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Do-It-Yourself Booklet No. 16

Simple AUTO REPAIRS

Popular Mechanics Press

Printed in U.S.A.

Periodic engine tune-up is an important item in car care. Regular servicing of the auto engine keeps it in top running condition and results in minimum wear, maximum fuel mileage and greatly reduces repair costs

Motor Tune-Up

TUNING UP an automobile engine isn't a difficult job nor does it require a vast assortment of tools. The average car owner can diagnose and remedy most engine trouble by just applying a little know-how.

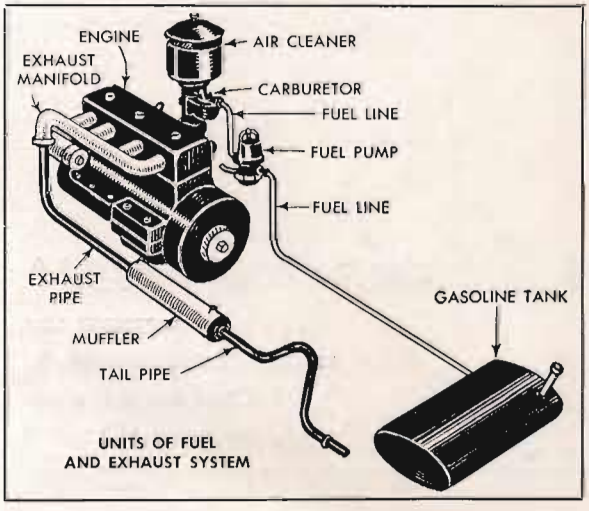
To make an engine run at all it is necessary that it first get gas and then an igniting spark. The gasoline must reach the inside of the cylinder and the spark must be there at the proper instant to ignite the gas. If you have both, something is bound to happen, even though there is but one explosion.

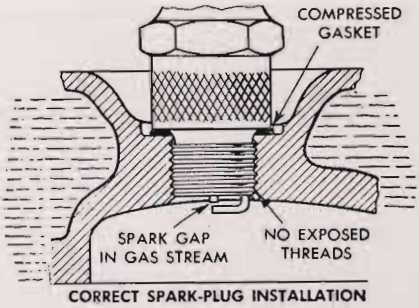
If an engine is stalled and won't start with just a few turns of the starting motor, chances are that there is something definitely out of order. If the ignition supplies a hot spark, the carburetor the right amount of gas mixture and everything else seems in good order, it should be as easy to start the engine on the second stroke as on the hundredth. Therefore it is better to find out the cause of the trouble than to turn the engine over and over until the battery runs down.

When attempting an engine tune-up, you should always try to figure out the possible cause of trouble before starting to adjust something that doesn't need adjustment. An adjustment should never be changed without a knowledge of why the change is to be made and the effect a change should have on the engine.

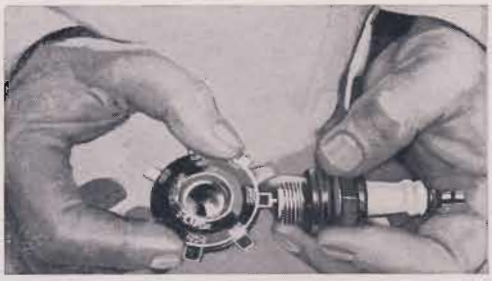
If the trouble is with the ignition, then start checking the spark plugs. Make sure they are clean, burning properly and that the points are spaced correctly. If the engine is still misfiring, follow the wiring from plugs to the distributor. See that these wires are not shorted and that connections are clean. Check the battery connections. Do not examine a spark plug and then leave it to make an adjustment on the carburetor and later come back to toy around the ignition. Follow one system straight through until the trouble has been found or it has been established to be in good order.

Related parts of the fuel and exhaust system. Gasoline must be vaporized, mixed with air before it can be exploded in cylinder





CORRECT SPARK-PLUG INSTALLATION



Above, always use a gap gauge in setting spark-plug electrodes. Left, tighten plug to compress the gasket

Spark plugs: It's good economy to replace spark plugs every 10,000 miles. The four photos at the bottom of the page show the usual history of a worn plug and also why plugs should be replaced at regular intervals. Besides going through regular stages of deterioration, which are readily apparent on careful examination, the plugs also are good indicators of the general condition of the engine and the ignition system. For example, the fouled plug indicates to a practiced eye one of two possibilities: Either the cylinder from which the plug was removed is in rather bad mechanical condition, or some defect in the ignition system is causing this particular plug to foul. When a plug misses, it does not burn off the oil vapors which come in contact with it in the normal cylinder. Hard carbon deposits quickly build up to the point where the plug no longer fires, even intermittently. If this condition is neglected, even for a comparatively short time, a scored cylinder will result.

When cleaning and adjusting the plugs, use the simple gap gauge, as shown at upper right. Always install new gaskets when replacing plugs which have been removed from the engine for servicing. Slight gas leakage at the gasket will cause the plug to run hot and may shorten its useful life by as much as half. When replacing the plugs, wrench torque should be just sufficient to compress the gasket.

For cleaning spark plugs, use alcohol, because it evaporates quickly. Gasoline or kerosene leaves a sticky film which adheres to the porcelain. Pour the alcohol into the inverted plug , let stand for a few minutes, then use a knife to remove the carbon, but do not mar the porcelain by scraping. If the glazed part of the plug is marred, it will retain carbon and will also cause porosity, which causes electrical leaks. If the oil is burned on the porcelain. muriatic acid will remove it. In placing the porcelain back into the shell, be sure that the copper washer is replaced and the bushing screwed tight so as to prevent leaking.

Faulty compression: To a greater extent than car owners generally realize, the loss of engine smoothness and operating efficiency is due to slowly accumulating deposits of hard carbon, gum and crankcase sludge. Short runs in cold weather, long trips at slow speeds and neglect of oil changes and general servicing of the engine contribute to fouling of the crankcase, upper cylinders, pistons and rings. The carbon and gum deposits not only adhere to these vital parts but circulate throughout the lubricating system and cause rapid wear. Regularly changing the oil-filter cartridge may help, but this precaution alone is not sufficient to correct other causes of engine inefficiency which are due to bad driving practices.

Lately the use of solvents has become so important in connection with general engine tune-up, that many mechanics use these chemicals regularly in tune-up jobs on engines which are rated in good mechanical condition. Solvents for sludge and carbon are used in three ways: added in

The general mechanical condition of the engine can be readily diagnosed by the appearance of the spark plugs. A fouled plug is an indication of a bad cylinder or a defect in the ignition causing the plug to misfire

WORN DIRTY FOULED CRACKED AND BROKEN

Radiators on many cars can be flushed with a garden hose after cleaning compound has had time to do its work. Hose at radiator outlet is disconnected

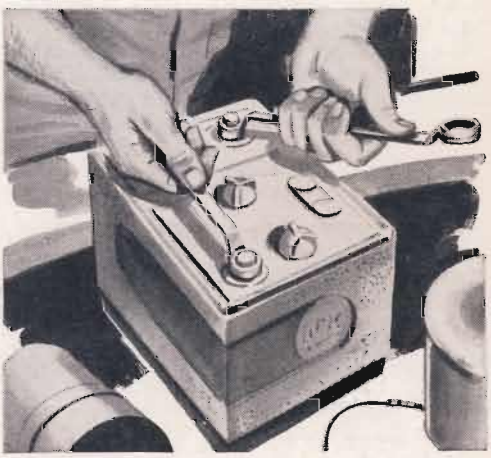
measured amounts to the fuel, introduced directly into the air inlet to the carburetor and combined with the crankcase oil. It's a general practice, after adding the solvent, to operate the engine for at least 30 minutes at fast idle. Following this desludging, or "limbering," treatment, the crankcase is drained and flushed, the oil-filter cartridge is changed and the crankcase is refilled with new oil.

One of the best quick checks of general engine mechanical condition is made with a compression gauge. A variation of more than 10 lbs. pressure between cylinders indicates the presence of mechanical faults which need further investigation. The test always should be made with the engine at operating temperature and the throttle and choke in the wide-open position. Two faults commonly turned up by a compression check are bad rings and valves. To determine whether the valves or rings are at fault without removing the cylinder head, unscrew the spark plug and place about a tablespoonful of heavy oil on top of the piston to form a temporary compression seal. Replace the gauge and repeat the test. If the gauge comes up to normal, it is safe to assume that the rings are defective. There also is the possibility that either the piston or cylinder wall is at fault. If no change in the reading results from the second test, then the trouble probably is due to faulty valves. Sometimes a head-gasket leak is the cause of a low reading in one cylinder but this is comparatively rare. If the result of the tests indicates valve trouble, an experienced mechanic will listen carefully at the carburetor air intake and tell you in an instant which valve is leaking in the faulty cylinder. He knows that a leaking intake valve makes a sharp, distinct hissing sound, but a leak at the exhaust valve cannot be heard because the leakage is going into the exhaust manifold.

Cooling system: When it comes to smooth operation, one of the most important parts of the car is the cooling system. If you have a late-model car, all that may be necessary to condition the system is to clean the radiator with one of the compounds made for this purpose and flush it out with a garden hose. Simply allow the compound to remain in the system the length of time specified in the directions on the can. Then, disconnect the outlet hose from the bottom of the radiator and insert the garden-hose nozzle into the filler neck, flushing out the radiator with a gentle spray. Be sure to disconnect the lower hose, rather than merely open the drain cock, as the latter will not permit a sufficiently fast flow of water to carry away all the rust and scale loosened by the cleaner. Don't forget that the efficiency of the cooling system, as well as the operation of the generator, depends on the tension and condition of the fan belt. Replace a worn belt and adjust the tension by swinging the generator on its mounting so the slack in the belt is between ½ and ¾ in.

Ignition system: The condition of the battery is the first thing to consider when getting the electrical system in shape. Keep

Box wrenches placed over the terminals, as shown, form convenient grips for lifting battery from car



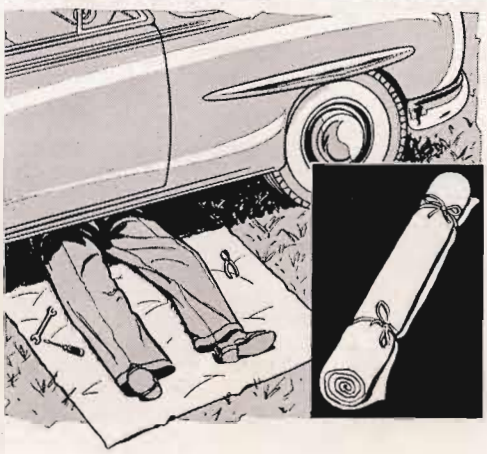
the battery terminals clean and the connections tight and recharge or replace the battery as necessary. The distilled-water level should always be about ⅜ in. above the top of the battery plates. A fully charged battery cell should have a hydrometer reading of 1.280.

Frequent causes of hard starting are dirty or wet spark plugs, wire or distributor cap which permit the current to leak away. See that these units are kept dry and clean and also clean the distributor breaker points. At the same time, check the points for pitting and proper spacing. If they are burned and pitted, they should be replaced, as well as the condenser which is the probable cause of this trouble.

Check the wires in the distributor for breaks and frayed portions. Examine the top of the distributor cap for cracks and be sure that the spark-plug cables and the center cable from the coil make good contact in the socket terminals. Also inspect the rain guards over the cable to see that they fit tightly and are not cracked. The rain guards prevent moisture from entering the distributor and, therefore, are important to good performance.

