use it to the limit.

Braking. Racing up to a traffic signal and slamming on the brakes is a well-known mark of the poor driver. You have spent money in the form of gasoline to build up that speed; you waste that money when you brake too suddenly, and you give your brakes a needlessly wearing workout besides. It is better, too, to form the habit of braking gently and preferably with a series of light "snubbing" actions—it may be important to you under conditions of extra heavy brake useage, such as going down a long hill.

Parking Brake. Form the habit of setting it *firmly* when you park—then you won't be able to drive off with it partly engaged, wearing out your linings.

Parking on a Hill. As an extra safeguard, turn the front wheels so that they will roll *into* the curb—not *away* from the curb—in case it should start to move. And leave the car in gear in case the brake should be released accidentally.

Coasting Downhill. Don't try to save money by coasting down hills in neutral. Even on the longest hill, not much gas is saved. And you may need the extra control and stopping power that leaving the engine in gear will give you.

Skidding. If the car starts to skid, *gradually* take your foot off the accelerator and at the same time turn the front wheels in the same direction the rear end is skidding. If you've begun to skid because of braking on a slippery surface, release the brake for a moment and let the wheels roll.

Use of the Horn. Experts estimate that 80% of the horn blowing is entirely unnecessary. In the country, you may have to lean on your horn to be heard at highway distances. But in the city one or two short taps will usually be enough. Frequently a long blast will have the wrong effect, by "freezing" or startling an unseasoned driver or pedestrian.

After a Hard Drive. If your engine is hot, let it idle for a moment before shutting off the ignition. It will help keep your radiator water from boiling, and protects against vapor lock.

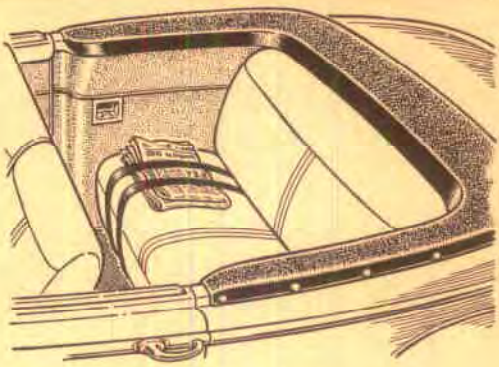
Passing Other Cars. Never try to pass unless you're *sure* you have plenty of room ahead. Passing a car going forty miles an hour is just like passing a standing string of cars 300 feet long or longer, depending on your own speed. Don't take chances. And when you have passed, be sure you can see the car you have just passed in your rear-view mirror before moving back to the right lane.

In Rounding Turns, always keep to your own side of the road and don't drive too fast. Brake *before* you enter the turn. Take a leaf from the book of professional racing drivers: They slow down when *approaching* a turn and accelerate as they begin to come out of it.

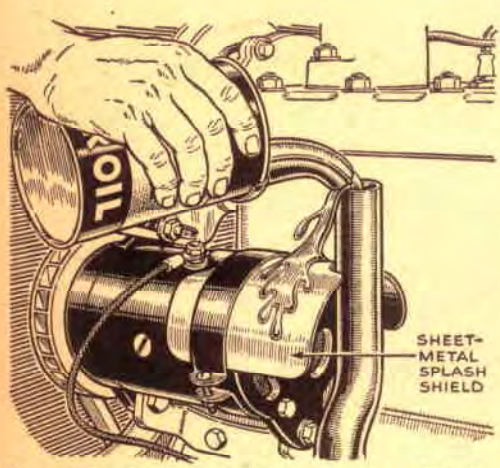
Tire Blow-Outs. The natural inclination is to twist the wheel to compensate for the drag, or to slam on the brakes. Neither is safe. Take the foot off the accelerator and let the car slow down, holding the wheels straight. Brake only gently. The same is true when one wheel runs off the pavement—let it roll until you can *safely* brake or bring it back onto the road.

Hints from the Model Garage

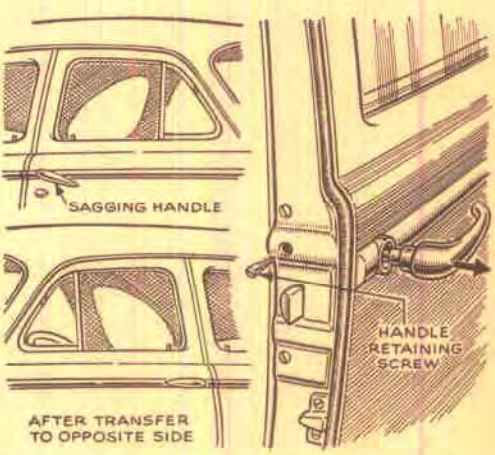
Prevent Overinflation. The new low-pressure tires are sometimes overinflated through carelessness. As a reminder to service-station attendants, paint the correct pressure on the rim beside each valve stem with white enamel, or apply waterproof adhesive tape with the figure inked on. You can also buy markers for your caps.



Straps Hold Back-Seat Items. If you own a convertible, here's a hint that may be useful. David A. Wallace, of Ada, Mich., suggests that one or more elastic straps placed around the rear cushion will keep papers or loose clothing from blowing out while the top is down. The straps won't interfere with passengers.



Shield Protects Generator. While filling up with oil, you may have noticed that the attendant sometimes allows a little to slop over the filler tube. Ray Wolfram, of Chicago, writes that he finally traced a mysterious generator trouble to such carelessness. Spilled over the generator, the oil had fouled the brushes. To prevent this from happening again, he installed a metal shield as shown.

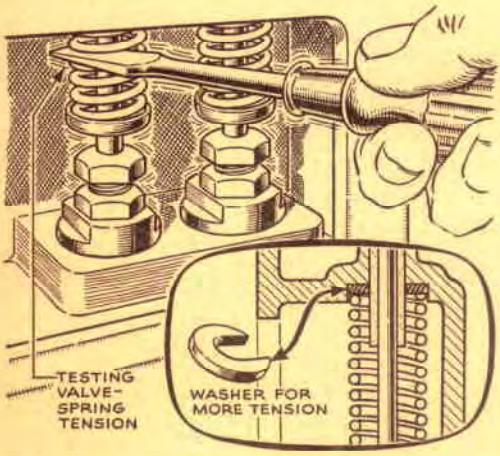


Reverse Sagging Handles. On some cars the door handles eventually wear enough so that they sag below the chrome strip they were designed to parallel. Don E. Braman, of Little Rock, Ark., found a simple solution for this on his 1941 Chevrolet. Removing the handles, he transferred each to the door on the opposite side. There, since the worn part was up, the handle didn't sag. Three minutes did the job.

Fan Belt Gives Tow. Forrest F. Starr, of Columbus, Ohio, makes a suggestion that may help you out of a tough spot.

"My neighbor's car was stuck in soft ground," he writes. "Having no suitable rope or chain, I used an old fan belt. It worked surprisingly well, for the stretch in the belt got the car started to rocking without any sharp jerks. I've carried the belt ever since for just such emergencies."

As seen above, the belt is especially good when you can't push the stalled car.



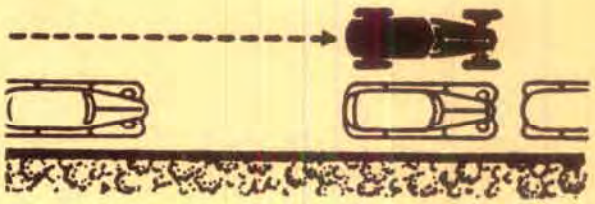
Washer Quiets Knock. A knock may occur at idling speed if the camshaft gear is worn and one or more valve springs do not have sufficient tension. W. M. Dierks, of Chicago, says such knocking usually can be quieted in the following way. With the engine idling, insert a screwdriver into each spring. When the knock stops, you've found the faulty one. Force a horseshoe washer 1/16″ thick under the seat.

Plastic Keeps Door Clean. Most everyone these days installs seat covers in a new car, but few give any thought to the door areas, where hands frequently soil the covering material. Frank J. Montemuro, of Philadelphia, is one person who does. Cutting a sheet of clear plastic to fit, he installed it as a shield around the door and window handles on each door. The plastic is easily wiped clean.

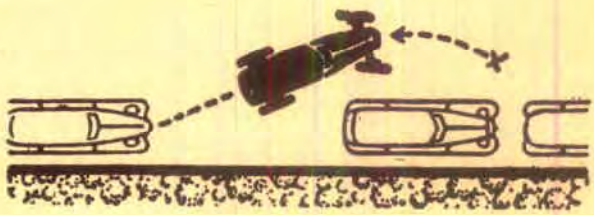
HOW TO PARK IN A TIGHT PLACE

FIRST, and of greatest importance, remember that traffic may be approaching from the rear, so always look back and make sure the road is clear before even attempting to park.

SECOND: Drive up in a straight line and stop even with *and fairly close to* the car in front of the space where you are going to park. Most trouble in parking comes from a wrong beginning—from not pulling far enough ahead or not getting close enough to the car in front—*or both.*



THIRD: Turn the wheels *sharply*—shift into reverse—and back the rear end of your car in toward the curb.



FOURTH: As your rear wheels near the curb—*you can determine this by lining up your outside REAR fender with the outside FRONT fender of the car behind*—continue backing slowly and at the same time swing your front wheels in the opposite direction so as to bring the front of your car in toward the curb.

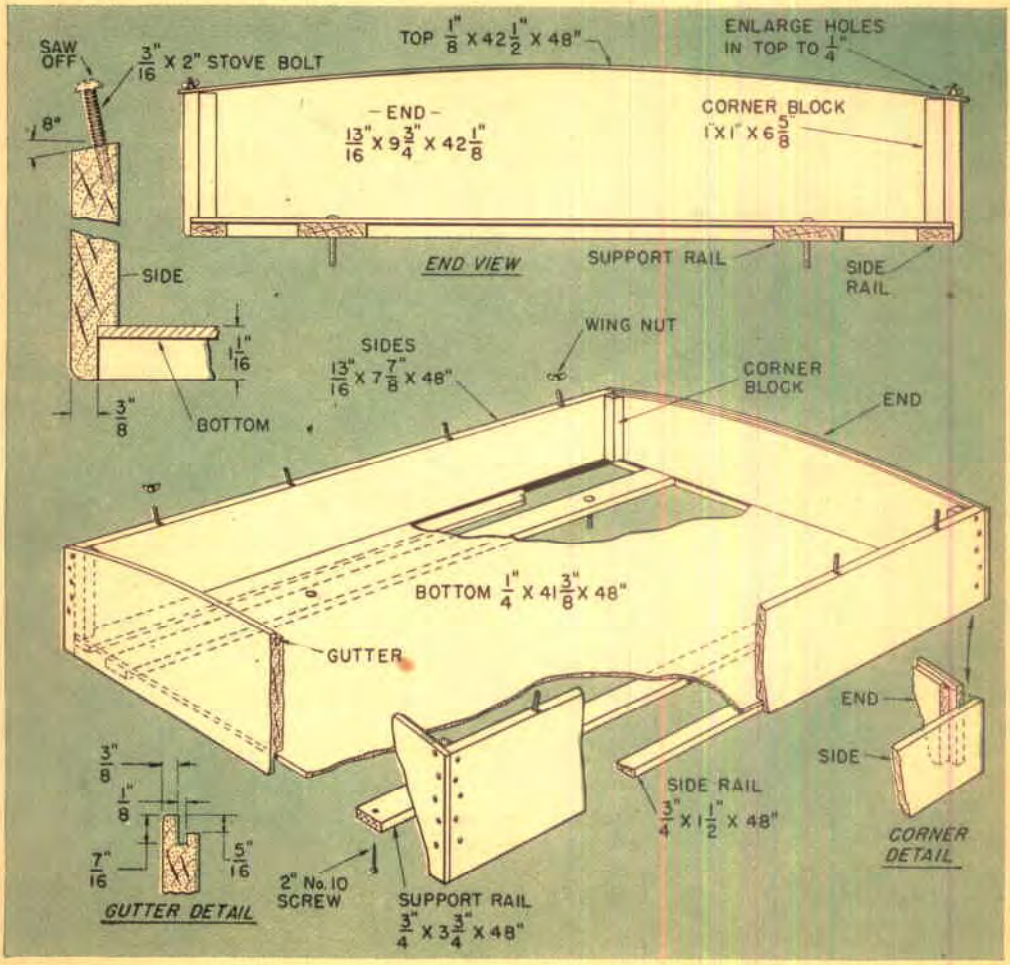
FIFTH: Now pull yourself ahead into parking position. But don't try to park *too close* to the curb because that makes it difficult to get your car back out again. In most cities you are allowed 6 inches.

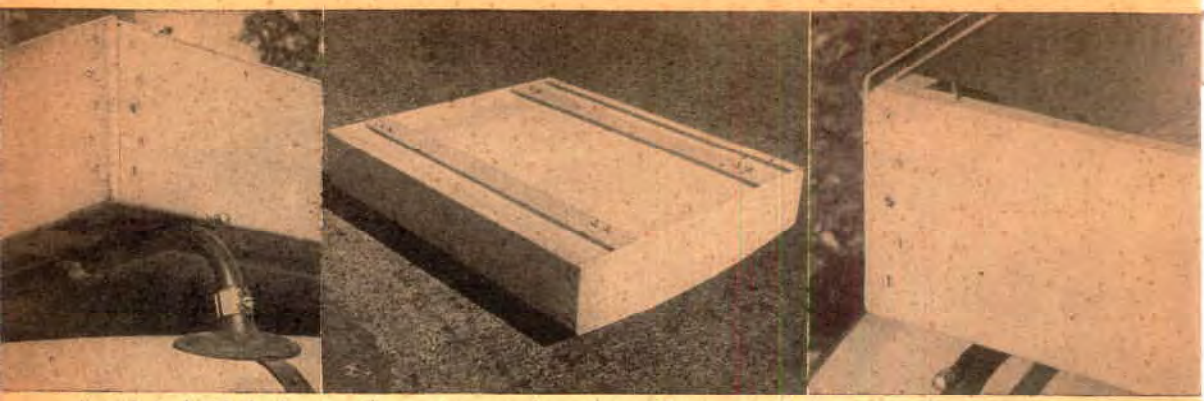
Car-Top Carrier Adds Outside Luggage Space

THERE'S little chance that rain will damage luggage in this carrier. Wind can't drive rain in, for the curved top panel rests below the ends. Drainage gutters in the ends carry off any seepage.

Make the ends and sides first, using white pine. Joint one edge of the stock and cut the pieces to finished length. Lay out the curve on each end and bandsaw to outline. Then clamp the pieces together and sand or plane smooth any irregularities.

Forming the gutters is easy on a shaper,





A rack to hold the box on the car top may be purchased. Attach the box with carriage bolts and pipe straps. A drainage gutter in each of the endpieces (right) carries off any surplus water. Note that a small notch should be cut in the sides in line with the gutters.

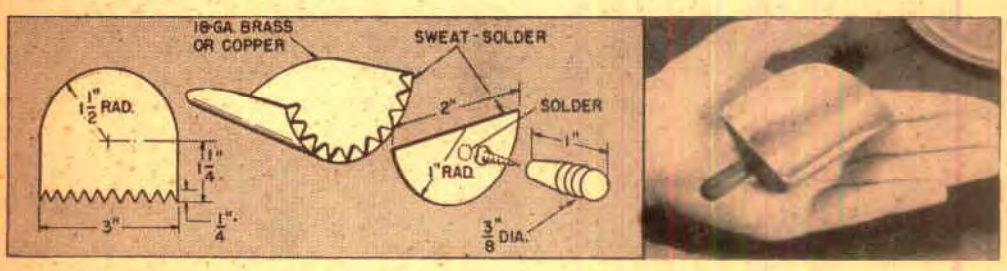
or with molding cutters on a drill press. Lacking that, use a dado head on the circular saw. Hold the stock vertically against the rip fence and rock it as you work. Make the shoulder for the top panel by holding the work flat on the saw table. Take several cuts at a tangent first. For the finish cut, rock the work against a guide line marked on the fence at the center of the blade.

Cut a rabbet inside the bottom edge of all four pieces, using the same saw setting for each. Next, saw rabbets in the endpieces to take the sides. Then make a trial fitting of one end and side to determine the angle at which the sides should be beveled.

Assemble the ends and sides with 1½" No. 10 flathead wood screws, driven into the corner blocks. Angle iron may be substituted for the blocks if desired. Cut the bottom plywood panel to fit the rabbets. Attach with ¾" No. 6 flathead screws.

Fasten the side and support rails to the ends with 2" No. 10 flathead screws. Attach the bottom panel to the rails with ¾" screws. Cut the top panel so that it just drops between the ends and extends beyond the sides about ⅛".

With the top panel in position, lay out and drill four bolt holes. These should be small enough so that 3/16" by 2" stove bolts may be threaded into the sides. Saw off the heads afterward and equip the bolts with wing nuts. Enlarge the holes in the top panel to slip over the bolts easily. Sand the box smooth, and paint or lacquer it to harmonize with the finish of the car.—*Glenn A. Wagner, Delmar, N. Y.*



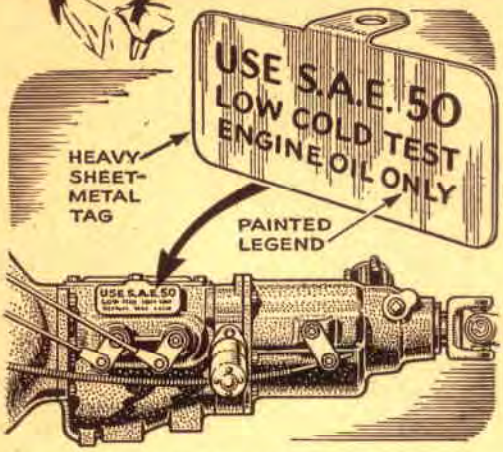
Scoop Fills Tobacco Pouch Without Spilling

This little scoop finally ended a long family feud. With it, I can now fill my tobacco pouch from a humidor or 1-lb. can—and get none on the floor.

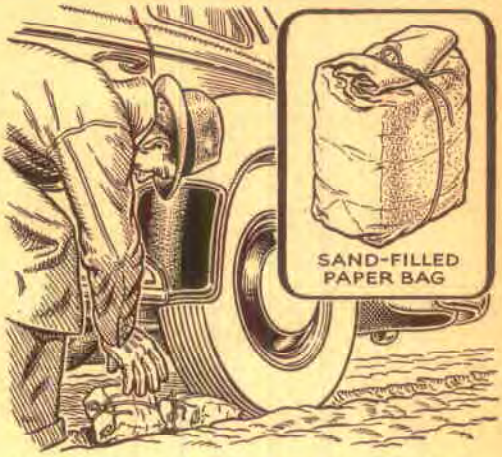
Cut the body to shape with tin snips, notching one edge as indicated. Bend in these projections, and sweat-solder the semi-circular end to them. Turn or carve a small ornamental wood handle, drill it for a flathead wood screw, and solder the screw head to the end of the scoop.

I tried to buy a suitable scoop. All were too long to fit inside the humidor. This one isn't.—*A. Zanelli, Clifton, N. J.*

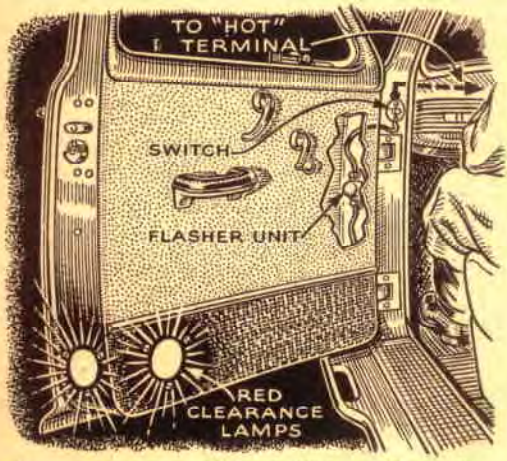
Hints from the Model Garage



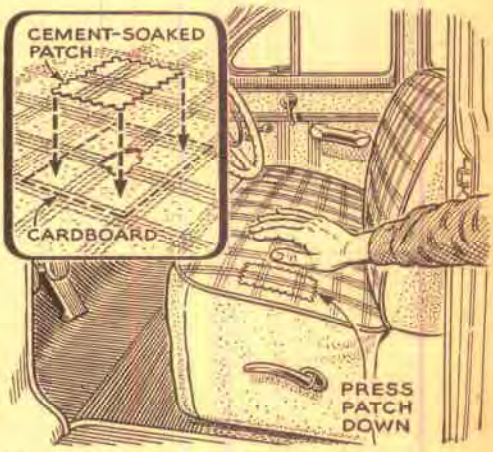
Tag Shows Proper Lubricant. In some new cars, a heavy motor oil is specified for the transmission instead of grease. To prevent careless errors, paint the oil recommendation on a metal tag and attach it near the transmission filler plug.



Sand "Bombs" Overcome Ice. If you frequently must drive on ice, keep sand in your luggage compartment, packaged in paper bags tied with string. Carry the bags in a cardboard box. Then, when stuck, drop bags under the rear wheels.



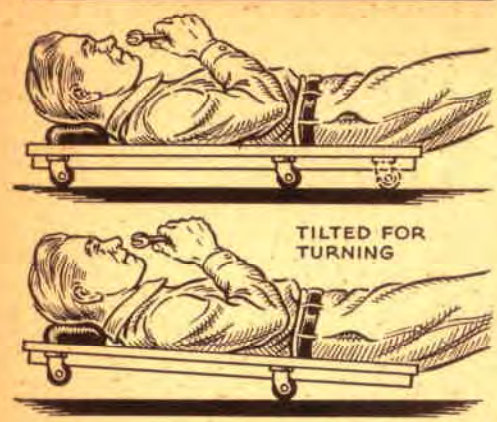
Door Lights Flash Warning. Before getting out the driver's door in traffic, it's always a good idea to look both ways. John W. Bell, of Des Moines, Iowa, has provided additional safety with this warning system. When the door is opened, a normally-off push switch in the door jamb shoots current to the flasher unit. An auxiliary switch on the dash cuts off the system if you want to keep the door open.



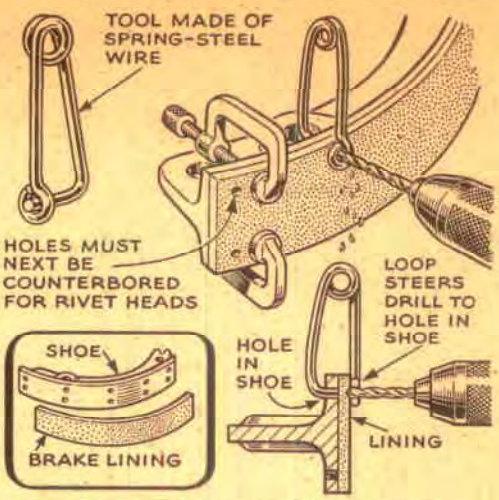
Patching Seat Covers. You can repair a worn area or tear in fiber seat covers by cementing on a patch. Cut the patch from a hidden part of the cover, using pinking shears if available. Put cardboard between the worn area and the upholstery to protect the latter, saturate the patch with clear model-airplane cement, wait until it is tacky, and press firmly in place. Let the patch dry overnight.

Turn the page, please, for four more auto hints

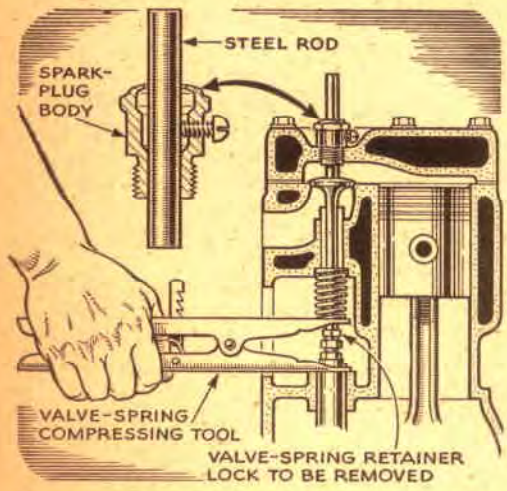
MORE Hints from the Model Garage



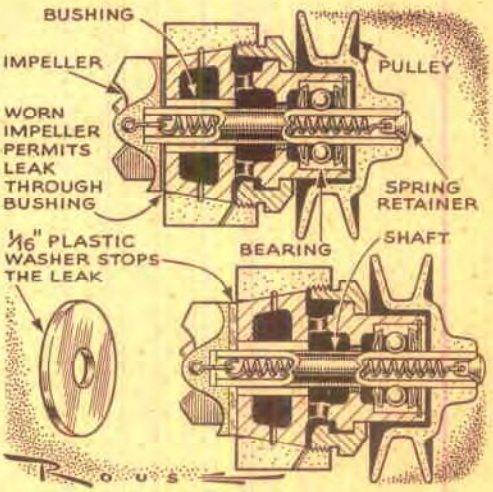
Turn Creeper by Tilting. On rough garage floors, it's often difficult to turn the usual shop creeper when you want to move to a new position. The creeper will work better if you set one pair of wheels back 12" or so from the end. Then, by shifting your weight, you can tilt the creeper slightly when you want to turn.



Aligning Holes in Lining. If you cut and fit lining to brake shoes, this tool will help you align the rivet holes in the lining. After the lining has been cut, attach it securely to the shoe. Then place the prong of the tool in the shoe rivet hole and drill through the tool eye. Counterbore for the rivet heads.



Replacing Valve Springs. This tool makes it easier to replace an intake-valve spring on an L-head engine without removing the head. It's used by adjusting the steel rod until it bears on the head of the closed valve. Turn the body into the spark-plug hole without forcing it. The spring can now be compressed and the retaining key removed. Marion L. Rhodes, Knightstown, Ind., developed the tool.



Washer Tightens Worn Pump. In overhauling a Ford "60" water pump, John Salzillo, of Brooklyn, N. Y., found that the edge of the plastic impeller had worn so much that the spring couldn't pull it snug against the pump housing. To take up the slack, he removed the impeller, and slipped a plastic washer on the shaft. This had the effect of building up the worn impeller. He cut the washer from 1/16" plastic.

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.

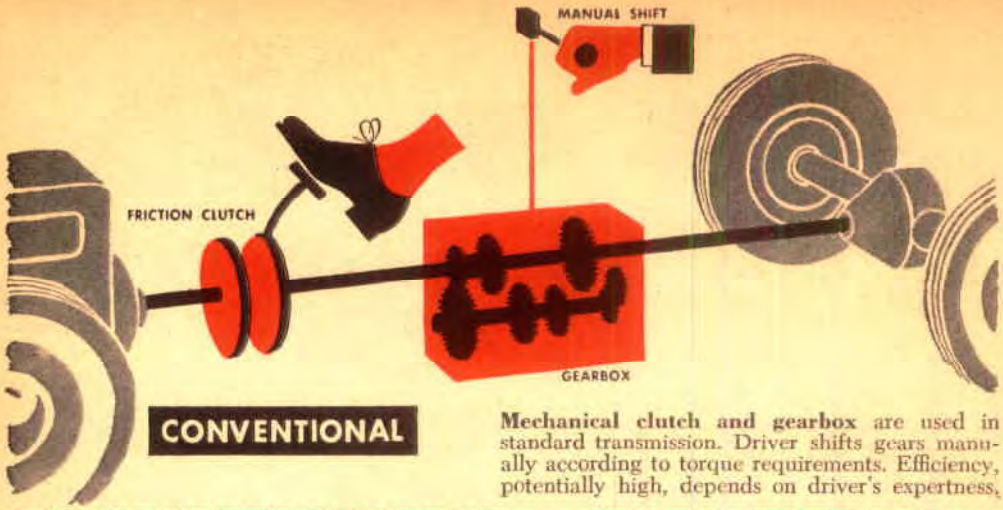
To give the car for many drivers this higher average driving ease, Detroit has performed nothing less than a little miracle. For all their complications, the new transmissions demand little or no more space or weight than a conventional transmission.

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.

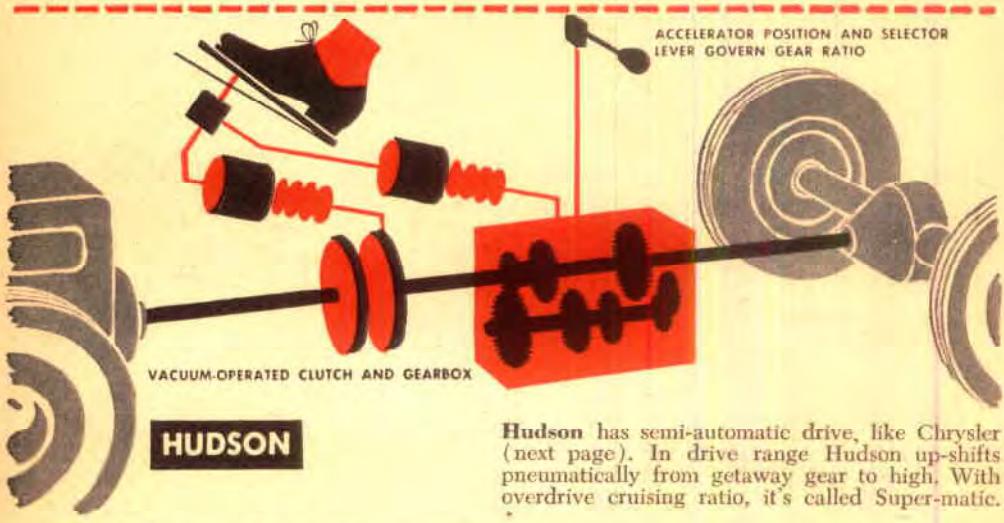
In these pages POPULAR SCIENCE presents a Who's Who of the new drives: how they work, how they differ, their advantages, disadvantages, and costs.

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.

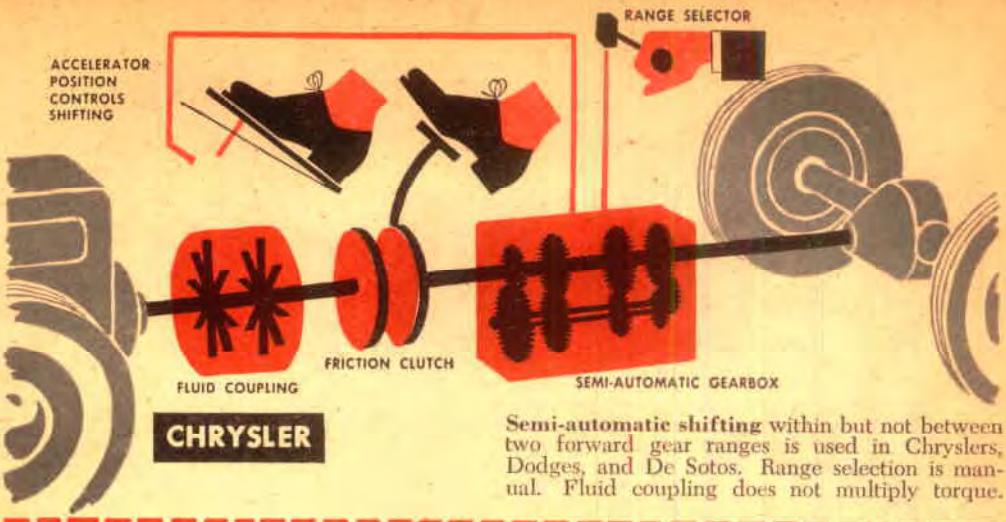
Some of the new drives use automatic gear trains as an adjunct to torque converters for an extra boost from a standing start. Hydra-Matic, oldest of the "self-shifting" transmissions, is a gear job throughout except for its fluid coupling.

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.

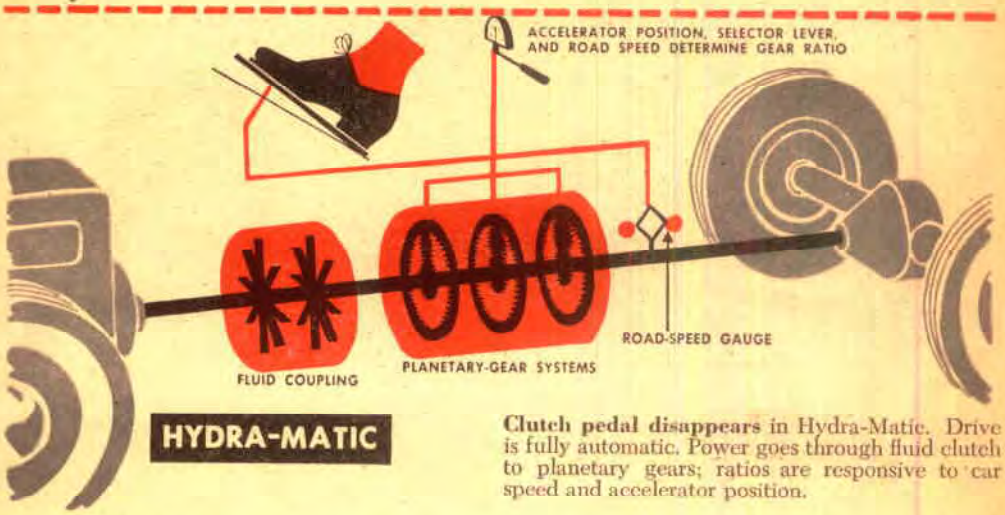
Make Them Shift for Themselves

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.

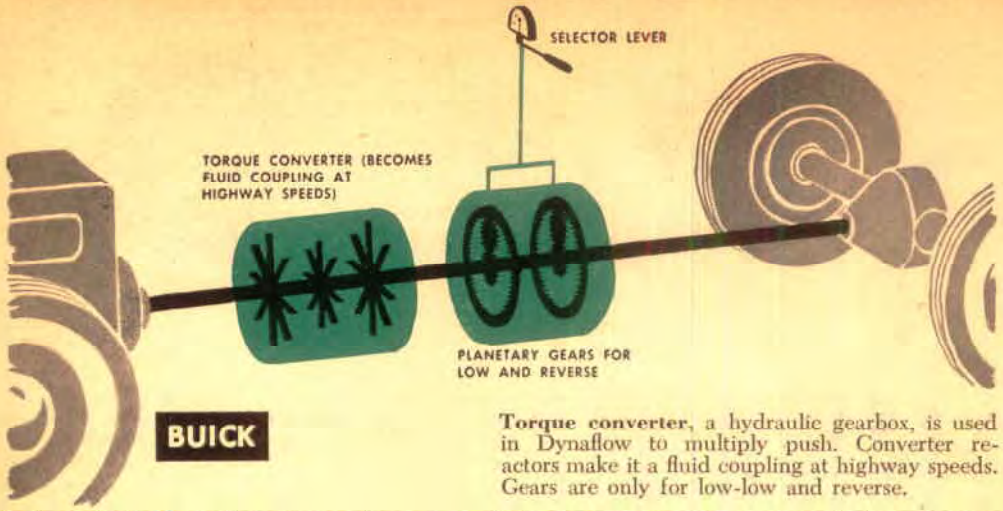
Here are some of the complicating elements that are packed into the new drives:

- 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.

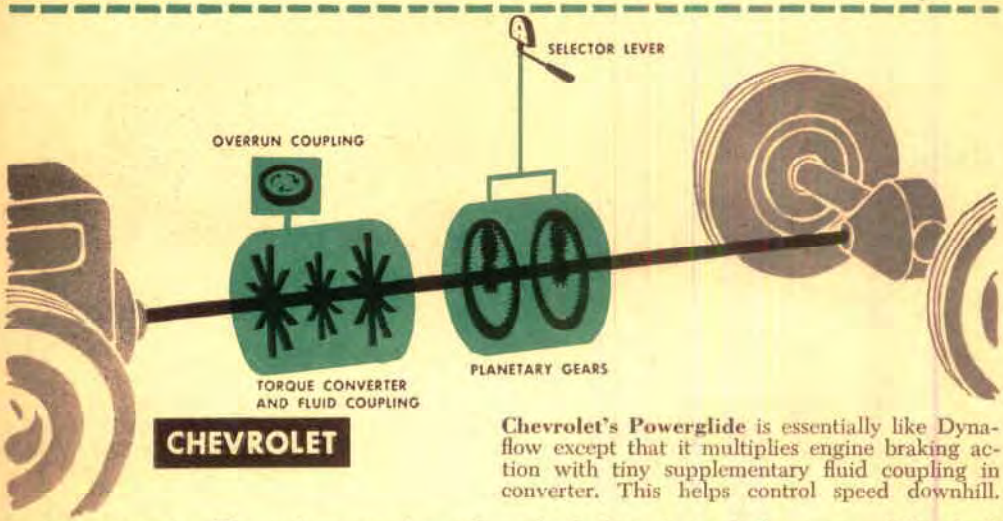
The torque converter and the planetary gears drive the car by transmitting and multiplying engine torque. What elements do *what* and *when* depends on speed, load conditions, and what brand of transmission you are driving.

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.

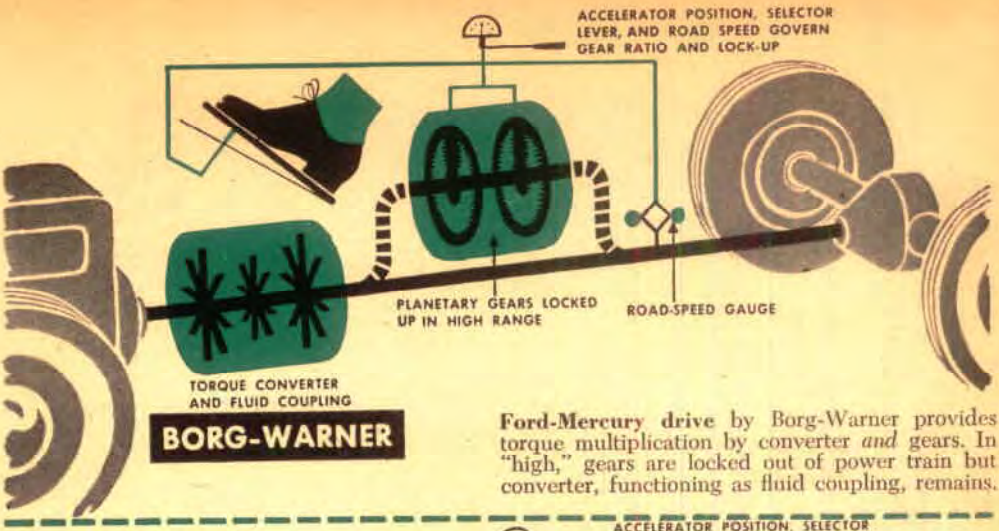
Most of the new drives have, besides the items listed above, a centrifugal *governor*. This is half of a team in the control system. The other half is the driver's accelerator pedal. Between them, they interpret the torque and speed you demand and go around or through the elements in the transmission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

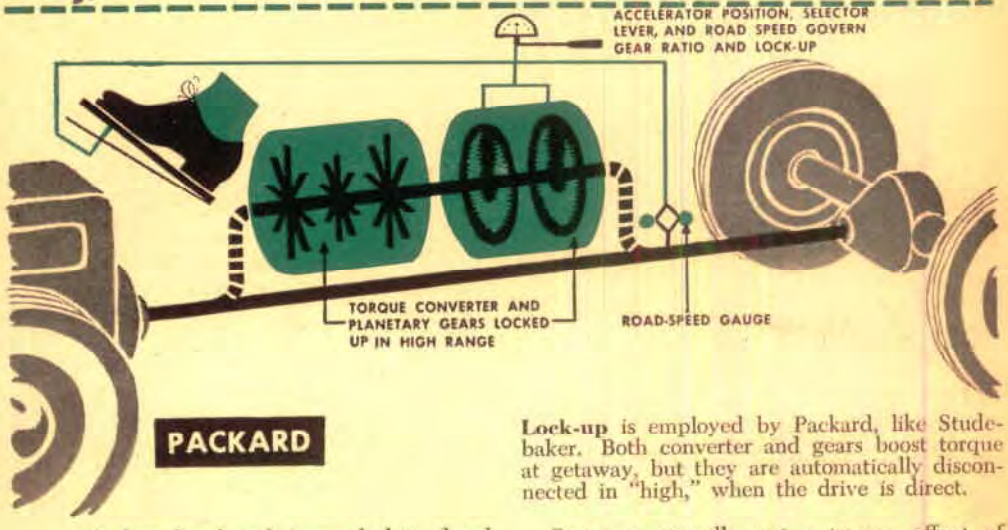
Old automotive words have taken on new meanings. In the new transmissions, "brakes" and "bands" are not those for the car's wheels but, instead, for gears. "Clutches" in the planetary systems are only second cousins to the clutch that responds to the pedal under the left foot. "Valves" have not to do 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.

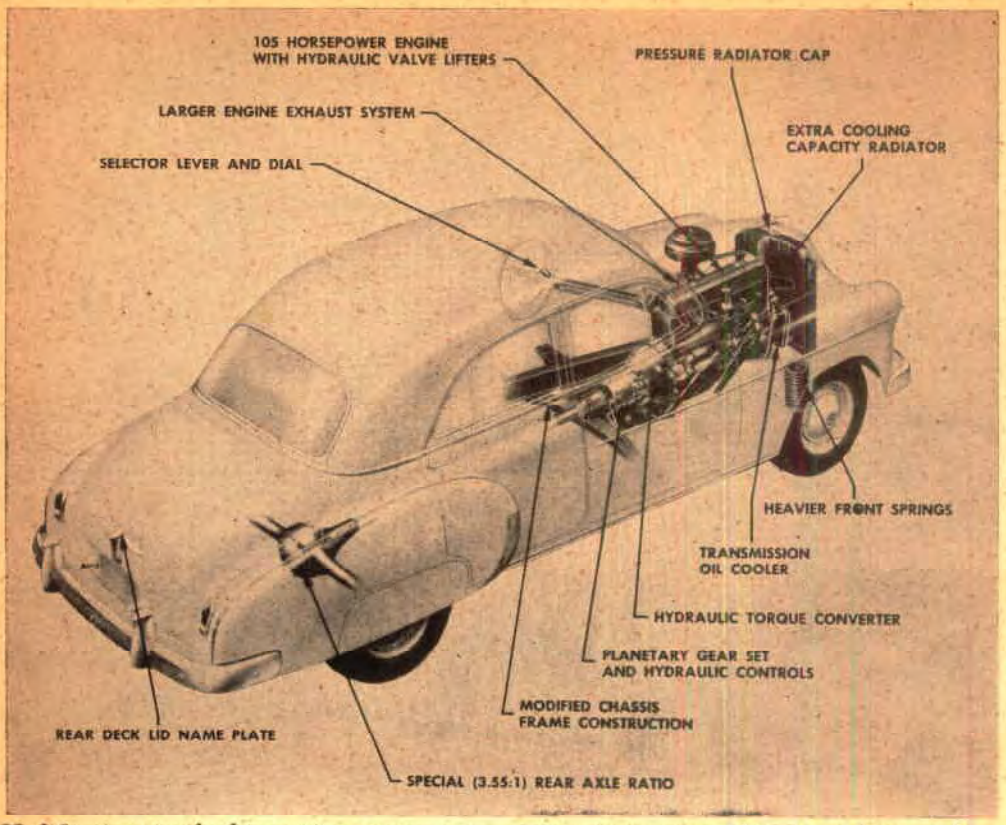
A *lockup band* and *forward drive band* are applied through their *hydraulic servo mechanisms*. The *lockup band* holds the *sun gear* of one of two *planetary* sets stationary, while the *forward band* holds stationary the *sun gear* of a *second planetary* set through a *free-wheel unit* fitted with *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.

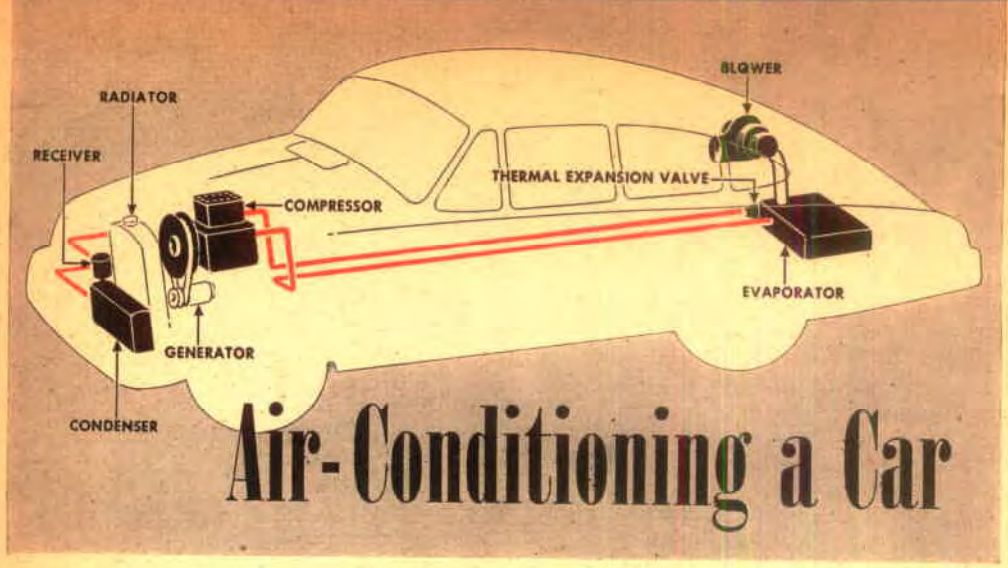
An automatic transmission is a great advantage if it only keeps peace in the household. END

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	

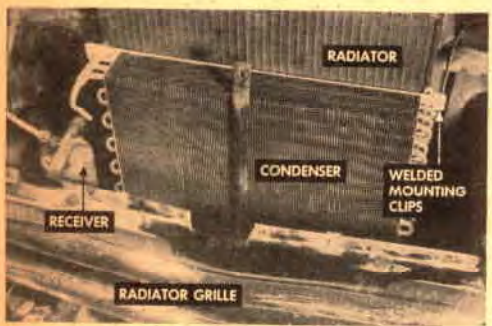
*To be announced



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.

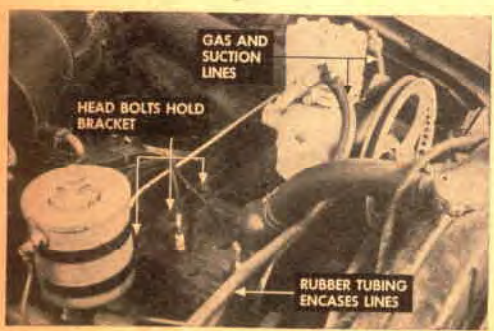


Though bolted directly in front of lower part of the radiator, the condenser has been found not to interfere with cooling of the engine.

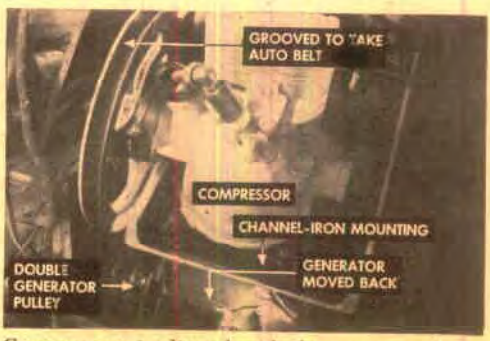
PITY the poor motorist who must drive on a heat-soaked highway under a broiling sun, cooped up in an upholstered steel box, and propelled by a gasoline-fired heat engine. It's about time we did something to cool him as well as his engine.

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.

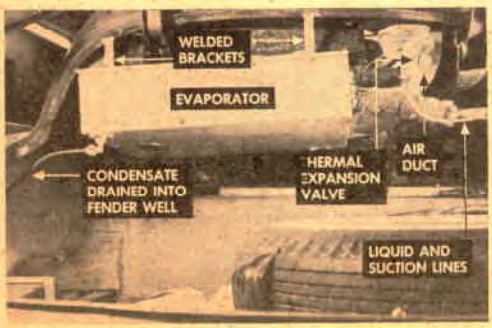
I mounted the compressor on a cut-down piece of 10" channel iron bolted to the head with the existing bolts. Rather than use a single belt on the engine, water pump, generator, and compressor, I drive the compressor from a special double pulley attached to the generator. This permits removal of the extra 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.

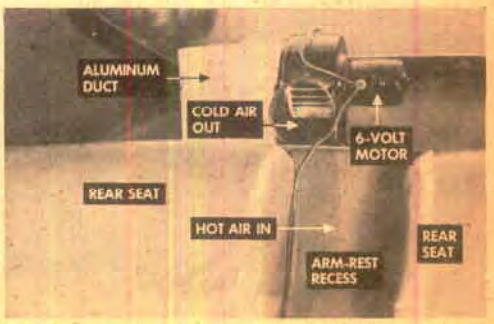
Located to minimize obstruction of trunk space, the evaporator is bolted under the deck behind the rear seat. Air entering the trunk around the seat and through the center arm rest is drawn through the evaporator to be cooled and dehumidified. The moisture it gives up is piped out the left fender well. 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.

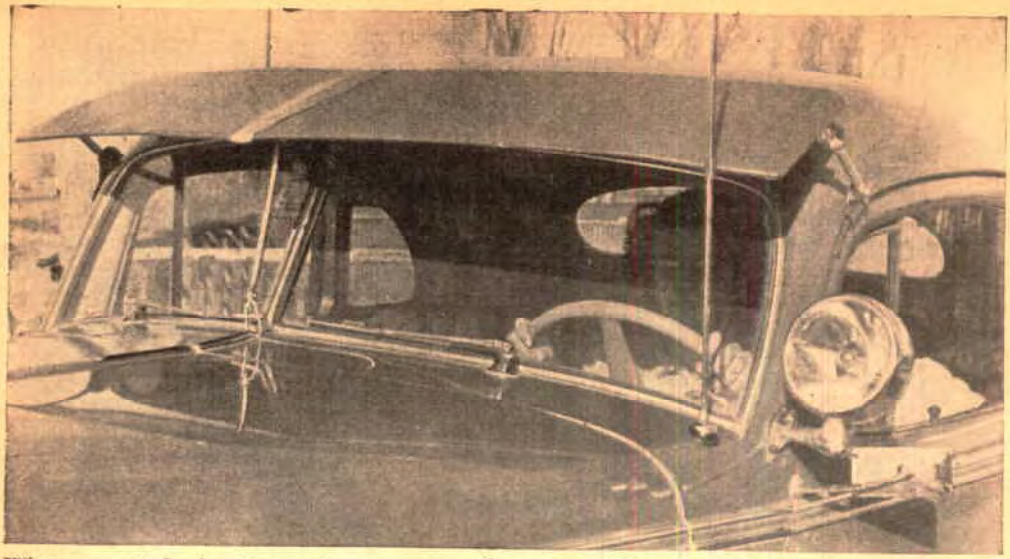
The refrigerant lines are mainly ½" soft copper and are fitted at several points with necessary flexible connections. I covered them with "spaghetti" insulation of sponge rubber and ran them back inside the right frame channel. END



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.

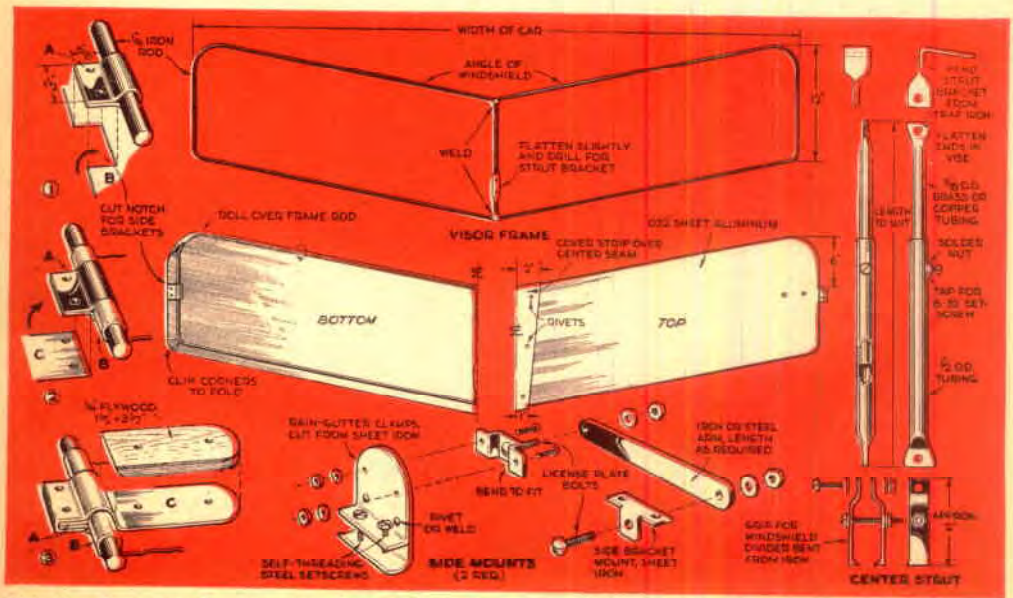
Homemade Visor Costs Only $4

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.

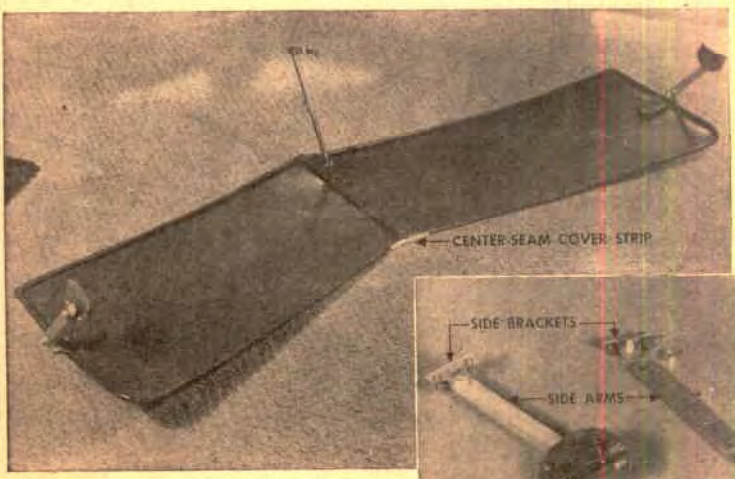
back angle. Then cut a cardboard pattern 12" wide for half the visor, transfer it to plywood, and saw it out.

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.

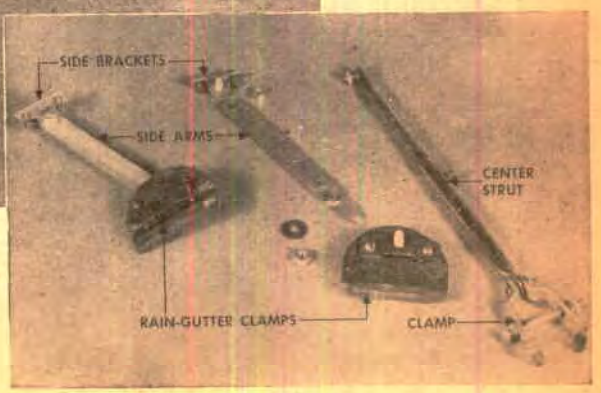
Covering. Use .032" aluminum for this. A sheet 18" wide and 5½' long will do the job. Put down the pattern and mark around it 1¼" from the edge except at the center line, which you mark flush. Snip out this panel. Then turn the aluminum over. Use the same center line to mark and cut the opposite panel.

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

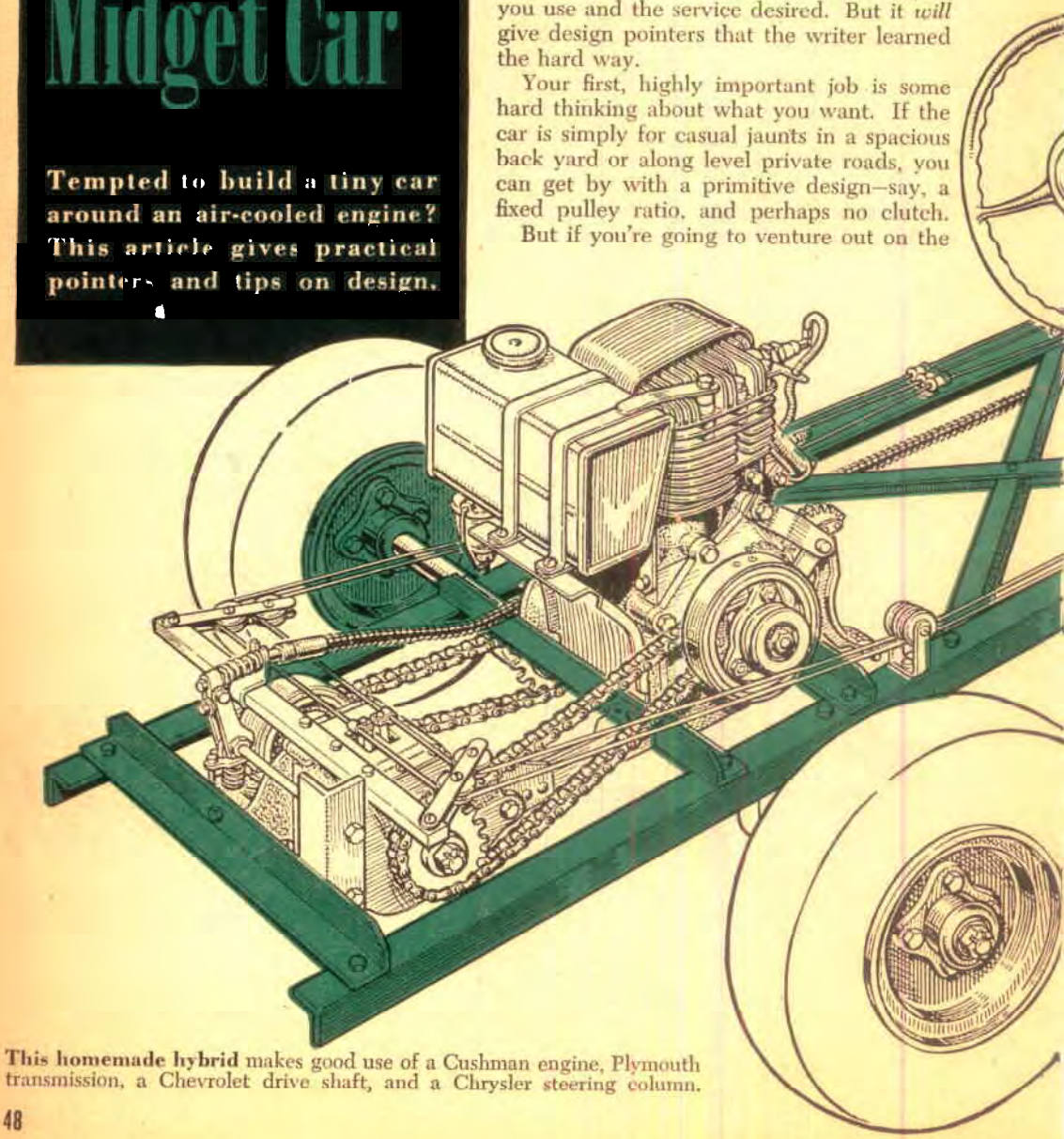
Tempted to build a tiny car around an air-cooled engine? This article gives practical pointers and tips on design.

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.

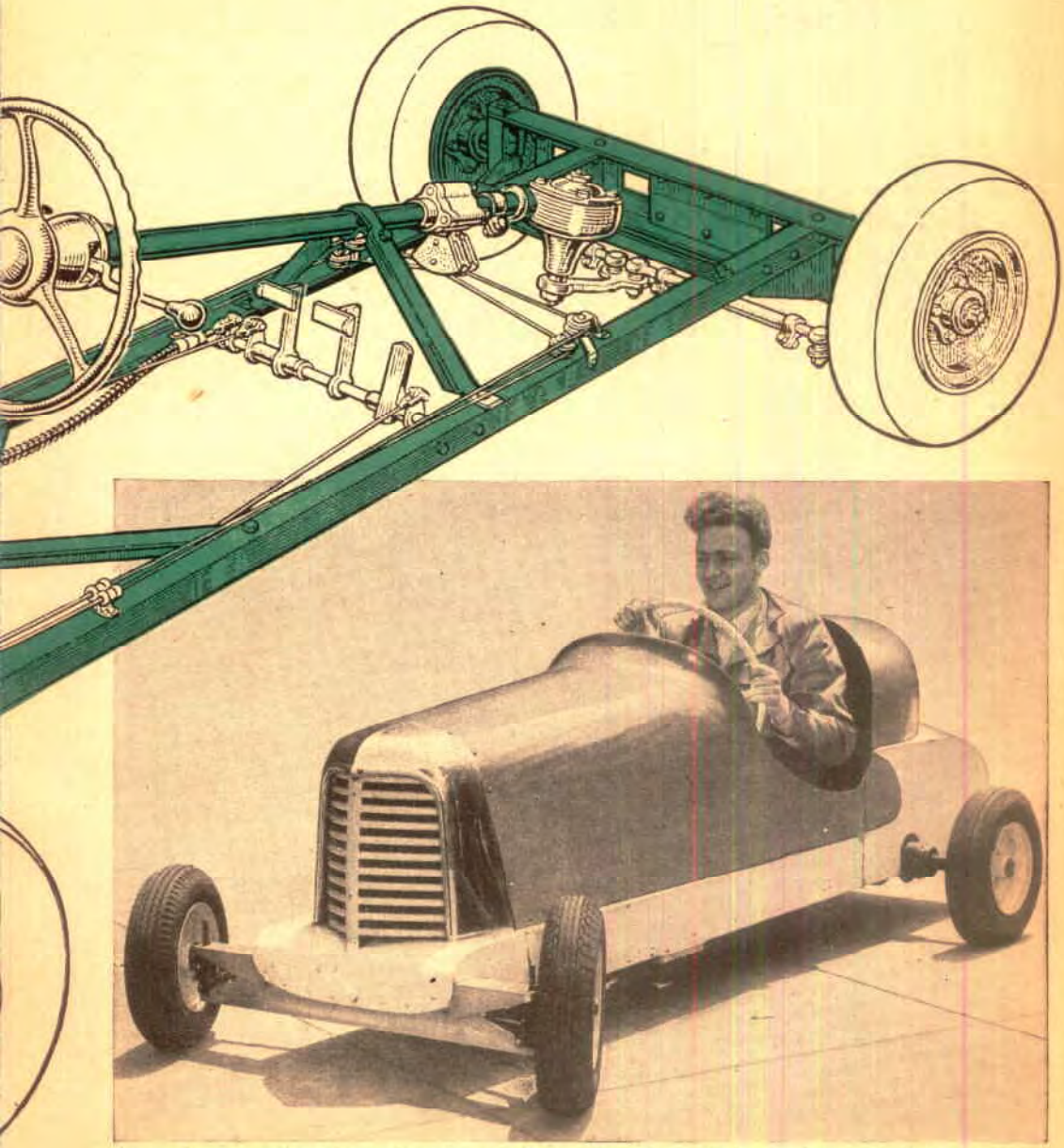
But if you're going to venture out on the



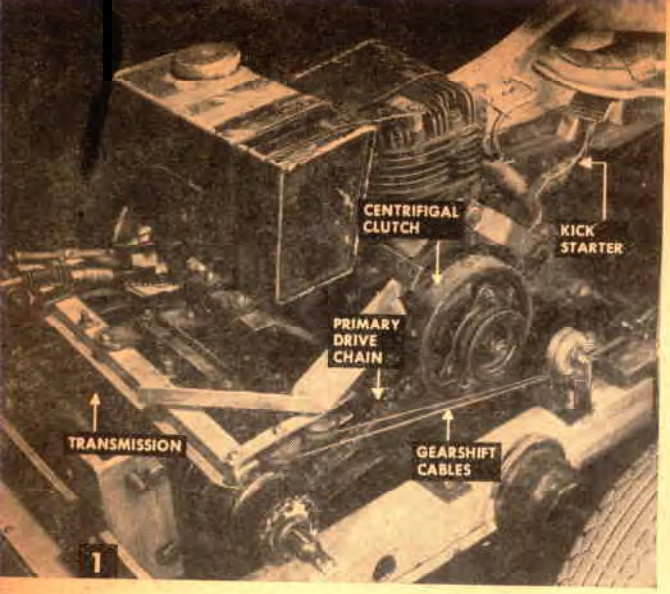
This homemade hybrid makes good use of a Cushman engine, Plymouth transmission, a Chevrolet drive shaft, and a Chrysler steering column.

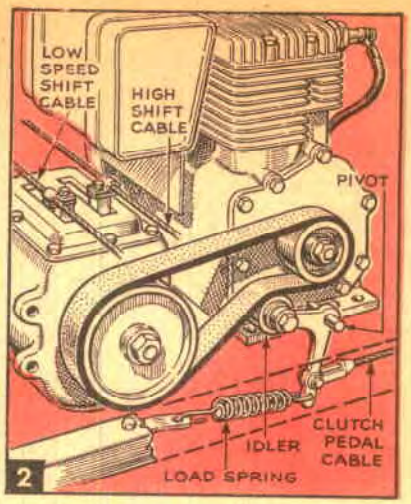
highways, where the car may mix it up with its big brothers from Detroit, you'll have to work harder. Not just because of the licensing requirements, either. You'll need good brakes, good lights, and reliable, flexible performance. Otherwise, the car won't be useful—or safe. If it's to go on the highway, 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 ¾- 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.)

HORSEPOWER NEEDED

% Grade	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

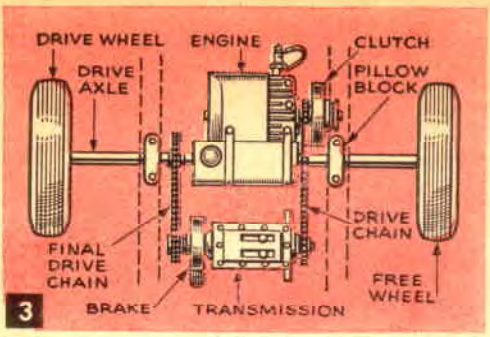
Let's assume you have a 3-hp. engine. The first table indicates it will drive a 450-lb. load at about 30 m.p.h. on a level road. The second table indicates the engine-to-wheel ratio in high gear should be about 4.45 to 1. And to take the same car up a 20 percent grade at 10 m.p.h., a ratio of 13.4 to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



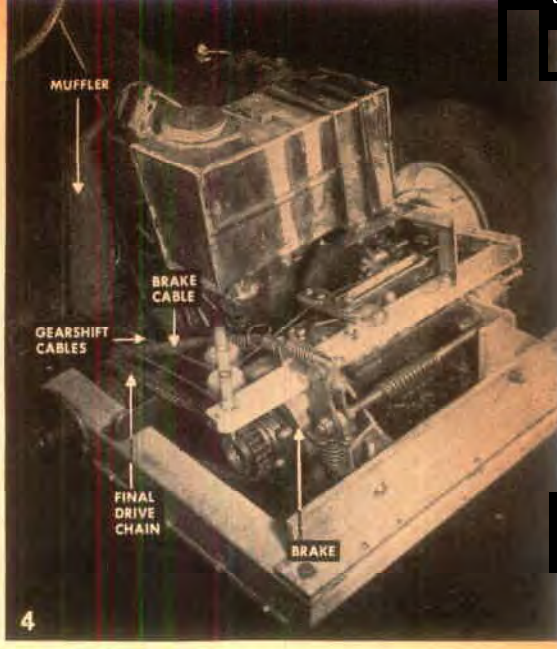
Figures 1 and 4 give details on such a setup. Note that the transmission is controlled by cables clipped to the shifter forks.

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 1⅛" 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.

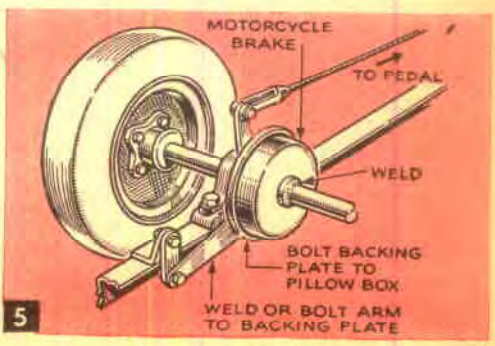
Steering geometry and front-end construction may be simplified by a study of Figs. 7 through 12. The most important consideration is to have the inner wheel on a turn cut in at a sufficiently sharper angle than the outer wheel. (This is necessary because the inner wheel travels a smaller circle than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

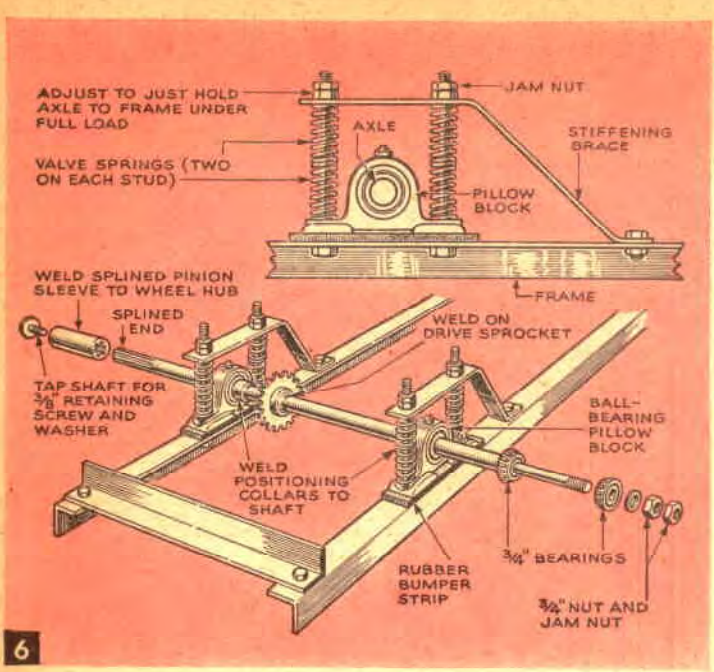


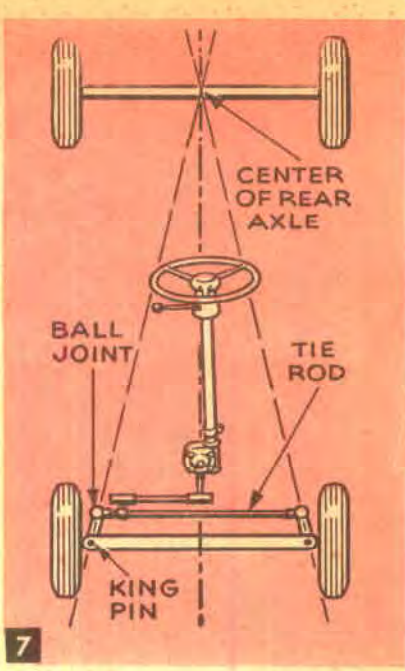
The correct angles will be approximated at all times if the steering is designed as in Fig. 7, with the two steering-knuckle arms pointing to the center of the rear axle when the front wheels point dead ahead. Be sure the king pins and their tie-rod ball joints are at that time accurately aligned with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



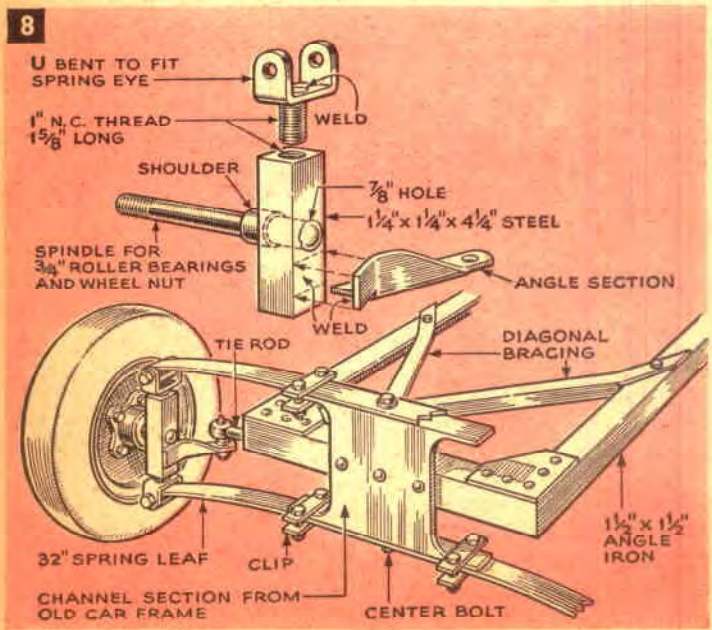


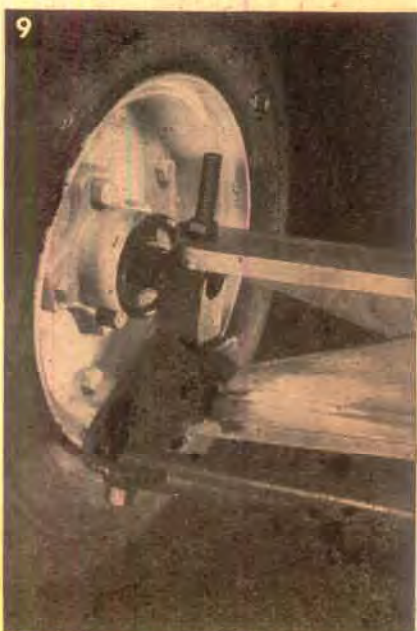


calls for a cut-down steering post and gear from a regular car, preferably of the type that uses a drag link parallel to the axle. Try to obtain one that's fitted with a shift lever, since this will simplify transmission control. Methods of mounting and bracing the gear are suggested in Figs. 10 and 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





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.

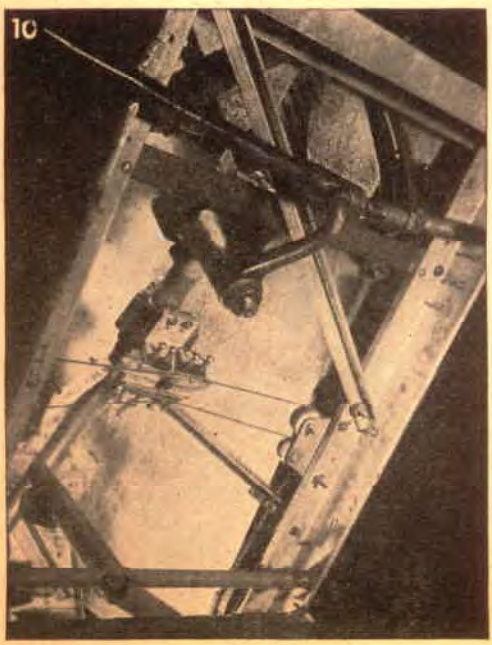
Light structural-steel angle stock with welded joints will make an excellent chassis, as will somewhat larger aluminum-alloy angle. With steel you will need to strike a nice balance between insufficient rigidity and excessive weight; with aluminum the problem will mainly be to get secure bolted or riveted 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.

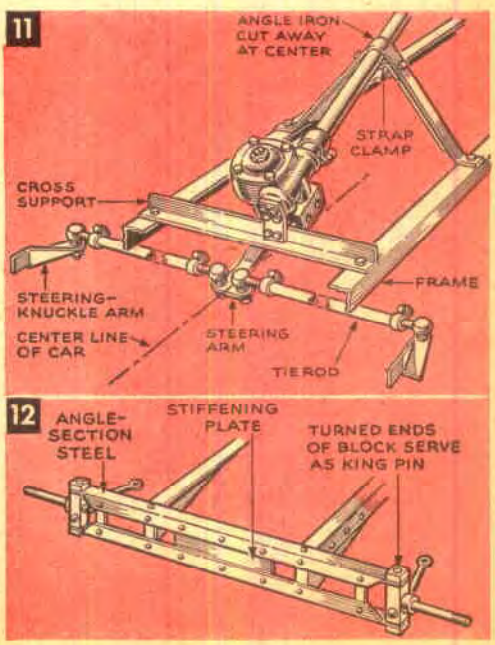
The location of the engine is up to you, but rear mounting has much to recommend it. Simplicity, compactness, and less heat and noise are among its advantages. Don't let the wheelbase and tread creep beyond modest dimensions. One way to determine the shortest wheelbase that will serve is to prop up the 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.*





Solder Smooths Auto-Body

By E. F. Lindsley

BUMPING out and refinishing will take care of many simple dents and nicks in the body and fenders of an automobile. But often you will encounter damage that demands filling and shaping with solder, perhaps in addition to straightening.

Unless the damage is extensive, both kinds of repairs can easily be handled by a careful amateur. Tips on the straightening type of job are given in "Bump 'Em Out Yourself" (page 152).

You must resort to solder in several fairly common situations. Dents inaccessible from the inside are most easily repaired with solder. Also, solder is a "must" when you want to hide weld beads in conspicuous spots, when you are repairing metal stretched too badly to be blended out, or if the metal has been filed so thin in previous repairs that it can't be worked.

But before deciding that solder fits your case, give some consideration to the place where it's to be used. Always try to avoid placing it in large quantities on an extensive flat surface, a fender skirt for instance. Since such parts generally are subjected to considerable flexing and vibration, a thick slab of rigid solder may eventually loosen. Areas with ample curvature to resist vibration are not so critical.

Tools and materials required for a body-soldering job in your back yard are not particularly extensive. Ordinary bar solder can be used if it has a reasonable tin content.

You'll need a wood paddle to smooth off the solder. Such paddles usually are made of a hard, close-grained wood. To prevent sticking while in use, the wood must be well soaked in paddle oil. This oil is available at an auto-body supply shop. If desired, tallow can be used in place of the oil.

Body putty also may come in handy. In fact, there are times when you may find it possible to take care of some body and fender repairs entirely with this rather than solder.

How to Do the Job

To see how an experienced body repairman works, let's tackle an actual soldering job and follow it through step by step. The example chosen, and illustrated in the drawings below, was a very sharp gouge in the upper front surface of a rear fender. This dent was inaccessible from inside and the metal had been stretched to the point where blending would have left a noticeable hump.

Hammer, bumping dolly, and file are used first to restore the general shape of the fender as well as possible. Also, the surrounding lacquered surface must be cut back for a distance of several inches with wet sandpaper to leave a bright, clean working area.

A sharp, deep dent in front part of rear fender is kind of damage requiring solder. For how it is repaired, see drawings at right.

Heated dent is cleaned with steel wool dipped in soldering fluid. Paint is first sanded off. Sheet asbestos protects finish.

Good tinning is essential. A thin tinning coat is first flowed on and then scoured with steel wool to provide an anchor for the solder.

Softened end of solder bar is now jabbed into the dent at several points, leaving enough blobs of solder to fill the dent.

Dents

Car scars that can't be fixed with a hammer will vanish under solder. Here's how to do it yourself.

Before starting the actual soldering, cut a sheet of ordinary asbestos paper to match the curve of the fender-body juncture. Tape this to the side of the body. Remove the wheel and protect the brake drum and adjoining parts with cardboard to guard against accidental splashing with acid flux and solder.

Once you have begun the soldering process, you should complete the job as rapidly as possible, not allowing the metal to cool between steps. Therefore, it pays to have all necessary materials within easy reach.

A good tinning job is the most vital step in successful body soldering. Haphazard tinning may cause solder to loosen. Using a gas or gasoline-torch, apply heat over the entire work area. If the torch has a relatively small and concentrated flame, be sure to move it about constantly to get even heating. When the metal has been well warmed, grip a wad of medium-cut steel wool in a pair of pliers and dip it into a jar of acid-type soldering fluid.

Continuing to apply heat, thoroughly scour the work area with the flux-soaked wool. Repeat this operation until no traces of paint, rust, or welding scale remain.

Still keeping the torch on the work area, hold a bar of solder near the flame so the fender and solder reach soldering temperature about the same time. Smear the fluxed surface with ample solder and then use the steel wool and pliers to spread it in a smooth, even tinning coat. Dip the wool in the flux as required. Because of the cooling action of the fluid, it will probably be necessary to apply more heat to hold the solder in a liquid state.

Consider the tinning job satisfactory only when the smallest area is completely wetted with solder. Remember this is the foundation upon which you must build.

Keep Heat on the Work Area

And don't put down the torch. Keep it directed on the dented area and again heat the bar of solder. This time heat the bar for several inches until it has assumed a mushy condition. Just before the solder is ready to flow, jab the softened end of the bar vigorously into the tinned area at several points, leaving behind ample metal to fill the depression.

Manipulate the torch as required to keep the solder soft, but be careful to prevent it from melting and flowing off. At this point, the wood paddle is brought into use.

After the paddle has been covered with oil, use forceful, trowel-like strokes to level the solder lumps to the approximate original contours of the fender. Do not overdo the paddling, but be sure the solder is forced into solid adhesion with all the spots it touches. Remember it is easier to work down

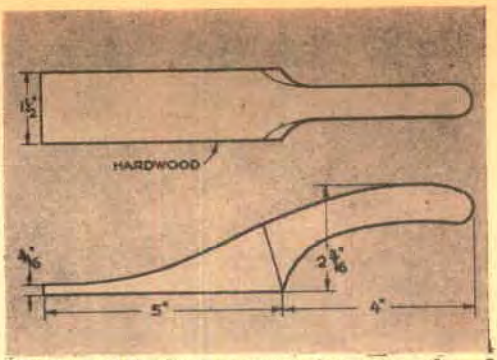
Kept mushy by the flame the solder is then leveled off to the contour desired. A wood paddle soaked in oil is used for this job.

When cool, soldered area is dressed off with coarse file or abrasive disk. As final step the surface is cleaned up with fine file.

As first step in applying a new finish area is washed with soda to neutralize flux. It is also gone over with pre priming cleanser.

Small blemishes are filled with body putty after priming coat has been smoothed by wet-sanding. Finish in usual manner.

Tools and materials used in a body soldering job include these. A flexible shaft and abrasive disks are convenient but not essential.



Wood paddle for smoothing down the softened solder can be made to these dimensions. Shape it from hardwood. It must be oiled before use.

a high spot with the paddle than to file it down later.

These steps conclude the actual soldering. Before going further, it is best to give the solder plenty of time to cool completely. Use your waiting time to wipe up any acid and spattered solder.

Actual finishing of such a filled area must be done with extreme care. Otherwise, you may leave ridges and flat spots that will stand out in the completed job.

Rock the File to Prevent Flat Spots

When roughing down the solder, you can do the quickest job with a flexible shaft and a coarse abrasive disk with a flexible back. But in a home job, where time is no great factor, you can use an ordinary coarse file. Stop occasionally and clean the solder from the file. When you have approached the final contours, switch to a mill-cut file to smooth off any deep file scratches that you have left. Remember to rock the file along the curved surface to avoid leaving any flat spots.

Before the area is primed, it must be neutralized to remove any traces of the acid soldering flux. Ordinary baking soda in water will accomplish this. Follow by wiping with the commercial cleansing agent recommended by the manufacturer of the primer you have chosen. This step is important.

From here on, the repair job follows standard refinishing technique. It probably will be best to repaint the entire fender or panel on which you have worked.

Remove the old wax and any oil with a commercial cleanser, sand down to bare metal, clean again, and mask any parts that will be in line with the overspray.

After spraying with primer-surfacer, fill any small imperfections or file marks with body putty. Apply with a scraping action of a stiff piece of cardboard. When the putty is hard, wet-sand the entire area and spray with a finish coat or two.

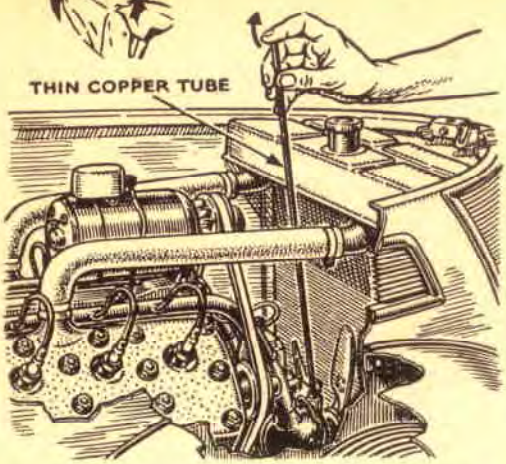
When the final coat has dried at least a day, go to work with rubbing compound. Follow this with wax. END

Powdered-Aluminum Paste Fills Dents in Cars

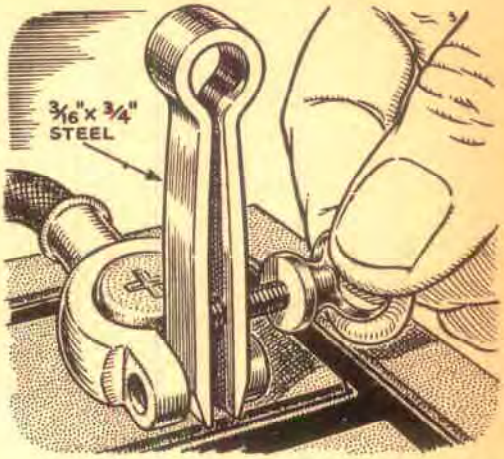
NEW powdered-aluminum products with a doughlike consistency are now being marketed as a substitute for solder in repairing damaged auto bodies and fenders.

These are applied cold with a spatula or similar tool, as seen at left. As the solvent evaporates, the metal hardens and can be filed or sanded smooth. The material is said to adhere well to a properly cleaned surface and to provide a good base for refinishing. Successive applications will build up thicknesses of as much as an inch. Reynolds Metals Company, Louisville, Ky., aided in developing the products.

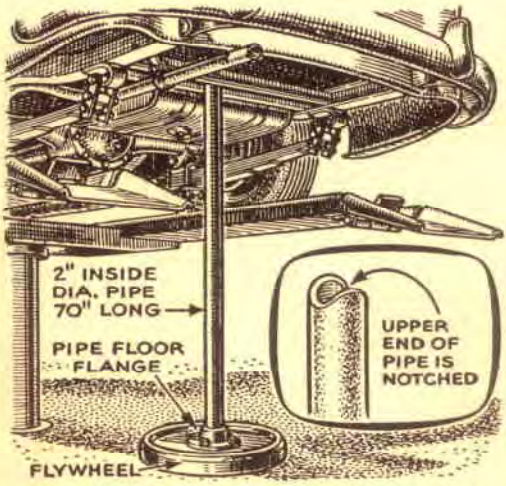
Hints from the Model Garage



Copper Tube Makes Oiler. To get at those hard-to-reach oil fittings, try this: dip some copper tubing about an inch into oil. Trap the oil in the tube by pressing your finger over the upper end. Removing your finger releases the oil in the fitting.



Wedge Loosens Battery Clamp. T. E. Waters, of Atlantic, Iowa, made this wedge to open up stuck battery clamps. The chisel-shaped end is tapped between the clamp's ears. Then the thumbscrew is turned to spread the clamp apart.

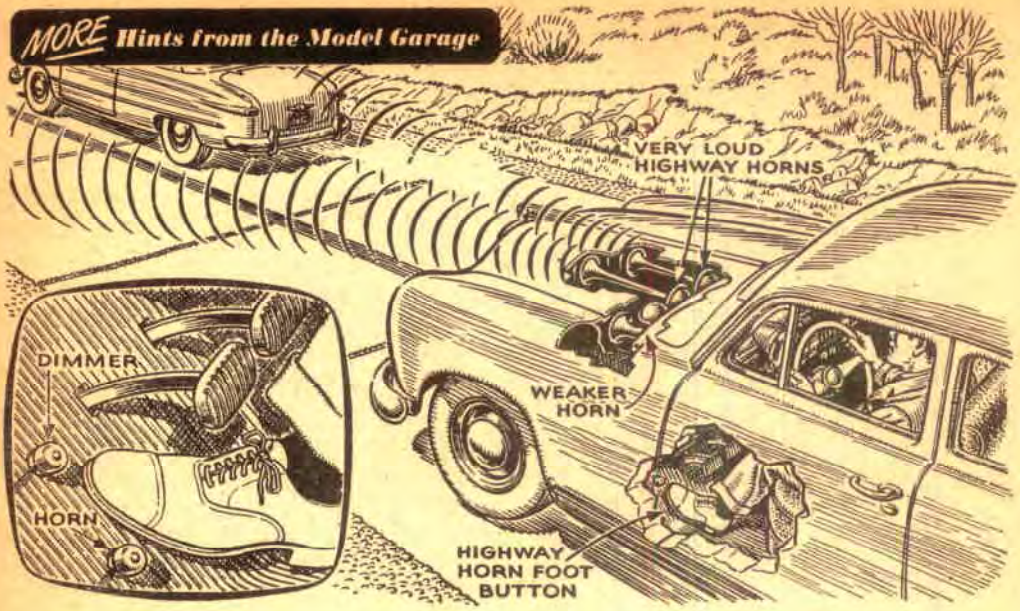


Stanchion Opens Springs. I really get oil between spring leaves with this stanchion. After the notched upper end is placed under a frame cross member, I lower the lift a couple of inches. This takes some of the load off the springs and the leaves open. You can almost pour oil between the leaves.—*Marion Rhodes, Knightstown, Ind.*

Rubber Pad Protects Kids. Sudden stops often result in bumped heads. A foam-rubber seat pad and two suction cups, mounted as shown, makes a practical dashboard guard. At the upper corners of the pad, punch holes with an ice pick. Tie heavy cord to each cup and run the cord through the holes. Large knots will hold the pad in place.

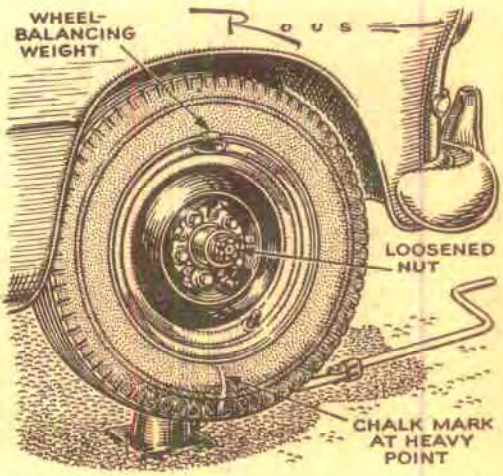
Turn the Page for Three More Hints

MORE Hints from the Model Garage



Horn Button on Floor. As a safety measure—so I can keep both hands on the wheel when I'm driving fast—I mounted an auxiliary horn button on the floor of my car. For this button, I used a floor-type starter switch. I located the switch near the dimmer switch but far enough away so there's no interference in the operation of either one. The floor button is connected to a couple of loud highway horns. A weaker horn, for city driving, is connected to the center button on the steering wheel.—*J. H. Carll, Hempstead, N. Y.*

Curved Needle Mends Rips. Henry Zave, of Chicago, offers this hint for keeping your car's seat covers and upholstery in repair. Use a curved upholsterer's needle for easier sewing. You'll find this type of needle lots simpler to handle. It's especially good when you have to work from only one side of the material.