Fuel system: Carefully check the fuel system to see that it is functioning properly. All the fittings and lines on both the suction and pressure sides of the fuel pump must be tight and in good condition. The carburetor-float level should be set high enough to provide a richer mixture for winter. The automatic choke also is likely to have a richer starting mixture for winter driving. The choke is adjusted by turning the thermostat control slightly. Take a look at the carburetor air cleaner. If the outside of the unit is dirty, you can be quite sure that the cleaner is no longer operating efficiently and should be removed for a thorough cleaning. Another way to check

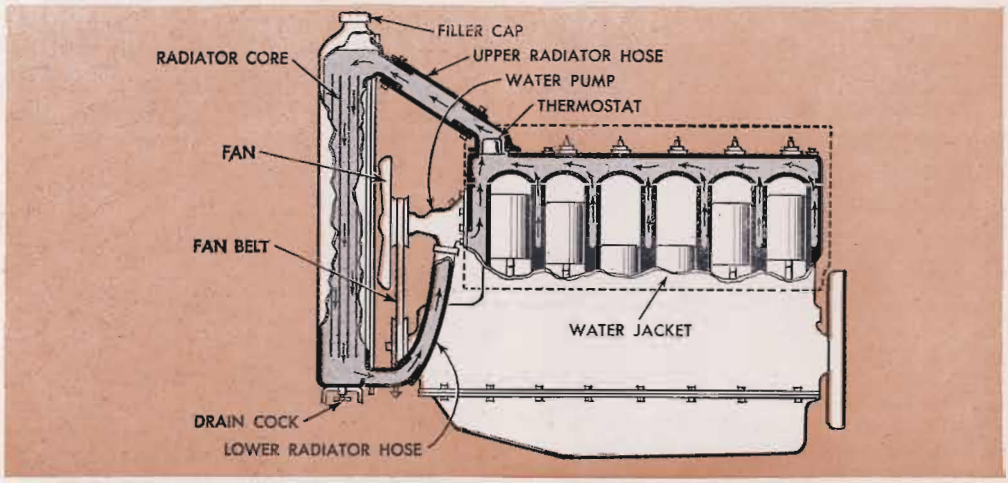
Canvas to protect clothes when doing unexpected repairs can be rolled and stored in trunk compartment



Radiator hoses are inspected and defective ones replaced. All hose clamps should be tightened carefully to prevent possible leakage of antifreeze solution

the cleaner efficiency is to remove it while the engine is running. If the engine speeds up considerably, the cleaner is either dirty or damaged. Should the air cleaner not be dirty after a few thousand miles of service, chances are that it is not working properly because of internal failure or bypassing of the air through a leak in the connection between the cleaner and the carburetor. Drain the fuel tank to remove any water and sediment and, if desired, add a special solution to the gasoline to absorb water condensation. The crankcase should be drained and flushed at intervals to remove sludge and other foreign matter which may clog the oil-filter screen and also cause sticky rings and valves.

Perhaps the greatest problem of present-day operation comes from running a car with the motor relatively "cold" due to frequent starts, slow speed and reduced mileage. The result is that raw gasoline works down past the pistons into the crankcase, washes oil from polished surfaces and invites destructive pitting. The gasoline also washes down abrasive metal particles, road dirt and carbon which scratch bearing surfaces and contribute to the scoring of the pistons. These bearing scratches are also caused by lack of oil.



Water is circulated through the system when the engine is running and, as it passes through the water jacket, absorbs heat which it carries to the radiator where it is dispersed into the air flowing through the radiator

Cooling System

A SUDDEN SPURT of steam from the radiator often is one of the few reminders to the average motorist that his engine has a cooling system; then it's too late. Severe damage to the valves, rings or cylinder walls may have been caused by this time.

A cross section of a typical passenger-car cooling system is shown at the top of this page. It consists of a radiator, its hoses, a water pump and fan, a thermostat and the water jacket around the engine. Water is circulated through the system when the engine is running and, as it passes through the water jacket, absorbs heat which it carries to the radiator where it is dispersed into the air flowing through the radiator.

Although water has excellent heat-transfer properties and is available almost everywhere, it has definite drawbacks. It has a comparatively low boiling point, a fairly high freezing temperature and a natural corrosive action on metals. A radiator completely filled with water will overflow when the water heats and expands.

Antifreeze must be added to the water in cold weather to prevent freezing. Rust-inhibitor should be kept in the water when no antifreeze is used. Standard antifreeze solutions contain a rust-inhibitor of their own which is efficient.

When checking an automobile for overheating, be sure that the brakes are not dragging and that there is plenty of oil in the crankcase. Bad ignition timing also will cause overheating. Examine the engine for external leaks in the hoses, radiator and heat gasket. Be sure the fan belt has only about 1 in. of play. If it is frayed or oily, it should be replaced. Test the thermostat by suspending it in water and heating it to the specified temperature, as shown on page 8. If the thermostat opens at a temperature more than 10 deg. F. below specified temperature or fails to open at a temperature of 10 deg. F. above the specified temperature, it should be replaced with a new one.

Check for internal leaks of combustion gas into the water caused by a leaking head gasket or cracks in the cylinder head or block. To make this test, remove the upper hose and thermostat, drain the water down to the level of the engine block and disconnect the fan belt. Then pour water into the radiator until the water outlet on

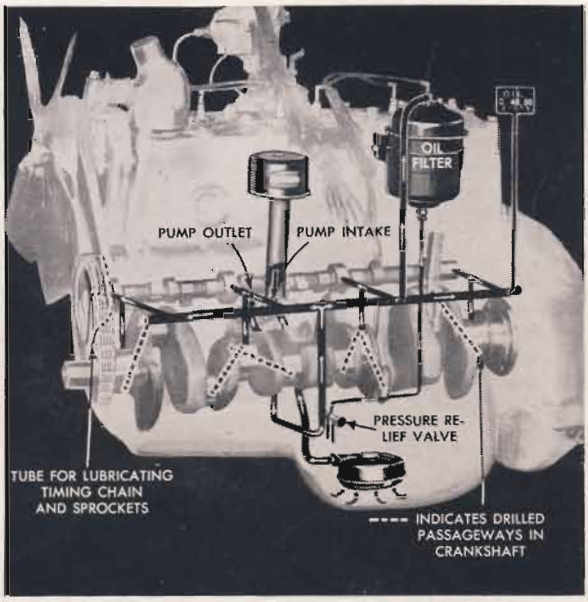
The fit of a piston pin is just one of many examples of close tolerances required in an automobile engine

the head overflows. Start the engine and accelerate it 6 or 8 times. If bubbles appear it indicates a combustion leak.

Next, check for air being sucked into the cooling system. This causes foaming which greatly lowers the ability of water to absorb heat. The foaming water also will overflow, causing a low water level. Air suction usually occurs through a leak in the pump or in a connection between the pump and radiator. To test for this trouble, lower the water level enough to eliminate the chance of overflowing from expansion. Then block open the pressure valve on the radiator. Attach a hose to the overflow pipe and insert the free end in a container of water. Run the engine until the temperature remains constant. Then, with the engine running at a fairly rapid speed, watch for air bubbles in the container. If there is no internal leakage of combustion gases, the presence of bubbles indicates air is being sucked into the cooling system.

If your engine runs too cool, check the thermostat and, if necessary, cover part of the radiator to adjust the temperature to a safe level.

Inspect the radiator core every spring and fall. If it needs cleaning, use a good grade of cleaning compound and reverse-flush as directed on the package. A badly clogged radiator will require the services of a professional radiator-cleaning shop. There are devices on the market which may be suspended in the radiator to assist in preventing corrosion and clogging of the radiator core.

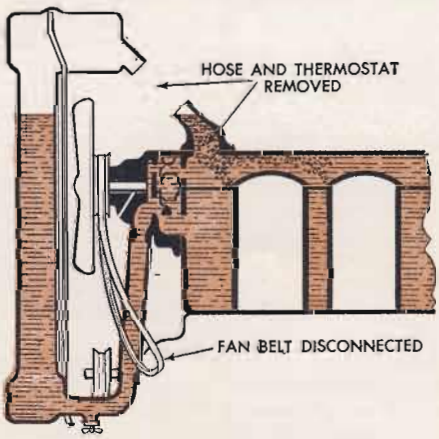


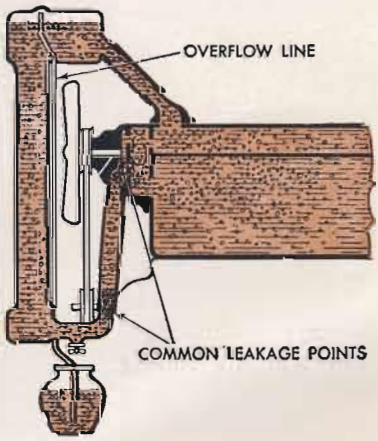
Efficient functioning of the lubrication system is important to the cooling system because it also helps to carry away heat

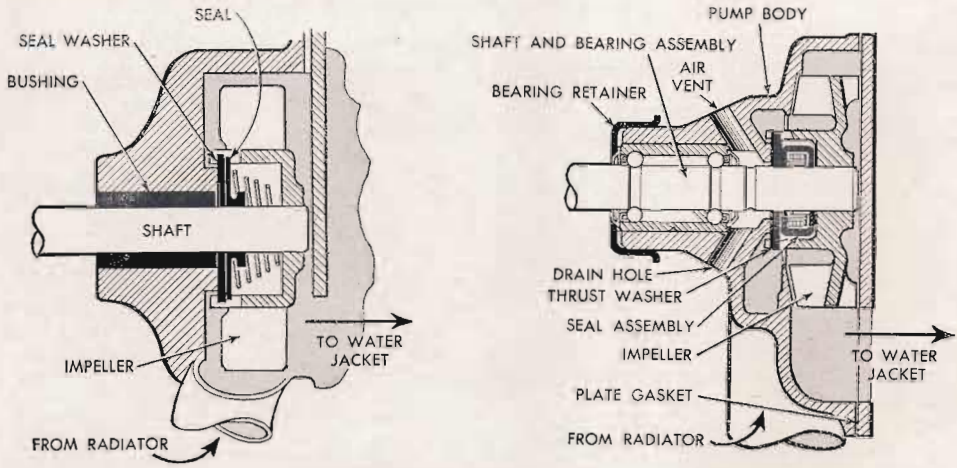
The fan belt requires no particular attention, except lubricating. Sometimes the belt gets loose and causes the fan to slip and not turn as rapidly as it should, causing overheating of the engine. If this happens, loosen the nut which holds the eccentric arm of the fan, raise the arm slightly and retighten the nut. This will tighten the belt. Frequently, this nut has a left-hand thread. Do not tighten too much as you are apt to crack the fan support.

Where a V-type fan belt drives the fan, water pump and generator, the adjustment is made by moving the generator in or out to tighten or slacken the belt. Too tight

Left, test for combustion gas leaks in the water jacket caused by bad head gasket or cracks in head or block. Right, test for air suction in system. Air will cause foaming and loss of heat-transfer properties of water







Two types of water pumps used on modern cooling systems. Water is kept from leaking around impeller shaft by self-adjusting seal. Too tight a fan belt will pull shaft out of line and cause it to leak

a fan belt may pull the water-pump impeller shaft out of alignment and cause excessive wear on the bearings and eventual leaks.