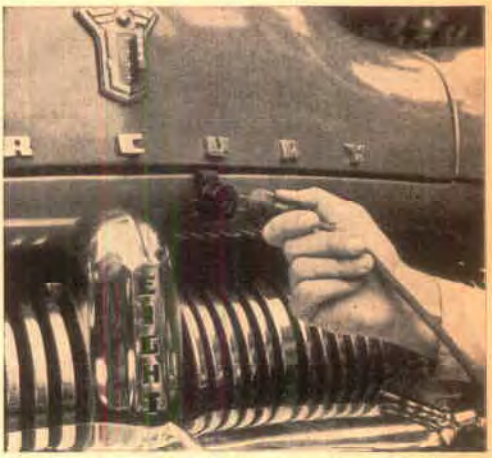


Balancing Auto Wheels. Mount the wheel on the front axle. Back off the bearing nut. Spin the wheel and mark with chalk the bottom point when it stops. Repeat for accuracy. Opposite the mark, mount a wheel-balancing weight. Continue to spin it, using lighter or heavier weights until the wheel has no heavy point.—*W. M. Dierks, Chicago.*

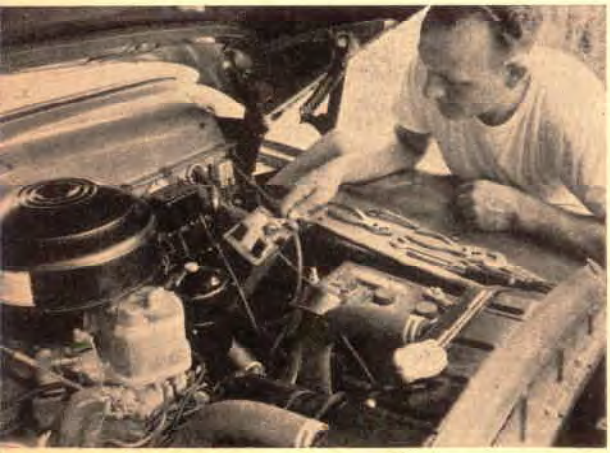
Here's How I Start My Car in the Morning

By Victor Dettling

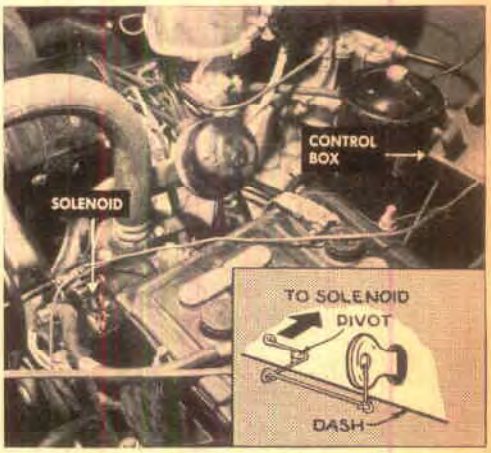
Before breakfast I press a switch near the window in the dining room. This closes a circuit leading to my car out in the garage. The object is to start the engine and have it at operating temperature before I set out for my job at an automobile plant in Manchester, Mich. The line leading from house to garage is a heavily insulated, two-conductor electric cord.



Each night I plug in the cord from the house after putting the car in the garage. The plug and socket are the type you would use in ordinary electrical wiring around the house. The socket is permanently mounted above the grille as shown. One terminal is grounded to the car body. The other is connected to a control box developed especially for my starting system.



Here's the control box. The two pegs projecting from the end are part of my safety system. Free to move lengthwise through the box, these rest against the gear-shift control rods. The engine can start only if car is in neutral. If a gear is engaged, the bars move, breaking an electrical contact. The box has another job, too, but I'll explain that later. From the box, a wire runs to a powerful solenoid starting switch installed in place of the original one.

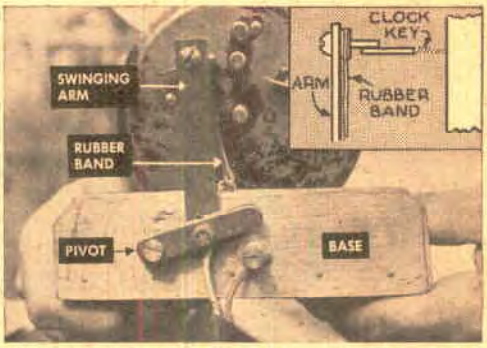


The solenoid does two things. When energized, it completes the starting-motor circuit. At the same time, by magnetic action, it exerts a pull on a wire linked to the ignition key by a bell crank as shown in the drawing. This turns the key. After the engine starts, increasing manifold vacuum acts on a diaphragm in the control box, breaking the starting circuit.

But that's not all: Turn the page and see

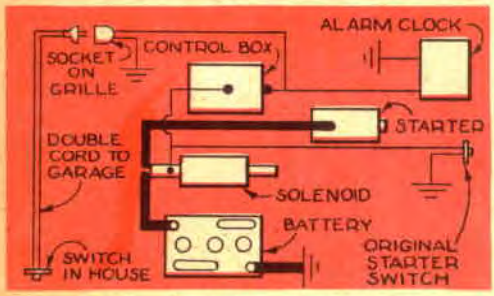
Just Before Quitting Time An Alarm Clock Starts Up Engine

During the day I leave the car in an outdoor lot near the plant. After parking, I set my alarm-clock switch, timing it a few minutes before quitting time. When the alarm rings, the engine starts automatically. This gives it a chance to warm up before I start home. I keep the clock switch in the glove compartment.

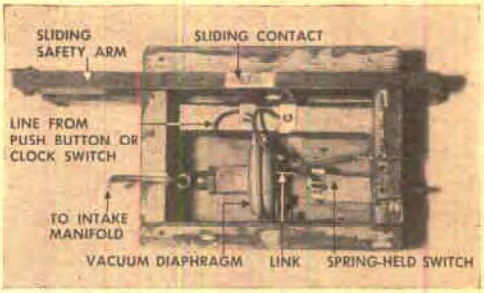


The switch works like this. After the alarm has been wound, a bolt through the swinging arm is hooked over the winding key, as shown in the drawing. When the alarm goes off, the key releases the arm, permitting the rubber band to pull it down and close the circuit. This does the same job as dining-room switch.

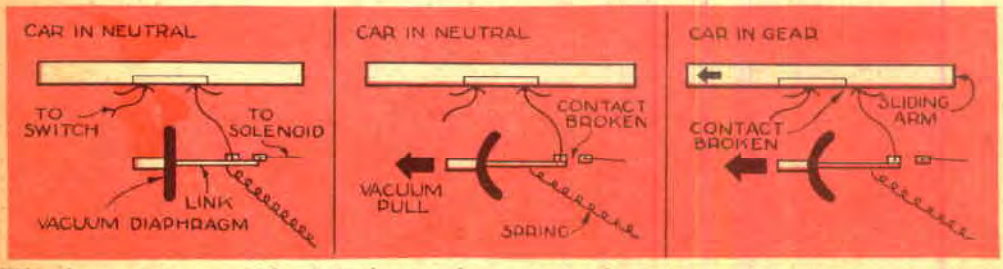
Here Are the Details of the System



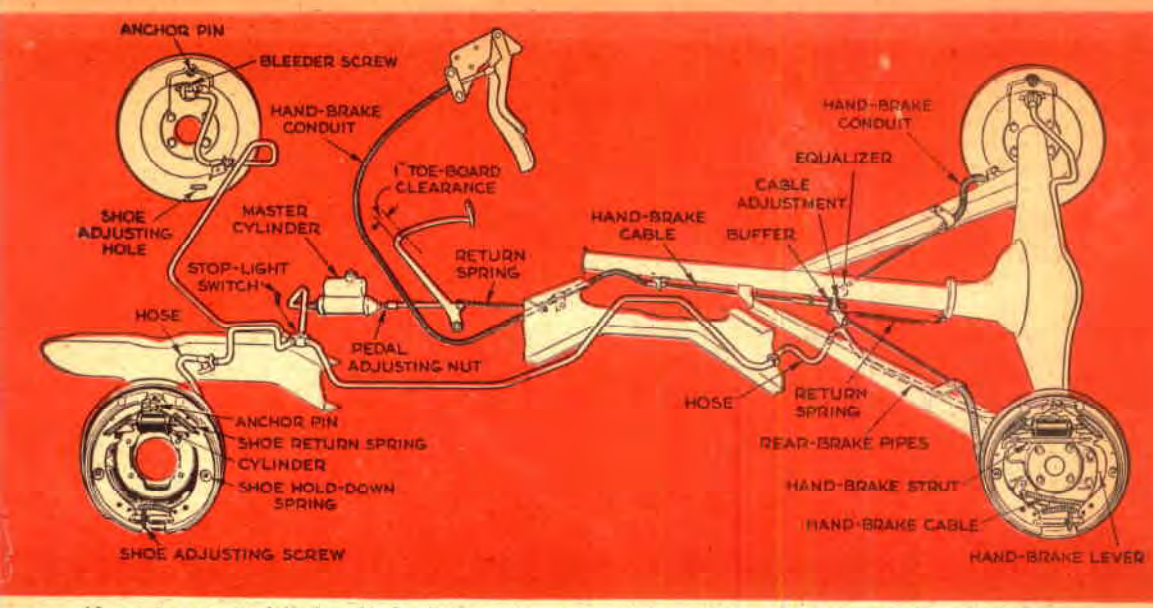
Wiring is simple. Notice that the automatic system operates independently of the original starter switch. The wire and parts required to set up my system cost me about $23.



A vacuum diaphragm is an important part of the control box. When the engine starts, rapidly increasing manifold vacuum moves the diaphragm and link, breaking the starting circuit.



What happens in control box? At the time the alarm clock goes off, or I press the dining-room switch, you have the situation in Fig. 1. Since there's no vacuum, the spring can keep the vacuum switch closed. When engine starts, vacuum overpowers the spring, breaking the circuit as in Fig. 2. This disengages starter. If the engine stalls, the vacuum disappears, permitting the spring to close circuit again. If it's the clock switch that has set off the system, current flows again—and again—until the engine catches or the battery runs down. While I'm driving the car, the vacuum and—when it's in gear—the sliding arm cut out the automatic system (Fig. 3). Moreover, the leads from the clock or the house are disconnected then. END



Above is a typical hydraulic braking system on a late-model car fitted with Bendix brakes.

How an Expert Repairs Brakes

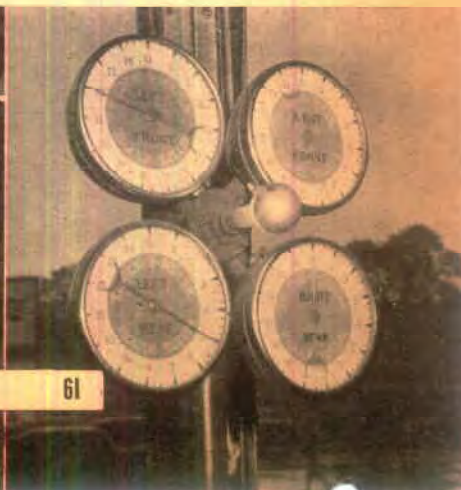
By R. P. Stevenson
PS photos by W. W. Morris

EVERY business has its experts. In any big brake shop, you may find several—mechanics with long experience who are locally known as the "best in the business."

Talk to them, and you'll learn that their abilities go well beyond the instruction-book techniques. They have their own pet shortcuts. They're capable of invention. In the accompanying photos, you'll notice several variations from traditional brake-repair procedure that sprang from this bent.

The photos were taken in one of the ten brake shops run by S. G. Tilden, Inc., in New York, New Jersey, and Connecticut. This company developed the Permafuse

1. Quick check-up. If you should take your car to one of the Tilden shops, it would first go on tester like this. Four dials (in foreground facing mechanic) register the braking power.



2. What's wrong here? When the Lincoln at the left was tested, here's what showed up on the dials. The right rear brake failed to register at all, and the others indicated unbalance.

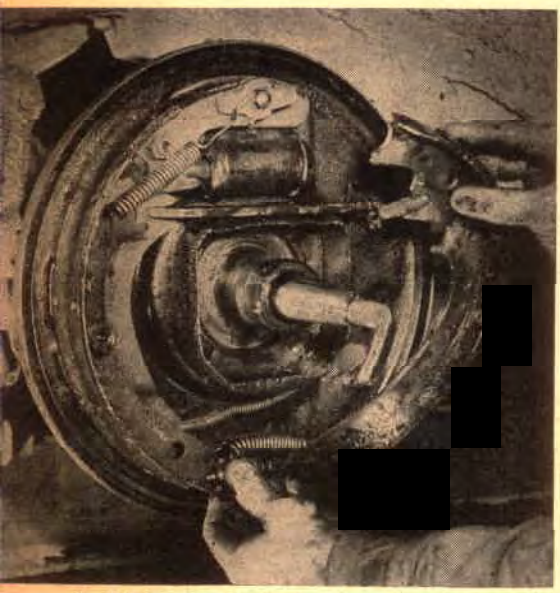
method of bonding brake linings to the shoes (PS, Nov. '47, p. 156). It now has abandoned riveting entirely.

That's why you'll find no riveting operation in this sequence of photos. Even in a shop where riveted linings are the rule, a riveter might not have been in use. Many shops now install shoes already reconditioned and lined by factory or supplier.

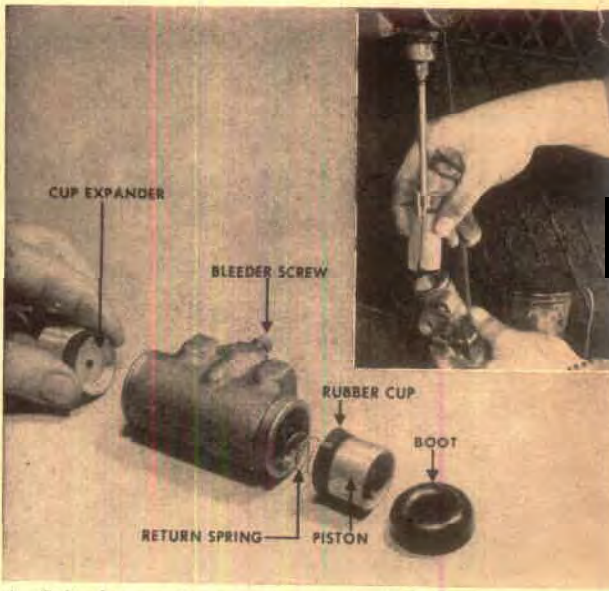
Shown in the photos are typical repair operations that might be performed by any first-class mechanic when your brakes begin to chatter, grab, drag, or otherwise demand attention.

The brakes illustrated are a Bendix product. Brakes of this make are found on the Hudson, Lincoln, Nash, Packard, 1949 Ford and Mercury, and all General Motors cars except Chevrolet, which uses a Huck brake. Studebakers, Jeeps, all Chrysler Corporation cars, and Fords and Mercurys previous to 1949 are equipped with the Lockheed type, but repair operations are generally the same as pictured here.

In a Tilden shop, a complete overhaul of your brake system takes just about two hours. The car goes first to a testing rack for a quick diagnosis of braking efficiency. This tester includes a refinement developed by the Tilden company itself. Torque read-



3. Right rear brake had been knocked out by rear-end grease leaking through the retainer. New linings were in order and springs were replaced because heat had removed the temper.



4. Cylinder on this wheel was rebuilt because fluid was leaking. In such cases, the casing is usually honed (inset) to smooth down any irregularities. Parts go together as shown.

7. Drum is refaced on special lathe if scored or out of round. The normal cut varies from .006" to .008". Cuts up to .020" are sometimes made, but oversize linings are then required.

8. Shoe and lining should conform to the drum arc before installation. A quick check is made in this manner. During use, shoes may deform enough to cause uneven wear on the linings.

ings from each wheel are relayed simultaneously to a panel of four dials. This makes it unnecesary to test each wheel individually.

With brake performance measured, the car is moved to a lift and raised high enough for the mechanic to work in comfort.

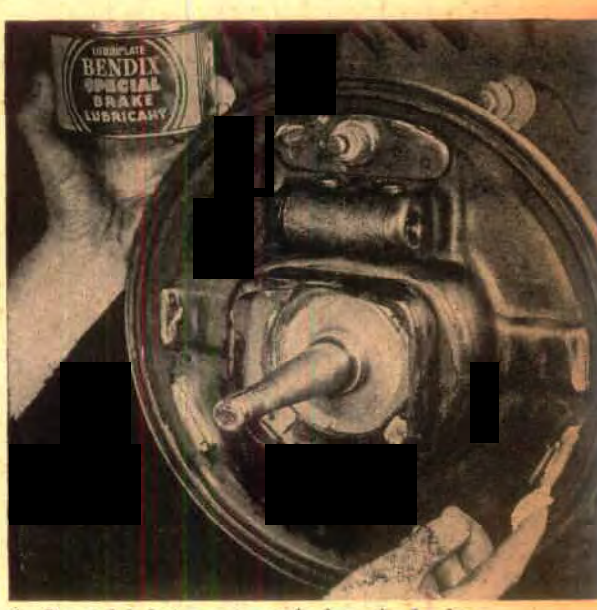
In Fig. 3, you'll note that every part of this brake had a coating of grease. The linings were impregnated with it.

This trouble occurs more often than you may think. As likely as not, it results from the desire of some untrained grease monkey to give you your full money's worth when he fills the differential housing. A good rule to follow is to keep the grease level just a little below the filler opening. Excessive grease in the rear end tends to break through the seals.

This lubricant level is one thing a good brake mechanic will check before releasing the car to you. He'll also take up end play in the rear axle, pack wheel bearings with the proper lubricant, and inspect and tighten the bolts that hold the backing plates to the steering knuckles and rear axle housing.

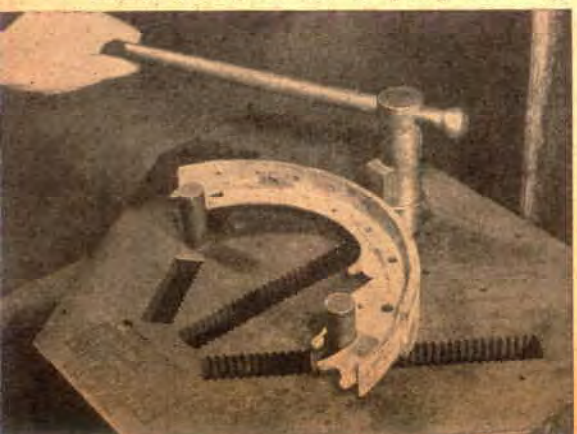
At Tilden's, the final step is another trip to the testing rack. When braking power satisfies the calculations of the tester, the car is considered ready for you.

5. Mechanic opens boots to look for leaks, and checks piston action with fingers. Clamp normally used to hold piston against fluid pressure wasn't needed here; lines had drained.

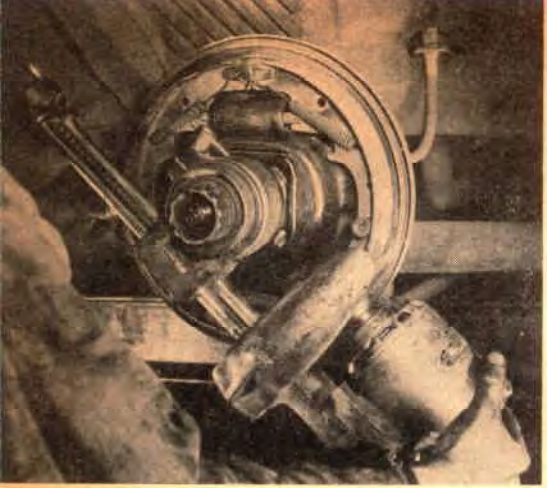


6. Special lubricant is applied to the backing plate at points where shoes will bear against it. Any grease, rust, or dirt is first cleaned from the plate with a wire brush.

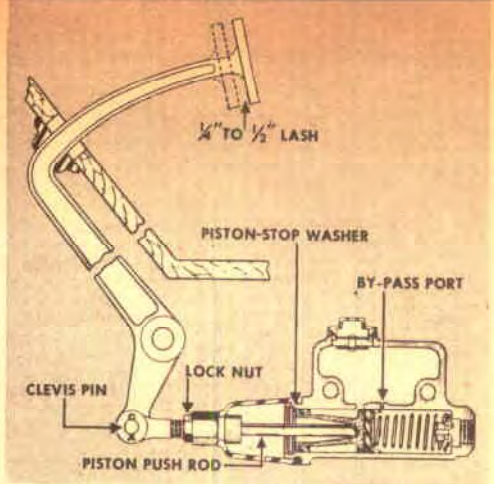
9. If shoe doesn't fit, it's taken to a fixture and sprung so it does. Here fixture is set to remove belly from shoe. When ends touch and middle doesn't, the shoe is sprung other way.



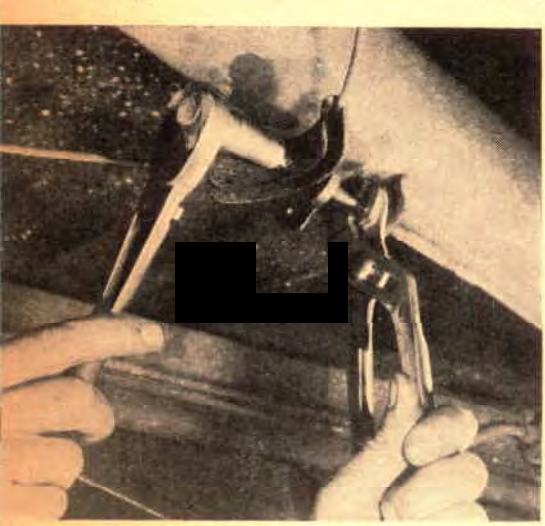
10. Drum is "miked" as first step in grinding new linings. Radius grinder is set about .008" less than this measurement. Slightly oversize linings are used when they're to be ground.



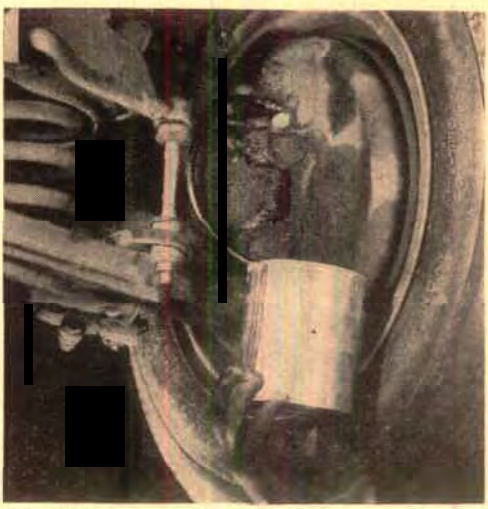
11. Radius grinder pivots on axle. After using it as a guide to set anchor, mechanic grinds .008" from heel and toe and smooths center of lining. This eliminates need for break-in.



12. Master cylinder and brake pedal are also given the once-over. Pedal should have ¼" to ½" play and be set so push rod allows piston to clear by-pass port when brakes are off.

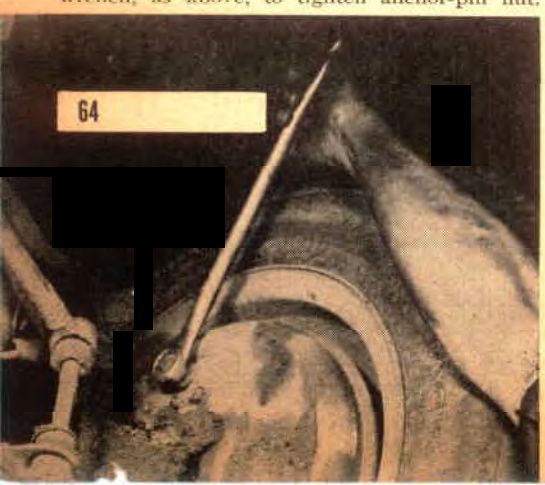


13. Parking-brake system likewise is checked through. When cable requires adjustment, it's done as above. Return spring has been removed here. Equalizer is seen between the wrenches.

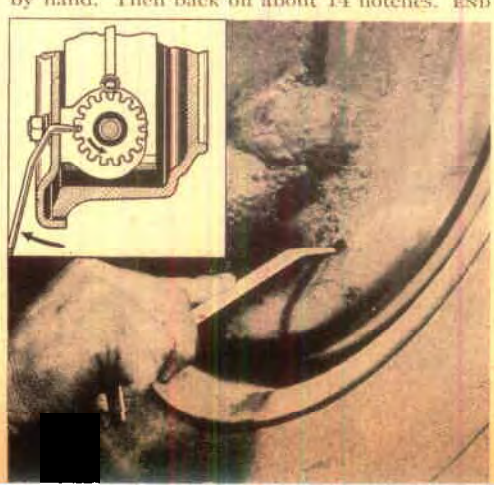


14. Bleeding air from the hydraulic lines is final step. A small hose is threaded into the bleeder hole and its end placed in container while fluid is fed into the master cylinder.

15. Anchors are set after the drum's in place if a shop doesn't grind the linings as seen in Fig. 11. In any case, the mechanic uses a 16" wrench, as above, to tighten anchor-pin nut.



16. Adjusting shoes like this is often the only attention brakes need. It compensates for worn linings. Expand shoes until drum just turns by hand. Then back off about 14 notches. END



1. Jack up the car. That's the first step when tires or tubes are fixed at the General Tire shop in New York without removing wheel from car. The jack lifts two wheels off the ground.

How an Expert Fixes a Flat

In this shop, they do the job without taking the wheel off the car—and they can do it in less than four minutes.

By R. P. Stevenson

PS photos by W. W. Morris

ONE day this spring a motorist drove into a tire shop on New York City's West Side. His car was secondhand, a recent purchase. Its rubber seemed good but he wasn't sure about the tubes.

Two tire men went to work when he ex-

2. Break outer bead. After letting out the air and sloshing liquid soap around rim and bead, mechanic frees outer bead with tire iron and hammer. Hammer never hits side wall, however.

3. Now free the tube. With the outer bead off the rim, he stretches tire toward himself to pull valve stem from the rim. He also checks to make sure tube isn't sticking to the rim.

4. Loosen the back bead. Several hearty tugs loosen the inside bead and it's then an easy matter to pull tire from the rim. Entire job up to this point took 1 min. and 40 sec.

5. Put in the tube. After being given a shot or two of air, a tube is shoved into casing. Mechanic's weight spreads tire enough so he can put in ordinary tube without difficulty.

plained that he'd like to check the tubes. One slid a hydraulic jack under the frame at the middle of the car and tilted it, raising a front and rear wheel off the ground. The other got together a few tire irons, a couple of hammers, and two battered old cans—one containing liquid vegetable soap and another filled with a greaselike substance.

Then both turned to the wheels, one at the front, one at the rear. Not bothering to pry off the hub caps or unscrew the lugs, they let the air from the tires, made a few passes with a tire iron, and dragged off the casings—leaving the wheels on the car.

With the casings and tubes inspected and a new tube installed, the tires were mounted again in a jiffy. After a repeat performance on the opposite side of the car, plus similar attention to the spare, the job was done.

Just a little more than ten minutes after entering the shop, the motorist drove away.

Such speedy service is a common occurrence at the shop of the New York General Tire Company. The secret lies in the fact that the job is done without removing the wheels from the car.

The procedure was adopted during the war, when both time and help were short. It proved such a time-saver that the company made it standard practice. Today, mechanics at the shop take pride in the speed with which they do the job.

At the outset, other tire men threw up their hands, said it was a bad idea. How could you, they asked, remount the tire without pinching the tube?

But General does it. In the years the shop has been mounting tires in this way there have been only a couple of returns for failure because of pinched tubes.

You can see how it's done in the accompanying series of photos. If you're an old grunt-and-strain tire hand yourself, it may be a surprise to learn that the job is done with such little effort and so few tools.

There's no reason you can't do the same thing yourself. Here's one caution. Be sure you have a good jack, one that will let you exert pressure without knocking the car down on your toes.

The General shop has elaborate equipment and labor-saving tools, as the photos on page 68 show, but the quick-change job is done with just the things that any motorist might lay his hands on.

In this, you have the key to the character of a real expert. He uses his tools, but doesn't depend on them to do the whole job. To the tools, he adds the skill of his hands and feet—plus a liberal amount of common sense.

In the quick-change tire job, these are exactly the ingredients you'll find. Taken together, they add up to a task well done.

6. Apply lubricant. A vegetable compound in paste form is applied to tube and bead with a brush. Acting as a lubricant, this allows the tube to seat properly, prevents rust on rim.

7. Pry on back bead. A tire iron quickly slips the inside bead over the rim after the valve stem has been lined up. When bead is on, the mechanic starts the stem through its hole.

8. Heave ho—and it's on. Here's the key to the job. Using one iron, plus knee and arm pressure, mechanic quickly works bead into its well. He presses with knee while turning tire.

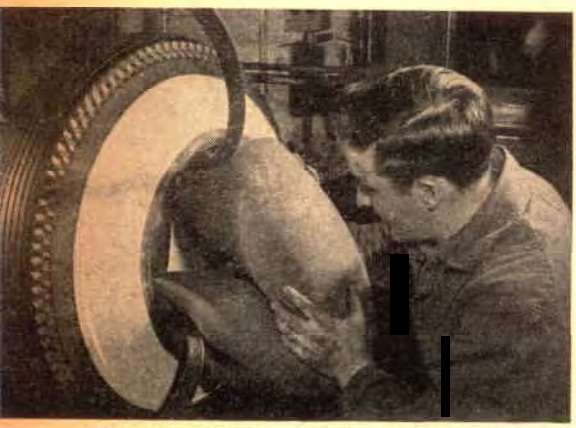
9. Some air, and job's done. Holding the stem with his thumb, he puts air in the tire before removing jack. This job took less than 4 min. Some mechanics in the shop work still faster.

Tire spreader operated by air pressure pulls the side walls far apart. With a used tire, this enables the mechanic to spot any cuts or breaks in the fabric on interior of the casing.

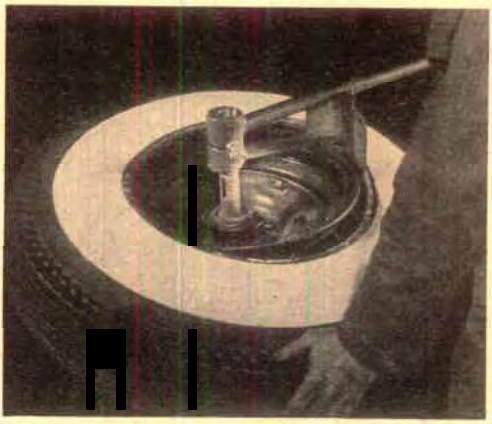
Specialized Tools Aid Tire Mechanics

ALTHOUGH changing a tire without removing the wheel saves time, it's sometimes necessary or convenient to do the job the old-fashioned way. At the New York General Tire shop, however, you'll find equipment that's anything but old fashioned.

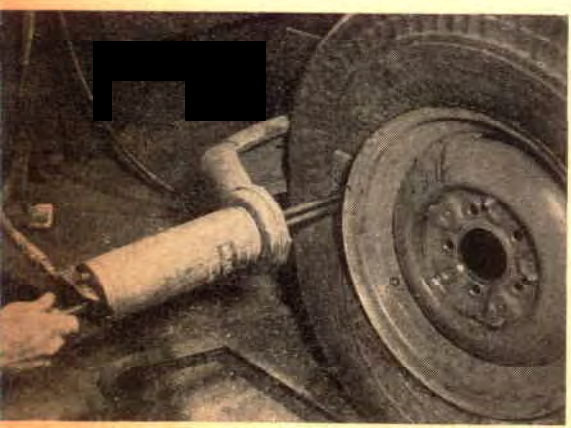
Some of the shop's labor-saving tools are shown in these photos. Several are used in almost any tire shop. Others are not so common. In addition, the General shop has complete equipment for balancing wheels, an important step in these days of lower tire pressures. And for truck work, there's a big air hammer to loosen stubborn beads.



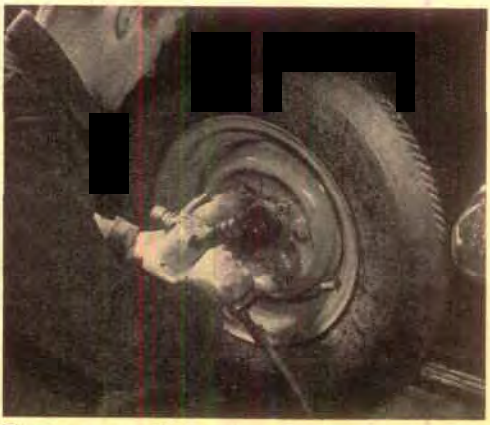
Spreader also is used for easier insertion of the puncture-proof tube made by General. This tube is much heavier than the ordinary type, and it's difficult to insert in usual way.



Greasy hands never touch white wall when the mechanic uses this tool. It consists of pedestal with a shaft to hold wheel. Turning the guide once around slips the bead on the rim.



A bead "frozen" to rim after long use quickly yields to this air-operated tool. As valve is turned on, a pressure foot kicks tire inward. Several strokes around the tire loosen bead.



Torsion wrench turns up the lugs to an exact tightness. They're tight enough to be safe, but still can be loosened with an ordinary lug wrench if you're caught with a flat. END

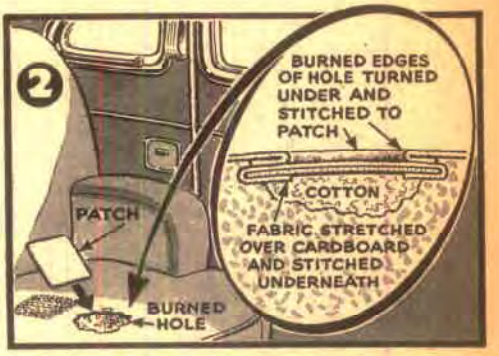
AUTO HINTS

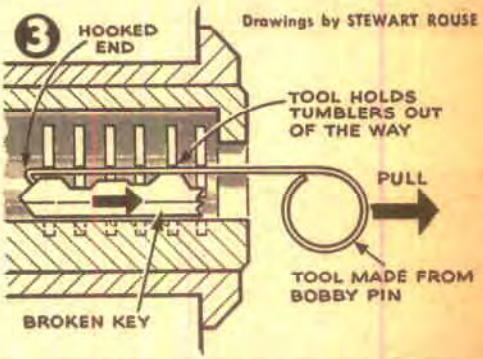
1 *Boxes Hold Garage Shelf.* A sturdy shelf may be quickly put up in the garage by nailing two boxes of equal size to the wall and then nailing a wide board across them. The boxes themselves also provide storage space.—W. H. McClay.

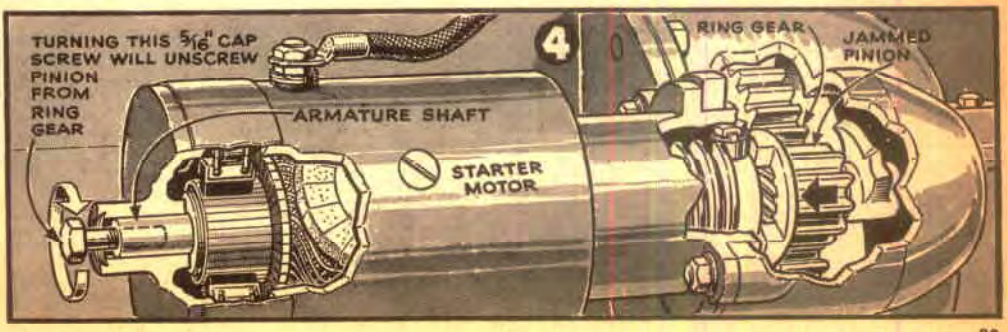
2 *How to Patch Upholstery.* To repair small holes in car upholstery, cut a piece of matching material about twice the size of the hole, place this over a piece of cardboard ½" larger than the hole, turn under the edges, and sew or cement them fast. If the inside padding of the cushion has been damaged, fill the cavity with cotton. Then work the patch into the hole, turn the edges of the burned area under, and stitch to the patch to give a snug fit.

3 *Pin Removes Broken Key.* A bobby pin, straightened and then bent to give it a small hook on the end, can be used to pull a broken key from a car lock. The pin holds the tumblers out of the way, letting the key be withdrawn.—S. Wooler.

4 *Screw Unlocks Starter.* If a starter has a habit of jamming, a 5/16" cap screw placed permanently in a hole drilled and tapped in the end of the armature shaft will enable you to loosen the jam quickly. In a starter of the type illustrated, turning the screw clockwise will pull the jammed pinion free from the ring gear. Remove the starting motor to drill the hole. It will also be necessary to drill a clearance hole in the dust cap.—N. W. Goodwin.







New Soft Tires Absorb the Bumps

Here's what to think about if you're planning to put them on your old car.

By R. P. Stevenson

IF YOU remember putting 60 lb. of air into the tires of an old Model T, it may seem surprising that a pressure of 24 lb. can support a modern car. But it does in the new soft tires. The result is the smoothest ride you've ever had.

First announced only a few years ago, the low-pressure tires are now original equipment on many new cars. At present, they're a luxury, but growing production should scale down the price.

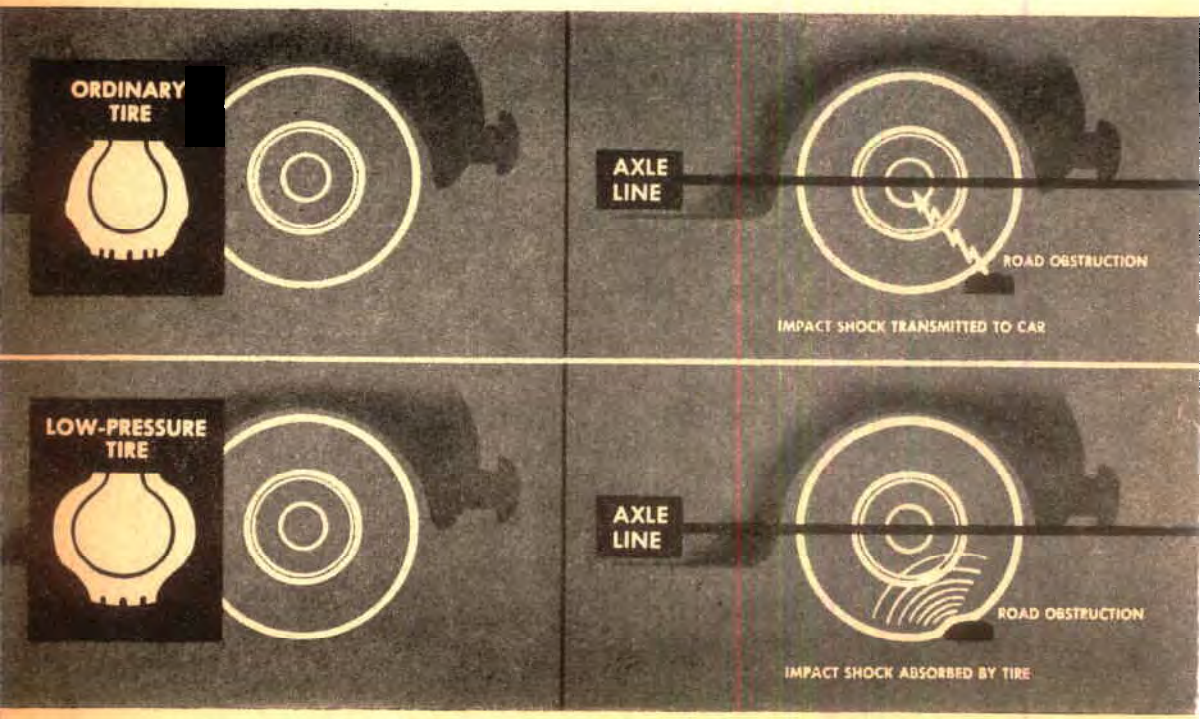
It should be noted that these are not the oversize tires sometimes used in the past for better cushioning. Such tires were just a larger size of the ordinary type. They were never fully satisfactory because of such disadvantages as hard steering, irregular wear, and excessive unsprung weight.

The new tires were designed and engineered specifically for a greater volume of air at lower pressure. In cross section, they are wider and a little higher than the corresponding old sizes they replace. From the side, they look much the same.

In addition to a softer, smoother ride, advantages claimed for them include better traction, greater safety, more positive steering, cooler running, less road noise, and—surprisingly enough—slightly better mileage. How they envelop a road obstruction is illustrated in exaggerated form below.

You can use the new tires on an old car, but here's a warning: You'll get some, but possibly not all their advantages. Some tire engineers contend you'll get full benefit only by mounting them on wider rims. Present rims may pull in the designed width of the tire, reducing the air volume and consequently the cushioning effect.

On older cars, the cost of installing new wheels would be considerable, leaving little alternative to using your present rims.



Before planking down the cash, however, make certain the tires have adequate clearance. In extreme cases, you may find that rear ones rub against the metal of the wheelhouse. Clearance also may be so slight that you can't use chains. The front tires may touch the fender or frame on short turns. It's also worth checking whether your present spare-tire carrier will accommodate the greater bulk.

If you wish, you can start with just two of the tires. But install both of them either at the front or at the rear, not one in front and one at the rear. The best choice appears to be to mount them at the front. Car stability is apt to be reduced if they're put on the rear only.

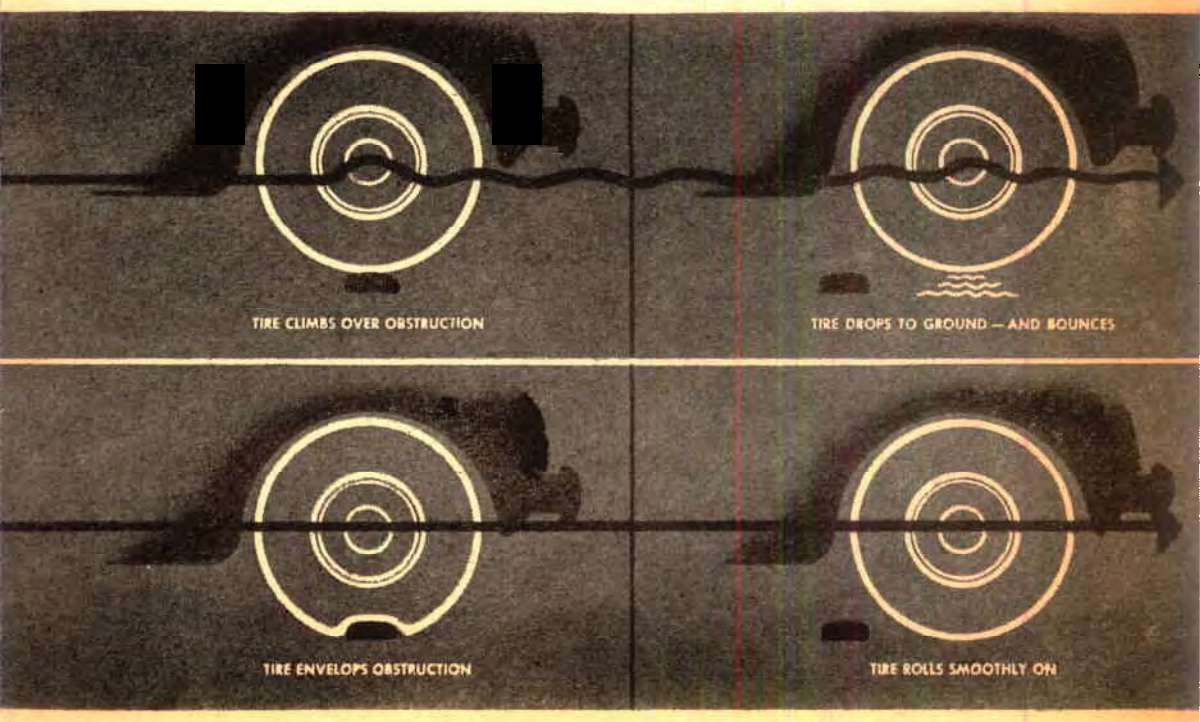
A change to the new tires will have a few adverse effects. Acceleration will be slower because the larger tires increase the circumference of each wheel. (Incidentally, this may throw off the speedometer.) Since the tire is softer, its footprint is longer. This greater area in contact with the road improves traction, but you'll have to exert more steering effort while parking. In at least one case, the footprint area has been kept down by making the tread narrower.

The old admonition to keep your tires properly inflated has never been more important. Since the recommended pressure for the new tires is lower, two or three pounds difference amounts to a greater percentage than at conventional pressures.

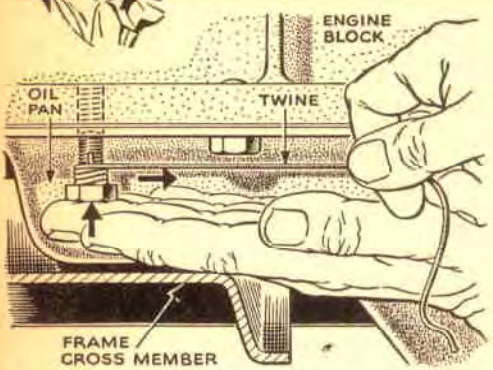
When the tires are used as replacements, pressure recommendations may vary either way from 24 lb., depending on the make, model, and year of the car—and of course the size of the tire. Therefore, in buying a replacement set, be sure the dealer has authorized pressure recommendations to suit your case.

One large tire manufacturer is now cautioning service-station operators to be on the lookout for the new tires and not overinflate them unwittingly. Until this campaign has had time to take effect, you'll have to shoulder the responsibility of seeing that someone doesn't run wild with an air hose.

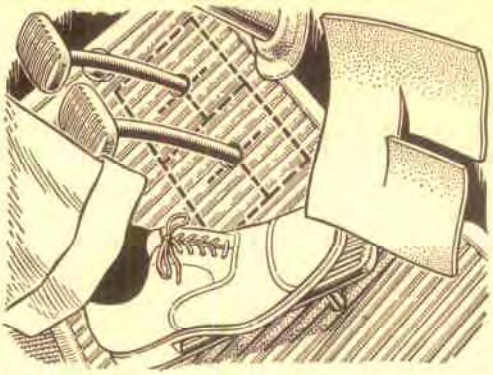
Size designations adopted for the new tires show the true cross-section measurement—the distance from side to side when the tire's inflated. For instance, 7.60 means exactly that—7.60". On the other hand, the corresponding tire that it replaces, a 6.50, actually measures 6.80". The latter discrepancy is found throughout the old size range. In general, the new tires take standard lightweight tubes one size larger than the tires they replace. END



Hints from the Model Garage

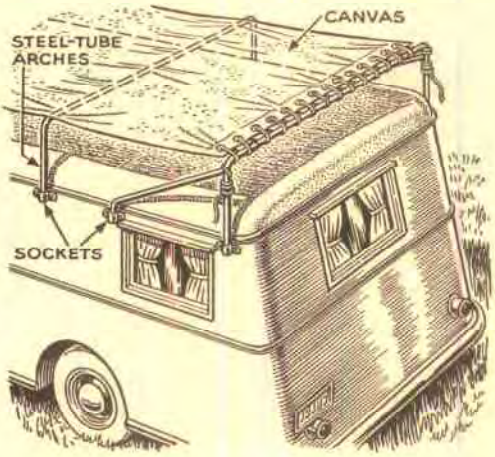


Twine Starts Bolts. Ben H. Clare, of Wellsville, Mo., suggests you use twine the next time you have to start a bolt in a hard-to-get-at spot. Wrap the bolt with twine, hold it in place with a finger or screwdriver and pull the twine. Sometimes it may be necessary to taper the end of the bolt.

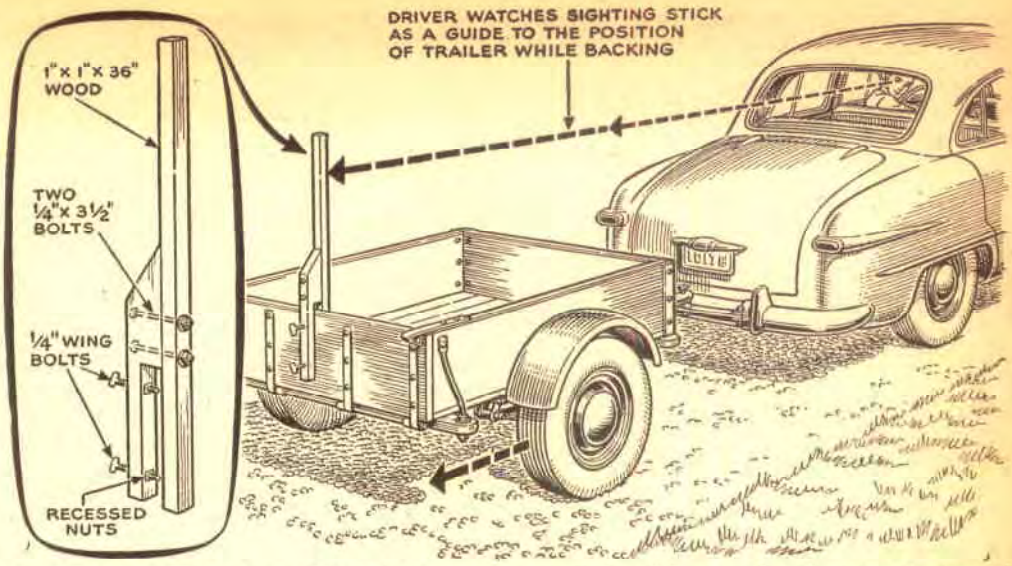


Floor Pads Stop Drafts. Wind that blows in around the shafts of the clutch and brake pedals can be stopped by pieces cut from an old inner tube or step pad. F. W. Marasco, of McKeesport, Pa., writes that it isn't necessary to secure the slit pieces if you cut them large enough.

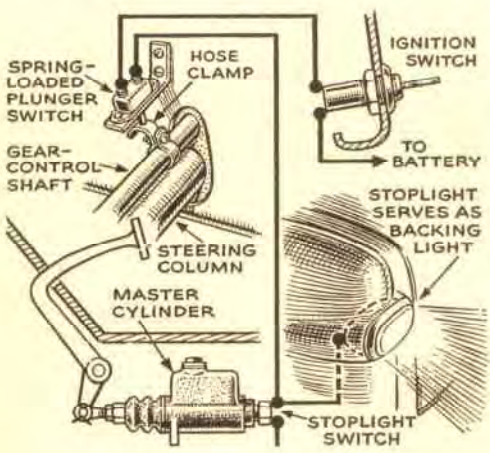
Keep an Auto Log. Adapt the idea of the airplane flight log to your car. Plane owners keep a careful record of engine checks and repairs, among other things. Put a notebook in the glove compartment and record lubrication, servicing, and overhauls. A date and mileage record of performance troubles, unexplained noises, or the like is often a source of clues for trouble shooting. A log also gives you a record of expenses.



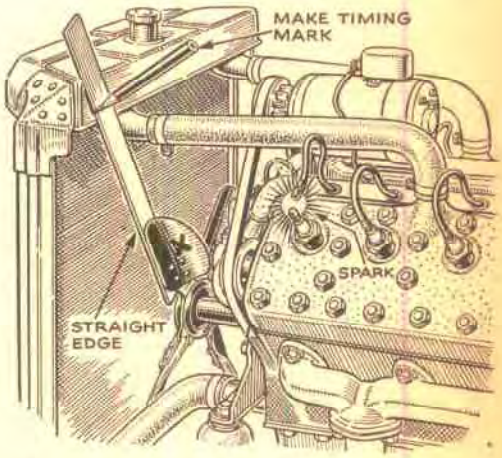
Awning Shades Trailer Roof. The interior of a parked trailer often becomes unbearably hot when the summer sun beats directly on it. To remedy this condition, A. V. Malone, of Los Angeles, built the shade shown above. It's canvas stretched over steel tubes that fit into sockets on the trailer. Mounted about 12″ above the roof, it has open sides for air circulation, lowering the inside temperature 10 to 20 deg.



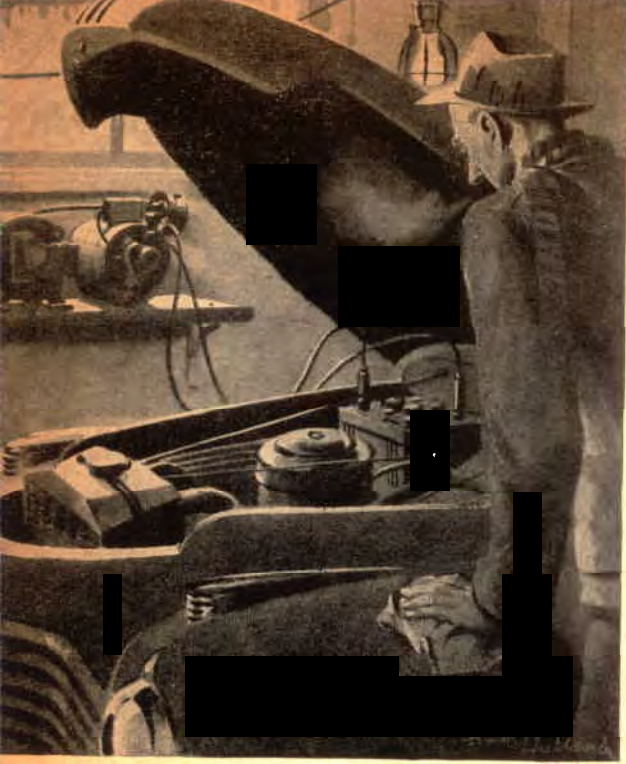
Guide for Backing Trailer. Anyone who has ever backed a two-wheel auto trailer will appreciate this simple guide to its direction. Suggested by Ralph S. Wilkes, of Keuka Park, N. Y., the directional guide is an upright hardwood stick about 1" square by 3' long and a clamping device. If you can't buy the wing bolts, make your own by heating the heads of ¼" or ⅜" machine bolts and flattening the heads with a hammer. The nuts are set into square recesses chiseled in the wood.



Light for Backing Car. F. W. Atwood, of Danvers, Mass., wired his stoplight so it serves also as backing light. He mounted a spring-loaded switch on the firewall and a hose clamp on the shifter rod. Shifting into reverse turns on the stoplight. It's wired through the ignition so the car can be left parked in reverse. The motor can be started without the key (with shift in reverse and brake on), but this does no harm.



Ignition Timing Kink. Here's an easy method, writes H. W. Mills, of Albion, Ill., for checking the timing of a car with a direct-drive fan. Slowly crank the engine with the ignition on after disconnecting No. 1 spark plug. When you get a spark, use a straightedge on a fan blade to mark a spot on the radiator. Also identify the fan blade as well. This is mainly useful if one mark is made when the timing is just right.



MOTOR

This Homemade Charger

ONE of the simplest and most dependable ways of charging storage batteries is with a motor-generator set. Readily assembled from a shop motor and an old auto generator, the unit affords an easy means of putting new pep into car batteries to meet heavy wintertime drain. It will also serve as a convenient D.C. supply for home electroplating, running a two-rail model railroad, charging electric-boat batteries, and the like.

The complete unit, shown in Fig. 1, consists of a ¼-h.p. split-phase motor, a generator picked up in a junkyard for $3, and a one-to-one V-belt drive. It will deliver a continuous 8-amp. charge without overloading the motor; and the rate could be increased to about 13 or 14 amp. by the use of a ½-h.p. motor. The generator is one of the older type employing third-brush regulation which was widely used on several makes of popular cars. In shopping for a suitable generator, don't buy a heavy-duty type unless you are prepared to supply the power to drive it efficiently. Pick one that appears to have good bearings and a commutator that is free of grooves and deep pits. You'll probably have to take a chance on the condition of the windings, since there's little chance to test them in most junkyards. If possible, get one with a cutout in good condition.

After cleaning up the generator case, inspecting the brushes, and lightly sanding the commutator, set up the generator temporarily for testing, and drive it at 1,700 or 1,800 r.p.m. If it is possible to determine direction of rotation from evidences of the way the generator was mounted in a car, it should of course be driven in that direction; if you cannot tell, try both directions to see which way it will build up current.

Sometimes it may be necessary to "flash" the generator to start the building-up process, that is, to short-circuit the generator for an instant while it is running. Connect a jumper

1 The complete unit, consisting of a shop motor, an old generator, a cutout, and an ammeter, is pictured here in finished form, charging an automobile storage battery

4 Adjustment of the charging rate in a three-brush generator is made by loosening a screw and then pushing the third brush with a finger. Retighten screw to lock

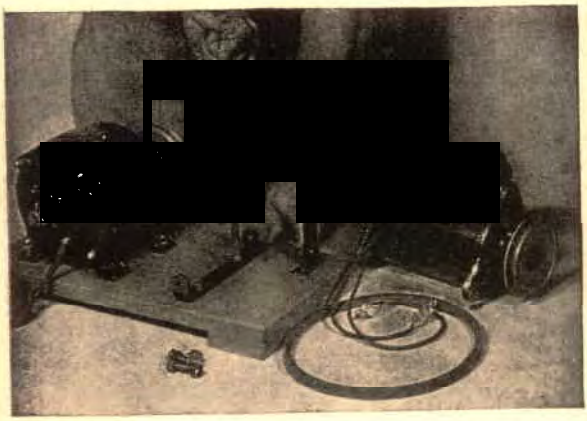
GENERATOR SET

Will Be Invaluable in Boosting Winter-Weakened Auto Batteries

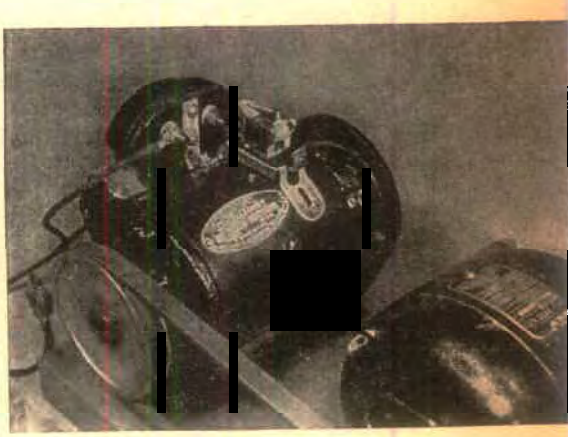
to the frame and touch it briefly to the input terminal on the cutout. If this doesn't work for either direction of rotation, try flashing the fields from an outside source. To do this, lift the insulated brush (the one that supplies output) and connect a storage battery with one lead to the frame and the other to the third or adjustable brush. With the generator idle, make several short applications of the current; then replace the lifted brush and try the generator once more. If it still doesn't generate, the only thing to do is to take it apart and test each component separately.

The armature may be tested for shorts or open circuits in a growler; if you don't have one, the job can be done in an auto service station. The field should also be inspected for open circuits and grounds by means of a series test lamp, as in Fig. 5, and the brush-holder assembly may be similarly tested, as in Fig. 6. Make sure that the ground connection from field to frame is clean and tight, that the insulation of the leads is in good shape, and that the bearings are not so worn as to permit the armature to touch the field poles. While you have the generator apart, it's a good idea to undercut the commutator and to turn it down in a lathe if the surface isn't smooth.

As soon as you have made sure that the generator builds up, mount it permanently with its motor on a wooden base. The original mounting bracket can be utilized by attaching it to the base with 5/16" machine bolts. A slotted arm, also secured to the base, will allow you to adjust belt tension. Details of the mounting method are shown



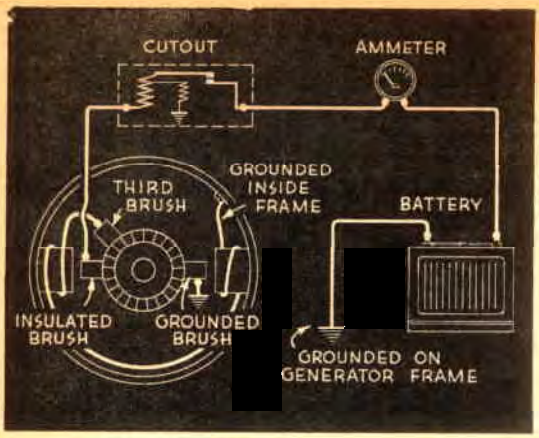
2 Here the mounting bracket originally used on the car is being affixed for holding the generator. A slotted upright helps in adjusting belt tension



3 A standard generator cutout is needed if the unit is used to charge batteries, because it gives protection if the motor should be stopped

5 If the generator fails to build up current, the field can be checked for a possible ground or a broken circuit by the use of a series test hookup

6 A series test lamp will also come in handy in making certain that one brush is grounded and the other two aren't. Replace them if badly worn



Three-brush generators were once common on light cars

in Fig. 2. About 1,750 r.p.m. is a good generator speed; if you use a motor of higher or lower speed, select pulley sizes that will produce this.

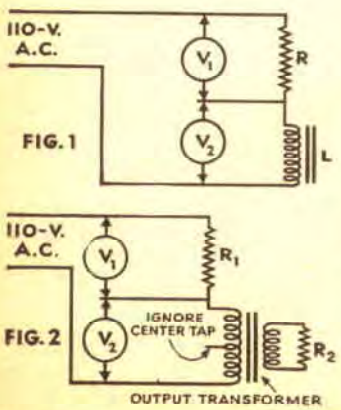
The circuit diagram of a three-brush generator is illustrated above. Note that one brush and one end of the field are grounded, that the other end of the field connects to the third brush, and that the insulated brush supplies the output in conjunction with the ground. If you plan to use the motor-generator set to charge batteries, be sure to use the cutout, since it protects the battery against accidental discharge if the power to the motor should be cut off.

In wiring the unit, run the insulated-brush lead to the cutout, where it should be attached to the terminal that is connected to one end of the heavy winding in the cutout. The other cutout terminal is connected by a short wire to one side of a small ammeter, to the other terminal of which is attached a wire terminating in an alligator clip. The other main lead runs from a ground on the generator frame, made by drilling and tapping for a 10-32 screw, and ending in another clip. Take pains to make all connections as clean and tight as possible, and use fairly heavy wire.

Before clipping the leads to a battery for a charge, determine the polarity of the charging line. This may be done with a D.C. voltmeter, or by placing the clips in a glass of salt water with the generator running. Bubbles will collect around the negative clip, which is the one attached to the negative battery terminal. Mark each clip with a plus or minus sign for future reference. Incidentally, do not ever run the generator for more than a few moments without attaching a load across it, because the voltage may build up to a value that will damage the field coils.

The charging rate may be adjusted by moving the third brush. Fig. 4 shows how, by loosening a clamping screw, the brush can be moved with the fingers. Pushing it in the direction of rotation increases the charging rate. To determine how much the rate may be advanced without overloading the motor, connect an A.C. ammeter in series with one motor lead. Then, with the generator charging a battery, advance the third brush until the motor ammeter reaches the figure stamped on the motor plate as the full-load current.

MEASURING IMPEDANCES



With the aid of an ordinary A.C. voltmeter, it is fairly easy to measure the actual impedance value of chokes, output transformers, and large paper condensers. If you have an inductance-capacitance-impedance-frequency chart, the impedance measurements so determined can be converted to henries or microfarads.

In Fig. 1, R is a known resistor approximately equal to the impedance of the inductance but, to prevent overheating, not less than 2,500 ohms, while L is the choke to be measured. Read V_1 and V_2 with the A.C. voltmeter; then use the following formula:

$$\text{Impedance of L in ohms} = \frac{R \times V_2}{V_1}$$

If R is 4,000 ohms, V_1 is 88 volts, and V_2 is 22 volts, then

$$L = \frac{4{,}000 \times 22}{88} = 1{,}000 \text{ ohms.}$$

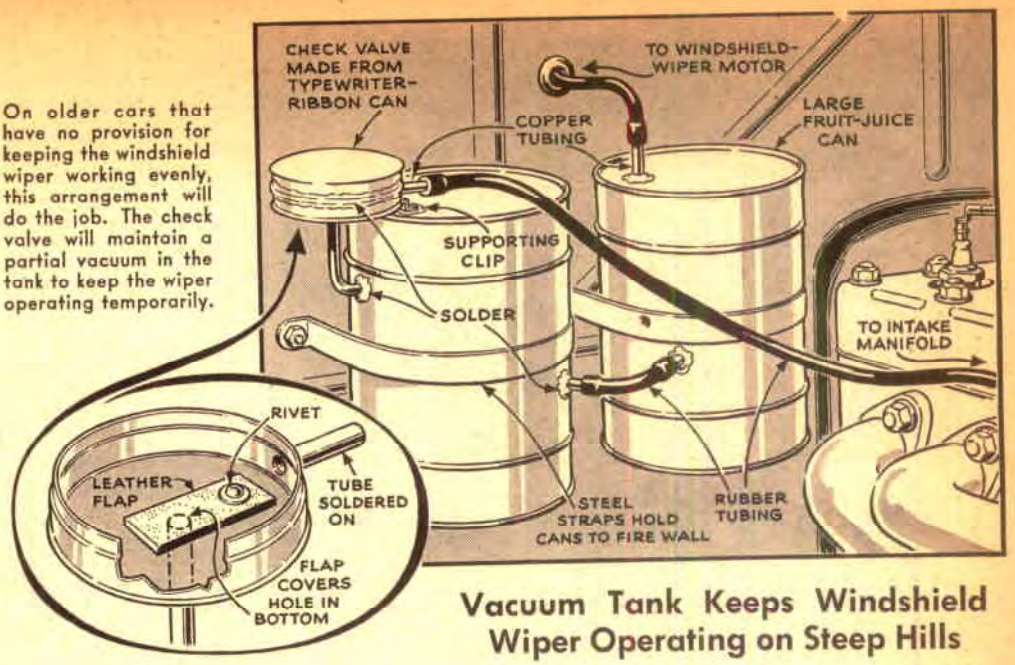
When impedance readings are made on transformers, the secondary must be loaded with a resistor of the value of the speaker voice coil normally used. The correct pair of secondary taps to match an 8-ohm speaker to a required output can be determined by measuring the impedance of the transformer with an 8-ohm resistor across different secondary taps.

In Fig. 2, R_1 is a known resistor approximately equal to the impedance of the transformer but, to prevent overheating, not less than 2,500 ohms, and R_2 is a resistor equal to the impedance of the normally used speaker voice coil. For push-pull transformers, use the two plate taps and ignore the center tap. Then, as with chokes, read V_1 and V_2 and use the following formula:

$$\text{Impedance in ohms} = \frac{R_1 \times V_2}{V_1}$$

If R_1 is 8,000 ohms, R_2 is 8 ohms, V_1 is 60 volts, and V_2 is 30 volts, then impedance $= \frac{8{,}000 \times 30}{60} = 6.666$ ohms.

On older cars that have no provision for keeping the windshield wiper working evenly, this arrangement will do the job. The check valve will maintain a partial vacuum in the tank to keep the wiper operating temporarily.



Vacuum Tank Keeps Windshield Wiper Operating on Steep Hills

UNLESS equipped with a compensating valve, a windshield wiper will frequently slow down or stop whenever the throttle is opened up. This annoying and sometimes dangerous habit can be overcome by installing a tank and check valve in the wiper line to maintain a partial vacuum for the few seconds needed to keep the wiper working evenly during the slack periods. The tank should have a capacity of about 1 gal.

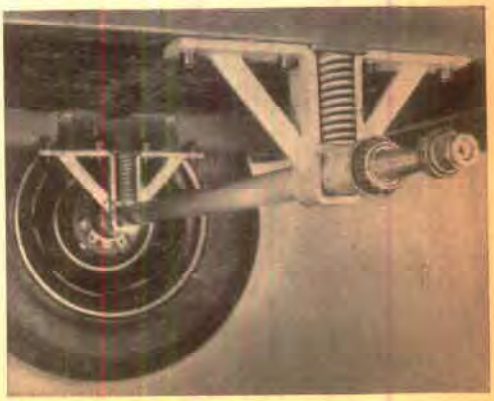
Two tall fruit-juice cans will give you approximately this capacity, and a check valve can be made from a typewriter-ribbon box. Cut two ¼" holes in each fruit-juice can at the points indicated, drain out the juice, and rinse with water. Solder short copper-tubing nipples in three of the holes and a longer L-shaped nipple in the one near the location of the check valve.

Two holes also are required in the check-valve can, one in the side for a nipple to accept the tubing from the intake manifold and another centered in the bottom to take one end of the L-shaped nipple. After the latter nipple has been soldered, remove any excess so that the leather flap valve will close tightly. Clamp the cans to the fire wall and connect the nipples with rubber tubing.

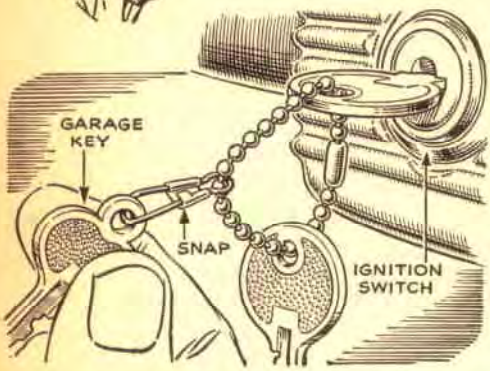
Axles for Homebuilt Trailers Have Coil-Spring Suspension

AXLES and spring suspension units are being produced by the Industrial Machine Tool Co., Inc., of Fenton, Mich., especially for craftsmen who want to build their own trailers. Of all-welded construction and manufactured of tubular steel, the axles are available in either the straight type or with 4" drop for most standard wheels.

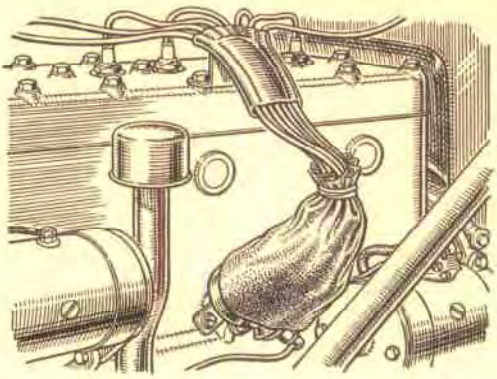
Two coil springs are contained in each suspension unit, providing four springs per axle. Although assuring a positive cushion to the trailer load, this type of springing eliminates any rocking motion. The axles have the standard 58" tread, but wider ones may be obtained on special order.



Hints from the Model Garage

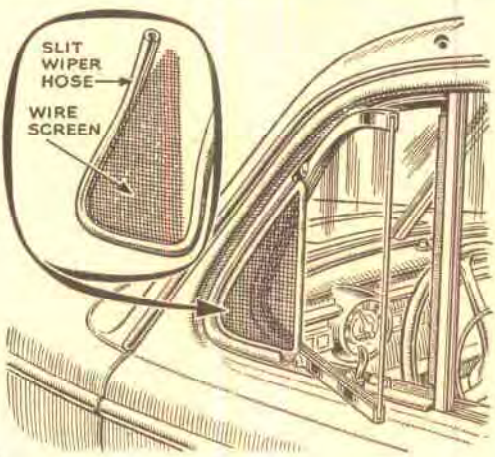


Garage Key Slips off Ring. It's always a nuisance if you must turn off the ignition and carry along all your keys when you unlock the garage door. This can be avoided if you have a quick, easy way to remove the garage key from the ring. Here's one possible way. The fishing-tackle snap shown can be bought in most tackle shops.



Sleeve Protects Ignition. If you have had trouble with the ignition shorting out during heavy rain, here's an idea that may help you. Cut an 8″ section from an old inner tube, snap loose the distributor cap, slip the rubber sleeve over the high-tension wires, and replace the cap. Draw together and tie the sleeve at the topmost edge.

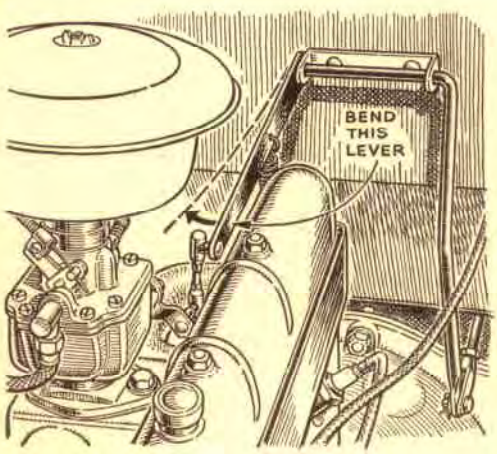
Get Off All the Streaks. Did you ever wash a car window and find when you're through that it's still streaked? H. R. Schaaf, of Louisville, Ky., says he has found it's best to use horizontal strokes of the cleaning cloth on one side of the glass and vertical strokes on the other. Then, if there are any streaks, you know at once which side they are on.



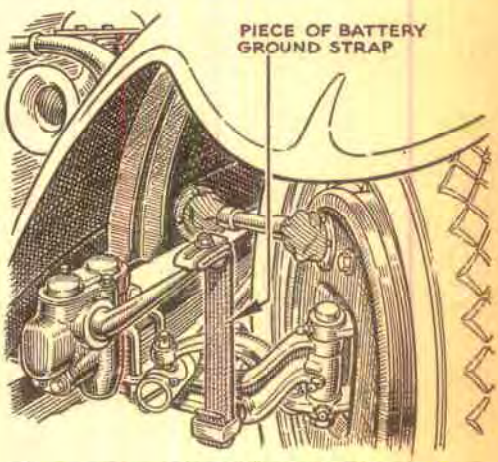
Screen Catches the Bugs. For summer driving, a triangular piece of screening fitted into the area in front of the vent pane will catch any insects that are drawn in with the air. You can solder a heavy wire around the screening or just slip on slit wiper tubing as in the sketch. It's only a moment's work to slip out the screen and close the ventilator.

Door Open, Light Off. Door-operated dome lights can't ordinarily be shut off if you just want to park with the door open. Wesley E. Charter, of Rockville, Conn., suggests that this can be done with a strip pivoted on one switch screw, preferably the lower one. It takes only a moment then to pivot the strip over the switch button.

Mirror Is Always Handy. Here's the way W. M. Dierks, of Chicago, filled the bill when his wife asked for a convenient mirror for use in the car. Buying a large compact, he mounted it as shown inside the glove-compartment door, drilling holes and attaching it with screws. While not in use, the compact is kept closed.



It Wasn't a Ghost. On right turns, Eric St. Clair, Richmond, Va., found his Crosley accelerating of its own accord. He traced the cause to contact between the throttle linkage and camshaft cover. Bending the link cured the trouble. His explanation: On right turns the engine mounting was flexible enough to let the camshaft cover bear against the linkage.



Strap Repairs Shock Absorber. This is how E. V. Collins, of Bantam, Conn., repaired an old-type shock absorber when the web strap broke. Unable to buy a new one, he tried woven brake lining but it soon broke. Then he used woven copper braid made for ground straps on batteries, installing it as shown in the sketch. It's given good service ever since.

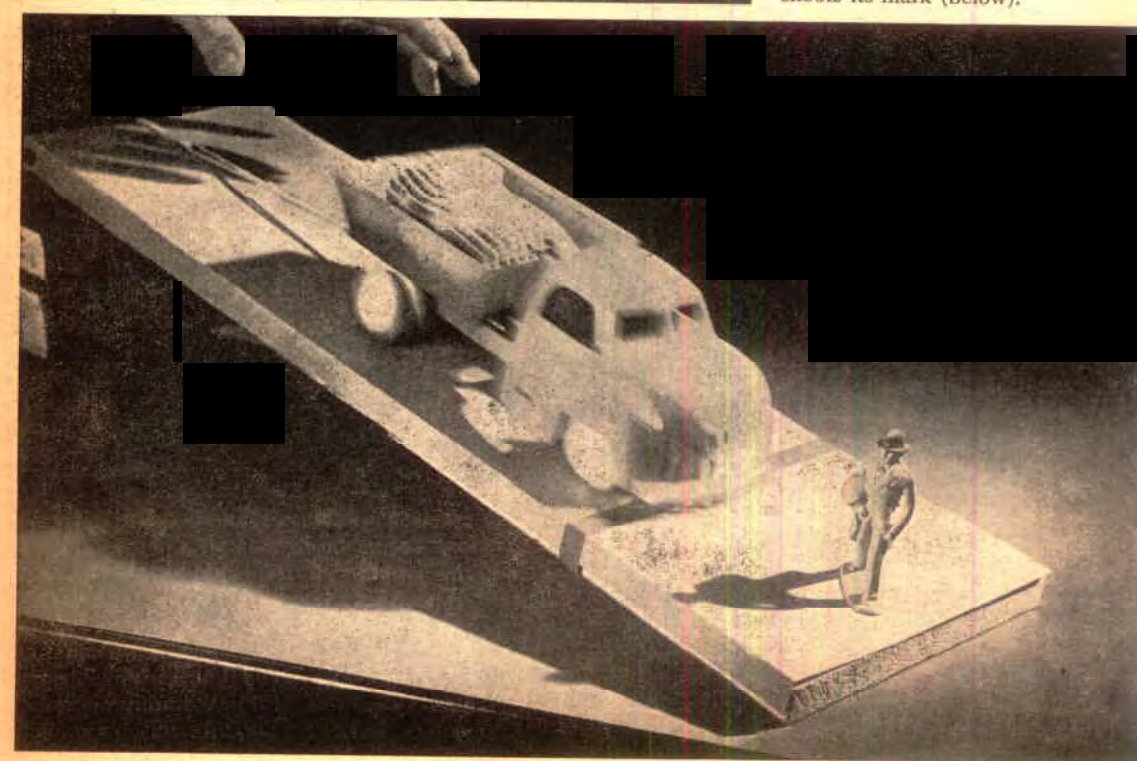
The Laws No Car Can Violate

These simple home experiments will show you why.

By Kenneth M. Swezey

SIR Isaac Newton's First and Second Laws of Motion, set down nearly three centuries ago, are far different from the laws on the local statute books. *You can't*

You can observe Newton's laws at work with this simple setup. Attach a toy car to the top of an incline by linked rubber bands so that its front bumper normally just reaches a line marked on the slope—the spot at which the driver supposedly applies the brakes. Now pull the car back halfway up the incline, as shown at left, and let it go. At such slow speed, car barely overshoots its mark (below).

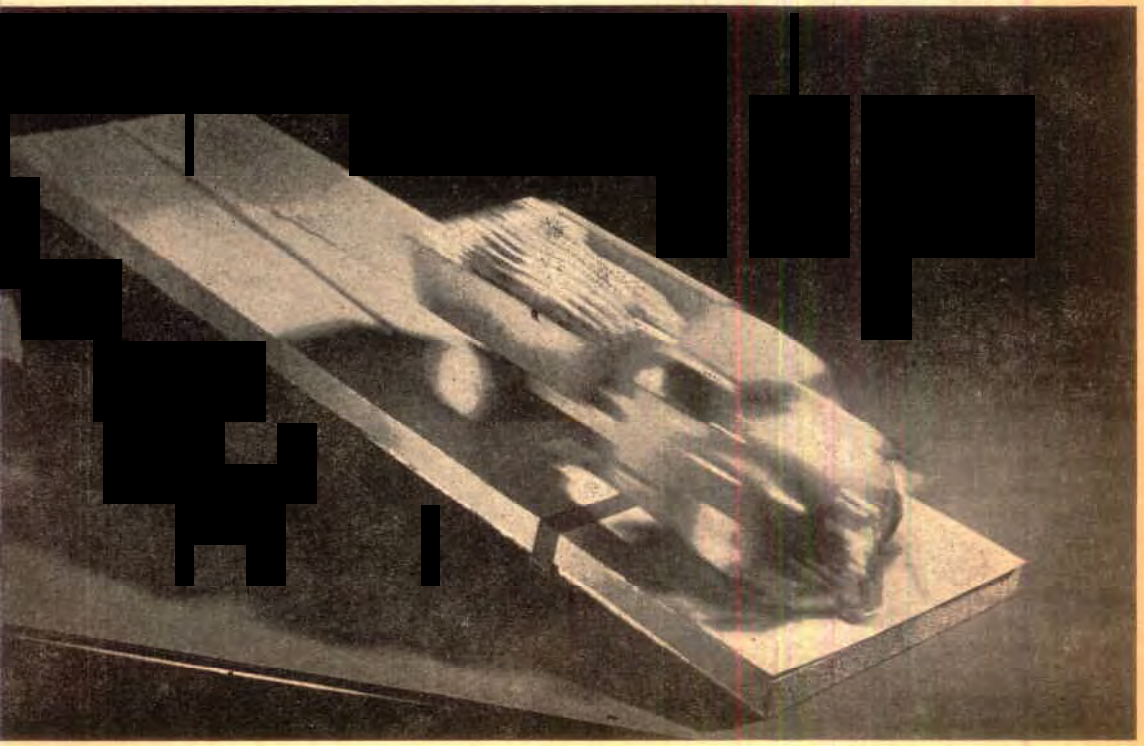


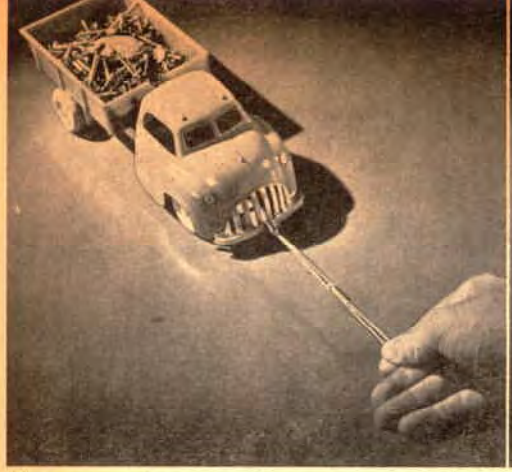
break them even if you try. But they can easily break you, causing property damage, personal injury, or even death.

According to these laws, every body remains at rest, or continues to move at constant speed in a straight line, unless acted upon by an outside force. The amount of force required to change the motion of a body depends upon two things: the mass of the body, and the rate at which you must slow it, speed it up, or change its direction.

Applied to your car, these scientific axioms explain why you can't stop short at high speed; why you must reduce speed to keep from skidding or turning over on a sharp curve; and why it takes more power to start your car, or to accelerate it, than to keep it moving at a constant speed. The simple experiments shown here and on the next page may help you remember.

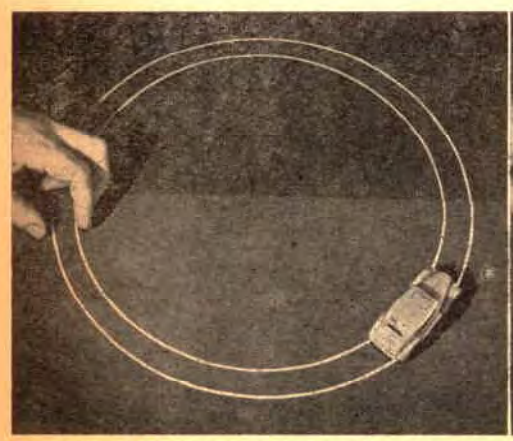
If you double your speed, the laws say, your stopping distance in a car will not merely be doubled—it will be *four times as great.* To demonstrate this rule dramatically, pull the toy car to the *top* of the incline, as at the left, and let it go. This time the car is rolling so fast when it reaches the braking line that it plunges right ahead and crashes headlong into the man in front of it (below).

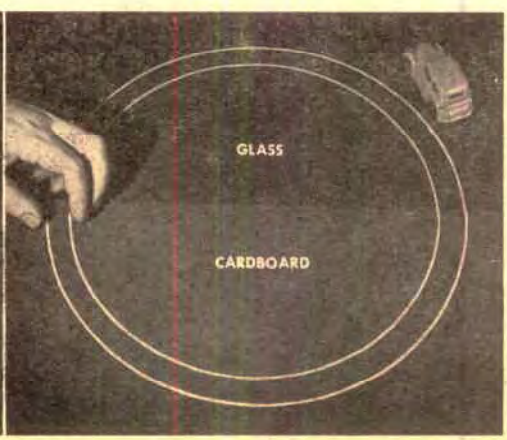




More power is required to start your car than to keep it going chiefly because of *inertia*. This can be defined as the inherent sluggishness of matter that causes it to resist any change in its motion. You can test this law on the living-room floor by pulling a loaded toy car with linked rubber bands. The bands stretch considerably while the car is starting, left above; but they contract a lot when their only work is to keep the car rolling at a steady speed, right above.

Cars skid or turn over when rounding curves because their speed is too great for the sharpness of the curve. Both speed and sharpness determine the force that tries to throw them off the road. You can show this with the experiments above. A marble rolled down a cardboard trough into a large pie tin (left) follows the curve. Rolled from same distance onto a small tin (center), marble jumps off. Rolled from halfway (right), it stays on the track.

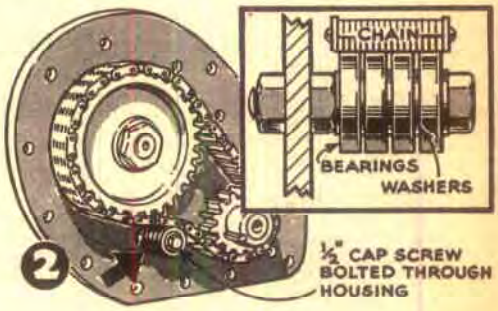




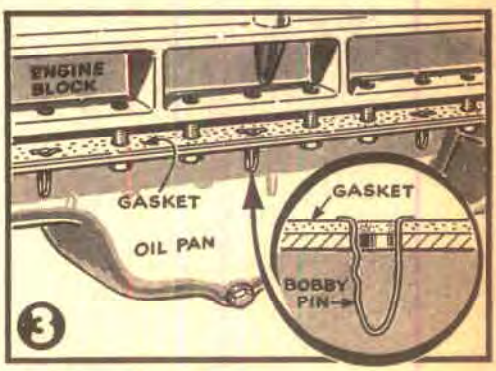
On unbanked curves, cars can keep to the curve only because of friction between the tires and road. Reduce this friction with dampness or ice, and cars may skid even at comparatively slow speeds. You can show this by running a spring-powered toy around a track that is half cardboard and half glass (to represent ice). On the cardboard, the car follows the curve exactly. But as soon as it hits the glass, at right, it swerves sharply off the track.

AUTO HINTS

1 Oiling Speedometer Cable. If you find that the inner part of your speedometer cable cannot be drawn out for lubrication, do not risk damage by trying to pull it out forcibly. Instead, bend aside or remove the cowl-ventilator screen and pass the cable through. This will give you ample elevation to oil it.—NORMAN E. NELSON.



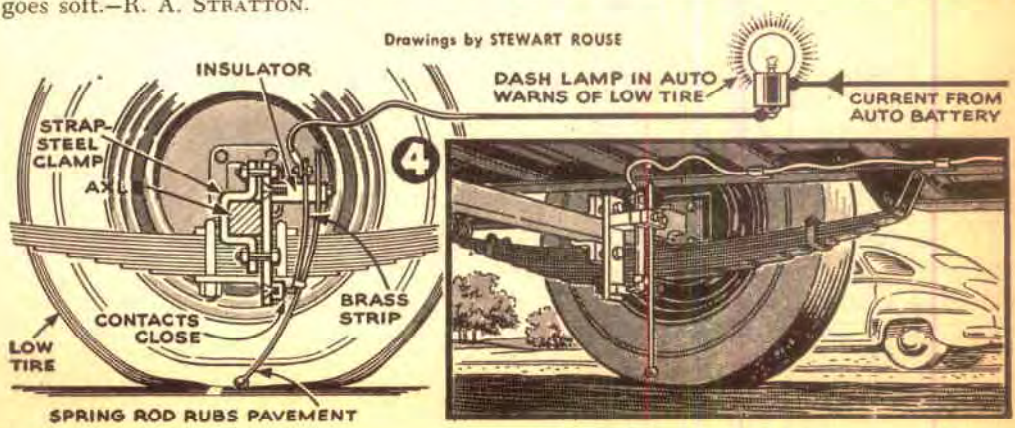
2 Takeup for Timing Chain. An idler pulley made from ball bearings on a cap screw will take up a worn timing chain. Clamp the screw to the wall on the slack side of the chain, using two nuts and a lock washer.—F. D. VANVOLKENBURG.



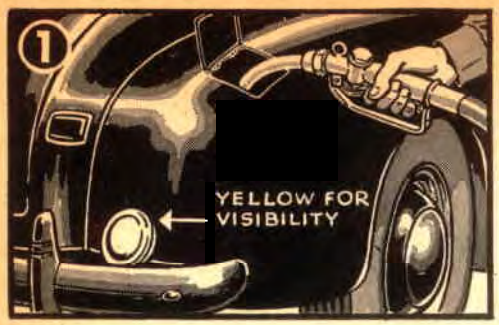
3 Bobby Pins Hold Gasket. A few bobby pins with their ends bent outward at a 90-deg. angle are an excellent means of keeping the gasket in place while an oil pan is being mounted. After several of the studs have been started, pinch the pins together and pull them out of the holes. —LELAND R. HALM.

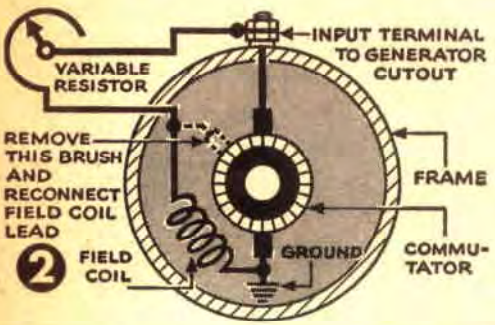
4 Light Warns of Soft Tire. When a trailer tire goes flat, the car driver may not discover it in time to prevent damage. So I built this warning system on my trailer. A red light signals on the dash if the springy rod, which normally clears the ground by about 1", is bent back as a tire goes soft.—R. A. STRATTON.

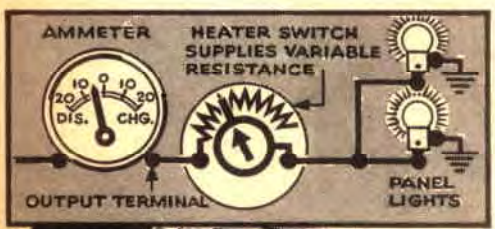
Drawings by STEWART ROUSE

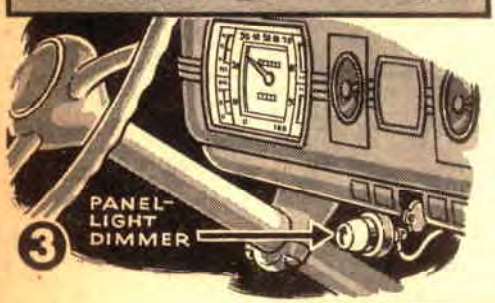


Hints From the









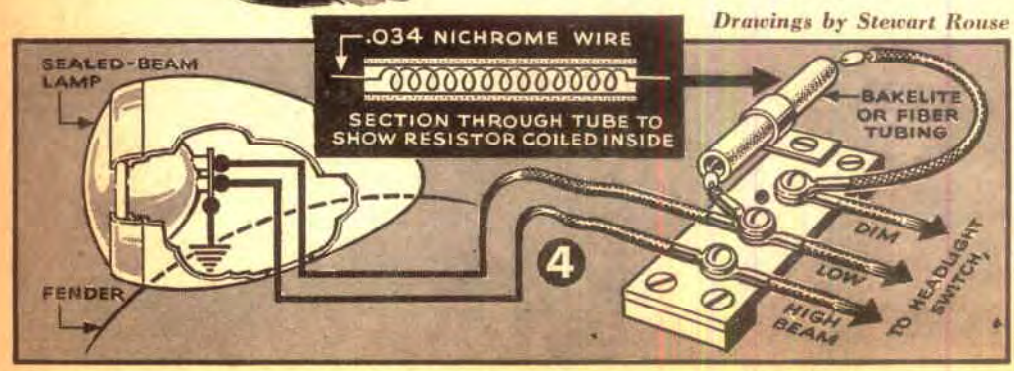
1. Watch Your Cap! Doc Kennedy drove into the Model Garage a couple of weeks ago and yelled for Stan Hicks to fill up his tank. Next day Doc turned up again, and accused Stan of forgetting to put the cap on the tank. Perhaps Stan did. Anyway, it was lost beyond doubt. W. Van Sandt, Long Branch, N. J., thinks grease monkeys like Stan would be less likely to overlook the cap if it were painted bright yellow for contrast. A good idea for the oil filler cap, too.

2. Vary the Voltage by Hand. When extra electrical accessories are installed, a problem always arises if the car lacks an automatic voltage control. If the generator is set to carry the extra load, it's apt to overcharge the battery when the load is off. As a solution, K. C. Anderson, Ames, Iowa, installed a manually operated field resistor rated at 100 watts, 5 ohms. The resistor was placed on the dash, and generator output can now be varied while driving.

3. Less Light on the Dash. If your car doesn't have a dash-light dimmer, a variable resistance switch from an old car heater will let you adjust the brilliance of the instrument-panel lights. J. R. Sisley, Seattle, makes the suggestion.

4. Parking Lamp Improvised. While installing several sealed-beam adapters, Henry J. Stauf, of Woodside, N. Y., found that the low beam could be dimmed for use as a parking lamp by placing a 1-ohm

Drawings by Stewart Rouse



Model Garage

resistor across the dim and low beam connections from the light switch. He used .034″ Nichrome ⓣ wire to make resistors.

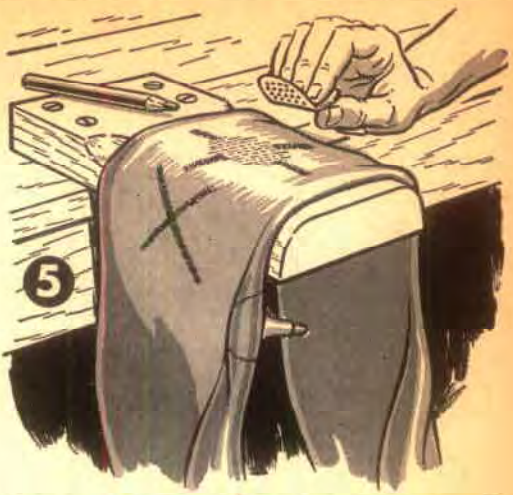
5. X Marks the Puncture. In a tire shop where he once worked, writes Fred C. Daley, of Oklahoma City, an indelible pencil was used to mark tube punctures, two lines being crossed at the pinhole. Then, after the tube was buffed for patching, the ends of the lines pointed toward the pinhole.

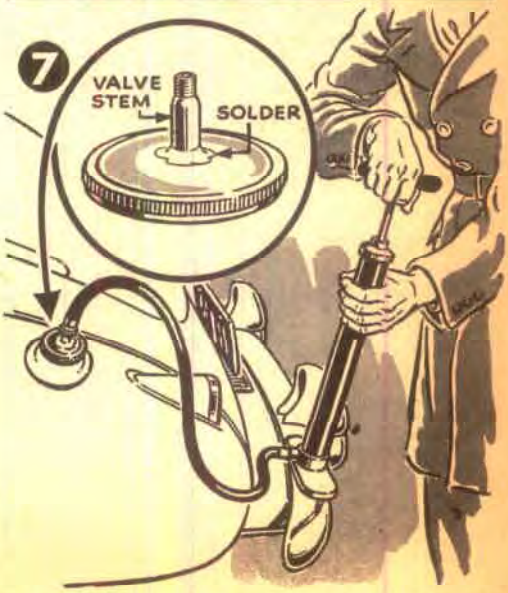
6. Aluminum Dresses Up Car. One reader has replaced scuffed and broken inside panels with sheet-aluminum ones, using sheet-metal screws. A little buffing gives a chromelike appearance.

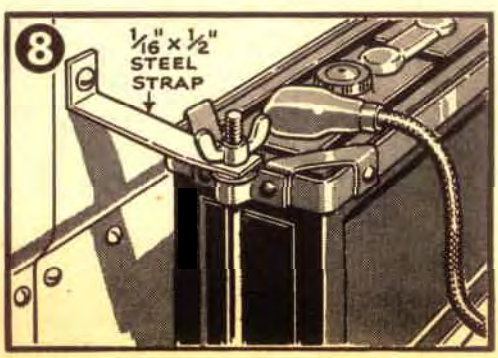
7. Emergency Fuel Pump. If you believe in preparing for trouble before it occurs, here's an idea. Should your fuel pump go bad, a spare gas-tank cap with an inner-tube valve soldered to a hole drilled in its center will enable you to pump enough gas to the carburetor to reach a repair shop. Just a few strokes are enough for several miles, according to H. W. Mills, of Albion, Ill., who has found the idea practical.

8. Bracket Steadies Battery. Vibration, the enemy of any car battery, can be lessened in under-hood installations by bolting a strap-iron bracket to the fender apron and the battery hold-down bolt. The idea comes from Glenn A. Wagner, of Delmar, N. Y.

Gus Wilson







Curing Auto Door Ailments

By Frank McCarty

CAR doors are usually the first things to give trouble when a body begins to wear. They have to be slammed to stay shut. Hinges become sprung. Window glass will not raise and lower easily or far enough. Rattles distract the driver, and latches that hold doors insecurely invite injury to passengers or passers-by. Balky locks cause delays and expose one to weather.

Preventive maintenance on doors, as on other parts of a car, saves hours of bother. It consists simply of regular lubrication. However, when something does go wrong, correct it without delay. How the most frequently needed repairs are made is shown in the photos on this and the facing page.

Stiff lock action or the danger of its freezing in winter can be prevented by a squirt or two of powdered graphite from a spray-type dispenser.

Door handles of this type are removed by loosening one setscrew in the edge of the door. Once out, the handle can be disassembled and the lock barrel removed if it should require adjustment, repair, or replacement.

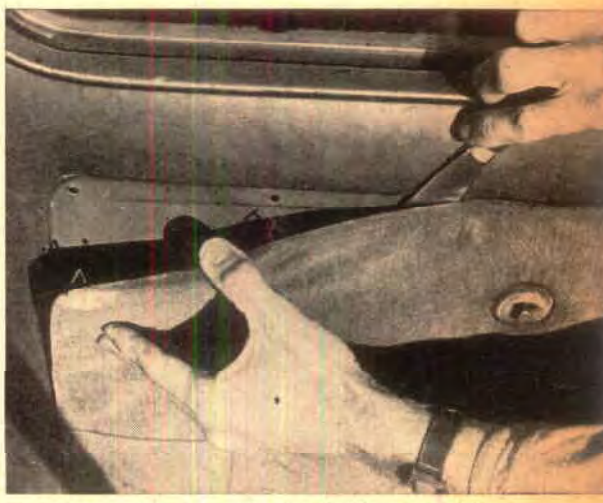
Separate lock units located under the handle are also held in place by one setscrew. When a lock barrel of this type is being replaced, a wire is inserted through the setscrew hole to help guide the square shank into the lock. Be sure to turn the setscrew down flush when it is put back.

Jamb strikes require lubrication with stainless graphite, which may be had in the convenient pencil shape. The strike shown has rubber insets that can be replaced by removing the two screws.

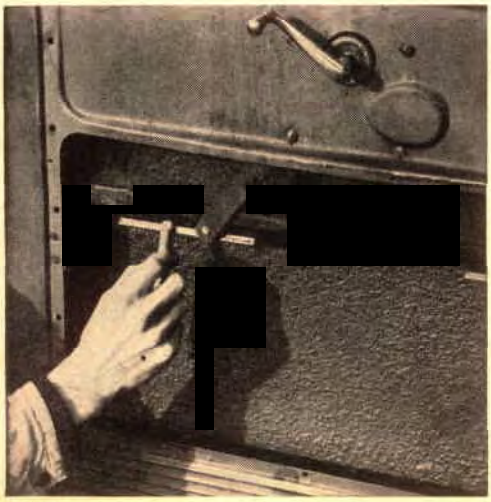
Worn-down latches are adjusted quickly with a metal shim set in behind the strike. Loosening the screws will permit inserting the shim.

Concealed hinges are oiled from the inside of the open door. Close examination will usually disclose an oil hole in the hinge.

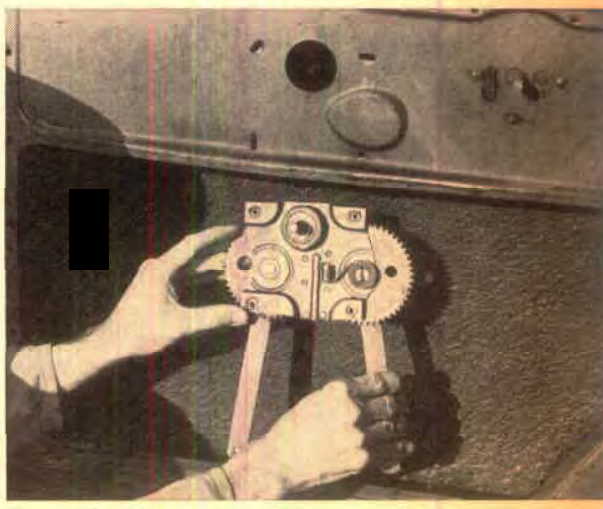
Inside handles are removed by depressing the escutcheon ring and pushing out a pin or clip. The handle is then slipped off the shaft.



Upholstery panels can be pried off with a wide putty knife. Press the blade against the spring clips or nails to avoid ripping the material.

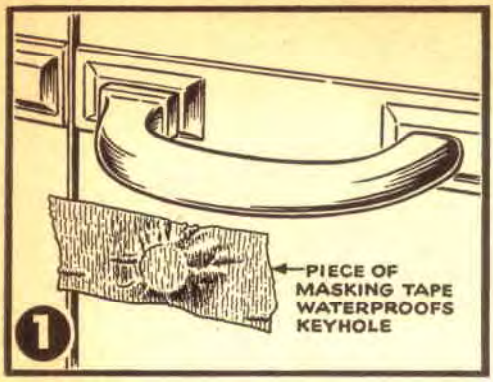


Lifting mechanism is revealed with removal of the door panel. Scrape dirt and grease off the rails and relubricate with a graphite pencil.

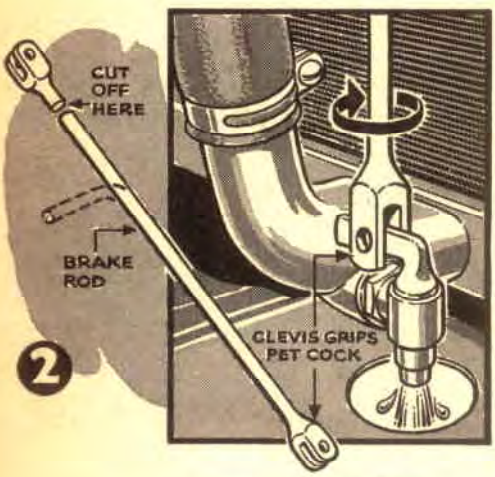


Removal of the mechanism is possible after lowering and taking out the glass. The spring on the gear at right acts as a counterbalance.

Hints from the



1. Avoid Freeze-ups. A roll of masking tape has been a valuable item this winter in the Model Garage. Before a car is washed, pieces of tape are placed over the door and trunk locks. Even though some of the cars were taken out at once into below-zero weather, there hasn't been one complaint of frozen locks.

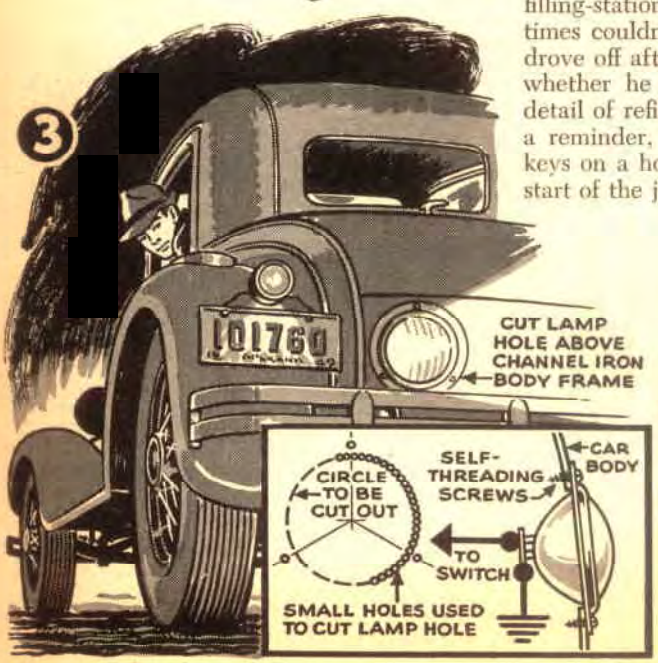


2. Tool Reaches Drain Cock. An old brake rod may be turned into a handy tool for reaching drain cocks that are difficult to get at. Simply hacksaw off one end and bend to form a handle.

3. It's a Back-up Light Now. Francis Hewens, of Boonton, N. J., reports he's using a sealed-beam headlight with one filament gone as a back-up light on a car he has. A hole slightly smaller than the rim was cut by drilling overlapping holes. One wire was run from the live filament to a switch on the dash, the other to ground.

4. You Can't Forget the Oil. One filling-station attendant found that he sometimes couldn't remember, when a customer drove off after an oil change and grease job, whether he had overlooked the important detail of refilling the drained crankcase. As a reminder, he now always hangs the car keys on a hook on the filled measure at the start of the job. Simple, but effective.

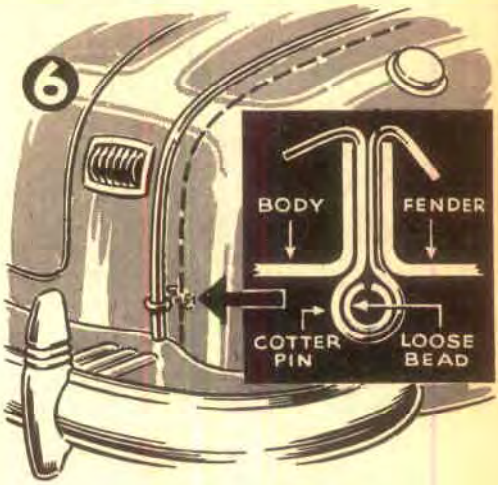
Drawings by Stewart Rouse



Model Garage

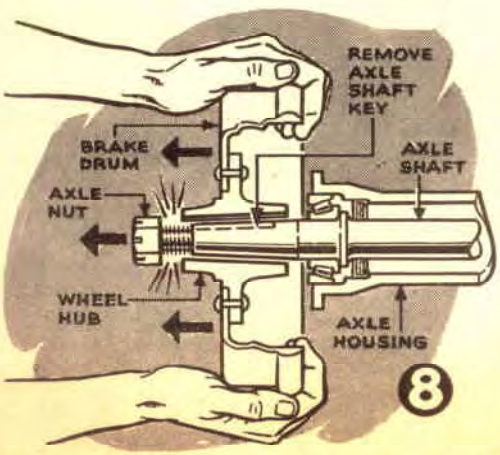
5. Parts Kept in Order. When J. C. Branstetter, of San Francisco, begins any extensive car repair, he always carries to the job several boxes made by cutting the tops from milk cartons. As he removes bolts and fittings, he keeps each group separate and drops a piece of paper in the container listing where the parts came from.

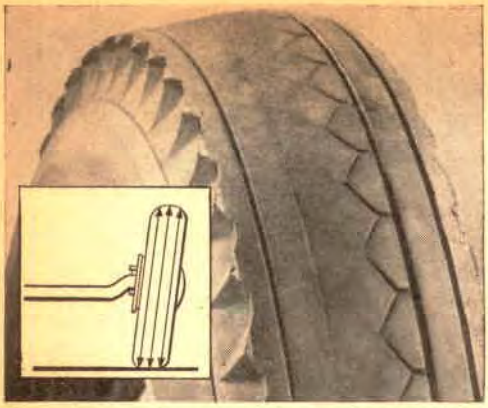
6. Cotter Pin Holds Bead. In some cars, a chrome bead finishes off the joint where the fenders meet the body. In time the fabric that ties it to the joint may rot, allowing the bead to spring out. One or more large cotter pins, slid over the bead, pressed into the joint, and then opened out, will keep it in place.



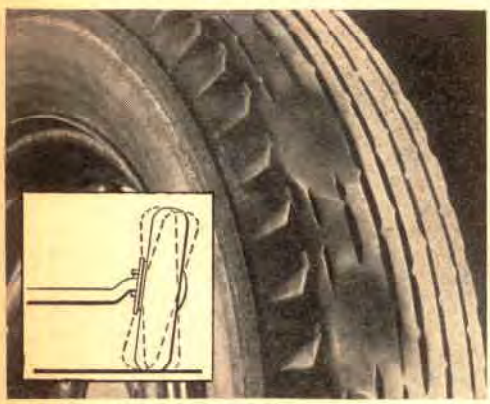
7. Clean the Trunk Gutter. It's a good idea to clean the gutter around your trunk compartment regularly. If dirt is allowed to accumulate, rain water may seep in even though the lid fits well.

8. Brake Drum Pulls Axle. Carl Vogel, of Chicago, points out that the brake drum may be used to pull the rear axle on Chrysler-made cars. After removing the wheel, drum, and shaft key, replace the drum and turn up the axle nut four or five turns. Then rap the drum against the nut several times and the axle will come out.





Excessive camber wears the tread away along the outer edge. When a tire shows wear like this, or as seen in the two photos below, an alignment job on your wheels is long overdue.



Wobbly wheels resulting from such mechanical defects as a bent axle or uneven caster soon make a tire look like this, flat spots being worn in the tread at irregular intervals.

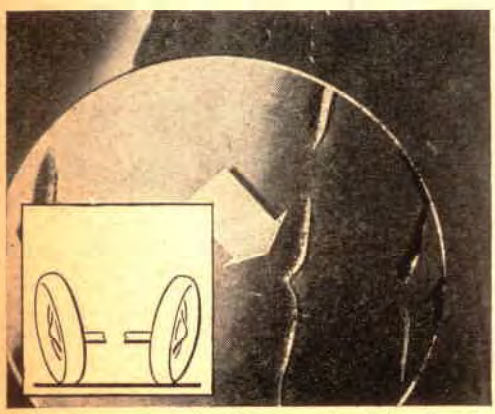
Most Flats Are Your Own Fault

By R. P. Stevenson

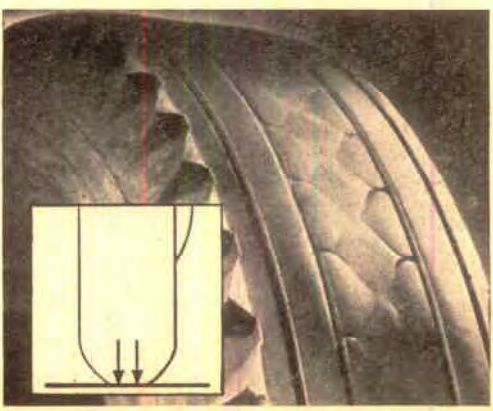
WHEN one of your tires goes suddenly flat along the highway, perhaps miles in the country on a dark and blustery night, it's a pretty safe bet that you might have detected the impending trouble and taken steps to prevent it. There's evidence to prove that some 90 percent of all such inconvenient tire failures can be avoided.

This doesn't mean you must scan every inch of the roadbed ahead for nails and tacks. Anyone is apt to puncture a tire now and then, and even the most careful driver occasionally bumps a rock or curb with sufficient force to break the fabric. Such damage almost invariably results in a flat. But —and this is a fact that drivers often fail to realize—complete failure may not come for days, and perhaps weeks. In the interval, there usually is ample opportunity to detect the symptoms of forthcoming failure and repair the tire before it hangs you up along the road.

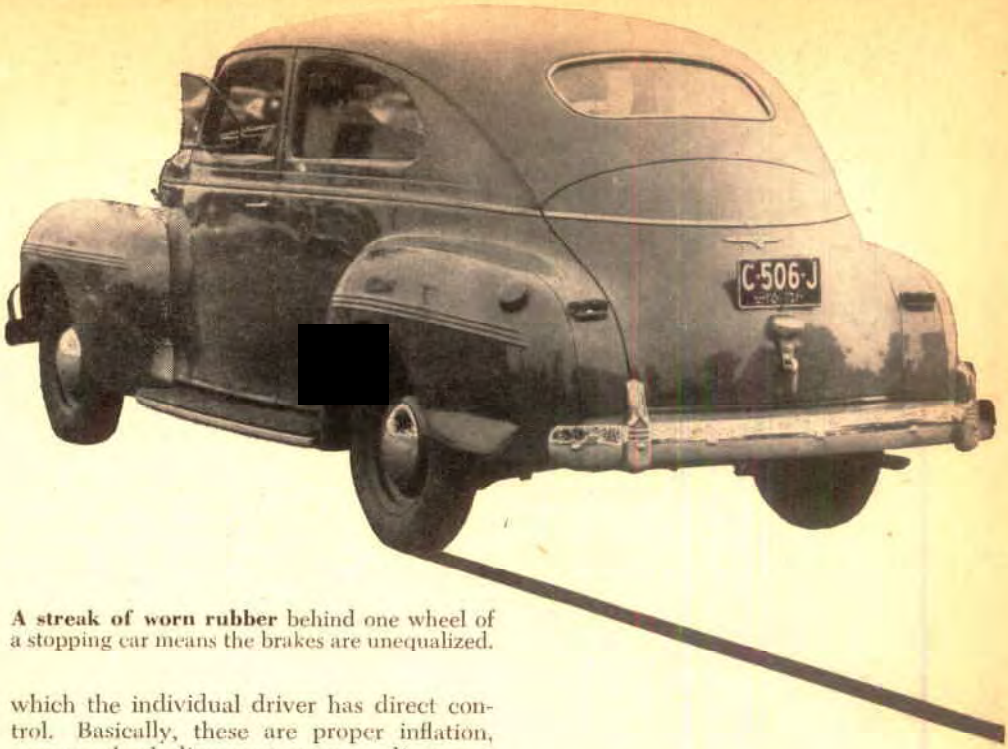
Tires are built to give their maximum mileage under operating conditions over



A feather edge of rubber on front-tire treads is a sign of wrong toe-in or toe-out. A wheel ½" out of alignment drags the tire sideways about 67′ every time the car travels a mile.



Overinflation wears the tread in the center, leaving the fringes in fairly good condition. Because of abnormal tension, such a tire also is more susceptible to cuts and tread breaks.



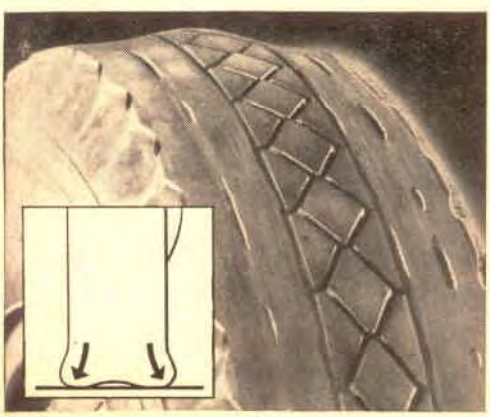
A streak of worn rubber behind one wheel of a stopping car means the brakes are unequalized.

which the individual driver has direct control. Basically, these are proper inflation, correct wheel alignment, proper adjustment and efficient use of brakes, and avoidance of damaging road obstacles. Carelessness about any of these points may quickly ruin a tire. Examples of such damage are illustrated on this and the preceding page.

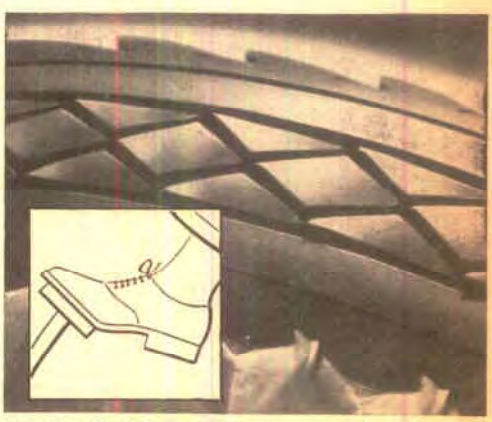
When a tire has been badly worn or damaged because of one of these reasons, it may of course go flat or blow out without warning. But suppose a comparatively new and apparently undamaged tire fails unexpectedly? What then?

In such cases, you may be sure that, barring a leaky valve or the slim chance of a manufacturing defect, the flat occurred because the tire, or maybe only the tube, was damaged in some way during operation—usually quite a while before the failure.

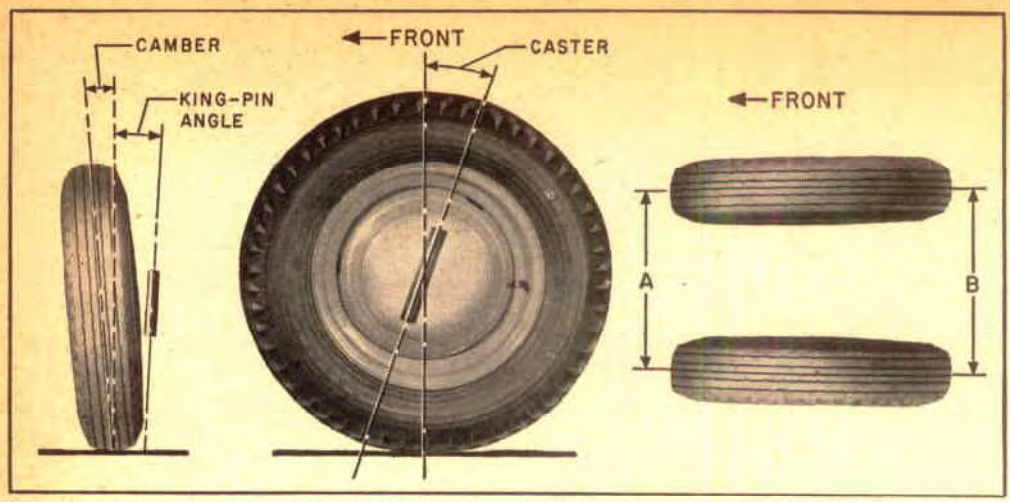
This fact may be turned to your ad-



Underinflation, especially if it is excessive, may have this unexpected result—heavy wear only on the shoulders. For the cost of underinflation, see the chart on the next page



Sudden braking causes one end of each tread button to wear more than the other, heaviest wear occurring on the end that first contacts the road. This is known as heel-and-toe wear.



Steering geometry involves proper relationship of camber, caster, king-pin angle, and toe-in (which requires that *A* be less than *B*.) If any element is off, undue tire wear will result.

vantage. It is the basis of a method of preventive maintenance developed by A. Schrader's Son, of Brooklyn, N. Y., a division of the Scovill Manufacturing Company, Inc. Called the "Comparative Air-Loss System," this method of preventing tire failure emphasizes that any excess loss of pressure, as shown by regular gauging, should be regarded as a warning that the tire has been damaged and will eventually go flat.

The system embraces four points:

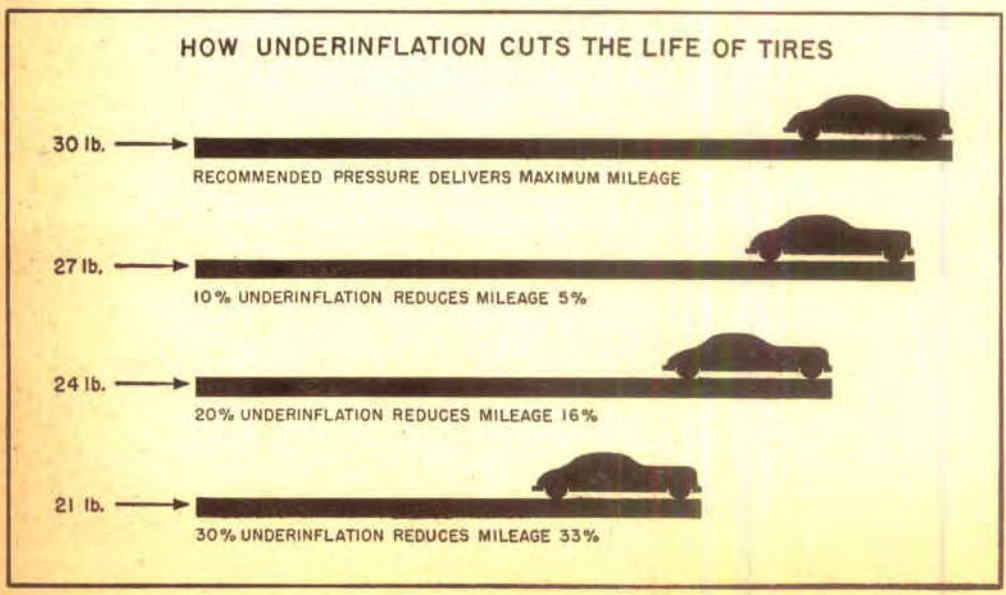
1. Gauging of tires when they are cool, once each week before adding air.

2. Recording and careful comparison of the pressures. If the pressure of one tire is 3 lb. below its running mate, there probably is a leak in the tube, and the cause should be immediately determined.

3. Keeping a valve cap firmly applied at all times, not only to prevent air loss in case the valve is faulty but also to restrict any source of leakage to the tube.

4. Removal of foreign objects from the tire surface when the car is lubricated.

Originated during the war as a tire conservation measure, the system was featured



Warning of a flat tire is contained in this record. The excess pressure loss in the right front tire indicates a slow leak. If a flat is to be avoided, this tire should be checked at once.

in a bulletin distributed to branches of the armed forces and to bus and truck fleet operators. That it produces results is shown by the experience of one company operating a fleet of trucks. Before adopting the system, the company had an average of three flats a day. Subsequently, the same trucks ran for six months and one day, a total of 236,000 miles, before the first roadside flat occurred.

The system can be applied to passenger cars with equal results, and a test on a 1946 model, reported by the Schrader company, shows why. At the beginning of the test, the car still had the original tires and tubes and already had run 11,284 miles. While cool, the tires were inflated to 28 lb. Then, 20 nails were deliberately driven into the four tires, and the car was started out on a test run at above average speed. At the end of five days, the tires were reinflated to 28 lb., after first being gauged. At that time, despite the presence of the 20 nails, the greatest air loss for any tire was 10 lb. On each day thereafter, the tires were brought back to 28 lb.

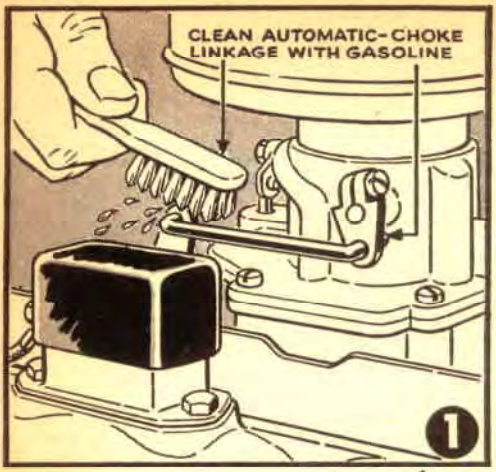
Finally, after the car had been driven 1,051 miles, one tire dropped from 28 to 10 lb pressure, and then went completely flat after the car had been standing about 10 minutes. The second gave out at the end of 11 days and the third after 16. It was not until the 18th day, after 1,844 miles of driving, that the fourth suddenly went flat on the road. If any one of these tires had been punctured accidentally, the excessive amount of air required to keep it properly inflated should have been taken as a warning.

One important point to remember in applying the air-loss system is that tires should be gauged and inflated only while they are cool; that is, at atmospheric temperature. During operation, normal flexing of a tire generates heat, and the heat causes the pressure to increase, possibly several pounds. If a tire is inflated—or deflated—at this time to what is assumed to be correct pressure, it will be underinflated when cool.

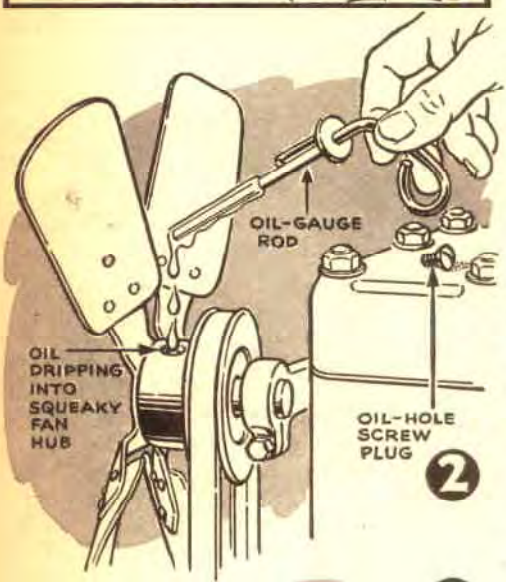
To make the air-loss system work to your best advantage, it is therefore advisable to have your own hand gauge and use it before moving the car from the garage. Then, if no tire shows an excessive loss, you can drive to a filling station and bring them up as needed. But if one does show a sudden drop, better investigate at once. END

Gauge your tires weekly, taking the reading after the car has stood at least two hours

Hints From the

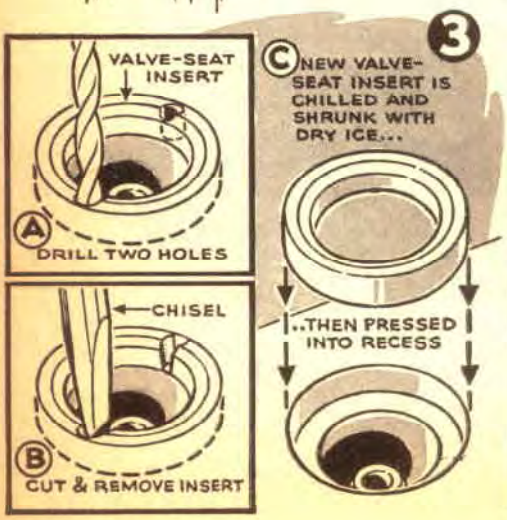


1. Automatic chokes sometimes get blamed unfairly. Here at the Model Garage we've learned to look first at the linkage between the carburetor and choke-control mechanism. Oil on the connecting lever will gum it up and make the choke sluggish. A toothbrush dipped in gasoline removes oil and dirt; very often that's all that is needed.



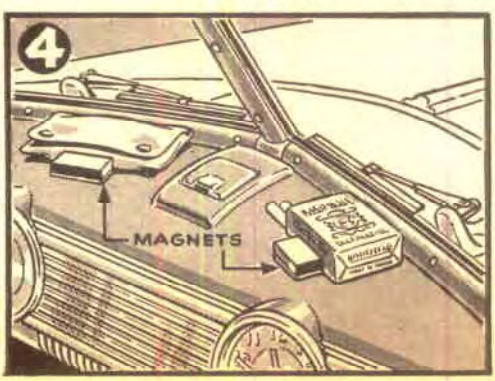
2. Fan Squeak Gives Warning. Many fans start to squeak when lubrication is neglected, and a scored shaft is never far behind. Marion L. Rhodes, of Knightstown, Ind., heard the warning noise, but he was on the road, had no oil can, and was miles from a service station. To forestall trouble, he removed the screw plug and held the oil dip stick over the opening.

3. Freeze a New Insert Ring. If valve inserts are being replaced and don't come out easily, remove with a drill and chisel, taking care not to damage the recess. Pack new rings in dry ice for at least 15 minutes to shrink them.



4. Magnets Peg Things to Dash. Cigarettes, sun glasses, and the like are always in reach for William G. Hykle, Montreal, who uses magnets to hold them up against the windshield frame on his car's sloping dashboard. Felt glued under each magnet keeps it from scratching.

Drawings by Stewart Rouse



Model Garage

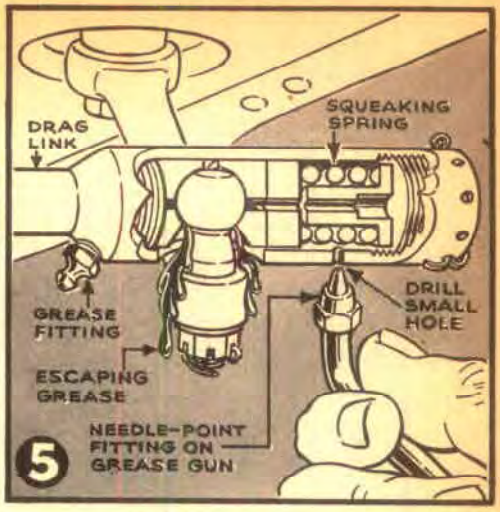
5. Grease Stops Squeak. A persistent squeak when you turn the steering wheel may come from the spring-cushioned end of a drag link that hasn't been lubricated properly because the grease didn't reach the spring. The squeak can be stopped by drilling a tiny hole in the housing and forcing grease directly to the spring.

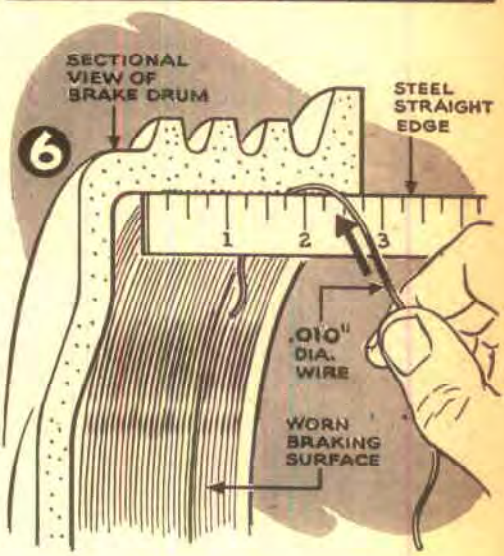
6. Gauging Brake-Drum Wear. John Krill, of North Lima, Ohio, reports that one truck-fleet superintendent uses a straightedge and .010″ wire to determine if brake-drum scoring is bad enough to demand machining. If the wire passes through any groove, the surface is considered in need of refinishing.

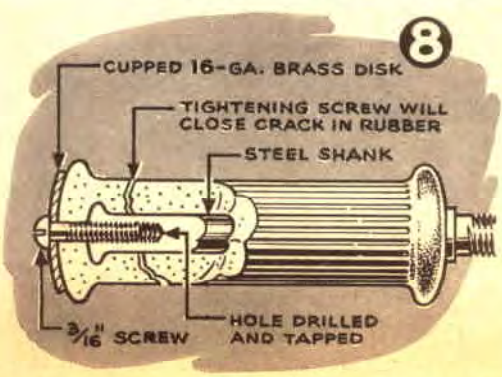
7. Blow Out the Dirt. One thing you'll never see in the Model Garage is a mechanic grab a wrench and remove a plug without preliminaries. Dirt should first be blown from the seat with an air hose—or failing that, a tire pump.

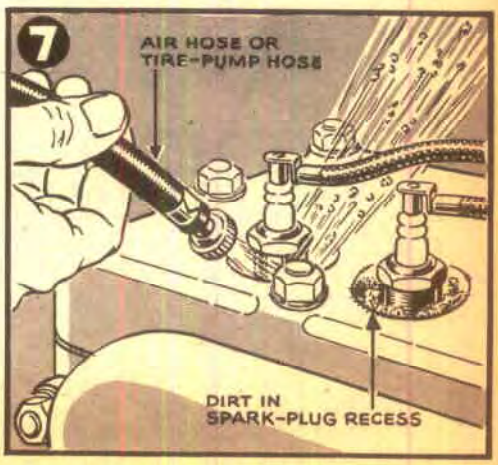
8. Cycle Footrest Repaired. If a crack occurs in the rubber casing of a motorcycle footrest bar, cut a disk out of 16-ga. brass, cup with a ballpeen hammer to conform to the casing, and drill the disk and shank for a 3/16″ screw. Turning up the screw will close the crack. I. J. Stretten, Detroit, makes the suggestion.

Gus Wilson

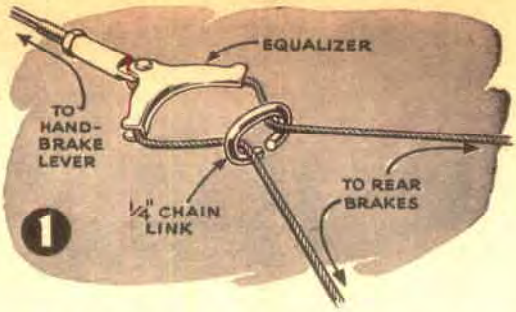




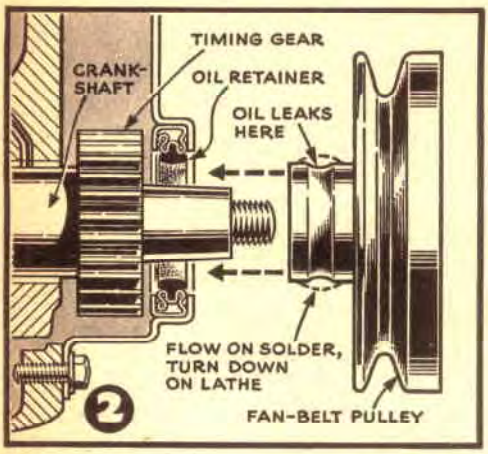




AUTO HINTS



1. HAND-BRAKE CABLE SLACK can be taken up when no more threads remain in the clevis by slipping a ¼" chain link over the cable near the equalizer. By pulling the cable together this provides 1" more of threads for adjustment. Use a replacement tire-chain link, and bend it closed after installation.—H. G. WEBER.

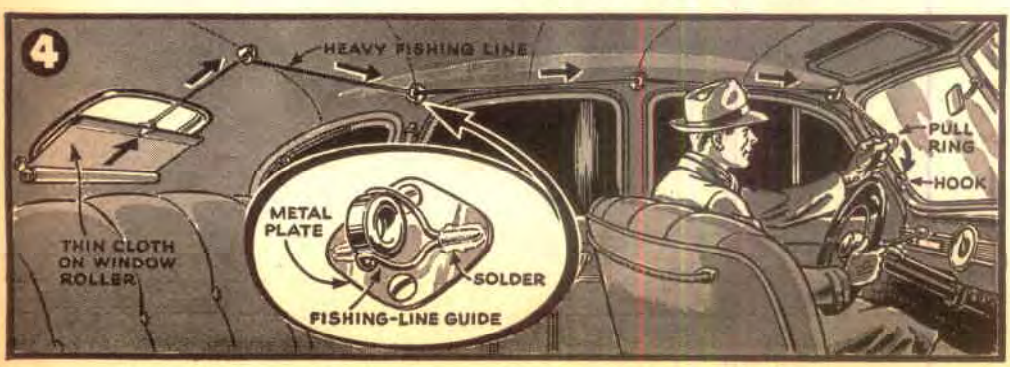


2. SOLDER ON THE WORN HUB of a fan-belt pulley will stop an oil leak when grooving by the oil retainer after long service has destroyed the seal. Build the hub up well with solder; then turn it down in the lathe, leaving it a little high to make up for wear on the retainer itself.—R. L. MCCLANNAN.

3. RAIN-LEAKING REAR WINDOWS and windshields can be plugged with wax dripped from a candle into cracks in the rubber seal. Drip the wax on for several inches on both sides of the breaks. Until the sun melts the wax thoroughly, the leak won't stop completely.—C. D. BASSETT.

Drawings by STEWART ROUSE

4. REMOTE REAR-CURTAIN CONTROL enables a driver to shut off glaring headlights from a car behind and to reopen the shade and restore rear-view vision when the car has passed. The pull cord is a heavy fishing line threaded through a series of casting-rod line guides on metal plates.



MONOXIDE Thumbs a Ride

Drowsy while driving? Make sure carbon monoxide isn't poisoning you at the wheel. A checkup may save a life.

CARBON monoxide is a hitchhiker. We all know that this odorless gas, generated by an automobile at the rate of about a cubic foot a minute, will quickly turn a closed garage into a death chamber, but we are apt to overlook the fact that it rides along each time we drive out on the highway.

Its handiwork shows up in traffic accident news more frequently than most persons realize. The police reports may say that the driver "apparently fell asleep," or perhaps a big question mark appears in the space where the cause of the accident should be recorded, since no one remains alive to tell about it. Some of these accidents, it is true, result from lack of sleep or just plain weariness after long hours of driving, but there seems to be no doubt that a good percentage occur when carbon monoxide, stealing a ride in the car, dulls the senses of the driver.

As an agent of death, carbon monoxide works by combining with the red corpuscles, preventing the blood from carrying oxygen throughout your body. A little goes a long way. Just two parts in 10,000 of air are enough to impair perceptions; and not much higher concentrations, breathed for a sufficient time, can prove fatal. When a car engine is operated in a closed garage, the air becomes dangerous to breathe within three minutes. Safety education has made most people aware of this, but comparatively few realize that there are equally important precautions that should be taken to minimize the danger of carbon monoxide out on the highway.

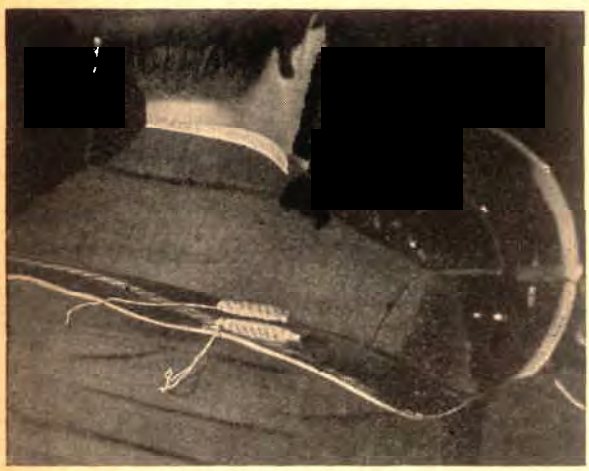
Tests conducted in Connecticut by the State Health Department and the Travelers Insurance Company underline the need for such precautions. Traces of carbon monoxide were found in nearly 50 per cent of a

group of cars checked at random along the highway, and in more than 10 percent there were dangerous concentrations—enough to dull the senses, and possibly produce unconsciousness.

Concentrations of carbon monoxide below about 3.5 parts in 10,000 are not immediately dangerous, but if you are exposed long enough this amount will produce headache, mental dullness, and a sense of physical weariness. At 2 parts in 10,000, these primary symptoms generally occur in about two hours. Such symptoms, usually disregarded, are often the cause of inefficient driving and accidents.

Hence, if you ever develop a feeling of unreality while driving and the traffic and city street or countryside seem like something seen in a dream, it is high time that you open the car windows wide and pull up and park immediately until you again feel normal. Also, be wary of a headache that develops while you are driving.

If you suspect that an unsafe percentage of carbon monoxide is contaminating the interior of your car, you can make a test with the detector ampoules manufactured by the Mine Safety Appliances Company, of Pittsburgh. Although devised for the detection of dangerous carbon monoxide concentrations in manhole entrances, the ampoules are now used by garages, chemical plants, and other industries for the same purpose. They cost $1.25 for 10 ampoules.



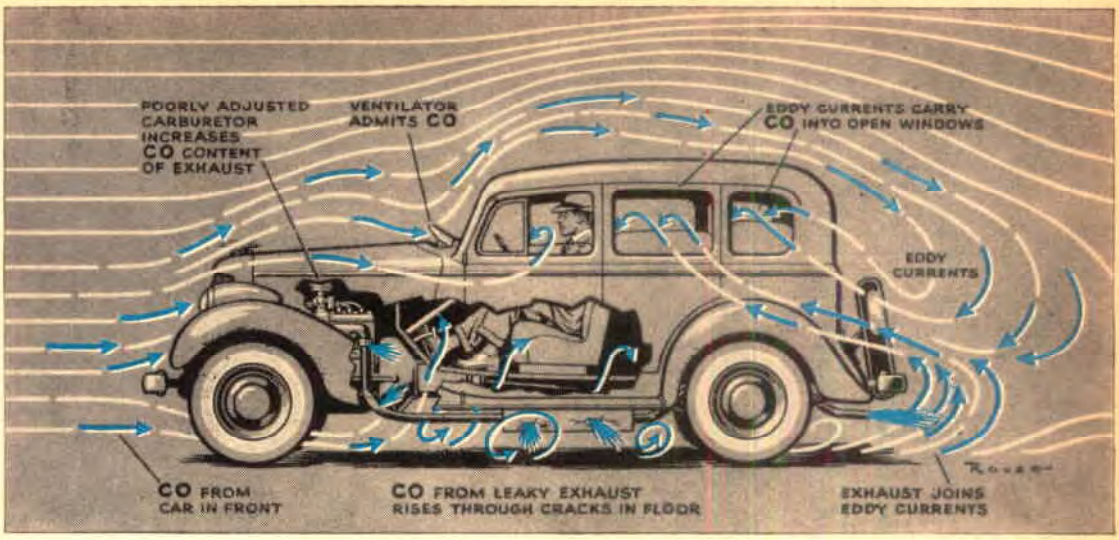
Small chemical detectors made by the Mine Safety Appliances Company provide a way of testing a car for carbon monoxide.

If monoxide is present, the detector will change color, the final color depending on the gas concentration. Comparing the exposed detector with a chart shows the concentration.

Smaller than a cigarette, one of these ampoules will detect the presence of monoxide in air in concentrations as low as 2 or 3 parts in 10,000. They consist essentially of palladium chloride in an acetone-water (nonfreezing) solution, sealed in a glass tube surrounded by cotton.

In use, the ampoule is crushed between the fingers, allowing the solution to saturate the cotton. The ampoule is then left for 10 minutes in a place where carbon monoxide is suspected. Originally, the crushed ampoule is yellow. If monoxide is present, metallic palladium will darken the cotton, the depth of discoloration (running from a light gray to a grayish black) depending on the concentration of the gas. The concentration then can be determined by comparing the color of the ampoule after 10 minutes with the scale of colors on a chart furnished with the set. In a car you might place the crushed ampoule on top of the front seat, or better still, hang it by a cord from the roof.

Contamination of the interior of a moving car may result either from the exhaust gases of your own car or those close ahead. A leaking exhaust system or a rusty or battered muffler often will allow the deadly gas to seep through cracks in the floor or doors. In some cars exhaust gases, instead of flowing away to the rear, actually move along with it because



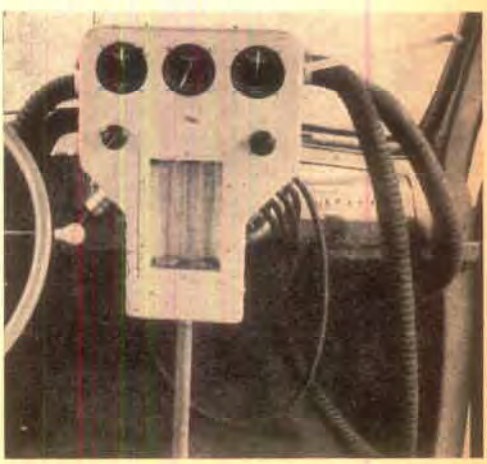
Monoxide, from the car in front as well as from your own, can enter by many routes, including open windows.

of the turbulent flow of air immediately behind, and monoxide-laden eddy currents may whip into the open windows—looking for a victim. If all of these sources of contamination joined forces, as easily they might, the car could soon become a rolling death trap.

Since carbon monoxide is a product of poor combustion, proper adjustment of the engine is an important factor in reducing the hazard. Experiments by the U. S. Bureau of Mines have shown that the proportion of this gas in automobile exhausts ranges from 1 to 13.72 percent and that the amounts vary widely at high and low speeds and with good and poor carburetion. As combustion efficiency increases, the monoxide content of the exhaust naturally decreases. The percentage may be as high as 13 from a poorly adjusted motor running at 50 percent efficiency. When the car has been tuned up to run at 80 percent efficiency, the monoxide content drops to 4 percent.

These percentages sometimes are put to use in reverse. Some garages have equipment to determine the monoxide content of a car exhaust. From this, it is possible to estimate the efficiency of the engine.

Flow Meter Developed by Ford Tests Crankcase Ventilation



DESIGNED for use in a test car under actual operating conditions, the flow meter shown in this photo was developed by the Ford Motor Company as a means of measuring the efficiency of various systems of crankcase ventilation. Such ventilation, which involves an induced flow of fresh air through the crankcase to carry away blow-by gases escaping past the piston rings, has been the subject of considerable research and study.

Instantaneous readings may be taken from the Ford meter, which is two duplicate instruments built as one and attached to the normal engine ventilating system. One measures the flow of fresh air entering the engine, the other the outlet flow.

A robot doorman you can build without vacuum tubes or a radio technician's diploma.

This Button on the Dash Opens Garage Doors

Service at your finger tips. Push this button in the car either to open or close the garage . . .

By J. Raymond Schneider

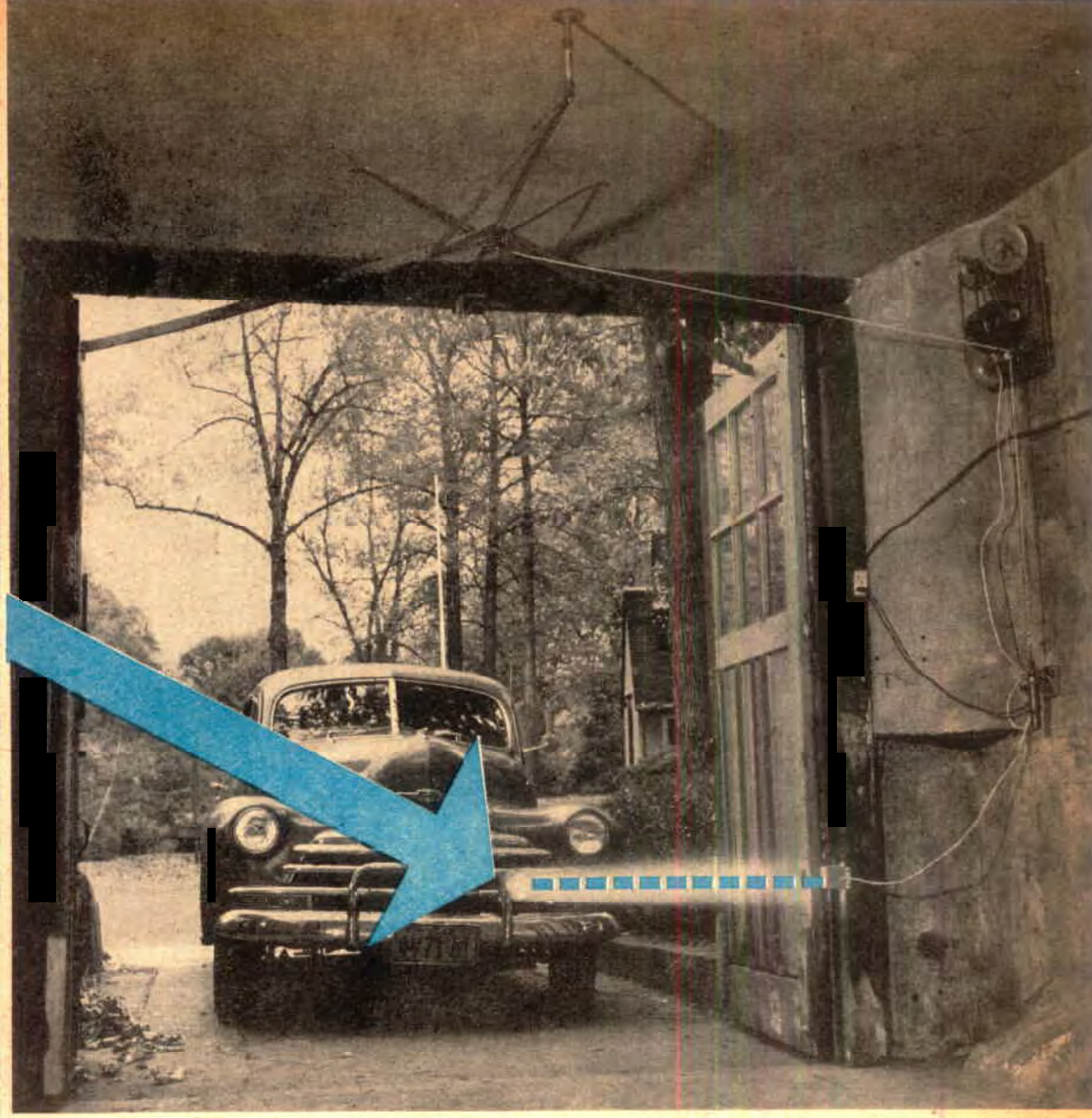
DOES your motoring day start like this? Open the garage doors. Get in the car and back it out. Climb out, make a detour around the front fender, and close and latch the doors. Dodge the fender again and get in. On returning, reverse the whole routine.

That's how I used to do it.

Today I walk into my attached garage from the house and touch a button. While the doors open, I get in the car. After backing it out, I pause long enough to touch a second button, under the dash. A spotlight on the car winks—and the doors close.

They lock, too. You can't get in from outside unless you have a key or drive up in my car. Headlights or an ordinary spotlight won't work. The rig takes no juice when it's standing by, because there are no vacuum tubes to be kept hot. But when I get back from a trip, whether in minutes or a month, it opens the doors at a touch of the button.

The dash button sends juice to the light and to a magnet that pulls a thin spring or reed on which a contact is mounted. This



. . . And a spotlight winks rapidly, exciting a photo cell that starts an automatic operating cycle.

breaks the circuit until the reed, released, closes it again, just as in a doorbell. Thus the light blinks at the reed's frequency.

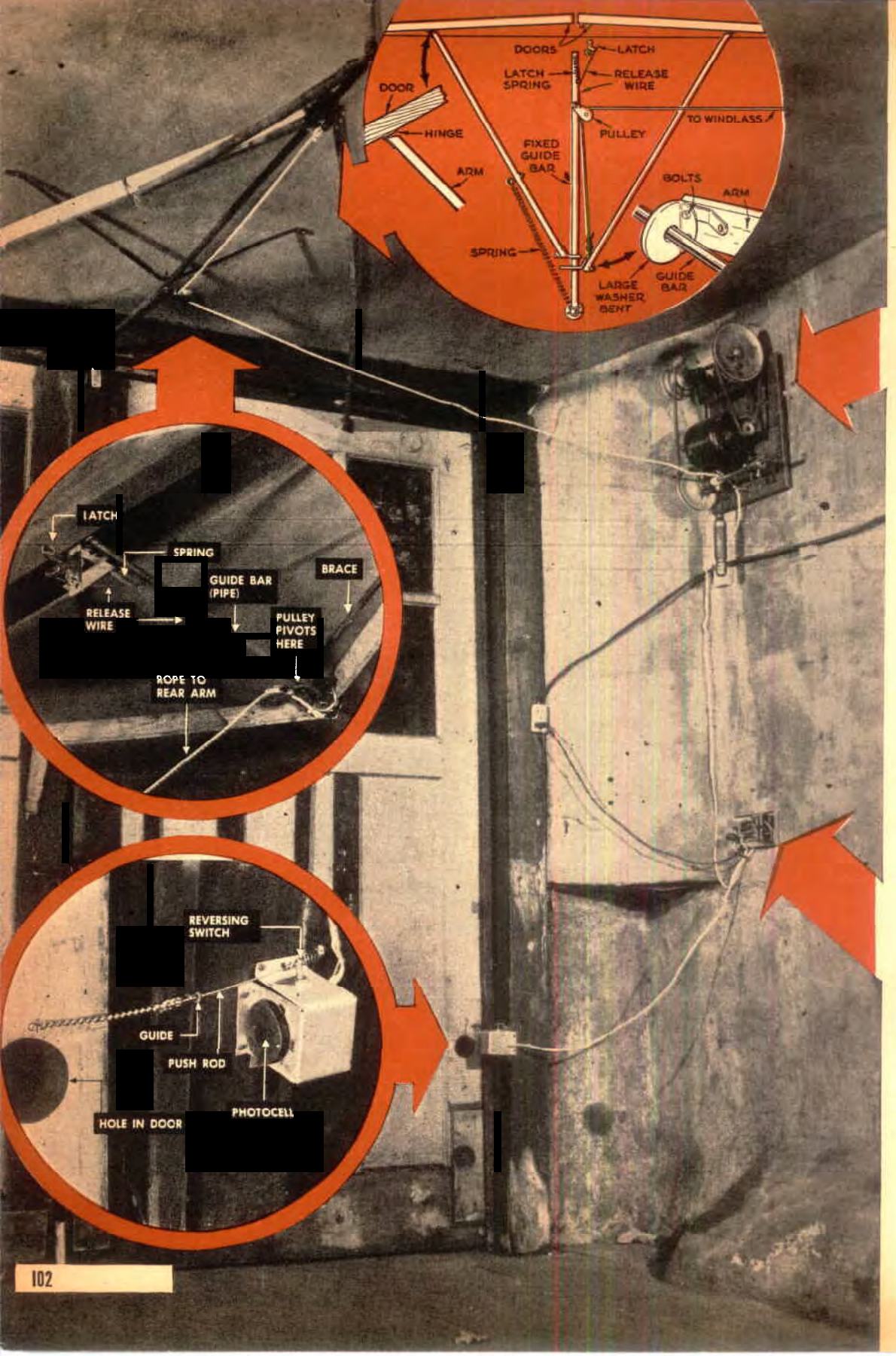
As the beam hits a photo cell on the garage, this generates a pulsating current that is fed into a coil of fine wire fixed on another, similarly tuned reed and poised over a permanent magnet. The current vibrates the reed at the same frequency, until it swings far enough to touch a contact that closes a 115-volt relay and starts the door mechanism.

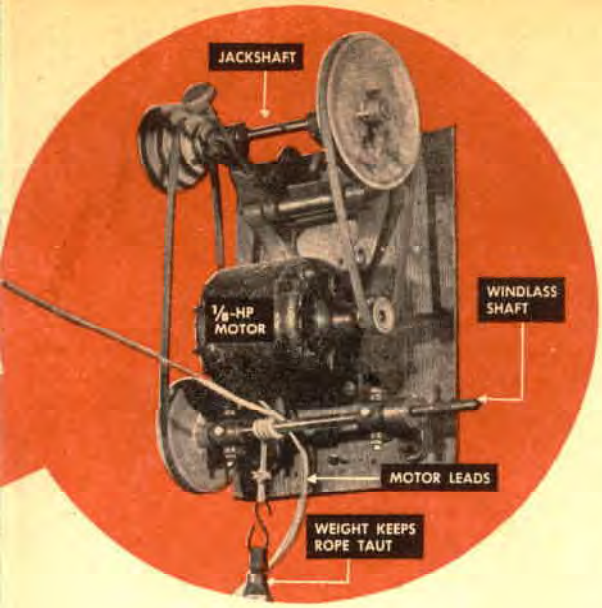
A steady light, or one of the wrong frequency, will agitate the resonant reed but won't swing it far enough to make contact.

Power unit. A ¾-hp. motor is the muscle that moves the doors. It's belted through a jackshaft to run an output shaft at about 175 r.p.m. Plain pillow blocks will serve instead of the adjustable jackshaft and self-aligning bearings shown.

The rope that pulls the doors is simply looped four times around the windlass shaft and tied to a weight that hangs close to the wall. This gives plenty of traction but will slip if something jams.

Door linkage. A piece of pipe set in


DOORS
LATCH
LATCH SPRING
RELEASE WIRE
DOOR
HINGE
PULLEY
TO WINDLASS
FIXED GUIDE BAR
ARM
BOLTS
ARM
SPRING
LARGE WASHER BENT
GUIDE BAR
LATCH
SPRING
GUIDE BAR (PIPE)
BRACE
RELEASE WIRE
PULLEY PIVOTS HERE
ROPE TO REAR ARM
REVERSING SWITCH
GUIDE
PUSH ROD
HOLE IN DOOR
PHOTOCELL



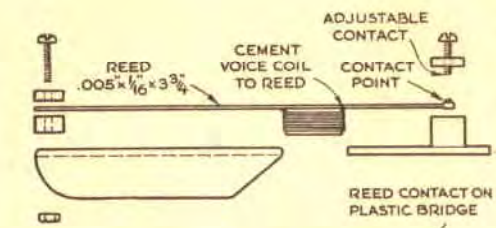
the center of the door lintel is fastened by an elbow and a short length of pipe to the garage ceiling. On this slide two large, loosely fitting washers bent to an angle along one side and bolted to wooden thrust arms.

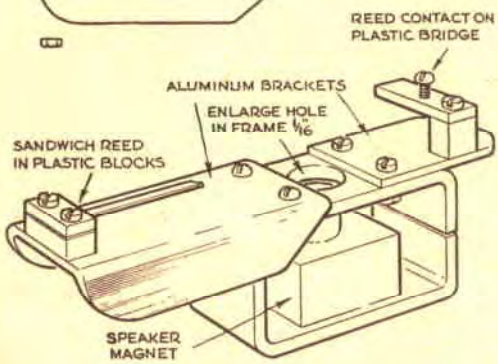
One washer necessarily slides behind the other. The rope from the power unit is fastened to the rear washer. As this is pulled forward, it pushes the other before it.

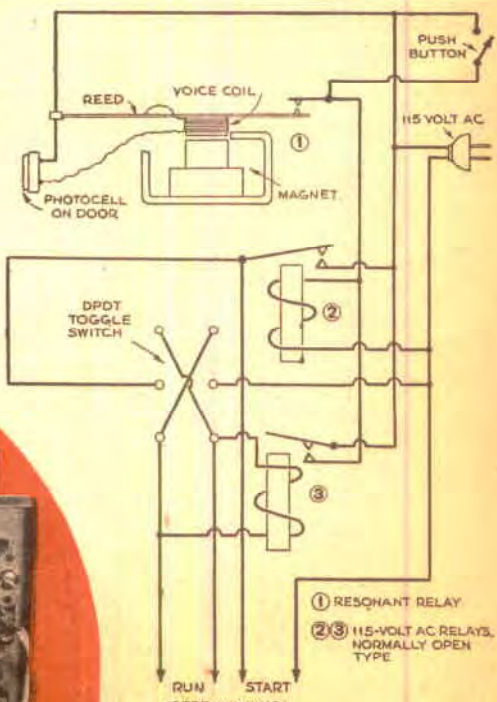
The wooden arms are pivoted on the doors by small hinges. A long spring holds the forward thrust arm back against the other thrust arm, so that the two move back together as the doors close. This spring is not powerful enough to drag the rope around the windlass and lift the weight. Thus the doors stay open until the motor reverses.

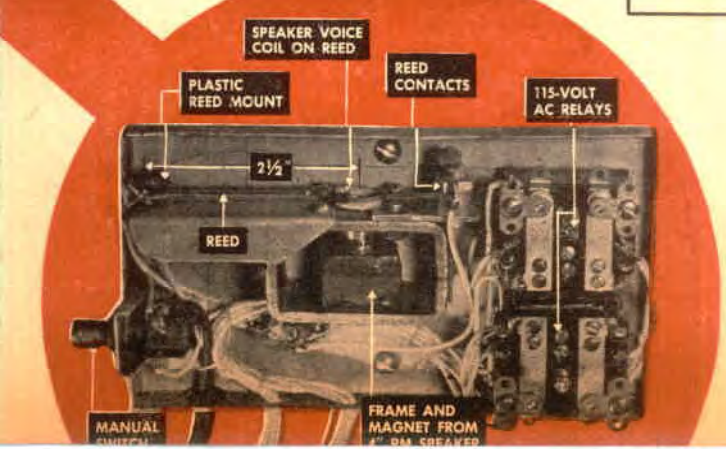
Any devices for holding the doors open must be removed. The center latch that secures one door shut is wired to a pivoted pulley over which the windlass rope runs. Being attached forward of the pivot point, the latch wire is tripped as soon as the rope pulls. A lock on the latched door enters a strike on the other, locking both.

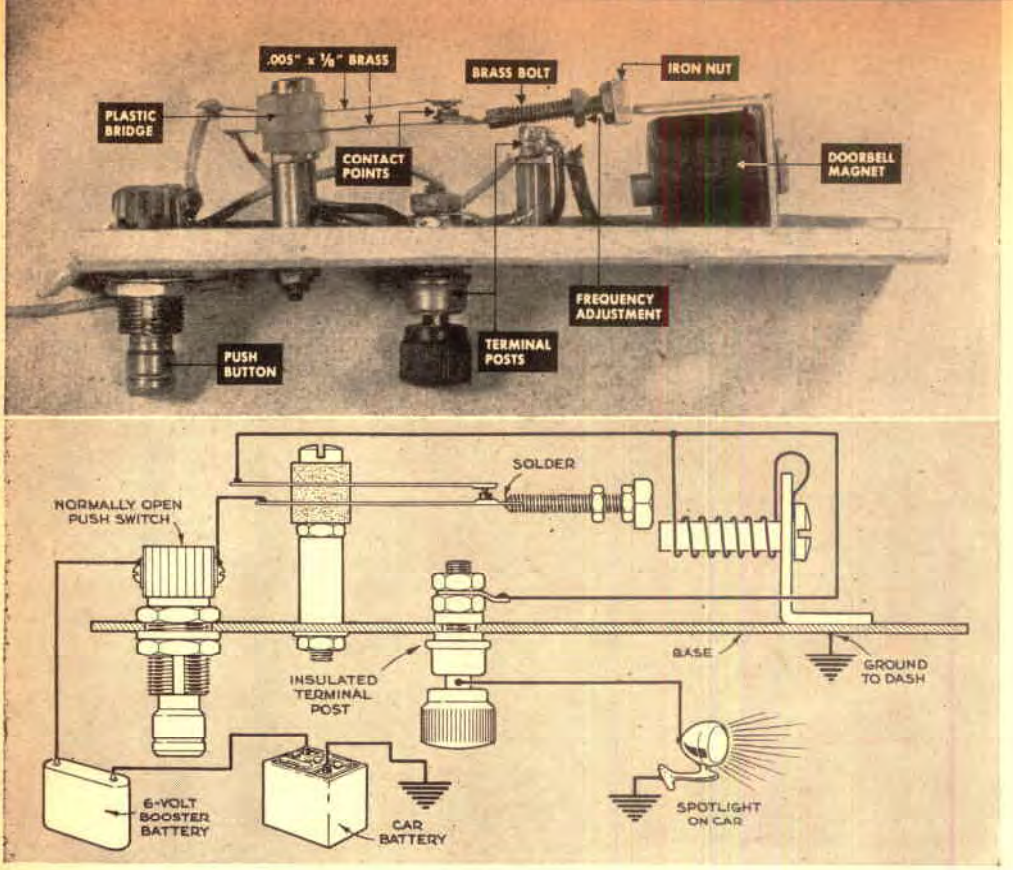
Reversing switch. This is a double-pole, double-throw toggle switch of a rating high enough to handle the motor current. It's mounted on the door jamb atop a box that also houses the photo cell.











A hole is drilled through the toggle arm parallel to its throw. A stiff wire through this is fitted with two stop collars and a spring, goes through a guide eye in the jamb, and is fastened to a small chain attached to the door. Proportion the wire and chain so that they snap the switch forward just before the door is wide open. This will stop the motor by opening the circuit for an instant, thus opening the power relay, and at the same time reverse it for the next half of the cycle. Set it so the door hits the end of the wire and flips the switch back just before it's fully closed.

Photo cell. This is an inexpensive selenium barrier-layer type, which generates a minute current when light strikes it. Bore a hole in the door for the light beam.

Spotlight blinker. This unit, which goes in the car, has a reed—a thin metal strip—that is vibrated by an electromagnet. Contacts on the reed open and close both spotlight and magnet circuits. The reed and its upper contact strip are sandwiched between plastic or fiber strips bridging two bolts. Contact points from an old relay or vibrator are soldered on. Adjust the reed, by turning the nut at its outer end, to vibrate six to eight times per second.

Since the spotlight current is intermittent, around 12 volts must be supplied to the 6-volt bulb to bring it up to full brilliance for exciting the photo cell. The easiest way to do this is to hook a 6-volt dry battery or four large dry cells in series with the car battery. The light is on only a second or two at a time, so they should have long life.

Resonant Relay. Triggered by photocell current, this is the control center in the garage. The permanent magnet of a junked 4" radio speaker was pried out of its bracket so that the bracket hole could be filed to a free fit for the voice coil. Then the magnet was cemented in place again. The reed itself forms one voice-coil connection; use fine wire for the other.

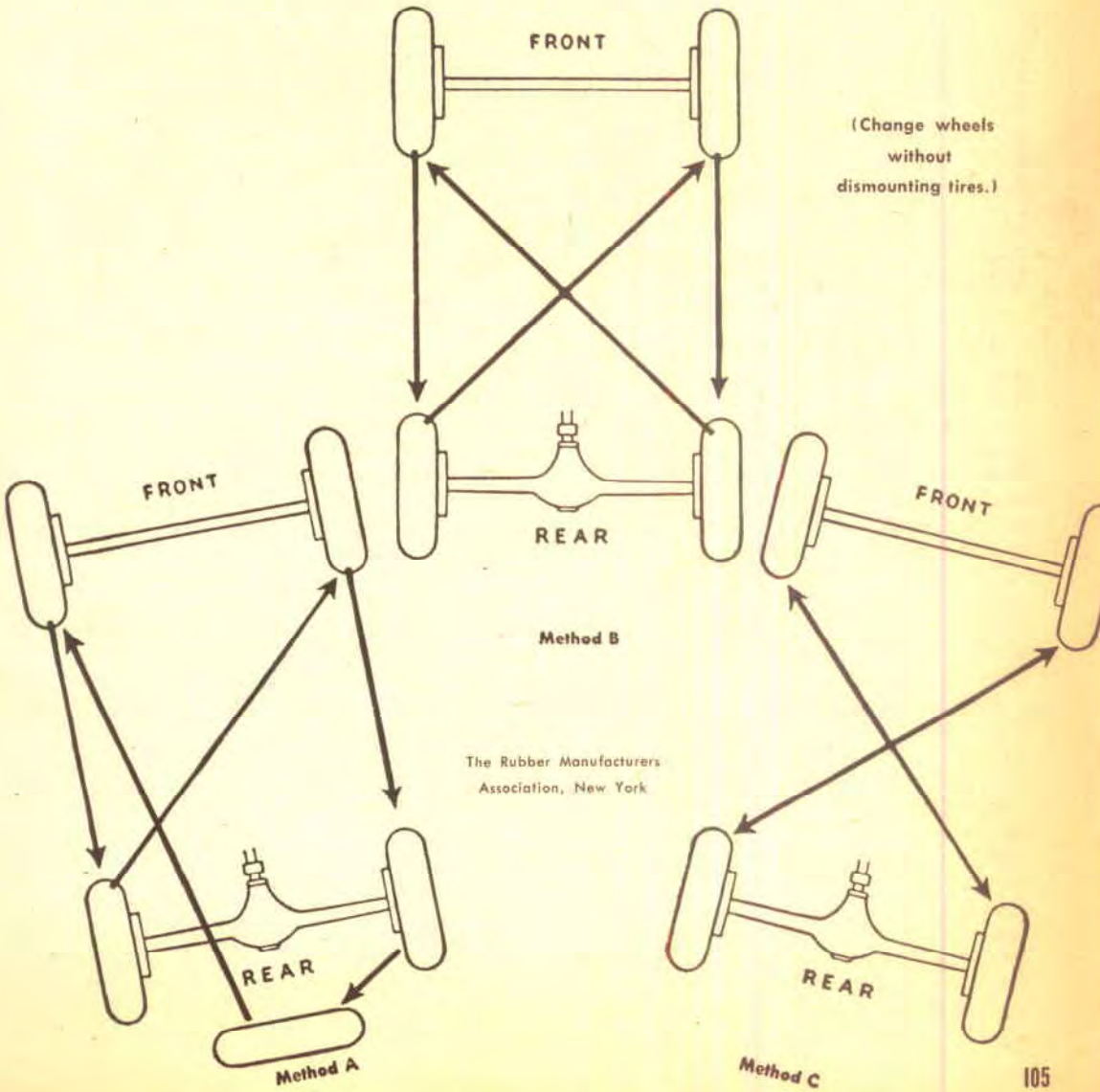
Adjust the reed to the same frequency as the blinker on the car by observing the reed in the spotlight beam, preferably at night, while tapping the reed with a finger. When in tune, the vibrating reed should appear still or nearly so because of the stroboscopic effect of the blinking light. Tune it by adding solder, or adjust the blinker reed.

Wiring. Remember the motor must turn to close the doors with the reversing switch flipped toward the door. Should you wire it backward, just loop the rope the other way on the windlass shaft.

You can adjust the resonant-relay contact so that the photo-cell current closes it in from a tenth to a full second. Half a second is about right. Closer adjustment may make the relay too sensitive to shock and vibration.

The reed contacts activate relay 2, which then sends current into the reversing switch. Besides starting the motor, this energizes relay 3, whose contacts shunt those of the reed and hold relay 2 shut after the reed stops. As the doors reach the end of their travel and flip the reversing switch over, the toggle throw cuts current to relay 3 momentarily, which opens relay 2, leaving all at a standstill until the resonant relay or garage button starts a new cycle. This button can be placed wherever convenient. END

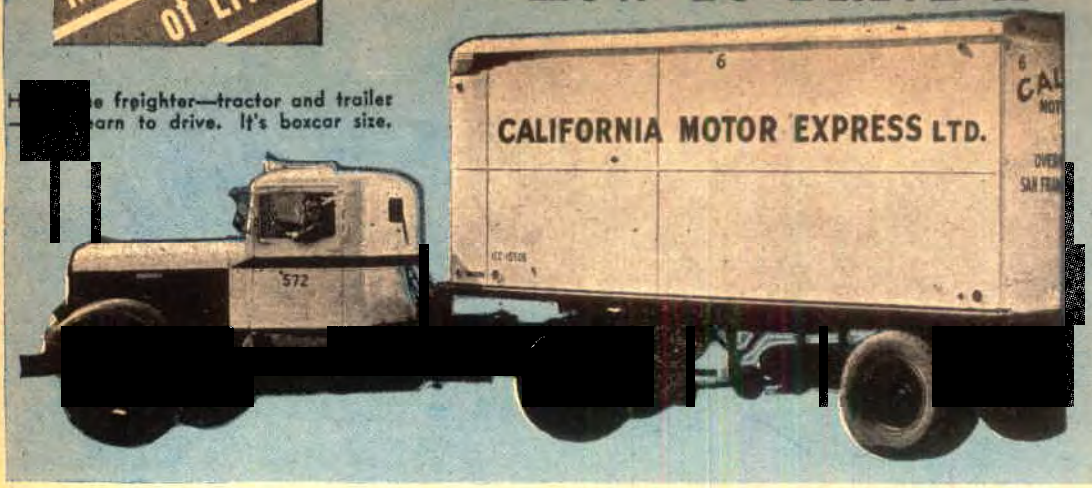
Three methods for rotating tires . . .



Mechanics of LIVING

HOW TO DRIVE A

H[redacted]e freighter—tractor and trailer [redacted]arn to drive. It's boxcar size.

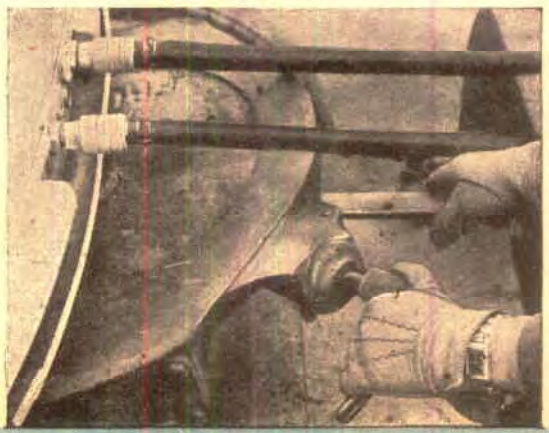


1. Our teacher is Edson Smith, twice world-driving champ. He checks warning flare to be sure it'll work. Rule No. 1: Inspect equipment.

2. Tractor's fifth wheel gets a good going over. It's the baby that carries the front end of the trailer. Tires, fuses, bulbs, brakes are also checked.

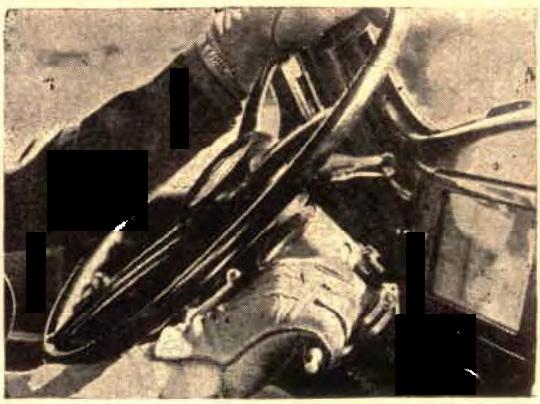
3. Next, hoses running from tractor to trailer's brakes are connected. This is a vital operation because load will run amuck unless all brakes hold.

4. Smith pulls auxiliary lever with right hand as his left jerks hook that drops fifth wheel. Next step is to hook up tractor and trailer.

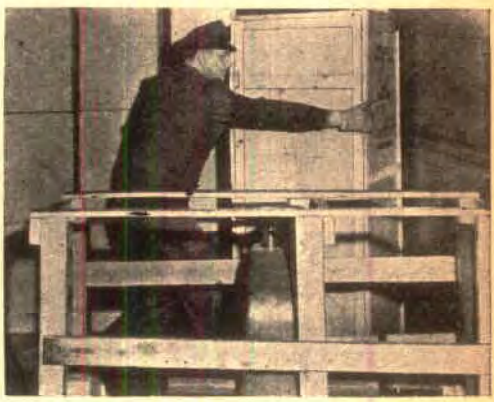


TEN-TON TRACTOR TRAILER

5. On the road. Smith is about to "take" the truck ahead. He looks into rear-view mirror, gives arm signal, eases to left, passes fast. When it's slippery chains are used on trailer and tractor wheels.

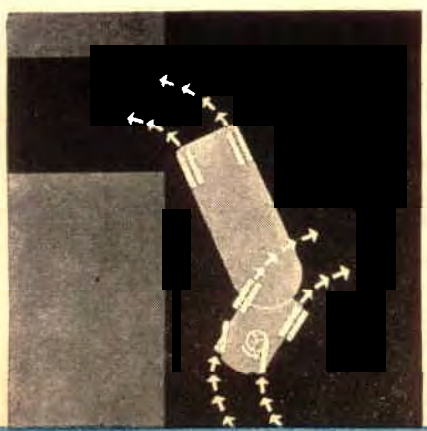


6. To stop, trailer brakes are hit first by pulling lever on steering wheel housing. If tractor brakes were applied first, trailer would fish-tail.

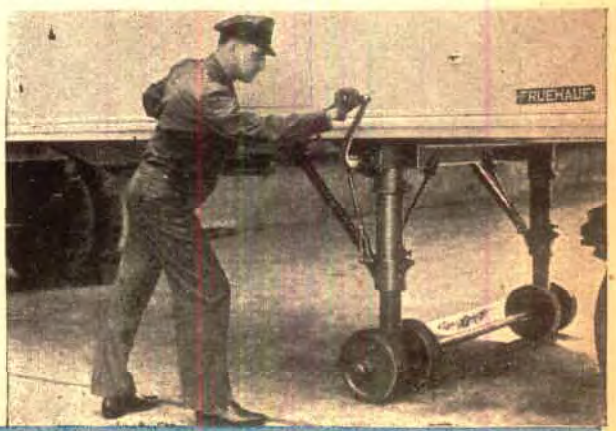


7. Now and then Smith stops and inspects his load. If it has shifted, he redistributes it. An unbalanced, shifting cargo could throw truck on curves.

8. Trip is over and Smith backs into unloading platform off narrow alley. Diagram shows how he stops ahead of target, backs with wheels cramped.



9. Before uncoupling, trailer's supports are cranked down. Huge freighters are seldom in accidents because their drivers know the safety rules.



How Dual-Fuels Pep Up Cars

By R. P. Stevenson

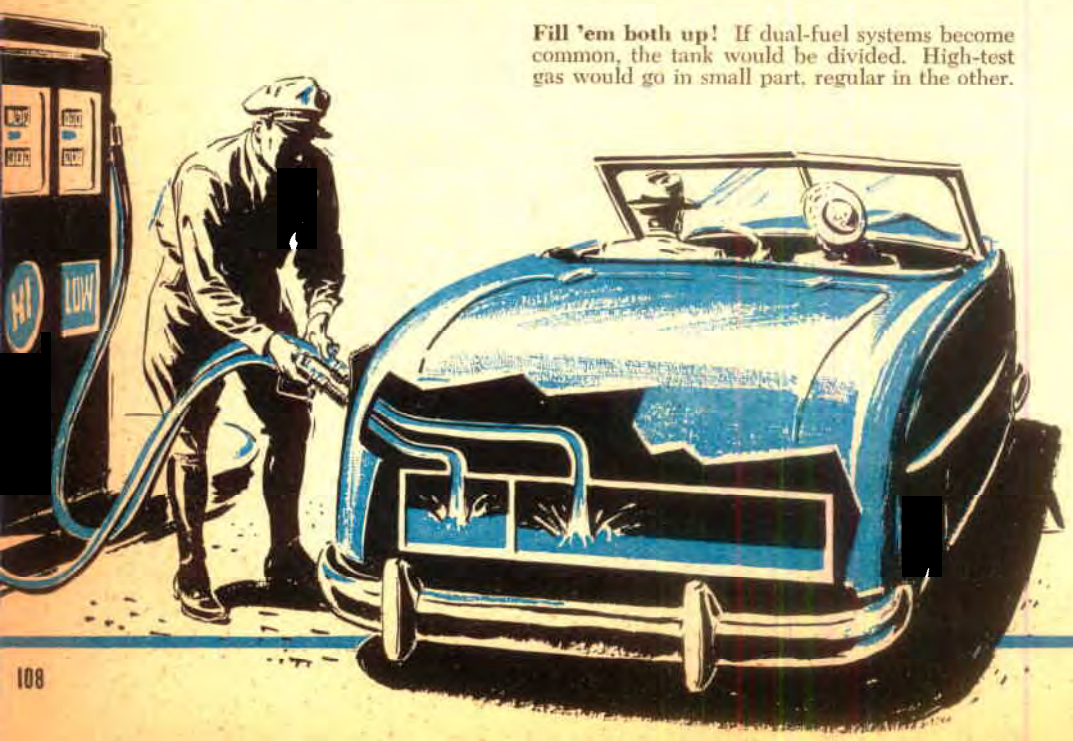
"Octane overdrives" save high-test gas by giving engines peak power only when needed.

YOU'VE been wasting gas. No matter how lean your mixture or how gently you tap the throttle, part of your gasoline dollar has been dribbling uselessly out of your exhaust pipe.

It's not your fault. It's simply that even the best auto engines now made don't take full advantage of the fuel you feed them. They need high-octane quality only a fraction of the time, yet they burn the extra quality all the time.

This wasted *quality* didn't matter when gas was cheap and quality was plentiful. But gas costs more and more. And increased demand—not only for gasoline, but for Diesel and fuel oils—has put a limit on the amount of high-test gas that can be made.

Auto engineers will tell you that engines with almost double present compression ratios are a very practical dream. They offer both efficiency and economy. But the trouble



Fill 'em both up! If dual-fuel systems become common, the tank would be divided. High-test gas would go in small part, regular in the other.

A two-bowl carburetor was developed for the dual-fuel experiments. Here it's installed on a Socony-Vacuum test car. A sheet-metal heat shield prevents vapor lock from exhaust heat.

Looking down on carburetor, you see low-octane inlet at right, the premium inlet above it at upper right. Below circular air horn is solenoid that helps change from one gas to other.

will be to get enough 100-octane to feed them. One such super-engine with a rumored ratio of 12 or 14 to 1 has already been cut to 9 to 1.

Any increase in compression above the present top ratio of 7 to 1 can't come too fast. In the past, it has cost the refining industry millions of dollars to add a single octane number to gasoline. Today costs are even higher. To boost production of premium gas above the present 85-octane also means more steel and crude production.

These are the conditions that have forced some brand-new thinking in automotive circles. Right now, refiners, carburetor and car makers, fleet operators, and others are testing developments ranging from dual-fuel systems to economy gadgets that can be hooked onto present cars.

Some of these developments will have to be engineered into cars not yet designed. Others are now in use in limited areas. All have one thing in common: a way of keeping an automobile on a low-calory diet by giving it a shot of pep only when pep is needed.

When you first start up, when you are going up hill, when you step out on the level —these are the only times your engine really needs the extra octane numbers it gulps all the time. Under average driving conditions, these peaks total only a fifth of the time the engine is running.

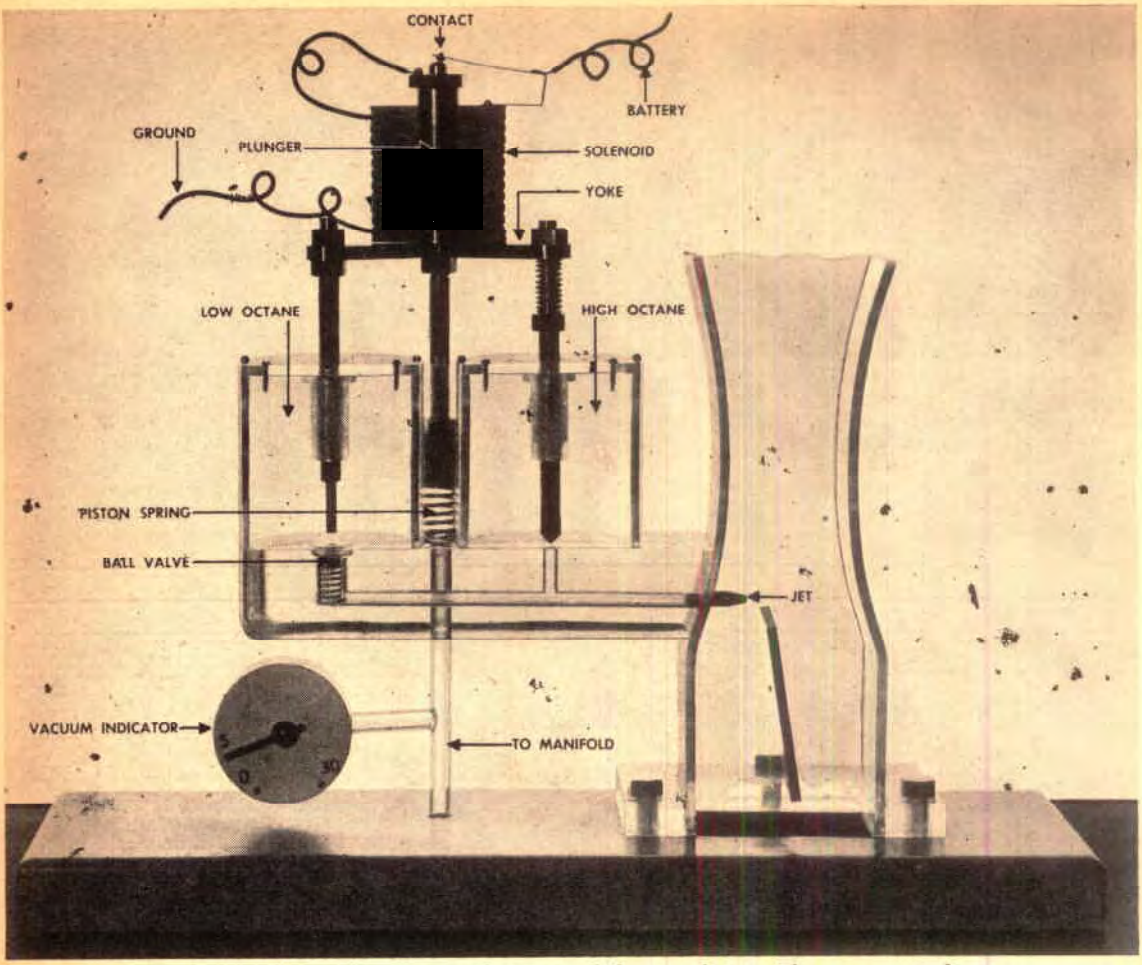
A dual-fuel system solves this problem automatically. You don't do anything but step on the gas. No push-pull, no switch-twist. The Socony-Vacuum experimental car I drove looked—and acted—like any other of the same make. But under the hood there were two complete gasoline systems, ending in a double-bowl carburetor that squirted high- or low-octane through a common jet.

Lights Tell What's Happening

Mounted on a special panel on the dash were two small lights, one green and one red, with a vacuum gauge between. The lights were wired so the green would glow when the engine was using low-octane, red when it was getting premium.

When the motor was started, the red lamp came on briefly, but soon gave way to the green. The red took another turn as I accelerated for the getaway—but not for long.

Very soon we again had the green light, the low-octane indicator, and it remained



This schematic model indicates basic parts of the two-bowl carburetor. An accelerating pump that feeds fuel from the high-octane bowl was omitted for simplicity. The vacuum indicator is merely for illustrative purposes. For operation of the carburetor, see the facing page.

shining as we drove a mile or so at normal cruising speeds.

Then I began putting the system through its paces. After slowing almost to a crawl, I abruptly stepped on the accelerator. The vacuum-gauge needle swung toward zero and the red light came on.

Alternately slowing and hitting the accelerator, I soon had the vacuum needle in a crazy dance and the red and green lights winking.