Water pump: Check the water pump for air or water leaks, end play, worn or scored shaft and worn bushings. The first condition can usually be remedied by tightening the packing nut slightly, that is, if the water pump has a packing nut. The other conditions, if present, will necessitate the removal of water-pump assembly for an overhaul or replacement.

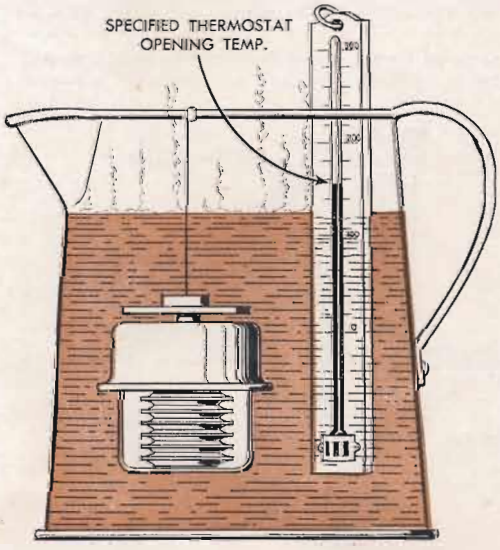
Hose leaks: The rubber hose and its connections are often a source of leakage. To secure a tight fitting, apply hose or gasket cement on the pipe ends before replacing the hose. Hose should be replaced when it shows signs of deterioration.

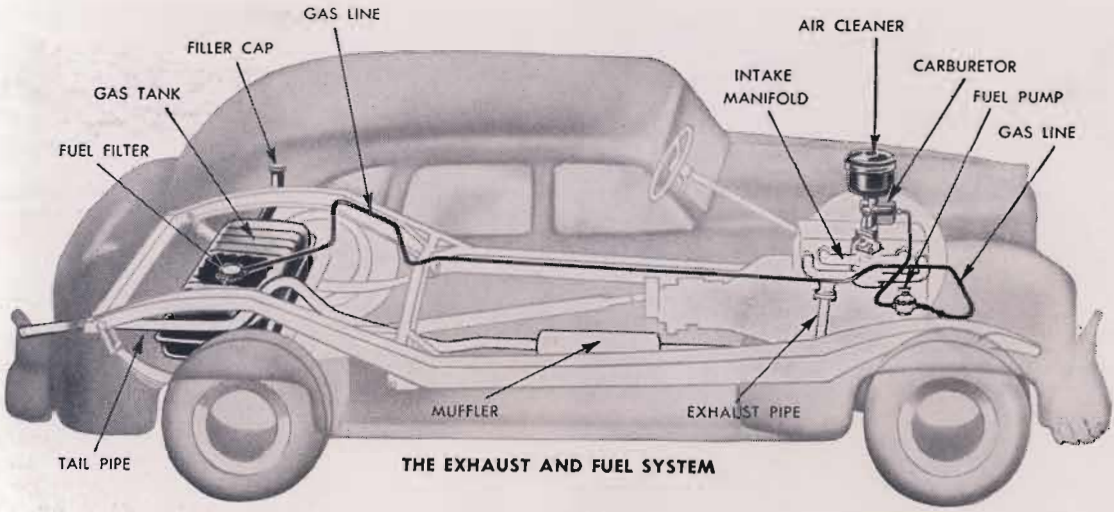
Rust preventive: The solution is added to the water in the cooling system for the purpose of preventing, not removing, the accumulation of rust and scale in the radiator and cylinder block and should be put into the cooling system of new cars and added when the system has been flushed.

Cleaning clogged radiator: When old auto radiators of the flat tubular type become clogged to such an extent that flushing will not remove the scale, they usually can be restored by rodding the tubes with a length of flat steel. Cut openings through the top with a fine-toothed hacksaw blade and bend the pieces back. Then insert a length of thin sheet metal in each tube and work it through slowly, turning the metal strip as it progresses. If available, a short length cut from an old bandsaw blade is just the thing for this job. When all scale has been removed from the tubes, press the bent sections back into place and solder the joints. This accomplished, flush the radiator in the regular manner. Water for the cooling system should be free of lime and alkali for the best results.

Releasing stuck thermostat: When the thermostat in the car radiator sticks, here's a simple trick that may save you the trouble of removing it. Cover the radiator with newspapers or a blanket and let the engine idle until the temperature rises 20 to 30 deg. above normal. Then stop the engine and permit it to cool before operating again. The wide variation in temperature generally will cause the thermostat to release and operate normally.

Below is illustrated the method for testing thermostats to determine whether they are opening at the proper temperature range. The thermostat is suspended in water and heated to the specified temperature





THE EXHAUST AND FUEL SYSTEM

Economy and efficiency in the operation of your car depend largely on the fuel and exhaust system. The typical passenger-car system illustrated indicates several definite and necessary services you should know

Fuel System

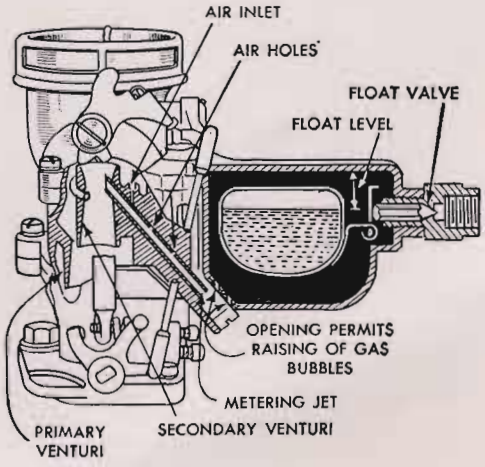
FREQUENTLY a thorough cleaning of the carburetor alone will make an old car run like new. Accumulations of dirt and gum probably result in more carburetor troubles than any other single cause, and periodic cleaning and adjusting of the unit will give you easier starting, snappier acceleration and greatly improved gas mileage for both summer and winter driving. Anyone can take apart, clean and reassemble a carburetor, but to avoid damaging certain of the delicate parts of the unit, you should acquire the "mechanic's touch," and handle everything as if it were made of glass.

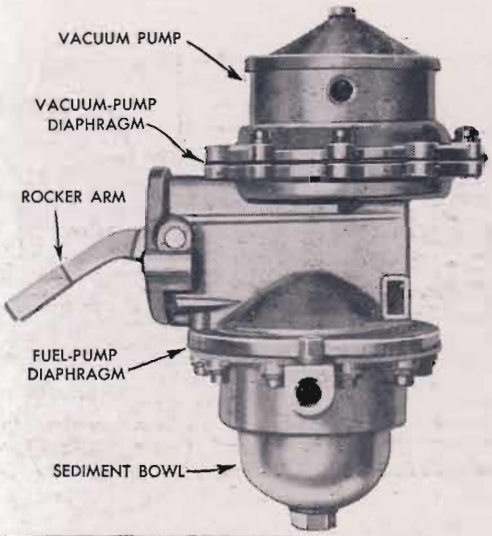
Anything that causes the engine speed to vary when the accelerator is set is an indication of a mechanical fault. The most common fault is a rich fuel mixture. In a new car there's a good chance that the trouble is due to a clogged air cleaner. In an older car the cause may be a bit of dirt or gum in the carburetor jets, and, more rarely, the float sticking, or not properly adjusted. Perhaps a needle valve has been damaged by turning it in too tightly. Sometimes the air holes in the metering jet are clogged with gum and dirt. These are among the more common causes of a rich fuel mixture and a rough engine.

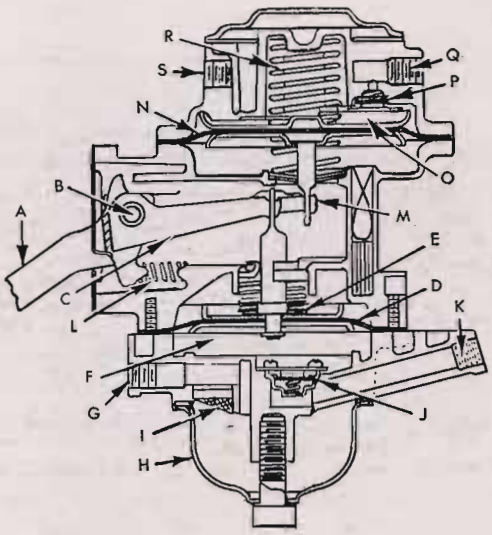
In carburetor diagnosis, one thing to keep in mind is the age of the car, both in years and miles. In older cars the float level will change gradually because of wear in the parts and, in time, looseness reaches a point where raw fuel is discharged into the air stream in ever increasing quantities.

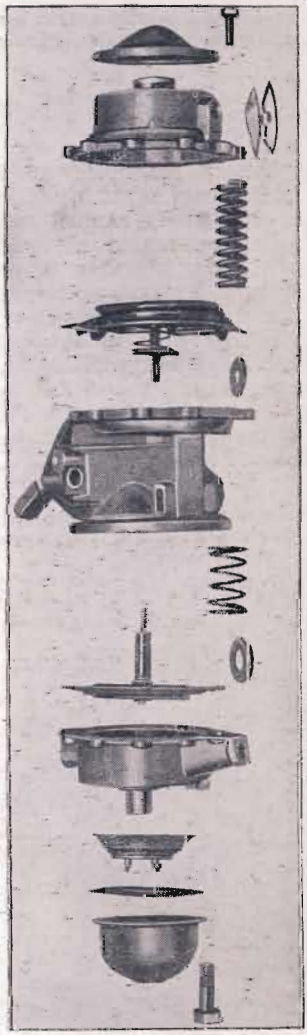
When the engine and carburetor are in good operating condition, adjusting idling speed and fuel mixture is simple, even though some engines are more sensitive to changes in the adjustments than others. First, turn the speed screw inward to speed up the engine, or outward to slow it, until the desired idling speed is obtained. Next, the mixture screw is turned in very slowly and by stages until the engine begins to roll and lose power. Then back off the screw (counterclockwise) until the engine smooths out and idles steadily. If the

Gum and dirt clogging the air holes in metering jet are causes of rich fuel mixture and a rough engine









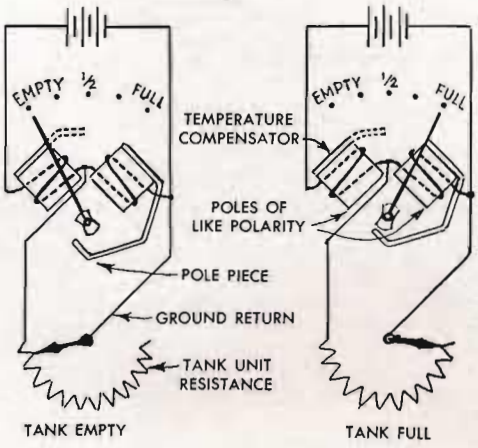
Below, left, is exploded diagram of combination fuel-pump vaccum booster. Above, left, assembled unit is shown with parts named. Right, cross section of pump with all parts lettered for reference

carburetor is clean and otherwise in good condition, the engine will respond almost instantly to sudden, hard acceleration and will return to idling speed smoothly when the throttle is closed. However, if the float is high, or if dirt and gum have restricted passageways, turning the idling screw in or out may make little difference in the performance of the engine. Under sudden acceleration it is likely to lag through a "flat spot" and pop back violently through the carburetor. When idling, the speed generally varies and the engine rolls from side to side on its mountings. Under these conditions it is also likely that the accelerator pump is defective. This generally is the case if there is a flat spot in the acceleration cycle above idling speed.