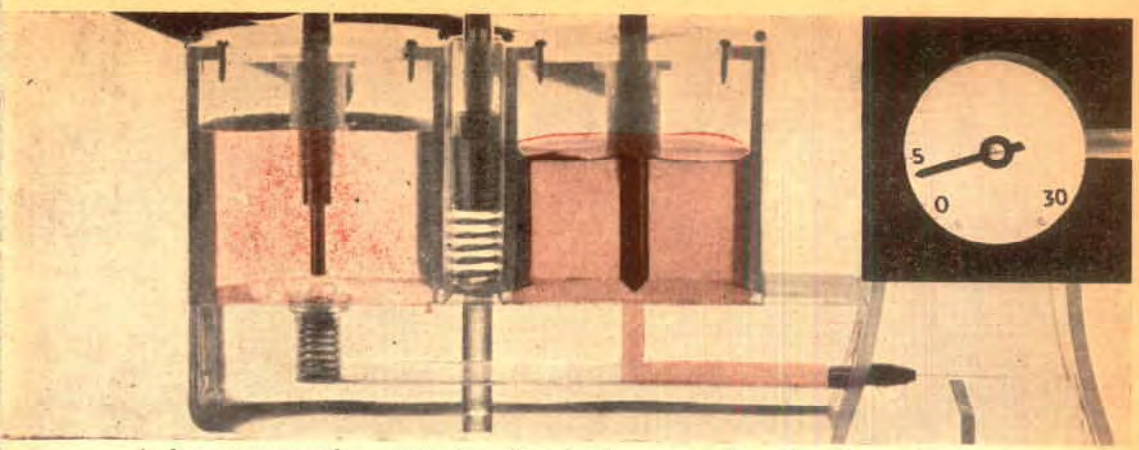
But the engine performed perfectly. When it demanded high-octane gas, it got it. When the lower grade was all it needed, the engine was satisfied. There was no confusing the system. It seemed almost human.

Both Socony-Vacuum and Ethyl Laboratories are experimenting with dual-fuel systems. Results will be turned over to the manufacturers for possible incorporation in the new models you'll be buying a few years from now.

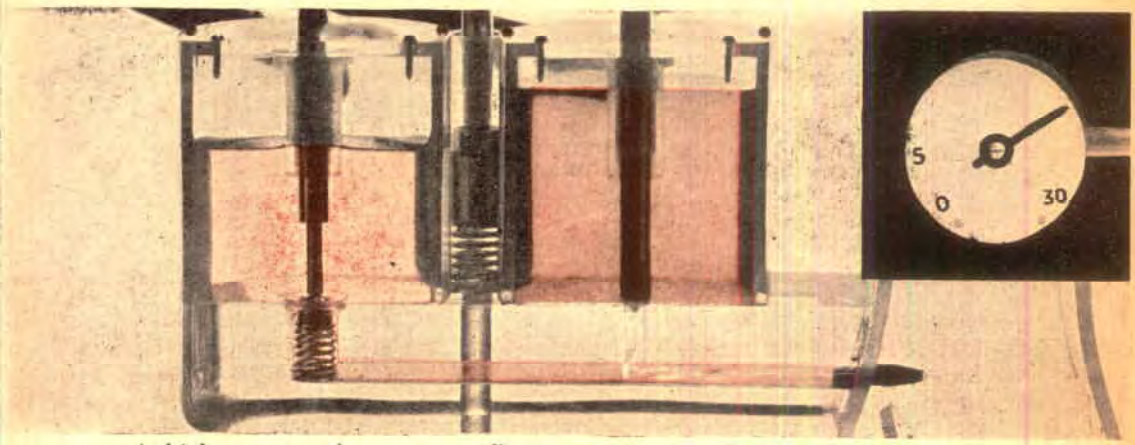
Eventually, if this program works out, you'll drive your new car up to a double pump. The attendant will stick two hoses into your double tank. And for every four gallons of ordinary gas a gallon of premium grade will be delivered.

The heart of the dual-fuel system is a double-bowl carburetor designed by Carter. Up to now, carburetors have been beautiful little machines for precisely measuring out the *quantity* of gasoline demanded by conditions. The new carburetor adds the new dimension of *quality*.

To illustrate the ingenious mechanism by



At low vacuum, when engine is pulling hard, spring has shoved up piston, plunger has closed solenoid contact, and this magnetized coil has snapped up the valve yoke. As shown above, this lets ball valve (left) close and opens needle valve (right). High-octane fuel now feeds engine.



At high vacuum, when engine is idling or running at part throttle, downward pull on piston has overcome spring, opening solenoid contact. Drawn by a second spring, the valve yoke has now dropped down. As shown, this shuts off high-octane (right) and admits the low (left).

which the carburetor shifts from one grade of gas to the other, POPULAR SCIENCE made and photographed an animated model of plastic and brass. Keep your eye on the pictures while we see just how this two-fisted fuel system works.

The changeover from one fuel to the other is instantaneous. A solenoid and a vacuum-operated piston, acting against a spring, do this part of the job. The tension of the spring determines at what manifold vacuum the change will take place. The manifold vacuum is low when the engine is working hard, and high when it is under no strain.

While the engine is stopped, there's of course no vacuum at all. This allows the spring to shove up the piston, closing a contact that leads to the solenoid.

As soon as the ignition is turned on, this solenoid is energized. It immediately draws up a metal plate, opening the high-octane valve and closing off the low-octane.

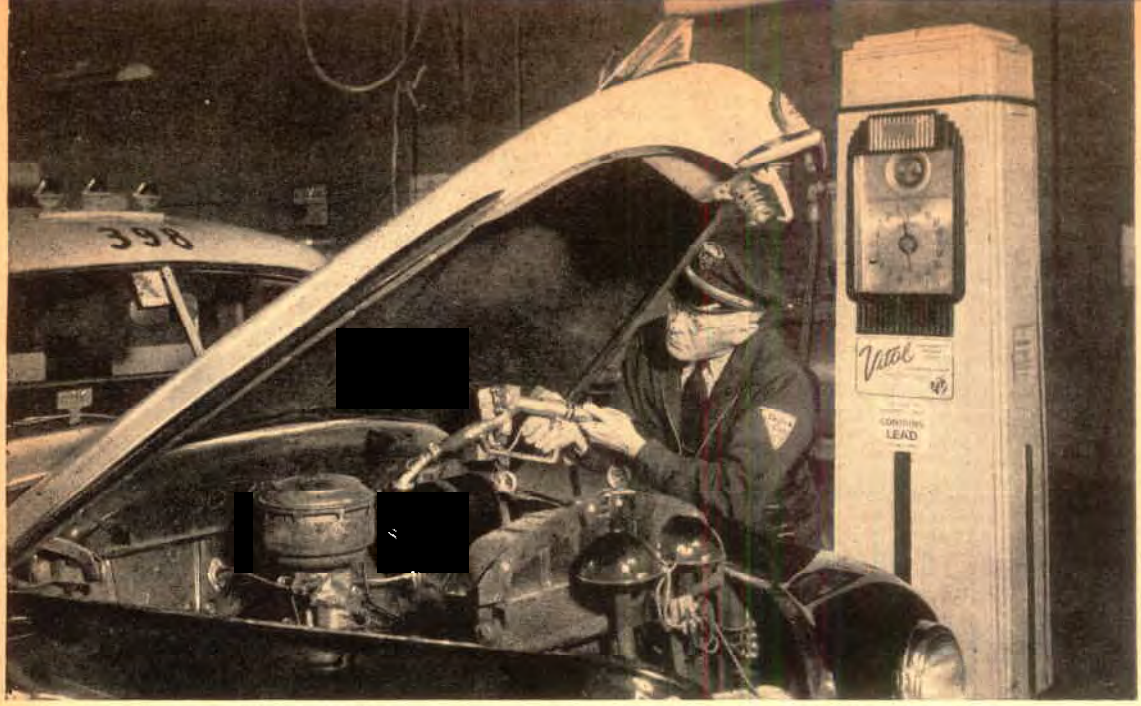
The engine starts and runs briefly on high-octane.

The predetermined changeover point is reached when the manifold vacuum pulls harder than the spring pushes. The piston is then drawn down, opening the low-octane valve and simultaneously closing the other.

During idle and part-throttle operation, the engine continues to use low-octane fuel.

Then perhaps you come to a steep hill—or step down hard on the accelerator for a quick pickup.

As the vacuum drops below the changeover point, the piston is pushed up by the



Water injection is another way of conserving gasoline quality. In Cleveland, Yellow Cabs are now making a wholesale test of the Vitameter Ⓣ, an injector developed by the Thompson Products Co. Above, the 5-qt. tank of a cab is being filled with Vitol Ⓣ, an alcohol-water solution that's used in the injector. You'll be able to buy antiknock Vitol soon at gasoline stations.

spring and closes the magnetic-coil contact. The low-octane valve closes and high-octane feeds to the engine.

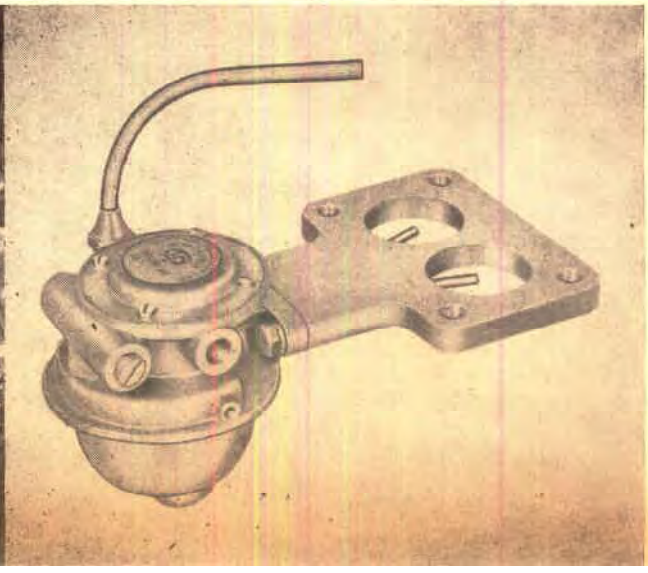
In Socony-Vacuum's test car, an electric pump delivers high-octane from a temporary tank, and the existing pump and tank are used for low-octane. In a production car, the dual-fuel system would have a double fuel pump.

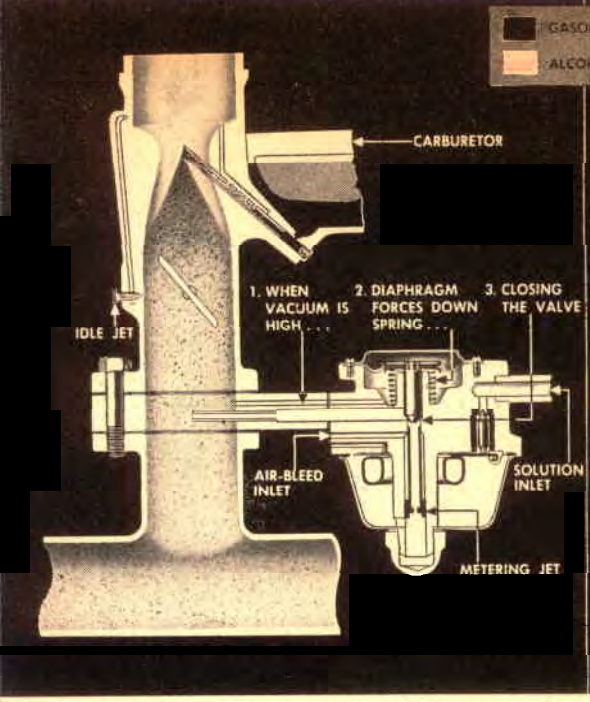
There's another way of shooting octane numbers into an engine for peak demands that is now being tried out. This method injects water or a water-alcohol solution into the fuel mixture.

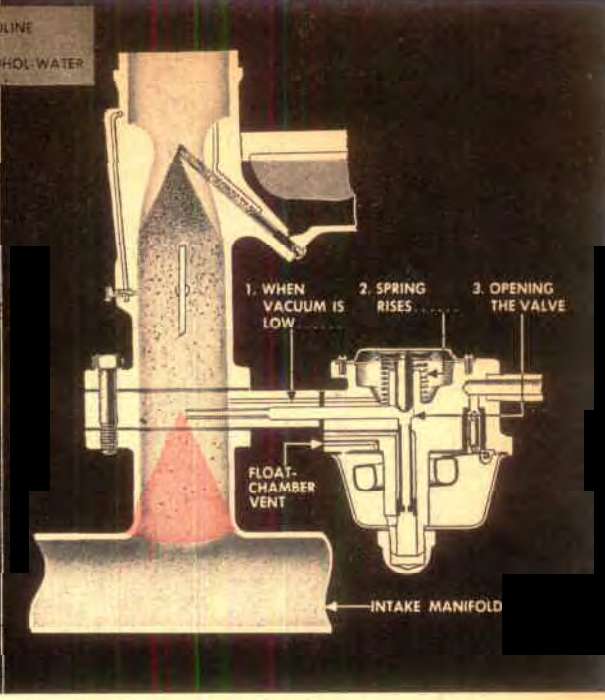
Since last April, Yellow Cabs have been running around Cleveland on 58-octane gas. Under their hoods is an injector flamboyantly named the Vitameter Ⓣ but engineered and manufactured by Cleveland's conservative Thompson Products—makers of valves and donor of aviation's Thompson Trophy.

It has long been known that a water-

Vitameters, right below, are mounted, as shown at left, by means of a flange that fits between the carburetor and intake manifold. Notice the filter bowl in the line running from solution tank.







How Vitameter works. Manifold vacuum determines when injection will occur. You've often noticed that a windshield wiper slows down or stops when vacuum drops during times of full throttle. At these periods, the engine needs injection to prevent knocking. Because vacuum is low, the spring can open the valve. Spring tension is adjustable for different engines.

moistened fuel mixture gives an engine more pep. You've probably noticed this on rainy days, when the air that mixes with the fuel is moisture laden.

By keeping down the temperature of the explosive mixture, injected water promotes a more even explosion and prevents detonation—the annoying knocking or pinging that comes from your engine when it's pulling hard.

With injection, you can use lower-octane gas and still have no knocking. That's why the Cleveland cabs get by with a gas that stands at only 58 in the octane scale.

Gives Pep When Needed

The Thompson Vitameter is engineered to inject a water-alcohol solution only when your engine needs the pep this injection can give. In effect, it is another carburetor. Anti-knock fluid, held in a float bowl, is metered into the air-fuel mixture as needed. Once again, it's the intake manifold vacuum that determines when injection will occur.

If the engine is idling or operating at low throttle, high manifold vacuum closes the main valve and no fluid flows. As the throttle is opened wider, a diaphragm spring overcomes the slight force then exerted by the low manifold vacuum. The valve opens, allowing fluid to be injected. The point at which this occurs can be varied by adjusting the spring tension. Interchangeable jets of different sizes regulate the amount injected.

Thompson engineers report that injection has the effect of adding 10 to 20 octane numbers to the fuel that's being used. This opens up three interesting possibilities.

How Injector Can Be Used

When the proposed new high-compression engines appear, you could install a Vitameter and still use the present premium gas. This was demonstrated at a recent meeting of the Society of Automotive Engineers. The engine of the demonstration car had been souped up to a 9-to-1 compression. Normally, it would have required 100-octane fuel for knock-free performance. Yet with the Vitameter it showed no detonation on premium gas of about 85-octane.

Or take the case of a current car that requires premium gas. By installing an injector, you could use the more economical regular grade and raise its 76-octane rating well above the premium level. Besides economizing on gas, you would get all the other advantages claimed for injection.

Again, if your car operates satisfactorily

on regular gas, you could install an injector and use a fuel of still lower octane rating. This means little to the average motorist, since refiners agree that it would be economically unfeasible to make a third grade of gas available at all service stations. But commercial fleets could buy third-grade fuel in tank-truck lots.

In fact, the Thompson company proposes that the big refiners supply fleet operators a special low-octane, straight-run gasoline to be known as Vitane Ⓣ. That's what the Cleveland cabs are using. Such gasoline can be produced at considerably less cost than cracked, blended, or reformed fuel—the type now available at gas stations.

Special Fluid Prevents Knocking

It's expected that gasoline stations will handle a special antiknock fluid to be used in the Vitameter. This will sell by the quart at about the price you pay for motor oil.

Called Vitol Ⓣ, the fluid consists of about 85 percent alcohol, 15 percent water, with 3 cc. of tetraethyl lead per gallon. It also has an inhibitor to keep rust from forming in the carburetion system.

Vitameters and Vitol will be available for passenger cars this year in part of Ohio. The territory will expand from there as rapidly as a supply of Vitol and service instructions can be made available. For most of the United States, this may not be before late in 1949.

Road tests in recent years have revealed some surprising results concerning octane requirements at different speeds and throttle openings. Both the Vitameter and dual-fuel system are based on these results.

Here's an example:

With the spark set for maximum economy, the experimenters found that fuels of only 20 to 30 octane number gave knock-free operations at low speeds on level roads.

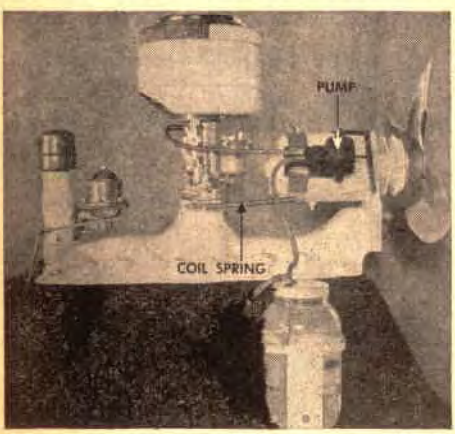
Even at 60 miles an hour at half-open throttles, a 45-octane gas was satisfactory. But for so-called "full-throttle" conditions —starting, hill climbing, and top speeds— the same car had to be given a 75- to 85-octane gas for satisfactory performance.

Dual-fuels are still in the experimental stage. Before they become a part of the package of transportation called "your car," they will have to meet the standards of volume production. The last hurdle will be, as always, testing in use by the public.

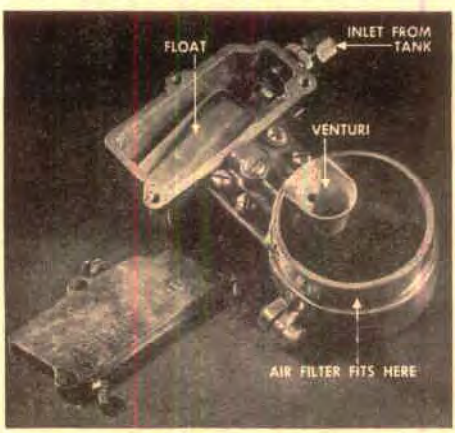
But as compression ratios creep upward, the need to conserve the limited octane numbers in every barrel of crude will push the development of dual-fuels.

You may be saying, "Fill them both up!" sooner than you think. END

Injectors on Market Give Power as Needed

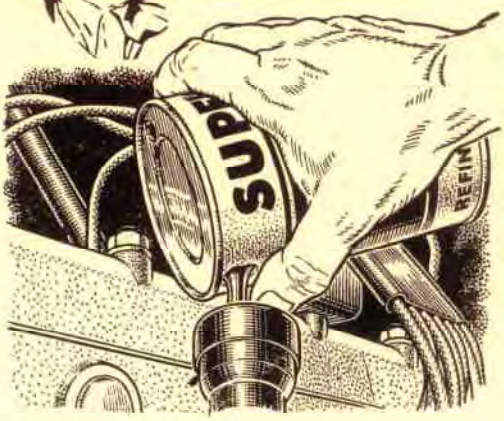


Hydro-Jector Ⓣ. Made by Associated Laboratories, Cleveland, it pumps a shot of water into carburetor each time you press gas pedal. If you then keep pedal steady, a coil spring, linked to throttle, relaxes in a few seconds and injection stops.

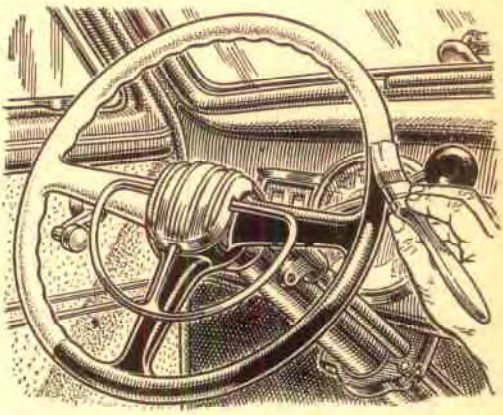


Octa-Gane Ⓣ. A product of Continental Carburetion, Richmond, Calif., it works like a carburetor. A collar fits between the air filter and carburetor, bringing the Venturi within the air stream. Water feeds in proportion to air-stream speed.

Hints from the Model Garage

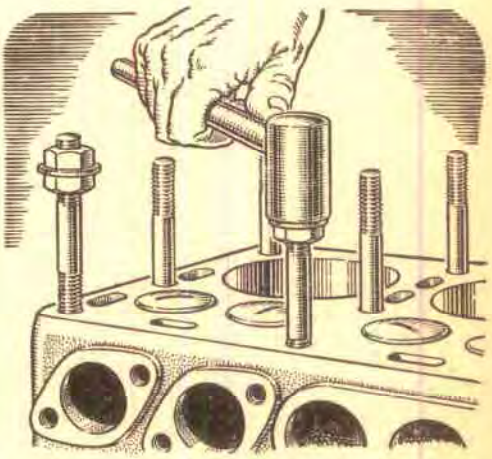


Where's the Funnel? If you can't find it, pour oil in the crankcase this way. Punch one hole in the top of the can and another in the side just under the top rim. Keep a finger over the side hole until it's in position over the inlet.



Refinishing Steering Wheel. Model-airplane dope is better than most paints for refinishing a steering wheel that tends to blacken your hands. It dries hard in a few minutes and is not affected by perspiration as paint may be.

High-Beam Indicator for Old Cars. If your car is an older model not fitted with a high-beam headlight indicator, you can quickly remedy the situation. R. L. Parmenter, of Middleboro, Mass., did the job as shown. Ground one of the lamp terminals. Drill a 1/16" hole through the dash ahead of the lamp and fill it with red nail polish. A fiber shield fitted around the lamp keeps light from showing on the floor.



Two Nuts Tighten Stud. This variation of the old two-nut trick makes it possible to use a socket wrench in reseating studs in an engine block. The washer between the two nuts keeps the wrench from slipping down over the lower one. After the stud has been seated by turning the top nut, the nuts are released by first turning down the lower one with an open-end wrench. This keeps the stud from loosening.

When Your Car Won't Start... What Would You Do?

Simple Screwdriver Tests Following a Systematic Procedure Will Help in Spotting the Trouble When You Are Stuck on the Road

WHEN you are out on the road, with no service station or telephone near, and your car stalls, what can you do? If you have a screwdriver and a little automobile sense, you can do a lot. You can also do a lot with these two things right in your own garage if your car stalls there. And even if you discover that the trouble is something that you aren't equipped to fix yourself, you can at least give the shop mechanic the proper clue and be sure that he brings the necessary parts to get you off in a hurry.

The chances are that the trouble will be in the fuel system or the ignition, most likely in the latter. With the ignition switch turned on, you can tell immediately whether you have gas in your tank, for the gas-gauge needle should register. If you have gas, take a look at the ammeter. Its needle will show a slight discharge, which is proper; it may swing completely over to show a full discharge; or it may show no discharge at all.

Turn off the ignition switch quickly if the needle shows full discharge, for that is a sign of a ground between the switch and the coil, and it could burn off the insulation. Search out the ground and repair it. If the needle shows no discharge, it could mean a dead battery or that the breaker points in the distributor are open, or it may just be stuck.

When the ammeter needle shows a slight discharge, it indicates that current is flowing. You will already have tried your starter; that's how you know you are stalled. But step on it again, and this time note whether the engine turns over freely, for if it does, then both the battery and starter are functioning properly. If the starter is sluggish, however, it may be because of a weak or defective battery, or the battery terminals may be loose, corroded, or dirty. It also may be caused by a mechanical failure in the starter or starter switch, or by a broken cylinder-head gasket that has allowed water to seep into one of the cylinders.

To determine what part of the starter circuit is at fault, turn on the light switch and step on the starter again. If lights go out or become dim, the trouble is probably in the battery or its connections. Clean and tighten the battery connections and the cable terminals, and replace any doubtful-looking cable if you have a spare one. The battery itself may be tested with either a hydrometer or a voltmeter if one of these is available. A hydrometer reading should indicate better than 1.250 specific gravity for a battery that is in good condition, while a voltmeter reading taken across the positive and negative posts should indicate about six volts, or close to whatever the voltage of your system happens to be.

If the lights remain bright when the starter button is pressed, the trouble may be between the battery and the starter, or the starter switch may be at fault. Try the connections in this part of the circuit first. If they are clean and tight, look for the disorder in the starter or the starter switch.

Should the ammeter needle refuse to budge when you step on the starter, there is no current flowing. This may mean that the breaker points in the distributor have been burned or that there is a loose or broken low-voltage wire or connection between the distributor and the ammeter. With a screwdriver, ground the low-tension wire at the distributor terminal. If you don't get a spark with this test, the current is cut off somewhere in the connections leading back to the ammeter. Working backward, ground each of these connections with the screwdriver until you come to one where

you do get a spark. The trouble will lie at this connection or between it and the distributor.

If you get the spark at the distributor terminal, it is an indication that current is flowing at least that far, and it is usually a safe bet that the fault will be found in the distributor—most likely the breaker points will be burned or dirty. Take off the distributor cap and check the condenser terminal and the condenser hold-down screw for tightness; then examine the condenser lead wire for a break. Should these things be found in good condition, open and close the breaker points and watch for a spark. If you fail to get one, the points must be cleaned and adjusted.

This cleaning can be done effectively enough in an emergency with the abrasive strip from a paper of matches, with a knife blade, with the sharp edge of the screwdriver, or with anything else convenient that you can use to scrape the scale from the contact faces. If you have no gauge for setting the gap, a quick adjustment can be made by using a piece of newspaper folded into four layers. This thickness will be about .020", which is the approximate gap setting for most distributors.

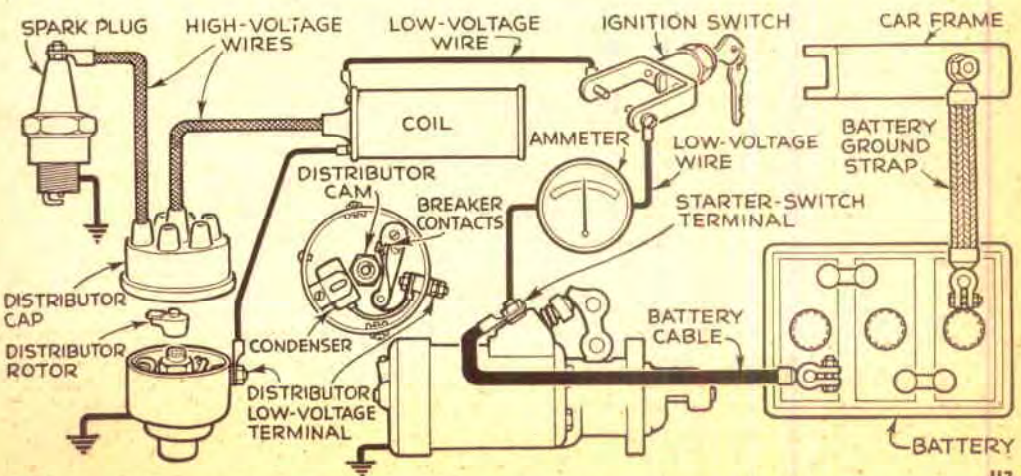
Suppose, when you stepped on the starter, the ammeter showed a discharge of from 3 to 5 amp. and the needle fluctuated rhythmically. This 3 to 5 amp. is the normal current the ignition coil draws, and fluctuation of the ammeter needle, which is caused by the opening and closing of the points, indicates that current is getting to the points. Should the ammeter register between 3 and 5 amp. but remain motionless when the engine is turning, start looking for a short somewhere in the distributor or the low-voltage lead connected to the coil.

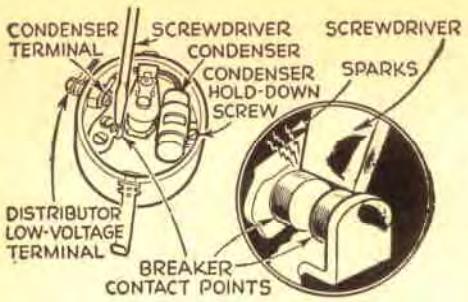
There is a good chance that the short will be in the condenser, so check this first by inserting a piece of paper between the breaker points to keep the current from flowing to the ground. The ammeter needle should return to zero if the condenser is good. If the needle still registers, take out the condenser hold-down screw and move the condenser away from the distributor. Should the needle now return to zero, the condenser is shorted and the current is leaking through its insulation. Unless he has been forehanded enough to take along a new condenser, there is not much that the average motorist can do about this except to thumb a ride or start walking to the nearest service station or telephone.

Another way of checking for a defective condenser is to examine the breaker points. If the contacts show a distinct blue tinge with a hard scale on the surfaces, the condenser is leaking. To check further, crank the engine until the breaker points open; then turn on the ignition switch and bridge the points with a clean screwdriver blade. If there are no sparks, the condenser is defective. For further proof, disconnect the condenser wire and again bridge the points with the screwdriver. If the screwdriver does draw sparks this time, it is a sign that the defect is in the condenser.

Should the ammeter-starter test prove O.K., that is, the needle show a discharge of from 3 to 5 amp. and fluctuate when you press on the starter button, there still may be trouble in the ignition system, or there

WHERE TO TRACE FOR A BREAK IN AN AUTO IGNITION SYSTEM





Sparking should occur when the breaker points are bridged with a screwdriver. If the condenser is leaking, you will not be able to get a spark

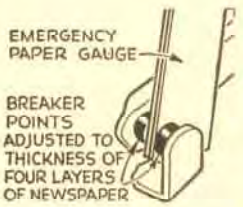
may be a stoppage in the fuel system. Look into the high-voltage circuit first. Remove the wire from one of the spark plugs and have someone press on the starter button for you; then, while the engine is cranking, hold the terminal of the wire ¼" to ⅜" from the engine or spark-plug base. If you get a fat spark that readily jumps the gap, the trouble is in the spark plugs or in the fuel system.

Before going any further, wipe the outside of the plugs to remove any dirt or dampness that would short-circuit the high-tension current, and then try to start the engine again. Should it still fail to start, remove one of the plugs. If the plug is wet around the base, it is an indication that the fuel system is all right and, naturally, that the spark plugs are at fault. Remove all of the plugs, clean them, and set the gaps. An emergency adjustment for this last can be made by folding a piece of newspaper into five layers for use as a gauge. Always bend the side electrode, never the center one, when changing the gap, as there is danger of breaking the insulation.

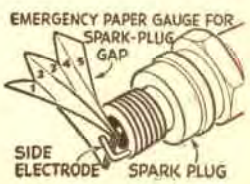
If the spark plug you first examine is dry at the base, check the fuel system. A quick test can be made by simply removing the air cleaner and looking down into the carburetor throat while the throttle is jiggled back and forth. If there is fuel in the carburetor, the accelerating pump will push gas through the pump jet, and the choke valve should then be checked. This valve should be closed when the engine is cold. If fuel is reaching the carburetor and the choke won't close, the engine can be started by covering the carburetor throat with your hand to prevent the entering of air while the engine is cranking. Don't choke this way after the motor catches; the vacuum created can injure your hand severely. Try priming the carburetor if you have one you can't see into. If the motor then catches but stalls again, fuel isn't getting into the carburetor.

Operation of the fuel pump is checked by disconnecting one end of the fuel line from the pump to the carburetor and cranking the engine. Fuel will spurt out of the line if the pump is working. If it doesn't, check for clogging in the line from the tank to the pump before putting the blame on the pump. Disconnect the line at the inlet side of the pump, remove the tank cap, and blow through the line. There should be a gurgling sound from the gas tank if the line is open. Be sure in addition that the air valve, or the tank-cap pinhole, which permits air to enter the tank as fuel is drawn out, is functioning properly.

If the pump seems at fault, remove the sediment bowl and clean the screen; then replace them, being sure that you have an airtight fit. Use a new bowl gasket, if possible, because it is sometimes difficult to get an airtight fit with an old one. If you have no new gasket at hand and the bowl won't fill up after being replaced, you can swell the old cork gasket by heating it with a match, but take care that you do not set it afire. Should the pump still refuse to function, it will have to be removed and repaired—unless you have been forehanded enough to carry a spare pump or diaphragm.

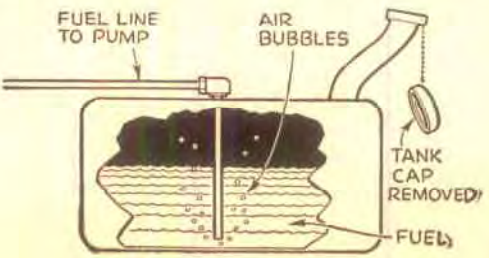


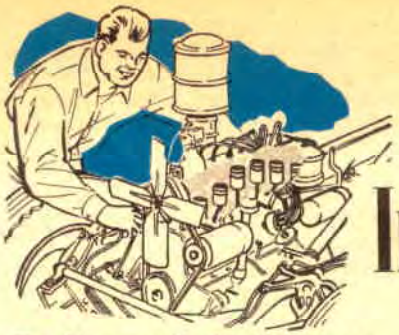
Folded newspaper forms a .020" thickness gauge that is near enough for setting a distributor gap



Newspaper is also used for emergency setting of spark-plug gaps. Bend only the side electrode in making the adjustment

Stoppage in a gas line is found by disconnecting the line at the pump and then blowing through it. Gurgling will be heard at the tank if it is clear





Seeing What Goes On Inside Your Car Engine

By Kenneth M. Swezey

BEHIND all the complicated mechanisms under the hood, in the chassis, and on the dashboard of your car lie simple and fundamental principles of physics, mechanics, chemistry, and electricity. Some of these were discovered hundreds or even thousands of years ago by such pioneers as Aristotle, Archimedes, Newton, Faraday, and Bernoulli. Many can be demonstrated dramatically in experiments you can perform in your own home.

On this and the next two pages, POPULAR SCIENCE shows you a few simple demonstrations of basic automobile principles that father and son—or even the whole family—might enjoy performing together. Your laboratory can be the kitchen or rumpus room; your apparatus such things as soda straws and tumblers, candles, and tin cans.

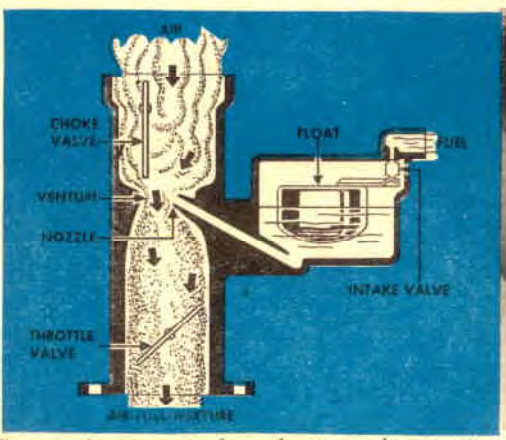
Let's start by looking inside the carburetor. With two halves of a soda straw and a glass of water, you can show how air streaming through this device lifts gasoline, scatters it as vapor, and mixes it with air.

After flattening one end of each straw, stand one in water and hold the other horizontally, flattened ends together. Now blow strongly through the horizontal straw, aiming the air across the tip of the other. Water will climb up in the vertical straw and spray out.

The secret? Daniel Bernoulli, famous Swiss scientist, discovered it more than 200 years ago. Increase the velocity of a fluid (such as air or water), and the pressure inside that fluid will be *decreased*.

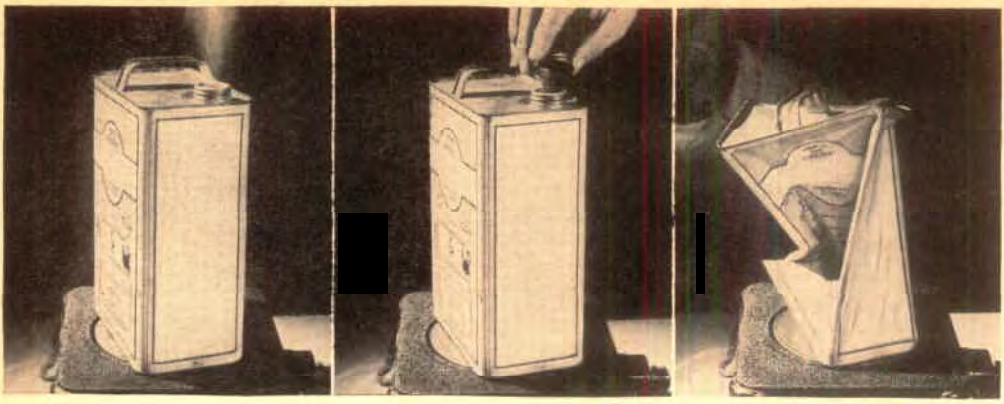
According to this principle, air speeding over the tip of the vertical straw is at a lower pressure than that of the still atmosphere. Since the atmospheric pressure on the water in the glass is greater than the pressure at the tip of the straw, water is pushed up into the air stream.

For some other unusual demonstrations of auto principles, turn the page.

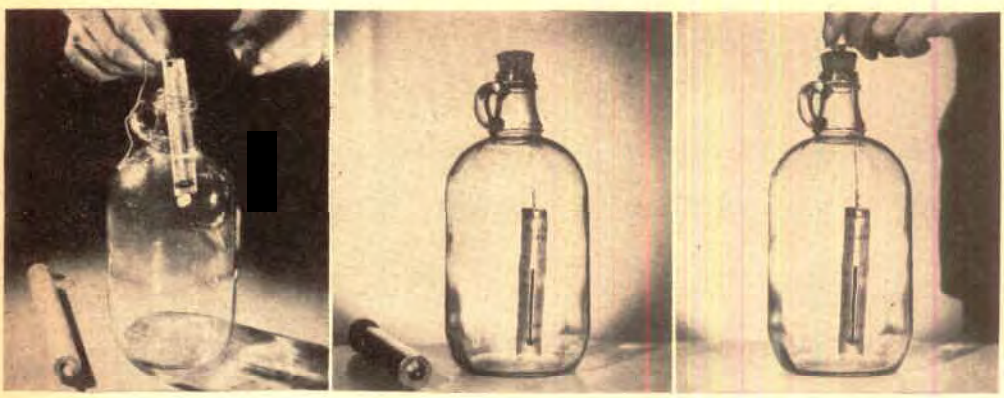


In a carburetor, air from the atmosphere must pass through a constricted tube, or "venturi," to reach the engine. This constriction speeds up the air, and the suction it creates pulls droplets of fuel from the nozzle. The mixture of air and vaporized fuel is highly explosive.

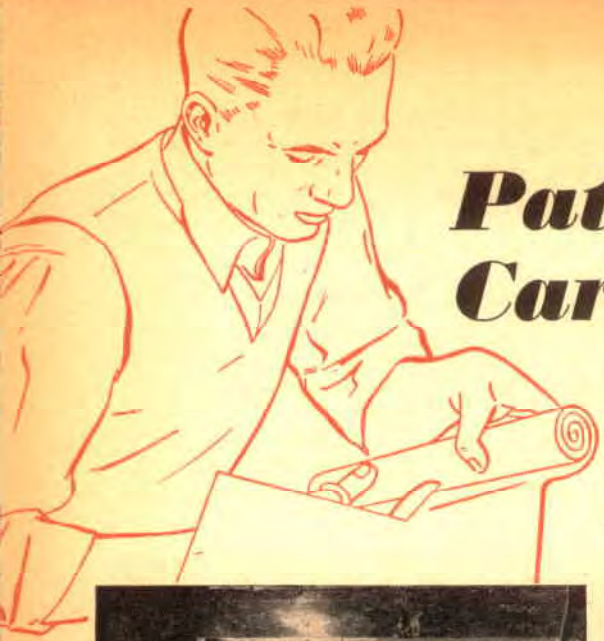
The venturi principle is shown graphically by this simple experiment. Air speeding across tip of vertical straw causes water to rise in it, emerge, and be sprayed out. Gasoline is similarly raised and vaporized. It's then ready to enter cylinder, as on next page.



INTAKE To give power to your car, its engine repeats over and over the four-stroke cycle shown in the diagrams on these two pages. On the intake stroke, the cylinder is filled with the gas-air mixture from the carburetor. From a design standpoint, the big problem is to supply enough air. In fact, a big roomful of air must be crammed into the cylinders for each gallon of gas. Atmospheric pressure of nearly 15 lb. per square inch does the trick. You can demonstrate this pressure. Put a half inch of water in a flat-sided gallon can and boil rapidly. Remove from the heat and cap quickly. The steam inside condenses and internal pressure drops rapidly, leaving the can unsupported. Then tremendous outside pressure crumples it.

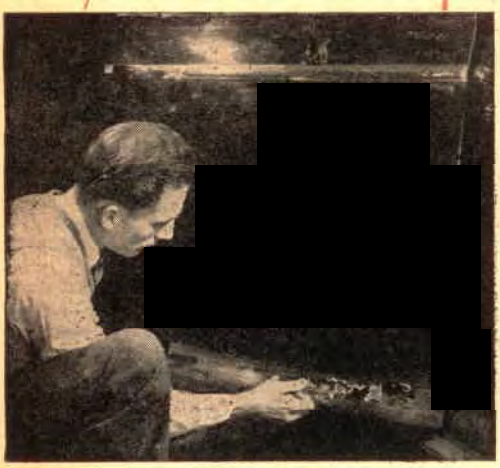


COMPRESSION Although gas and air will burn at atmospheric pressure, more power results if the mixture is squeezed by a compression stroke. Theoretically, the greater the squeeze the more the power. Practically, the amount is limited by the tendency of gasoline to explode prematurely from the heat of compression. Such premature explosions are one cause of "knocking." That gases heat when compressed can be shown by suspending a thermometer in a half-gallon jug and squeezing the air in the jug. Note the normal temperature first, then insert a bicycle-pump nozzle through the stopper. Pump about 15 strokes. (No more, or you may blow out the cork or break the jug.) The mercury will climb a degree or two.

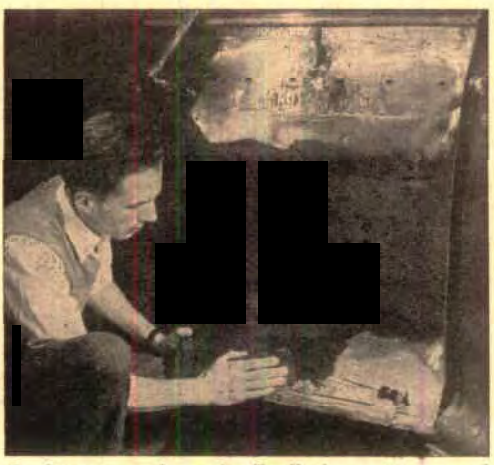


Patch Up Your Car with Cloth

COTTON cloth impregnated with plastic offers an easy way to cover rusted or broken-metal areas in the fenders and body of your car. Already being used by a number of repair shops, the procedure is so simple that any handy man can do a good

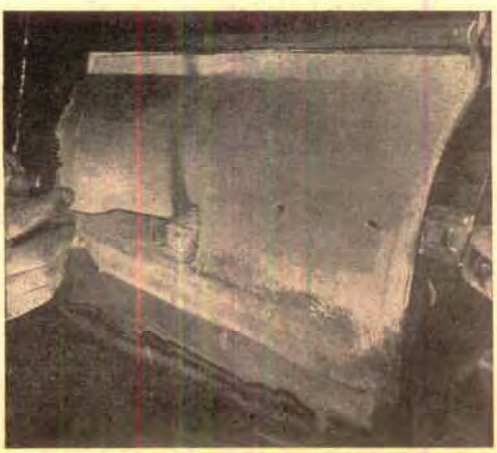


1. Here's the problem. Rust has eaten away the metal to such an extent that it breaks or you may poke a finger through it. This looks like a shop job—but you can do it yourself.

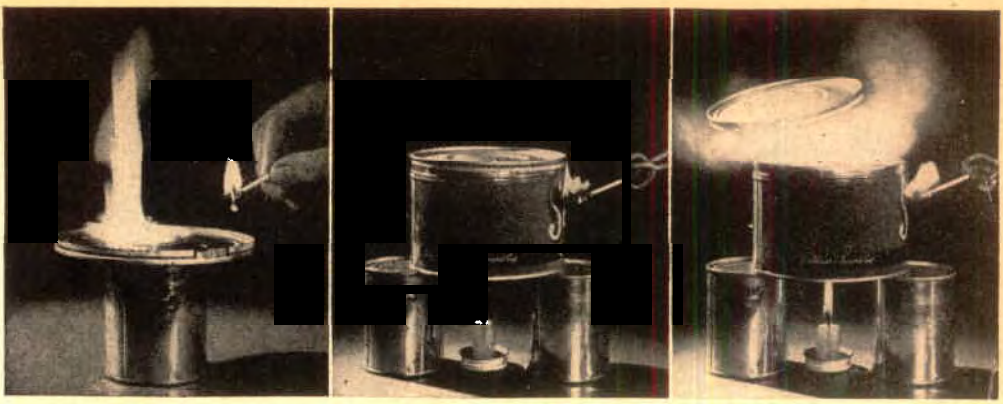


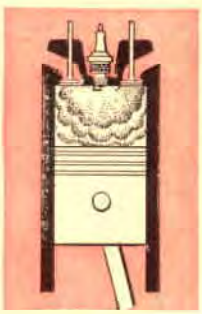
2. Scrape and sand off all the paint around the rust and clean down to the live metal. If the metal were broken or torn in a collision, you would start the repair job the same way.

5. Successive layers of Celastic Ⓣ may be used to build up spots where the original metal is completely gone. Allow each layer to set 15 to 30 minutes before applying the next one.

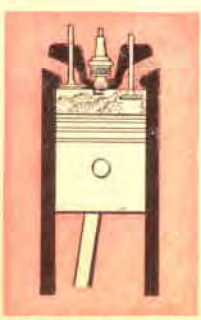


6. Brush metallic-base putty over the patch after feathering back the edges about 1½" with sandpaper or a power sander. Cut the putty to a thin paste. Allow it to dry several minutes.





POWER In the power stroke, a spark ignites the gas-air mixture, causing it to explode (more accurately, burn very fast) and drive the piston downward. *Because gasoline is too dangerous to play with, especially in the house, you had better not try this experiment, but the photos above show what happens.* In your car engine the gasoline must be vaporized. Liquid gasoline burns, as you see at the left, but not fast enough. At the center you have a situation comparable to a cold engine. In the can are a few drops of gasoline, but the vapor given off is so meager that nothing happens when a match is held to a hole in the lightly-covered can. But if the can is heated with a candle, as at the right, an explosion blows the lid off the can.



EXHAUST To prepare the cylinder for the next intake, an exhaust valve opens at the end of the power stroke and the spent gases are pushed out. Unless these burnt gases are forcibly removed, some would remain to prevent efficient combustion. It is easy to prove how this would happen. Light a short candle, fix it to a jar top fitted with a wire handle, lower the assembly to the bottom of a tall tumbler, and cover the tumbler with a piece of cardboard. As soon as the candle goes out, slide off the cover and lower a lighted match into the glass. Lacking oxygen, the match flame goes out. Now remove the burnt air by pulling out the jar top. Again introduce a lighted match. This time it continues to burn. END

patching job at home. It also has the advantage of being inexpensive.

In the form that you buy it, the material looks and feels much like any closely woven fabric. You can roll it, crumple it, and cut it with a pair of scissors. But dipped into a solvent, the plastic-treated fabric becomes extremely rigid as it dries and will hold the form into which you mold it.

Three bonded layers of the material are said to have a tensile strength equal to the sheet metal on an ordinary car. It does not rot, rust, or mildew, and it's not affected by severe climatic conditions. When dipped into an acetone-base solvent, the plastic-impregnated material bonds itself to any surface that does not have a highly glazed finish. After it has set, you can coat it with a metallic-base putty, sand it down to a smooth surface, and apply paint or enamel.

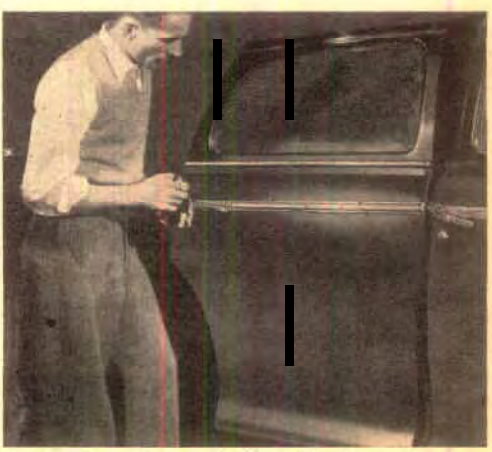
The material was developed several years ago and employed as an outer stiffener for self-sealing airplane fuel tanks. Since then, its characteristic of setting into a rigid form has brought it into use in a number of fields, often under the tradename of Celastic.

A. P. Deckert, of Buffalo, N. Y., distributes Celastic for use in the automotive trade. In addition to supplying repair shops, he

3. Cut a patch, allowing at least a 2" overlap, dip in solvent—but not longer than five seconds—and then whirl it in the air for a few seconds until the coating becomes tacky.

4. In applying, press the patch down firmly and mold to the original contour of the metal being replaced. Be careful to avoid pressure where there's no backing. Let it dry an hour.

7. Sand the putty to a smooth finish with a fairly fine paper (preferably No. 280). If the surface is still not as smooth as you'd like, apply a second putty coat and again sand it down.



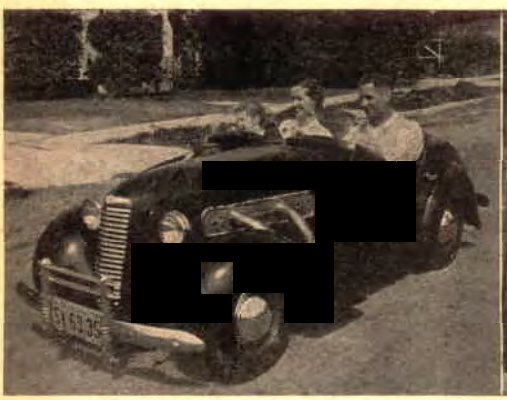
8. Apply paint—and the job's done, this one in a matter of only two hours. If you work carefully, the area will look almost like new. The cost? Well, it's surprisingly low.

is considering inexpensive kits for home use which include three thicknesses of the material, a can of solvent, some metal putty and reducer, sandpaper, and directions for carrying out the job. The three weights of the material are: heavy, about 1/16″ thick; medium, 1/32″, and thin, 1/64″.

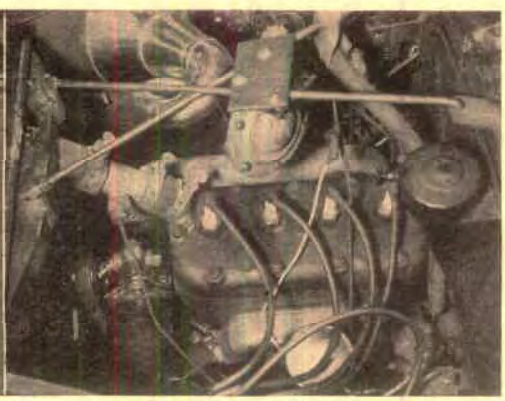
Body shops already have found Celastic both a time and money saver. For example, the job illustrated here took only two hours from start to finish, including a one-hour setting period for the patches, and the materials that were employed cost in the neighborhood of $1.50. Tests have shown that a patched area is practically as durable as a welded repair.

One automotive shop that has been using Celastic for body repairs also has found that it can be used to strengthen the sheet aluminum cabs supplied for Jeeps Ⓣ. Applied inside the cab, the material makes the aluminum much stiffer. END

As a stiffener, the fabric may be used in many ways. At the Crystal Collision Co., Brooklyn, it's applied inside aluminum cabs on Jeeps Ⓣ.



Everyone in the family can squeeze into the single seat. Notice the Nash grille at the front.



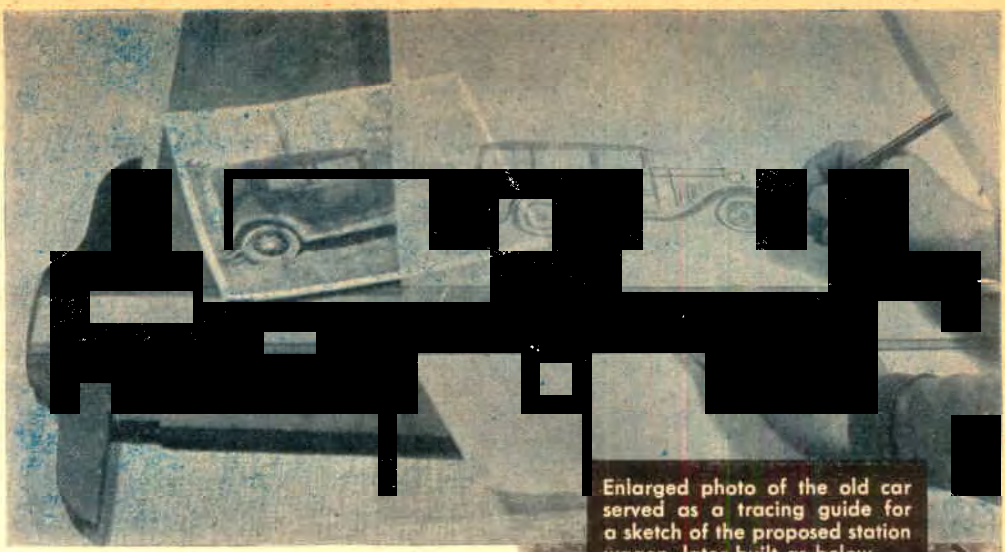
A souped-up Austin engine delivers 25 hp., and gives about 35 miles to a gallon of gasoline.

Homemade Midget Car Carries Three Persons

PARTS from a lot of different cars went into a midget auto that Harry B. Johnson, of Los Angeles, built in his spare time. Only 33″ high, it's wide enough to seat three persons with ease.

Both the chassis and engine are of American Austin manufacture. Frame and springs were lowered and midget racing-car tires installed. Plymouth instruments find service in the cockpit, Ford bumpers were cut down to suit, and a Nash grille was used. Fenders and body panels came from an Austin and Pontiac. False stacks decorate the hood.

The steering wheel is a plane-control wheel. Windshields were formed from clear plastic.



Enlarged photo of the old car served as a tracing guide for a sketch of the proposed station wagon, later built as below.

How to Build a Station Wagon

By George Daniels

A NEW station wagon from the showroom floor was too much of a luxury for my pocketbook. But I now have one—and the amount I spent converting my old bus, a Model-A Ford, to this style of body was only a trifle more than the price of a couple of new tires.

Given an old car in good running order, you can make a similar conversion. There are two ways you can do it—apply plywood panels over the old car body, or remove the body and build a new one from scratch.

If the car dates back to pre-streamline days, the first method is easier and cheaper. You use the old body as the inner framing, cutting out its back end. The flat body panels make it easy to install the plywood.

But if the car has lots of curves, it probably will be best to cut away the body just behind the windshield, leaving the posts in place. In a pinch, you could cut it away with just a pistol-grip keyhole hacksaw.

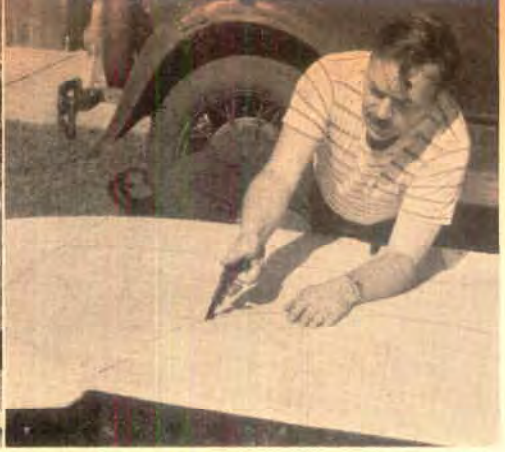
As the first step in either type of conversion, take a broadside photograph of the car. Line up the camera at right angles to the wheelbase at its middle point. Have the picture enlarged to 8 by 10 size.

Over this photo, trace the general outlines of your intended station-wagon body, using the roof, windshield, and window posts as guides if you are going to use the old body as an inner frame. In your sketch, extend the body at least as far back as the rear tips of the back fenders. If you wish, it can overhang another foot or so.

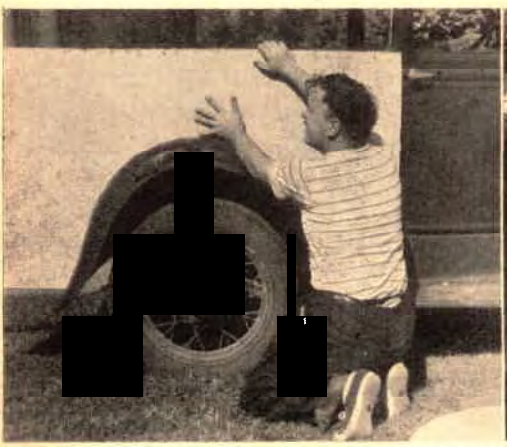
This sketch will enable you to visualize the appearance of the completed body. From it, you can also estimate the materials needed. Using a ruler on the sketch, measure the proposed body in units of wheel diameters. Then measure the wheel diameter on the car itself. A little figuring will give you the approximate measurements of the body you plan to build.

You are then ready to start to work. The photos on the next two pages show you how the new body can be built using the old body as the inner framework.

1 **Make patterns** of the body panels from fiberboard, using your sketch as a guide. After lining up the pattern sheet, mark it on the inside with a pencil for the fender cutout and for cutting to the lower edge of windows.



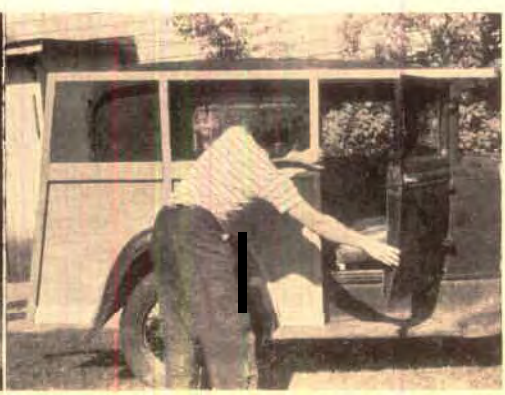
2 **Cut the pattern** along the waste side of the pencil lines. In addition to this pattern, you'll need another for the door. Patterns for one side are usually all you'll need; you can use them on other side with opposite face against car.



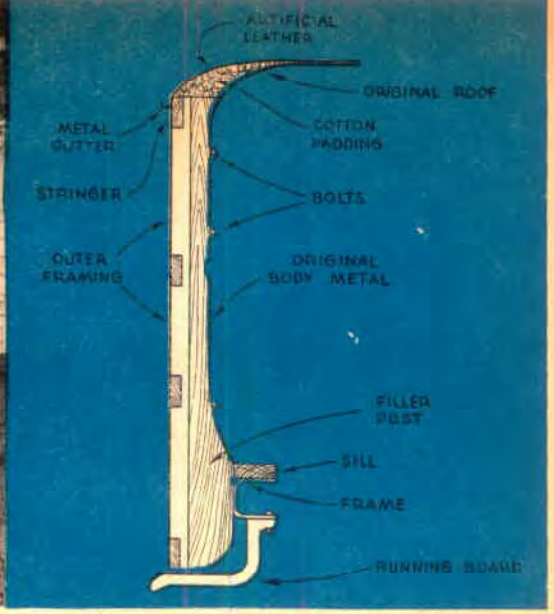
3 **Fit pattern snugly,** using a rasp to trim it as needed. Swing back or remove bumper for this. Cut filler-block frames to conform to body contours and fill space between pattern and body. Tack these temporarily to pattern.

4 **Trace pattern** on ¼" waterproof plywood after you have a good fit. Cut on the lines. Try the panel on both sides of car. If the body has been badly sprung, it may be necessary to make patterns for both sides.

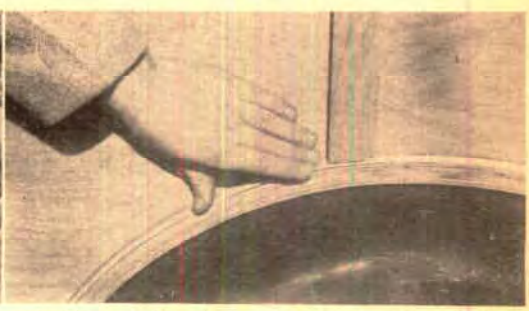
5 **Cap top edges** of panels with wood sills, covering space between metal and panels. Mastic in the joints will lessen squeaks. Attach panels with ¼" rustproof bolts.



6 **Try door clearance** after attaching framing temporarily. After trim fits perfectly, secure it with waterproof glue and screws. You now begin to see how your station wagon will look.



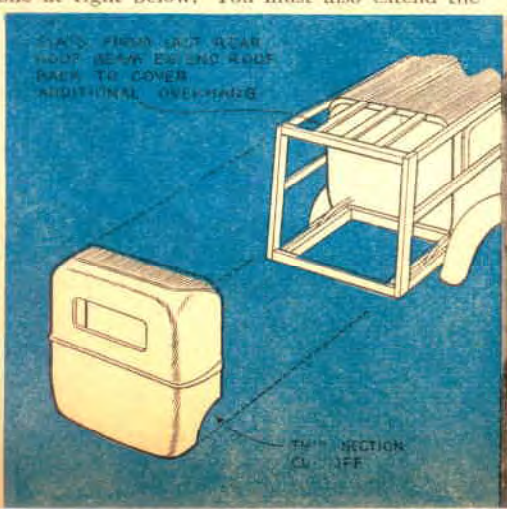
7 **Cut the inside panel frames** to follow the contours of original body. Remove handle from door for greater ease in fitting door panel. In stage shown above, rear panel is assembled but has not yet been attached permanently. Before bolting on the panels remove the upholstery from the inside of car. In drilling for bolts, be careful to locate them so as not to interfere with door or window mechanisms. The drawing above shows how the roof is finished off.



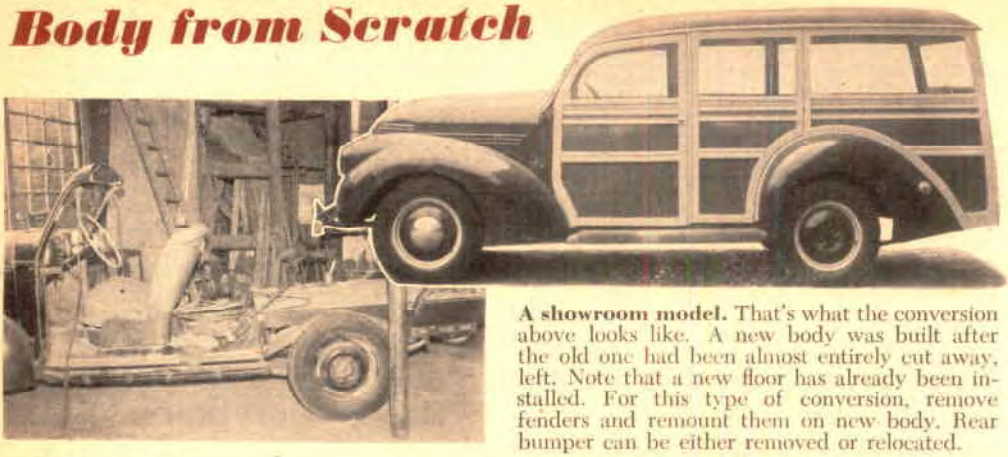
8 **Leave top longitudinal** of rear panel overlength to serve as guide in fitting the door panel. Clamp the latter in place to try it. Allow at least ½" clearance over the running boards so snow or ice won't jam the doors.

9 **Curved framing** over the fender can be laminated with waterproof glue, as this one was. You could also steam-bend it, or glue it up in sections. You will probably want to refinish the fenders and hood of car.

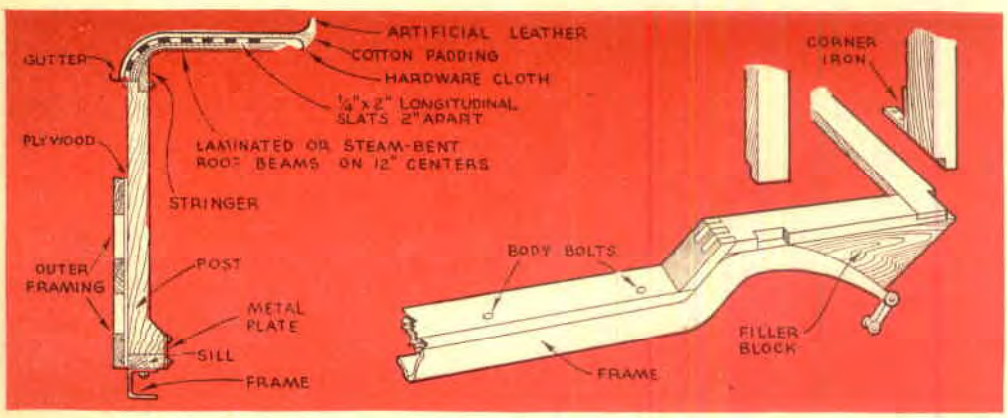
10 **Cut away the rear** of body and extend roof to suit new body overhang. If the station wagon is to be just a workhorse, you can install a simple half-height tailboard like the one at right below. You must also extend the floor back from the rear seat. Place a two-by-four cross beam under its rear edge. You can either remove the rear seat or build a frame of pipe to support it. For details on a curved-body conversion, turn the page.



For a Slicker Job, Build the Body from Scratch



A showroom model. That's what the conversion above looks like. A new body was built after the old one had been almost entirely cut away, left. Note that a new floor has already been installed. For this type of conversion, remove fenders and remount them on new body. Rear bumper can be either removed or relocated.



Construction details are suggested here. Dimensions should be adjusted to suit the particular car. If the original front doors hinge at front, you can mount new ones on the same hinges. In any case you can probably use the old hinges, door catches, and window mechanisms. For uprights, glue up hardwood to at least 3" by 3". Assemble with bolts and glue.

Fit all joints nicely and strengthen them with metal angles where possible. For a professional-looking job, use two hinged panels at the rear as above. Three coats of outdoor varnish followed by wax will give the body a fine finish. If heavy loads are to be carried, install overload springs. And one final point: notify your state license bureau of the model change.

Charging current for a motorcycle battery must not exceed 2 amp. Never connect it directly on an auto-battery charging line. The inset is a cut-away of a Harley-Davidson battery.

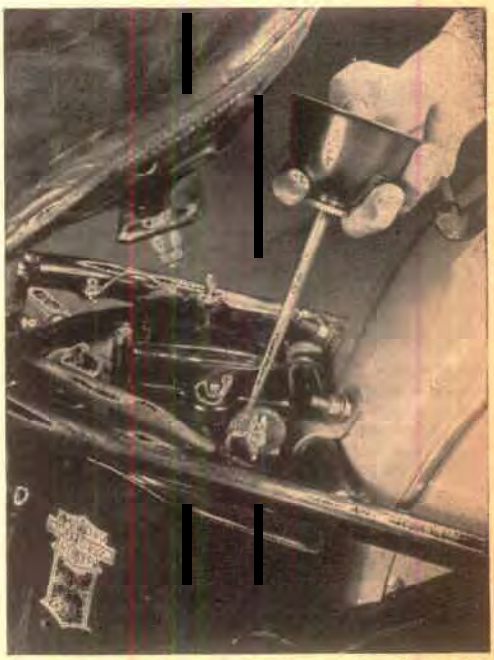
Check the specific gravity each week. At the same time add distilled water if needed. To insure uniform coverage of the plates, make certain the motorcycle is perfectly upright.

More Juice for Your Motorcycle

YOU can't expect to abuse a motorcycle battery and get away with it. In general, you should treat it like an automobile battery. But in some respects it's a special case, requiring extra care.

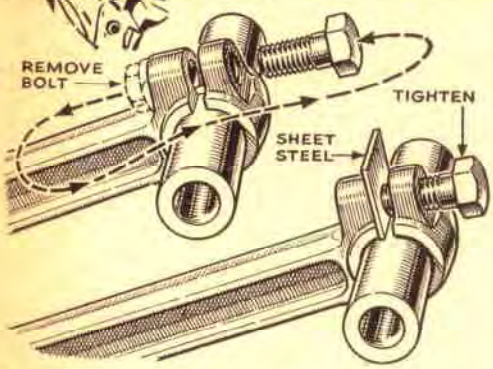
Make a habit of checking the specific gravity of each cell once a week. If the hydrometer reads 1.150 or less, recharge the battery promptly. With the hydrometer, also add distilled water as necessary to raise the level about 5/16" above the plates. It's best to do this just before using the machine. Avoid too much water.

Don't hook up a motorcycle battery directly on an auto-battery charging line. The current is excessive. Two amperes is tops for a motorcycle battery. If automobile charging equipment is used, bleed off a lower charging current. This can be done by connecting the battery in parallel with one of the car batteries on charge. Be careful not to charge beyond 1.275 specific gravity.

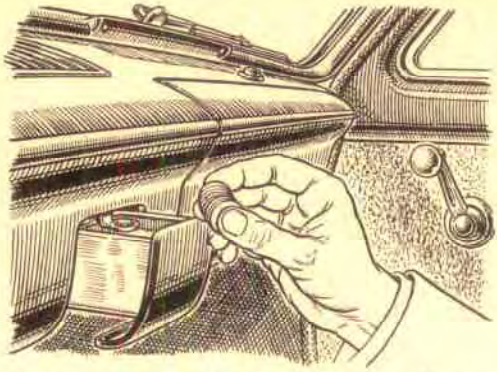


Apply a drop or two of oil occasionally to the felt washers on the terminals. This forms a protective film on the terminals, preventing corrosion and permitting better lug contact.

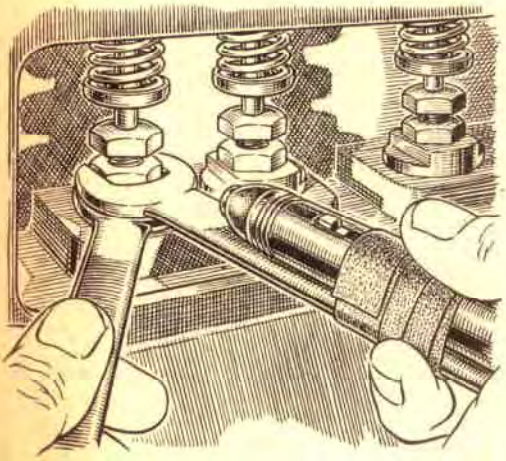
Hints from the Model Garage



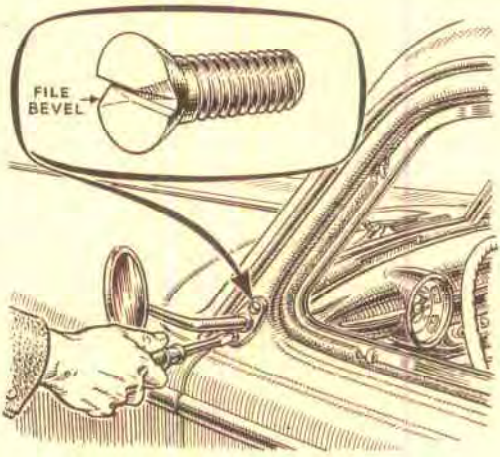
Con Rod Pressed Open. Wrist pins to be clamped in connecting rods of the kind shown will not always go in easily, even with the bolt loosened. If assembly proves difficult, reverse the bolt as shown and use it and a piece of thin steel to spring open the con rod very slightly. Replace the bolt in its proper position after doing this.



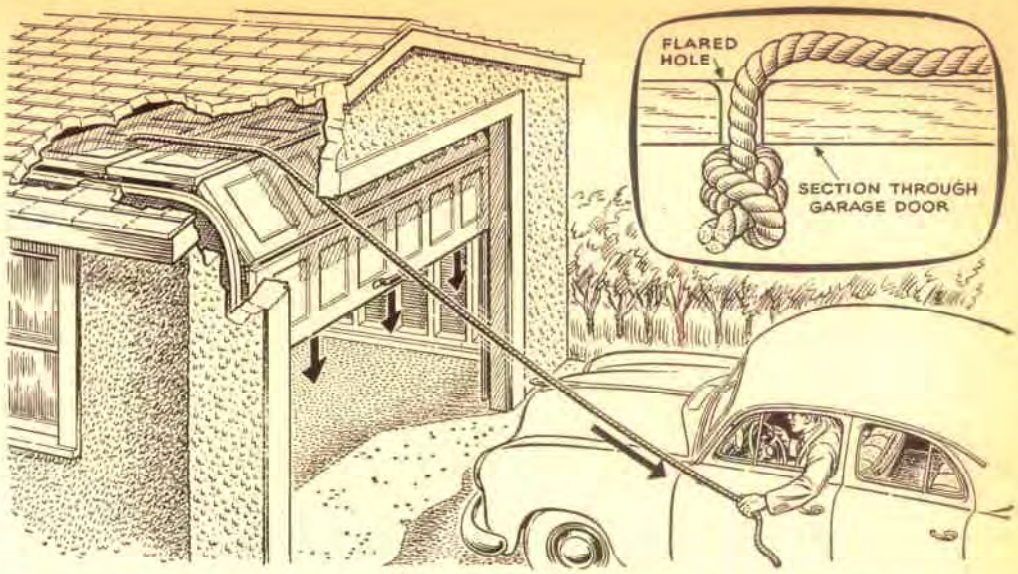
Coins Kept in Ash Tray. If you are a nonsmoker, the dashboard ash tray is a handy place to keep a supply of pennies, nickels, and dimes for parking meters and toll gates. For convenience in removing the coins, bend down the snuffer. Felt or cotton lining cemented to the bottom and sides will stop rattles.



Light on the Spot. Adjusting valve tappets on a car is a fussy job to do just right. What makes it troublesome is the necessity of manipulating wrenches and a thickness gauge in cramped quarters with inadequate light. Albert S. Eaton, of Belmont, Mass., reports that the work goes a little easier if you tape a pocket flashlight to the upper tappet wrench.



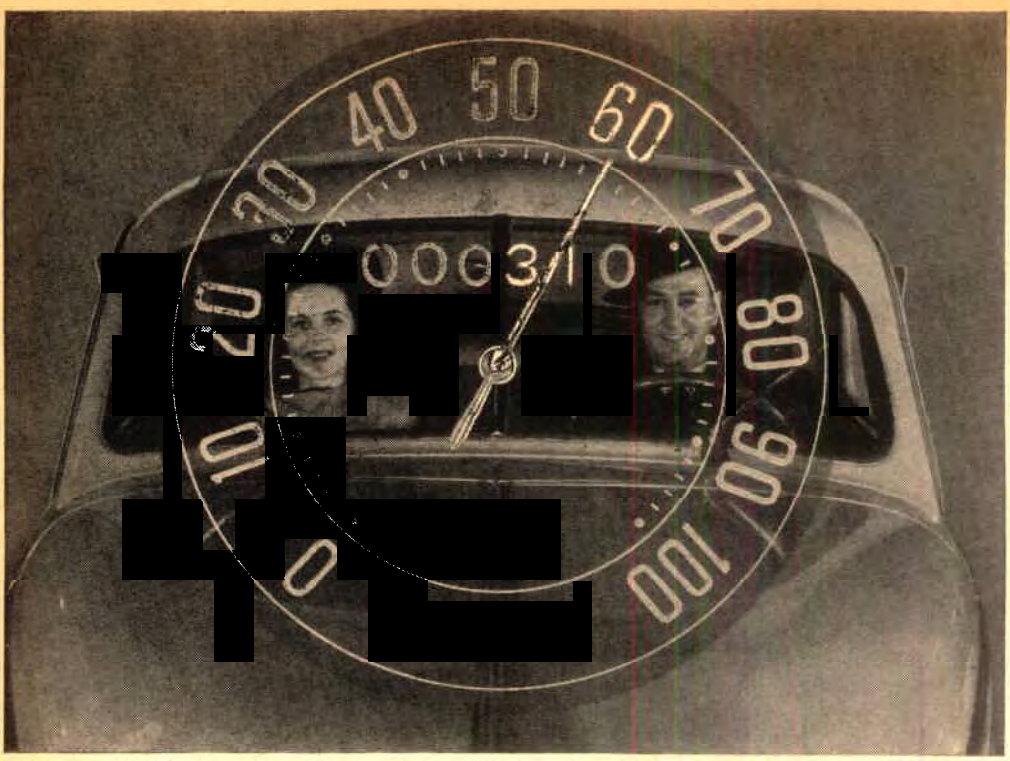
Filed Screws Prevent Theft. If you attach a mirror, road light, or other accessory with external screws, safeguard it against theft by filing off those corners of the slots that the screwdriver bears against during removal. Once tightened, the screw is next to impossible to remove, so use it only on permanent installations. You can retighten it, however, if vibration loosens it.



Rope Closes Overhead Door. With this arrangement, you don't have to get out of the car to close the door after leaving the garage. Just grab the rope dangling near the jamb, and give it a pull after you have backed out. Attach the rope (a clothesline will probably serve) by drilling a hole a few inches down from the top of the door. Charles Morse, Elmira, N. Y., says he finds the rope trick very convenient. For easy operation of the door, keep the rollers and track well lubricated.

Tire Cushions Towing Bumps. An old tire makes an excellent coupling to a car that you want to tow. Pass a few turns of heavy wire or rope around the tire and the respective bumpers of the two cars and you are ready to go. The tire effectively smooths out the jerks and nicely cushions the bumps in stopping, writes Leslie H. Housel, of Grass Lake, Mich.

Corrosion Knocks Out Lights. If either beam of a sealed-reflector headlight goes out, be sure you really need a new unit before putting down the cash. In some cases, particularly in older cars, you will find the contacts have become so corroded that the resistance prevents the lamp from lighting. Careful cleaning of the contacts will restore the light to usefulness.



Driving at 60 with only a few miles "on the clock" isn't as harmful for a brand-new car as it once was.

Must You Break In a New Car?

Fast speeds at lower mileages are now all right, but the answer still is "yes" if you want the best ultimate results.

By R. P. Stevenson

BREAKING in a car no longer demands the crawling speeds of a decade ago. Improvements in design and manufacture, and in lubricants, have contributed to outmoding the old, slow break-in process. Since the war, virtually all manufacturers have issued revised recommendations for operation of their cars during the first few thousand miles, most of them now approving faster speeds at lower mileages. Going even farther, several have dropped the subject of break-in entirely from the instruction booklet they furnish with a new car.

Consequently, you may hear it said that a break-in period no longer is necessary. If you do, it would be well to raise a skeptical eyebrow—particularly if you are interested in getting the most from the investment a new car represents.

The fact is that, although you may safely drive fast sooner, you still are dealing with a piece of machinery that is not yet capable of its ultimate performance at the time it reaches you, however perfect it may seem in comparison with the standards of some years ago.

A new car these days has many so-called frictionless bearings (that is, ball and roller), but it also has many friction-producing metal-to-metal movements – rotating contacts, as in the crankshaft and wristpin bearings; and sliding contacts, as in the cylinders and rings. On how these surfaces wear in, a great deal depends—including the eventual

power of the engine, its silence or noisiness, and its oil economy.

As any machinist knows, a properly sized bearing at first is a bare running fit, with a tendency to be stiff, to run hot, and to seize or score if not babied. As it runs, the exceedingly small (millionths of an inch) protuberances on the facing surfaces are worn away, leaving a bearing that is free running but in no way loose.

Improvements in the finish of mating parts are given a big share of the credit for cutting down run-in time. By modern techniques, they are sized within a few ten-thousandths of an inch and given a smoothness of millionths of an inch. As a result, they are ready for their best work sooner.

In the field of metal finishing, a process that is a comparative newcomer has been assuming a position of increasing importance. This is honing, a method by which a bonded abrasive is worked over an area. If the customary finishing methods were to be ranked in an ascending order of nicety, honing should be given a place above the other three—machining, which at best gives a comparatively rough surface; grinding, always useful but by no means perfect; and lapping, which has production disadvantages.

Honing finds perhaps its greatest usefulness in the finishing of cylinder bores, but it also now helps give an ultrafinish to many other auto parts. A great increase in mileage between ring jobs in the last two decades may be traced mainly to this process. Without enlarging the diameter of the bore to any extent, honing knocks down the peaks

Watch These Points During the Break-In

LUBRICATION. Metal-to-metal contacts need plenty of oil while wearing in. So check the oil often.

ENGINE HEAT. Allowing a new engine to overheat is an invitation to all kinds of expensive repairs.

WATCH SPEED. Gradually push the car up to higher road speeds. Crawling along won't break it in.

WARM UP FIRST. Allow the engine to run a bit before driving so the oil will be warm and flowing.

BABY THE BRAKES. Go easy on the brakes for a few hundred miles until the linings are broken in.

SERVICE CHECKUP. Most new-car service policies entitle you to these. Don't fail to have them.

and jagged tips of surface irregularities that are apt to wear out the rings.

Until a bearing has run in, it will operate at a higher temperature than ordinarily. For that reason proper lubrication is never more important than during the break-in period, if scoring or seizing are to be prevented. Motor oil has a dual function—to cool the moving parts and to reduce friction. New processes by which protective metal platings are applied to bearing surfaces in some new cars offer a safeguard against temporary oil starvation.

Always Warm Up the Engine

Temperature is an all-important tipoff while an engine is new. Like the temperature of your own body, the engine temperature quickly reflects any abnormal condition. Never allow a tight engine to run too hot. If you do, your nose probably will let you know, since an engine running on the hot side has a distinctive smell—a hot metal and varnish odor. So keep an eye on the heat indicator—after the engine has had time to warm up.

Proper warmup is essential whether an engine is old or new. Engineers have found that the greatest amount of damage occurs during the first three or four miles of driving, when the lubricants have not yet thinned out sufficiently to coat all the moving parts. Before leaving the garage, let the engine idle for about five minutes. If you must set out immediately, drive slowly for the first dozen miles or so.

During the break-in period, some new cars may require what appears to be an unusual amount of oil. This should cause no worry. Until the piston rings are properly seated, oil may get past the rings and into the combustion chamber. This often is helpful, for the extra lubrication allows the rings and pistons to wear more gradually and form a good seal. After the car has been driven 2,000 or 3,000 miles, the oil consumption should drop to normal.

Faster Speeds Make Better Cars

A memorandum distributed by Plymouth to its dealers explains that some new owners who report using more oil than expected may be keeping the oil level at the "full" mark rather than the "running level" mark on the dip stick. When the level is too high, the excess is vaporized and escapes through the crankcase ventilator. Plymouth advises that in checking the oil when the engine is warm the level should be kept up to but not above the "running level" mark.

When many new cars are delivered, the crankcase oil is S.A.E. 10-W, no matter what the season. This should remain in until the first checkup—at 1,000 miles, or whatever your service policy stipulates. If oil must be added before then, the manufacturer usually recommends use of the same grade. A careful owner will of course not neglect to take in his car for these checkups.

There is now a fairly general feeling among automotive engineers that faster break-in speeds produce a better final result. The slow speeds of the past sometimes failed to accomplish the purpose for which they were intended. Although the driver may have complied with all instructions, his car would sometimes not be broken in by the time the specified mileage figure had been reached. Consequently, when the driver speeded up, thinking it was safe to do so, the bearings often were scored or other damage caused.

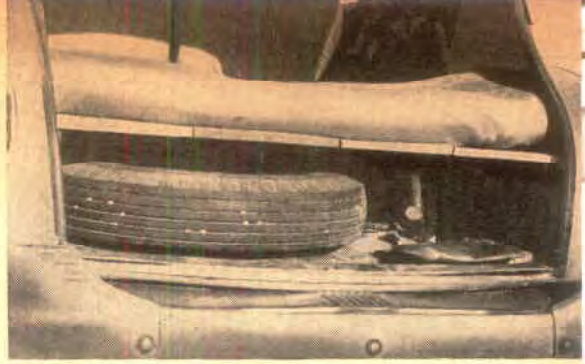
One prominent Detroit engineer believes that limited break-in speeds are not needed by a man with good engine sense—an expert who knows and understands his car and can make it a part of himself. Such a driver can feel when a new car is tightening up and not responding as it should. When that occurs, he will ease off to a slower rate. Unfortunately, not all drivers can classify as expert.

Break In the Brakes Too

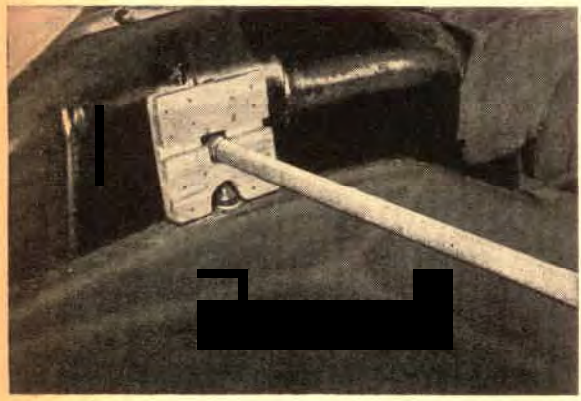
One rule on which there is agreement is that a new car should never be held at any speed the first time it is pushed to that figure. For example, the first time you reach 50 m.p.h., keep the car there only a brief time before dropping back. Then, after it has been raised to 50 on several occasions, push it to another slightly higher point. Keep repeating this procedure until you have reached the peak performance of the car. If a car never has been driven over 40, don't raise it suddenly to 70 or 80. Work it up gradually.

In addition to the engine components, the rear axle, gears, and brakes also require time and use to wear in properly. Rear ends used to be especially subject to damage, but the high-pressure hypoid lubricants now used in many cars help reduce this. In the case of the brakes, fast stops should be avoided for the first few hundred miles until the linings acquire a smooth finish. END

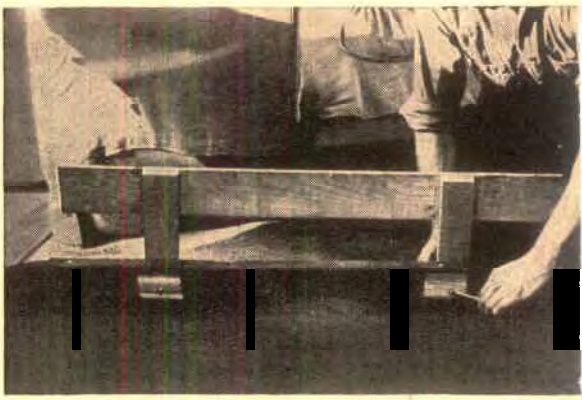
Full-length sleeping comfort on vacation trips is provided by this modification of a two-door sedan. The foot of the bed is in the trunk.



Here's how the bed looks from the trunk end. This one takes a 6' double mattress. There's room for the spare tire and tools under it on the floor.



The other end of the pipe is held between blocks. If the spare-tire brace isn't on the side, put in blocks at both ends and use a wood crosspiece.



For the front support, a T-shaped piece is bolted to the front of the rear-seat frame. A sort of low sawhorse will do if bolting is inconvenient.

Build a Bed in Your Car

CONVERTING your car so that it will serve as a bed on vacation trips isn't a difficult job, and it will free you of dependence on tourist courts and hotels. Most coaches and sedans as well as many coupes can be modified simply by removing the back seat and adding a mattress platform. Though less flexible than arrangements in which seat backs fold down to form a mattress, the conversion is far simpler and entirely satisfactory.

After removing the rear seat and cushion, take out the cardboard or fiber trunk partition by removing the screws or prying off the locking buttons. If there is a light channel-iron brace between the seat and trunk, saw it out and drill holes so it can be replaced later with strap-iron "splints" and bolts. In cutting, leave stubs long enough to take the replacement bolts.

Many cars have the spare-tire bracket on one side of the trunk. In this case, a length of 1" pipe can be fitted over the bolt in the tire brace and run to a notched wooden block fastened at the opposite side. It serves as a support for the foot of the bed platform. If there is no tire bracket on the side, use wooden stands at both ends of the support, which then may be a length of 1" by 3" stock turned on edge. In any event, level the support by having the blocks or the block and bolt at the same height.

Build a support for the head of two uprights and a 1" by 3" crosspiece bolted to the seat-cushion frame or, if this is impracticable, on small sawhorse legs placed close

AUTO HINTS

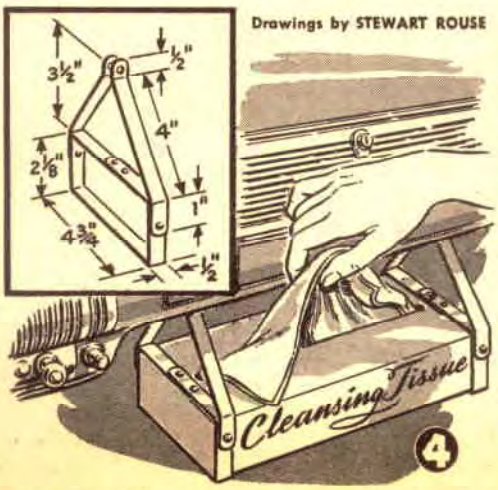
1. COLD-WEATHER STARTING in an unheated garage is often made easier by heating the engine independently. One way is to mount an infrared heat lamp under the hood and direct it on the bottom of the radiator. It will warm the engine in a short while. In very severe weather, it can be left on all night.—HARRY MORRIS.

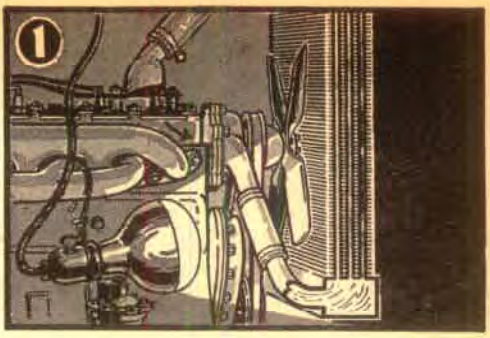
2. A TROUBLE LIGHT can be made of a discarded sealed-beam lamp if a test shows one filament still to be good. Mount the lamp in a box and solder on two long wires ending in clips.—A. G. BELESON.

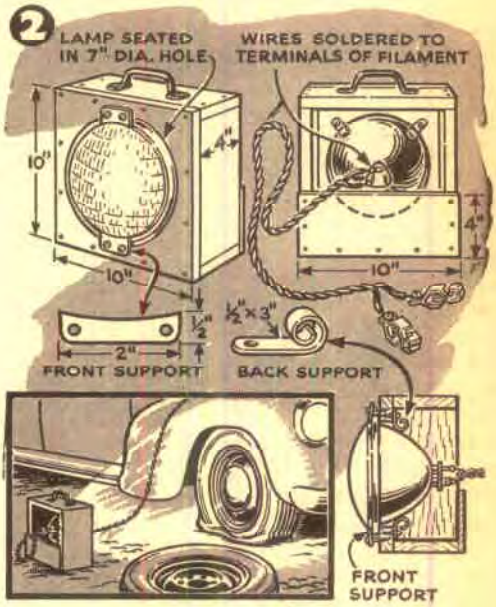
3. ELECTRIC FUEL GAUGES, which sometimes give trouble when the tank float arm makes an imperfect ground, can be repaired by soldering a jumper on the arm and rheostat housing. To test the old ground, remove the unit and connect it in series with a flashlight.—VAN ALLEN LYMAN.

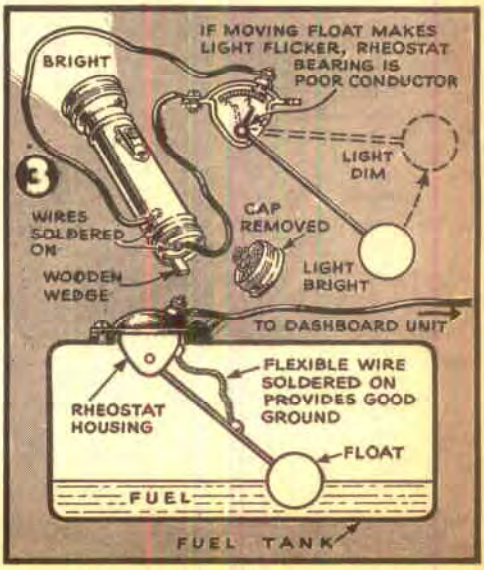
4. CLEANSING TISSUES for use on a windshield, lenses, or soiled hands are conveniently held in banding-iron brackets under the dashboard. An empty box can be removed and a new one put in by spreading the bracket arms.—S. P. MEEK.