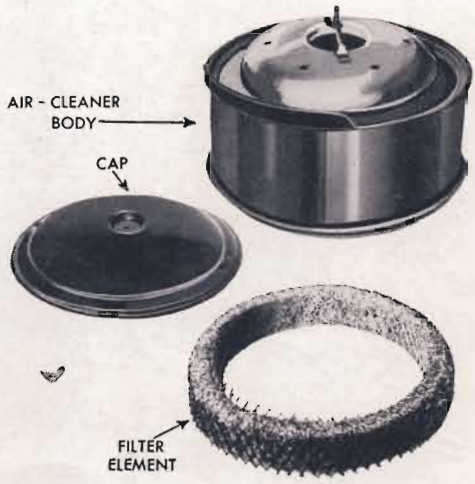
To remove the carburetor, first disconnect the ground cable from the battery. Then wash away accumulated oil and dirt from the choke and throttle controls and also the mounting flange, using white gasoline or other suitable solvent. Remove the air cleaner and, if it is of the oil-bath type, be sure to place it upright on a table top or other level surface until you are ready to clean it. Disconnect the throttle and choke rods and remove the cap screws holding the carburetor on the mounting flange. Remove the gasket carefully so that no part of it falls into the intake manifold.

Fold a cloth and press it tightly into the open end of the manifold to prevent the entrance of dirt and other particles. Place the carburetor on a large clean sheet of paper on a table top. Grind down a screwdriver blade so that you can reach into tapped holes and remove retainers and other small parts without damaging the threads. As parts are removed, place them in order so that they are readily assembled. Apply penetrating oil, or better still, lacquer thinner, to parts that refuse to loosen under moderate pressure of the screwdriver.

Many manufacturers supply replacement kits which include retainers, jets, accelerator pump, gaskets and parts of the throttle and choke controls. It is recommended that in carburetor servicing these units be installed to replace parts that have become worn or damaged. After removing all the



THE A.C. FUEL GAUGE



Left, a sketch of one type of electric fuel gauge. Motion of the tank float causes the movable contact to slide over a rheostat. Right, disassembled view of air cleaner. Filter is easily cleaned with gasoline

parts, the carburetor body should be given a thorough cleaning with lacquer solvent (thinner), which will remove the accumulated gums and dirt. Pour the solvent into a container and place the carburetor body in the liquid, allowing it to remain immersed for about one hour. Cover the container during this time to prevent rapid evaporation of the contents. *Caution:* Lacquer solvent is highly flammable and volatile. Remember the fire hazard, and also avoid inhaling the fumes.

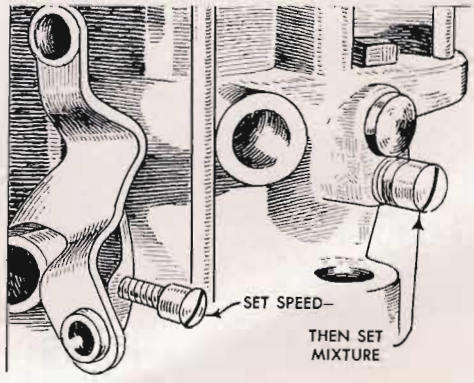
After cleaning with solvent, remove the carburetor body and blow out all the passages with compressed air. A bicycle pump will provide sufficient air pressure for this job. Clean small parts by placing them in a fine-mesh wire strainer and shaking them lightly in the solvent. Never use a sharp-pointed tool or a wire to clean the passages in the carburetor or jets. The jets are calibrated to precise dimensions and any enlargement of the openings or scoring of the seats will affect the operation of the carburetor.

Be especially careful when assembling jets and ball valves to make certain that dust and fine abrasive particles do not find their way into the seats and openings. Be sure that all retainers are installed with the proper gaskets. After installing the float, check the level to be sure that it agrees with the float level specified for that particular carburetor. Likewise, carburetor manufacturers provide specific recommendations for setting the metering rod and the antipercolator mechanisms as well as the automatic choke. These recommendations will vary for different makes and types of carburetors, so it's a good idea to have this information at hand for the particular carburetor you are servicing.

After the carburetor has been cleaned, checked and reassembled, replace it on the manifold, using the proper gasket, and drawing the mounting screws down uniformly. Connect choke and throttle controls and the fuel line. Then disassemble the air cleaner and clean it thoroughly before replacing. To get the best performance from the carburetor, the engine must also have good ignition, strong compression and clean spark plugs.

Start the engine, and while it is warming up note carefully the action of the heat-control mechanism. When the engine is cold, the valve is closed and the hot exhaust gases are deflected upward and around the intake manifold. As the engine manifold warms to operating temperature, the thermostatic spring gradually loses tension, permitting the valve to open. Proper operation of the valve mechanism is

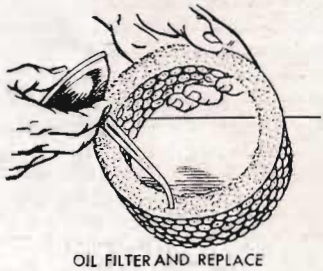
When engine and carburetor are in good operating condition, adjusting idling speed and mixture is simple



UNSCREW WING NUT ON TOP OF CAP

REMOVE AIR FILTERING ELEMENT

WASH ELEMENT IN CLEANING FLUID



OIL FILTER AND REPLACE

essential as it provides a means of shortening the warm-up period and thereby reduces fuel consumption and crankcase dilution. Other points to check at the time of servicing the carburetor are the tension of the foot-accelerator spring and the setting of the fast idle. On some carburetors, the fast-idle mechanism requires no adjustment, but on others there is a recommended clearance between the throttle-lever adjusting screw and its bearing point, usually a dimple on the carburetor casting. A weak spring on the carburetor permits movement of the pedal when driving over rough roads or pavement and causes the accelerator to discharge excess fuel into the air stream at the carburetor venturi. This defect should be eliminated by renewal of the spring. Occasionally, this defect alone accounts for unusually low gas mileage and unsatisfactory operation of the engine.

Fuel-pump vacuum booster: Three views of a combination fuel-pump vacuum booster are illustrated on page 10. The booster serves to increase the vacuum needed to operate the windshield-wiper motor when the engine-manifold vacuum is low, as when the engine is being accelerated rapidly. All fuel pumps, with or without a vacuum booster, have a filter and sediment bowl at the bottom, which collects dirt and other foreign matter. The sediment bowl is easily removed by loosening the bolt that passes through its center. When the bowl is removed for cleaning, the gaskets should be replaced if they are not in good condition.

Operation of a typical fuel-pump vacuum-booster combination can be followed by reference to the lettered sketch illustrated on page 10. Rotation of the camshaft eccentric actuates rocker arm *A*, pivoted at *B*, which pulls link *C* and diaphragm *D* upward against spring pressure *E*. This creates a vacuum in pump chamber *F*. This suction stroke of the pump causes fuel from the tank to enter sediment bowl *H* through inlet *G*. The fuel passes through strainer *I* and enters pump chamber *F*. On the return stroke, spring pressure *E* pushes the diaphragm *D* downward, forcing fuel from chamber *F* through outlet valve *J* and through discharge *K* to the carburetor. When the carburetor bowl is full, the carburetor-float valve is closed, thus setting up a back pressure in pump chamber *F*. This pressure holds diaphragm *D* upward against spring pressure *E*. Thus, the fuel pump is inoperative until the carburetor float valve opens and the back pressure is released. Spring *L* simply serves to keep the rocker arm in constant contact with the camshaft. Hard starting or a "flattening out" of engine speed in highway driving indicates that the fuel pump should be tested.

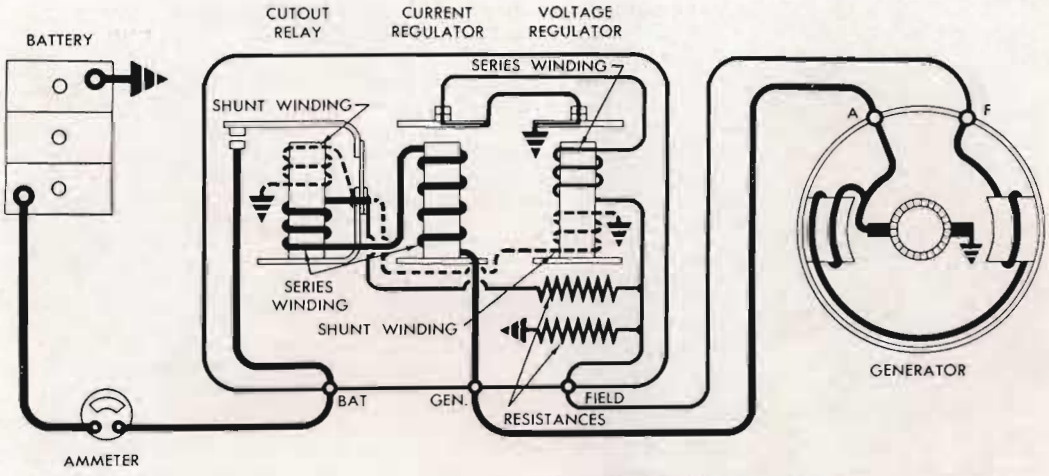
The carburetor receives the fuel from the pump, mixes it with the proper amount of air and distributes the vaporized mixture in the correct proportions to the engine.

An air cleaner, illustrated at left, is clamped to the top of the carburetor.

First remove the oil-bath air cleaner, drain out old oil and wash the container and the filter elements thoroughly. Refill with new oil. Be sure parts are in the proper position

POUR OUT OLD OIL, CLEAN AND REFILL

WASH FILTER IN CLEANING FLUID



To protect the generator from damage, the cutout relay opens the circuit, preventing a reverse flow of current from the battery to the generator. As shown above, the cutout relay has two windings on the same core

Ignition System

A DIAGRAM of the ignition system is shown at the lower right. The ignition system is only a branch of the electrical system. It handles the job of actually firing the fuel charge in the cylinders. The ignition system includes the battery, coil, distributor, condenser, spark plugs and wiring.

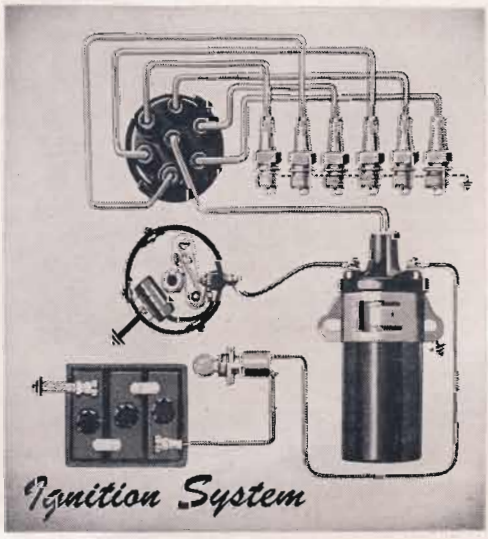
The schematic drawing shown above is the wiring layout for the generator regulator. The regulator gauges the amount of electrical current supplied by the generator. The regulator consists of three instruments—the circuit breaker, current regulator and the voltage regulator. All three instruments are merely relays, two of which—the current and voltage regulator —open and close the generator field circuit. In reality, the circuit breaker is an automatic switch, which opens the generator-charging circuit when the generator is inoperative, or when the voltage output is below that of the battery. This prevents discharging the battery back through the generator.