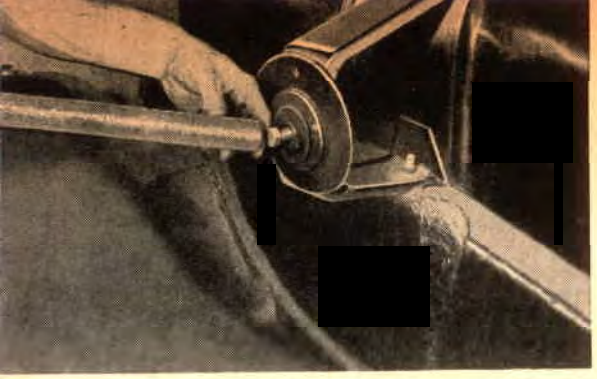
Drawings by STEWART ROUSE











After removal of the back seat, supports for the bed platform are put in. One can be a length of 1" pipe over a nut in the spare-tire side brace.

Finally planks are nailed to the front support as a platform for the mattress. When the vacation is over, the bed is taken out and the seat put back.

By H. C. Marhoff

to the back of the front seat. Be sure it is level with the foot support. Nail planks for the platform to the front support; their length will be governed by available car space and the length of the mattress. Notch the outer plank on the tire-bracket side to pass this bracket, which will serve as an anchor. If there is no side tire bracket, anchor the two outer boards with metal straps held by body bolts.

Almost all coaches have room for at least a 6′ mattress. Extra blankets folded under the mattress will make up in part for lack of a bedspring, though an air mattress is preferable. The spare tire and tools can go under the bed platform. Luggage can be carried on the bed when traveling and stacked at night on the front seat.

Knowing Auto Noises Can Speed Repairs

Every auto mechanic has a lingo all his own to describe trouble noises. One man's "bump" is another's "clunk." A "hiss" may turn up as a "buzz," "wheeze," or "fry."

Hearing the noise, the experienced mechanic usually knows where to locate the trouble. But if you just drive in and ask him to "get rid of the squeal," he may go off on the wrong track.

To avoid misunderstandings between driver and mechanic, General Motors engineers have divided trouble noises into seven classifications. These are:

The Rattle. A series of hard, sharp sounds in rapid succession, like a hard object being shaken around in a metal container. This noise usually indicates a loose or broken part striking against another.

The Thump. A dull sound, generally made when a soft part strikes against a hard part. An example is the noise made by a deflated tire on the road.

The Squeak. A sharp, shrill, piercing noise, generally made by two dry metal parts rubbing together. The sound may be sharp and erratic, or drawn out—a squeal. Lack of lubrication causes many squeaks.

The Grind. This is a continuous crushing sound like a part being crushed between two revolving parts. Such a sound might come from the transmission.

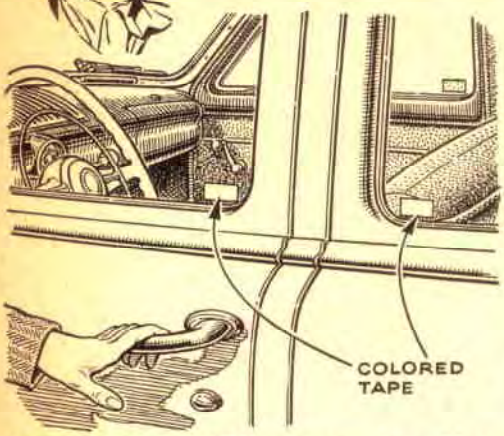
The Knock. This is a sharper and more distinct sound than a thump. It's generally associated with a loose rod or crankshaft bearing. (Not to be confused with the "knock" or ping of a laboring engine.)

The Scrape. A grating or harsh rubbing sound, often made by two pieces of material rubbing together. The sound of a dragging brake could be described as a scrape.

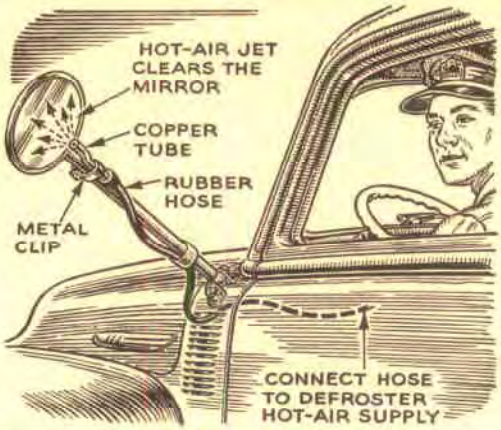
The Hiss. This is like escaping air or steam or the sound of water on a hot metal part.

These definitions are contained in a booklet, "How to Report Trouble," prepared by GMC Truck & Coach Division for distribution to coach drivers. Besides telling *what* the noise is, the driver is expected to report *where* it comes from and *when* it happened. With this report, the mechanic has a good start toward learning *why* it happened.

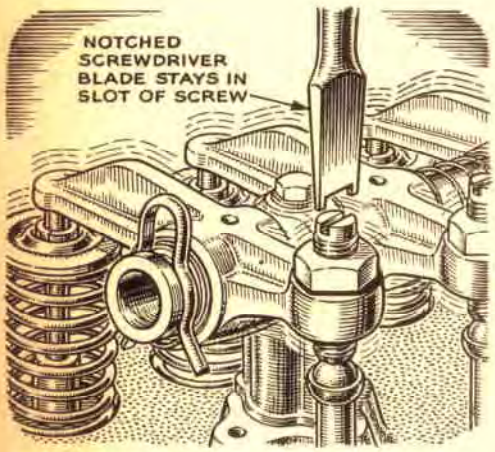
Hints from the Model Garage



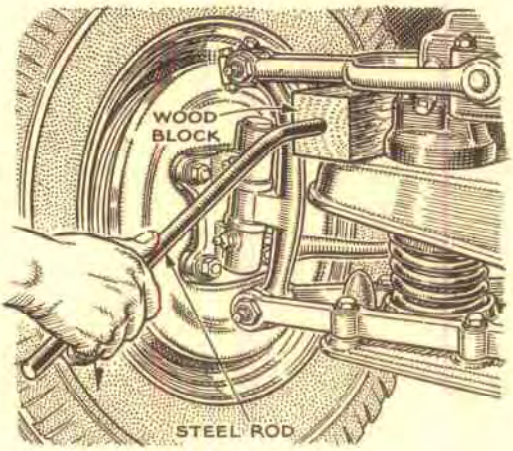
Tape Shows Windows Are Up. If you keep your car windows clean, it may be difficult to tell that they are up when you're locking the car. Small spots of colored tape applied to the inside near the bottom will show you at a glance.



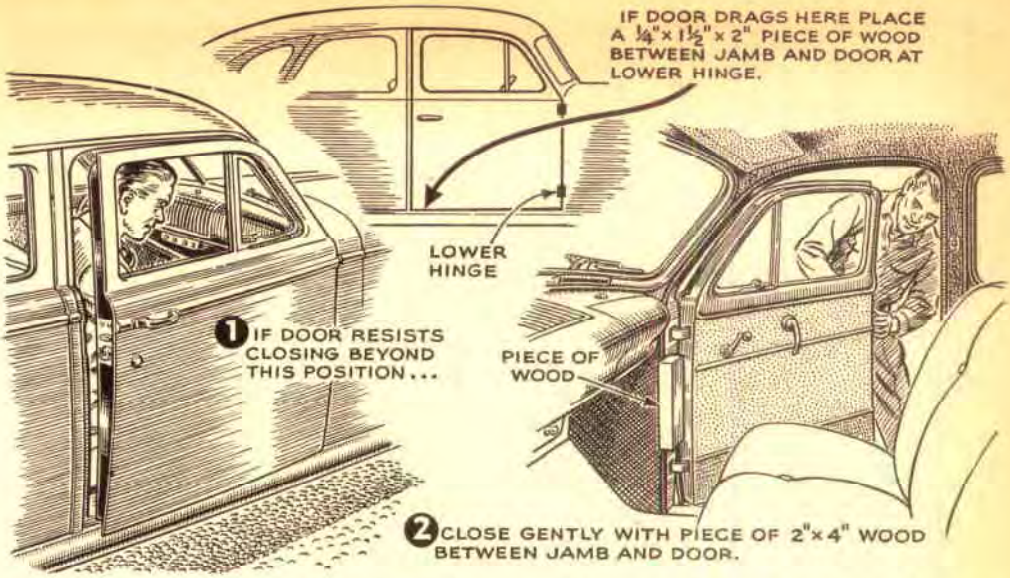
Defroster Clears Mirror. In sleety weather, Ronald Weller, of Jerseyville, Ill., found that the rear-view mirror on his truck frequently became coated with ice. To keep the mirror clear, he ran a rubber hose from the defroster out to the mirror.



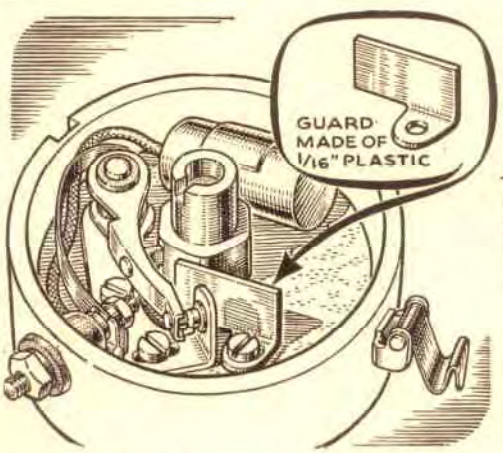
Tappet Adjustment Is Easier. It is usually recommended that the tappets of an overhead-valve engine be adjusted while the engine is warm and idling. However, you've probably found that it's hard to keep the screwdriver in position on the bouncing adjusting screw. To simplify the task, W. M. Dierks, of Chicago, filed a wide notch in a screwdriver blade. This keeps the blade in the slot while adjustments are made.



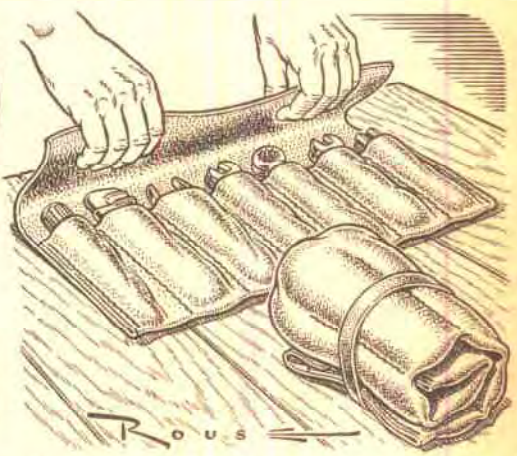
Block Stops Wheel Sag. If you've ever used a bumper jack, you've probably noticed that the front of a car must be raised quite high before the tire is free. This is because the suspension arms allow the wheel to sag. You can overcome this by thrusting a block of wood between the frame and upper wishbone. A block cut from 3″ by 3″ stock will do the job. To position the block, fit a steel-rod handle into it.



Repairing Sprung Doors. Unless they are too badly damaged, doors with sprung hinges can sometimes be put back into working condition by deliberately jamming them against a piece of wood. Burk Jaggers, Rushville, Ind., writes that he has used the method above. In closing the door, always proceed gently and keep testing—or you may have the problem of correcting an overcorrection. Should the door rub at the upper rear corner, place your block of wood between jamb and door at the top hinge.



Guard Prolongs Point Life. Ira S. Nelson, of Chicago, reports that he has experienced considerable difficulty with burned and pitted breaker points on his '49 Ford V-8 because oil worked up the distributor shaft. As a solution, he installed a small plastic shield between the cam and breaker arm, mounting it with a 6-32 screw as seen above. The shield helps keep oil from being thrown on the points.



Rubber Kit Stops Rattles. This tool kit, made from an old inner tube by Robert R. Leist, of New Albany, Ind., keeps small tools from rattling around while carried in the car. Cut a piece from the tube large enough to suit the tools you want to have at hand. Pockets to suit them can be sewn with strong cord. Cut a rubber band from the same tube to put around the kit after it has been rolled up.

Give Your BATTERY a Break

ALL WORK AND NO CHARGE WILL MAKE IT GO DEAD. HERE ARE TIPS TO PROLONG ITS LIFE.

By RICHARD W. CRANE

MOTORISTS sometimes literally work a battery to death. Perhaps they are careful to keep the electrolyte above the plates, but all too often responsibility stops there. They overlook the fact that unless the car is operated so as to keep the rate and periods of battery discharge at a minimum, the battery will have little chance of lasting long.

In this respect, judicious use of the starter is the most important point, for a battery expends more energy in cranking a car than in performing any of the many other jobs it is called upon to do. Here are five ways you can reduce this starter drain:

1. When possible, park on a hill and start the engine by coasting.

2. Depress the clutch while using the starter. This disconnects the transmission and lessens the load. On a sub-zero day, when the oil may be virtually a solid, this may determine whether you ride or walk. Even in warm weather, it will help.

3. To decrease the total load on the battery, shut off all other electrical equipment before pressing the starter button. A relay that is available commercially does this automatically, but you can do it by hand with little trouble.

4. In cold weather, use the light oil specified for your car. But if you are caught in a sudden cold snap with summer oil in the crankcase, it will help to pull out the choke just before stopping the engine. This should not become a habit, however, for it washes the oil from the pistons and cylinder walls.

5. Develop a technique for starting the motor when cold. If your car does not have an automatic choke, a little experimenting to determine the best choke and throttle settings will save a lot of battery wear. Generally, the choke should be pulled out all the way and the throttle slightly. When the engine takes hold, push the choke in as soon as you can without stalling the engine.

Some drivers habitually pump the accelerator while using the starter. This is unwise. For one thing, an open throttle increases the proportion of air to fuel, making the mixture leaner; and on cars having acceleration pumps, it may also cause flooding. However, on cars having such pumps it may help to push the accelerator several times to the floor *before* touching the starter, since this is a form of priming.

Next to the starter, the headlights are the largest user of battery power. While you may use them freely any time the generator is turning fast enough to compensate for the current drawn, they should be kept off as much as possible when the motor is idling or not running. When the battery is run down and you must drive at night, switch to the parking lights whenever the engine is idling, as while waiting for traffic lights.

On some cars the current the headlights draw does not go through the ammeter. Because of this, it often may appear that

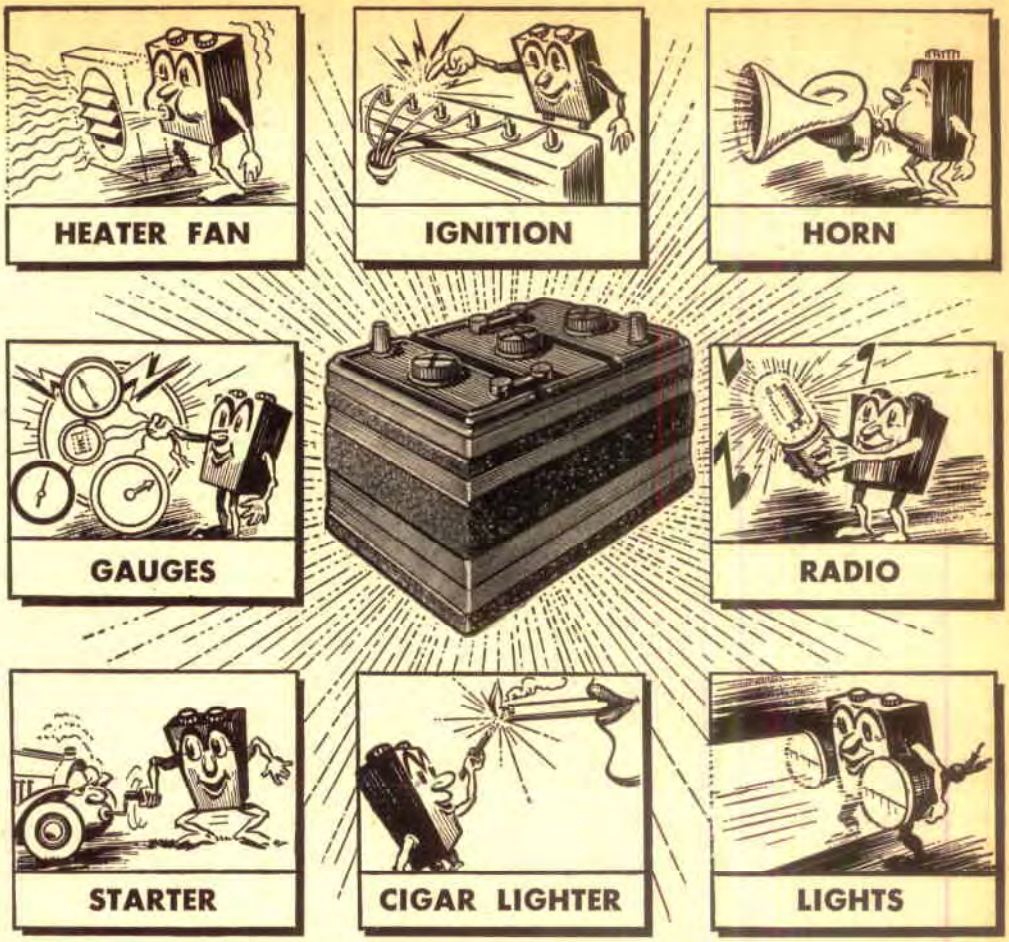
YOU CAN HELP YOUR BATTERY DO ITS BEST JOB. OPERATE YOUR

Use the right oil. If the oil is heavy, the starter takes more battery power.

When starting an engine, first turn off the lights and all accessories . . .

. . . Then adjust the choke (if it isn't automatic), and the hand throttle . . .

Next, pump the accelerator several times to prime the engine . . .



A BATTERY SERVES YOU IN MANY WAYS. BUT DON'T OVERLOAD IT.

the battery is being charged when it actually is discharging. Check your owner's manual on this point.

As for radios, heaters, fog lights, and other electrical accessories, it is a good practice to use them sparingly. Each alone may use little power, but lumped together they take a lot; and when, at night, this is added to the demands of the headlights, dash lights, tail lights, and ignition system, the total may be greater than the maximum generator output, especially on older cars.

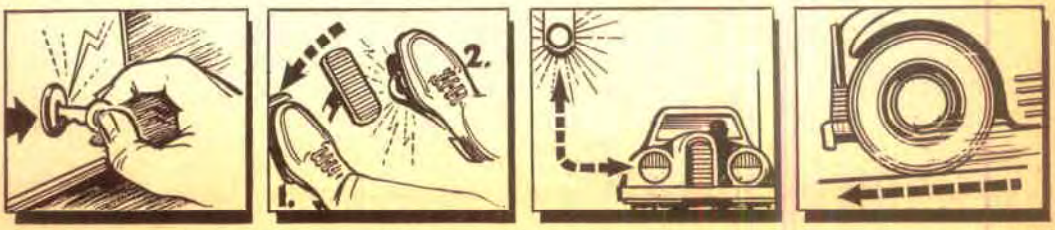
CAR PROPERLY AND THE BATTERY WILL SERVE YOU MUCH LONGER.

. . . And don't forget the ignition. (It's silly, but a driver often does) . . .

. . . Depress the clutch and you finally are ready to touch the starter button.

If your battery is low, switch to parking lights when held up in traffic.

When possible, park your car on a hill and start the engine by coasting.



Next best to getting a new car is to inject new life in the old one. The right kind of servicing does just that.

Instrument tests help spot trouble points quickly.

How an Expert Does a Tune-up

By R. P. Stevenson

PS photos by Hubert Luckett

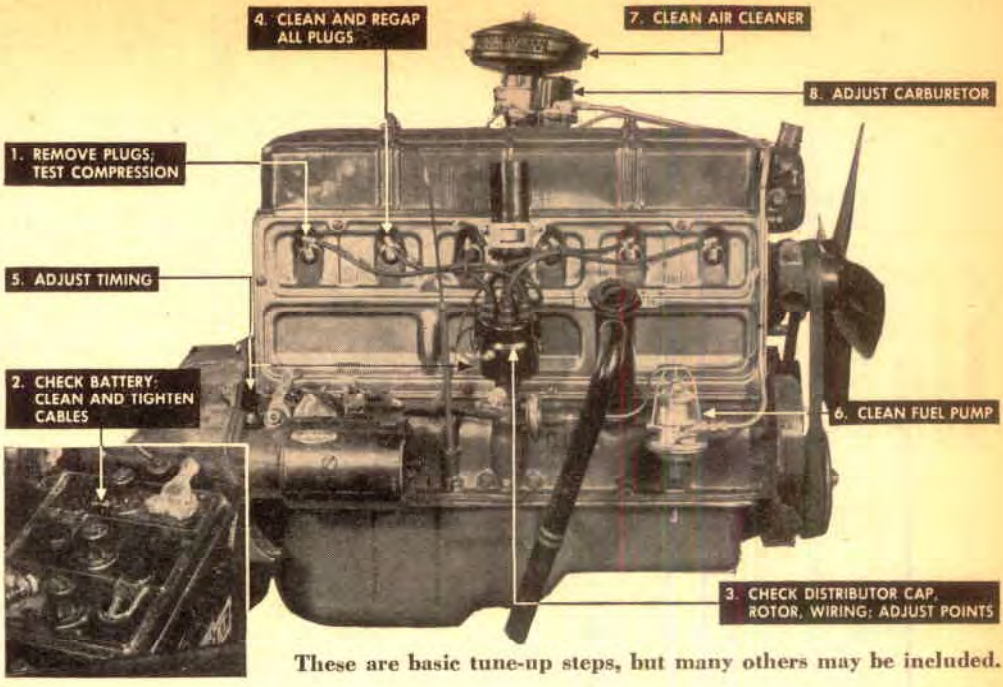
WHAT *is* an engine tune-up, anyhow? Like the blue-plate special, a lot depends on where you buy it. Different manufacturers specify different procedures, and further variations are introduced from shop to shop and mechanic to mechanic. Sometimes the job is done with little more than a few hand tools and a well-pitched ear; at others it's turned out with enough diagnostic instruments to stock a flight engineer's panel.

However it's done, the underlying idea is to restore some of the efficiency that the engine has lost through use and wear. These inevitably bring a gradual decline in engine performance; vibration jars precise adjustments out of kilter; contacts and electrodes pit and burn away; filters choke up with dirt or sludge; and friction and heat do the rest.

That's why your engine needs a going-over at regular intervals. The job should give you quicker starting, more power and pickup, better gas mileage, and smoother

1. A compression test comes first. An engine cannot be tuned satisfactorily if compression is uneven. In such cases, a valve or a ring job may be required before the tune-up.

2. Good ignition depends on a battery in good shape. Here each cell is being checked under load. Corrosion is removed from terminals and cables examined.



These are basic tune-up steps, but many others may be included.

idling. (In evaluating a tune-up your car has had, don't forget that the better shape it was in beforehand, the less improvement you'll notice.) A tune-up may also spot minor trouble before it becomes major, and for that reason alone is a good idea before any long trip.

The accompanying photos show a tune-up done by a competent mechanic with modern equipment. This was an actual job done on a 1946 Chevrolet by John Riccardi, tune-up specialist for the East Side Chevrolet Corporation in New York City, who in his own words "began as a kid" and has "been at it for 20 years."

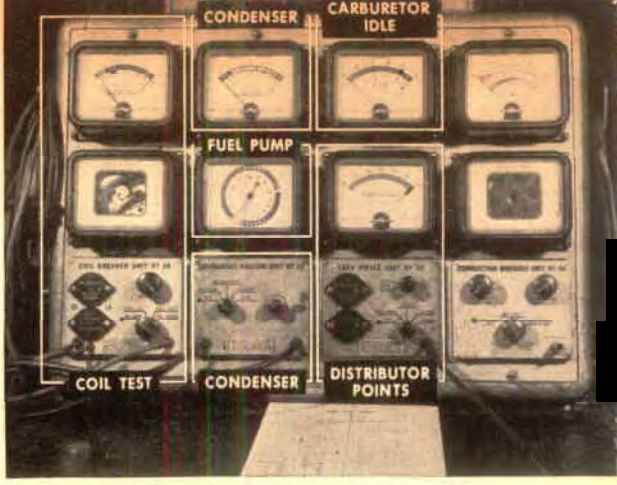
Most automobile manufacturers recommend an engine tune-up each 5,000 miles or twice a year, in the spring and fall, but hard usage under difficult conditions may make it advisable even more frequently. Spring and fall tune-ups coincide with conditioning the car—oil changing, addition or removal of antifreeze, and so on—for the season that's to follow.

Tune-up may be considered to deal mainly with three engine functions—com-

3. Spark-plug gap is set with a wire gauge, even when new plugs are installed as here. If old ones are retained, they're cleaned and inspected for cracks as well as regapped.

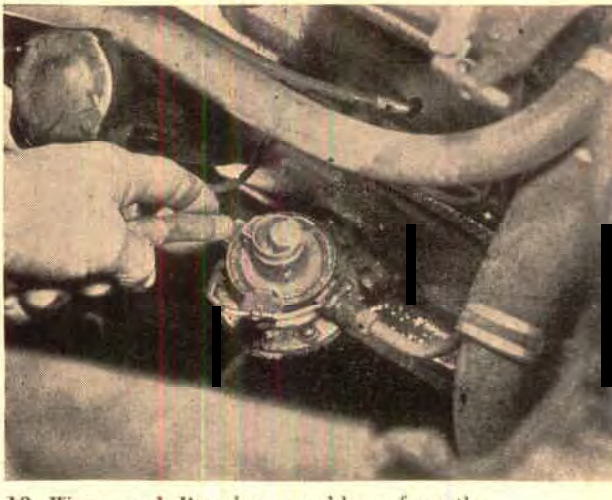
4. Distributor wires were all inspected for worn insulation. After removal, both the cap and rotor were checked for cracks, chips, and burning, and the cap wiped out with a cloth.

5. Contact points are removed from the distributor and cleaned with a fine-cut file. If the points are badly oxidized or pitted, new points and a new condenser are installed.



6. Degrees of dwell, registered on the motor tester, show whether point setting is correct. The machine also tests coil, condenser, fuel pump, and gives engine a final vacuum check.

9. The fuel-pump bowl is about to be removed here. The bowl was wiped clean and examined for cracks and chips, and the strainer freed of dirt with a blast or two from an air hose.



10. Water and dirt also were blown from the pump with a hose. A new gasket went into the pump when it was reassembled. The gas filter on the line at the carburetor was also cleaned.

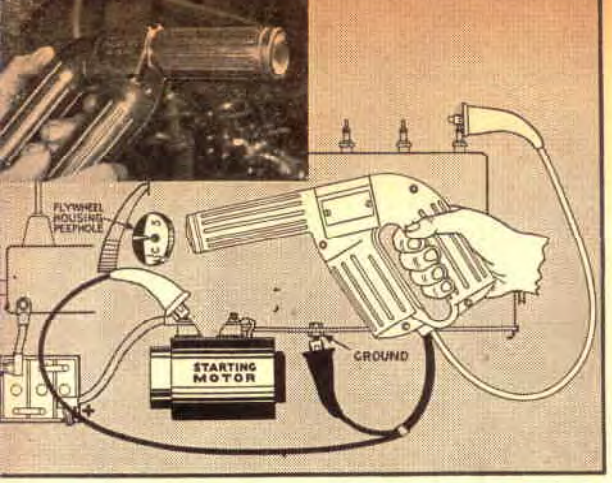
pression, ignition, and carburetion. Each engine part affecting any of these is checked and then adjusted if necessary.

You may also have heard tune-ups classified as major and minor. As the word suggests, a major tune-up includes more steps than the minor. But there is no standardization. What one manufacturer or shop considers a minor tune-up may include steps that another may perform only in the event of a major job.

The tune-up illustrated here was classified as minor. However, the addition of only two other steps—overhaul of the carburetor and blowing out the fuel lines—would have raised it into the major class. In the photos, you will notice that the tappets were adjusted to the recommended clearances. This is a customary part of tune-up procedure for an overhead-valve engine. Although not illustrated, fan-belt tension also was adjusted, for slippage will affect generator output.

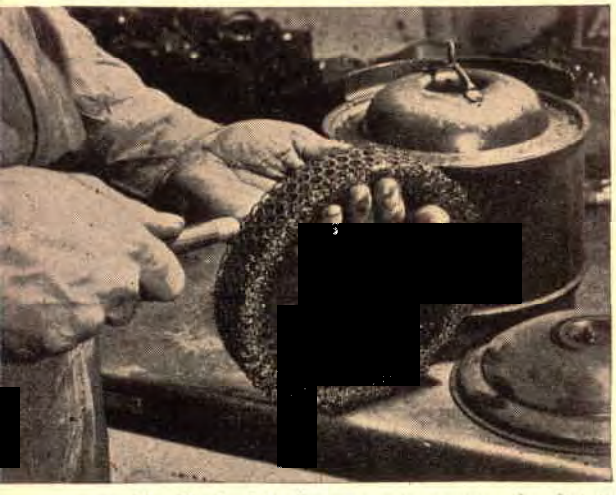
A more pronounced difference between a major and a minor tune-up is found in the factory recommendations issued for Buick. Here a minor job includes only four points—cleaning and adjusting the spark plugs, adjusting the distributor points, resetting the timing, and adjusting the carburetor.

On the other hand, Buick recommends that a major tune-up should include adjusting the distributor points, timing, carburetor,



7. Ignition timing is adjusted by attaching a neon light to No. 1 plug, setting the octane selector at zero, and rotating distributor to line up flywheel mark while the engine idles.

8. Valve tappets were set at the recommended clearances with a feeler gauge and adjusting wrench as seen here. A new gasket was used when the rocker-arm cover was reinstalled.



11. Sloshed in kerosene to remove the dirt it had collected, the filter element of the air cleaner was blown dry. It then was dipped in clean oil, allowed to drain, and replaced.

12. Idle speed and mixture were both adjusted when the air cleaner was in place. (It was off here so as not to obstruct the photo). Notice hose connected to vacuum-test engine.

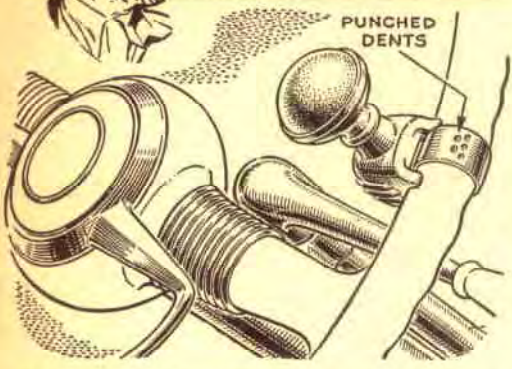
valve lash, fan belt, and voltage control; cleaning the air cleaner, crankcase ventilator, fuel filters, battery terminals, and spark plugs; checking the coil, condenser, distributor, vacuum spark advance, battery, automatic choke, and manifold heat control; and tightening the cylinder head, manifolds, and hose connections.

The testing equipment that's available also may extend the scope of the job. For instance, in the job presented here, the mechanic used an A. V. R. gauge to test the generator and voltage regulator (see top photo on page 142) after he had checked and cleaned the battery and terminals. In this shop the step is considered essential, for a generator output higher than the recommended maximum has a tendency to burn the points or damage the generator.

Some mechanics consider a lot of fancy equipment unnecessary, and they undoubtedly can give you an excellent tune-up job without it. But when properly maintained and honestly used, the testing equipment now seen in many shops can work to the benefit of both you and the mechanic by showing unmistakably what's needed.

At the conclusion of the tune-up illustrated here, a trained mechanic took the car out for a short road test. When he was satisfied, the job was marked okay for delivery to the customer. END

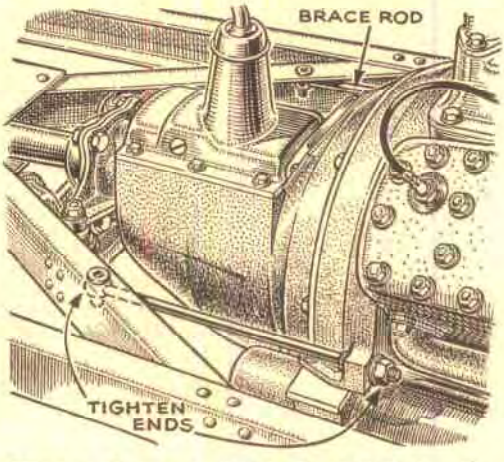
Hints from the Model Garage



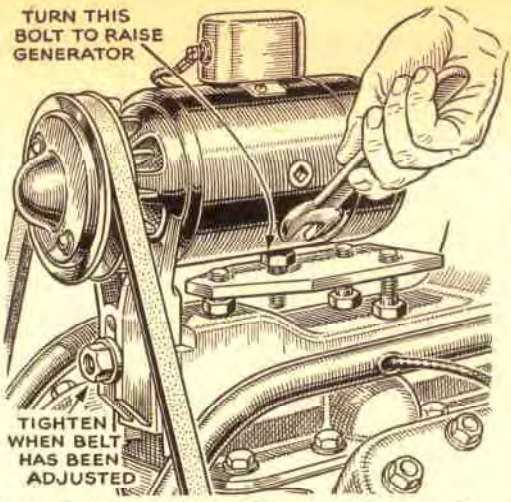
Steering Knob Kept Rigid. A spinner knob that twists in or out on the steering wheel can be cured by putting a few punch dots in the clamp. To avoid the possibility of cracking a plastic wheel, it's best to remove the spinner and clamp it on a broom handle or similar object. With a prick punch, make four or five dimples on opposite sides of the strap. When clamped, the spinner will remain in position permanently.—*Jim Sisley, Seattle, Wash.*

Light Does Double Duty. An accessory back-up light—the kind controlled by a separate switch—can be put to extra use as a direction indicator. Using red paint, I painted on the lens a big arrow pointing to the left. Now, when I'm making a left turn or pulling away from the curb, I flick the light on and off a few times. I've used the light for some time now and find it does its new job very nicely. It still gives ample light for backing.—*Ray Smiley, Detroit, Mich.*

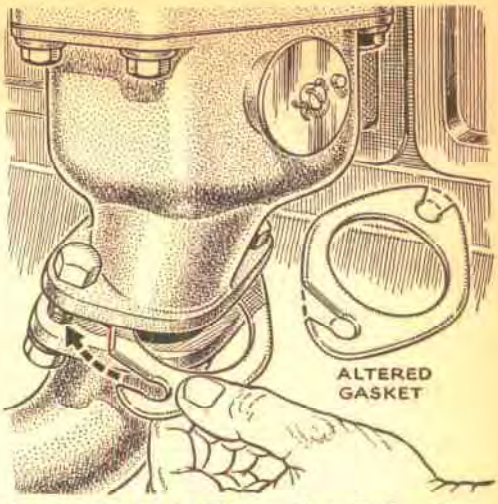
Replacing a Skirt Gasket. You can use a wide washing-machine cover gasket to replace a worn one on the fender skirts of some cars. Cut the rubber to length and stretch it around. Run a small wire hook through the inner side of each end. Fasten the hooks to the projections on the back of the skirt to hold the gasket.



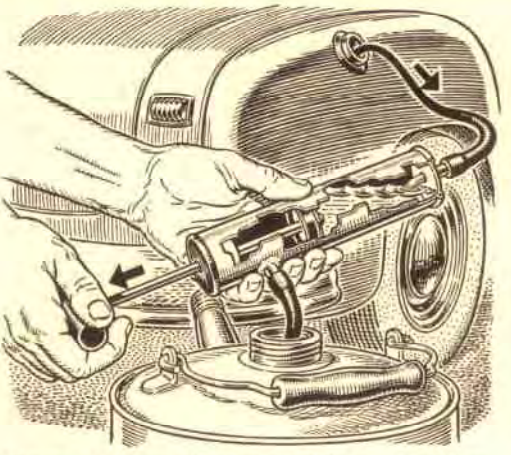
Keep Support Rods Tight. On prewar Ford V-8s, the two support rods that help anchor the engine at the rear have sometimes led to false diagnosis of clutch trouble. If the rods loosen up, the result is similar to clutch chatter. The remedy is simple: either tighten the rods or replace them.—*A. Zanelli, Clifton, N. J.*



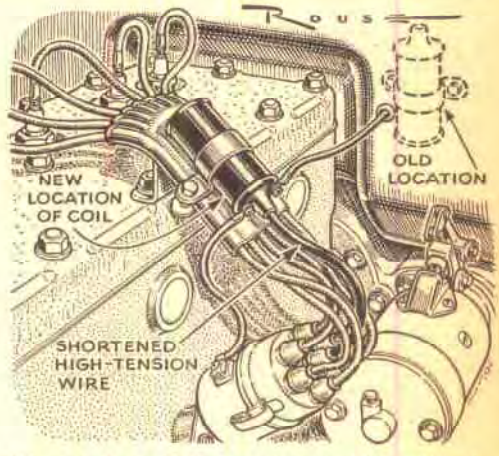
Tool Supports Generator. On some cars it's very tough to hold the loosened generator up in position while adjusting belt tension. The tool illustrated takes care of this. It consists of a piece of ½" steel plate tapped for four ½" bolts. Turning the one at the center with a wrench gives a powerful upward thrust, holding the generator at the desired level until the belt-adjustment nut can be tightened. Adjust the length of the leg bolts as required.



Gasket Slots Ease the Job. Narrow slots cut from the edge of a gasket to the bolt holes allow you to install a new one without taking out the bolts. This may be specially helpful on exhaust manifolds or other parts where bolthead clearance is scant, or where threads are so rusty that complete removal would be a time-consuming job. Just loosen the bolts enough to separate the flanges. The slots do not impair the efficiency of the gasket.



Spray Gun Siphons Gas. A siphon for drawing gas from a tank can be made out of an insect spray gun. Take out the plunger and reverse the cup leather. Cut off the spray container, enlarge the hole in the end of the cylinder, and solder in a piece of ¼" copper tubing. Solder a delivery tube near the other end.



Short Lead Improves Starting. On an older-model Plymouth, I have found that moving the coil from the firewall to the spark-plug cable support makes the engine easier to start. In the new position, the high-voltage wire from the coil to the distributor cap is shortened considerably.—*Ralph Wyant, Indianapolis, Ind.*

Educational Tricks Explain Car's Ignition

You can "make" a battery, hydrometer, ammeter, and spark coil.

By Kenneth M. Swezey

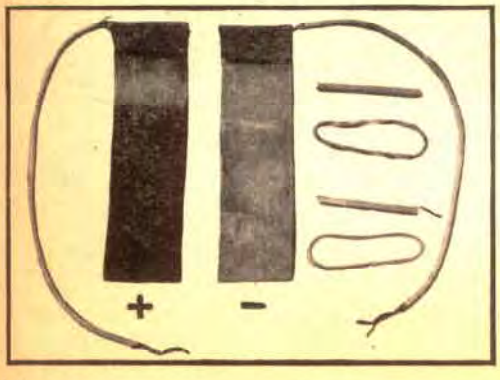
THE presto-chango stunts of the stage magician are trifles compared to what goes on in your car's ignition system.

There, in the battery, you start with a chemical reaction that produces low-voltage electricity. This current, as it is, runs the starter, horn, lights, and radio. But you also wind up, via spark-coil sleight-of-hand, with 18,000-volt miniature lightning flashes in the cylinders.

Oddly, a storage battery doesn't really "store" electricity. It merely changes electrical energy into chemical energy and vice versa. Its cells contain sets of porous lead plates, one filled with lead peroxide and another with spongy lead, immersed in dilute sulphuric acid. When the battery is discharging, the sulphuric acid reacts with the lead peroxide, forming lead sulphate. When the battery is charging, the sulphate is changed back into peroxide, and sulphuric acid is restored to solution.

The usual three-cell battery gives six volts. But the action of one coil that has only a few turns of wire on another that has several thousand times as many boosts this voltage to put sparks in the spark plugs.

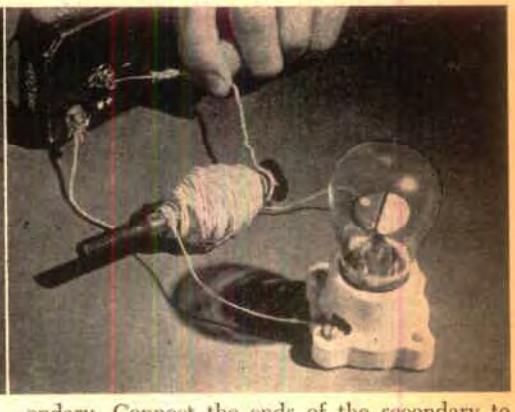
These setups "expose" this magic.



An experimental storage battery can be made in a jiffy from two lead plates (clean with sandpaper), two matchsticks to hold them apart, rubber bands to hold the assembly together, and a jar containing 1 part sulphuric acid in 9 parts water. (Caution: always pour the acid into the water.) To charge the battery, connect the plates for 5 minutes, as above at left, to 2 to 4 dry cells wired in series. During charging, oxygen is released at positive plate and hydrogen at negative. Some oxygen unites with positive plate to form brown lead peroxide. (Note its darkness in photo at the left.) To prove that the chemical change made by electricity can also return electricity, connect a flashlight bulb to the plates of your charged battery. The bulb lights as above.

How a hydrometer indicates the state of charge in a battery can easily be shown. A hydrometer is a simple float-sink device for checking the density of a solution relative to that of water. Improvise one by weighting a small vial so it floats upright in plain water in a bottle. Mark the water level on a paper scale as seen at left. If you now slowly add sulphuric acid to water, vial will rise, as at right. When a battery charges, lead sulphate is changed to sulphuric acid. This increases the density, making the hydrometer float higher. On discharge, acid is removed, causing hydrometer to sink.

An ammeter keeps tabs on car battery circuit by telling whether battery is charging or discharging. You can show in principle how one works. Wind several turns of wire around a pocket compass. Then turn the compass so that needle is aligned with the turns. If you connect a flashlight cell in series with the wire and a bulb, needle will swing to one side, repelled by magnetic field set up in coil. Now switch connections to battery, reversing direction of current flow, and needle will swing other way. This is what happens in car's ammeter. When battery is charging, current flows one way; when discharging, current reverses.

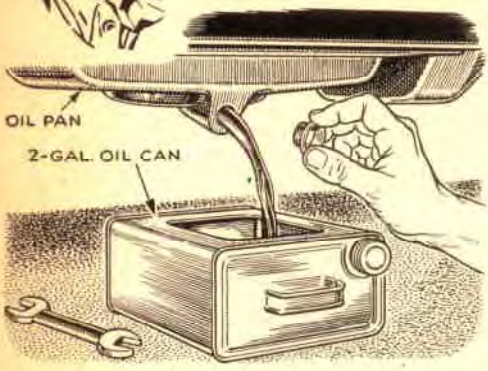


How a spark coil works. Without a coil to increase the voltage, the spark plugs wouldn't spark. As a demonstration, connect a 6-volt battery to a small 115-volt neon bulb, left. The battery alone won't light the bulb.

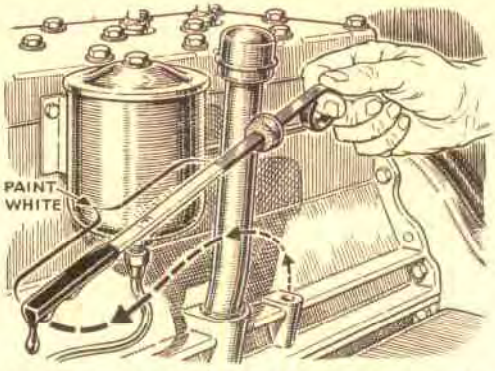
Now make a simple step-up transformer. Anneal an iron bolt by heating it red hot and letting it cool slowly. Wind 20 turns of bell wire smoothly on the bolt as the primary. Over this wind 400 turns of finer wire as the secondary. Connect the ends of the secondary to the neon bulb. Touch the ends of the primary momentarily to the battery posts. Each time you break the battery circuit, high voltage will be induced in the secondary coil. This will light up the neon bulb.

The same thing happens in a car's ignition system. A rotor in the distributor breaks the battery circuit. High voltage induced in the spark coil sends a spark across the plug gap.

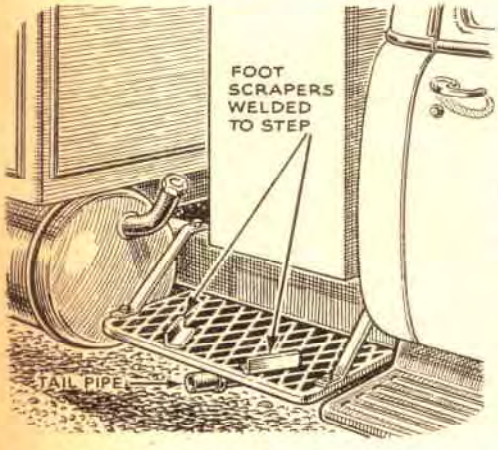
Hints from the Model Garage



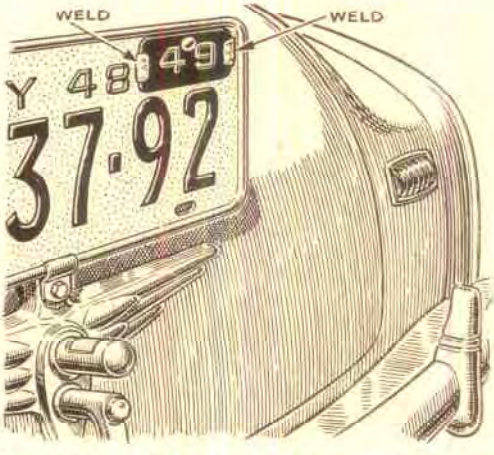
Oil Drained into Flat Can. Some new cars are so low that it's awkward to drain the crankcase without a lift. The job calls for a shallow but capacious pan. Victor H. Lamoy, of Upper Jay, N. Y., reports that an empty 2-gal. oil can with a large opening cut in one side gets under easily. Leave a lip around the hole to keep the oil from slopping when you drag out the filled can.



White Stick Shows Oil Level. It's always a little difficult to be sure of the oil level on a dark dip stick. M. M. Dierks, of Chicago, says a coating of white lacquer has taken care of the problem in his case. Before applying the lacquer, he scoured off all traces of oil from the stick and then cleaned it thoroughly with a wire scratch wheel to give good adhesion.



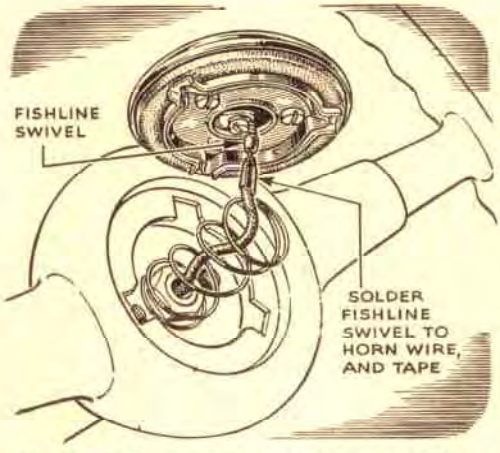
Foot Scraper Aids Safety. Wet mud is as dangerous on the step and floor of a truck cab as slippery ice. Operators of one Texas truck fleet welded foot scrapers on auxiliary steps just behind the regular ones to enable drivers to clean their shoes as they enter. To keep the step clear in winter, the exhaust line is piped underneath.



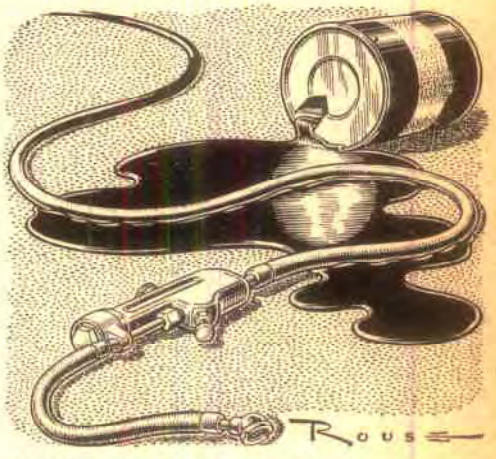
Welding Prevents Loss. To save metal, several states have adopted the practice of issuing small year tags for renewal of old license plates. To prevent loss or theft, you can tack-weld them to the plate. If carefully done, low-heat arc welding will not distort the metal nor burn more than a small, easily retouched area of paint.

Handkerchief Tags Car. When you must park in a lot where there are hundreds of cars, as at the beach, ball park, or fair grounds, you can make it easier to find your car by extending the radio aerial to its full height. First tie a handkerchief or piece of tissue paper to its tip.

Back Rest Flips Out of Way. Does your wife need a cushion behind her to reach the pedals easily? Here's an excellent method of having the cushion always available but still out of the way when not needed. You may also find it handy yourself for changing your position on long drives.

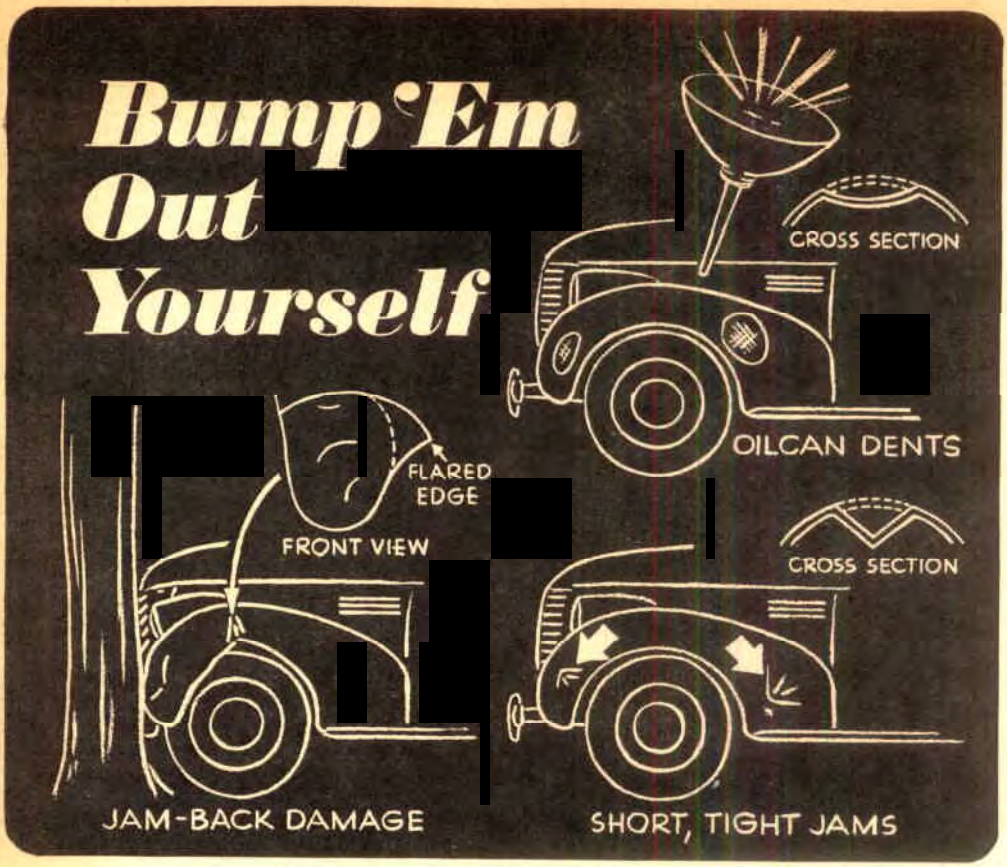


Swivel Safeguards Horn Wire. In some cars the horn wire inside the steering column is subjected to considerable twisting. C. B. Hopkins, of Tacoma, Wash., found that this caused the wire on his 1941 Ford to break several times. A brass fishline swivel, taped as shown above, took care of the problem nicely.



Oil Rots Rubber. If you run a shop, you know the cost of air hoses, battery-charger cables, and other rubber equipment. One sure way of increasing this cost is illustrated here. Grease and oil cause rubber to disintegrate rapidly. So keep such equipment off the floor. It's also a good idea to wipe off the lines occasionally.

Bump 'Em Out Yourself



Are your fenders dog-eared? It's easier to iron out dents than you may think. Just common tools are needed.

By E. F. Lindsley

THERE'S a rule to remember when you're removing a dent from an automobile fender. Even more than you'd like to get rid of the dog-gone thing, the dent itself *wants* to come out. Here's why:

A dent is as out of place in a stamped sheet-metal part as one in a drum head, and built-in strains are constantly trying to force the metal back to its original curvature. It follows that your work should be planned to give these forces a helping hand. Metal that's badly stretched, torn, or cracked is the only exception.

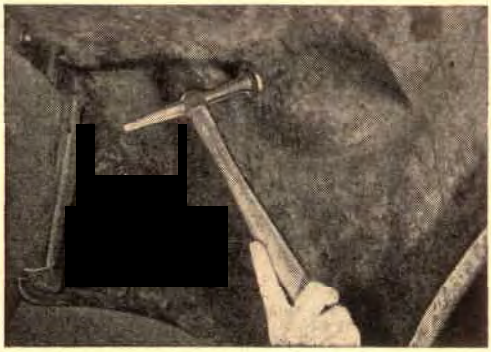
Fender dents fall into three general classifications. First and most common is the oil-can or dish-shape. A type more difficult to remove is the short crease, or jam, stretched into the metal by such unyielding objects as bumpers and lamp posts. The most troublesome is the jammed-back fender resulting from head-on impact. Here, the rolled edge of the fender shows a definite belling out and the front part is bent back toward the wheel.

All three conditions also are found in doors, hoods, rear decks, and other locations—but such cases usually require expert attention and special tools. Stick to fenders until you've gained experience.

Step one in removing any dent is careful examination of the edge contours of the fender. Sighting along the rolled bead and comparison with an undamaged member will usually disclose irregularities in the basic alignment. Once these have been spotted, use a jack or timber to force the misalignment back towards its original curve, and use blocks as needed to hold this pressure on the metal while removing the dent. Restoration of the original pressed-in stresses makes dents come out easily. If the rolled bead at the fender edge is buckled, straighten

Few tools are needed for home fender repairs. The main ones are hammers, a jack, spray gun, vixen file, wire brush, dolly, and wood blocks. A flexible-shaft sander-polisher also is useful.

Oilcan dents usually are easily removed and often the finish is still good. Sometimes just pressing out with your hand will do the job. Place the other hand on the outside as above.



Gentle tapping along the edges with a hammer will cause a stubborn oilcan dent to pop out. Avoid heavy blows and never strike the center.

Short, tight jams take hammer work from inside and a bumping dolly against the outside. Again confine the blows to the edges.

it at least partially before going further.

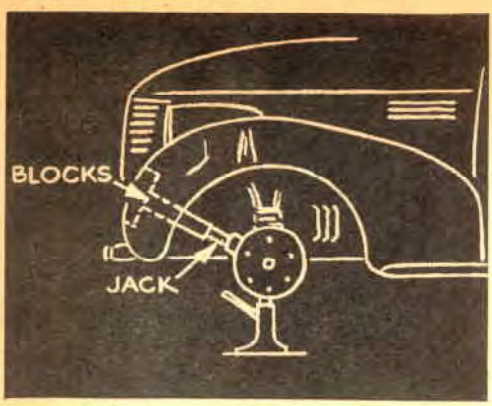
At this stage, a clean oilcan dent can often be popped out by a simple push with the hand. This is a satisfying occurrence. If a pop-out seems impossible, sight along the outer fender surface at the edge of the dent. Often a very slight raising of this edge can be detected. If such is the case, tap around this raised area from the outside. In theory, at least, the tapping builds further tension in the dented area. In practice, the theory will commonly prove out by allowing the dent to be popped out.

Should the depression still not yield to hand pressure, start with a light hammer, working from the inside of the fender, and tap gently around the edges of the dent. *Do not strike the dent in the middle.* Although a tempting tactic, the latter almost always results in stretched metal and a bulge in the finished job. The object of edge tapping is to reduce the sharpness of the dent edges. If this tapping is done in easy stages, the dent will either come out suddenly of its own will, or a push with the hand will spring it back.

Once the main dent has been returned to the natural contours, a few small dimples and a slightly raised area around the edges usually remain. Ordinarily these can be cleaned up with a few well chosen blows from a light hammer. Use the backing dolly here to prevent any tendency for dents to become "warts."

The jammed-back fender usually requires the application of a jack or timber, and over-forcing is necessary to allow for the natural spring-back. The technique is one of working back and forth; force the fender partly into line, straighten edges and remove major dents, bring more pressure on the alignment jack or timber, clean up the dents a bit more, and continue until the fender holds its proper alignment without springing back.

The removal of sharp, stretched depressions is often a real job. Severe metal stretching requires an acetylene torch and



Jammed fenders may be returned to position by placing a jack between padded wood blocks and a solid frame member. After normal contours are restored, clean up all minor dents.

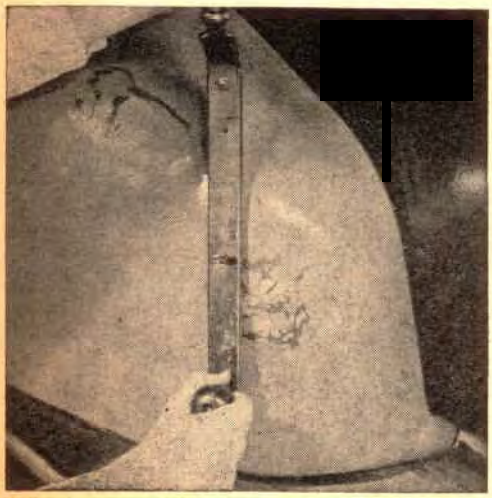
Refinishing the dent area requires thinner, primer-surfacer, rubbing compound, sandpaper, finishing color, and masking tape. Lacquer is preferable to enamel since it dries quickly.

a metal-shrinking technique to cure it, and a repair shop is the place for such work. However, if the damage is not too serious, treat it the same as you would an oilcan dent. Begin at the edges and gradually level out the entire area to the general contour. Frequent backing of the hammer with the dolly is called for here. When a sharp dent is removed, it should be remembered that the excess, stretched metal must go somewhere. It may compress slightly, but not enough to return to its original form. Hence, it is necessary to distribute, or "blend," the extra metal over a somewhat larger radius of curvature than the original shape. If this blending is skillfully done, the ordinary eye cannot spot it.

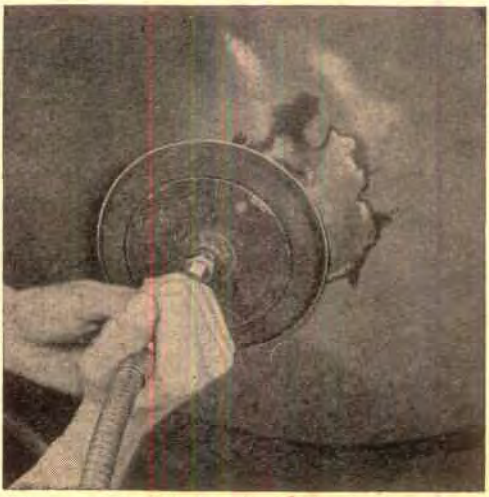
Refinishing is essentially the same for all dents. Begin by cutting down the high spots with a vixen file. Excess filing is, of course, to be avoided. When a slight amount of cutting fails to bring the entire surface true, it is a sign that the hammering is not right and more gentle tapping is needed to bring up the low spots the file misses.

When the repaired area reveals no irregularities to the eye or fingertips, a flexible shaft and rubber-backed abrasive disk are useful for removing file marks and feathering back the old paint finish. If such equipment is not available, the worst file marks can be taken out with a mill-cut file.

In home repairs, a better job will result if the entire fender or panel is repainted. The first step is removal of old wax, oil, and



Using a vixen file in long strokes, begin to remove tool marks and feather back the old paint around the damaged area. Also clean all wax, oil, and dirt from the surface.



Clean up the file marks with abrasive paper and rubber polishing disk on a flexible-shaft tool. Then rub the area with wet sandpaper to get a good priming and painting surface.

dirt. Cleaning preparations made for this particular job by paint manufacturers should be used. Sanding does not remove wax satisfactorily but merely forces it into the old finish. Once the surface is clean, water-sanding with No. 320 paper is in order. Incidental scratches can be leveled down and the old paint surrounding the repair feathered back with 280 paper. Always use the finer paper over the spots sanded with 280; the coarse scratches have a way of coming through.

After sanding, clean the surface once more and avoid touching it from there on. Mask any parts in line with the overspray.

Mix a supply of primer-surfacer and spray it lightly over the repaired area and any areas that were deeply scratched. Build up successive thin layers of surfacer but at no time apply so much that it tends to run or sag. Drying time depends somewhat on the air conditions. For best results, the temperature should be around 70 deg. F. In any case the primer-surfacer should be "hard" dry before you attempt to sand it. Usually an hour or less is adequate for drying and a careful pressure with a finger nail will show if the primer is hard.

Use 320 paper and water to sand the primer to an absolutely smooth surface and to feather out the edges. Clean the surface carefully with water and examine it for imperfections. If any are found, it means that the sanding was inadequate, or, if the sanded primer is thin and bare metal shows through, insufficient primer was applied. In the latter case, another build-up of primer is indicated.

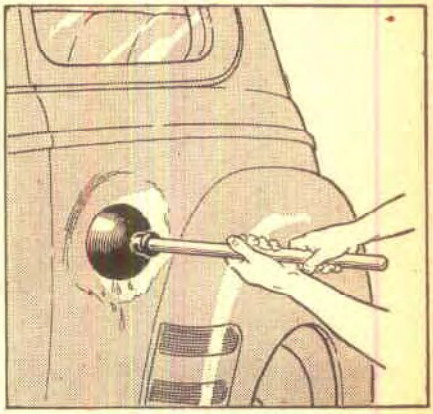
When the car has a synthetic enamel finish, enamel may be used if a dust-free work place is available. However, lacquer is probably best for amateur finishing. It can be applied outdoors in nearly anything short of a high wind or plague of gnats, and it dries rapidly. If you don't have a spray gun, you can still get excellent results with auto enamel, paintbrush, and patience.

The usual spray procedure with lacquer is a thinned out mist coat—to give the following coats something to "hang" to—followed by several cross-lap coats for build. Don't be afraid to put on enough lacquer, and pay particular attention to the fender edges and projections where subsequent rubbing is likely to cut deep. Once the final spray pass has been made, clean out the gun and forget the job for at least a day.

Then examine the spray job carefully for orange peel, blemishes, runs, and other imperfections. (Orange peel is the term applied to innumerable tiny pits resembling the skin of an orange.) A surface skillfully sprayed with good equipment should need no more than a quick rubbing with compound. An amateur job may require more elbow grease. If done very gently, wet sanding with 400 or 600 paper generally will remove runs, orange peel, small dust motes, bugs, and pipe ashes.

Follow the sanding with rubbing compound, and then wax the fender. END

Lay a smooth surface for the finish coat by applying the primer with a spray gun. Follow the priming coat with wet sanding. You'll get a better job by refinishing the entire fender.



A sink plunger often will enable you to pop out a dent that's located in a spot you can't get behind. Dip the plunger in water first. The drawing shows how it's done.—*L. B. Wessel, Madeira, Ohio.*

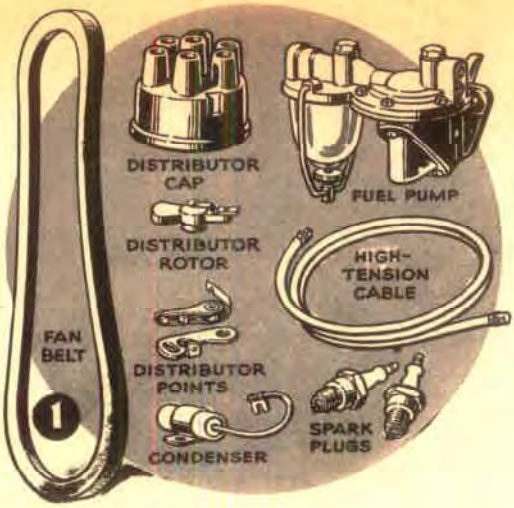
AUTO HINTS

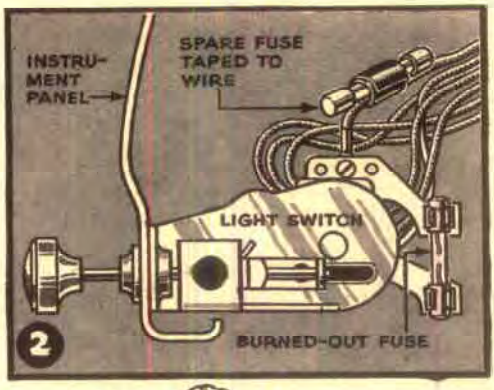
1. Spare Parts Pay Off. Some years ago I adopted the practice of always carrying this kit of spare parts, and at one time or another I have found a use for each item. Even if someone else makes the repairs, it is often a timesaver to have the necessary part readily available. Incidentally, the cable, long enough to reach from the coil to distributor, may sometimes be the means of starting the car when the original has become wet.—WALTON E. BRIGGS.

2. Keep Extra Fuse Handy. A fuse seldom blows on a car, but when it does you may be out of luck if you haven't another. A good idea is to tape a spare to a wire leading from the fuse or at some other adjacent point.—J. O. SACKERSON.

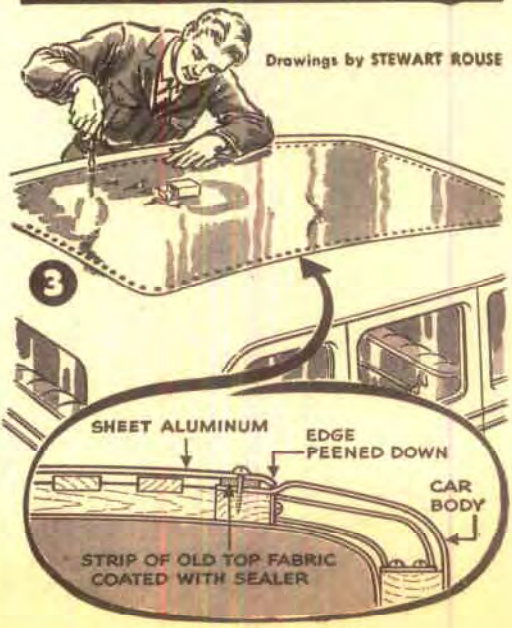
3. Aluminum Used for Top. A new car roof may be made from a 4′ by 6′ sheet of war-surplus aluminum. Using the old roof as a pattern, I cut the aluminum ¾″ wider all around. Then I peened down the edge, cut strips from the old fabric top, coated them with sealer, placed them around the edge, and fastened the aluminum with brass screws spaced 1½″ apart. The roof is perfectly rainproof.—HOWARD CARE.

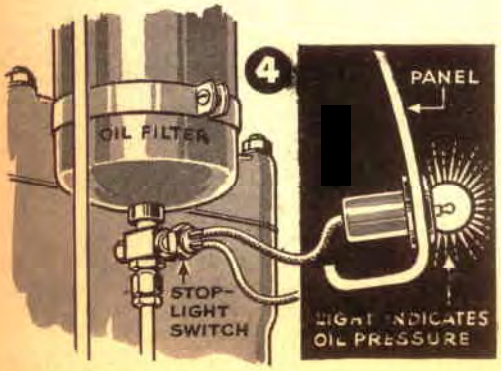
4. Light Shows Oil Pressure. Unable to buy a new oil-pressure gauge, I installed a hydraulic stop-light switch on an oil line, ran a lead from the hot ammeter terminal to one side of the switch, and a wire from the other side to a light on the dash. As long as there is sufficient oil pressure, the light glows.—JAMES SWAIT.





Drawings by STEWART ROUSE





Replace That Worn Upholstery

RIPPED or worn door lining makes a car look years older. Replacing the old lining with composition board is a simple job. You don't have to be an expert upholsterer, and all you need are a few hand tools. The board will give your car's interior a clean, neat look and it'll wear for years.

The photos below and on the next page show such a job being done with ⅛" Leatherwood®, made by the Masonite Corp., Chicago. This board has a simulated-leather surface. The board requires no finish, but you can paint or tone it to any shade you want. It can be cut with an ordinary saw, but should be cut slightly full. Frayed edges left by the saw can be removed by careful filing after the new panels are mounted on the car doors. Use a medium file and draw it from the surface of the board toward the back. Don't file in both directions or you may chip the board.

After you've cut out the new panels, clamp them in place on the doors. Check the location of the holes that are already ➧

First step in replacing upholstery of car door is removing window frame. Back out screws and you can lift the frame out of the window.

Take off door handle and window crank. Press inward on base plate to expose lock pin. Use small nail to push pin out of collar and shaft.

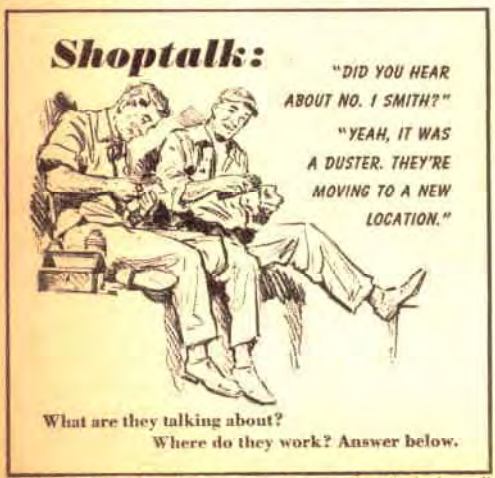
The old backing board usually is held to door by spring prongs snapped into holes in door. Pry prongs out of door with a screwdriver.

in the door before you drill new holes. Then you won't be drilling through the board and into an old hole. The old holes will be too large for the ½" 8-32 self-tapping screws that you'll use.—*Emil E. Brodbeck, Mt. Vernon, N. Y.*

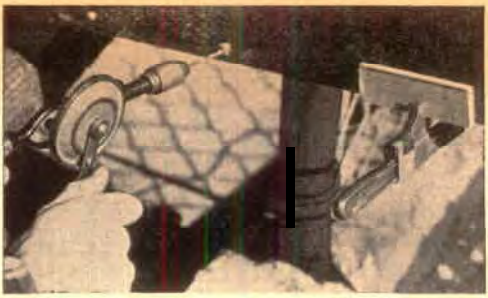
Place new material face down. Put old board face down on top of it. Use old board as pattern and draw all around it with chalk.

Paper Cup Lines Gluepot

WHEN mixing a small quantity of glue or wood filler, I raid the kitchen for one of the paper containers that's used for baking cup cakes. I insert this in a small tin can, mix the glue in the cup, and, when I'm through, discard the cup. Result: no messy gluepot to wash out.—*Tom Griberg, Moline, Ill.*



They're oil-field workers. No. 1 Smith is the name of a well—the first well drilled on the Smith lease. Duster is a dry hole. The drill rig is being moved to another spot to drill another well.



Use No. 28 drill and ½" 8-32 self-tapping screws. Drill holes through composition board and into car door. Space holes 6" or less apart.

Holes for window crank and door handle will have to be drilled before board is mounted. Round edges of the board with a file.

He Drives from the Sidecar

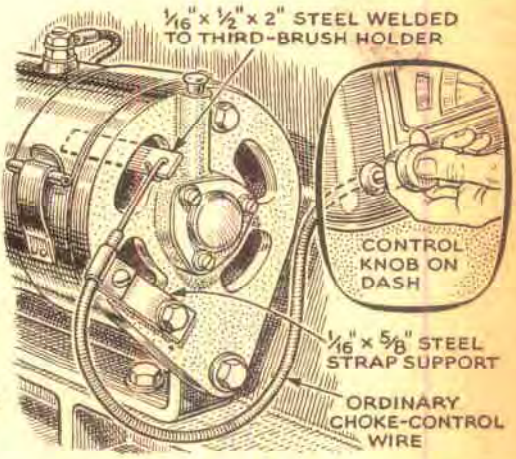
WHEN August Paul travels with his motorcycle, he rides comfortably in the sidecar instead of straddling the bike in conventional fashion. A mechanic in Munich, Germany, Paul rigged up the vehicle himself, installing a steering wheel, gear shift, and other controls in the sidecar.

Hints from the Model Garage

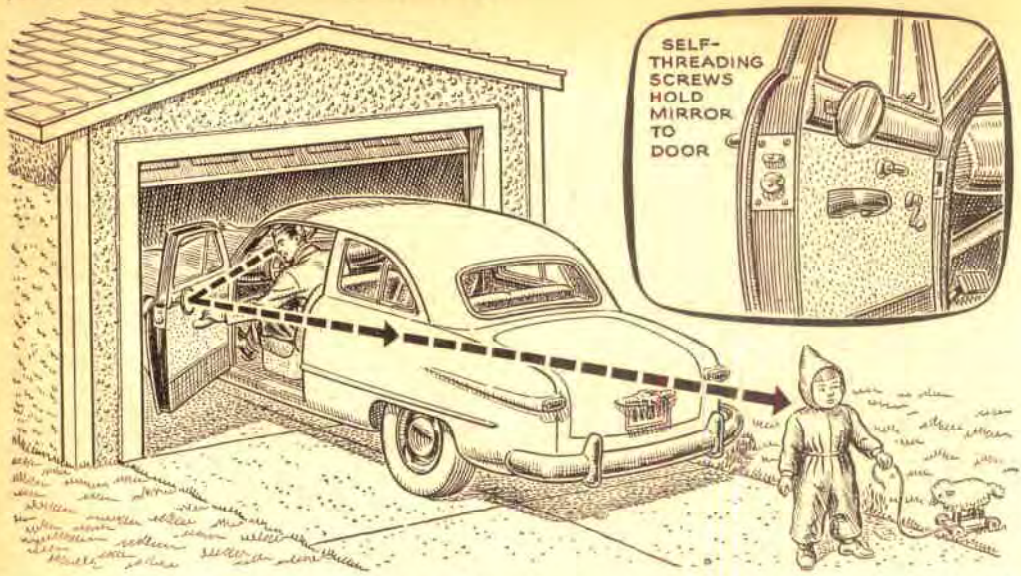
Look, One Hand! In a spot where there's barely space for one hand, how can you tape a wire? Simple enough, says Harry Morse, Oakland, Calif. Tear off a piece, re-roll with the sticky side out, and wind on with the fingers of one hand.

Filter Your Antifreeze. Before putting stored antifreeze back into your car, it's a good idea to filter it through a wad of absorbent cotton placed in a big funnel. You'll find a surprising amount of last year's dirt on the cotton.

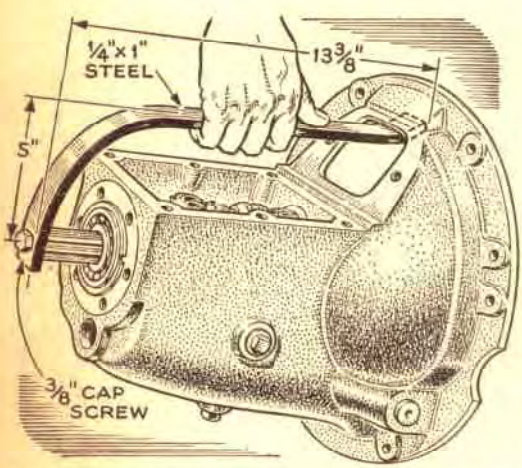
Clearing Fogged Windows. Richard H. Hanson, of Melrose, Mass., makes it a practice to carry an extra windshield-wiper blade. Besides serving as a spare in case of loss of one of the regular blades, it also comes in handy as a squeegee for clearing fogged windows. It's also useful for drying the windows after a car wash.



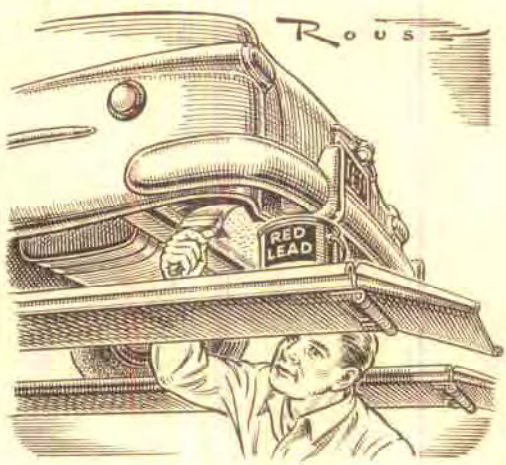
Varies Generator Output. This control enables Rowlins Howard, Rushville, Ind., to vary the generator output on his 1934 Chevrolet to suit conditions. On short hops and at night, he pulls the knob and gets readings of 15 or 20 amp. On a long trip he cuts output back to 4 or 5. This helps prevent battery overcharging.



Door Mirror Widens View. If there are children in the neighborhood, backing out of a driveway is always a risky business. A mirror mounted on the driver's door as above will help cut down any blind spot behind the car. Locate it as near as possible to the outer edge of the door to get a wide angle of vision.

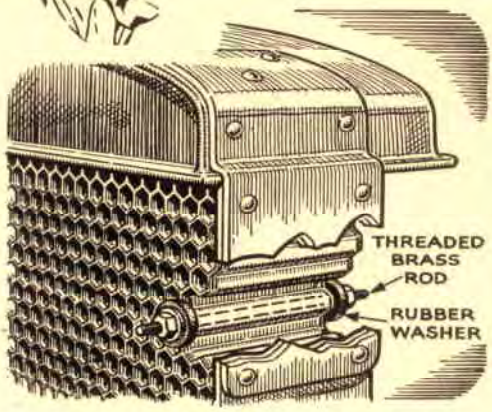


Transmission Lifter. Back in the days when Fords had the shift lever on the floor, the lever could be used to lift the transmission out of the car. But on later models there's practically nothing to which you can hold. To ease the job, mechanic William E. Ware, of Shirley, Ind., made the lifter shown here.



Red Lead Stops Rust. If you don't want to spend the money for a regular undercoating job, you may want to try red lead. You won't get any sound deadening, but at least you can protect the fenders and other metal from rust. A. Bogossian, Brooklyn, N. Y., reports he finds absolutely no rust two years after doing his car.

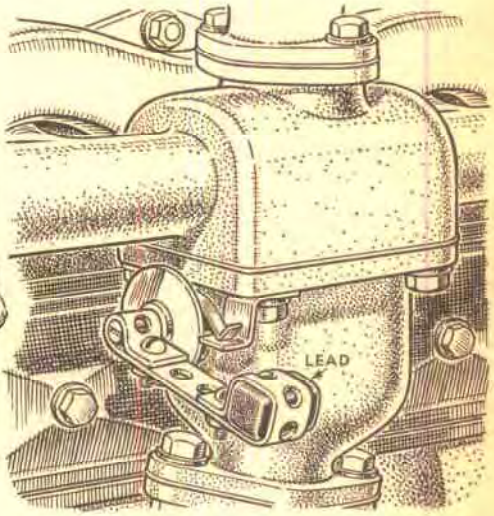
Hints from the Model Garage



Stopping a Radiator Leak. When a leak developed in one cell of his honeycomb type of radiator, Joseph C. Cappetta, New Haven, Conn., stopped it as shown. The brass pin must be longer than the depth of the cell. The rubber washers seal the leak.

Oil Line Shows Better. To make the oil line more visible on your crankcase dipstick, Edward Wujcik, of Detroit, suggests heating the gauge end red hot in a gas flame and then letting it cool. The heat changes the color of the stick.

Paper Tests Brakes. Not sure which of his front brakes was grabbing, Lewis A. Emswiler, of Etna, Ohio, placed several sheets of newspaper on the garage floor in line with the wheels. Driving on the paper, he applied the brakes. The wheel with the grabbing brake ruffled the paper. It remained smooth under the other.



Homemade Balance Weight. When the balance weight on his manifold heater broke off, Sidney E. Lang, of Bakersfield, Calif., made his own as shown. After bolting a piece of plumber's strap around the control rod, he formed a loop in the other end, adding just enough lead to keep the valve open while the motor was cold.

ENGINE NOISES

Does Your Engine Purr . . .

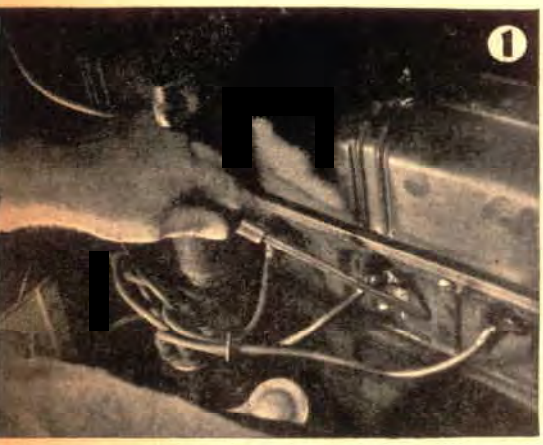
ANNOYING though it may be when your engine develops a click, rattle, thump, squeak, or pounding that you haven't heard before, such noises serve two valuable purposes. They act as danger signals, and they also serve as clues by which you can determine where the trouble lies. Once you have tracked down the sound to its source, it is usually easy to decide what, if anything, you ought to do about it. Some noises—once you know what causes them—can safely be ignored.

Any knock is first of all a warning—a warning that some part of your engine isn't functioning as it should. It usually comes in plenty of time for you to make the necessary repair before serious damage is done. And for the average driver, faced among other things with a shortage of major replacement parts, this *is* a blessing.

All drivers are familiar, of course, with the fuel knock. When using a poor quality of gasoline it is often heard when your car is pulling a heavy load. Provided ignition timing is correct and the engine isn't loaded with carbon, this knock simply means that the engine wasn't designed for the poor gas it is forced to burn.

But those raps, slaps, thumps, metallic knocks, clicks, throbs, roars, whines, hums, and squeals—they can mean something entirely different, and they frequently do. You will find it well worth your while to learn what each means, if only to know which can be safely ignored and which can't.

An illustrated table of eight of the most



1 Shorting out each cylinder in turn will often locate the one in which the cause of a knock exists. This eliminates much unnecessary work in hunting for a faulty part. Short the spark plug with a screwdriver that has an insulated handle

2 Warped valves or broken springs like those shown in the photo cause rapid clicking. The noise can be lessened by the shorting test. New parts should be installed for the defective ones

3 Running an engine having broken piston rings can cause trouble. The ruined piston shown below was chewed up by faulty rings. Sharp clicks at all engine speeds indicate a broken ring. The noise is not decreased by shorting the spark plug

AND WHAT THEY MEAN

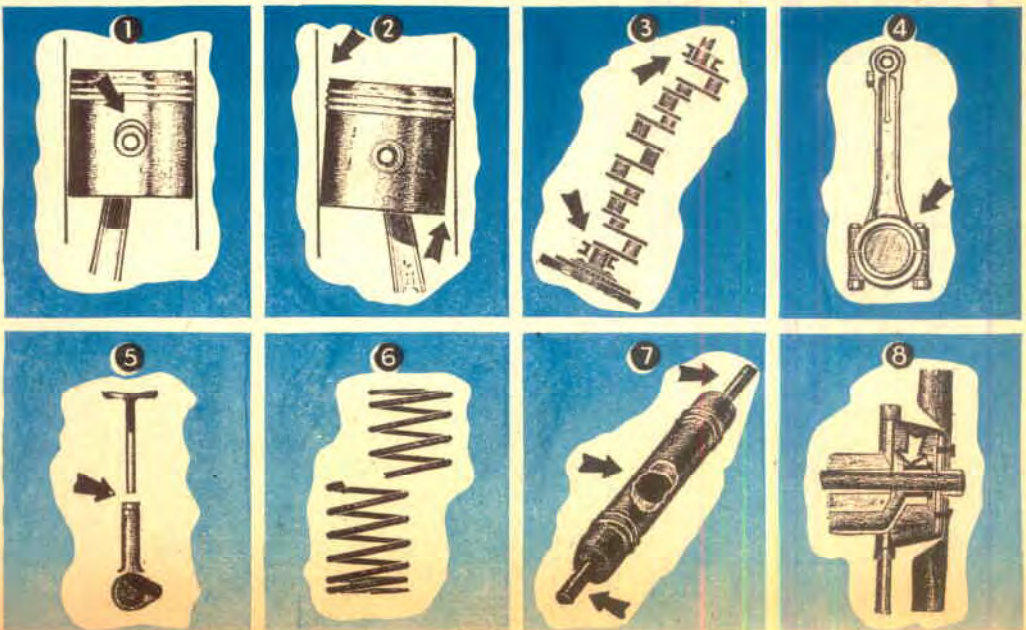
or Does It Knock, Thump, Pound, and Chirp?

important of these noises is given in the chart below along with their causes and cures. You must remember, though, that noises in an engine are at best difficult to describe, and many are so nearly alike that you may find it hard to distinguish between them. With practice you should be able to tell most of them apart and learn to locate the underlying trouble by considering three factors: the kind of noise, when it occurs, and what effect shorting out spark plugs has. This will prove a great help in determining whether to look for it on the spot or whether you can postpone the search until a convenient time.

A simple trick is used by expert mechanics to locate a knock. They hold a screwdriver or other rod of iron or steel to various parts

COMMON ENGINE NOISES

SOUND	WHEN HEARD	CAUSE	DIAGNOSTIC CHECK	TREATMENT
SHARP RAP	IDLING SPEED	❶ LOOSE WRIST PIN	CAN BE SHORTED OUT	REPLACE PIN
FLAT SLAP	ACCELERATING UNDER LOAD	PISTON SLAP ❷	CAN BE SHORTED OUT, LESSENS WITH HOT ENGINE	REBORE BLOCK AND REPLACE PISTON
INTERMITTENT, HEAVY THUMP	RUNNING WITHOUT LOAD	CRANKSHAFT END PLAY ❸	CANNOT BE SHORTED OUT, DISAPPEARS UNDER LOAD	TAKE UP
METALLIC KNOCK	IDLING AND SLOWING DOWN	WORN OR LOOSE BIG-END BEARINGS ❹	CAN BE SHORTED OUT, DISAPPEARS UNDER LOAD	REPLACE BEARING
RAPID CLICKING	CONSTANT	INCORRECT VALVE ADJUSTMENT ❺	CAN BE SHORTED OUT BY CYLINDERS, FEELER GAUGE SHOWS WRONG GAP	READJUST
LOUD, RAPID CLICKING	CONSTANT	BROKEN VALVE SPRING ❻	CAN BE PULLED BUT NOT STOPPED BY SHORTING	REPLACE
THROB, ROAR, KNOCK, OR CLICK	CONSTANT, CONSPICUOUS ON ACCELERATION AND AT HIGH SPEED	LOOSE MUFFLER, BAFFLE, OR PIPE ❼	CANNOT BE SHORTED, INSPECT FOR TIGHTNESS	TIGHTEN OR REPLACE
WHINE, HUM, OR SQUEAL	CONSTANT, CONSPICUOUS AT IDLING SPEED	WORN WATER-PUMP OR FAN-PULLEY SHAFT OR BEARING ❽	CANNOT BE SHORTED, DISAPPEARS WITH GREASING	GREASE, REPLACE IF NEEDED



of the engine and listen at the other end to locate the point at which the noise sounds loudest. This may not be easy at first, but with a little practice the trick should prove valuable. Try holding your thumb on the rod at one end. Place your ear close to the thumb and touch the engine here and there with the other end of the rod.

If the noise originates in one cylinder, it can often be located by a process of shorting it out. In this test use a screwdriver with a wood or insulated handle and simply short out one spark plug after another until the noise disappears during the shorting. The cylinder in which the trouble is occurring can thus be determined, and the loose wrist pin, slapping piston, faulty connecting-rod bearing, or defective valve can then be ferreted out without taking down more of the engine than is necessary.

A loose or worn big-end bearing on a connecting rod can be located in this way. It also often makes itself known to the experienced mechanic by its metallic knock when the engine is idling or slowing down—a noise that disappears when the engine is under a light load. One test is to accelerate the engine and then to close the throttle suddenly, at which time the knock should be very pronounced. Examine the bearing, and if it is worn or loose, the most practical treatment is to replace it with a new one.

The identifying noise of a loose wrist pin is a sharp rap, also occurring at idling speed. Such a pin is also best replaced by a new one. If the old pin is broken, the noise will be very loud and very metallic. Such a pin is dangerous as it may break the piston and cause serious damage to the engine. Even if the noise can't be shorted out entirely, shorting will soften the sound.

A piston that has become loose in the cylinder slaps against the walls with a flat, slapping sound heard when accelerating and when under load. It is less apparent when the engine becomes hot. The noise disappears when the correct cylinder is shorted out. The remedy is to remove the faulty piston, rebore the cylinder, and install an oversize piston. Broken rings cause a sharp click at all speeds and can't be shorted out. They should be replaced before they do any damage.

Loose main bearings are indicated by a deep, heavy, dull thump, increased on acceleration and under a heavy load. However, loose bearing shells in the crankcase cause a knock so similar to a main-bearing knock that it is almost impossible to distinguish between them without tearing down the engine for inspection. If a main bearing is at fault, it is best to replace all the main bearings while the engine is torn down; but only the bearing shell that is loose needs to be replaced. A loose shell can rarely be made to fit correctly again. Too much end play in the crankshaft causes an intermittent, heavy thump. It disappears under even a slight load. The end play should be taken up by the means provided in the design of your particular engine.

Replace loose camshaft bearings, but check first for broken or sheared dowel pins and replace them as well as the faulty bearings. Inspect the gear if end play is indicated, for it may not be tight enough on the shaft and pressing it on tighter may eliminate the difficulty. If a worn thrust plate causes end play, it should be replaced by a new one, as should a gear that has a chipped or broken tooth.

Valve noises range from light taps and slaps to squeaks and knocks, and as a rule they do not indicate trouble that might lead to a major breakdown. The most common are those caused by improperly adjusted push rods where excessive clearance results in tapping. It is simple to readjust them to the manufacturer's specifications unless the adjustment units have become worn, in which case new adjustment units should be installed. You can short out or reduce noises caused by incorrect tappet adjustment.

It may be necessary to put in a new push-rod assembly if wear in the push-rod guides cause side slap. If the assembly is loose on the block, indicated by a rattle, a general tightening of all nuts is sufficient. New valves and guides are required when valve stems are loose in the guides. If valves stick, the engine should be cranked over slowly with the valve cover off so you can see whether all the valves come to a normal closed position. Any that do not will probably be warped or have a broken spring. Defective units should be replaced. Broken valve springs cannot be shorted out completely, but the sound can be dulled.

In addition to these main engine noises, there are miscellaneous knocks and thumps that it is well to know. Various loose engine supports may allow the engine to thump on its bed on rough roads or when the clutch is being engaged or disengaged. A loose muffler or loose baffle plates in the muffler can set up a disturbing racket, as can a loose tail pipe. Ungreased or worn water-pump bearings or ungreased fan pulleys will often cause an eerie whine. A loose flywheel knocks most noticeably when the engine is accelerated and also while the clutch is being engaged or disengaged. Wear in a distributor shaft or bushing often causes a grinding noise when the engine is idling. Timing gears that are meshed too tightly will hum like a worn rear end but not so loudly. Most of these parts can await repair at your convenience.

Does Your Car Look Its Best?

YOU CAN GET RID OF DENTS, SCRATCHES, AND SQUEAKS IN YOUR OWN GARAGE BY FOLLOWING A FEW SIMPLE STEPS

DAMAGED body and door panels and bent fenders can spoil the appearance of your car even when they are thought to be too small for a professional shop-repair job. Usually where there is a dent, the paint will be cracked and will soon begin to peel, making a spot that can be attacked by rust. All small repairs can be done in your own garage, and many more serious ones, including straightening and welding of actual breaks, are not too difficult for the driver-mechanic if he follows a few simple rules.