Cleaning contact points: One of the most important service operations on regulators is cleaning contact points. Dirty or oxidized points arc and burn, cause reduced generator output and run down batteries. If points are properly cleaned, the regulator will be restored to normal operation. If improperly cleaned, improvement in performance will be small and only temporary. Remove the upper contact supports so that each point may be separately cleaned. Use a thin, fine-cut contact file and file each point separately. Do not use the flat file excessively on the rounded (smaller) point. If the flat point has a cavity in it, use a spoon or riffler file to clean out the pit. Reassemble contact supports and adjust air gap. Never use emery cloth or sandpaper to clean the contact points.

Quick checks: Should trouble of any type be suspected in the ignition system, the following quick checks will prove helpful in isolating it.

If the engine will not run even though the starter cranks it at normal speed, remove the lead from a spark plug and hold it about 3/16 in. from the engine block while

Parts of ignition system which handle the job of actually firing the fuel charge in the engine cylinders



Regulator and generator frames connected together with copper wire determine poor ground condition

the starter is cranking the engine. *Be careful not to touch the metallic connections on the lead.* If a good spark occurs, the primary and secondary circuits can be considered okay. The trouble then should be hunted in the spark plugs, timing, or the centrifugal and vacuum-advance assemblies. Quite often the difficulty will be found outside the ignition system.

If, however, the difficulty is found to be in the ignition system, it's a matter of eliminating the most likely causes of the trouble progressively. Suppose, for example, you had a spark at the distributor breaker points, but none at the plugs. The trouble is probably a damaged rotor. The spring contact may be broken or worn so that it doesn't touch the center contact in the cap. Sometimes a temporary repair can be made by binding a piece of tin or other thin metal to the rotor to carry current from the center contact through the rotor. Don't overlook the possibility of a loose ground on the condenser, which should be tightened.

To make sure about the coil, remove the "hot" primary wire from it and rub the end against an unpainted metal part of the car. There should be some indication of sparking. If there is sparking, and the connections in the distributor are tight and in good condition, the trouble is likely a dead coil, which will have to be replaced. If you did not get sparking at the end of the primary wire, the trouble is between the coil and the battery. Trace the circuit, tightening all connections as you progress. Likely you will find a loose connection or a broken wire, but don't overlook the possibility of trouble in the ignition switch. Be sure the ignition switch is on when making the tests on any parts in the ignition system.

In making periodic checks to avoid engine failure, consider the following at least twice a year:

Spark Plugs

1. Clean, inside and outside
2. Look for cracks in the porcelain
3. Adjust points to recommended setting

Distributor

1. Clean, inside and outside
2. Clean, terminal sockets in cap and metal contacts on wire ends
3. Inspect for cracks in cap and body
4. Adjust breaker-point gap. Replace points if necessary
5. Replace frayed or swollen wiring
6. Test condenser and tighten connections
7. (Monthly) Oil drive shaft and wick under rotor. Smear a trace of petrolatum on cam face
8. Check breaker-spring tension and condition of fiber bumper on breaker arm
9. Inspect rotor contacts for burning or wear. Also, inspect metal inserts which distribute current to spark-plug wires
10. Have timing and various timing controls checked

Coil

1. Clean and tighten connections
2. Test for condition

Battery

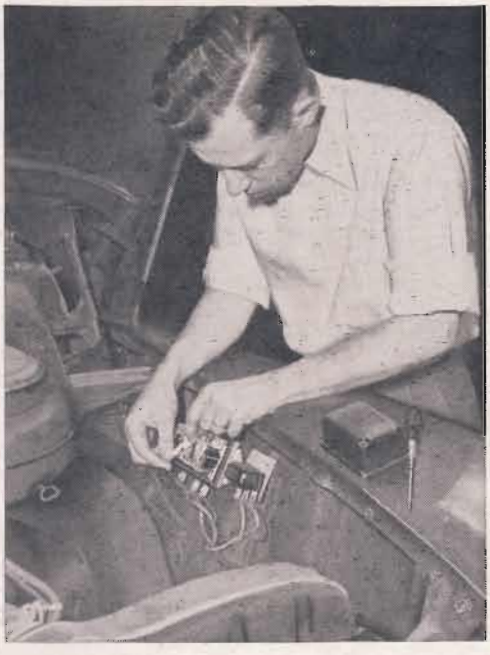
1. Clean surface. Grease terminals
2. Clean and inspect ground strap and starter lead
3. Check gravity and water level

Instrument Panel and Wiring

1. See that all gauges work properly
2. Check wiring under dash for loose connections and frayed or broken insulation

Renewing auto-wiring insulation: In older cars where the insulation on the wiring

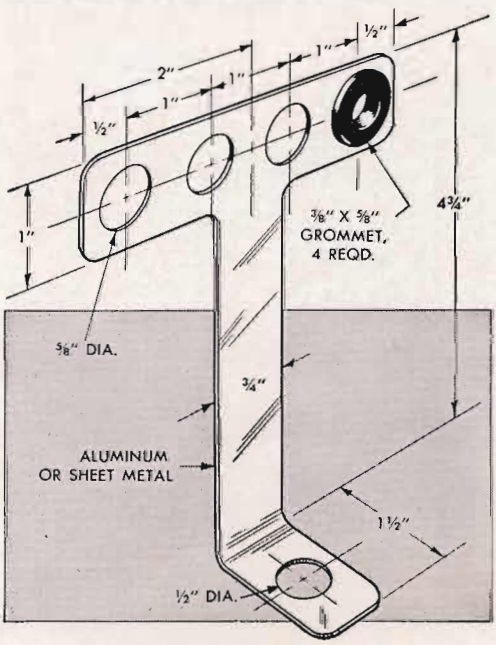
The generator regulator controls the flow of current (amperes) and the voltage produced by the generator



has become worn and frayed, grounds and short circuits are likely to occur along with the ever-present possibility of fire. Low-voltage wires leading to the lights, horns and other accessories can be reinsulated with friction tape and a coat of lacquer. Trace each wire individually from the accessory to the point where it enters a sheathed cable, or loom, inspecting the wire with special care under the metal clips which fasten it to the car body. If the insulation at the cable is doubtful, remove as much of the sheathing as necessary. Then, tape the wire tightly, using a long spiral and overlapping each turn about one third its width. When all the leads have been taped, coat them with clear lacquer. Tape the opened end of the cable, secure loose wires to other leads or a firm support and tape them together. Finally, apply lacquer to all taped joints to seal the tape and prevent its coming loose because of wear.

Installing spark plugs: When installing new or cleaned spark plugs, proper dissipation of heat through the plugs can usually be assured by following these simple rules. First, clean the threads of the plugs and those in the cylinder head, being sure to remove all accumulation of carbon. Always use new gaskets and take care that they are not seated in a "cocked" position. To avoid this, place a small amount of grease on each gasket to make it adhere to the body of the plug, and then start the latter with your fingers. If plugs cannot be turned all the way in without the aid of a wrench, apply a small amount of oil to the threads. Finish tightening the plugs with a torque wrench to the value specified by the manufacturer of the plugs.

Current leakage is cut down and engine missing is reduced if spark-plug wire holder is made with metal



If low beam burns out, tilt both headlights downward so high beams will serve as low beams, shown above

Starting the car easier: Not being able to start your car on a miserably cold, wet day is a disheartening experience that may be prevented by a few simple preventive measures. Dirt on spark-plug porcelains absorbs moisture which causes the plugs to short. Wash all the spark-plug porcelains with alcohol, then wipe dry. Scrub gasoline over the irregular shape of the distributor cap with a clean paintbrush, using enough gasoline to flush away the dirt. Leave the cap on the distributor so gasoline does not drain through the distributor into the crankcase oil. Brush gasoline inside the distributor cap, holding the cap away from the distributor. Wipe each spark-plug and ignition wire with a rag saturated with gasoline, then dry the wires with a cloth to remove loosened dirt. To insure ease of starting and economical performance, replace any wires on which the insulation is rotted, as it will absorb moisture and cause trouble.

No possible cause for leakage of current should exist. A single strand of fine wire projecting from a flexible cable will be enough to cause a short circuit.

All connections must be bright and clean because dirty conections will add resistance. Binding posts, screws and the ends of the wire must be scraped clean before the wire is attached. This is very important in low-voltage wiring.

Starter

All passenger-car starters are much the same in general design and operation, differing mainly in the type of drive used.

When a starting motor fails to crank the engine properly, the trouble will most commonly be found not in the motor itself, but in the starter gear, or in the external circuits. If closing the starter switch puts the lights out, and releasing it causes them to come on again, the fault is likely to be a corroded or loose connection at the battery. You can tell by closing the switch for 20 sec. and then feeling the battery terminals. The faulty one will be very warm. The cure is to remove the terminal, scrape it bright and coat it with petroleum jelly.

If the lights merely dim when the switch is closed and brighten after release, the battery usually will be found partially discharged or in poor condition. But, should pressing the starter switch have no effect on the lights, there is an open circuit in the wiring.

Failure of the starter to make any effort to turn is frequently due to a bad contact within the switch. Removing the switch and filing the contact will generally correct such condition.

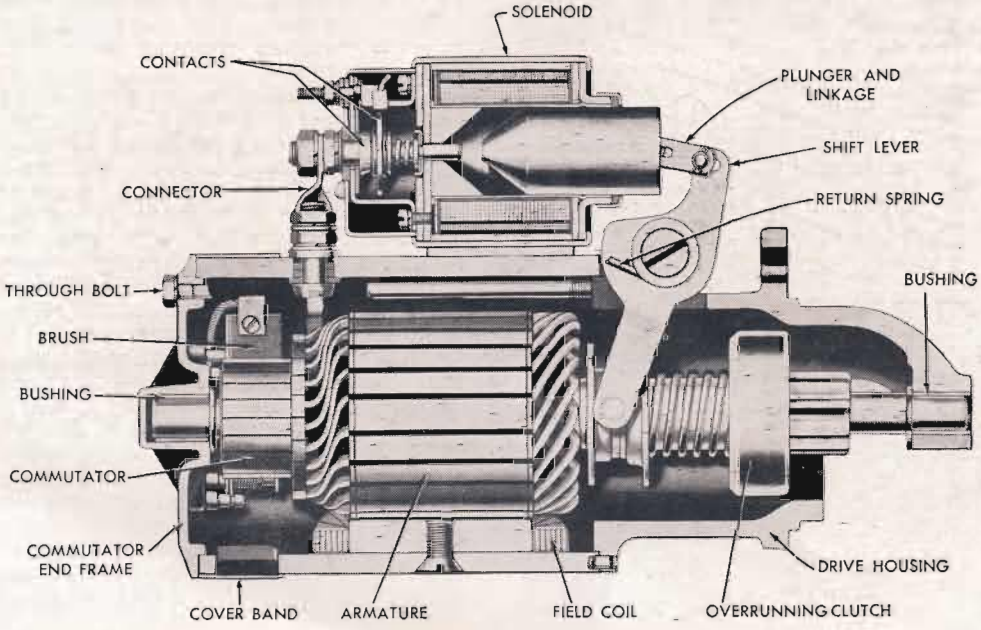
Should dimming of the lights result when the starter button is pressed and the battery is known to be fully charged, the trouble is likely caused by excessively heavy oil on a very cold day, mechanical jamming of the starter drive so that the starter cannot turn, or a ground or short within the starter or switch. A short or ground will generally reveal its location by smoking when the switch is held down for 20 sec. Trouble within the starter generally can be located by visual inspection. A charred brush lead indicates that it was grounded when squeezed under the commutator cover. Look at all insulation for charred conditions that would indicate "shorts" or grounds. A test light should be used to check armature, field and brush ring for grounds also.

It is not unusual for starters to be very weak and to draw too little current. This is commonly due to worn brushes, worn commutator and weak brush springs.

Probably the most common starter trouble is worn brushes. And when replacing brushes don't check for size alone. Be sure that the replacement brush is a real starter brush. Generator brushes are primarily carbon and have relatively high resistance. Starter brushes, however, contain a high percentage of copper or bronze, and when they are scraped lightly with a screwdriver they will show a coppery color.

The brushes should not bind and must rest on the commutator with sufficient tension to give good, firm contact. If brushes are worn down to half their original length, they should be replaced. New brushes should be grooved to fit the commutator.

Sectional view of a typical modern passenger-car starter. Purpose of the drive mechanism is to transmit cranking power to the engine flywheel and to disconnect starter from flywheel after the engine has started



Generator

The generator is one of the hardest working units of the electrical system. It requires regular checking and maintenance to keep it operating efficiently. The view below is that of a typical passenger-car generator. It is a shunt-type generator having two magnetic poles and two brushes.

Generators should be given the following six-point inspection and lubrication every 5000 miles:

Step 1—Check the belt for tension and the mounting and pulley nut for tightness.

Step 2—Be sure that the connections at the terminals are tight and the leads in good condition.

Step 3—Check the cover band for thrown solder. This is evidence that the generator has been overloaded, and if detected before the armature is too badly damaged, the leads simply can be resoldered to the riser bars. Of course, the trouble which caused the overloading must be located and repaired immediately.

Step 4—Clean the commutator. A slight coating of gum or dirt can be removed by holding a strip of 0/0 sandpaper against it with a small stick while the commutator rotates in the generator. Do not use a degreasing or cleaning compound. If the commutator is worn, especially dirty, out of round or has high mica, it should be trued on the lathe. Then, the mica is cut from the slots to a depth of 1/32 in. with a hacksaw blade, and the slots carefully brushed clean of all dust particles.

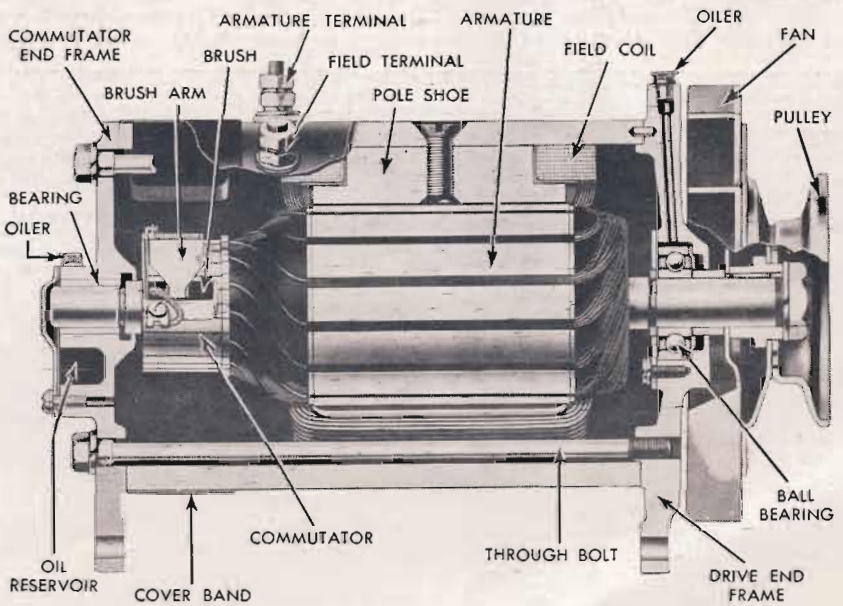
Step 5—Inspect the brushes to make sure they are free in the brush holders and rest against the commutator with sufficient pressure to insure good contact. Replace them if worn to half their original length. Seat new brushes.

Step 6—Apply 8 to 10 drops of medium engine oil to the oilers. Avoid excessive lubrication and be sure that only clean oil is used. Don't lubricate the generator while it is running.

After a generator has been dismantled and repaired it must be repolarized to be sure that it has correct polarity with respect to the battery it is to charge. Failure to do this may result in burned relay contact points, a run-down battery or serious damage to the generator itself. The method of repolarizing depends upon the generator-regulator wiring circuits, which vary with different manufacturers, so the manufacturer's specifications must be followed.

Lubricating the generator: Clean and tighten the generator connections, especially at the cutout, and inspect the brushes. Also see that the contact points on the voltage regulator are clean. Do not over-oil the generator. A drop or two of oil on the bearings every thousand miles is sufficient, as too much lubricant coats the commutator with a film which results in arcing and pitting. This film can be removed from the commutator by merely touching the surface with 0/0 sandpaper while the generator is running.

The generator, supplying current and keeping battery charged, is the hardest-working unit in the electrical system. For this reason, it requires regular checking and maintenance to keep it operating efficiently



Switches

Mechanical switches, with the exception of the direction-signal switch, do not lend themselves to maintenance and repair. Any motorist, however, can insure more trouble-free operation by occasionally checking mechanical switches on his car for loose or corroded contacts and freedom of moving parts. Mechanical stop-light switches which are exposed to road splash, for instance, are especially likely to stick or freeze in the closed position.

Direction-signal switches vary considerably in design and construction. In case of failure or improper operation, such switches should be checked exactly according to the manufacturer's instructions or turned over to an experienced automotive electrician.

The most important adjustment concerning the solenoid switch is correct cranking-motor pinion clearance. To be done right, it must be made with the starter taken off the engine and clamped in a vise. Adjustment of pinion clearance is required whenever the starter has been dismantled and reassembled, or whenever the solenoid has been removed or replaced.

Testing headlight switch: If headlights on a car are dim, even when the battery is fully charged, and it is suspected that there is a voltage drop somewhere in the lighting circuit, here's one way to locate the possible source of trouble. Make a testing instrument by attaching a battery clip to one end of a length of No. 14 insulated wire and a test prod to the other end. When it is dark — or in a darkened space — turn the lights on a screen or white wall. Fasten the clip to the positive terminal and force the prod through the insulation at a point near the light. If the light becomes noticeably brighter, the voltage loss is probably in a switch, which may need replacing. If the lights remain dim, the ground circuit of the headlight connections may be the cause of the trouble and should be checked.

Fuses: If fuses blow mysteriously in your car, the trouble may be due to loose and corroded fuse clips. To correct this, wrap a piece of fine sandpaper around a fuse and rotate it gently in the clips. Then bend the clips inward in order to increase their tension.

Increasing headlight power: If you want more light than usual from the high beams of the sealed-beam headlights, this can be done easily. Connect a jumper from the battery terminal of the foot switch to the low-beam terminal of the dashboard switch. With the jumper in place, the low beam turns on with the dash switch and remains on until the switch is turned off. Thus, when the high beams are turned on with the hi-lo switch, the low beams remain on, adding their strength to the light thrown by the high beams.

Lighting circuit: The lighting circuit almost always starts at the positive side of the ignition and lighting switch and therefore circuits are traced from that point.

Common troubles found in lighting circuits, include open circuits, grounds, short circuits, poor connections, burned-out bulbs and blown fuses.

A few of the specialized mechanical switches built for cars having automatic transmissions. Three switches control accessories and safety devices such as stop lights, neutral safety feature and turn signals

Horns

Should either or both horns become inoperative, or operate only intermittently, a thorough check should be made. First make sure the battery is charged sufficiently to crank the engine. If it is not, it must be recharged before the horn checks and adjustments can be made satisfactorily.

Clean and tighten all connections in the horn wiring circuit, including grounds. Look for frayed insulation or breaks in the wiring. If necessary, check for defective wiring by connecting separate test leads from the horn to the battery.

A loose connection or poor contact at the horn button may cause the horn to operate intermittently. Shunt around the horn button to determine whether there is poor contact at the horn-button switch.

If the above procedures do not locate the source of trouble, check and adjust the horn relay. This entails checking the point opening, the air gap and closing voltage, or low amperage circuit. Checks and adjustments of the air-gap and contact-points openings are made with the battery disconnected.

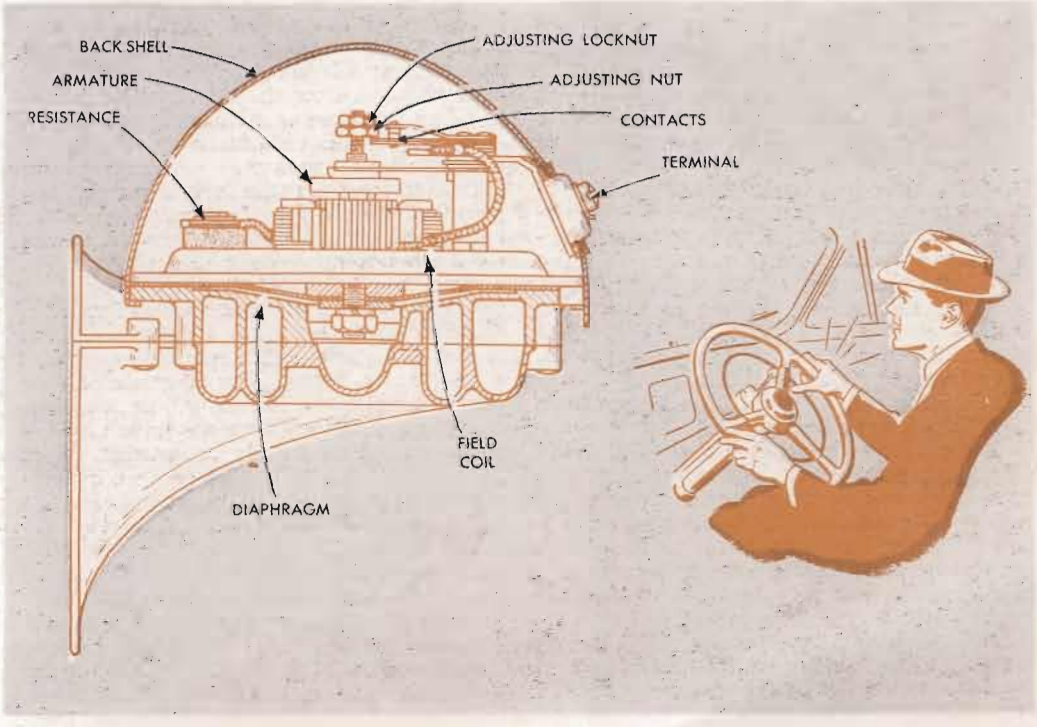
Adjusting a typical, seashell-type electric horn is not difficult. Remove the horn back shell and check for loose or broken wiring or defective soldering. Make sure there is no dirt, metal shavings, or other foreign material in the air gap. Clean the air gap if necessary. Then insert a .007-in. gauge, not more than ¼ in. wide, between the adjustment nut and the contact blade. Loosen the locknut and turn the adjusting nut down until the horn will not blow. Back off the adjusting nut (slightly less than ⅒ turn) and tighten the locknut. See if horn will blow. Repeat this procedure until the horn just barely blows. Then remove the gauge and replace the cover.