The driver who takes pride in the appearance of his car will also want to touch up thin spots in the finish even when the metal has not been damaged. And he will be wise to take a few elementary precautions to keep an original finish or a new paint job looking its best for a long time.

Before an attempt is made to straighten a panel or fender, the damaged place should be examined carefully to determine from what direction the damaging force came, at what point it first made contact, and where it continued its line of travel across or into the metal. This is important, for if an expert repair is to be made, the metal must be pushed back in just the opposite sequence to that in which it was caved in. The place to start the repair is the place where the damage stopped.

High spots, where the metal buckled out after an impact pushed it in, are always hammered down first; then the low spots are hammered up. Never start by hammering the low spots because this will stretch the metal out of shape, causing additional work to bring it into line and making it necessary to repaint an entire panel.

Be sure also to clean the undersurface with a wire brush, putty knife, or scraper to keep hardened dirt from pitting and blistering the metal and from scarring the dolly and hammer. A thin coating of oil on the finished side will show up defects that might not otherwise be seen, will protect the finish during hammering, and on small jobs may even save repainting. If it is more comfortable to work with a wheel or bumper removed, do so, for plenty of room is needed to handle the tools properly. Torn metal

should be straightened first and then welded.

Drawings below show a system of unlocking and unrolling the damaged metal in an auto panel as suggested by a tool and forging company of Cleveland. The panel was struck at *B* (Fig. 1) with force moving in the direction of the arrow. *B* was pushed in, and the flange at *C* and the point at *A* bulged out. *A* was the last to buckle and is the first point to be unlocked, a dinging spoon and hammer being used, as in Fig. 2. *C* is dinged down next; then the low metal is bumped up from below with a dolly block, starting at *B* and working to *E* (Fig. 3) and completing the job by working from *B* to *C*. The contour on finishing these simple steps will be exactly the same as before the accident, as shown in Fig. 4. Fenders are straightened similarly.

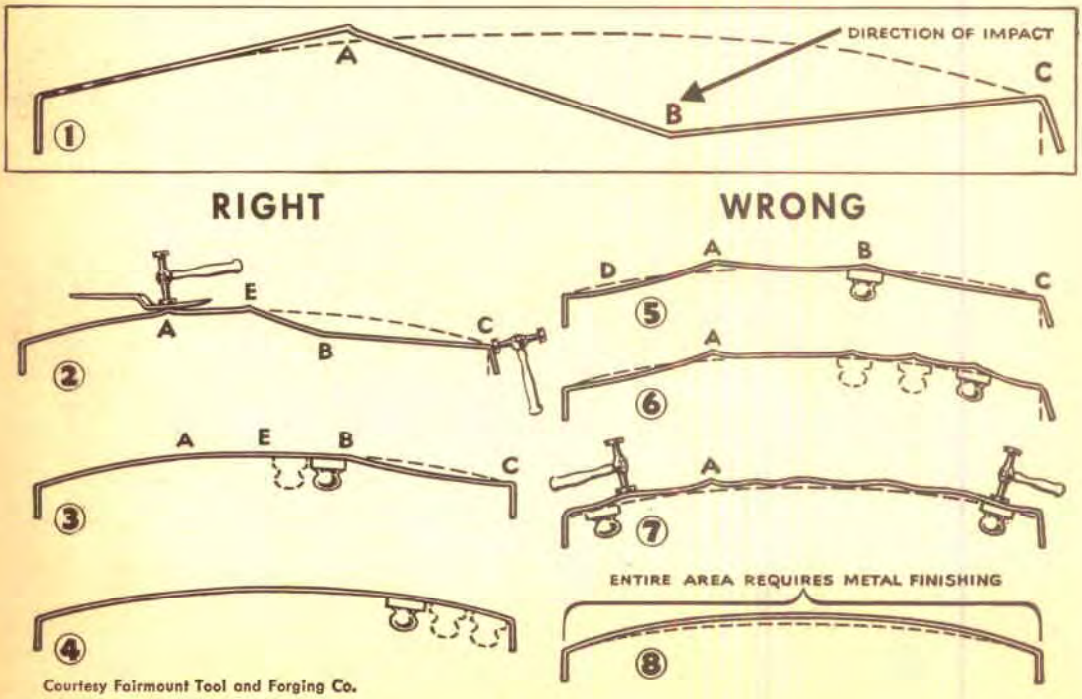
Figures 5 to 8 illustrate a wrong way to straighten the same panel. When *B*, the low point, is roughed out first (Fig. 5), *A* remains locked and acts as a fulcrum to depress *D*. Further roughing from the underside raises a series of humps (Fig. 6) that must be smoothed out with hammer and dolly (Fig. 7) and will leave the metal stretched beyond its original contour (Fig. 8).

Use the same finish as the original when touching up spots or painting a panel, for while enamel and lacquer may match perfectly in color, they react differently to weather and the patch will soon be noticeable. Dry enamel with a heating lamp, if possible, to approximate factory procedure; then allow a little time for seasoning before applying polish. Lacquer can be treated with liquid polish as soon as it dries. Wait about two weeks before using wax on either to let new and old finishes blend.

Original finishes and new paint jobs can be made to last longer if the car owner realizes that even the new synthetic lacquers, rustproofing undercoats, and better enamels of the last decade or so need some care. Few realize, for instance, that the ultraviolet rays of sunlight are destructive to the binder carrying lacquer or enamel pigment or that, if a car remains outdoors overnight, dew and fog assist the action of the ultraviolet rays when the morning sun gets in its work. Fortunately this deterioration takes place only on the surface, and a suitable polish will remove the dead film and restore the gloss.

Salt and calcium chloride, used sometimes to melt ice and snow, make solutions that

REPAIRING DENTS IN YOUR CAR is simplified by the process shown below. The buckle that occurred last is the key to a perfect job of straightening. The panel below was hit at *B*, which caved in, C buckled next, and then A. Dinging A down unlocks the damage so bumping can unroll the bent metal



Courtesy Fairmount Tool and Forging Co.

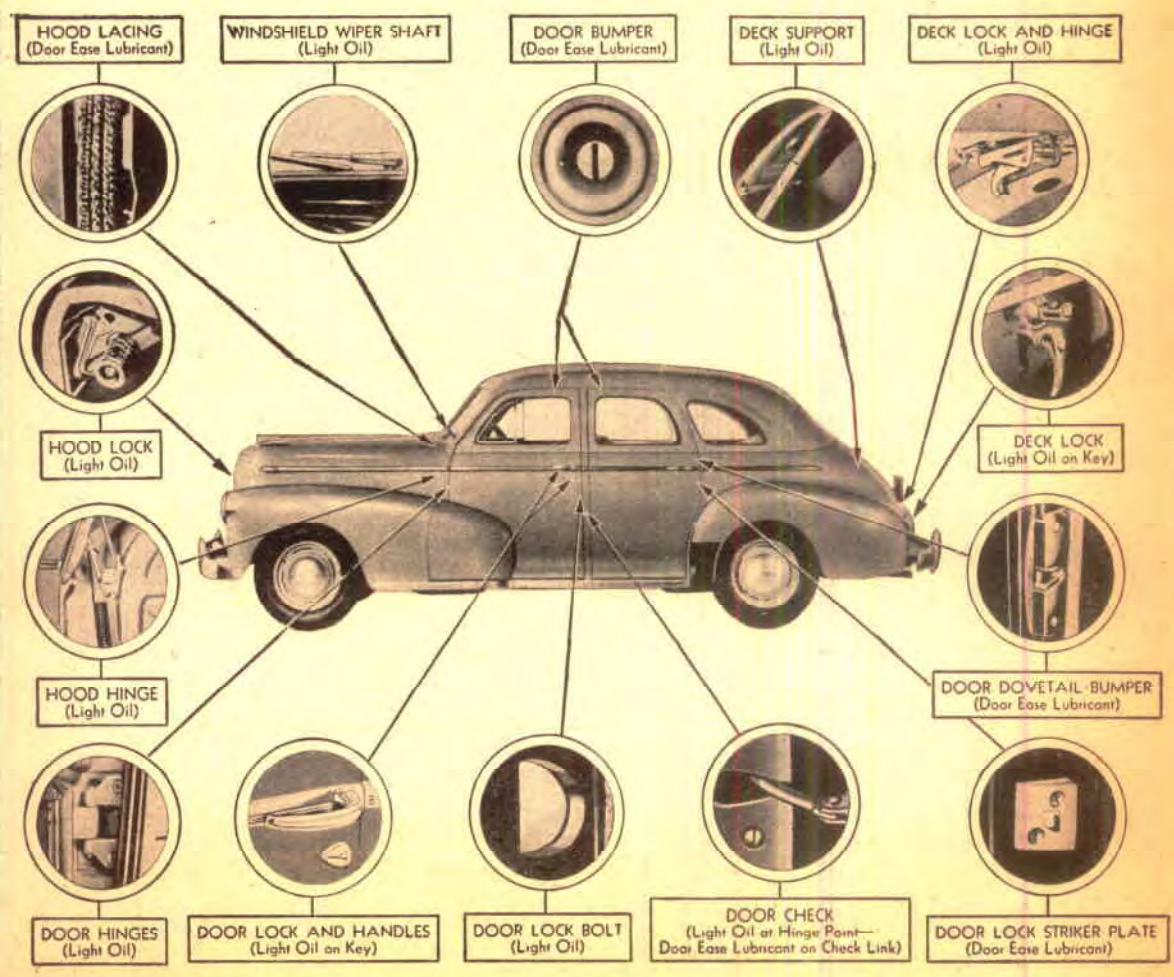
may splash on a car with harmful effects to lacquered and enameled finishes and to chromium plate. The air near the seacoast is salty and humid, and its damaging action is increased by high temperatures.

Even without these hazards, when a car becomes covered with a film of dust, it should be washed with plenty of clear, cold water and a sponge. Avoid rubbing until all grit has been removed. Any soap should be mild and should be thoroughly rinsed off because it can make difficult spots when it dries. Never wash a car in direct sunlight, and always allow the metal to cool if it has become heated. When washing won't suffice, liquid polish cleans well. A light abrasive paste cleaner, used sparingly to avoid wearing the finish thin, will help if the car has been neglected for a long time. Complete this job with liquid polish or wax. A good brand of tar remover is also useful. Hardened tar may be softened first with lard, butter, kerosene, or gasoline containing no coloring matter or ethyl.

Chromium-plated parts require occasional wiping with light oil or kerosene. They can be protected with a coating of clear lacquer or wax. Scuffed or worn places should be cleaned with a mild kitchen scouring compound, such as is used on porcelain, or a standard chromium-plate cleaner, and then protected with wax, clear lacquer, or a thin film of oil. Repeat the process occasionally on spots worn through to the metal. Stainless steel can be cleaned effectively with a light abrasive polish.

Care of the auto body should always include judicious lubrication that will correct or prevent annoying squeaks. The chart below shows the parts that need attention and the kind of lubrication recommended by a well-known automobile manufacturer.

BODY LUBRICATION CHART



Courtesy General Motors

How to Pick Out a

Gus suggests ways to identify disguised and how to estimate mileage

Dear Bill:

You asked me about buying a used car. If I were doing it, I would buy only from a dealer with a good reputation. I would also inspect the car very carefully. I wish I could help you do this. But since I can't, I am attaching to this letter a few notes about things to look for.

If you go to a used-car lot, remember that many established dealers wholesale some used cars to the lots because it would cost too much to recondition them for sale with a guarantee. If a lot operator offers a guarantee, check it carefully. Also, ask him where the shop is that would make good any repairs for him.

There are two types of second-hand cars that you'd be smart to avoid - cars that have been in major crack-ups and former taxis. The wrecked car may look like new, but still have serious mechanical faults. The ex-taxi, even though a recent model, may have the life hacked out of it.

Don't trust the salesman or speedometer on mileage. Instead - as a rough estimate - multiply the car's age by 10,000. That's the average distance the average car goes a year. Don't let the car's looks influence you too much. Many shops buy used-car reconditioning kits that make old cars look like a million bucks. I heard of one the other day that even includes something to make a car smell new.

Don't just drive the car around the block. If you can, give it a real road test of 50 miles or so, including all kinds of road - level, rough, smooth, and some good hills. In New York, salesmen used to take prospects for a ride under the elevated tracks. The noise helped many a sale.

Unless you know the dealer, watch out for tricks! An over-full crankcase and extra heavy oil will often quiet a noisy engine. So pull out the dip stick and measure the oil

Good Used Car

wrecks or former taxicabs, and use the "book" price.

level. If it's too high, ask that it be lowered, and if the oil is heavier than #30, ask that a lighter grade be put in. A fast idle is another way of smoothing out a worn engine, so if the engine idles too fast, ask that it be set back to normal. Get out your gauge and check the tires, too, because soft tires can hide a lot of flaws.

After finding out what's wrong with a car, find out what repairs will cost. An engine overhaul is about the most expensive job you can run into. Fixing up a bad transmission or rear end or a loose steering gear or slipping clutch is also likely to cost real money.

Quite often a salesman will use the term "book price." The "book" is a pamphlet issued by the National Automobile Dealers Association, listing the average retail prices of all makes and models. These recently have been put out monthly. Regional variations in demand and supply sometimes make the book a poor reflection of a local market. But if the price quoted to you differs greatly from the book price, it's a good idea to find out why.

The book can help you in another way, too. It lists serial numbers by model years. By checking it, you can be positive of the age of the car you're considering.

Finally, before closing the deal, make sure that the numbers on the car agree with the numbers on the legal papers your state requires. And watch out if the numbers have been defaced. That may mean the car has been stolen.

Good luck!

Your friend,

Gus Wilson

Was It Wrecked?

New Parts Are a Tip-Off. Throughout your inspection, be alert for parts that are obviously new. New hood, grille, fenders, wheels, radiator core, bumpers, or frame-to-bumper members may indicate the car has been in a wreck.

Do the wheels track? Rear wheels should follow front ones squarely. You can tell by riding behind the car or watching as it is driven off. Also note whether the wheels wobble, which can be a sign of a bent axle.

Welding or heat marks on the frame mean it has been repaired or straightened. Check for this by crawling under or putting car on lift.

Sticking doors suggest that the chassis may have been twisted. Try them all. Also nose the car to the curb at an angle and ease one wheel over the curb. If doors now stick, a loose frame may be allowing the body to twist.

Tires worn more on one side of car than other suggest a sprung frame, bent axle, or loose wheels.

Body or fender repairs are another sign. Be suspicious of marks indicating a roll-over. Drum on body panels with your knuckles. If there has been extensive filling, the solder will cause the metal to give off a dead sound.

Was It a Taxi?

Badly worn upholstery in a model only two or three years old indicates more than average use. If the car has seat covers, try to get a look at what's underneath.

Roof patches or worn paint may suggest that a taxicab roof light has been removed.

New paint may hide a former bright taxi color. Pry up the windshield seal or scratch down to bare metal on an inconspicuous part of the body to see if there's paint of another color. Has lettering on the doors been painted over?

New pedal pads or floor mat on a recent model may hide the hard usage of a taxicab.

How's the Engine?

Visual checks. Examine the head and block carefully for indications of a crack or a welding bead. Any such sign is usually sufficient reason for turning your attention to another car. Are there rust spots on the radiator core? Such spots would come from a leak. Check the block for the same thing. A good fan belt normally lasts about 20,000 miles. Its condition, therefore, offers a rough guide to the car's mileage.

Does it accelerate smoothly? After dropping down to about 10 m.p.h. in high gear, accelerate quickly with full throttle. Observe whether the car gains speed smoothly and quickly without choking, sputtering, or bucking. If it does, the carburetion, valves, valve guides, and ignition are probably okay.

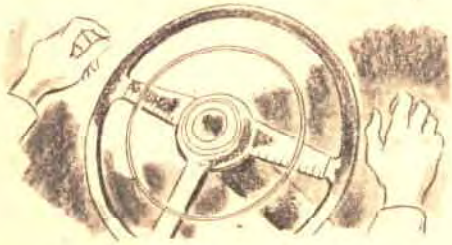
Does it need an overhaul? After the engine has warmed up, race it with short, heavy thrusts on the foot throttle and watch for clouds of bluish-white smoke from the exhaust. This indicates the need for new rings—or perhaps new pistons, bearings, or a cylinder rebore. Black smoke is a sign of a badly adjusted carburetor. If the smoke is black, have the adjustment made and check again. As a further check, look for oil around the spark plugs. Remove a plug and note its color. If it's black instead of a normal brown, the engine probably burns oil. If the oil pressure remains low, the engine is worn or the oil pump out of order.

An engine overhaul is one of the most expensive car-repair jobs.

Are the bearings faulty? While moving at about 15 m.p.h., slowly apply the brakes with your left foot, and simultaneously feed an increasing amount of gas with your right to maintain speed. Don't stop the car with the brakes until the throttle is clear down. Disregarding the carbon or spark pinging, listen for a muffled, hollow knocking. If the muffled knocks are even, the bearings are all in the same condition, probably okay. A loose bearing will knock more loudly.

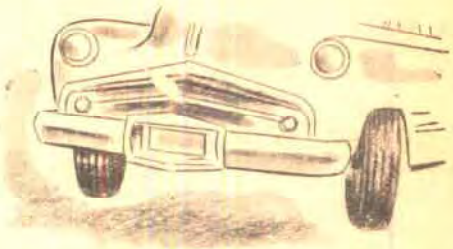
Steering?

Are the wheels loose? Grab a front wheel at the top with both hands and try to move it back and forth in the vertical plane. Can you feel any play, even the slightest? Do you hear a faint sucking noise? The first is a sign of a worn kingpin bushing, the second of a loose wheel bearing. (A damaged wheel bearing makes a clicking sound while the car is in motion. This click becomes more noticeable while you are passing a concrete retaining wall.)



Does the car veer to the side? On a straight flat road, without noticeable cross wind, speed up to about 25 m.p.h. and take your hands from the steering wheel. The car should travel 100 yards or so without any tendency to turn. Try this several times. If the car turns to the same side on each test, the wheels may be out of alignment. A sagging spring or bent axle or frame (also wreck signs), however, can have the same effect. Should the car veer sometimes to one side and sometimes to the other, loose steering connections or worn kingpins may be to blame. Have a mechanic find the cause.

Do the wheels shimmy? Drive over a rough pavement, the rougher the better. If the wheels shimmy, it may come from at least a half-dozen causes. Repairs are liable to be troublesome and can be costly.



Do the wheels bind? Driving very slowly, turn the car sharply right and sharply left to the full limit. If the steering gear binds, someone probably has attempted adjustment to compensate for wear. Such a car can be dangerous to drive.

Too much steering-wheel play? With the tires evenly inflated, point the front wheels straight ahead and grasp the steering wheel with the thumb and forefinger. How far can you turn it without moving the front wheels? If the play exceeds two inches, the steering mechanism is too worn or loose for safe driving. Adjustment may be possible, but replacement is expensive.

Are the tires unevenly worn? Spotty wear on the front tires often comes from wheels out of alignment. So does "feathering"—a thin projection of rubber on the edges of the tread ➧

blocks. Check all tires, including the spare. Improper camber and toe-in cause such wear.

Brakes Good?

Does the hand brake hold? Try it on a steep hill. If it doesn't, a simple adjustment of the linkage may overcome the difficulty.

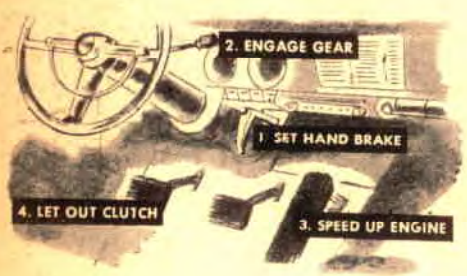
Does the pedal soften? With the car at a standstill, depress the brake pedal as far as possible and hold it that way at least half a minute. (It should not go closer than 2" to the floor.) If the pedal tends to sink, the cylinder pistons are probably worn, permitting hydraulic fluid to leak past.

Is the pedal spongy? Apply and release it several times to find out. If so, there is air in the lines or the cylinders are bad.

Does braking swerve the car? On a straight, level road, apply the foot brake hard several times and note whether the car has any tendency to swerve. If it does, one possibility is a defective oil seal, permitting linings to become saturated. Get an estimate from a brake shop.

Power Train?

Clicks in the drive shaft? Jerk the car a little by taking your foot off the gas pedal and then jabbing it back while moving at 10 to 15 m.p.h. Do you hear clicks or the sound of slack being taken up? It may indicate looseness in the universal joint, differential, or rear-axle shafts.



Does the clutch slip? A clutch pedal should have at least half an inch free play at the top. Check it with your hand. If you can detect no play, the clutch is probably slipping. Check by setting the hand brake hard, putting it in second gear, speeding up the engine to a fast idle, and slowly letting out the clutch pedal. The clutch is slipping if the engine does not stall promptly. The slipping is certain to become worse, finally demanding a complete clutch overhaul. Also try the clutch in normal driving. If it grabs—takes hold so quickly that the car jerks or shudders—the facing probably is badly worn.

Is the transmission worn? Shift into low gear and speed up quickly to about 20 m.p.h. If the gears are badly worn or the teeth burred, the transmission will howl or grind. (This same test will also show up bad engine bearings.)

As a further test, go down hill in high and second gear with your foot off the gas; a worn transmission may clatter. Repairs come high.

Automatic transmission noisy? Many of the automatic or semiautomatic transmissions have now been on the road long enough to reach the used-car class. If you encounter one, give it a thorough trial at all speeds. A high-pitched singing sound is often a tip-off to coming trouble.

Noise in the differential? To check the rear-axle assembly, ride in the rear seat or, better still, remove the rear-seat cushion. On a smooth road (preferably a smooth blacktop to lessen tire noise), pick up speed slowly and evenly to about 50 m.p.h. with your ear cocked to the rear. Then shift into neutral and coast to a stop. Should you hear any grinding, knocking, or hum from the rear end, a heavy repair bill may be in the offing.

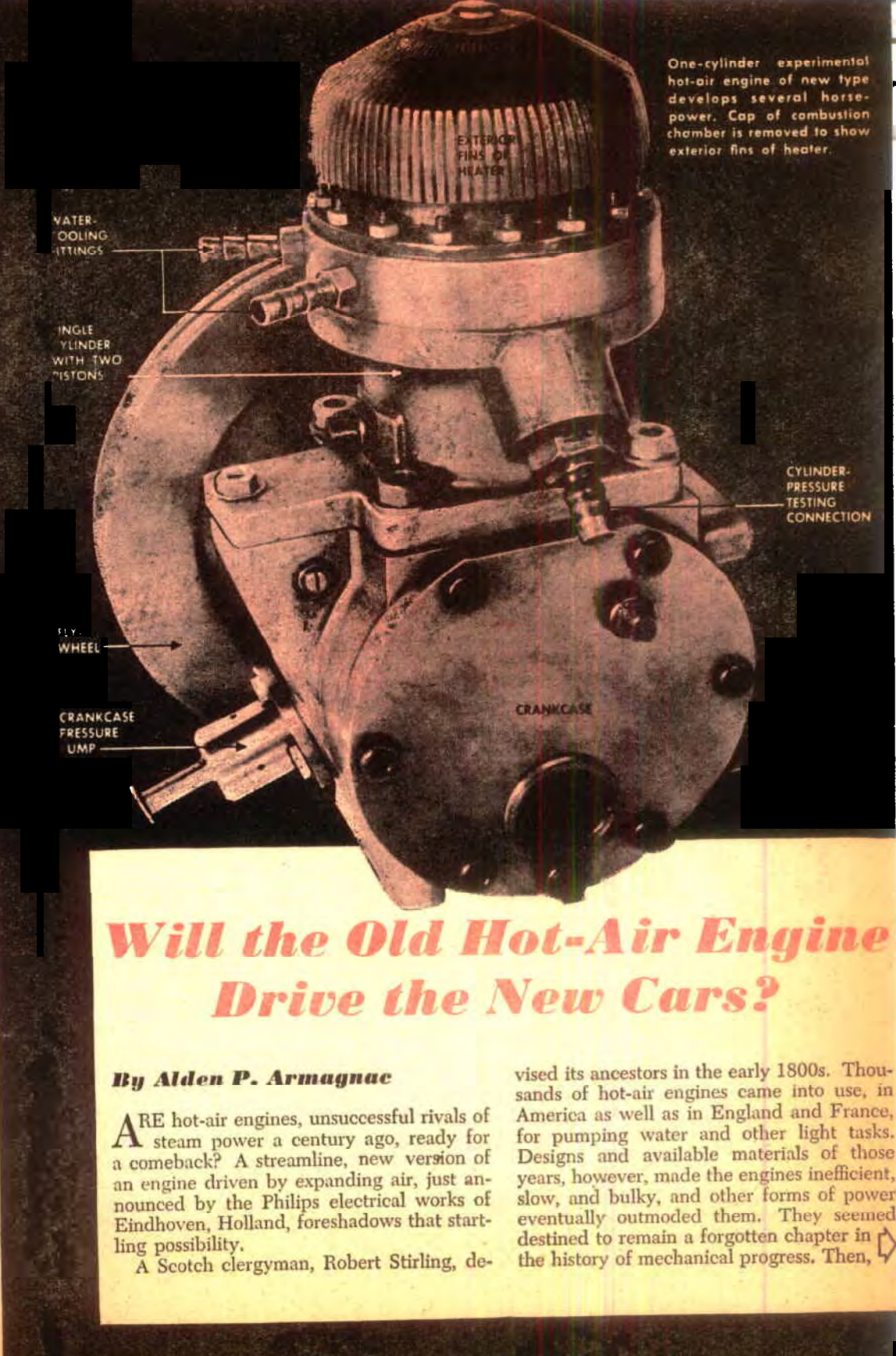
Don't Forget . . .

Test the starter. With the ignition off, press the starter button for about ten seconds. Repeat several times. Any pronounced grinding or clashing means that teeth in the flywheel starter gear are broken, burred, or badly worn.

Test the shocks. Jounce on the front and rear bumpers. If the car continues to bounce after you jump off, the shocks need repair, or perhaps replacement. (This also tests the bumpers themselves for tightness.)

Test the ammeter. When you speed up the engine, does the needle move at least a little to the charge side? If not, the generator, regulator, or battery is defective.

Test the lights. Depress the brake to check the stoplight. Step on the gas and notice whether the lights brighten considerably. If so, the battery may have been spiked with acid.



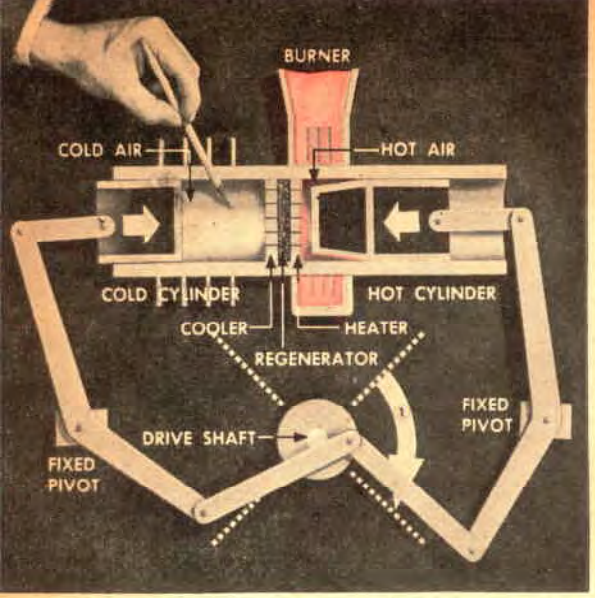
One-cylinder experimental hot-air engine of new type develops several horsepower. Cap of combustion chamber is removed to show exterior fins of heater.

Will the Old Hot-Air Engine Drive the New Cars?

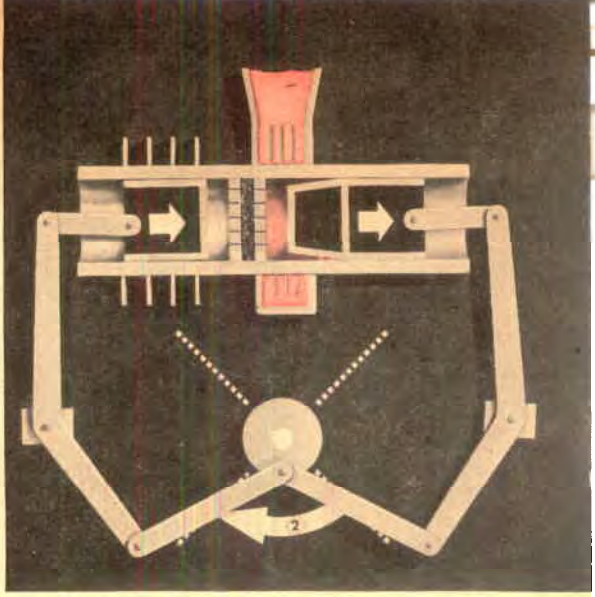
By Alden P. Armagnac

ARE hot-air engines, unsuccessful rivals of steam power a century ago, ready for a comeback? A streamline, new version of an engine driven by expanding air, just announced by the Philips electrical works of Eindhoven, Holland, foreshadows that startling possibility.

A Scotch clergyman, Robert Stirling, devised its ancestors in the early 1800s. Thousands of hot-air engines came into use, in America as well as in England and France, for pumping water and other light tasks. Designs and available materials of those years, however, made the engines inefficient, slow, and bulky, and other forms of power eventually outmoded them. They seemed destined to remain a forgotten chapter in the history of mechanical progress. Then,



1. Compression stroke is first shown of four movements of Philips hot-air engine, demonstrated here by cutaway model. Short arrows show both pistons moving inward, compressing air mostly in "cold" space indicated, during travel of crankpin marked by curved arrow.



2. Transfer stroke now moves compressed air from cold cylinder to hot cylinder without change in volume, and air picks up heat from regenerator and heater. During this stage, both pistons travel from left to right, as will be seen by study of ingenious W-shaped linkage.

seeking a convenient source of power for radio sets in rural districts without electricity, Philips engineers became interested in the possibility of bringing the hot-air engine up to date—and fascinated by what they found modern design could do for it.

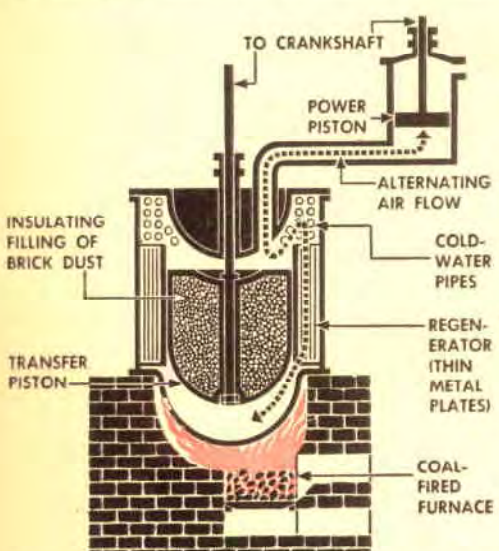
Today they have built and successfully tested models ranging from two to 15 horsepower, and plans for others up to several hundred horsepower are ready. Laboratory trials of the new types give performance figures that the producers themselves, at first, could hardly believe. For the modern hot-air engines, careful tests show, surpass gasoline engines and even approach Diesel engines in efficiency!

Hot-air engines for automobiles are made practicable by the new design, its sponsors declare. The smooth, cushioned power, in contrast to the impact of explosions in an internal-combustion engine, would simplify or perhaps dispense altogether with transmission gears. Another advantage would be long life, since absence of corrosive gases and extreme, high temperatures would minimize wear between pistons and cylinders.

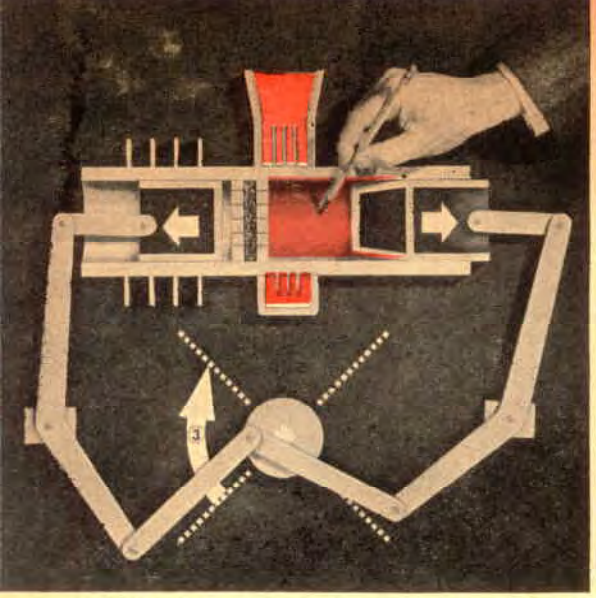
Other applications foreseen include electric generating plants for homes and perhaps for larger-scale power production.

To those who have watched it run, one of the most remarkable features of the Philips hot-air engine is its silence. It has no exhaust, no valves, no explosions in its cylinders. Hence a 15-horsepower hot-air engine, large enough to drive a small car, makes no more noise than a sewing machine.

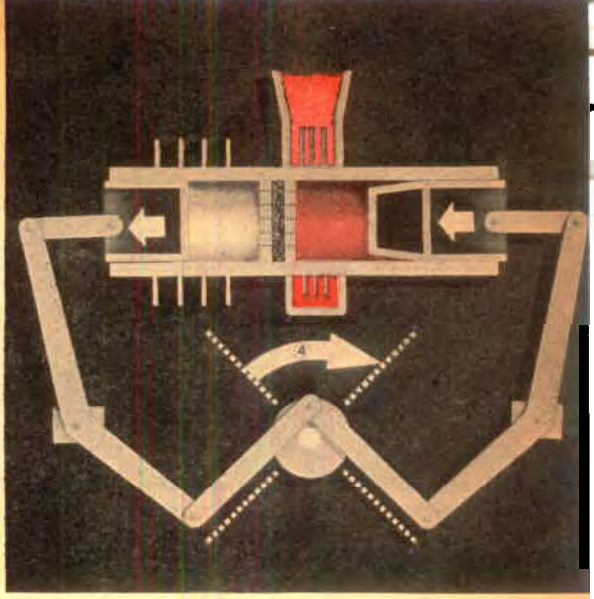
Since it uses an external burner, instead



Pioneer hot-air engine, Stirling type of early 1800s, was this ponderous machine. Thousands of hot-air engines were built in the nineteenth century, but were superseded by other forms of power. Lightweight and efficient high-speed design now foreshadows their comeback.



3. During power stroke, heated air expands, mostly in "hot" space indicated, driving both pistons outward. Amount of power delivered exceeds the amount consumed in other three movements of complete cycle, and the surplus represents the useful output of the hot-air engine.



4. Transfer stroke now moves expanded air, without change in volume, back to cold cylinder. Air gives up most of its heat to regenerator, rest to cooler. Then whole cycle begins again. First Philips engine was patterned after this model and ran successfully.

of igniting an explosive vapor in a cylinder, a hot-air engine isn't choosy about its fuel. It can run on gasoline, oil, gas, wood alcohol —practically anything that will burn.

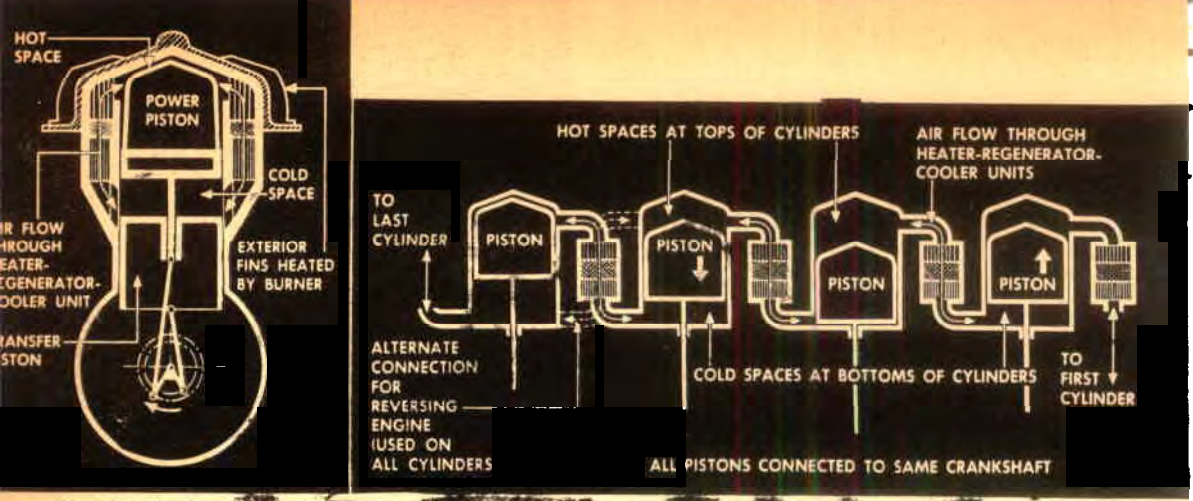
Just as new heat-resisting alloys made possible the development of jet engines for planes, they have been the principal factor in making hot-air engines practical. The elevated cylinder temperatures they permit have transformed the sluggish and ponderous hot-air engine of the nineteenth century into a compact, high-pressure, high-speed design turning up 3,000 revolutions per minute or more. With reduced size, heat losses can be more easily countered by insulation, lighter moving parts decrease friction, and efficiency improves all along the line.

How Hot-Air Engine Works

Like steam engines, hot-air engines apply the fact that a heated gas will expand and furnish power. A steam engine uses heat to turn water to a gas, steam, and the expanding steam then drives a piston. Simplest of all prime movers, the hot-air engine uses heat directly to expand air, the gas that drives its piston.

In an ideal arrangement, heated air would be allowed to expand in a "hot cylinder," driving a piston and furnishing power to a flywheel and drive shaft. Next, the expanded air would be transferred to a "cold cylinder." Here another piston, driven by the flywheel, would compress the air to its original volume. Finally this air would be returned, without change in volume, to the hot cylinder and the cycle would start all over again. Because the pressure of the hot, expanding air is greater than that of the cooler air being compressed, the expansion stroke would yield more power than the compression stroke uses up. This net gain, resulting from heat input turned into mechanical energy, is the useful power delivered by the engine. No heat is lost in an exhaust, since the same air is used over and over again, shuttling back and forth between the two cylinders.

Actually, designers must compromise between an ideal form and a practical one. It is more feasible mechanically to let most, but not all, of the expansion take place in the hot cylinder; and to compress most, but not all, of the cool air in the cold cylinder. This can be done by arranging a pair of pistons so that the motion of one follows that of the other with a time lag or "phase difference" corresponding to about a quarter-revolution of the flywheel; it may vary a little, and need not be exactly 90°. With an experimental engine patterned after the model illustrated above, Philips engineers found that high efficiency could still be realized. The pictures show the four movements of

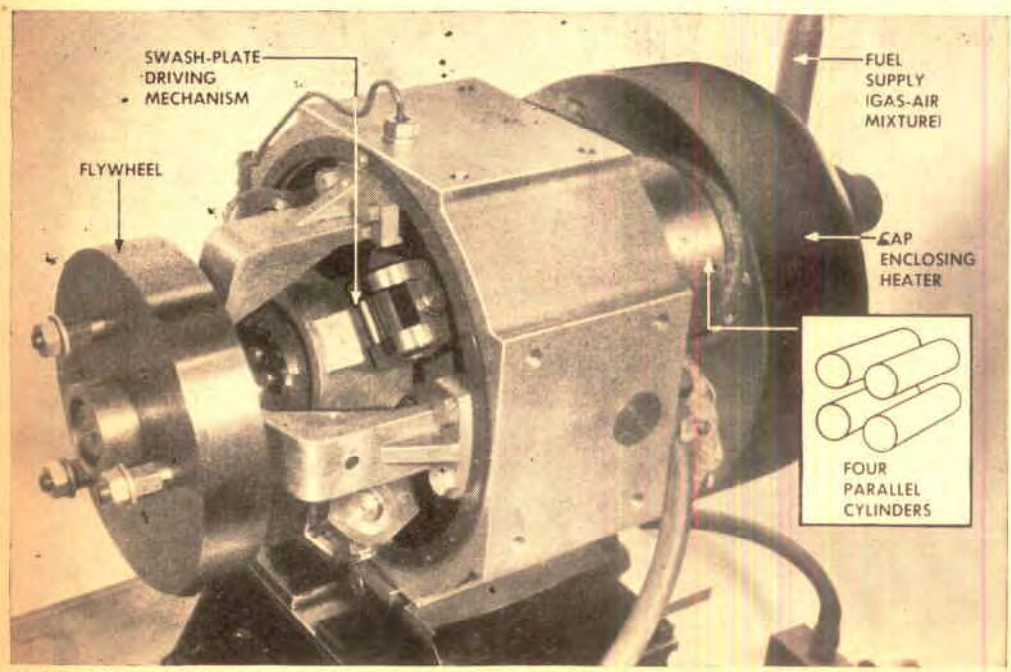


Simplified diagram at left, above, shows practical adaptation of hot-air principle in modern single-cylinder Philips engine. Two pistons operate within the same cylinder. Adding more cylinders actually makes the design simpler, as shown at right. One double-acting piston suffices in each of four cylinders, which may be grouped radially, in two Vs or in a square.

this elementary type of engine, beginning with the compression stroke.

Passing freely between hot and cold cylinders, air moved by the pistons alternately flows in opposite directions through the same passages of an assembly consisting of a heater, a cooler, and a regenerator.

The heater is a piece of aluminum bronze, an alloy that conducts heat well. It has exterior fins to pick up heat from the burner; and interior fins, forming a honeycombed passageway, that transmit this heat to air passing between them. The cooler is built almost exactly like the heater, with fins on the inside that remove heat from the air, and fins on the outside to be cooled either by air or by a water jacket. The regenerator, a thermal storage device designed to absorb heat almost instantaneously and give it up as quickly, is a porous mass of thin metal



Four-cylinder Philips hot-air engine, only 19 inches long over-all, develops 15 horsepower, enough to drive a small car. It turns up 3,000 r.p.m. and runs as quietly as a sewing machine.

wire between the heater and the cooler.

This "heat reservoir" has the important job of taking most of the heat out of the air as it passes from the hot cylinder to the cold cylinder, holding this heat momentarily, and then restoring the heat to the air as it returns from the cold cylinder to the hot cylinder. That leaves the cooler with much less work to do and prevents serious heat loss. A temperature of about 1,200° F. is maintained in the hot cylinder and 175° F. in the cold cylinder.

Following successful tests of their first engine, Philips experts have applied the same principle in improved designs.

A little one-cylinder model develops several horsepower. Its two pistons work in the same cylinder, part of which serves as the hot space and part as the cold space. An added refinement, not shown in the simplified diagram on the opposite page, is a pump that keeps air in the crankcase under the same pressure as that in the cylinder. This counterpressure obviates need for a tight-fitting piston to prevent air leakage past it, and also reduces bearing load. The effect on efficiency is so great that the engine's power can be controlled by an adjustment that varies the pumping rate.

Multicylinder Models

Multicylinder hot-air engines, instead of complicating the design, actually simplify it. When four cylinders using single pistons are suitably interconnected as shown in another diagram, a hot space at the top of each cylinder constantly exchanges the air it contains with a cold space at the bottom of the next cylinder. Each piston delivers power on its downstroke and acts as a compressor on its upstroke. The pistons have a 90° "phase difference." When No. 1 is at the top of its stroke, No. 2 is descending and delivering power, No. 3 is at the bottom of its stroke, and No. 4 is rising and compressing air.

For a good arrangement with short interconnecting passages, four cylinders may be arranged in radial fashion, grouped in two Vs, or set in a square. In the last type, suitable for up to 30 horsepower, pistons drive plungers acting against an inclined disk, called a swash plate, that turns the shaft.

The wide range of available designs emphasizes the variety of purposes to which the new engines may be adapted. Robert Stirling may yet take place with Robert Watt as a prophet of the Age of Power. END

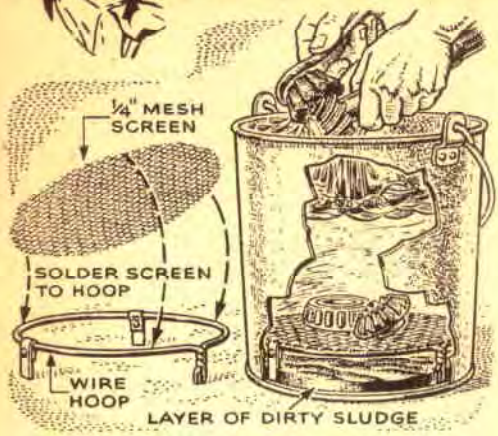
By applying the principle of a hot-air engine in miniature, Joseph Tracy, a New York automotive engineer, provides the actual motive power for a model of a Diesel engine, above, that he has built. When a ring-shaped alcohol burner is attached as shown and lit, a pair of pistons begin operating, and the tiny flywheel spins merrily. A handsome example of precision craftsmanship, the model has a power cylinder of half-inch diameter and a one-inch stroke.

Applications of hot-air engines in recent years have been limited to driving models and toys and to stirring chemicals in laboratories, because of their low efficiency, slow speed, and bulkiness. "Even with these drawbacks," model-maker Tracy commented, "this principle is worth serious study. Possibly by the use of modern materials and scientific design, this type of engine might be vastly improved." As if to confirm his words, news of the efficient new hot-air engines described in the preceding article reached this country almost simultaneously.

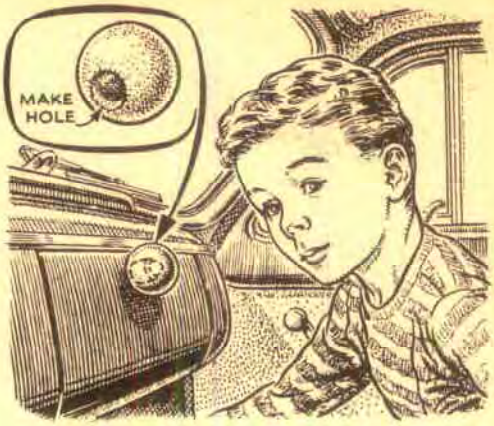
Chemical Prevents Stocking Runs

NYLON runs will become less frequent when stockings are treated with Syton, a run preventive developed by the Monsanto Chemical Co. Syton also removes the shine from the surface of cotton, wool, and rayon fabrics, and makes them more durable and hard-wearing.

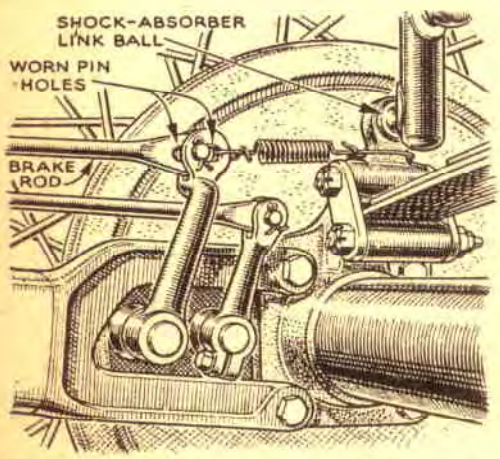
Hints from the Model Garage



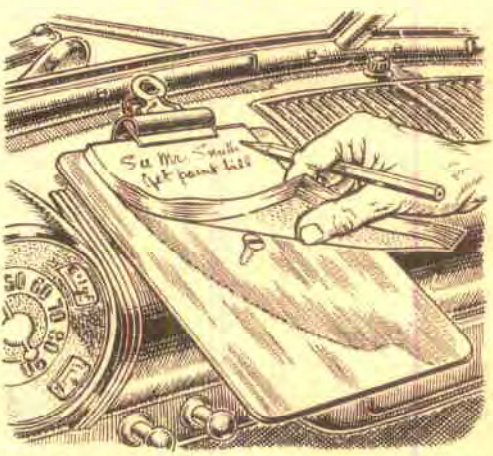
Solvent Stays Clean. Harry Morse, of Oakland, Calif., suggests putting a screen in your parts-cleaning bucket when you're taking down a unit. It lets dirt settle to the bottom and keeps it from being stirred up while you're brushing parts.



Ball Protects Children. Knobs or handles on the dash can give youngsters a bad bump on sudden stops. Sponge-rubber balls fitted over the protruding parts reduce this hazard. A dab of gasket shellac in the hole will attach the ball securely.



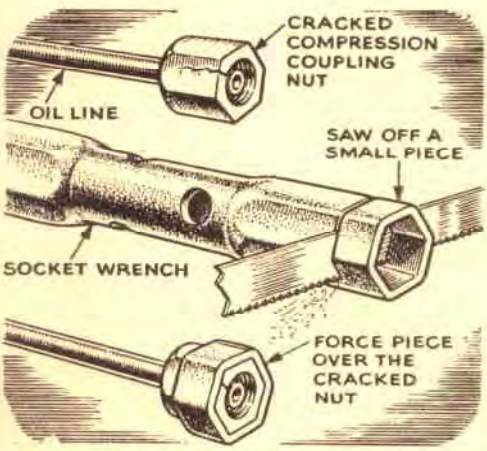
Spring Holds Brake Rod. Model A Ford owners sometimes have trouble keeping the mechanical brakes in adjustment because of worn linkages. In such cases, it's probably advisable to install new linkages if available. But you might like to try the idea illustrated above, suggested by J. O. Troemner, of Madison, Wis. The spring takes up the slack that results from the worn pin holes, preventing the brake from dragging when off.



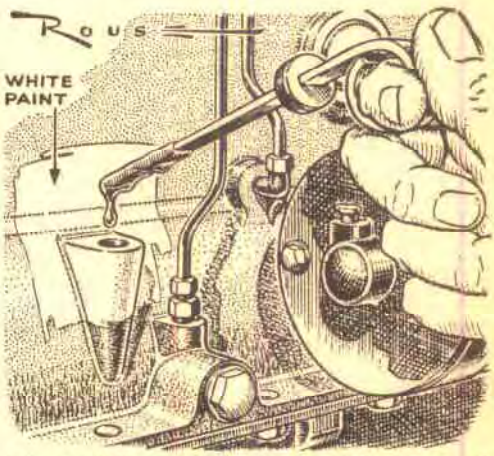
Make Notes While You Ride. A note pad is often a useful thing to have at hand in a car, especially if you are apt to be forgetful. S. D. Laing, of Burrton, Kan., made provision for one in his car by mounting a 4" by 7" piece of heavy sheet aluminum on the dash at a convenient writing angle. A single self-tapping screw holds the piece of aluminum. A pad of note paper is clipped to this, and a pencil is kept in the clip.

Scraper Cleans Your Shoes. A shoe scraper conveniently mounted will help keep the interior of your car cleaner. The one shown was designed and built by members of the auto mechanics class at the senior high school in Midland, Mich.

Dimensions were chosen to suit a new Hudson, an existing hole being used to mount the scraper. By changing the dimensions, you could adapt the scraper to other makes. It might be best, however, to bend up a strip of tin first as a template.



Socket Repairs Oil Line. When an oil line began to leak because of a cracked coupling nut, Norman EnHolm, of Lake Mahopac, N. Y., made an effective repair in this way. After disconnecting the union, he selected a hex socket wrench that would not quite fit on the nut. He then hacksawed a piece off the socket, squeezed the cracked nut together with a clamp, and drove on the collar. It stopped the leak.



Keep Your Oil Clean. The dirt and grit that gets into your crankcase through the dipstick hole may not amount to much, but why take a chance? Scrape the accumulated oil and dirt away from the opening occasionally so you won't shove it inside by accident. At the same time, apply white enamel around the hole. It will make future cleaning easier and help you locate the hole to replace the dipstick.

An Expert Tackles a Valve Job

By R. P. Stevenson

PSM photos by W. W. Morris

YOU can't drive a car forever without getting a carbon-and-valve job. Sooner or later, the engine begins to knock badly, idle roughly, or skip under load. Or perhaps a mechanic looks up from a compression gauge and tells you the compression is low in one or more cylinders.

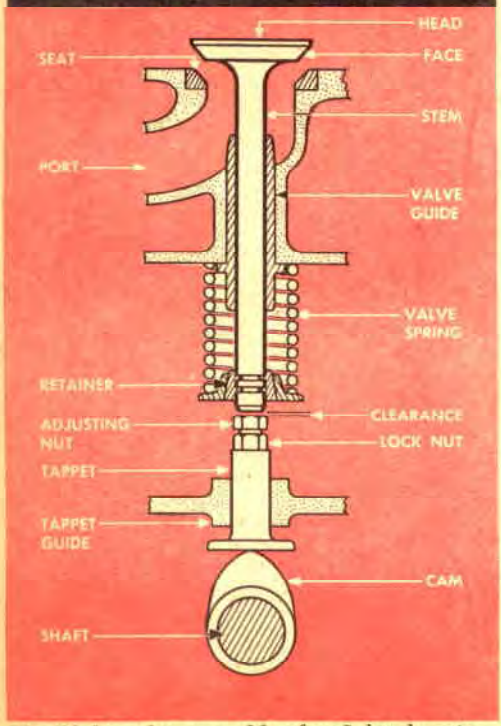
When Model T's were stylish, lots of men did the job themselves, and it's still within the range of the man who likes to work on his own car. But in many ways, the job no longer is as simple as it once was. So, whether you are a hot man under the hood or turn the job over to a mechanic, you should know how an expert does it.

Your expert in this case is John Kowalski, who spends a great many of his working hours peering into cylinder blocks in the shop of James F. Waters, Inc., a company that operates one of the largest service garages in the East. These are pictures of an actual job performed on a 1941 Plymouth. The procedure may be considered typical for an L-head engine.

One thing you will notice is that the valves aren't ground against their seats; instead, every valve and seat is refaced. Because this can be done uniformly, the valves need not be kept in order.

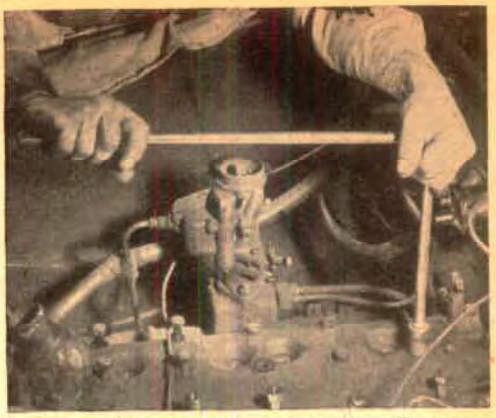
Although not shown in the sequence of photos, the mechanic also checks each valve spring with a spring-compression tester, discarding those that don't come up to a specified pressure. To keep the valves from sticking when the engine is first started, a drop or two of oil is placed on each stem before reassembly.

Along with a carbon-and-valve job, Plymouth factory policy specifies a complete engine tune-up. A working period of eight hours is allotted for the entire job.



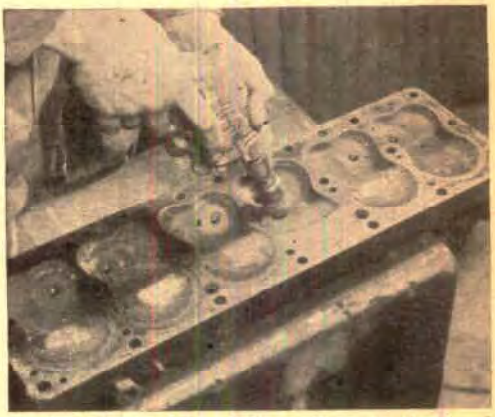
Here's the valve assembly of an L-head engine. Valve seats are refaced as shown in the photo.

1. A compression gauge hints that the job is needed, as a low reading suggests that a valve is sticking or burned. In this shop, compression is always tested as part of a regular tune-up.



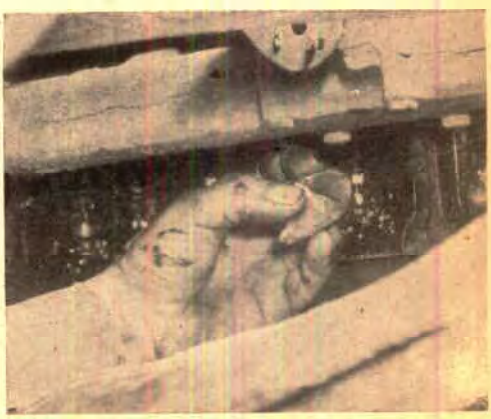
2. The job begins. To clear the way, the water is drained off, and the hose, air cleaner, oil filter, distributor, and wiring are removed or loosened. Then head bolts are removed as above.

3. As the head is lifted off for cleaning, carbon may be seen on the piston and valve heads. The mechanic gets a good grip on the head; even aluminum ones are awkward to handle.

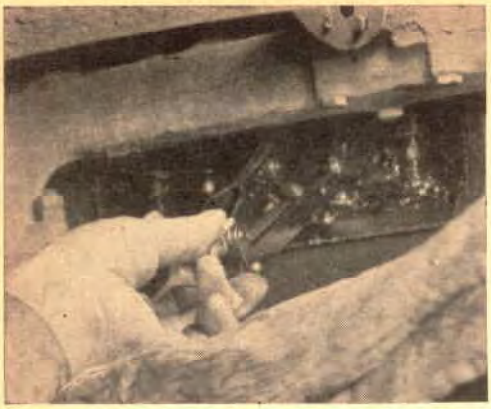


4. Carbon is cleaned from the cylinder head with a wire brush chucked in a small electric drill. This step could be postponed until just before it is time to reinstall the head.

5. To reach the valves, the front is jacked up and the right wheel removed. Then the mechanic takes off the fender plate, heat shield, fuel line, and (above) side plates over the valves.

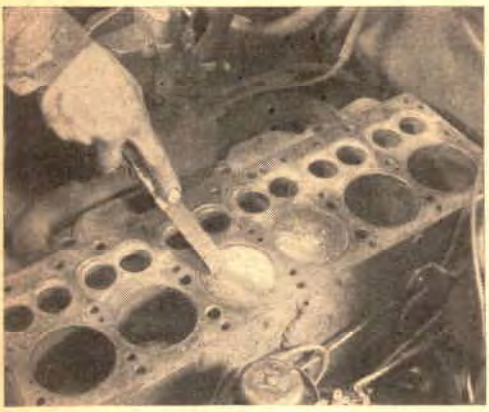


6. Oil-return openings near the tappets are plugged with cloth before the valves are touched. This keeps the small locking keys from falling into the crankcase. [*Turn the page.*]



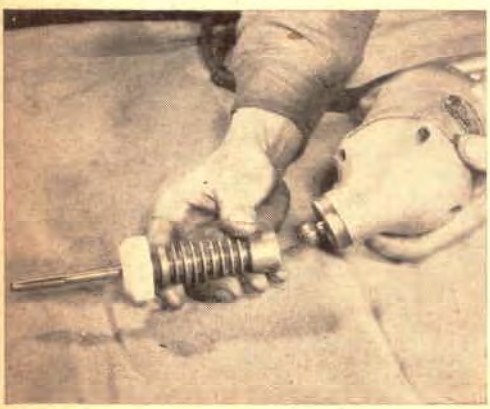
7. Inserting a valve lifter, the mechanic now compresses the spring so that the keys may be removed. Before this, he checks to see that the valve is in the down position; that is, closed.

8. Using a mallet, he taps the valve head after it has been raised by the lifter. This loosens the keys for removal. Unless it is stuck, the valve can now be lifted out with the fingers.



9. Carbon is scraped from the piston heads and the entire upper surface of the block when all valves have been removed. The mechanic works carefully to keep scrapings out of the bore.

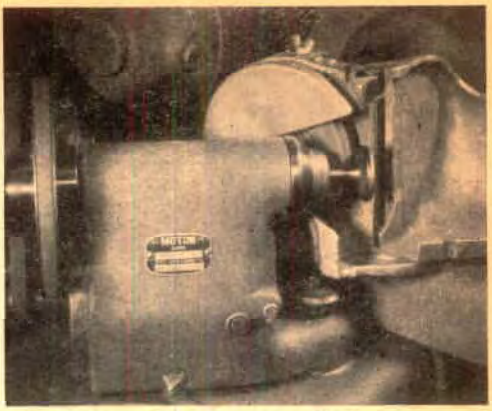
10. All valve guides are cleaned with a reamer chucked in the ever-handy drill. Sometimes, a guide is worn so much that it must be replaced. Note the clean block after the carbon removal.



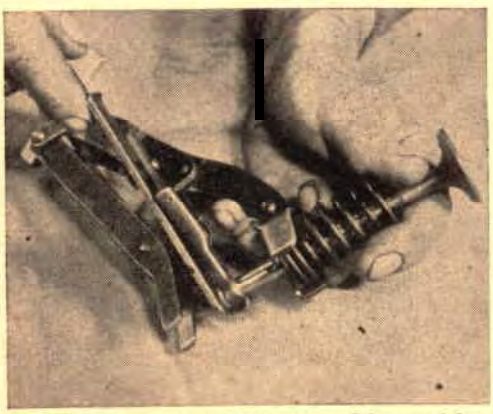
11. Valve seats are refaced with this grinding tool, shown in use on page 180. The protruding stem keeps the stone and seat in proper relationship. The grinder has a 45-deg. face.

12. Since the seats must be refaced at exactly 45 deg., the cutting stone is dressed from time to time in this way. In some cars, for instance the Pontiac, the valves are seated at 30 deg.

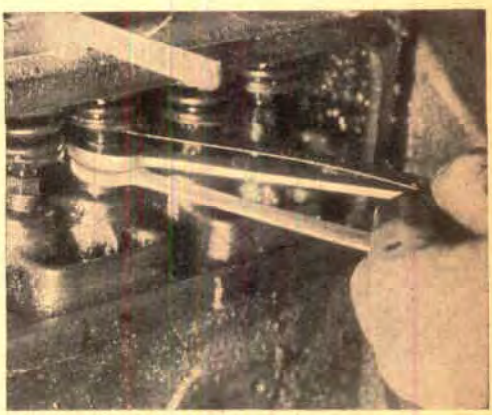
13. Valves are cleaned with a power brush in a machine shop adjoining the garage floor. The carbon quickly comes off and the metal of the head, face, and stem is left bright and shiny.



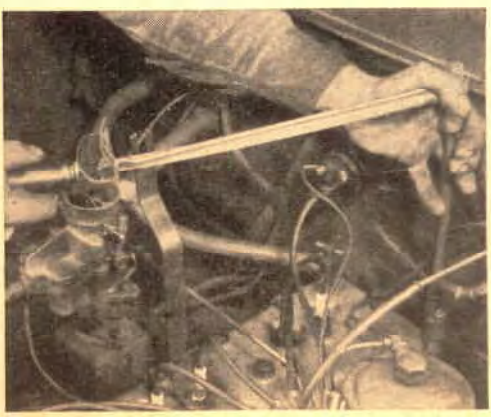
14. Valve refacing is next. Each is mounted so its face contacts the grinding wheel at 45 deg. Valve and wheel revolve in opposite directions. The ends of the stems are also faced off square.



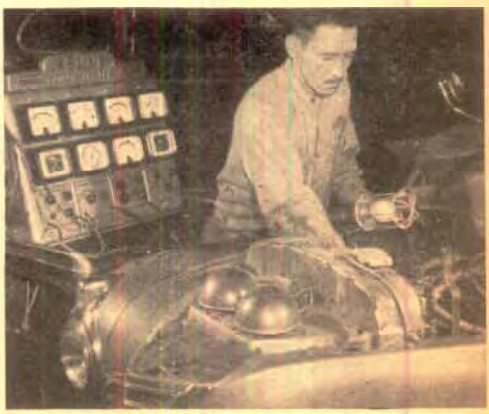
15. Valves are installed with a lifter and key inserter. When the lifter is removed, spring tension forces the retainer down over the two small keys, locking them in place on the stem.



16. Setting the clearance is an exacting step. With one wrench on the lock nut and another on the adjusting nut, a feeler gauge does the job. Here, intake clearance is .006", exhaust .008".



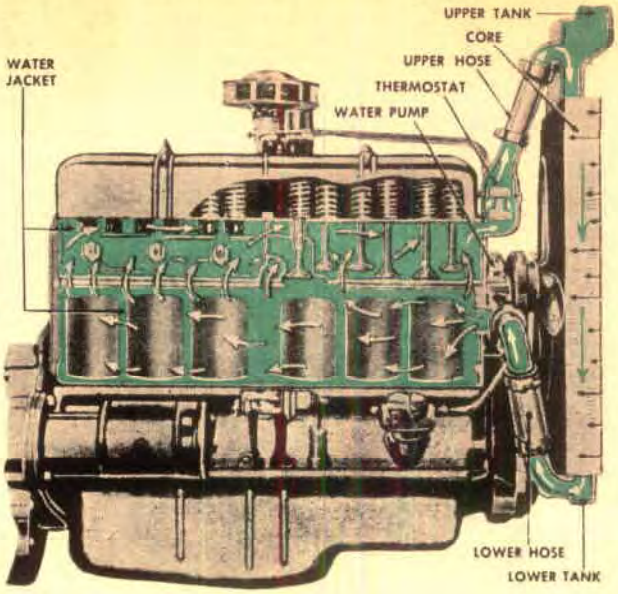
17. A torque wrench sets the head bolts at the proper tension as the final step. New gaskets are installed, of course, before the head and valve-cover plates are returned to place.



18. When the job's complete, a motor analyzer gives the car a checkup before release to the customer. It tests compression, timing, setting of the points, and carburetor adjustment.

How Your Car's Engine Is Cooled

Three simple home experiments suggested by Kenneth M. Swezey.



ALTHOUGH heat makes your car go, too much would quickly bring it to a halt. Left unchecked, the intense heat of combustion would soon warp and burn the valves, break down the oil, overheat the bearings, and "freeze" the pistons to the cylinders.

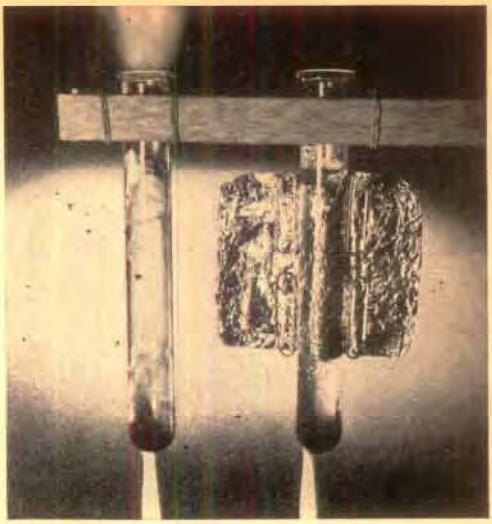
Part of this excess heat passes out the exhaust. The cooling system takes care of the rest. A typical system is shown in the drawing above. Urged on by the pump, water circulates through the jacket, picking up heat from the combustion chambers, valves, and cylinders. Then it carries the heat to the radiator, releases it to the air, and returns again to the water jacket.

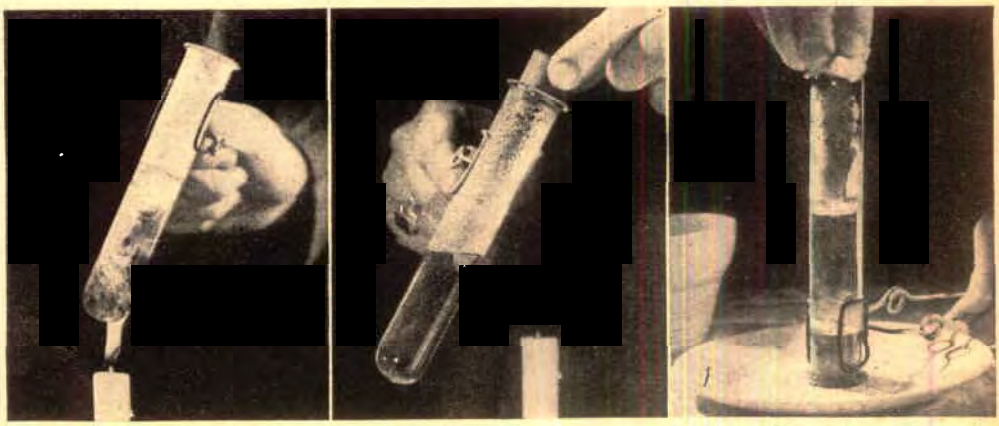
To learn at first hand a few more facts about the cooling system of your car, try the simple demonstrations on these pages.

How can plain water keep your engine at a safe working temperature despite much higher temperatures inside the cylinders? Partly for the same reason you can bring water to a boil in a paper cup without setting the cup afire. If you don't believe this can be done, try it. Use a single-bottom cup, about a quarter full of water. Hold it over a candle flame, and the water will soon boil. Why doesn't the paper burn? Because the hot water keeps it cool. The paper gets hot, it is true, but the water carries off the heat before it rises to kindling temperature. In like manner, water circulating through the engine carries off heat from the working parts, preventing them from being distorted, or even melted, by the combustion heat.

How does the radiator transfer heat to the air? After collecting in the top tank, hot water from the engine passes down through the core. The core's function is to divide the water into many small streams and expose each to air drawn through the radiator by the fan and forward movement of the car. As the air rushes past copper fins on the water tubes, it takes up heat from the water inside the tubes.

How fins help cool water can be shown with the setup in the photo at right. Attach broad fins of heavy aluminum foil to one of two identical test tubes. Put the same amount of water in each tube and hold them over identical candle flames. The water in the plain tube will soon steam. The other will take longer because it loses heat to the air through the fins.





Why are pressure cooling systems now used in most cars? Strangely enough, you can find the reason on a mountaintop. A few years ago, when all cars had nonpressure systems, radiators often boiled at high altitudes. Why? Because of the drop in atmospheric pressure.

At sea level, the boiling point of water is 212° F. When you climb a mountain, atmospheric pressure drops and the boiling point drops. The experiment above shows this.

Fill a test tube half full of water. Bring it to a vigorous boil, quickly stopper the tube, invert it, and apply cold water with a wad of wet paper. This condenses the steam inside, causing a partial vacuum and reducing the pressure. Although cooled, the water begins boiling again. In a pressure cooling system, this works in reverse. Since the system is airtight, the steam that's generated exerts pressure on the water, raising its boiling point above 212°. This permits the engine to operate at a more efficient higher temperature without boiling.

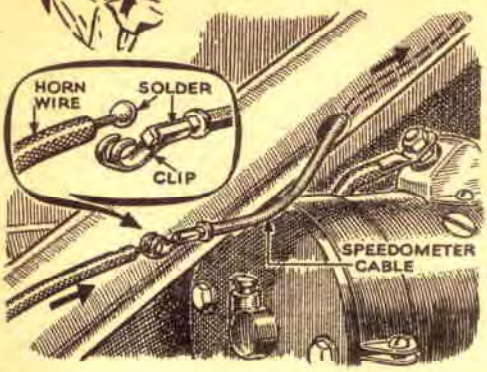
Waxed Nails Hold Securely

Some nails that you buy are wax-coated for better holding qualities. Recently, unable to buy a supply, I coated some common nails myself. Dissolving 1¼ lb. of rosin in a pint of liquid paint drier, I dumped this solution and two kegs of nails into a tumbler made from an old oil drum. Then I gave the tumbler a few turns and took out the nails.—*John E. Heisson, Fitchburg, Mass.*

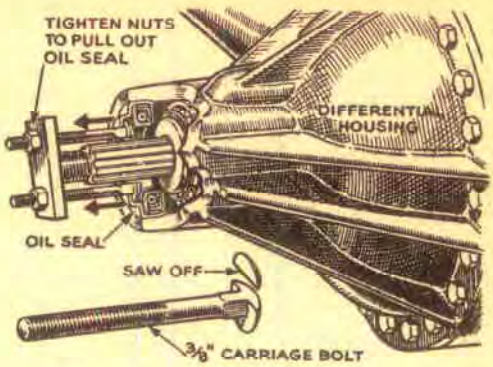
White-Lead Putty Won't Bleed

If you have trouble with ordinary putty "bleeding" through your paint and showing up as yellow spots, try a homemade putty that is free of this trouble. Into a small can of white lead stir some powdered whiting. Add a little at a time until the mixture has the consistency of putty. The whiting can be worked in best with a spatula or knife.—*Joseph E. Bird, Carrollton, Ill.*

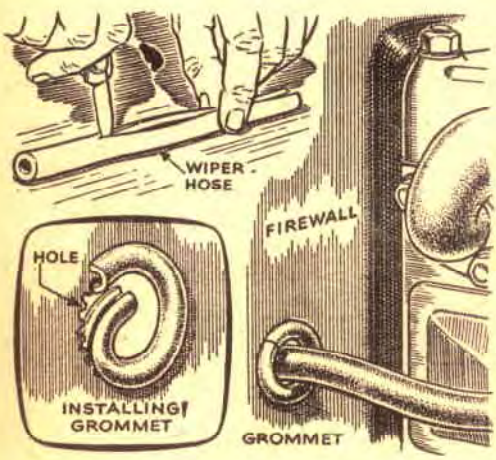
Hints from the Model Garage



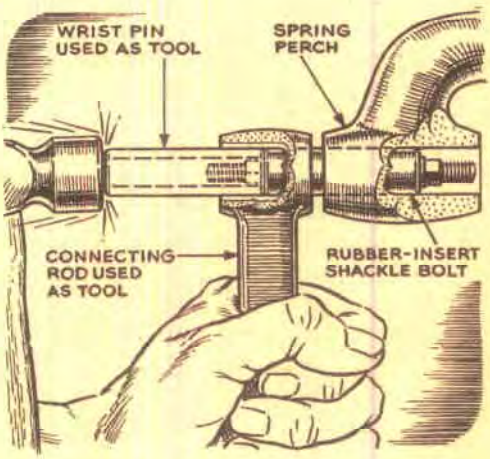
Speedometer Cable Fixes Horn. A good way to replace defective horn wiring is reported by Lester L. Haberman, of Hartford, Conn. Instead of fishing wire through the steering column, he uses a broken piece of speedometer cable as a leader. A bent clip soldered to the end, small enough to pass through the hole in the column, hooks the horn wire to pull it through. A blob of solder on the tip will engage it securely.



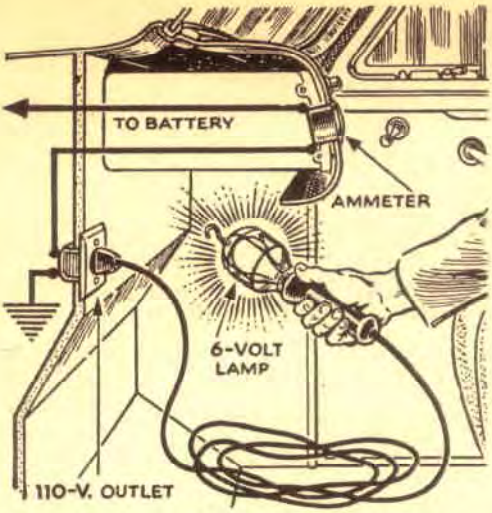
Bolts Pull Oil Retainer. The oil seal on the differential housing of one Plymouth seemed to be in for good, but Stanley T. Lusas, Woodbury, Conn., found a way out. Sawing a flat on two 3/8" carriage bolts, he was able to slip the altered boltheads into the groove from which the felt ring was removed. By alternately tightening nuts against a simple bar yoke, he drew out the seal. Different bolts may be needed on other cars.



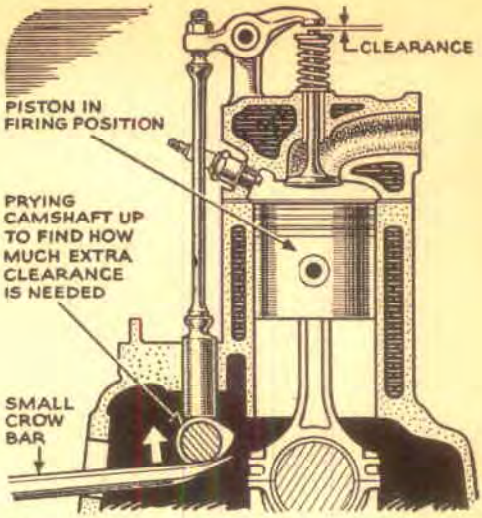
Grommet Guards Heater Hose. In making a hole in the firewall for heater hose you may have to drill a circle of holes and chisel out between them. Protect the heater hose from the jagged edges by slitting a piece of windshield-wiper hose and cementing it around the rough inside edge.



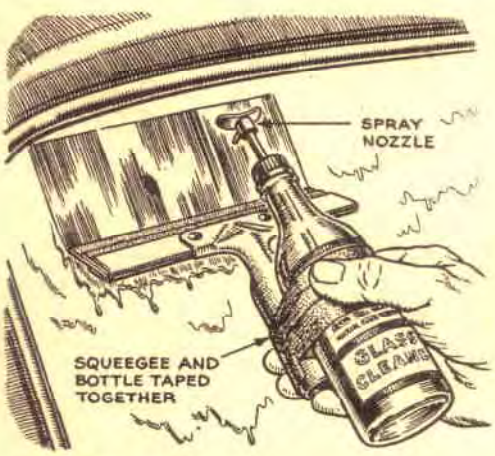
Wrist Pin Drives Shackle. When installing rubber-insert shackle bolts, George Pedley, of N. Grosvenordale, Conn., uses two other parts as tools. A wrist pin, annealed by heating, is employed for driving the bolt, and a connecting rod is used as a guide to keep the rubber from expanding.



Trouble Light Doubles in Car. One extension cord kept in the car is always available for use as a trouble light with the accessories added by W. M. Dierks, of Chicago. He installed a standard 110-volt outlet in the car, wiring it from the ammeter to ground. At the other end is a 6-volt bulb with a standard screw base. For use on house current it is only necessary to replace the bulb with a 110-volt one.



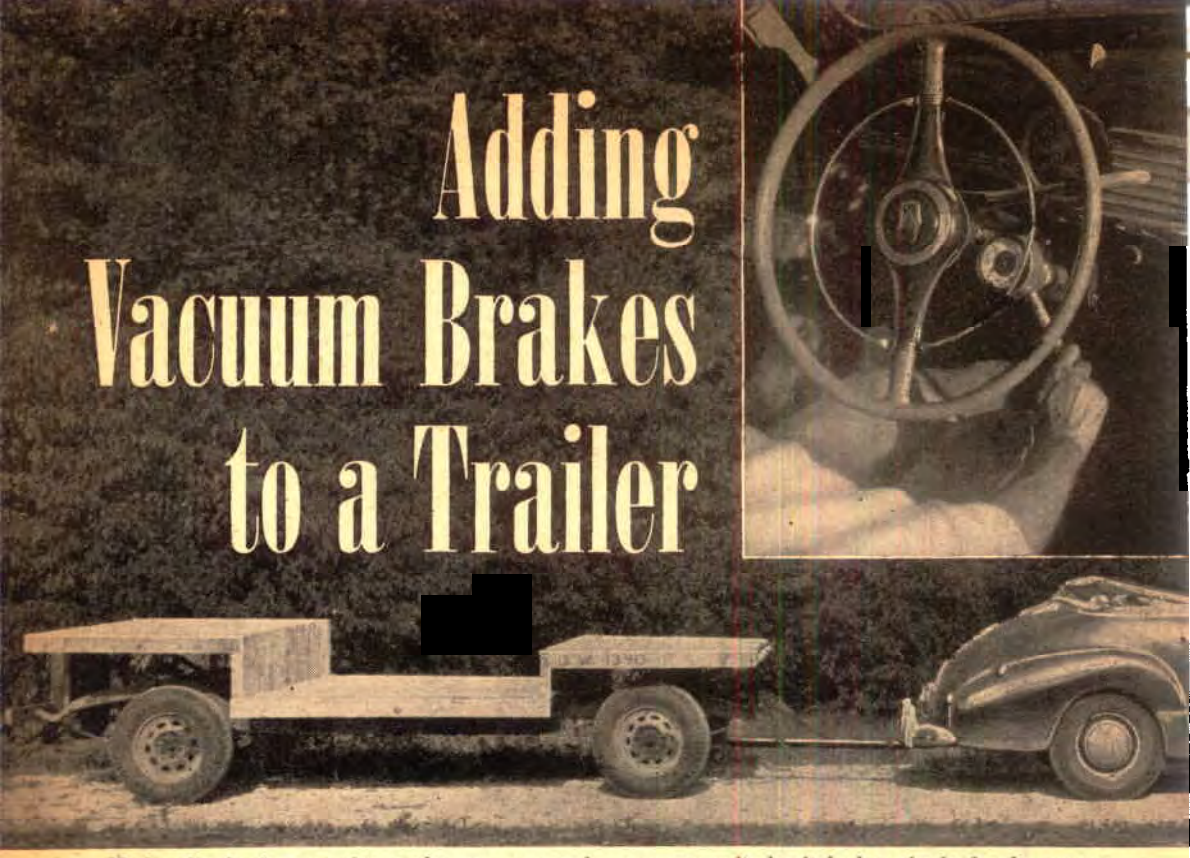
Wear Alters Clearance. Worn camshaft bushings may cause burned valves by reducing the apparent tappet clearance. Caral Lee, of Weld, Me., suggests this test for Chevrolets: Set the No. 1 tappet, remove the fuel pump, pry up the camshaft, and recheck the clearance. Since the camshaft tends to ride at the top of its bushings during rotation, the measured difference should be added to the normal clearance.



Unit Windshield Cleaner. Tape a rubber squeegee to a bottle of glass-cleaning fluid fitted with a spray nozzle, writes Sally Mills, of Syracuse, N. Y. When the windshield needs cleaning you only have to dig out the one unit to spray the fluid and wipe it off immediately.

Stool Built of Brake Drums. One mechanic made his job easier by welding two discarded brake drums together. Four casters on the bottom and a sheepskin buffing pad on top make it a serviceable rolling stool. It's particularly good for jobs for which you'd ordinarily have to kneel.

Adding Vacuum Brakes to a Trailer

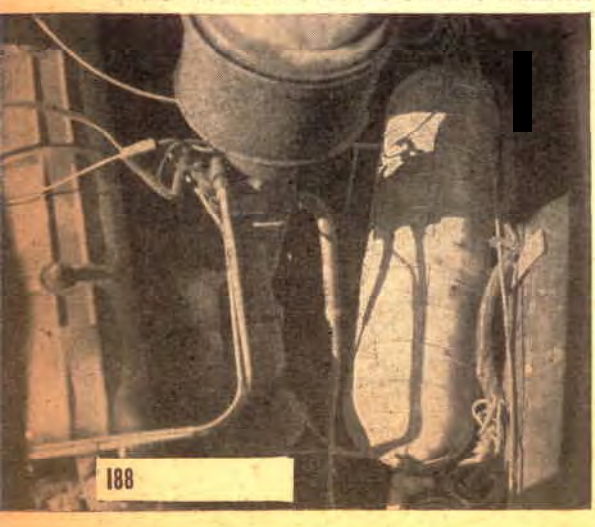


Hydraulic brakes on this trailer are operated from the car. A hand valve (inset) actuates a vacuum cylinder linked to the hydraulic master cylinder. A gauge shows the vacuum being used.

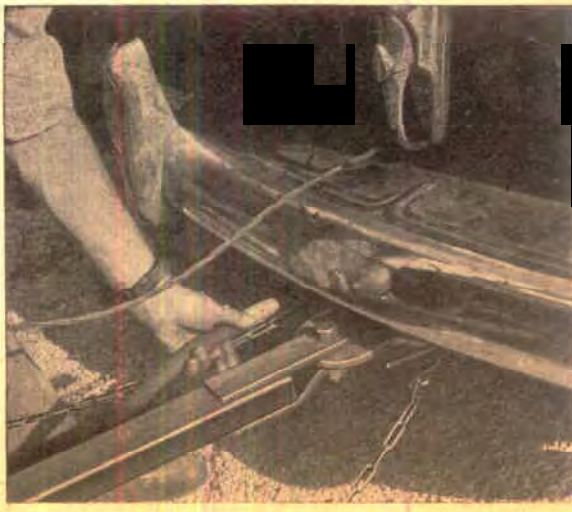
STRIPPED down to serve as a trailer, the old auto chassis above still has its hydraulic brakes but they're now applied by vacuum instead of by foot pressure. The intake manifold of the towing car provides the vacuum. A vacuum-line connector designed for trailer trucks allows quick coupling or uncoupling of the trailer.

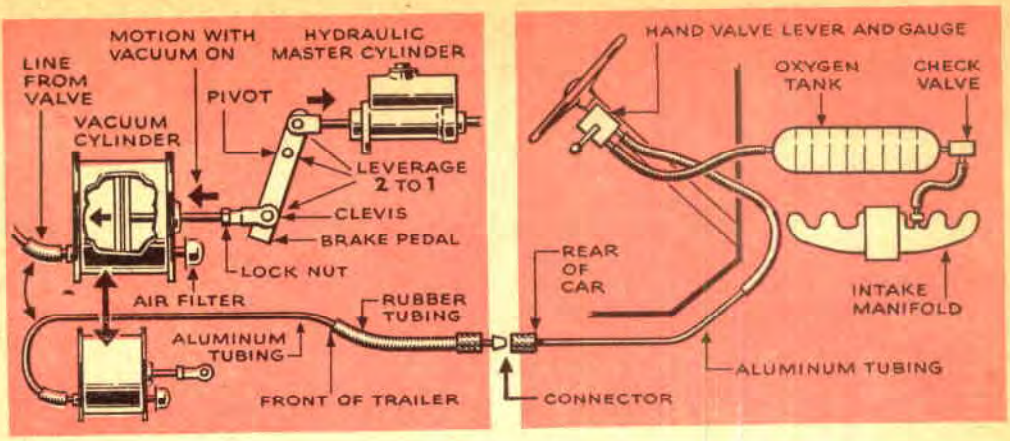
Nearly all the parts required were obtained from a truck-supply company. No

Reserve vacuum for faster brake action comes from this booster tank. There's a check valve in the vacuum line from the intake manifold.



A connector designed for trucks couples the vacuum lines, and a plug makes the electrical connection. Most states require safety chains.





changes were made in the chassis aside from installation of a towing and steering mechanism and addition of two extra leaves to each spring. A drop center in the trailer floor lowers the center of gravity. If desired, a house trailer could be placed on this chassis, or the brake system adapted to a two-wheel house trailer.

The trailer brakes are operated with a hand valve clamped to the steering column of the car. This valve includes a gauge to indicate the vacuum being applied. A booster tank with a check valve provides reserve vacuum. This was originally an oxygen tank, obtained from a war-surplus outlet. A T-fitting, substituted for the wiper fitting on the manifold, permits attachment of both the wiper and brake lines.

Two ¾" holes were drilled in the instrument panel, one for the line from the manifold to the hand valve and another for the line to the trailer. Most of the line is ½" aluminum tubing, but thick-walled rubber tubing was used at some points for flexibility.

The vacuum cylinder used in this installation has identical outlets at each end to give either a pulling or pushing action. About 8" in diameter, the cylinder has a 5½" stroke. Only a small part of the stroke is employed, however, when the brakes are properly adjusted.

In this case, it was found possible to retain the brake pedal as the linkage between the hydraulic and vacuum cylinders. Swung downward to provide clearance for the trailer floor, the pedal was pivoted for a two-to-one leverage. Its lower end was drilled for connection to the vacuum-cylinder piston. With the position of the pedal reversed, the cylinder pulls to apply the brakes.

Except on trailers of welded construction, a two-wire electrical circuit to the tail, clearance, and stop lights probably will do the best job. The hot side can be taken off the car taillight and the other side grounded. On the trailer, hook up the stop light through the master-cylinder switch so it will operate when the brakes are applied.

A little practice will show how much vacuum is needed to apply the brakes evenly. Smoothest action is obtained by pulling the hand valve a short distance, releasing it, and then pulling again. Full vacuum will usually slide the wheels. When parking with the engine shut off, it's probably wise not to count on the trailer brakes, though this one has held full vacuum for as long as 45 min.—*Charles T. Pearson, Chicago.*

Simple Light Checks Timing

HERE'S a simple timing light that will help you check and adjust the setting of distributor points. It also serves as a handy trouble light.

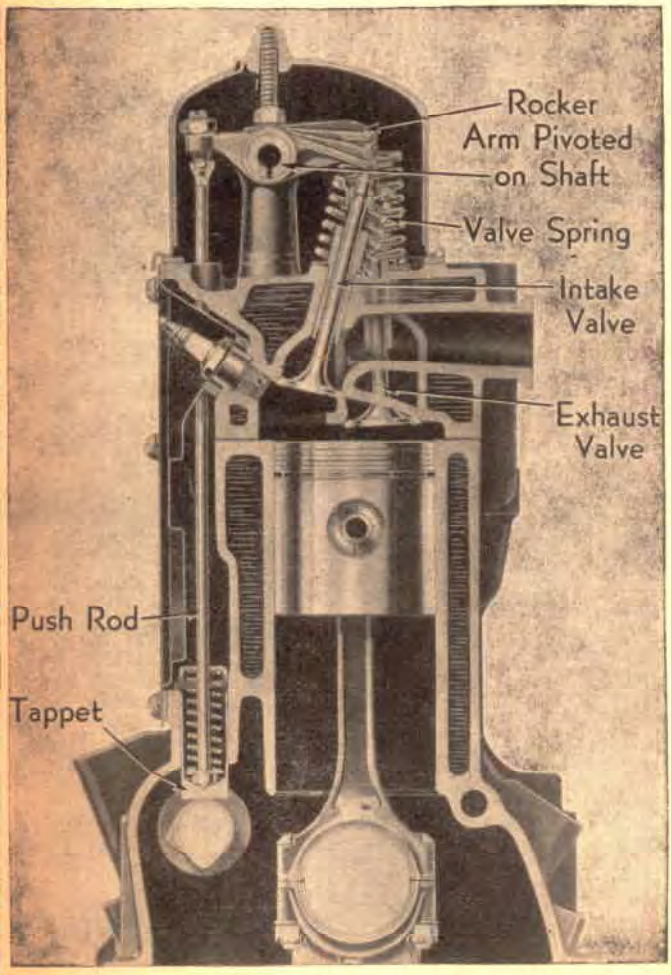
It was made by soldering the socket of a single-contact parking-light bulb to the pivoting end of a storage battery clip. One end of a 6′ length of insulated wire was then attached to the socket and the other to a small battery clip. It may be used for timing by attaching the small clip to the low-voltage distributor terminal and clipping the bulb in a place where it will illuminate the flywheel timing mark as it flashes on. This will enable you to rotate the distributor body as required.—*John M. Avery, Delhi, N. Y.*

Good Valves Give Engines

THESE HARD-WORKING PARTS TAKE A BEATING EVERY TIME YOU

EVERY time you drive for one hour at 40 m.p.h. in an eight-cylinder car the 16 valves open and close 840,000 times. Your exhaust valves are exposed momentarily to temperatures as high as 3,800 deg. F. and operate normally at cherry-red heat.

And yet, a dripping faucet, which is also a valve, is apt to get attention more quickly —for you can *see* the faucet dripping. Waste because of pitted valve faces or faulty operation is just as pernicious, but frequently it is not apparent to the automobile owner until his motor begins to run erratically. Serious trouble can often be nipped in the bud, and fuel can be saved, by having your engine "stethoscoped" twice a year by a competent repairman whose shop is equipped with a motor analyzer. If attention should be required then, fewer replacement parts will be necessary if you are warned in time.



Both valves are over the cylinder in an overhead-valve engine, as shown here. On the facing page is an L-head engine valve assembly

You can make a quick check yourself by hand-cranking your engine. Valves that seat fully will hold the fuel charge and cause the crank to bounce back or rock as the engine is turned over. If resistance is lacking on the compression stroke, there is a leak—it can be heard usually as a hiss, and unless this hiss is in the breather, which indicates a leak past the piston and rings, it will mean a faulty valve.

Test with the hand crank on the compression stroke of every cylinder, and if any valves leak, they should be inspected. Punch holes in a piece of cardboard to accommodate the valves as they are removed, numbering the holes so the valves can all be returned to their original openings.

Clean off all carbon and burned oil and examine each valve carefully. Look for pitting and uneven wear on the valve faces, check the stems and their fit in the valve guides, and test the valve springs.