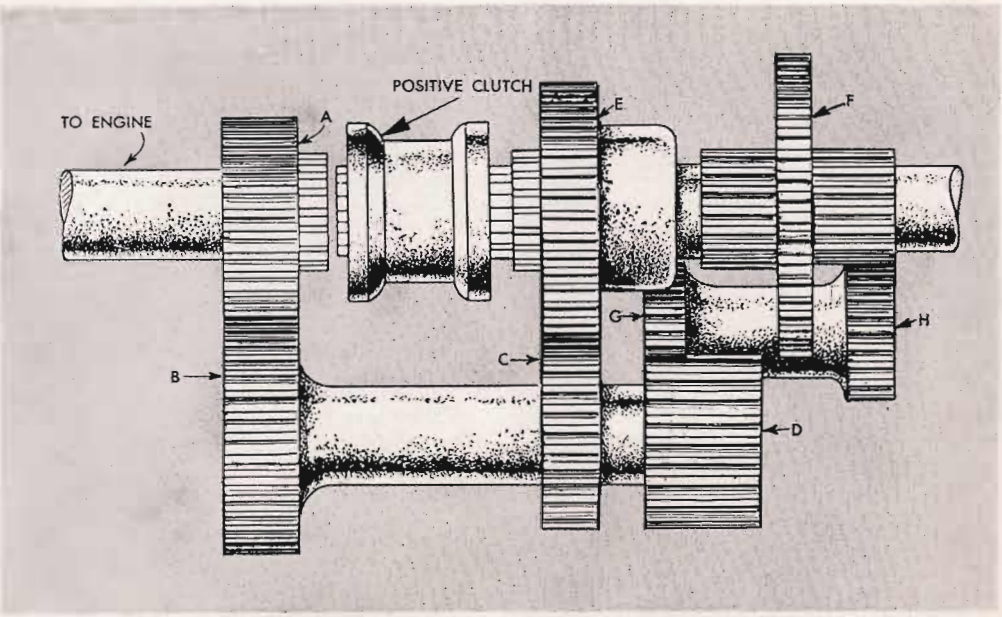
If it is found that a low place has been worn on the adjusting nut where the contact blade vibrates against it, either replace the nut or turn it over so that the worn place is on the top side. Otherwise, the worn portion of the nut may prevent obtaining perfect adjustment.

Occasionally a passenger-car horn gets "stuck" and blows continuously—frequently when the car is unoccupied. In most cases this is caused by a short circuit in the horn button, or the horn-button wiring.

It can be caused, however, by stuck contact points in the horn relay or other maladjustments. In such an emergency, the battery, or "hot," wire should be removed quickly from the center horn-relay terminal to disconnect horn from the battery.

Cutaway view of a horn. The electric horn is similar to an auto starter in that it is designed to operate under a terrific overload for short periods of time. Most horns are tuned to the musical notes E flat and G





Neutral position of gears in constant-mesh transmission. For low, gear *F* slides forward to mesh with *D* and back to *H* for reverse. Positive clutch locks with *E* for second gear, with main and clutch shafts for high gear

Transmission

Anything that causes the transmission gears to clash when shifting them or causes the clutch to grab, throws undue strain on any gears, shafts and bearings throughout the drive system. This causes excessive wear and even breakage of the parts.

Protection of the transmission with a high-quality lubricant is vital in two ways: It reduces wear and prevents excessive clutch spin. Also, "riding" the clutch — keeping your foot on the pedal while driving—causes unnecessary wear. Light contact of the foot brings the throw-out bearing into play and exerts end thrust on the crankshaft, creating end play prematurely. Slightly increased pressure on the pedal contributes to slipping, which wears out the clutch-plate lining and may damage the pressure plate. There is no wear of any kind on the clutch when no pressure is applied on the pedal.

In order to shift gears noiselessly, the engaging gears should be running at approximately the same speed. Even when shifting "synchromesh" transmission, it is desirable to have the parts to be united operating at similar speeds. Therefore, the center disk that turns with the transmission is made as light as possible. This, in conjunction with the predetermined drag of the lubricant, brings the clutch to rest quickly when the foot pedal is depressed. Insufficient lubricant, or lubricant with too light a body, allows free spinning of the clutch, which contributes to wear in several parts and to difficulty in shifting. If lubricant of the proper kind, as recommended by the manufacturer, is kept up to the bottom of the inspection-hole plug located just below the transmission opening, little trouble will be experienced.

When gears have a tendency to slip out of mesh, the cause may be wear or a sprung shifter fork. When the fork is sprung, the gears of the old-type transmission or the synchronizing unit of the modern transmission are not moved far enough to mesh correctly.

Wear in the throwout mechanism of a clutch should be adjusted promptly. If it is not done, the clutch may drag or slip, with the result that gears or synchronizing parts cannot come to rest or will not function properly. Few clutches have any adjustment within the clutch housing. Most adjustments are made by some combination of screw-and-bolt linkage between the pedal and the clutch shaft. A typical example is the adjustment of free travel on a clutch pedal. Here the pin at the lower end of the screw adjustment is removed, and the adjusting clevis screwed in or out as necessary to give the clutch pedal a free travel of about 1 in. before it acts on the clutch mechanism. Lacking this free travel, the throwout bearings will be in continu-

ous operation, causing increased wear, which will result in immediate and serious slipping.

With the demands for quieter operation, engine mountings have been made softer and in some cars the engines are free to move considerably. Sometimes clutch trouble has been stopped by replacing or tightening the engine mountings. In the case of chronic clutch chatter, a general tightening of the chassis often has proved effective. When we realize that the full power of the engine is transmitted through a clutch disk no larger than a dinner plate, it will be appreciated that any jerking resulting from looseness in the drive line can break momentarily the grip of the clutch, and cause a slight slip, which in itself is not serious but causes wear on the clutch facings over a period of time.

Looseness of rear-wheel hubs on axle shafts, or even looseness of the wheels on hubs over a period of time may cause clutch trouble. Also, excessive play between the pinion and ring gear within the rear axle, or between the differential side gears and the axle shafts, may result in trouble often diagnosed as a faulty clutch. And any looseness in the driveshaft, either in its splines or at the universal joint, may be the cause of mysterious clutch difficulty.

The nuts on the clutch fingers seen through the clutch-inspection opening should be adjusted only by manufacturers who have precision fixtures for the purpose. The fingers must be at exactly the same height. When the complete clutch pressure plate is assembled at the factory, all of the ten or more springs and the six or more fingers are checked accurately. In time the springs may become weakened and cause trouble, but if any attempt is made by an inexperienced person to compensate for this condition by adjusting the clutch finger nuts, slipping or grabbing is almost certain, with the result that further damage will be done.

In cars that have a torque-tube drive (tubular housing covering the torque tube between the transmission and rear axle), careless handling of the car may cause clutch trouble. For example, should an owner of such a car back up against a solid object, the impact would be transferred directly to the rear end of the motor, which is the clutch housing. This could cause misalignment between the clutch housing and the flywheel. Often, by tightening one flywheel bolt slightly more than another, this condition can be corrected within reasonable limits.

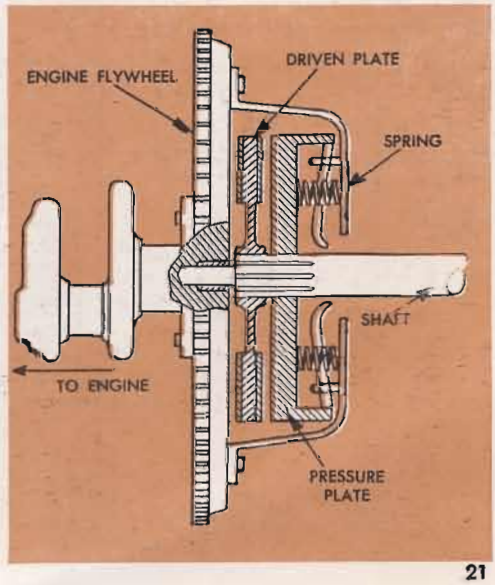
The clutch can also be affected by the faulty use of the choke. The jerky action of an engine that is operating on too rich a mixture, or missing for any other reason, causes strain on the clutch. Another thing that is responsible for clutch difficulty is the use of too light a lubricant in the transmission, or too much of it, with the result that some may work forward onto the clutch and cause slipping or grabbing. A loose rear main bearing in the engine also may cause seepage of excess oil.

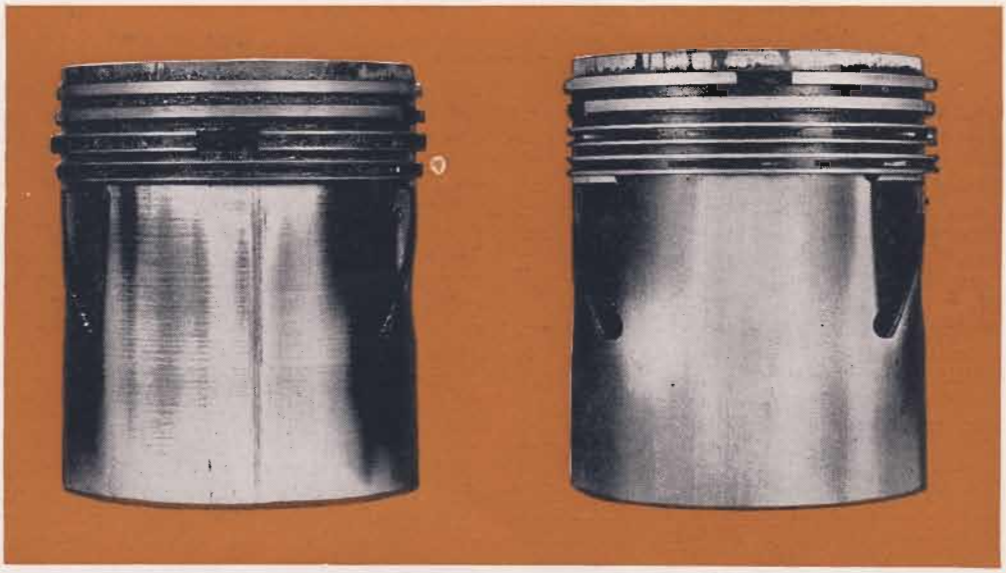
Transmission and engine noises occasionally are confused with rear-axle noise. To best isolate these noises, first observe approximate car speed and condition where supposed rear-axle noise is most pronounced. Then, with the car in a quiet place to avoid interfering noises, and car stationary, hold out the clutch with transmission in high gear and run the engine. Accelerate slowly through engine speeds corresponding to the car speeds at which axle noise was most pronounced and listen for sounds similar to the axle noise. Next, shift gears to neutral and again run engine at various speeds, while slowly letting the clutch engage while listening for idling noises in the transmission.

Difficulty in shifting gears can result from a sticking or dragging clutch caused by heavy oil, burred teeth on the shifting gears or worn bearings that throw the shaft out of line. Gears should be shifted without a particle of noise.

When gears do not stay in mesh, it is usually due to weak or broken springs in the gear-shifting shaft, plunger or lock.

Cross-section drawing of a representative friction clutch used with a manual-shift transmission, shown in the released position. The driven plate has a friction facing on both sides and slides on the splined shaft. When the clutch is engaged, the springs in the pressure plate force it against the flywheel





Actual, unretouched photos of good and bad road-test pistons. Scored and fouled piston at left is result of badly contaminated oil due to infrequent changing. Oil filters are of great help in prolonging oil life

Lubrication

GOOD ENGINE lubrication isn't accomplished by merely adding a quart of oil now and then. Oil in the crankcase becomes contaminated with certain acids and mildly abrasive particles which must be removed at intervals.