Excessive wear in either the valve stem or guide will make it impossible to obtain a tight seat by grinding unless a new guide is provided. In a very bad case, both the valve and guide may have to be replaced. Too much clearance in an intake guide admits air and oil into the combustion chamber and results in upset carburetion, increased oil consumption, and heavy carbon deposits. Sloppy exhaust-guide clearance causes misalignment and bad valve seating with rapid wear on both the valve and seat. In the absence of the manufacturer's specifications,

Extra Punch

STEP ON THE GAS

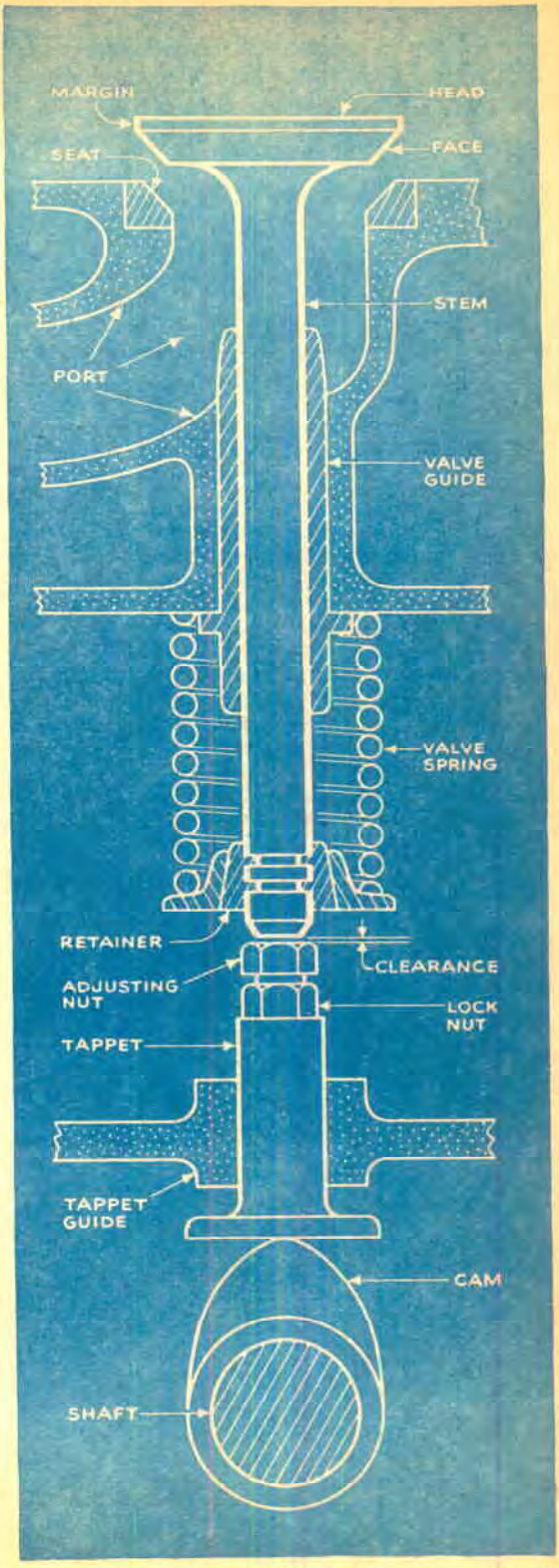
which should be followed exactly if available, replace any guide or valve that produces sidewise movement beyond that which is barely perceptible.

Valve springs should be tested for uniform length and correct tension. If available, a regular valve-spring tester should be used, but fairly accurate results can be had by standing the springs on a level surface and holding a straightedge across the tops to determine irregularity in height. Unequal or cocked valve springs will undo in the assembled job all the good work that has been put into it. Valve-spring tension that is too weak allows a valve to flutter, while tension that is too strong causes what is known as "stretched" valves.

Inlet valves, admitting gas instead of providing an exit for hot flame, do not pit as badly as exhaust valves and rarely need grinding. A valve that leaks compression can usually be ground successfully if it is not burned or warped and if there are no ridges or shoulders on its seat. Burned or warped valves should be refaced with a refacing machine, and ridged seats require reseating with a reseating reamer.

Grinding is done by smearing the face of the valve with a grinding paste or compound and turning the valve back and forth in its seat until the roughness is worn down. This can be accomplished with the aid of a valve grinder—a tool similar to a hand drill, but provided with prongs that fit into the slotted top of a valve or with a suction cup that grips a valve with a smooth top surface. Grinding may also be done by hand, that is, by turning the valve stem.

When grinding, turn the valve back and forth until both valve and seat show a bright ring about 1/32" wide all the way around. Clean the valve and seat occasionally when using the hand method to see how the grinding is progressing. It is generally helpful as a guide after the pits have disappeared to clean the valve and seat and to place about eight equally spaced marks with a soft-lead pencil on the valve seat. A quarter turn of the valve



To be ground successfully, valves need a definite margin. A knife edge causes breakage and burning

Use one new spring, if possible, when checking length and tension with the aid of a straightedge

A valve seat should be narrower than the face, for if it is too wide it tends to collect carbon

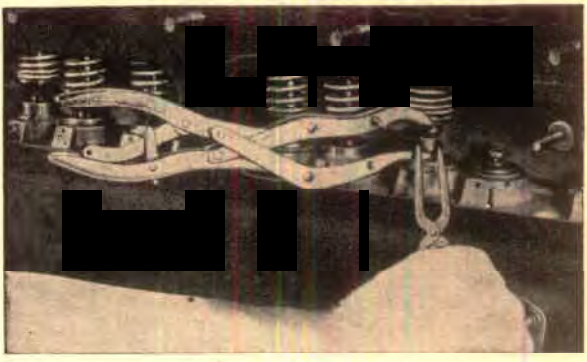
should then rub each pencil mark. If any marks are untouched, continue grinding.

Be sure to remove all traces of abrasive matter from the valve chamber and ports when the grinding has been completed. Then oil the valve stems and *reassemble each valve in its own opening.*

Some cars have insert rings as seats for exhaust valves. They seldom have to be replaced unless they become loose or are rendered useless by some abnormal engine operation. Loose rings are easy to remove, and others may be cut away with a drill and chisel. Use a bit with a diameter smaller than the width of the insert ring and drill a hole at two opposite sides, being sure not to drill all the way through as this may damage the recess. The undrilled portion can be cut with a chisel so that the ring can be removed in two pieces. A new insert ring should be packed in dry ice for at least 15 minutes before installation so that it will contract enough to be pressed into the recess. If a recess has been worn, an oversize insert can be obtained.

After reassembly, adjust the tappet clearances according to the manufacturer's specifications, which may be stamped on the valve cover plates. Unless directed otherwise by these instructions, warm the engine for about 20 minutes to attain normal operating temperature. Since exhaust-valve clearance is usually greater than intake, you can avoid confusion by adjusting all of one kind first and then the other.

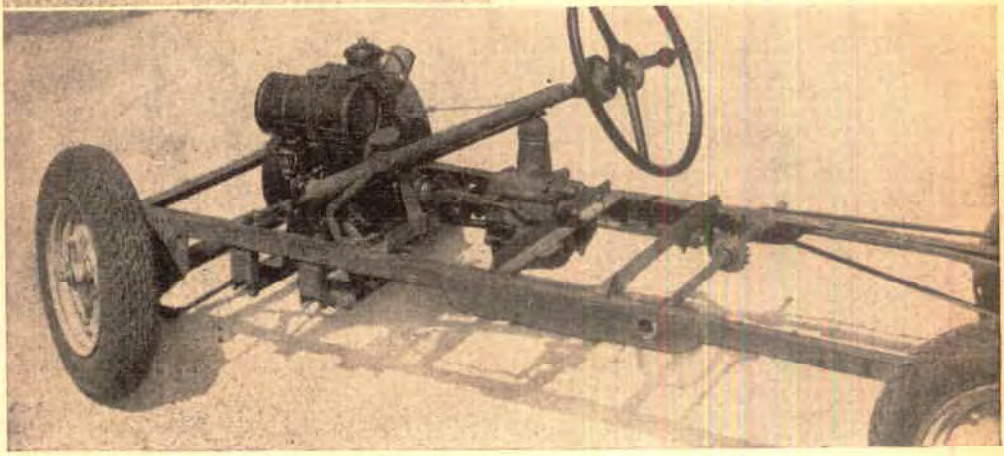
For certain cars adjustments can be made only by grinding the valve stem. To do this, drop each valve into its opening before assembling the guides and springs, and rest the tappets on the heels of the cams on the camshaft. Slip a feeler gauge between a stem and tappet and, if there is insufficient clearance, remove the valve and grind the end of the stem carefully until the desired clearance is obtained.



Use a valve-spring lifter to compress the spring when removing a spring retainer in an L-head engine. Pincers are needed to grip the retainer to avoid endangering the fingers. Below, a feeler gauge measures the clearance between the tappet and valve stem. The wrenches fit the lock nut and adjustment nuts

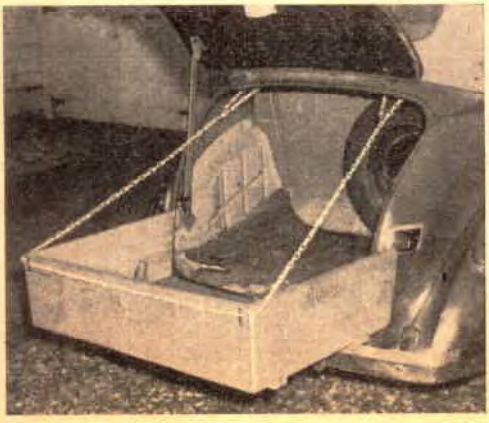
Play Car Teaches Young Driver

To TEACH his son to drive, L. S. Robbins of Chickasha, Okla., built a play car for him with a gearshift, clutch, brake, and foot throttle that work like those in a big car. Robbins used a 1½-hp. Cushman motor, a V-belt clutch, a Model-A transmission, and a drive shaft brake from a Plymouth. Tires are 4.00 x 16. The body is an aluminum airplane fuel tank. The car's top speed is 15 m.p.h.—plenty fast for a beginner. Rear wheels are belt-driven, and slight belt slippage eliminates need for a differential.



Extension Hauls Big Loads

WITH the trunk extension shown below, you can easily carry bulky loads. Made of 1″ by 12″ boards with a plywood bottom, the box rests on the bumper. The bumper guards stick up through holes in the bottom, keeping the box in place. Chains with snap fasteners support it as shown. Cleats on the side make it easy to lash a tarpaulin in place.—*Karl Greif, Binghamton, N. Y.*

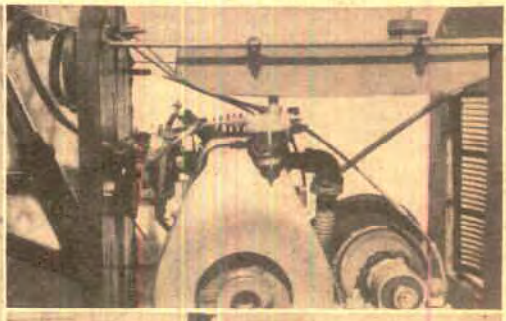


Car Carries Roof-Top Bed

ON TRIPS, Carl M. Miller, of Zion, Ill., never has to worry about hotel reservations. He carries his bed on top of his car. Made of ¾″ plywood, the platform is 4′ wide and 6′ long. The folding framework for the canvas tent and the ladder were formed from ½″ rigid conduit. The windows are plastic screening, and the window flaps are controlled from inside. The job cost $48.47.

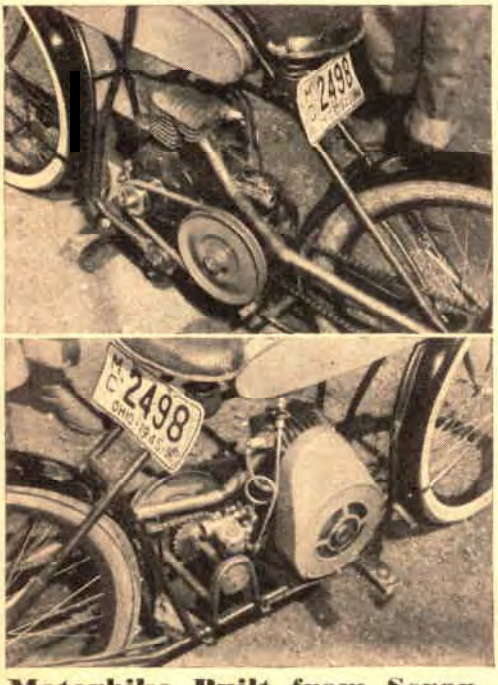
CRAFTSMEN ON WHEELS

Scooter Has Three Speeds. Before becoming a cadet-midshipman at the US Merchant Marine Academy, William R. Kern welded some ¾" pipe, added a few gears, chains, and a 1½-hp. motor, and came up with the two wheeler shown above. It carries him 80 miles on a gallon of gas at an average speed of 30 m.p.h. A V-belt the tension of which may be varied by an idler pulley acts as a clutch to engage the three-speed transmission. The latter transmits power to the rear wheel through a chain. Gears were cut on a milling machine and hardened.



Front Wheel Is Motorized. Using a standard bicycle as a base, Dr. William S. Voorhees constructed this unique front-wheel driven motorbike. In addition to the 2-hp. engine, the front housing holds a 1-gal. gasoline tank—enough for 120 miles. The motor is connected through a belt and a ball-bearing idler pulley to a countershaft which is geared to a sprocket on the front wheel. A brake on the countershaft is actuated by a handlebar lever; with this and the coaster brake, both wheels have braking action. Speeds from 6 to 42 m.p.h. may be obtained, and the bike is said to be quite stable on turns as well as straight runs. The speedometer works off the rear wheel.

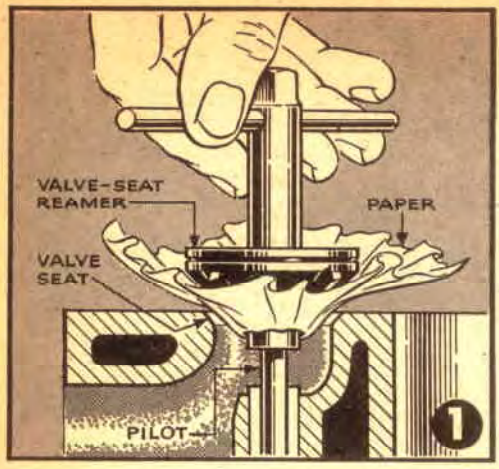
Scooter Takes Hills Easily. Employing a reduction of about four to one from motor to driven wheel makes this little scooter an excellent climber. Since it uses a 2.3-hp. engine, it still has enough power to cruise at 35 m.p.h. The Rev. J. Karlton Dewey, who built the machine, used ½" water pipe for the frame and welded all joints. Fittings are made from flat and angle iron. Clutch action is obtained through a jackshaft located just behind the motor. The shaft, which swivels in a horizontal plane, is moved by a pedal to slacken or tighten the drive belts in operation.



Motorbike Built from Scrap. Cast-off parts that he found lying around his father's machine shop became the raw materials for Robert Barr's lightweight motorcycle. A washing-machine motor, to which he added a carburetor for smoother performance, gives Barr a top speed of better than 40 m.p.h. Wheels, front assembly, and coaster brake were salvaged from old bicycles, and additions to the frame were made of ¾" gas pipe. Drive pulleys and chain sprockets give a ratio of 6 to 1.

Aluminum Goes for a Ride. Bob Wurgaft gets a top speed of 25 m.p.h. from his aluminum-framed scooter. It uses a ¾-hp. washing-machine motor whose action simplifies the design. For one thing the machine needs no clutch because it starts readily with just a slight push; the brake was also omitted since it was found that motor compression stopped the wheels quickly after the motor was shut off. With two passengers a cruising speed of about 15 m.p.h. is obtained.

Hints From the



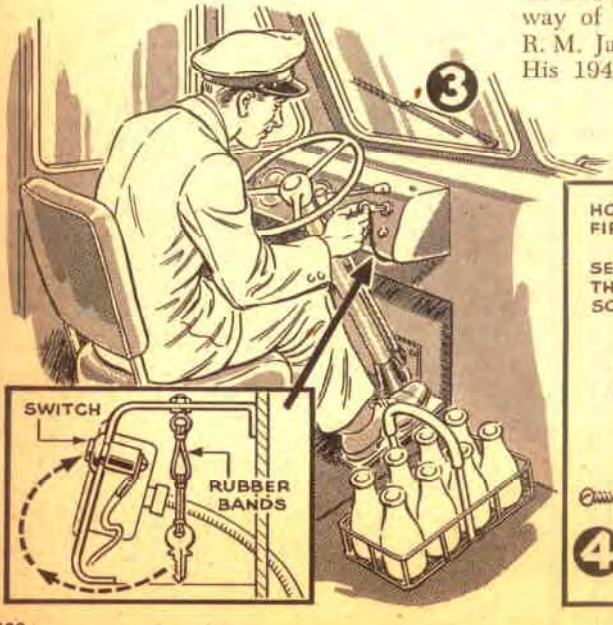
1. Stopping Chatter. If you have to ream a valve seat by hand, here's a trick that has been useful in the Model Garage. Slip a piece of thin paper over the pilot and ream right through it with short, quick turns. This will prevent the vertical ridges or chatter marks that sometimes ruin jobs of this kind.

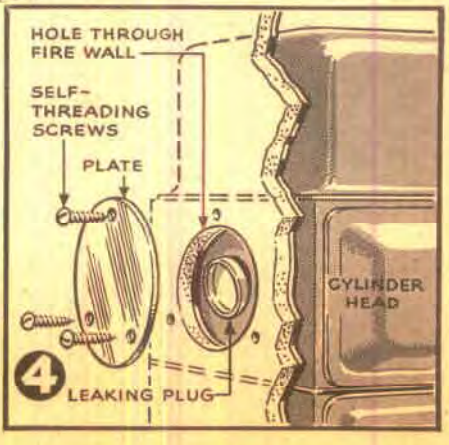
2. Ring Sized in Jig. Piston rings that are oversize in width can be ground with this jig. Saw out the disk and turn a groove in which the compressed ring will partially fit.

3. Ignition Key Hidden. A milkman must often go out of sight of his truck while making deliveries. Rather than invite theft, one driver pocketed his ignition key each time that he left. But it was always a nuisance to fish around for the key when he returned. He has now solved the problem by fastening the key behind the instrument panel with a rubber band. This keeps it hidden, but always at hand.

4. He Kept His Head On. An easy way of doing a tough job was found by R. M. Jackson, Jr., of Patuxent River, Md. His 1941 Buick developed a leak in the

Drawings by Stewart Rouse





Model Garage

freeze-out plug at the back of the head. The repair job threatened to be long and costly, because the closeness of the fire wall seemingly meant that the head had to be removed. Instead, he cut a hole in the fire wall and had the job done in minutes. A plate closed the hole.

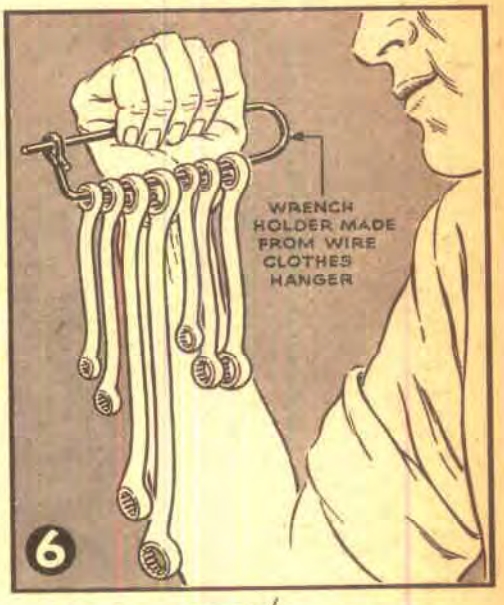
5. Getting Back Lost Plates. Erich Dallmer, of Narrowsburg, N. Y., suggests painting your name and address on the back of each license plate. It's a fine idea, and costs less than a replacement.

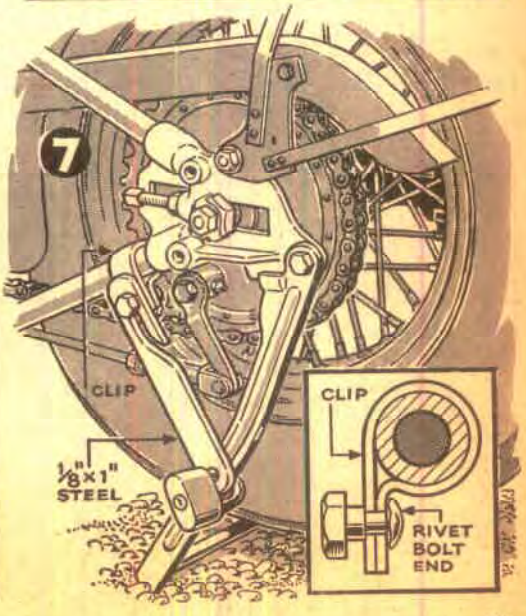
6. Wrenches Kept Together. Tired of hunting through his tool case for a needed box wrench, Arthur E. Nordhoff, of Seattle, made a large "safety pin" from a clothes hanger. This keeps them all at hand.

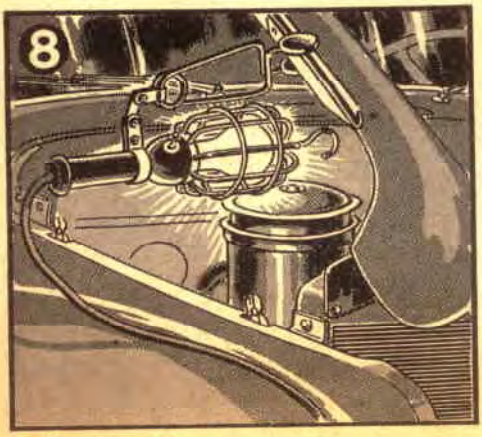
7. Lock Protects Motorcyle. This rig, writes Ivan J. Stretten, of Detroit, will both lock a motorcycle and prevent it from rolling off the stand. The slot in the arm lets you stow the arm in the tool box when it's not in use.

8. Clamp Added to Light. A spring clamp of the kind used on photographic lights lets you clip a trouble-shooting lamp in practically any desired position. H. Zave, of Chicago, makes the suggestion.

Gus Wilson







"Traffic cop" along desert speedway sits in airplane seat on 12½-ft. tripod. He has red signal light to warn drivers of impending mishaps.

Gunning the Hot Rods

By Andrew R. Boone

BILL BURKE is an Alhambra, Calif., welder; Don Francisco, a city fireman. They're not sure just what their car is: it has the chassis and running gear of a Ford roadster, a Mercury engine, and a body made from the wing tank of a P-38 fighter plane. They put it together themselves, and in it Burke recently whizzed along a stretch of the Mojave Desert at 149.75 miles an hour.

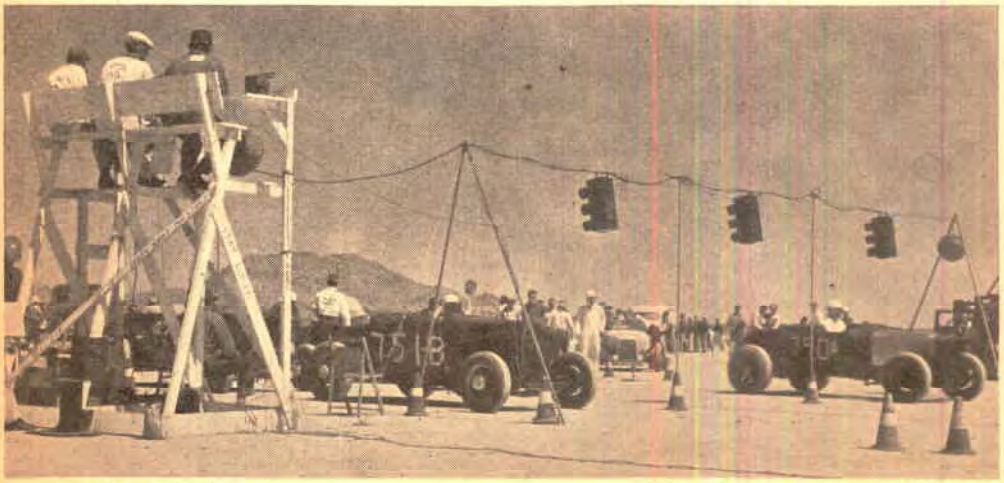
That's the current record of the Southern California Timing Assn., at whose speed trials every week end some 250 hybrid jaloppies like Burke's go screaming over the hard, smooth bed of El Mirage dry lake. It won't stand long if the drivers of these hot rods—as they're called—keep on thinking up new tricks to streamline a racing car and jazz up its engine.

Many of the drivers are ex-GIs who learned how to doctor engines while repairing jeeps, tanks, and airplanes at bases in a dozen countries around the wo In the last year they have added an average of about 10 m.p.h. to the top speeds of their patchwork racers.

To keep pace with their growing numbers and their steady push toward the 150-m.p.h. mark, the association has installed an elaborate speedway traffic system and an electronic timer that clocks the cars over a measured quarter-mile course to 1/1,000 of a second.

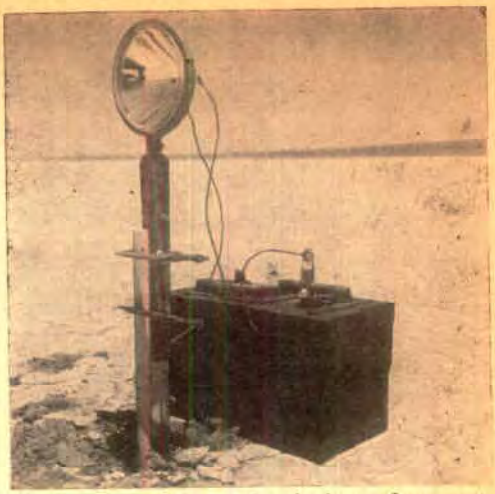
And after the hot rods hit 150?

"Up to 160—we hope," says Wally Parks, club secretary. He figures that dream may come true this year—or next.



Starting lights flash red, amber, and green signals in succession to send cars out of three lanes at 20-second intervals on 1½-mile approach to their carefully timed runs through speed trap. As many as 250 hot rods may make 500 starts on a week end. Starters get reports by phone from patrol judges and timers, and direct cars to the starting line by a loudspeaker system.

Electronic stop watch, calibrated to 1/1,000 of a second, times hot rods during speed runs. Shown with the apparatus is man who designed it, J. Otto Crocker, a San Diego bank technician.



Clock starts when car breaks beam from spotlight (above) to photoelectric cell at start of ¼-mile course. Breaking a second beam at finish line stops clock, which then shows elapsed time.

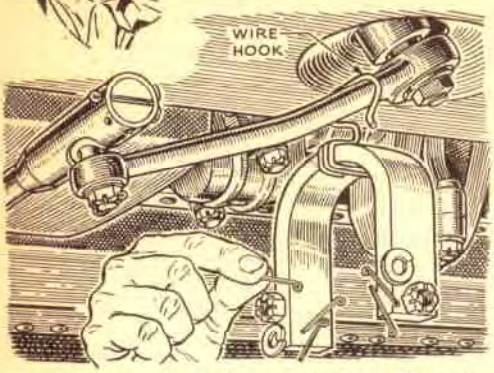
Hot rod is started by towing it with another car. Towline is attached to right front axle with airplane seat strap that can be unhooked while in motion by a tug on cord running to tow car.

Rear-engine speedster gets a push start. It has 1937 Cadillac V-8 motor mounted on the body of a 1923 Dodge roadster. Streamlined nose is a war-surplus wing tank cut in half.

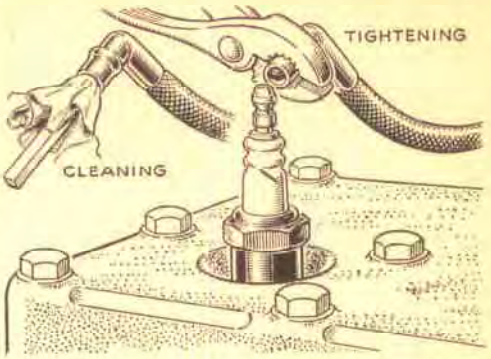
Radiator is eliminated to sharpen nose of this model. Instead, it has a 10-gallon water tank behind engine. Car is drained after each run and takes an hour and a half to cool off.

Half the hot rods now burn alcohol instead of gasoline. This one carries its 5-gallon supply in an aircraft oxygen bottle. At better than 100 m.p.h., car gets about two miles to a gallon.

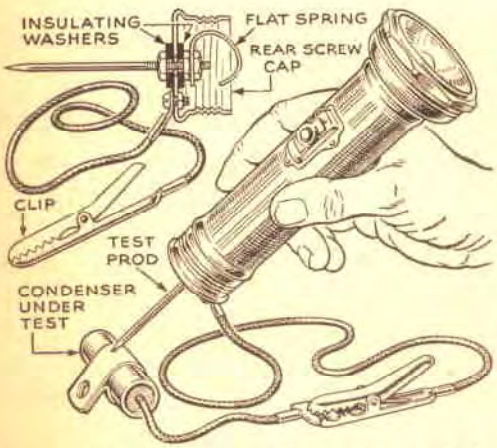
Hints From the Model Garage



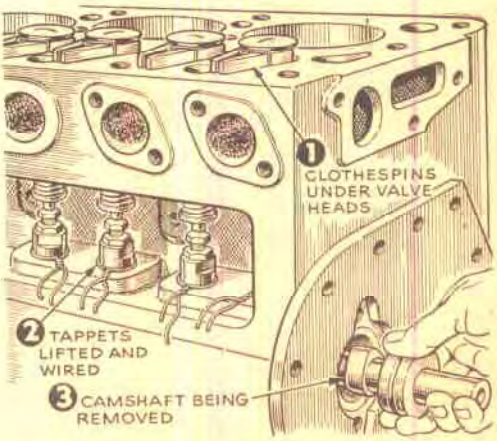
Magnet Holds Small Parts. When you're working under a car, hook a permanent magnet nearby. As you remove nuts, cotter keys, pins, or small parts, just stick them to the magnet. P. R. Wilson, of Brooklin, Ont., says this is a help when you replace the parts. They're right there when you want them, and they don't pick up grit.



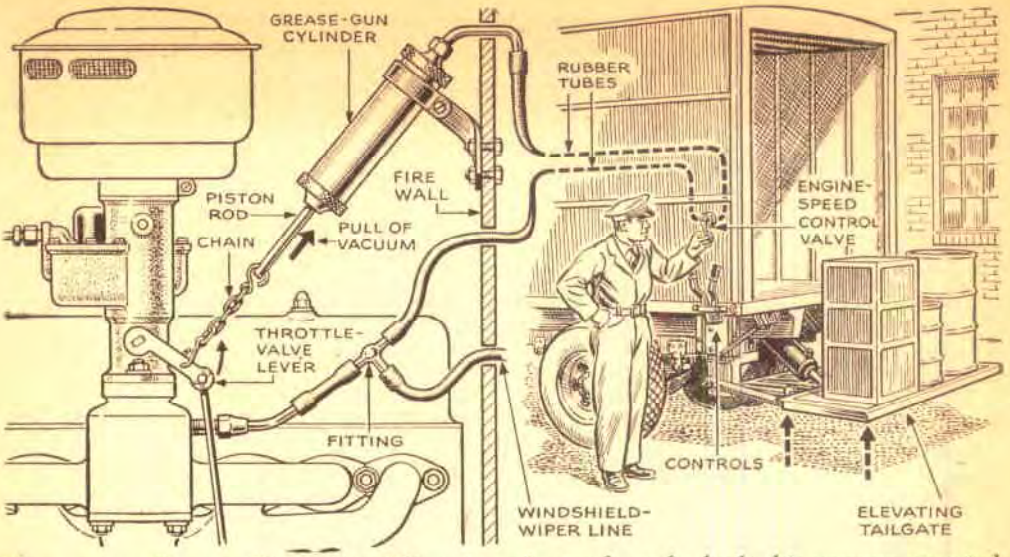
Dirty Cap Causes Miss. On high-compression engines, mysterious low-speed missing or bucking may sometimes be traced to poor electrical contacts in the high-tension leads. According to Frank Tobin, of Manhattan, N. Y., cleaning out and tightening the plug caps will often cure skips seemingly caused by defective plugs.



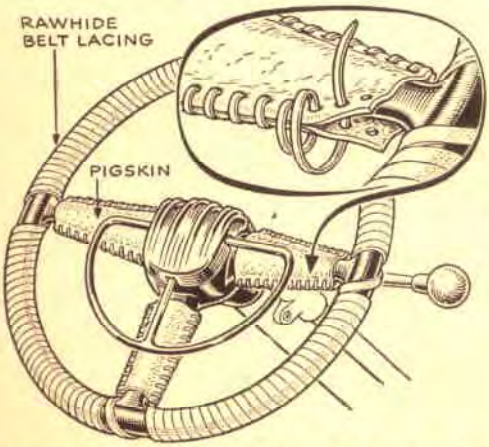
Flashlight Tests Circuits. A flashlight with a metal case makes a good continuity tester. Rufus P. Turner, of New Bedford, Mass., rigged this one. The test prod is a 3″ brass rod threaded for 6-32 nuts and insulated from the cap by fiber washers. The other lead runs directly to the cap. In use, the bulb lights to indicate grounds and shorts. No light shows on an open circuit or an unshorted condenser.



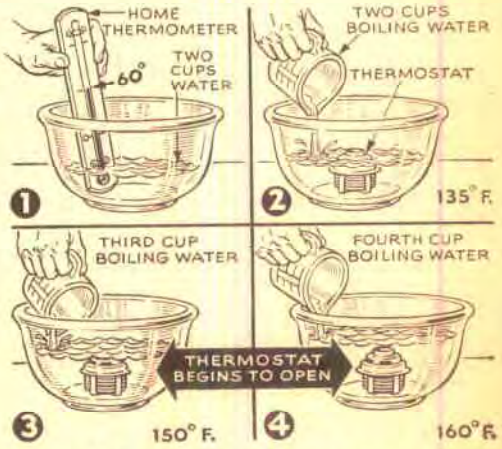
Clothespins Wedge Valves. Here's a time-saver in removing the camshaft of an L-head engine: Instead of removing the valves, springs, and tappets, just raise each valve spring with a valve-spring lifter and wedge a clothespin or piece of wood under the valve head. Then lift and wire each tappet up out of the way. The thrustplate then can be removed and the shaft pulled out. Kaiser-Frazer Corp. suggests this.



Vacuum Runs Remote Throttle. Powered by a take-off from the engine, an elevating tailgate takes a lot of labor out of truck loading. Mike Walt, of La Porte, Ind., says he had trouble with flexible-cable rigs varying engine speed from the back of the truck, so he built this vacuum-operated remote control. The cylinder is an 8″ grease gun and the lines are windshield-wiper hose. A two-way valve opens the throttle, or in second position bleeds air into the cylinder, letting the throttle-closing spring take over.



Glove for Steering Wheel. You can lend your car a custom-built touch by wrapping the rim of the steering wheel with rawhide thongs and lacing pigskin covers on the spokes. Leather not only has a good feel to begin with, but its texture generally improves with use. Cut the spoke covers as wide as the combined width and thickness of a spoke, and use a darker lacing on the edges.



Checking Thermostats. If you don't have a high-temperature thermometer, you can test auto thermostats with an ordinary one, using a method suggested by Roy Howell, St. Albans, N. Y. Put 2 cups of water at 60 deg. in a bowl with the thermostat, and quickly add 3 cups of boiling water for about 150 deg., 4 cups for 160 deg., 5 for 168 deg., 6 for 174 deg., or 7 for 178 deg. Car manual gives opening point.

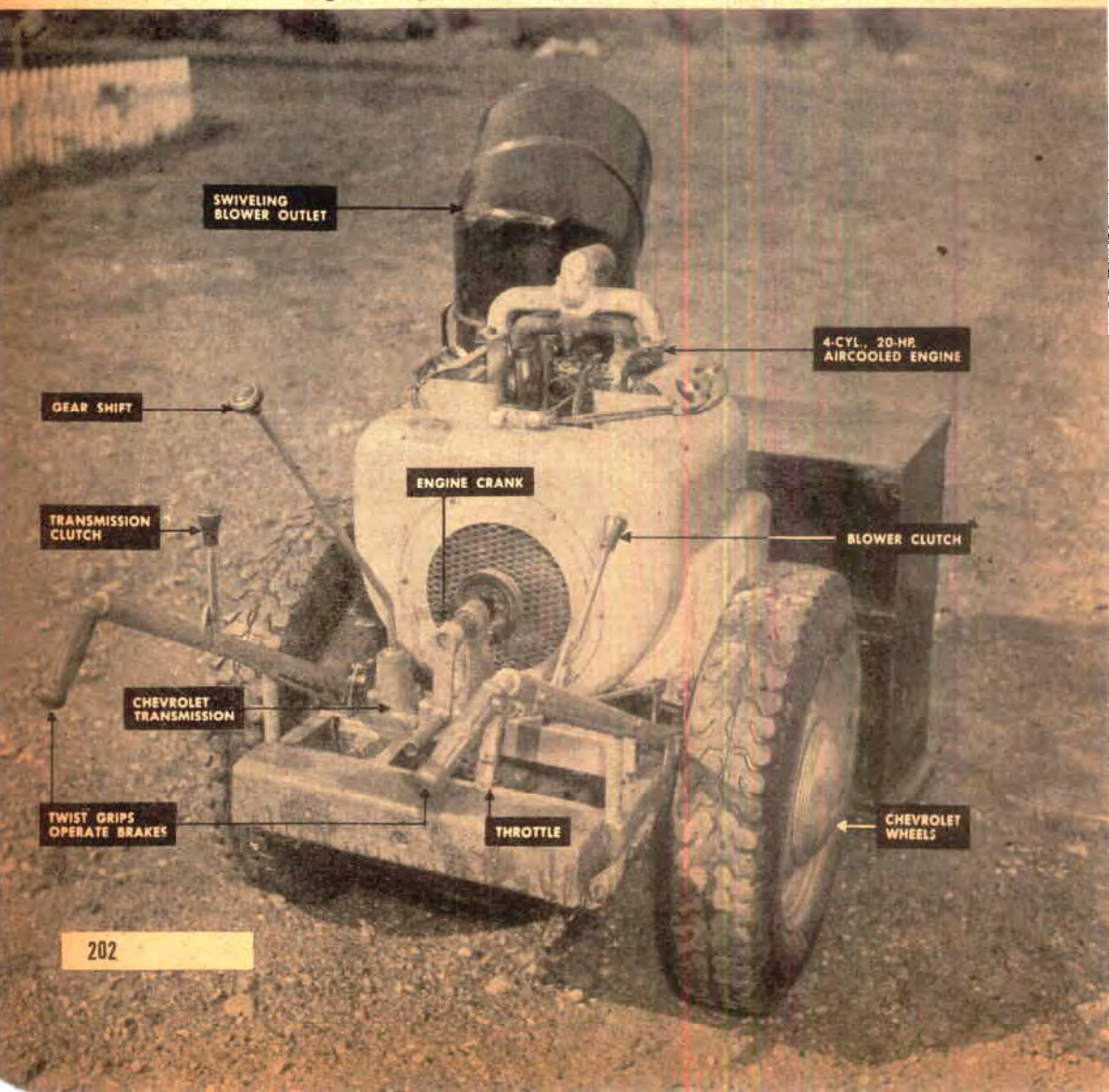
How I Blow Snow Away

In action, my homemade plow blows path 42 in. wide through snow up to 36 in. deep. It throws snow 40 ft. Chains improve traction.

By Paul Walker, Jr.

PS photos by Hubert Luckett

Convenient controls make the plow easy to operate. A disk clutch lets me disengage blower at will while another clutch permits shifting the transmission into desired gear. Engine has a governor, but I prefer to hand-feed the gas because there are times when it must be shut off quickly. The 900-lb. plow is steered by applying brake to inside wheel on a turn.



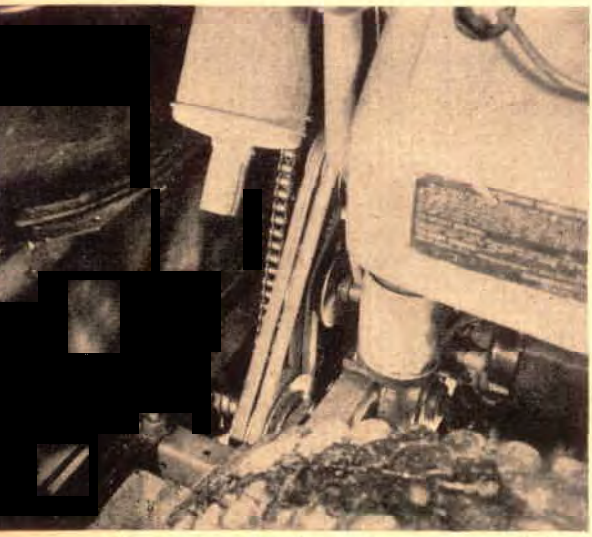
BLOWING snow off sidewalks and driveways beats shoveling it any day. It's easy—now that I have my rotary snowplow.

In building it, I cut down an old Chevrolet rear end so the wheel distance, center to center, was 32 in. I also reversed the unit to bring the drive into the differential from the rear. Then I mounted a 20-hp. Wisconsin engine on a channel-iron frame.

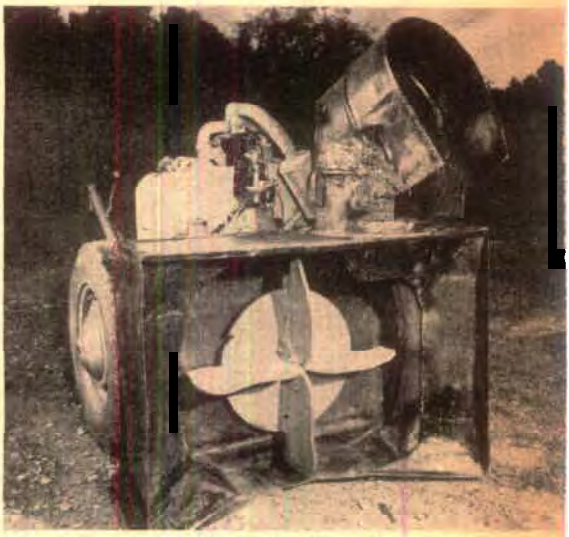
A ¾" roller chain drives the blower, the sprockets giving a four-to-one reduction from engine speed. When necessary, a dry-disk clutch on the fan shaft allows me to disconnect the blower. To propel the plow, two ⅝" V belts operate a pulley and dog clutch on a shaft running back to the transmission. There's a two-to-one reduction at this point. From the transmission, power goes to the axle, with a five-to-one reduction, by sprockets and a roller chain. Low seems to be the best plowing speed—about 2 or 3 m.p.h. Engine speed must be kept at about 2,400 r.p.m. to throw snow well.

The brakes are applied individually. Turning the twist grip operates a rod inside the hollow handle and a linkage at the lower end. Handles were made of pipe.

Later, I expect to adapt the unit for use as a garden tractor. For that reason, the blower was made detachable. END

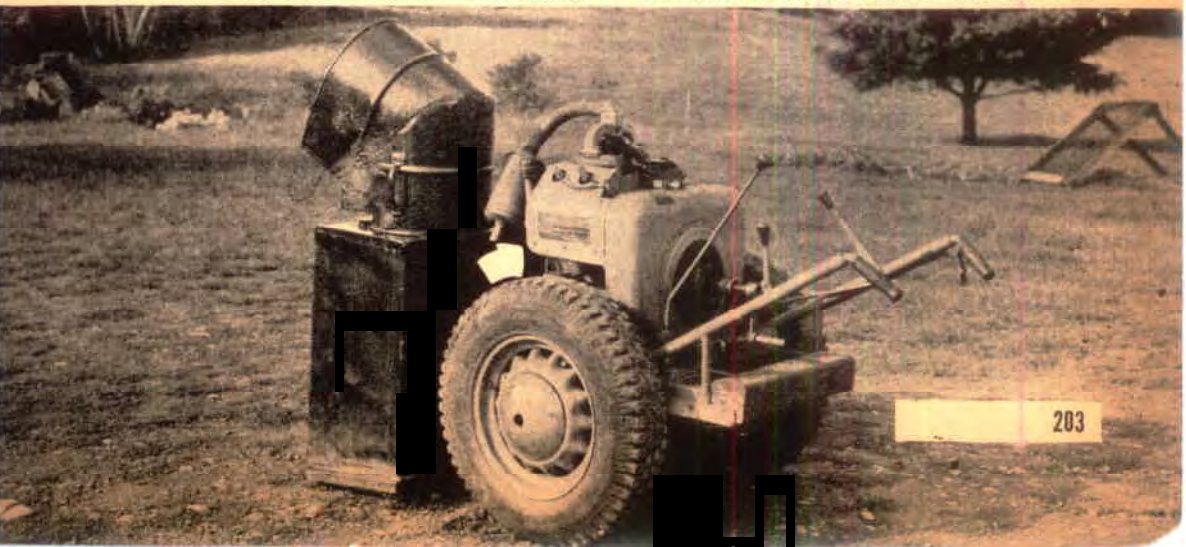


Power take-off at front of engine (arrow below) drives blower and propels plow. Roller chain turns blower, and the two V belts turn shaft running back to the Chevrolet transmission.

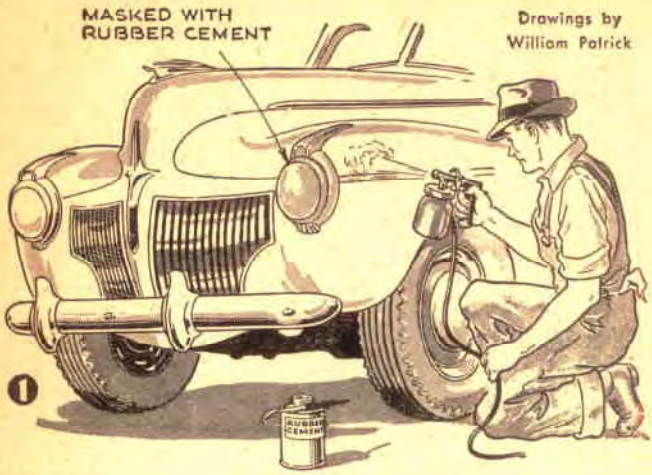


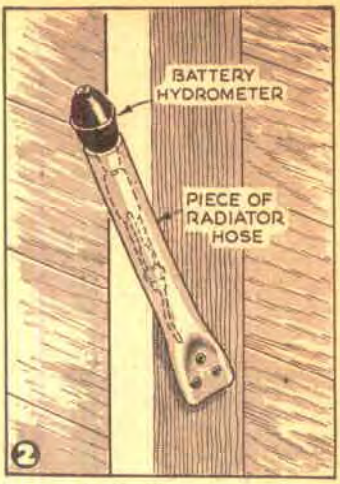
Blower housing is 30" high, 42" wide, and 18" deep, welded from 1/16" sheet steel reinforced with ¾" angle iron. The 24" blower, cut and welded from ½" plate, has a 2"-diameter shaft.

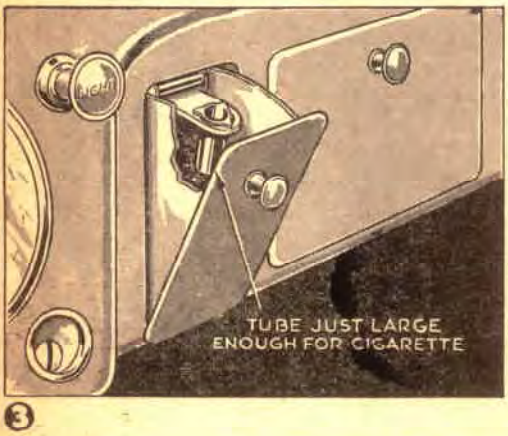
The snow outlet turns in any direction except to rear. This lets me shoot snow with the wind.



IDEAS FOR MOTORISTS







1 MASKING CHROMIUM TRIM on your car in preparation for a paint job may be difficult with the customary tape. Some of the brightwork may be hard to reach, and some may be so narrow as to make tape awkward to handle. Paint these places—or all the trim, if you like—with ordinary rubber cement. This material peels off easily along with paint sprayed on it.

2 YOUR BATTERY HYDROMETER can be kept in your garage without danger of breakage if you enclose it in a short length of discarded radiator hose. Nail the hose by one end to a stud, letting the upper part project at an angle, as shown in the drawing, and insert the hydrometer.

3 AUTOMATIC EXTINGUISHING of cigarettes, instead of letting them smolder in the bottom of the ash receptacle on your dash, is possible with the addition of a short metal tube the diameter of a cigarette. Drill the extinguishing bar in the ash receptacle for a tight fit, flare the upper end of the tube, and press the tube into the hole. A lighted cigarette inserted in the tube will go out. It will be pushed into the ash receptacle when the next butt is inserted.

4 REGISTRATION PAPERS and road maps can be kept conveniently away from other items when held at the top of a glove compartment by a piece of old inner tube. Slot the fiber top of the compartment, slip the doubled end of the tubing through, and hold it with a nail as shown.

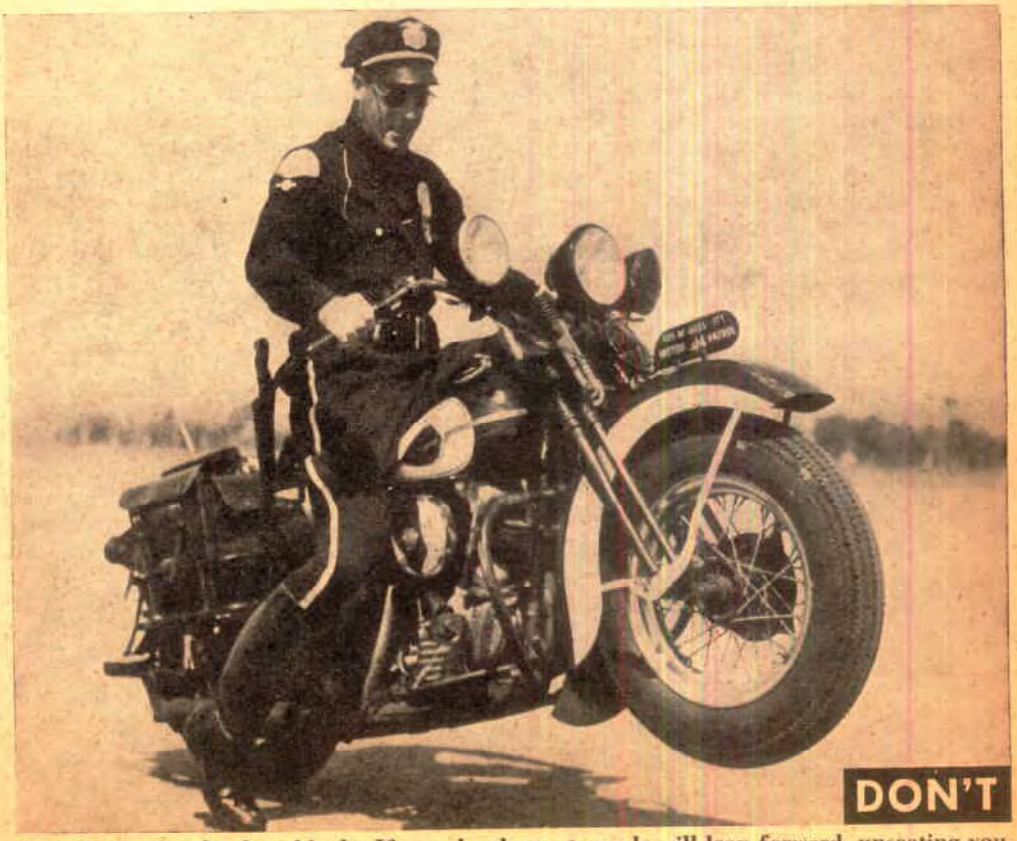
Motorcycle Cops Show How to Ride 'Em

By Tom Cameron

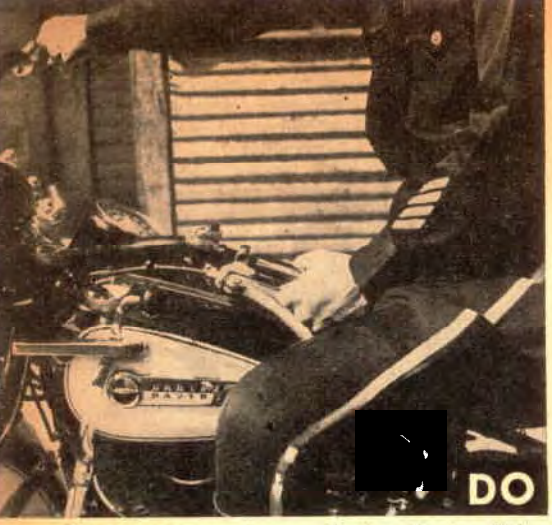
IF YOU'RE learning to ride a motorcycle, the policemen who patrol your streets and highways could give you some valuable pointers. Chances are these men are just about the best riders in the community. Because of the nature of their work they have to be. And it's likely this ability was not won through trial and error, for many police departments give their men a course in riding before sending them out.

One that has won acclaim for the thoroughness and success of its motorcycle training program is the Los Angeles Police Department. Out of many years of experience, embracing use of machines from the old one-lungers to the four-cylinder speedsters of today, the instructors there have evolved detailed "do" and "don't" procedures. The "don'ts" come first:

Don't be a throttle hound. This is the designation for one of those chaps who opens and closes the throttle in quick sequence to create the window-rattling bursts of sound that irritate the rest of us. Such a practice



Never let in the clutch suddenly. If you do, the motorcycle will leap forward, unseating you.



Swing out your knee, allowing the handlebar to turn when you must cut sharply to one side.

Never lock yourself in by sitting forward on a single seat in this way to carry a passenger.

is hard on the motor, causes backfires, and damages the valves, wristpins, rings, and the bearings.

Don't forget to put the sidestand in retracted position before starting the engine. The stand has a knuckle that keeps it extended. If you try to make a left turn with the stand sticking out, you may be dumped.

Don't let in the clutch suddenly. If you do, and open the throttle at the same time, your steed may unseat you.

Don't try to turn left with your left knee inside the handlebar. This locks you in. You might not be able to disengage the clutch, and you may lose control.

Don't ride double in such a way that you must sit forward on the seat to accommodate the passenger. This also locks you in.

Don't try to "rack up" your motorcycle when parking. This means turning out and sliding the rear end around to halt—you hope—at right angles to the curb or parallel to another motorcycle. If the rear wheel hits an oil spot, scrap of paper, a patch of sand, or a puddle, you may crack up.

Now here are some "do's":

When stopping for more than a minute or two, switch off the engine. It's air-cooled, and if permitted to idle it will heat up—as well as run down the battery.

When stopping, put the shift in neutral, with the clutch engaged. If you leave it in gear with the clutch disengaged and use the throttle, the clutch may drop in—and you'll take off without intending to. Also, if you try to start the motor with the clutch disen-

Keep your right hand up close to the front of the throttle at all times. This will give you greater stability on the motorcycle, as well as provide more certain control of the speed.

Deflate the tires to about 12-lb. pressure if caught by rain. This lessens risk of skidding.

With the stand extended, this rider is heading for a fall—just as soon as he turns to the left.

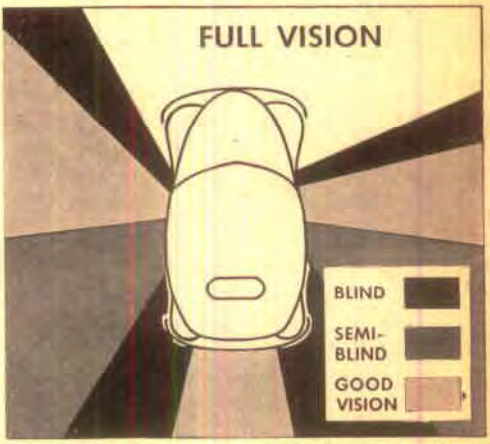
gaged, you'll have no compression against which to thrust. Consequently, when you stamp on the starting pedal, your foot will hit the ground hard and you may injure yourself.

Keep both hands (particularly the throttle hand) well forward on the hand grips. This gives better control and increases stability.

If you're caught out in the rain, stop long enough to deflate your tires from their normal 18 lb. to about 12 lb. This decreases the danger of skidding.

If you must ride through sand, turn only a few degrees at a time. Don't lean, or you will spill.

Watch every car driver like a hawk. There are blind spots where he can't see you—as the accompanying chart shows. END



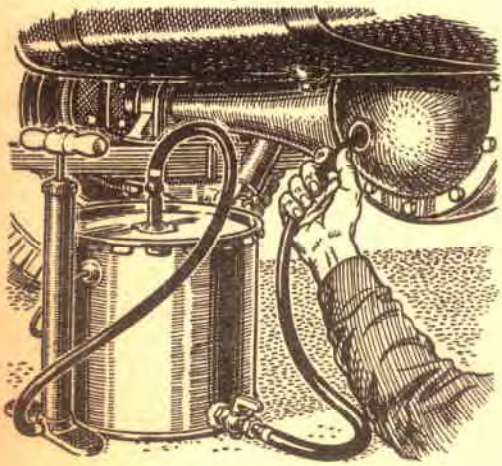
The blind spots of a car are dangerous places to ride in; a driver won't know you're there.

When the hand brake is applied suddenly on a turn, the rear wheel may slew ahead, causing the rider to spill. It's best to use it only while traveling in virtually a straight line.

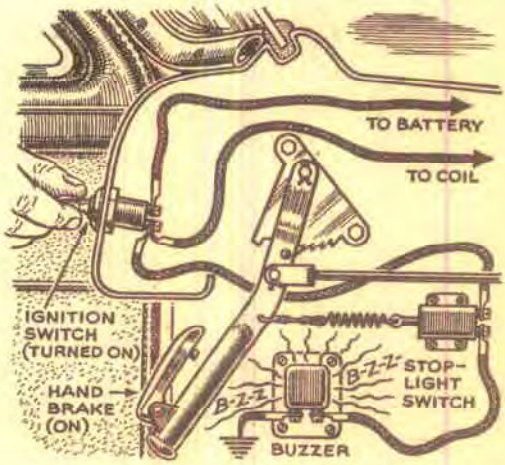
Hints from the Model Garage

Shaving Cream Removes Grease. I carry a tube of brushless shaving cream in the glove compartment and find that it is fine for cleaning grease from my hands after a tire change or minor engine adjustment. The cream doesn't require water, and comes off with the dirt as you wipe your hands.—*Donald P. Greiner, Dundee, Fla.*

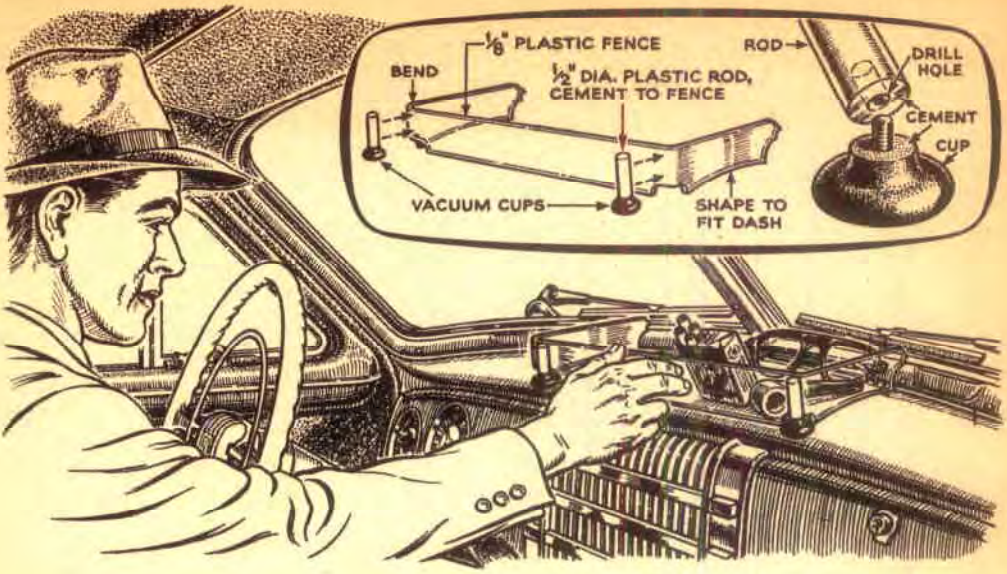
Linseed Oil Dresses Fabric Top. I have found that a good dressing for fabric tops is boiled (not raw) linseed oil. It even seals small leaks in the top, and does not crack because it is flexible. However, it requires considerable time to dry. Any paint store has it, but be sure it is boiled linseed oil.—*G. E. Boyd, Youngstown, Ohio.*



Can Makes Pressure Filler. A 2- or 5-gal. can, with a tire valve soldered in the top and a petcock soldered in the side near the bottom, makes a pressure filler for auto differentials and transmissions. Attach a flexible hose to the petcock and put a few pounds of air through the valve with a hand pump or air line and the filler is ready for use. The same idea works on a 55-gal. drum for dispensing bulk liquids.

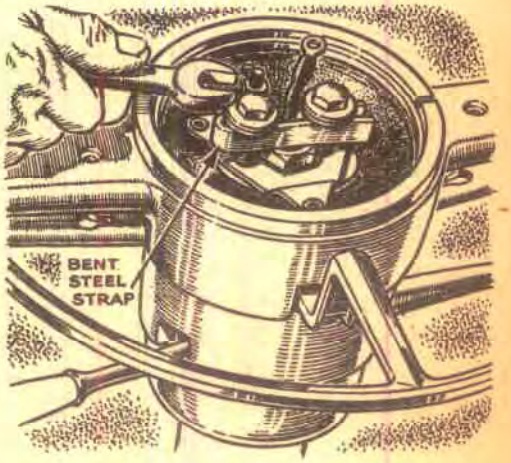


Buzzer Warns Hand Brake Is On. After catching my wife driving with the hand brake on for the third time, I devised this simple warning gadget that is similar to those found on newer cars. I connected a doorbell buzzer through a stoplight switch to the ignition switch, as shown in the drawing. Turning the key sounds the buzzer until the brake lever is released. The buzzer is under the dash.—*W. M. Dierks, Chicago.*



Dashboard Fence of Plastic. A strip of ⅛" plastic, bent and cemented to two posts, forms a dashboard fence that will hold a lot of those miscellaneous items you frequently need while driving. Small vacuum cups cemented and threaded to the rods will hold the fence but will not scratch the finish. Use ¼" diameter rods for the posts. Shape the sidepieces to the curve of the dash, either by cutting or by molding the hot plastic against the metal. Cigarettes, matches, pencils, and other items are kept in easy reach.

Hook Aids in Attaching Chains. Putting on strap-on chains—sometimes called mud hooks—usually is a messy and difficult job. To save my fingers and time, I use a stiff piece of wire bent to an L-shape. Most wheels have a rather small opening through which the webbed strap must pass. Run the hook through the opening and use it to pull the strap through.—*John Wright, Middleboro, Mass.*



Steering Wheel Puller. Removing the steering wheel of a Frazer without damaging the wire to the horn button was a problem until I hit on the simple puller illustrated here. It is a piece of ⅛" by ½" steel strap bent to a U-shape. Two bolts, supported by washers, were used to pull the wheel. Of course, the nut on the steering post was loosened, but not removed, to provide a bearing surface for the U-bracket.

How Safe Is Your

When your car is next on a grease rack, inspect the exhaust system carefully—its failure can ruin your engine or even take your life

PROBABLY no parts of an automobile receive less attention, even from conscientious motorists, than those in the exhaust system. And yet, far from being free from wear because of its lack of moving elements, the exhaust line is subject to deterioration unequaled by that of any other unit.

Faults are not readily discernible, and the average driver is apt to remain falsely assured as long as the exhaust is muffled. This is doubly unfortunate for, aside from the mechanical failures that can be traced directly to faulty exhaust, the carbon monoxide discharged from an automobile motor is a relentless killer. Even small amounts of this odorless, hard-to-detect gas produce drowsiness, and this in turn can lead to serious accident. The danger is lessened in summer, for carbon monoxide dissipates quickly in fresh air; but in the winter, with windows tightly closed, leaks in the exhaust system can fill a car in a short time.

There are several sources from which carbon monoxide can seep into the body of a car, the most common being from a leaking exhaust manifold. This unit is under the hood directly in front of the dashboard through which the engine fan can force fumes. Holes for wiring are not often sealed, nor are the spaces around a steering post, clutch, brake, and accelerator, and these offer a ready entrance for the deadly gas. Badly fitting floor boards extend the same invitation to gas from leaks in a muffler or in exhaust pipes. These parts are in the open, but forced drafts created by the movement of the vehicle can send much of the exhaust from them into the car.

An easy method of testing for exhaust and muffler leaks is to disconnect the windshield-wiper hose and introduce a small amount of light oil into it while the engine is running. Any light crankcase oil will serve the purpose, and it is a good idea to speed the engine to about a quarter throttle to avoid stalling. The vacuum in the intake manifold will suck all the oil from the container used, and an extremely heavy exhaust smoke will result. Two or three ounces of oil will produce smoke for several minutes, long enough for a thorough inspection.

Have an assistant partially restrict the exhaust at the tail outlet by holding a board or a wad of rags over the opening. This will cause excess pressure in the exhaust system and force the smoke through any openings or cracks that are present. If you have no helper, the exhaust can be restricted by temporarily jamming a wedge-shaped (not round) piece of wood into the outlet.

Most leaks will be found around the

Car's Exhaust System?

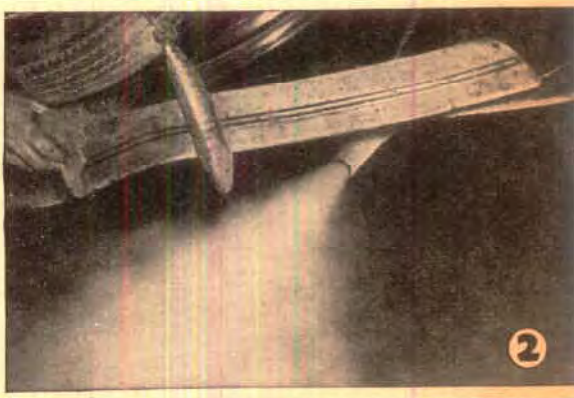
manifold gaskets or at the muffler where it is connected to the pipes. Manifold leaks can frequently be stopped by tightening the bolts that hold the unit to the engine. If this fails, a new set of gaskets is needed. Leaks at the muffler connections are usually the result of pipes working loose because of vibration. Pull the pipes from the muffler, clean the ends with penetrating oil and steel wool, and reinsert them firmly.

Cracks in the muffler housing and exhaust pipes are a different problem, resulting most often from inside corrosion. Patching is poor practice when this is the case, and a new unit should be installed. In the rare instance, however, where a muffler has been punctured from the outside, stovepipe will make an effective patch. Split the stovepipe lengthwise with a hacksaw, wrap the muffler with two layers of heavy sheet asbestos, put the stovepipe around this, overlapping the ends a few inches, and clamp it tight with strap-iron clamps.

Most mechanical damage caused by a faulty exhaust can be laid to back pressure —an abnormal pressure built up in the exhaust circuit by restriction resulting ordinarily from a bent or crushed exhaust pipe. Driving on high-crowned country roads or in heavy snow can damage a pipe or muffler, as can flying stones or a rear-end collision in which the bumper of the other car hits the tail pipe and buckles the line.

Back pressure is also caused internally by corrosion. For every gallon of gasoline burned, a gallon of water is produced by heat and condensation, and this passes into the exhaust circuit, tending to rust the iron and steel walls. Most gasoline also contains sulphur and bromine which combine to form a corrosive exhaust acid. These corrosive elements build up scales that in time fill the pipes and the baffle plates or perforated tubes in the muffler, collecting natural exhaust soot that further adds to the stoppage. Corrosion often is sufficient to dislodge baffle plates or tubes and form greater restrictions.

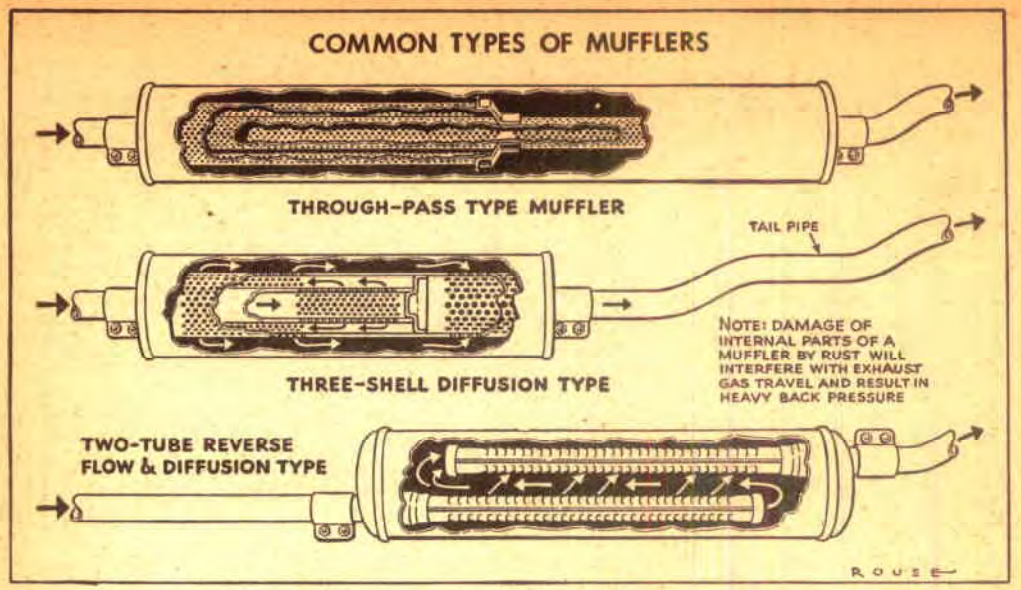
A sure way of retarding corrosion is not to start your motor unless you intend to let it warm up thoroughly. Short runs deteriorate mufflers rapidly, for during them



1 Leaks in the muffler or exhaust pipes can be spotted by disconnecting the windshield-wiper hose and allowing it to suck up a little light oil

2 Two or three ounces of oil will produce heavy smoke in the exhaust for several minutes—long enough for you to make a thorough inspection

3 Have a helper partially restrict the exhaust by holding a wad of rags over the outlet as you watch for smoke leaking at cracks and joints



the exhaust system does not have a chance to heat to a point where moisture is vaporized. Some mufflers are plated inside with lead or a tin alloy, and this tends to prolong their life, but heat and acids from a long run at high speed may melt the plating away and expose the bare metal.

Among the most annoying failures traced to back pressure are burned-out exhaust valves. Exhaust temperatures reach extreme heights and, unless this heat is carried away swiftly, the valves may burn out in a matter of a few miles.

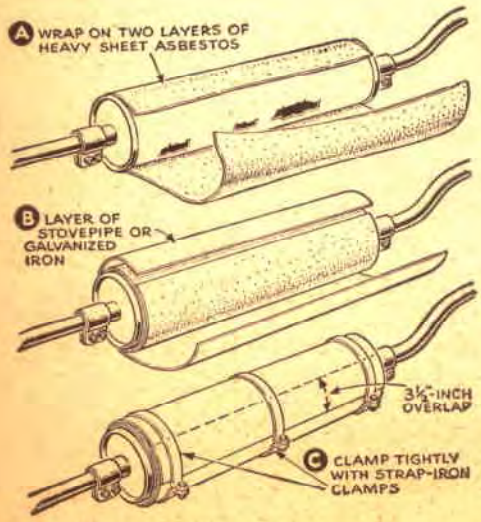
Crankcase oil often becomes contaminated by gases that are present in the crankcase in greatly increased volume when back pressure exists, and contaminated oil can ruin bearings and wall surfaces.

Sometimes one of the most difficult breakdowns to trace is a boiling radiator. Automobile servicemen have treated a supposedly defective radiator, boiling it out and blasting its cooling walls with steam repeatedly without results, only to learn the cause of the trouble when a break occurred in the exhaust line and released the pressure. Each automobile cooling unit is designed to handle a given heat in a given time, and when back pressure raises the internal heat in the combustion chambers and around the exhaust ports, the cooling system is often unable to take care of the excessive load.

Back pressure greatly decreases gas mileage and kills acceleration by preventing scavenging of the burned gases and thus much reducing the volumetric efficiency of the fresh charges in the cylinders. Spark plugs can be ruined by the heat of back pressure which is sometimes sufficient to crack the porcelain.

Testing for back pressure is difficult, but there are several symptoms that can be easily recognized. The engine runs warmer than usual, acceleration falls off, and the motor is rough at idling speeds. A volumetric-efficiency tester is used at the factory to determine back pressure, but service stations and garages rely chiefly on experience and judgment.

Where back pressure is suspected, it is a **good idea to attach a vacuum gauge to the intake manifold and note the reading at idling** speed. Then disconnect the muffler from the pipe leading from the exhaust manifold. If there is an immediate rise in vacuum, you can be sure that back pressure existed in one of the disconnected parts, for the efficiency of an engine can be measured by the vacuum on a set throttle. In cases where back pressure is severe, the improvement on disconnecting the muffler should be noticeable even without a gauge.



Grownups Put This Toy to Work

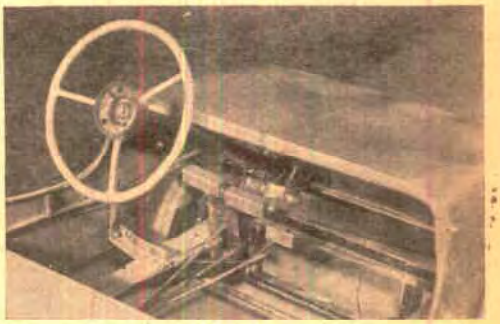
The tiny car is a natural for daily shopping chores and short trips. Seat has room for a passenger, laundry bag, or parcels. Car has motor-scooter wheels.

IT COSTS you gasoline when your wife runs an errand in the family bus. As an economy substitute, she might go for a midget car like this one, built by Paul E. Matous, of Orangeburg, N. Y. With it, a gallon of gas would cover a week of gadding around.

Actually, Matous built the midget for a friend's 10-year-old son. But the grownups soon took it back. It proved too speedy and tricky for the youngster.

Built on a 41" wheelbase, the car is 60" long and 37" wide—small for an adult, but you can cram yourself in.

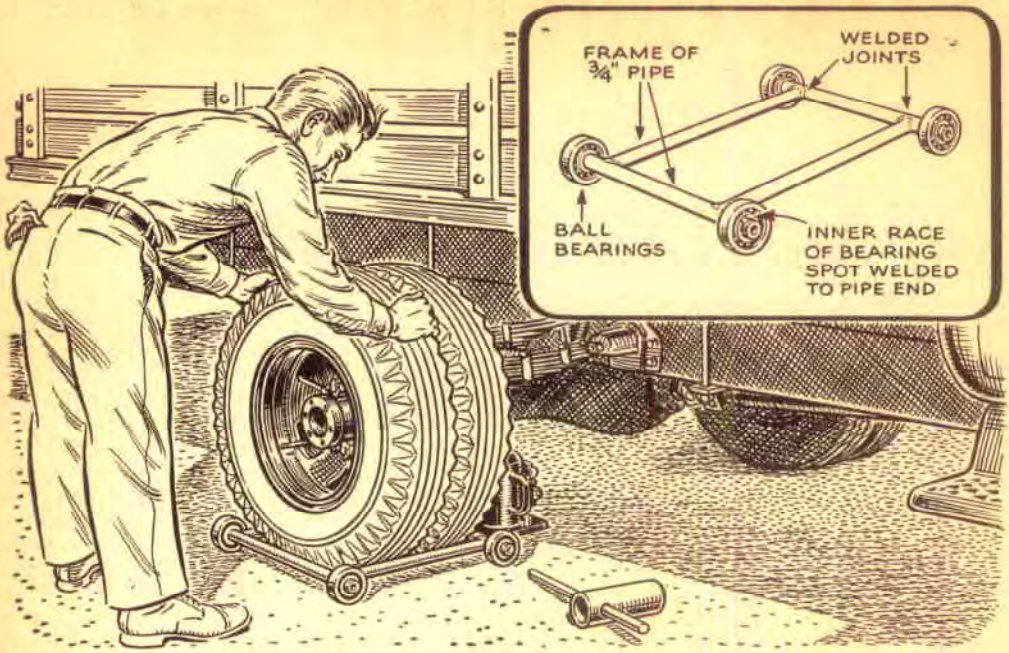
Motor-scooter engine is coupled to Indian motorcycle transmission. A chain drives one rear wheel. You shift gears with lever behind you.



The pedals work like those of big car. Brake operates mechanically on a rear wheel. Steering gear is from a Ford. Frame is angle iron.

Kick pedal starts 4-hp. Cushman engine. The car gets up to about 45 m.p.h. and will cover around 40 or 50 miles on a gallon of gas.

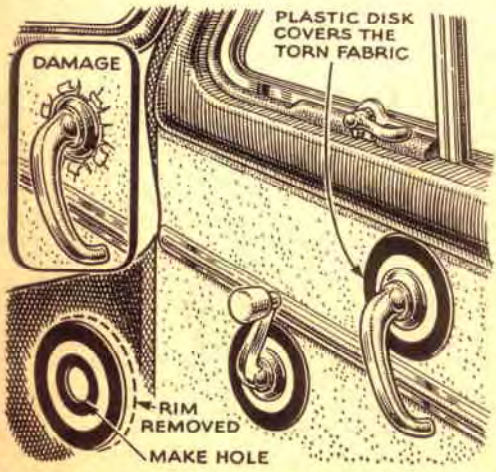
There's no reverse gear, but don't worry. Anyone can pick this car up and whirl it around. And it can be parked right at your door.



Dolly Handles Dual Tires. For removing and installing dual truck tires as a unit, Charles D. LaRue suggests making up a dolly like this. The original is in use at a shop in Sacramento, Calif.

The dolly is inexpensive to make. Four used ball bearings will serve as the wheels. Adjust the frame dimensions to suit the size of the truck wheels.

To use, lower the jacked-up wheels on the dolly. After removing the retaining nut, you can then pull the wheels away on the dolly.



Repairing Handle Wear. Plastic coasters from the dime store can be used to hide torn fabric around a door handle. Cut the rim from the coaster and make a hole large enough to slip over the handle. Clamp in place with the original flange.

Handy Polishing Pads. Pieces of old carpet run through the washing machine and then dried make convenient pads for polishing cars. If no old carpet is available, your furniture store may be able to supply small remnants.

RING TROUBLES and How to Cure Them

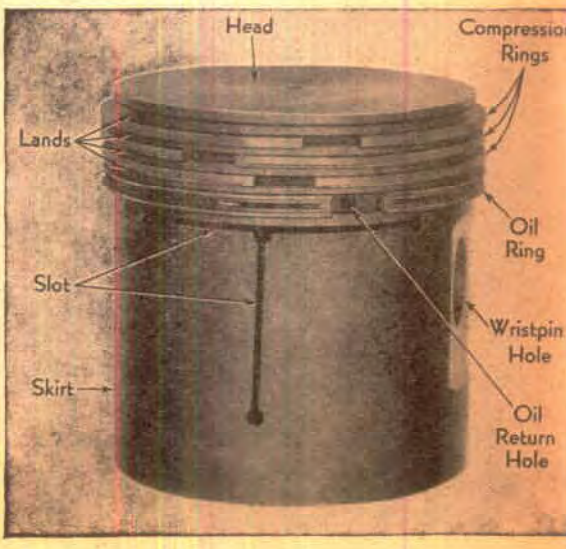
PISTON rings, tailor made by the manufacturers to individual engine design, are precision parts of the modern automobile. They serve to fill up or seal the clearance between a piston and cylinder wall, keep blow-by or burned gases from escaping into the crankcase during the power stroke, and regulate the flow of oil to the walls of the cylinders.

Just why a piston ring must be a precision part may be seen from the figures of one maker who has calculated that the average automobile engine burns three one-thousandths of a drop of oil per explosion. If it burned as much as a tenth of a drop, it would use 90 quarts of oil on a 600-mile trip traveled at 60 m.p.h.

However, there are other parts of a motor that help control oil consumption, so don't jump to conclusions if it seems excessive. Too often an extreme ring setup is installed when it isn't needed with the result that the upper part of the cylinders runs dry and wear and failure are rapid.

Look first for external oil leaks at the valve cover, fuel pump, and oil-pan gaskets; then see that oil lines, pipe plugs, front and rear main-bearing seals, and the crankcase ventilator are not leaking. A thorough inspection can best be made by wiping these parts clean and road-testing the car at various speeds, after each of which an examination should be made for signs of fresh leakage.

Many cars are equipped with combination fuel and vacuum pumps, the vacuum section being used for the operation of windshield wipers and other accessories. A leaky diaphragm will suck oil from the crankcase into the vacuum line from where it will enter the intake manifold and combustion chamber and produce a blue smoke at the exhaust. Watch for sluggish action of the windshield wipers



CHECKING THE CYLINDER BORE will show whether honing is advisable. Here a dial gauge is used. Right, a typical piston with its parts named

SIDE CLEARANCE must be allowed between a new ring and the groove. Measure with a feeler gauge and, if insufficient, lap both sides of the ring on fine emery cloth placed on a flat surface

RINGS ARE INSTALLED or removed with a ring tool or pliers, opening the ends to expand them. Stagger gaps of new rings, except on a Hudson, but put no gap over a wrist-pin hole

during acceleration as an indication of a defective diaphragm.

Two other points should be examined before concluding that the piston rings are at fault. If the intake-valve guide clearances are excessive, the thing to do now is to replace the guides; if the guides are all right, the next thing to do is to check carefully the engine bearings. An average safe clearance for intake-valve guides is .002" to .003", while that between the crankshaft and bearings is .002" to .0025". The manufacturer's directions should be followed if available.

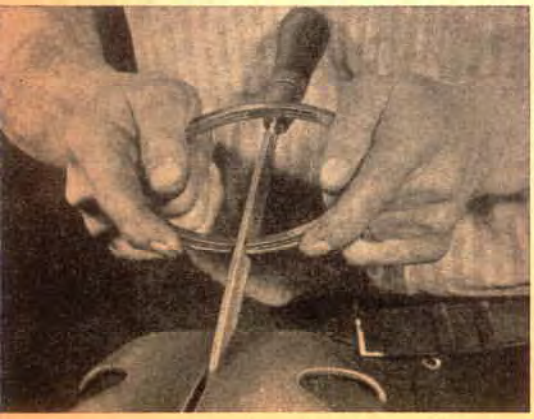
Pistons on all present-day cars are removed through the top of the cylinders, which means that the cylinder head will have to be taken off. In doing a piston job, there are some important precautions to take. After removing the oil pan and cylinder head, but before taking off the connecting-rod caps, examine each cap to see whether it is stamped with the number of the cylinder with which it goes. If there are no markings, number the cylinders yourself on *both the rods and caps* with a sharp punch and a hammer, noting on which side of the engine you place the markings.

Now, before attempting to remove the piston, ream the top of the cylinder bore where a ridge has been formed at the end of the ring travel and thus avoid the possibility of breaking the second ring land and ruining the piston. Use a special ridge reamer, and do not cut down further into the ring-travel area than 1/32" or half the width of the top ring.

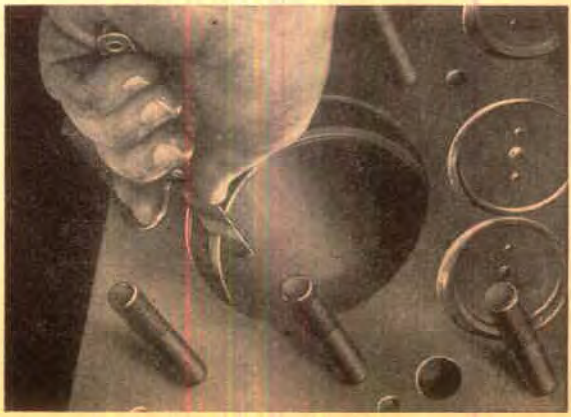
Examine the piston assembly after removing it to see how the rod is attached. In most modern engines, which have a force-feed lubrication system and aluminum pistons, the rod is assembled on the piston with the oil-spurt hole facing the camshaft and the slotted side of the piston facing the other side of the engine. Cast-iron pistons do not have slots, and rods in splash-lubrication systems do not have oil-spurt holes.

Next, check the cylinder bores for wear, taper, and out-of-round, using a dial gauge, an inside micrometer, or a telescope gauge and an outside micrometer. Take measure-

END GAP IS INCREASED by filing lightly. The ring below has a butt joint. File both ends of a ring with a step cut or lap joint



TEST THE RING in the bore, pushing it down with the piston to be sure it isn't cocked. Insufficient end gap will cause heat to buckle it



ments within the ring-travel area near the top and bottom. If the bore is worn more than .003" per inch of cylinder diameter, a full honing or reboring job is advisable and should be done at a shop having the equipment. For example, if the standard diameter of the cylinder is 3", and the wear is .010", a rebore job is indicated. New pistons, of course, will also have to be fitted. They are usually available in oversizes of .010", .020", .030", and larger.

When new rings are to be installed, the old ones must be removed carefully to avoid scarring the piston. One method is to expand the ring with thin-nose, outward-opening pliers, slipping a thin strip of metal between the ring and piston and working it around to the far side; then expand the ring a little further and work in a second and third strip, after which the ring can be slipped off. Take off the top ring first, and in installing new ones, put on the lowest first and work with the same thin metal strips. If special instructions are provided with the new rings, they should be followed. Be sure also to clean the grooves, taking care not to score the metal.

New rings sometimes have to be lapped slightly to allow proper side clearance in the ring grooves, and the ends may have to be filed to obtain the proper end gap. If the specifications of the car manufacturer are not available, it is safe to allow a minimum end gap of .003" per inch of cylinder diameter, that is, .009" for a 3" bore. Minimum side clearance for aluminum pistons should be .0015" to .002" in the top groove and .001" to .0015" in the lower grooves; for cast-iron pistons, .002" to .0025" in the top groove and .0015" to .002" in the others. Do not allow excessive side clearance, for it may cause excessive oil consumption.

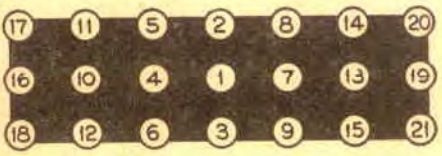
The sides of a ring may be lapped on a piece of plate glass, using a fine lapping compound and rubbing gently with a circular motion on one side and then the other. One photo shows a method of filing ends.

Do not force or drive a piston when returning it to its cylinder. The new rings will have to be compressed sufficiently for them to enter the bore. This can be done either with strong cord or with a sleevelike device that closes the rings as they enter.

When retightening the connecting-rod bolts, use a torque-indicating wrench and follow the manufacturer's recommendations for torque tension. If these are not available, it is safe to use a 12" socket or box wrench. After pulling up a nut tight, if the cotter-pin hole is not visible, bring the nut up further—do not back it—until the cotter pin can be inserted. Never use old cotter pins. Where lock nuts are employed instead of cotter pins, tighten the bolt nuts firmly, put on the lock nuts with the open side out, turn them finger tight, and then give them a half turn with a wrench.

Clean the gasket, cylinder head, and cylinder block of carbon and dirt, and then place the head on the block. The bolts and nuts should be tightened in the order recommended by the manufacturer or, if his instructions are not available, according to the charts shown at the bottom of this page. Use a torque-indicating wrench or one with a 9" handle. Cylinder-head bolts and nuts should be drawn down evenly and gradually with the operation repeated until all are normally tight. Final tightening on iron heads is done after the engine has been run long enough to bring it to operating temperature; on aluminum heads, allow the engine to become cool after running and do the final tightening while it is cool.

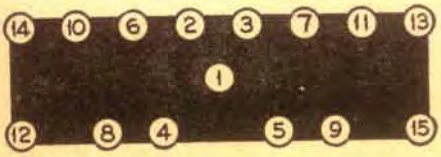
SEQUENCE FOR TIGHTENING CYLINDER-HEAD BOLTS



Six-cylinder L-head engine

Eight-cylinder L-head engine

Six-cylinder overhead-valve engine

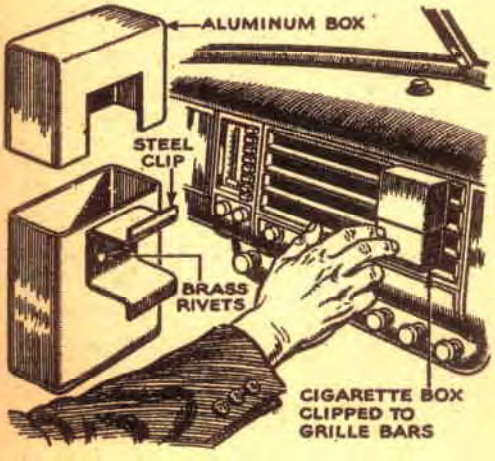


Eight-cylinder overhead-valve engine

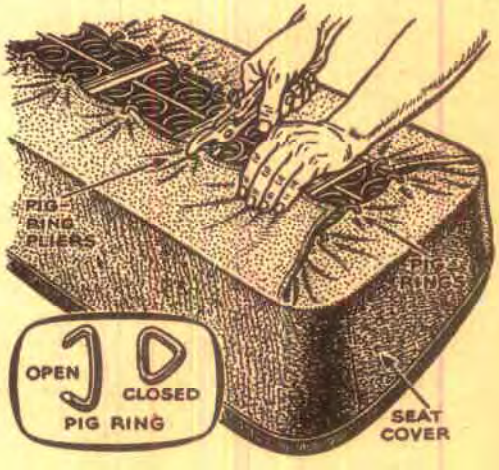
Hints from the Model Garage

Shoe Bag Stores Toys. Before starting out on a long trip with a child, fasten a shoe bag to the back of the front seat. You can then stow toys, fruit, cookies, tissues, and other travel needs in the pockets. Besides keeping the inside of the car tidy, it saves packing and unpacking a suitcase en route.

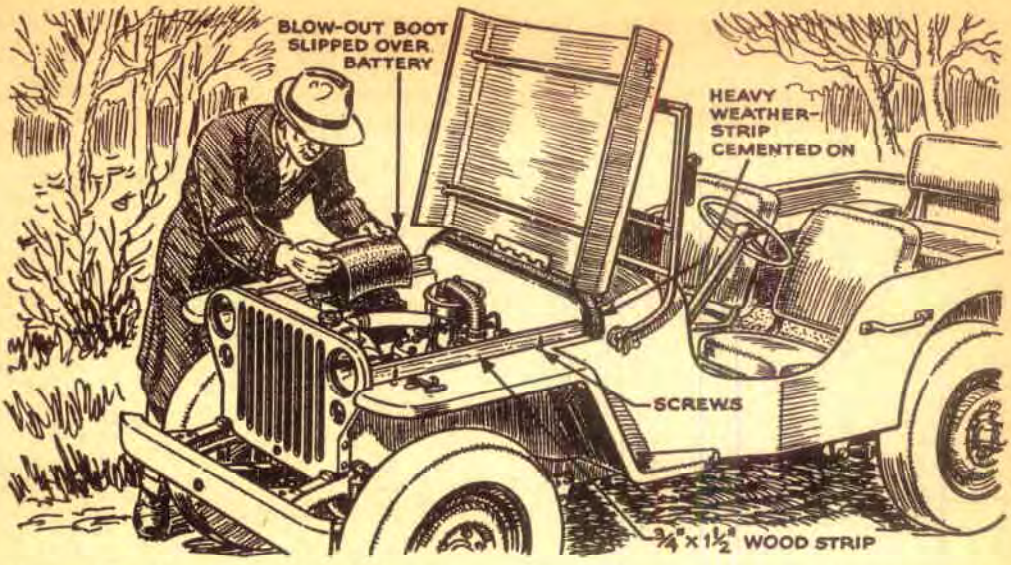
Eraser Cleans Windshield. George A. Smith, of Quarryville, Pa., suggests that a clean blackboard eraser is a handy item to carry in your glove compartment. When moisture collects on the inside of the windshield, a few strokes with the eraser will quickly give you unobstructed vision.



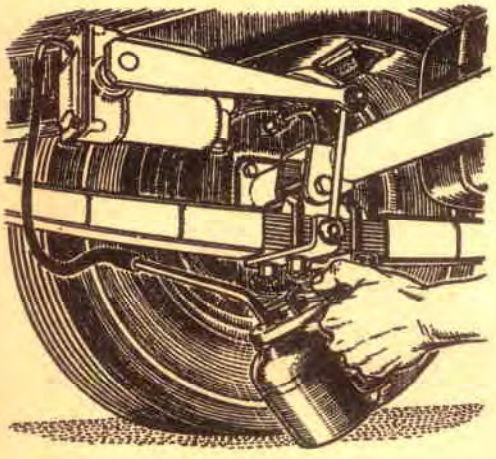
Cigarettes at Your Fingertips. Here's how Claude Wiseman, Jr., of Elizabethtown, Ky., mounted an aluminum pocket cigarette case on the radio grille of his car. A clip, bent from fairly heavy sheet steel, was riveted to one side of the body of the box and the cover notched to slip down over the clip. The clip is snapped between the grille bars. For a grille with vertical bars, the clip could be rotated 90 deg.



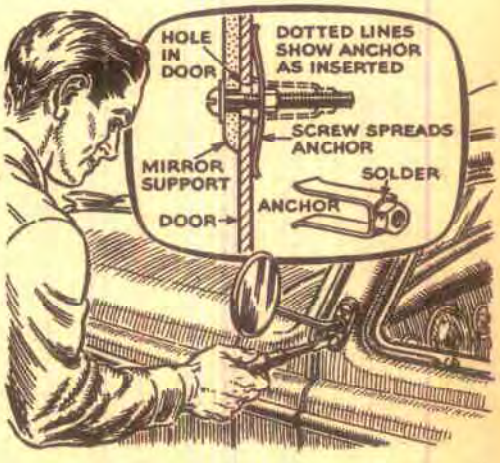
Pig Rings Fasten Seat Cover. There are many ways that you might attach seat covers to keep them from wrinkling, but C. F. Bigwood, of Malta, Mont., comes up with one that looks especially convenient for motorists who live in rural areas. He recommends the use of pig rings to clip the cover to the springs. With a pair of hog pliers, a handful of rings can be quickly locked in place around the edge of the cover.



Jeep Engine Kept Dry. David Horvath, of Yonkers, N. Y., writes that he frequently had trouble starting his Jeep because water and snow collected around the spark plugs and on the battery and wiring. This sketch shows how he waterproofed the engine for less than 75 cents. The openings between the hood and mud guards were closed with ¾" by 1½" wood strips, fastened to the mud guards with wood screws. A length of weather strip diverts water flowing from the cowl. A blow-out boot protects the battery.



Shocks Filled with Oil Can. Here's a rig that will enable you to refill shock absorbers without difficulty when the filler plug is located in a hard-to-reach spot. Suggested by Marion L. Rhodes, of Knightstown, Ind., it consists of a pump-type oil can, a length of rubber tubing, and a small nozzle bent from copper tubing. With the nozzle inserted, a few strokes on the pump handle will quickly refill the shock.

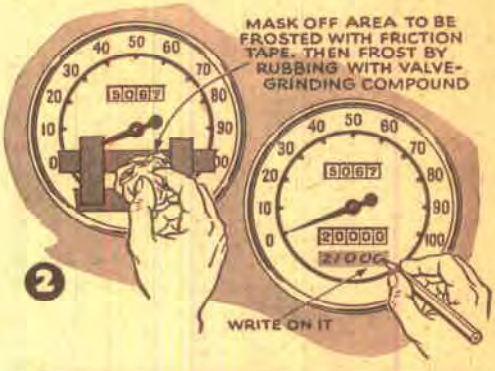


Toggle Nut Holds Mirror. When the original self-threading metal screw tore loose, B. Leo DeMare, of Aberdeen, Md., devised the nut shown above to fasten a rear-view mirror to his car. A nut first was filed down slightly to clear a hole in the door frame. A strip of sheet brass was drilled, soldered to the nut and bent into a U. The nut and anchor were threaded on the bolt, inserted in the hole, and drawn up tight.

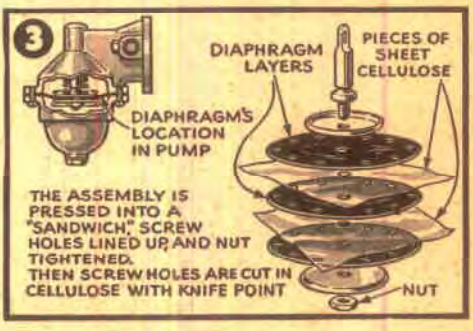
USEFUL AUTO HINTS

1 RUBBER VACUUM CUPS with strength enough to hold light articles on top of your car can be made from discarded flush balls that your plumber may be glad to save for you. There should be no puncture in the upper part. Cut off the balls about ⅛" below the halfway mark and face the edge on a rough emery wheel. Affix a spring clip to each threaded top.

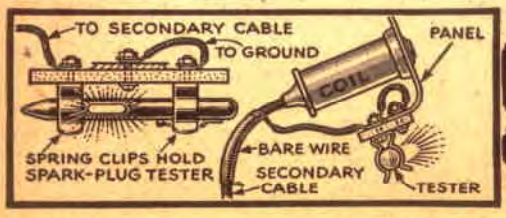
2 FOR A CONSTANT REMINDER of when to change oil or rotate tires, frost a strip on the speedometer glass to take penciled memoranda, which can be erased or washed off when desired. One way to frost the glass is to mask an area with tape and rub with valve-grinding compound.



3 EMERGENCY REPAIR to a fuel-pump diaphragm is possible with the transparent cellulose wrappings from a candy bar, loaf of bread, or the like. Sandwich a sheet between each two adjoining diaphragm layers, trim the edges, and punch screw holes; then replace the assembly.



4 CHECKING ON SPARK PLUGS is continuous with an electrically wired holder for a neon-type tester mounted within sight under the dashboard. Remove 12" of insulation from a length of wire, wrap it around the secondary cable, tape it over, and connect the other end of the wire to one holding clip. Ground the other terminal. Make the base of some insulating material. The tester will light by induction.



Is Your Car Wasting Gas?

An Ordinary Vacuum Gauge, Used for Easy Tune-Up Tests, Will Aid in Getting the Best Fuel Mileage Your Auto Can Give

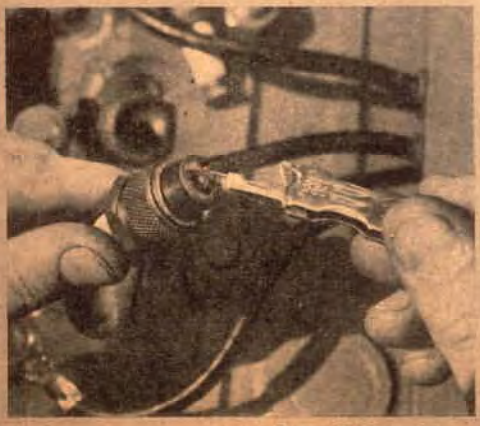
DESPITE the incentive of utilizing all gasoline, not one car in a hundred is kept in condition to give the fuel mileage that it might. Naturally, no exact figures exist, but many auto-servicing experts feel that the average car does not give more than 80 percent of its potential gasoline mileage. In other words, if your car is typical and if you're now getting about 16 miles per gallon, you're wasting four miles of travel for every gallon you buy—because you *could* get 20.

In a campaign to get more from the gasoline you buy, you'll probably find that it is the sum of a number of adjustments, rather than any single improvement, that will pay off. Your engine should be the first field of action in this campaign, because that is where your gasoline is spent and where the biggest gas-robbers usually lurk. A vacuum gauge will be found extremely useful in correcting engine faults and in tuning it up to peak efficiency. This gauge, which may be the same as those found on many vacuum-steam domestic furnaces, can ordinarily be purchased at plumbers' supply houses for less than $2. Be sure that the gauge has a scale reading from zero to 30" of vacuum.

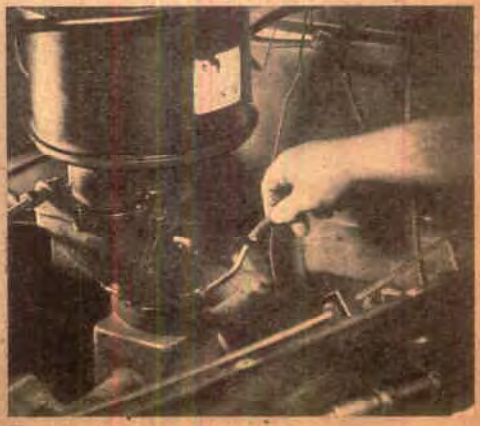
Spark plugs. First step will be to examine the plugs, perhaps the most crucial single part of a gasoline engine. Make sure that they are of the correct heat range for the engine in which they are installed, referring if necessary to the auto or plug manufacturers' specifications. If the plugs have been operated for some time without servicing, the chances are that you'll find an excessive gap between the electrodes, so clean them and set to the gap specified by the manufacturer.

It's also possible to test the plugs in the engine by shorting them out with a screwdriver having a well-insulated handle. Much can be determined about the condition of the plug by slowly drawing the grounded screwdriver away from the plug terminal and noting how far the spark will jump. A spark that jumps about the thickness of a nickel indicates that the plug is working satisfactorily; while one that won't jump more than .020" usually indicates a fouled plug. If on the other hand the spark will

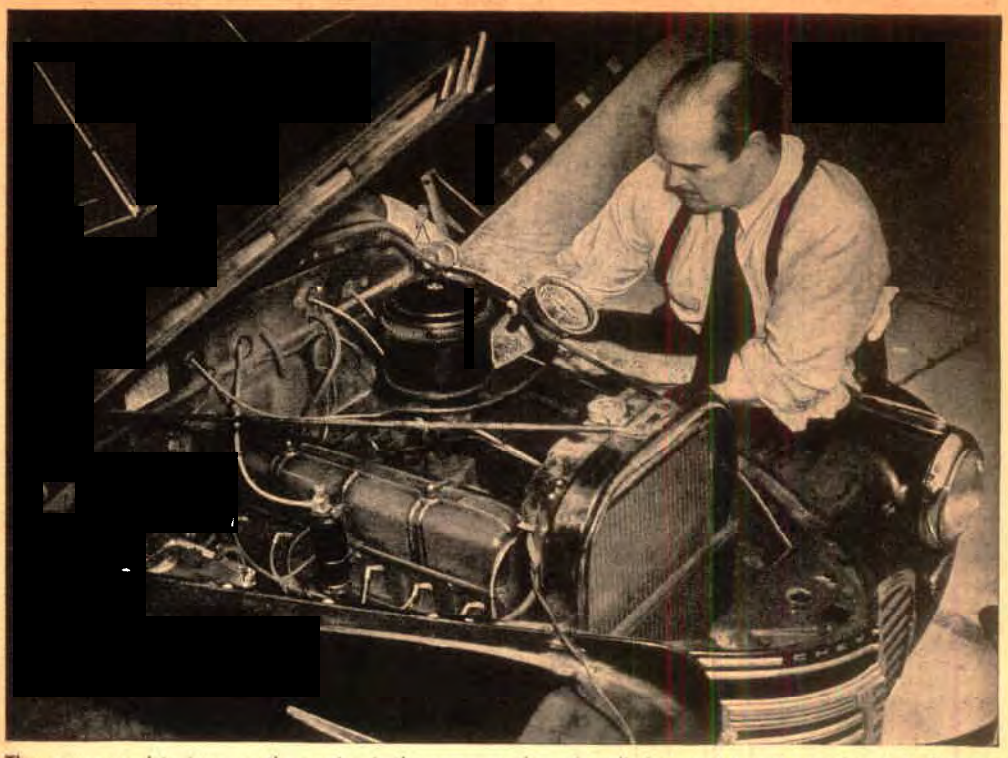
Make sure that the spark plugs in your car have the proper heat range for the engine, that they are reasonably free of carbon deposits, and that the gap is correct. If you cannot obtain the car manufacturer's specifications, use a gap of .025"



Probably the most convenient spot to connect the vacuum gauge used in the tune-up is at the place where the windshield-wiper line joins the intake manifold. Pull off the rubber hose that leads to the wiper and attach the gauge hose in its place



Courtesy The Texas Co.



The gauge used to tune up the engine is the same as those installed on vacuum-steam domestic furnaces

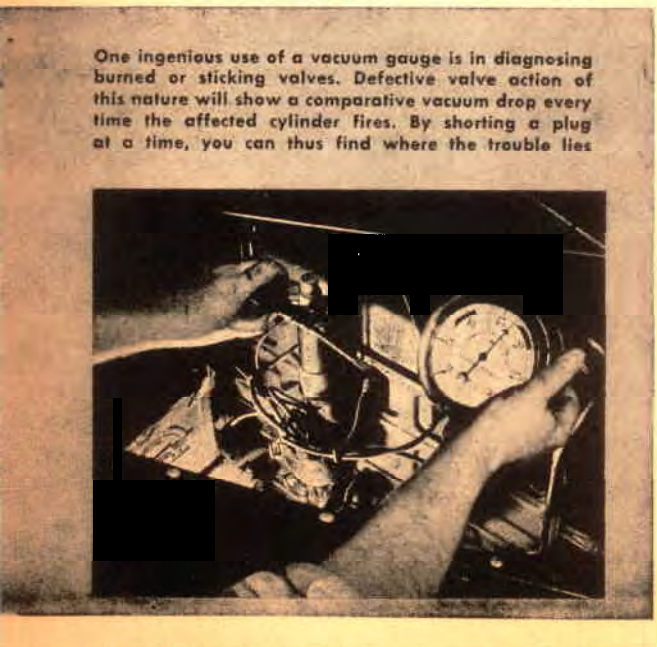
jump around ¼" or more, the gap is far too wide, since the spark "prefers" to jump to the screwdriver instead of across the electrodes.

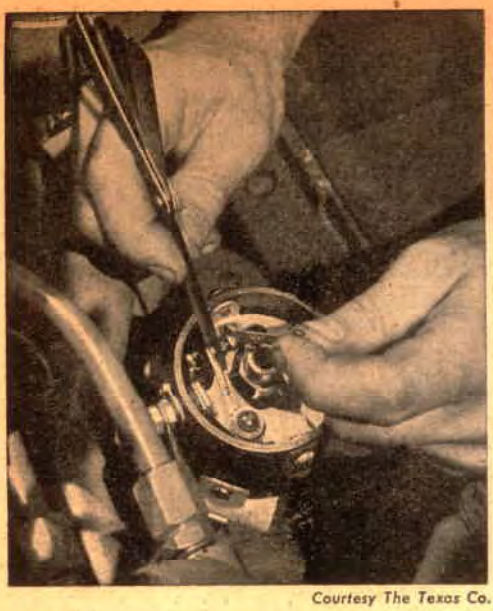
The next step in tuning up the engine is to connect the vacuum gauge to the intake manifold. On most cars the windshield-wiper pipe is tapped into the manifold and the gauge can readily be attached by pulling off the wiper hose and replacing it with the gauge hose. If the engine is in average condition, the gauge will show between 18" and 21" of vacuum at idling speed. Bear in mind that the higher this vacuum can be raised on any given throttle setting, the more efficient the engine will be. In most of the following tests, an extremely accurate tachometer would do as well.

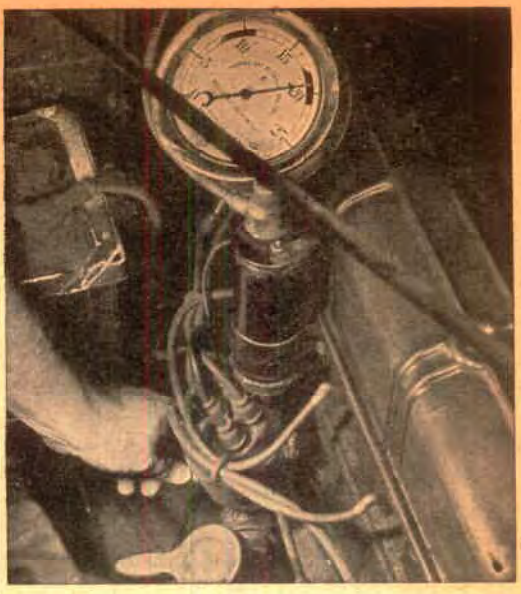
Timing. Spark timing can be adjusted with hairsbreadth accuracy by means of the vacuum gauge, provided the distributor points are set correctly. Here's how to do it:

The gauge pointer will rise and drop as you advance and retard the timing. Retarding will cause a comparatively smooth drop, whereas advancing will bring a rather erratic drop. First, retard the distributor slightly until you can see the retarding effect on the gauge, and then advance the distributor slowly until the maximum obtainable rise in vacuum has been achieved. When this point has been reached, the advance can be continued for several degrees without changing the reading, indicating that the firing position is at top dead center. Now retard the dis-

One ingenious use of a vacuum gauge is in diagnosing burned or sticking valves. Defective valve action of this nature will show a comparative vacuum drop every time the affected cylinder fires. By shorting a plug at a time, you can thus find where the trouble lies







Courtesy The Texas Co.

Distributor points should be examined periodically for excessive pitting, and dressed by means of a point file. Use a feeler gauge in setting the gap

With this vacuum gauge, the timing can be adjusted very easily. The distributor should be advanced or retarded until the gauge shows the highest reading

tributor very slowly to a point where the hand is just about to show a retarding drop, and lock it in this position.

If the operation is done with care, you will find that practically perfect timing results. The writer has timed scores of engines, using timing lights, top dead center finders, and other instruments for the purpose. Timing by vacuum gauge is not only quite as accurate, but it also takes a small fraction of the time required by other methods. It is important, however, to remember that the distributor points must be set properly before timing is attempted.

An automatic spark-advance mechanism, either of the vacuum or mechanical type, may also be tested. This should be done after the timing is correctly set at idling speed. Open the throttle approximately three-quarters of the way and again advance and retard the timing setting. If you can increase the vacuum indicated, the automatic advance mechanism is not operating properly, for it should maintain the correct timing over the complete range from idling to full throttle.

Distributor. Since it's the nerve center of a gasoline engine, the distributor is often the cause of off-peak performance. Here are a series of quick checks you can make to be sure it is not wasting your gasoline.

First, remove the cap and examine the inside of it. If the cap is shorting, there may be bluish-gray traces left on the surface, or tiny cracks near the electrodes. A cap in this condition should be replaced, for it will cause poor performance and make starting in damp weather extremely difficult.

Next examine the condition of the points. If either the stationary or moving points show substantial pits or deposits, the condenser and its connections should come under immediate suspicion. Points in good condition will be gray in color and can be readily cleaned with a point file.

A condition which very few mechanics will think to check, but which can be extremely important, is a weakened point spring. This will result in poor performance and even missing at high speeds. In the writer's opinion, it is something that has caused more unnecessary changing of carburetors, coils, and condensers than any other single motor ailment. If it's inconvenient to have the spring tested in a service station, borrow or purchase a point-spring scale, obtainable from several manufacturers for about $1.50, and see if it has the minimum tension required for proper operation. The correct tension can be learned from a service station dealing in your make of distributor.

Distributor experts can often check the point gap with exceptional accuracy without looking at the points, for their trained eyes can tell at a glance what the gap must be by the shiny section on the cam. Since the cam opens and shuts the points by bearing against the fiber on the breaker arm, the part of the cam which touches the fiber will be shiny and the part which does not touch will be dull. In most distributors, if two-thirds of the cam area is dull and one-third is shiny, the point setting will be approximately correct. However, unless you are very familiar with the way your cam

should look, don't rely on this check, but instead use a feeler gauge in setting the points to the manufacturer's specifications.

Carburetor. It is possible to make sensitive carburetor adjustments with the vacuum gauge. You'll notice that as the mixture adjustments are changed, the vacuum reading rises and falls. The highest reading obtainable on a fixed throttle setting will be the correct setting. If your carburetor has separate idling and high-speed adjustments, place the throttle in the appropriate speed range before making the adjustments.

Many autoists have labored under the notion that a carburetor adjusted for top performance will not be economical, and that one set for maximum economy will not give full power and speed. This is not entirely correct; a properly adjusted carburetor will produce both good performance and good economy.

Fuel Pump. If you suspect that your fuel pump does not deliver sufficient gasoline at high speeds, test it by means of the vacuum gauge. Disconnect the intake pipe and attach the vacuum-gauge hose to the pump; then run the motor at idling speed by means of the gasoline already in the carburetor. The pump should show from 5" to 11" of vacuum. If it doesn't, it should be removed, dismantled, and inspected for faults.

Valves. Burned or sticking exhaust valves will be indicated on the vacuum gauge by a drop of 2" or 3" every time a cylinder with a defective valve fires. By shorting out one cylinder at a time you can locate the bad valve; when its cylinder is shorted out, the pointer will stop its erratic dips.

Compression. Poor compression can be located in the same manner. If difficulty of this sort is suspected, start shorting out one cylinder at a time and note the drop in vacuum caused by each inoperative cylinder. Let's assume that five of the cylinders in a six-cylinder engine cause drops ranging from 1½" to 2", while one cylinder brings a drop of only 1". You may be sure that the latter cylinder is the weak one, with poor compression caused by bad rings or valves. If the test shows fairly uniform drops for all cylinders, compression trouble can usually be ruled out.

With practice you will find that you can even make what doctors call a "differential diagnosis"—that is, you can tell with fair accuracy whether trouble of this nature lies in valves or rings. Compression loss resulting from bad valves is generally shown by a larger drop and by erratic behavior of the pointer, whereas ring trouble is characterized by a lesser and more regular drop.

Aside from the engine there are auto ailments elsewhere that can steal from the true value of your gasoline supply. One of them, not often recognized at its real importance, is underinflations of tires. To visualize how much this can mean, remember your bicycling days—how hard it was to pedal when the tires were low, and how much easier it became when you pumped them up. Actually, inflation of tires to a pressure from two to 10 lbs. above manufacturers' specification increases mileage.

Four other potential fuel wasters should also be considered. Unnecessarily heavy lubricants in the transmission or rear end, dragging brakes, misaligned front wheels, and careless driving habits—which include jack-rabbit starts and overuse of the gear-shift lever and choke—are capable of making a deep cut in the gasoline mileage that your car *can* give.

Mixture controls on the carburetor are turned carefully until the hand on the vacuum gauge is as high as possible. A high-speed jet can be adjusted only if the engine is turning at a good speed

Driving 30 miles an hour is as dangerous as driving on the roof of a high building! If you hit another car head on going at the same "safe" speed, it would be like driving off a nine-story building.

Good Driving Is a Habit

...How to teach your family the Seven Keys to Safety

By Devon Francis and John F. Stearns

THE driver of a suburban bus outside Detroit was rolling along at a moderate rate the other day when suddenly he hauled on the wheel and swerved. The maneuver was puzzling. Except for some snow-covered cars parked by the right-hand curb, the road was clear.

As I stepped off the bus I asked him about it.

"Oh, that!" he replied. "Well, as we came up to that line of parked cars, I saw the snow on the hood of one of them begin to slide off. I figured his engine was running and maybe he was getting ready to pull away from the curb. I wasn't taking any chances."

That bus driver was a good driver. He made good driving a habit. He knew he had to. It's no longer possible to make each move in driving a conscious move. Speeds have become too fast for that. Stopping distances are too great. Safety on the highway demands practice until the proper reaction in an emergency becomes automatic.

The first thing to teach your family about the operation of the family car is that good driving must be habitual. Good driving includes keeping a constant lookout for what the other fellow is going to do.

Slip into the right-hand front seat of the family jalopy and have your student settle himself comfortably behind the wheel. We'll assume that he knows the rudiments—how to depress the clutch, shift, brake, and steer. Knowing how to manipulate the controls is the least of knowing how to drive. Now let's take it from there.

Pulling from the Curb

Make your student keep his clutch depressed until he has looked backward out of the window and forward up the street for other cars. Don't let him rely on his rear view mirror. It only shows about three-fourths of the road. Explain that to him. You know that, but he doesn't. And watch out for pedestrians, too. Stick out that hand. Other motorists must know what

your car is going to do *before* it does it. It's too late after the crash. Ease out, now, in low. Shift carefully, accelerate slowly.

Make your student develop the habit of driving ahead of himself. Say to him, "Imagine you're sitting on the front bumper. You'd keep looking ahead to see what was coming, wouldn't you?" There's a car at the curb. Its exhaust pipe spits a puff of smoke. The engine must be running. Its driver may pull into the street. Ease by, watchful. There's another car parked just ahead of it. Its front wheels are turned out. Is it going to pull away from the curb?

A kid's ball bounces into the street. Use the brake. Don't wait to see if a kid follows. Take that for granted. Slow down.

"Rule Number One at intersections," you tell your student, "is that a yellow light means slow down. No light at all means slow down. A green light means slow down. At intersections just slow down! It's healthier. Look left first, since the line of cars you'll meet first will be coming from the left. Make it a habit.

"Watch every other car in the intersection and every car that can reach the intersection before you leave it. Some dope in a hot rod may come screeching through. Look at that line of cars to the right now. If one of them tries to pass another one inside the intersection, put out your hand and stop. Let the fool get out of the way before you move. And in stopping, don't jam on the brake. The car behind you may smack into your rear end. That could well-nigh break your neck."

Tell your student to make it a habit to keep his eye peeled for clues to what the other fellow is going to do. Front wheels on the roll telegraph a lot of information. The car coming into the intersection just opposite you is slowing. Its wheels turn just a shade. Its driver is going to make a turn. Easy, that may mean a full stop for you to let him get out of the way.

Stop for a Talk

When you get through the intersection have your student pull over to the curb for a talk. How fast was he going as he approached the intersection? Twenty. That sounds safe. But does he have any idea how far his car would travel in a half-second at 20 miles an hour? The answer is *fourteen feet*. And what's the half-second for? Well, that's how long it would take him to react to an emergency. Fourteen feet can be the difference between safety and collision.

A moment ago you warned him against drivers who tried to pass within the intersection. Why? Well, supposing he himself tried to pass another car that had slowed down. The other car may have slowed down to let a pedestrian cross in front of him. Could *he* avoid the pedestrian? Or the other driver may have been looking for a cross street. If he found it, the chances are he would swing hard left. How much chance would he have to avoid a collision? Or the other driver may have spotted a car on the cross street coming in fast. If your student had been passing, would he have been able to stop in time?

Try another intersection. Here, a streetcar going in the same direction stops as you

This was the inevitable result of driving too fast *for conditions*. Up ahead, two cars collided. Nine other motorists couldn't stop in time. The cost: seven drivers were injured.

approach. Ask your student, "Know what may happen if you barge on into that intersection? Another car may come in fast on you from the left. The streetcar hides it. What'll the other driver do—go under you, over you, or through you? Get the habit: STOP."

Railroad tracks are intersections too. Roll your student up to a crossing. Where it says stop, it means STOP. Trains use wheels too, and anything on wheels is potentially dangerous. Single track or double track? Look both ways. The tail end of that passenger train rumbling by may hide the head end of a freight a hundred feet away. Wait. You may spend 30 seconds and save your life.

Turning

Practice making turns. Tell your student he must learn a habit of signaling. Make him learn to work his way into the proper lane minutes before he intends to make a turn. He must ease off on the accelerator several hundred feet ahead of his turn. He'll learn that the braking power of his engine compression with the power off is one of his chief assets in car control.

To make that turn he must signal. Say to your student, "put out your hand. For a right turn, you must be in the right lane. For a left turn, you must be in the left lane. That's elementary, but make it a habit. To change lanes you've got to signal. You've got to look behind you for following traffic. You've got to signal again for your actual turn. That's just protecting yourself from the other fellow."

Now for the turn. It's you talking: "Swing left just short of the center of the intersection, if the law permits. That leaves room for drivers coming from the opposite direction who also want to turn left. Complete your turn just to the right of the cross street's center line. See how this keeps the number of traffic lanes you have to cross at a minimum?"

Right turns are money in the bank. Start from the right lane. Complete the turn in the right lane.

Passing

Take your student out on the open road. Here's space. He's got a lot of horsepower under his foot and he aches to use it. If the road's clear, let him. It satisfies an urge.

He's going to overtake cars going his way that are jogging along uncomfortably slow. He wants to pass. What's a safe passing speed? What's a safe passing distance? Those are hard ones to answer. But maybe this will help.

If your student is going to pass a car going 40 m.p.h., he should have about 1,000 feet—or about 55 car lengths—between him and any car coming from the opposite direction before attempting it. And there's a catch. These conditions hold good if the oncoming car is making about 45. They hold good if the pavement is dry, if the road is straight and level. If the pavement isn't dry, tell him to double his estimate just for safety.

If there's a hill or a curve, tell him to make it a habit to let up on that accelerator and keep his position.

He makes an experimental pass. The car gets by all right, but he cuts in too sharply in his anxiety to get back into the right-hand lane. "Wait," you have to tell him, "until you can see some part of the car you've just passed appear in your rearview mirror. Then ease back into your lane."

There was something else. Did he forget something? He looks blank. Did he look behind before he started to pass to see what traffic was following him? Did he put out his hand? No, he didn't. Let those answers ride on the double zero for the next spin of the wheels without saying anything more. It's effective.

"At night," you can tell your student, "passing is more critical. Make it a habit to allow yourself more room. Be more critical of your judgment of speed. Flick your headlights to tip off the car ahead that you're going around him."

Speed

That speed itch is eating at the ball of your student's right foot. You know it. The needle on the speedometer keeps creeping up. Let him go. Wait until she hits 50. Then tell him to brake to a stop as fast as he can and still keep the car under control.

He starts braking. "Did you look behind?" you ask him. "Did you put out your hand in a slow signal?" No, he didn't. Okay, just a reminder to make it a habit.

As the car snubs to a halt, ask him if he has any idea how much distance he ate up in stopping the car. No, he hasn't. Then explain it to him: "It took you a total of almost a full city block to bring this jalopy to a stop from 50 miles an hour. But there's something even more important—do you know how far your car traveled from the

time I told you to stop until your brakes began taking hold? No? Well, it was 55 feet, more than the width of a city lot. It took you that long to react."

It will help that itchy accelerator foot if he forms the habit of thinking of a car as a huge steel flywheel. The faster it goes, the more kinetic energy it builds up. The kinetic energy goes up as the *square* of the speed. *It's 25 times as great at 50 miles an hour as it is at 10.* The only way that kinetic energy can be dissipated fast is with the brakes.

And here's another valuable habit to form—have him keep thinking of driving conditions. The trouble with most drivers is that they go *too fast for conditions.* Visibility, for instance. There may be fog, rain, or snow. Ever hear of a pilot taking his personal plane off the ground when the airport was fogged in? Okay, take a cue from people who fly airplanes. Even 10 miles an hour may be too fast under certain conditions.

What's the condition of the road? Ice? Snow? Rain? What's the condition of traffic? Light? Heavy? What's the condition of the terrain? Hills? Hairpin curves? What's the condition of the car? Brakes okay? Headlights bright? What's *your* condition, Mr. Student? Sleepy? Worried and preoccupied?

Remember, teacher, you can't do your job in one lesson. You are trying to form a habit. So short, frequent sessions are best. And watch yourself: don't *you* get excited. Keep your voice deliberately low and calm.

As your pupil progresses, keep him at the wheel longer. Let him get confidence, but when he becomes over-confident, as he will, check him gently. Let him get away with two or three blunders. *Then* tell him.

That's enough for today. Tell your student to turn around and head for home. Whoops! How about a signal for that turn? Remember, make it a *habit!* END

Seven Keys to Safety

1
Learn to judge conditions: traffic, visibility, road surface, mechanical condition of cars, physical condition of drivers.

2
Don't forget that it isn't how fast you go, it's how fast you can stop. Stopping = braking distance + your reaction distance.

3
Keep one (1) car length behind the other fellow for every 10 miles on your speedometer. Double (× 2) it for wet days. Double that (× 4) for snow or ice.

4
Suspect every pedestrian of suicide.

5
Slow down at yellow lights. Slow down at no lights. Slow down at *green lights. Every intersection is a crash point.*

6
Signal *your* intentions. Protect yourself from the other fellow.

7
Expect the worst from the other fellow.

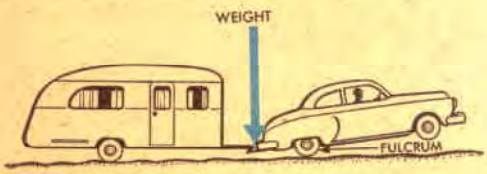
What You Should Know About

Towing a Trailer

By R. P. Stevenson

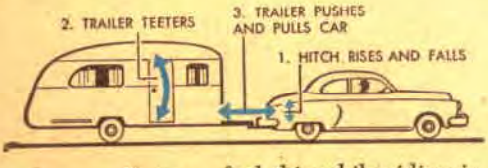
YOUR car was designed and built primarily to haul passengers, not to tow a heavy trailer coach. That it can and will do the towing job too is an extra dividend tossed in your lap. But as the car stands, it's not ready for the job. You must take up where the designers left off.

This would become plain enough if you were to install an ordinary bumper hitch, hook up a fair-sized trailer, and set off without further preparation. Here are some of the undesirable results you might observe:

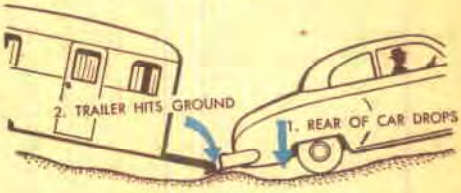


Leverage. Because a trailer imposes a portion of its weight on the end of a car, a cantilever would be set up—with the car's rear axle as the fulcrum. The extra weight could easily load the rear axle beyond the maximum for which it was designed. You might not notice such an overload at once—but you couldn't help seeing that the car's front end tends to rise as the trailer bears down on a bumpy road.

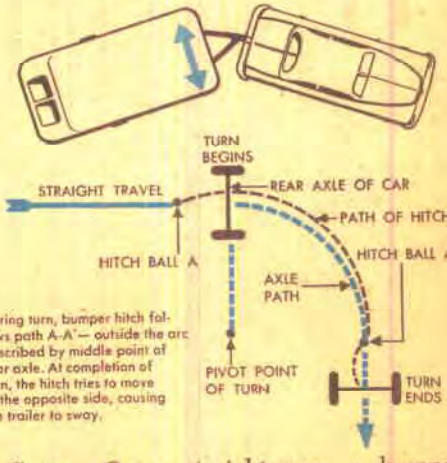
Because of the heavy strain, the car's springs may break, the frame twist, the axles bend, or the hitch snap.



Surge. You can feel this while riding in a tow car. It is a push-pull effect produced by the normal rising and falling of the bumper hitch. As this occurs, the trailer's center of balance shifts back and forth—that is, the trailer teeters endwise. Consequently, the tow bar alternately shoves and pulls back on the hitch ball. The hitch and car frame take a beating.



Nose-diving. This occurs when the rear wheels of the car have just dipped into the valley at the bottom of a steep ramp or service-station apron. The rear bumper sweeps low, causing the trailer nose to strike the pavement. Because of this, you may be unable to haul a trailer across a ditch.



Sway. On a straightaway, a bumper hitch follows behind the center of the rear axle. As you begin a turn, the hitch swings outward—away from the direction of the turn. Momentarily, the hitch turns the trailer in the *wrong* direction.

Once headed the wrong way, the ➧

These overload springs don't cause hard riding after trailer is unhitched. Swiveling the H-shaped block removes or applies tension. The makers also offer releasable leaf-spring helpers for cars with coil springs. Another manufacturer sells helpers that adjust to suit the load.

Hitch the dolly to the car, the trailer to the dolly. That's the principle of this and several other dollies. The two hitch balls make the unit more flexible, reducing road shock both in car and trailer. Another type has one or more wheels under the trailer without a second hitch.

heavy trailer resists the pull of the hitch ball, and the tires and car frame take an extra load. When you come out of the turn, the hitch ball tends to swing in the opposite direction. This sets up a whip action, and the trailer begins to sway.

Should you make a sharp turn to avoid a road obstruction, sway can tip the trailer over. If the road is slippery, your unit may jacknife.

What you can do. Because of the forces at work, a sturdy hitch is a must. Hitches are available commercially for most cars, but you can have a special one made to order. Some are bolted or welded only to the rear cross member of the car frame. To spread the load, others have arms extending to the side frame. It is important to keep the hitch from shifting sideways. After the hitch is made, the tow bar should incline up toward the car instead of being left level.

To counteract leverage effects, some owners use overload, or helper, springs. But you should note that these merely keep the rear of the car from bottoming. They do not remove an overload from the frame, axle, and tires of the car.

A dolly under the trailer will do this. Some dollies are designed to carry all the load, others only part. Overload springs can be combined with the latter. As a rule, some extra load should remain on the car. This improves traction.

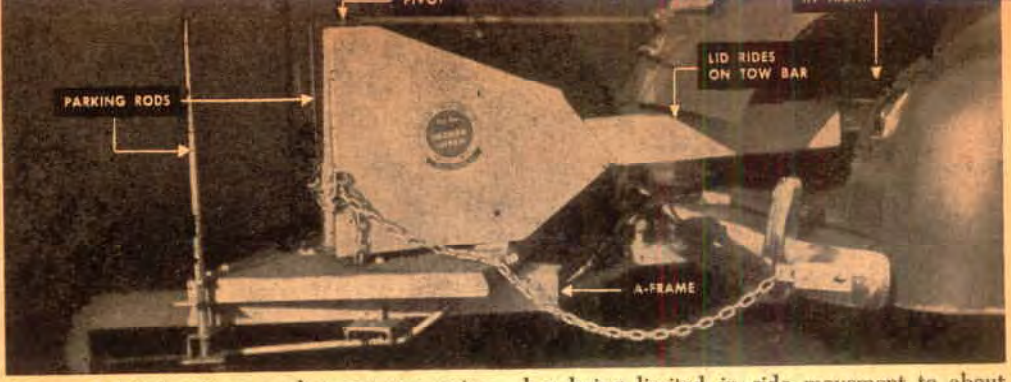
A dolly also will lessen surge action by keeping the trailer on a more even keel. Overload springs will forestall nose-diving by preventing the hitch from going so far down. A dolly with a tow bar that's free to rise and fall with the bumper ball will also keep the trailer nose clear.

The possibility of sway is inherent in any bumper hitch. A dolly may help a little but will not prevent it. Your best protection is caution on turns.

Trailerites disagree on whether it's best to use helper springs alone, a dolly alone, or a combination of the two. A good case can be made for or against each method, depending largely on the particular equipment and whether it's installed and adjusted as the manufacturer recommends. If the trailer is small and well balanced, helper springs may get you by. For one of the big jobs, a dolly probably will be a must.

Avoid an overload. Every trailer has a certain hitch-ball weight. This may range

A chrome cover will protect your hitch ball and improve appearance of car. This one is made by John Hill Plating Co., Lansing, Mich.



Over-axle hitch now on market uses same principle as the fifth wheel of a trailer truck. Tow bar attaches to a pivoting hitch located in trunk above the car's axle. Entire tow bar also pivots at the trailer. On ordinary, slight road curves, the bar pivots only on hitch ball in trunk, the bar being limited in side movement to about five inches. On greater curves, tug of safety chain causes second pivot at rear to go into action. On straightaways, this is locked by two rollers that sit astride a cam. The maker claims open lid is no disadvantage.

from 200 to about 700 lb., depending on the trailer's size and balance.

At least one car maker (Buick) recommends that the rear-axle load be kept below 500 lb. This is probably a safe maximum in any car. If you are in doubt about the load, haul the trailer to a truck scale. Park the car on the scale and weigh it both with and without the trailer attached, keeping the trailer wheels off the scale. The difference is the rear-axle load. Do this after you have loaded the trailer for traveling. A few extra furnishings up front can produce a sharp increase in the ball weight. Your solution is to distribute the furnishings to keep the hitch weight from climbing.

Rear-tire pressures usually must be increased because of the extra load. Buick recommends 30 lb. at the rear, 24 at the front for its recent models. For more comfortable riding, deflate the tires to normal pressures after unhitching.

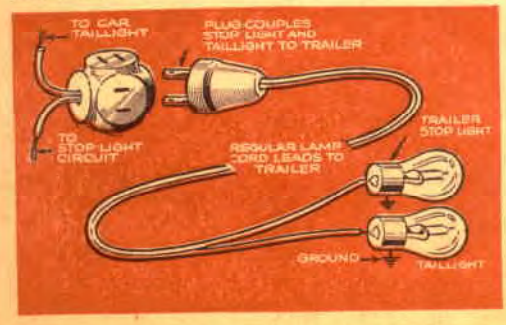
What about a fifth wheel? Trailer men have long realized that a hookup patterned after the big truck trailers would have advantages. Moving the hitch ball up to or ahead of the rear axle would reduce or eliminate many of the bumper-hitch faults. Obviously, this presents difficulties in a passenger car. However, you can buy several outfits that make the hitch under the axle—and at least one that goes over the axle. The latter is shown above.

Is an automatic transmission suitable for trailer towing? That's a question you'll want to know these days. The engineers have wondered too, and have made some test runs. Their answer:

Yes. Uphill, there's no lack of power. Downhill, the transmission can do a good braking job. And on starts, the engineers say, there's a positive advantage, for the oil cushion helps get both car and trailer under way easily and smoothly. END

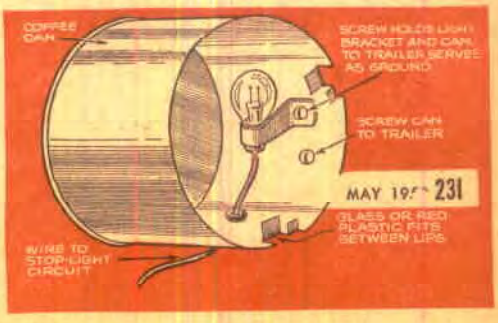
One Plug Connects Two Lights

You can use household electrical supplies as below to connect a trailer tail and stop light to the tow car. Mark the plug and socket so you won't reverse the connections. You'll need a ground return if trailer and hitch aren't metal.



Stop Light from Coffee Can

An effective stop light for a trailer can be made as shown here. If you don't use the trailer a lot, you can probably get by without investing in a bulb socket. Just solder the bulb to the can and the hot wire. Use a 21-candlepower bulb.



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.

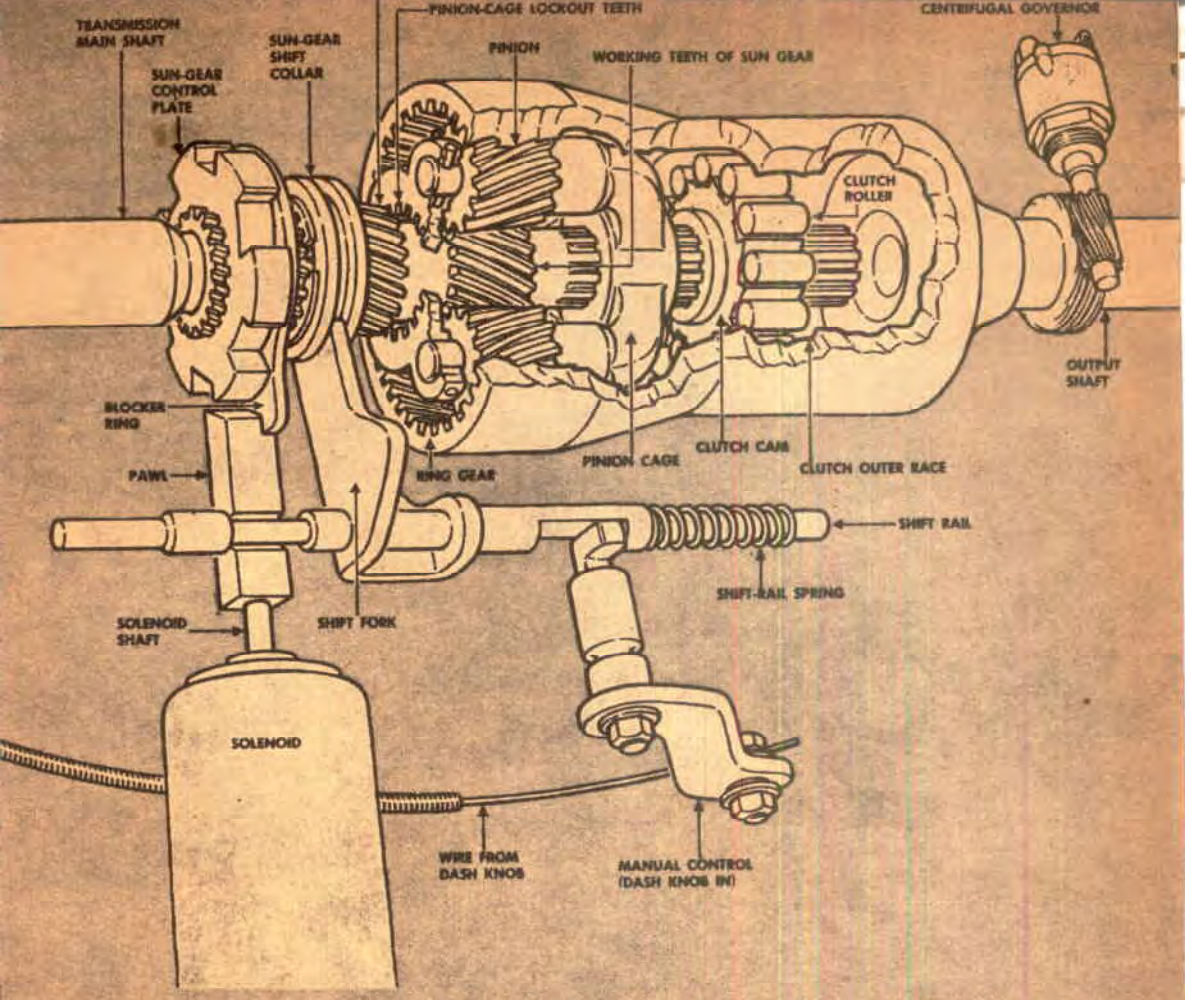
A modern overdrive unit is a supplementary two-speed transmission. It's mounted directly behind the normal three-speed trans-

DID YOU KNOW?

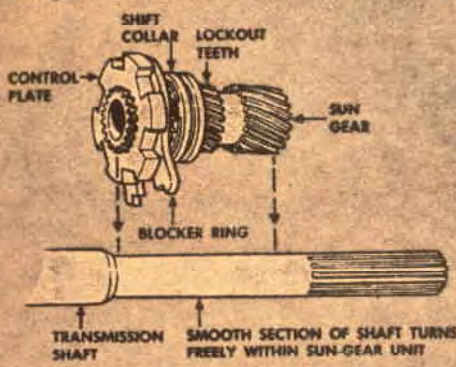
- Overdrive adds two extra speeds to your three-speed transmission—overdrive second and overdrive high.
- Overdrive second permits you to drive in traffic without touching clutch or shift lever. After engaging second, you can shift back and forth between second and overdrive second simply by manipulating 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.

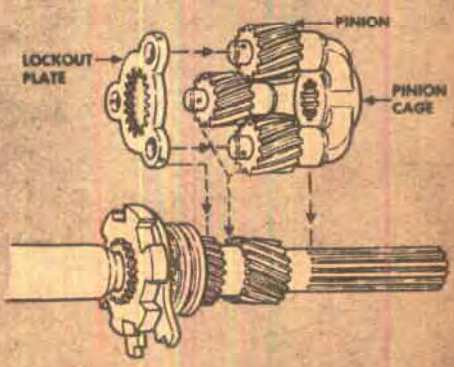
A FEW CAUTIONS

- 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.



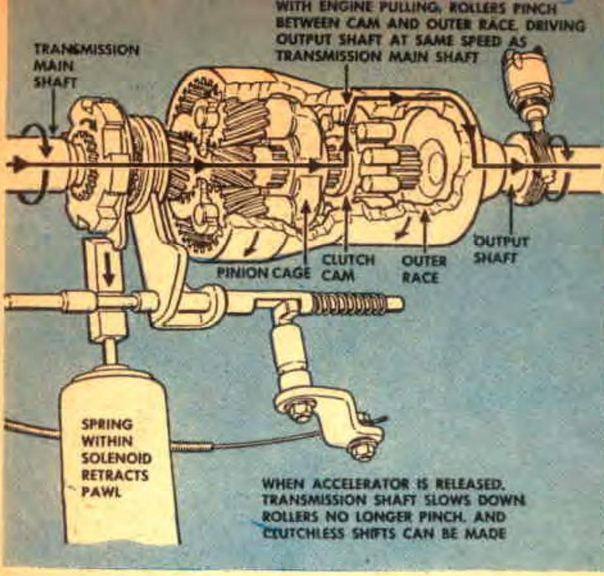
The parts of an overdrive unit are in the position above while car is at rest with dash knob in.



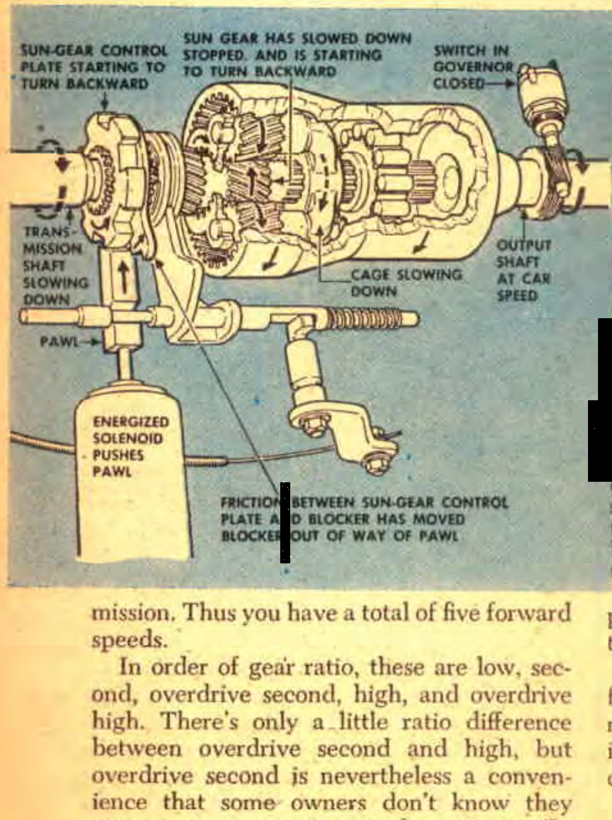


Planetary gears form the heart of overdrive. They give a ratio change that reduces engine speed in relation to car speed. The planetary set consists of a sun gear, three pinions that walk around it, and an outer ring gear. Entire sun-gear unit simply rests on smooth section of main shaft.

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 s[redacted]eed [redacted] m.p[redacted] the freew[redacted]eelin[redacted] main sha[redacted] ext[redacted] spl[redacted] into the [redacted] cl[redacted] cam. As [redacted] cam t[redacted]h ma[redacted]haft, roll[redacted] move o[redacted]nto w[redacted]g co[redacted] with ou[redacted] race, ca[redacted]tter to[redacted]e and deliver power to wheels. Let up on the gas and roller clutch releases, allowing shifts without the regular clutch.



[redacted]**car reac**[redacted]**cu**[redacted]**-in** [redacted]es solen[redacted] an[redacted] the [redacted] engagem[redacted] wi[redacted] s[redacted]-gear [redacted]engine is [redacted]ving, [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 disengages, sun ge[redacted]and plate slow, stop, and make sli[redacted]t backward [redacted]rn. By means of friction, control plate carries[redacted]horseshoe-shaped blocker ring ba[redacted]kward too. T[redacted]is frees the pawl, allowing it to engage notched plate.

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

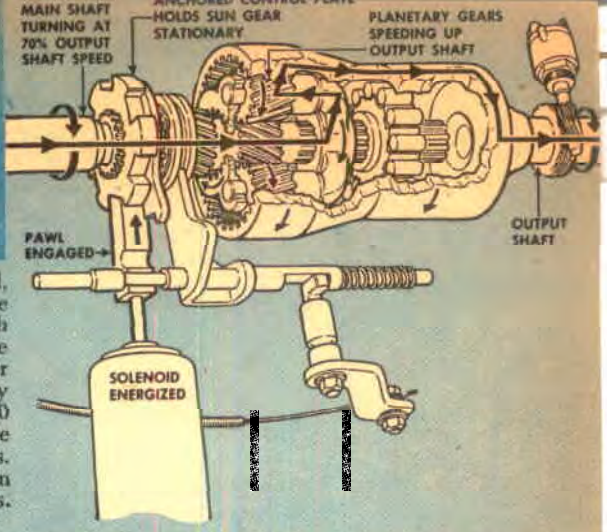
In order of gear ratio, these are low, second, overdrive second, high, and overdrive high. There's only a little ratio difference between overdrive second and high, but overdrive second is nevertheless a convenience that some owners don't know they possess—an automatic gear for easier traffic driving.

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.

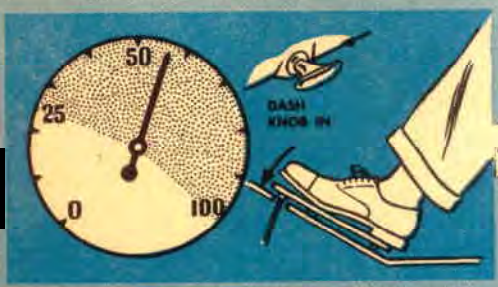
The things you do to operate overdrive are few and simple. To place the mechanism in readiness for automatic operation, you push in the dash knob. You can do this while the car is at rest—or at any speed.

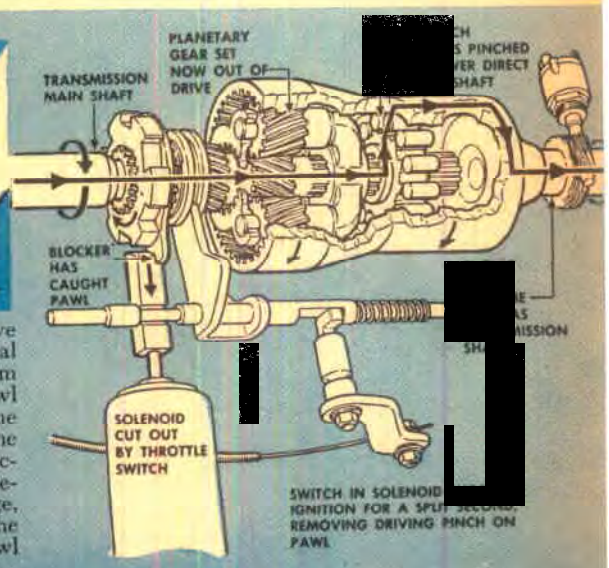
Starting from a standstill with the knob in, you shift into low in the usual way. From then on, *until you reach the overdrive cut-in speed,* you can shift into or out of any conventional gear without touching the clutch.

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 [redacted] nches and holds pawl. To overcome this, the [redacted] ckdown switch also interrupts ignition for frac- [redacted] on of second, slowing engine and causing re- verse 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.

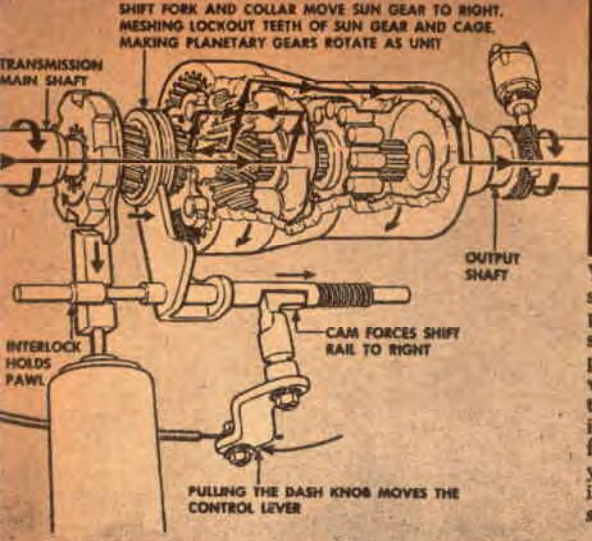
This clutchless shifting at low speeds is made possible by the freewheeling built into the overdrive unit. Each time you let up on the gas, the car freewheels. When you shift, the overrunning clutch within the unit automatically does the job of the regular clutch.

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.

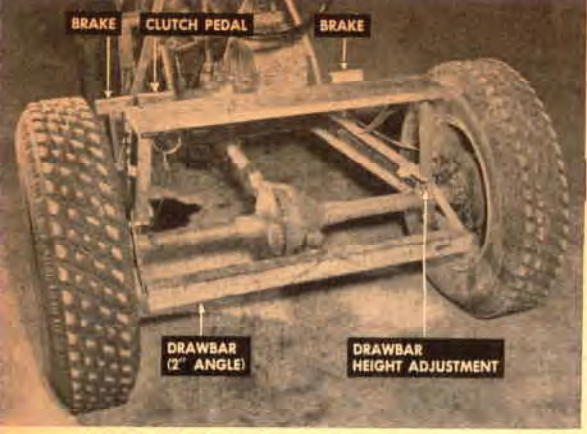
PS photos by W. W. Morris

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

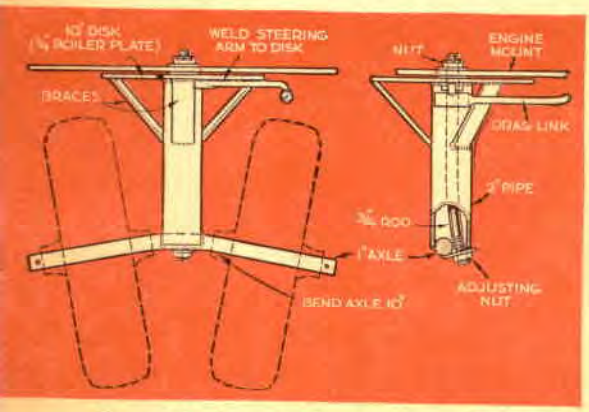
"As a gag, he yelled to me to come and pull him out," says Matous, a building contractor at Orangeburg, N. Y. "He thought I couldn't possibly move the car."

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!*"

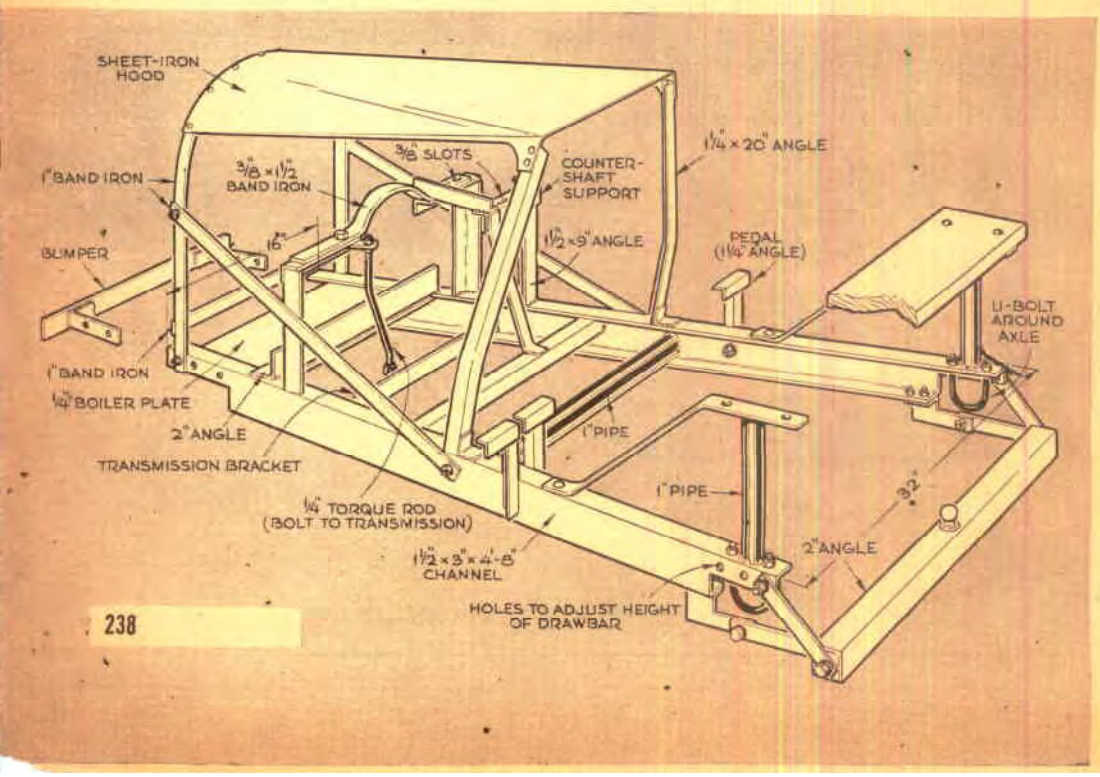
Matous is a shrewd bargainer, as well as a good craftsman. Otherwise, he couldn't have kept the cost of his doodlebug so low. He paid only $35 for a surplus engine—a single-cylinder, air-cooled, four-cycle Briggs & Stratton. A Ford transmission, Ford steering gear, pre-war Austin rear end, and other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

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

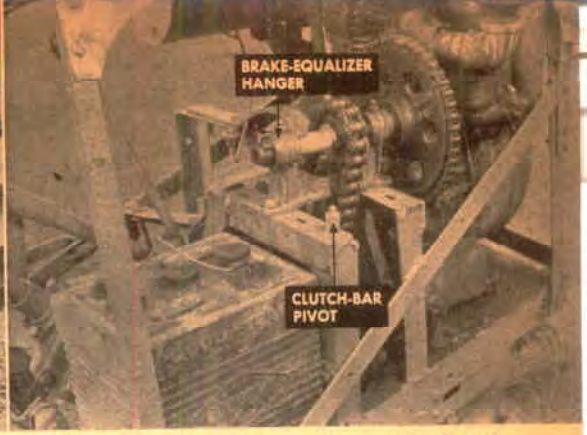
The Matous tractor doesn't compare in looks with some of the commercial jobs, but its builder offers to bet it will easily outperform at least two famous makes. On that score, Matous argues with some authority. His main job several years ago consisted of repairing agricultural tractors.

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.

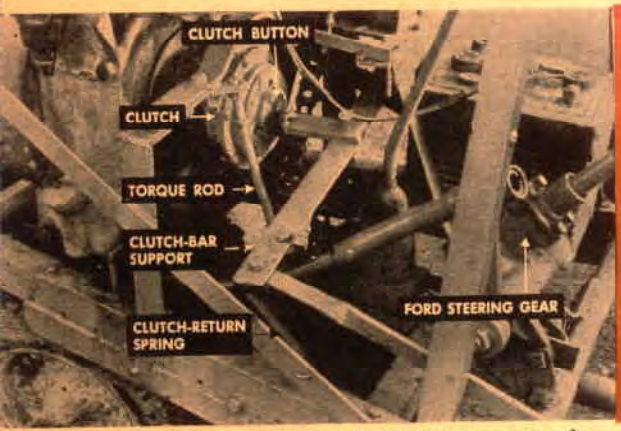
Good weight distribution explains this. The engine rests as far forward on the frame



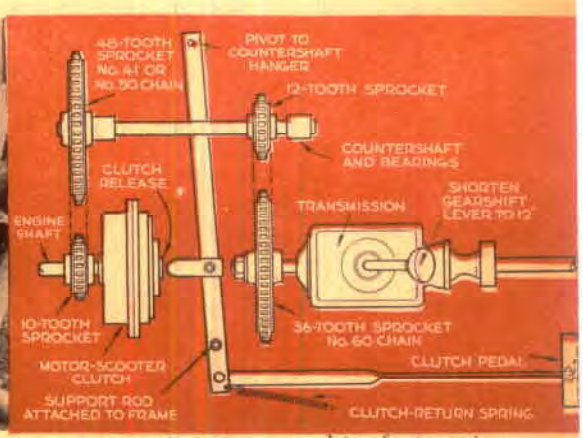
A shear pin protects power train. Universal joint was kept only to make assembly easier. Since rear is unsprung, it could be omitted.



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.

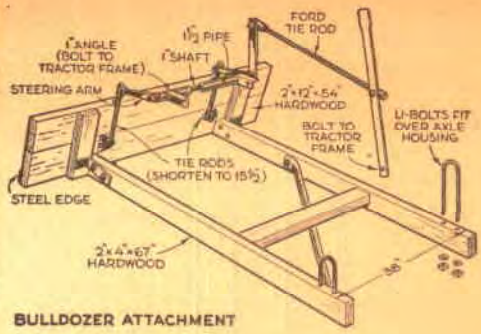
Sprockets, countershaft, and chains carry the drive to the Model-A transmission. Speeds are about 10 m.p.h. in high, 4 m.p.h. in second, and 1½ m.p.h. in low.

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

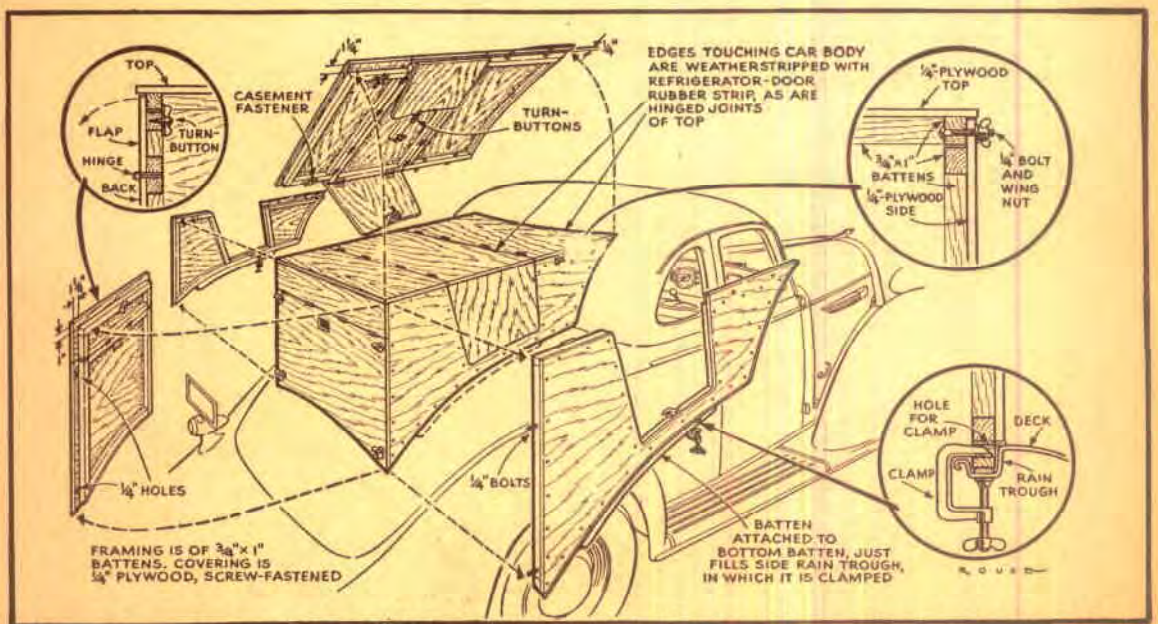
HINGED PLYWOOD PANELS ADD COMFORT FOR EXTRA PASSENGERS

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.

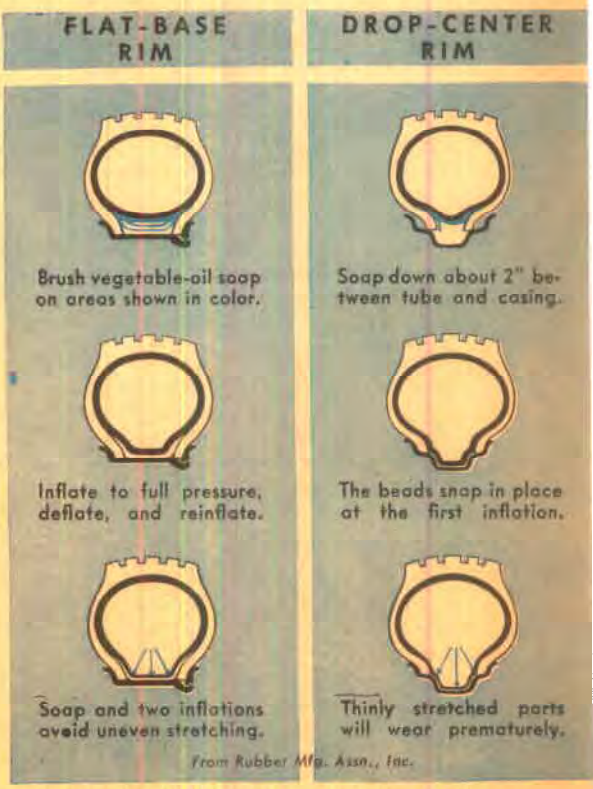
You may have heard that, because butyls hold their air so well, they need not be inflated with the regularity or frequency of natural-rubber tubes. Tire technicians warn, however, that pressure should continue to be checked every week or so because of the possibility of leaks for other reasons. Synthetic 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.

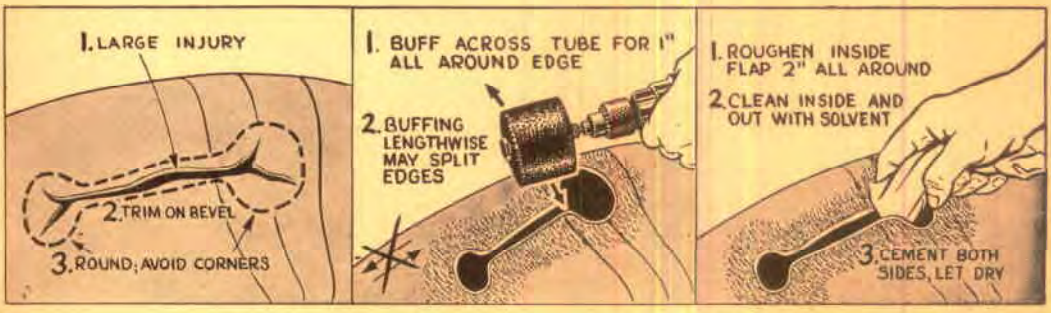
Warning: When the core has been removed from the valve, inflation with a high-pressure air line that has no pressure-regulating device may prove dangerous. The sudden entrance of air at high pressure may snap the beads against the rim with such force that they will be damaged and later on may cause a 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.

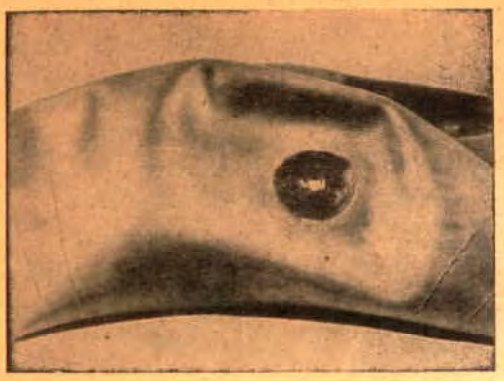
When a synthetic tube is inflated out of the casing, as in testing for a leak, be careful not to admit so much air that the tube will be stretched beyond its original size. Once so stretched, a synthetic tube hardly ever comes back to size.

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.

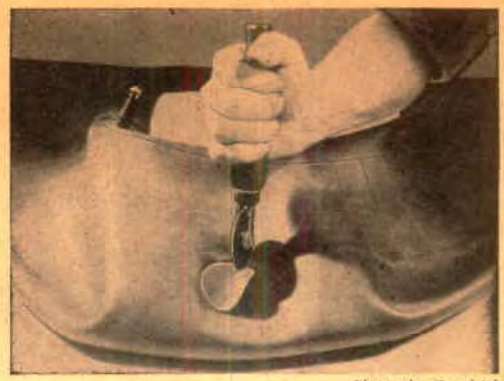
Patches are made on synthetic tubes in the same manner they are on natural-rubber tubes, except that for injuries 1" or more long GR-S tubes require a reinforcement patch on the inside. Both hot and cold patches can be applied successfully. Tire manufacturers recommend heat-vulcanized patches for permanency. 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

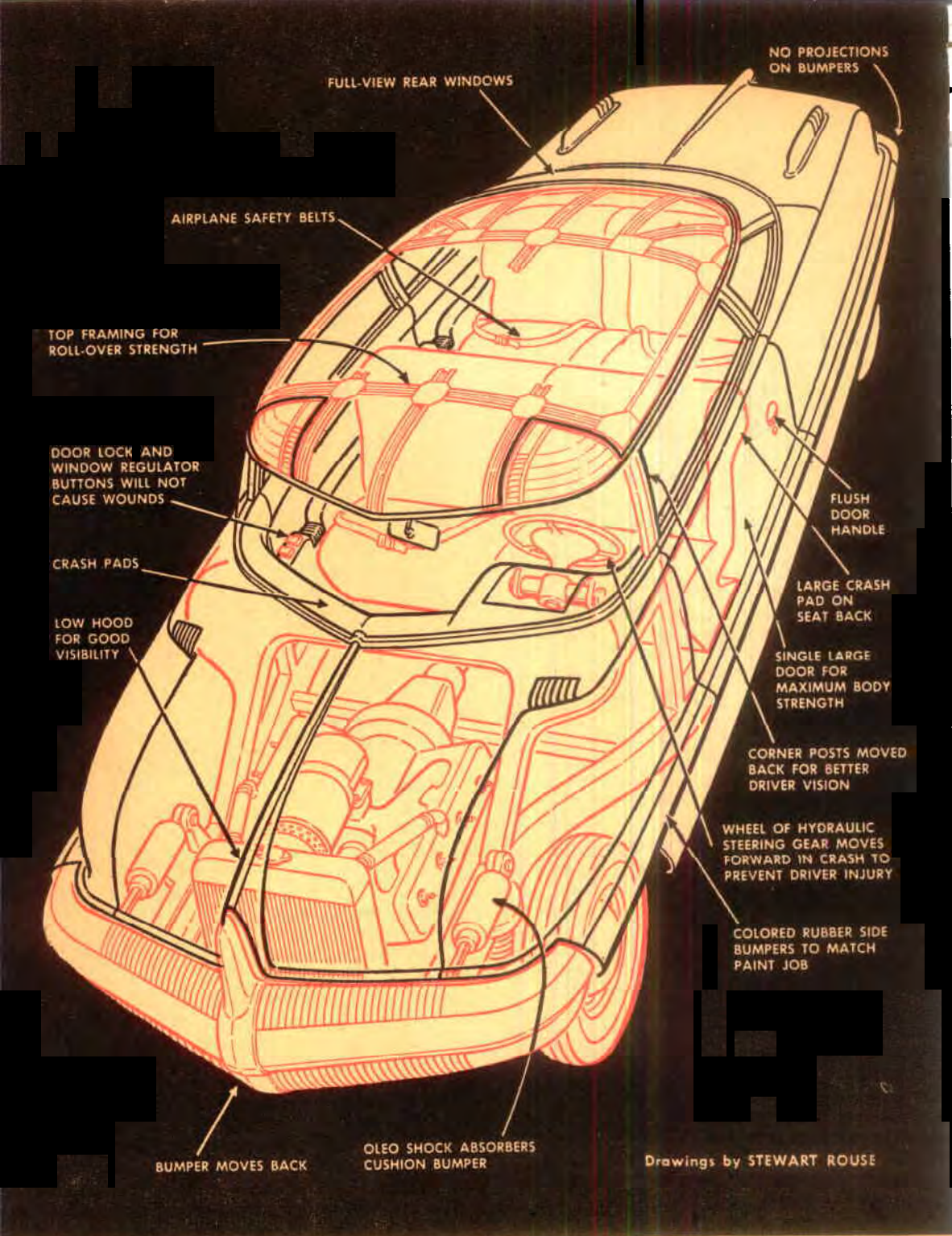
YOU have left the outskirts of town and are rolling on the highway, the speedometer comfortably short of 50. Your car is fresh-tuned for spring; tires are newish, brakes sharp; there is not a squeak or rattle to spoil the purr of the engine. Suddenly, a car comes toward you. It is not going very fast. 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.

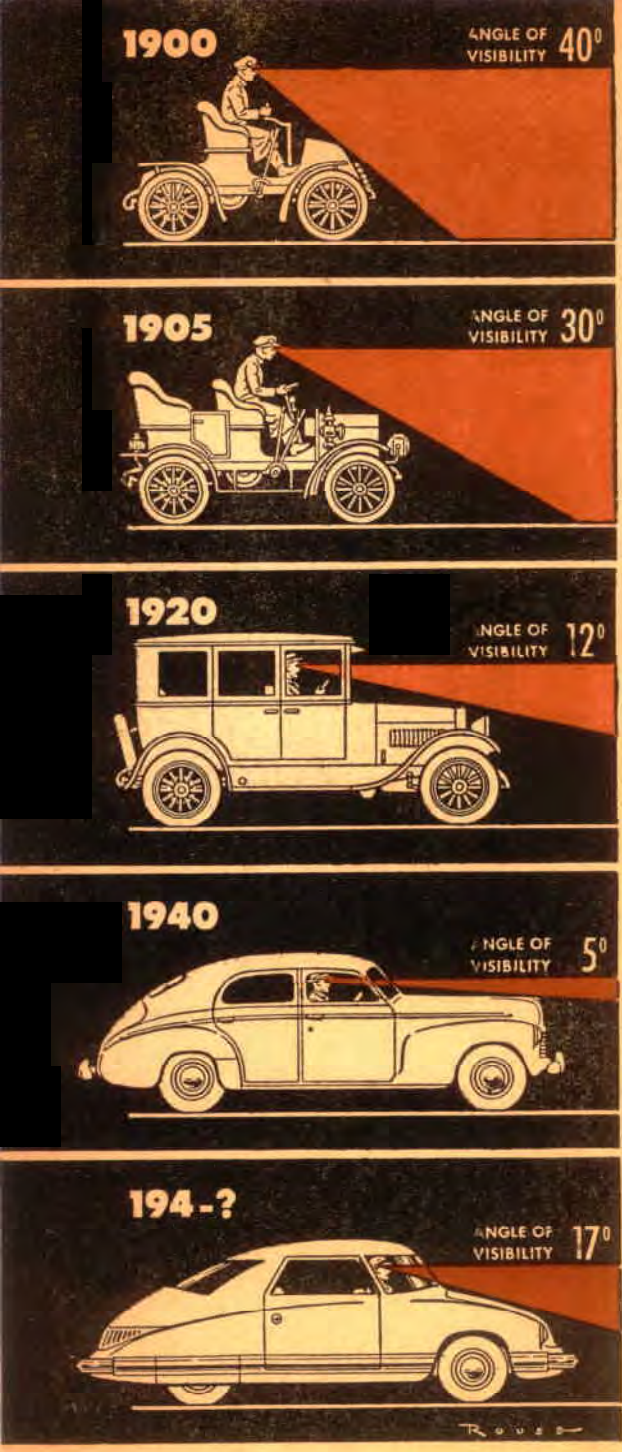
You may be the best driver on the insurance companies' records, but if you don't carry the scars of an accident as you read this, you can thank your good luck as well as your skill.

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.

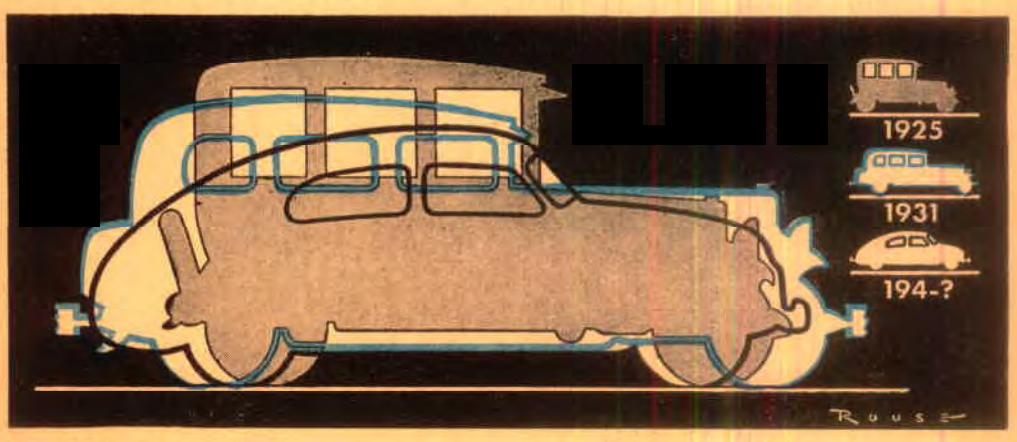
Even a medium tank cocooned with foam rubber would not be as safe—if it hit another medium tank—as a car on a pedestal, with an empty gas tank, in the Smithsonian Institution. But cars will be made safer as soon as the American people give the manufacturers the green light.

Safety Isn't Gratis

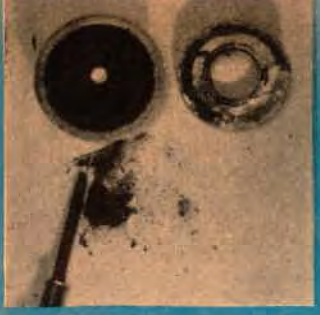
Already an automobile is the second largest collective investment (a home costs more) of the typical American family. Safer cars are likely to cost more. You can't put welds and ribs into a frame for free. And auto makers cannot bet against your whims.

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.

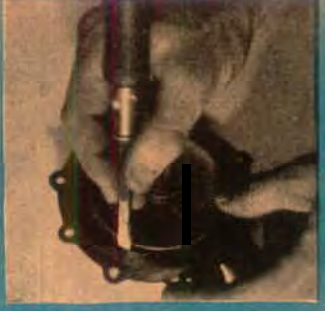
END



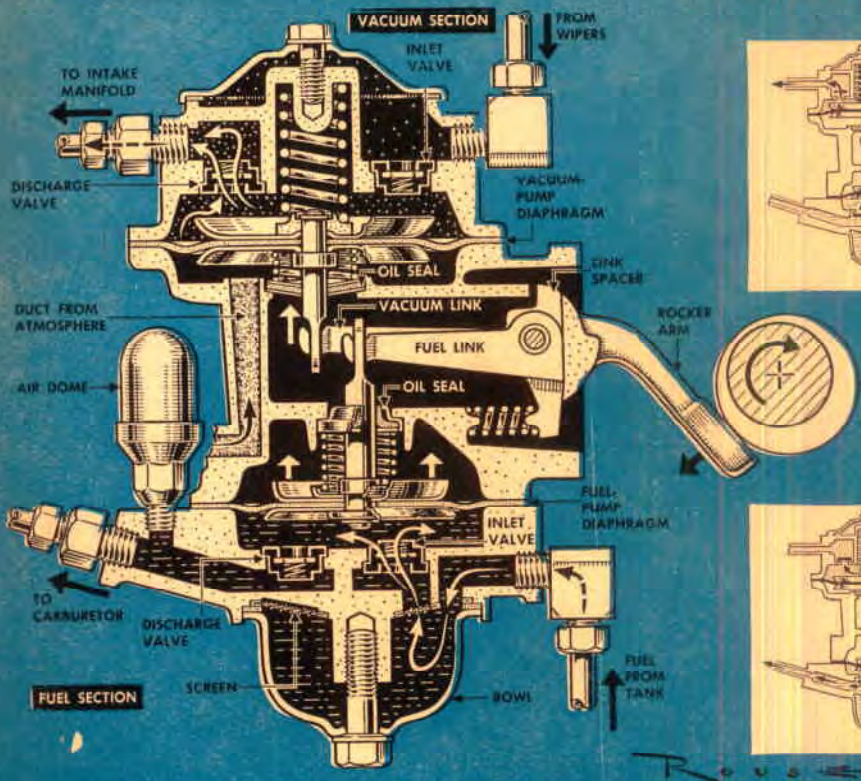
Once high and short, then long, cars are getting more compact and closer to the road. Other changes involve weight, which is being reduced, but engineers are restricted by the rough necessity of a 50-50 front and rear balance. Incorrect weight distribution could multiply the hazards of applying brakes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

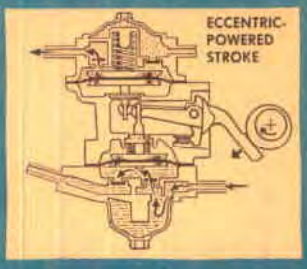


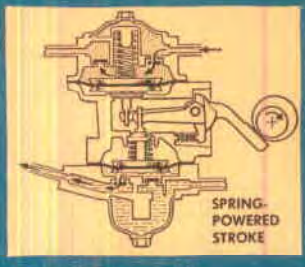
Common trouble sources in a fuel pump include, left, rust and sludge choking the filter bowl and screen; and at right, a ruptured pump diaphragm.



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.





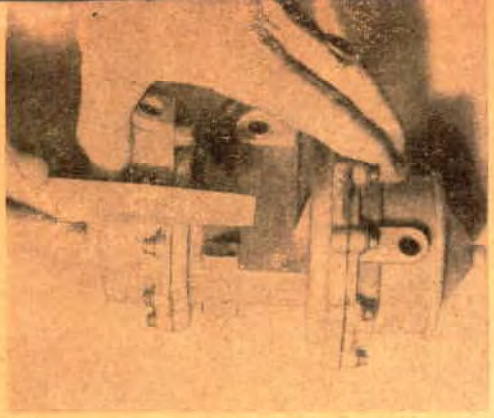


How to Overhaul a Fuel Pump

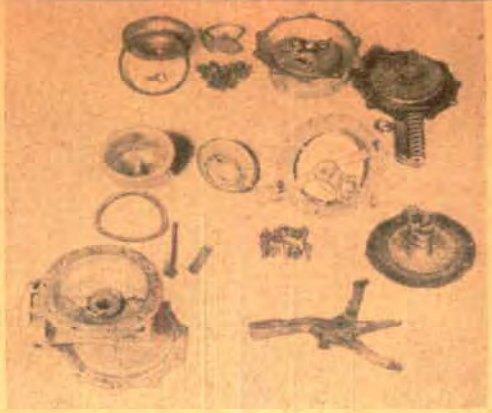
By E. F. Lindsley

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.

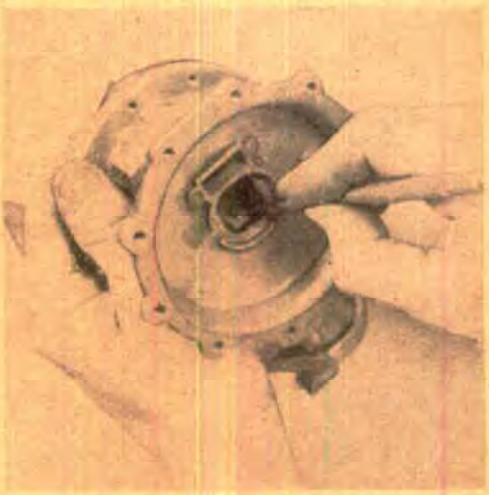
Dying out, poor acceleration, hard starting, low power, and popping back in the intake manifold may be symptoms of too little gas—although some of these might also result from a leaking or plugged fuel line, or carburetor trouble.

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.

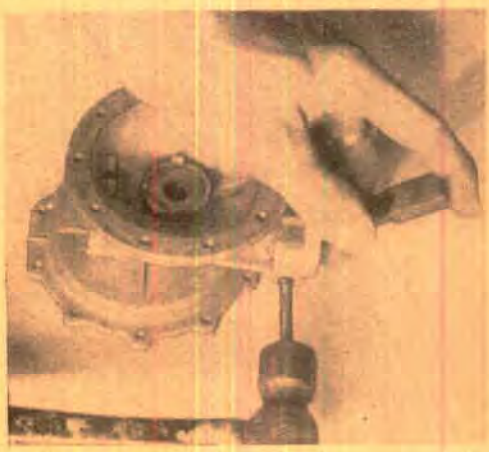
One of the surest signs, of course, that something's wrong with the vacuum pump is slow action of the wipers while you're climbing a hill or accelerating.

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.

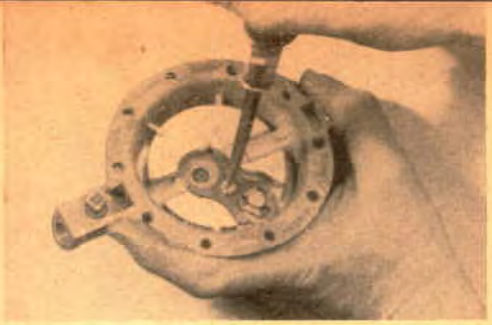
If a pump's delivery is weak, check for diaphragm-flange leaks by applying a



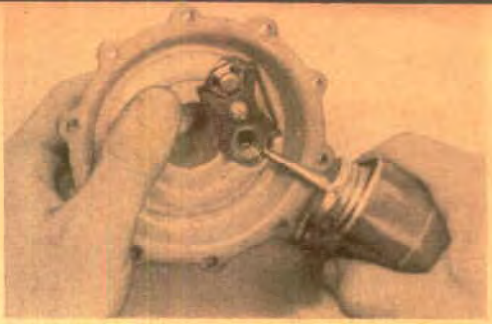
Diaphragm pull rod in this pump hooks on the rocker link. Some engage in a different way. Attaching one may require patience and care.



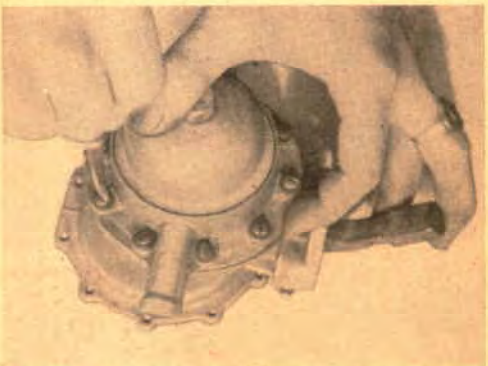
Keep rocker arm aligned with pivot-pin hole, or use a drift, when installing the pin. Stake pin with a punch to keep it from working out.



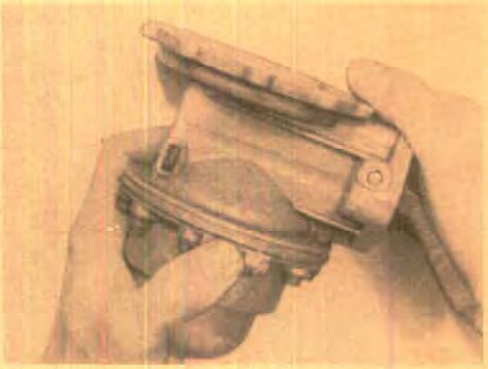
Install new valves and gaskets exactly as old ones came out. Watch whether large or small end of each valve cage goes down or up.



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

Thick-Shelled Atom

THE most complicated atom, that of uranium, has seven shells of electrons around its nucleus.

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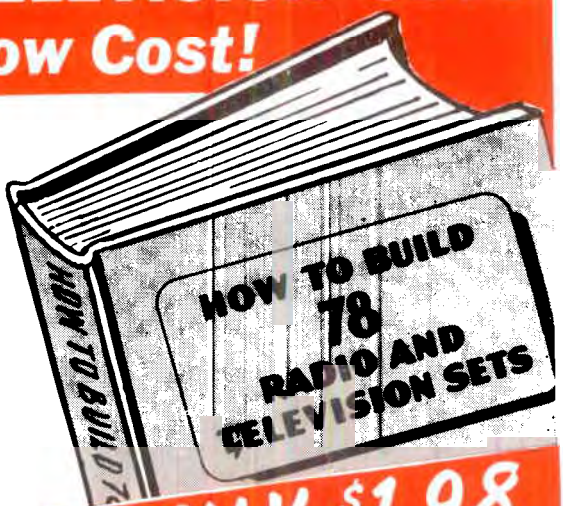

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