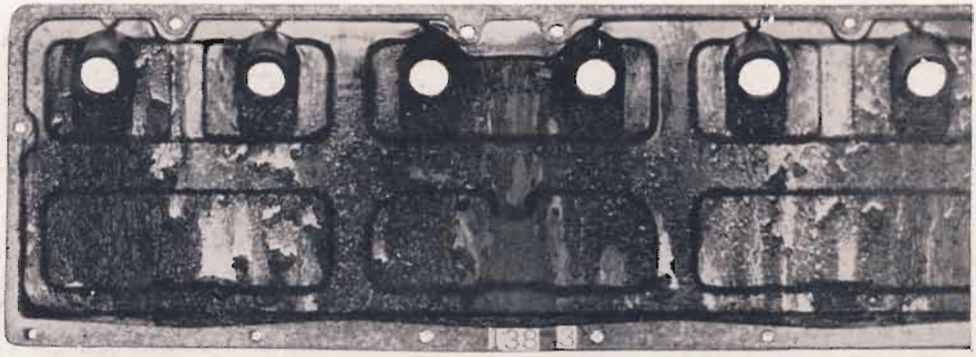
An oil filter does not remove moisture, acid or gasoline. It will remove most solid contaminating and abrasive agents, such as dust, metal and rust particles from the engine, gummy residues from leaded fuels, etc. However, even with an oil filter and a carburetor air cleaner, the oil should be changed at regular intervals, length of the intervals being determined by the operating habits of the driver, distances the car is driven regularly, season of the year and condition of the roads on which the car is operated most of the time.

The deposit-free valve at left shows how clean the valves remain when oil is changed regularly. Dirty, fouled valves at right clearly show the difference

One method often suggested for determining oil-change periods is to test the oil for contamination, especially acid content, at regular intervals over a period of time, and from this data work out an oil-changing schedule for both winter and summer.

A lubricating oil has to perform several separate jobs in protecting the engine from excessive wear. It must lubricate moving parts and reduce friction to a minimum. The oil also acts as a coolant in carrying off heat from the cylinders and the bearings. In addition, it seals engine compression by providing an oil film between the pistons and the cylinder walls. Some oils also act as cleansing agents by removing dirt and carbon from the working parts of the motor.

Always use a high-quality motor oil of the correct viscosity for the particular engine, selecting it according to the type of operation and season of the year. For best results, engine operating temperatures should never be lower than 140 deg. or more



This sludge-covered valve side cover is an example of what happens to an engine when dirty oil is used

than 180 deg. F., and preferably should be between 160 and 180 deg. F. The proper operating temperature is important as it affects the efficiency of the lubricating system.

Poor crankcase ventilation, especially in a cold-running engine, will cause extra condensation of water in the crankcase. Short runs in cold weather aggravate this condition. Check and clean the crankcase ventilator openings at regular intervals. Wash the filler cap in gasoline and then reoil. An efficient oil filter is helpful in maintaining a clean oil supply, provided the filter element is replaced regularly. However, a filter does not eliminate the need for a regular oil drain; it simply permits the extension of time between drainings. Always renew the filter element when changing to a premium grade of oil. An oil that looks clean may contain too much acid and fine abrasives for safe lubrication. Only a complete draining, flushing and oil renewal will provide adequate protection.

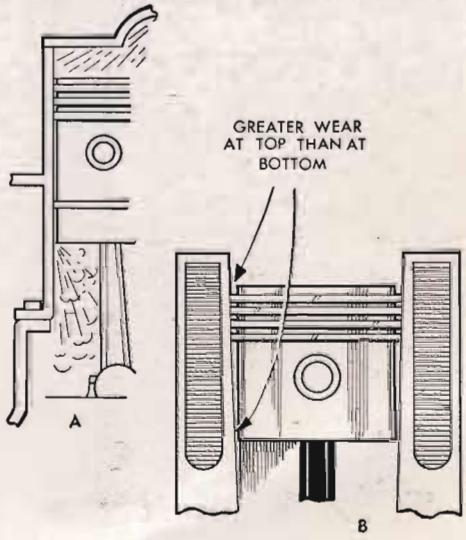
As the cost of a complete oil change is small compared to the yearly bill for gasoline, repairs, storage, etc., it pays to drain and flush the engine oiling system at least twice a year—spring and fall. Without an efficient filter, draining should be done more often. Flush the crankcase at each draining. Use a flushing oil, which has the properties of a light lubricant, to eliminate any danger of the bearings running dry during the flushing process. Always drain the oil when hot and be sure the drain plug is replaced tightly. See that the plug gasket is in good condition. Check the oil level after the engine has run awhile.

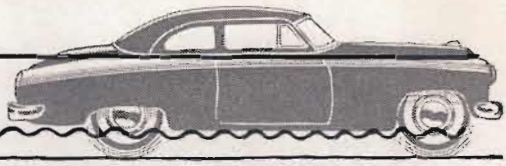
Remember that the filter takes about a quart. When checking the oil level, allow time for the oil to drain back to the crankcase to get an accurate reading. In both new and reconditioned engines, a light-grade lubricating oil should be added to the gasoline for upper-cylinder lubrication. Too heavy an oil may foul the plugs and cause extra deposits of carbon and gum around the valves, pistons, etc.

Generator and starting-motor bearings, if provided with oil cups, require a few drops of light motor oil at regular intervals. Clean the cups before oiling to prevent dirt getting into the bearings. Do not overlubricate. Use a high-temperature grease in the distributor-shaft grease cup, and put a few drops of oil on the felt pad under the rotor. Smear a little grease on the rotating cam face to save wear in the breaker assembly. Water-pump lubrication varies, and some have bearings that do not require lubrication. Use a medium oil in the water-pump oil cups and a special water-pump grease in the grease cups. This grease will resist heat and the dissolving action of water. Do not overlubricate the pump.

Use a small amount of chassis lubricant for engine fans having pressure-type fittings, and a motor oil for those having sump-type lubrication.

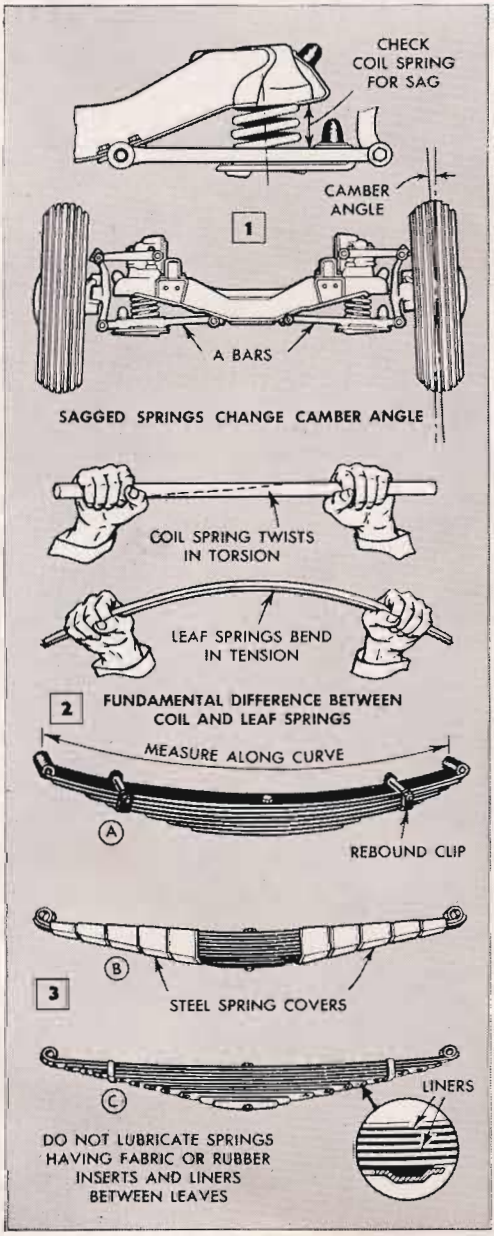
Impurities wash past or blow by the pistons into the crankcase instead of being blown out of exhaust pipe





Regular servicing of springs keeps your car riding like new. Straight-line steering and smooth riding qualities that were built into your car are retained by simple check-ups and the proper use of lubricants

Servicing Springs



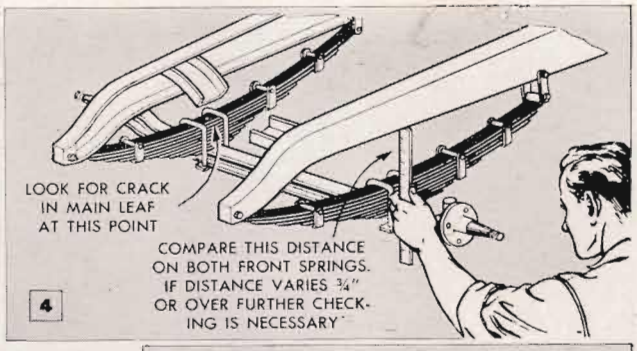
WHEN YOU hit a hole in the pavement or a bump in a side road the shock absorbers snub out the rebound of the car axle. But the springs take the real punishment by preventing the shock from reaching the car frame and body. Even when you're cruising on a smooth highway, the springs soften the ride by constantly flexing to equalize irregularities in the road surface.

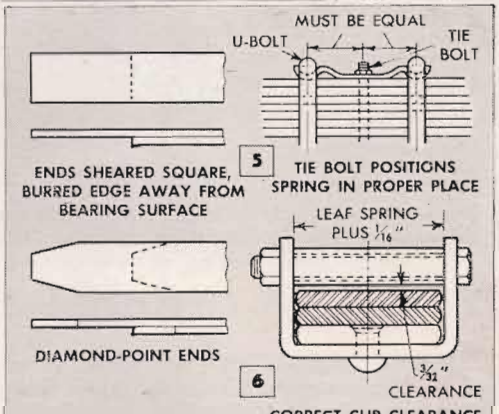
Lack of lubrication can cause rapid wear in leaf springs, and rust and metal fatigue combine to cause a slow loss of "life" in a coil-spring suspension of the type shown in Fig. 1. Under normal load conditions, spring suspensions of this type are designed to operate with the A-bars, or control arms, in an approximately level position. After years of service the springs may weaken and, in effect, shorten slightly under the body load which, of course, remains the same. This changes the normal position of the control arms and, in some cases, may even change the front-wheel camber as in the lower detail in Fig. 1. This condition can cause a serious loss in steering response and it also results in rapid wear on the tires. Often the defect can be corrected by shimming the springs with spacing washers which fit into the retaining caps at the top and bottom ends. However, if body sag is excessive, or if one spring is lower than the other, then both springs should be replaced. On some older cars it will be necessary to check steering and possibly to realign the front wheels after shimming or installing springs. On certain newer cars, coil springs may be shimmed or replaced without changing the wheel alignment. Coil springs are simply torsion bars, upper detail in Fig. 2, and any surface flaws caused by rust will weaken them. To protect coil springs against rust, keep them well painted or coated with any of the rust preventives which are available. The rust preventive also acts as a lubricant and eliminates regular spring lubrication.

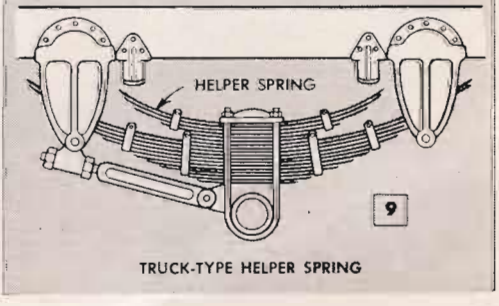
Leaf springs and shackles on nearly all older-model cars and trucks require lubricating at regular intervals. The method of lubricating depends on the type of spring and the provisions made by the manufac-

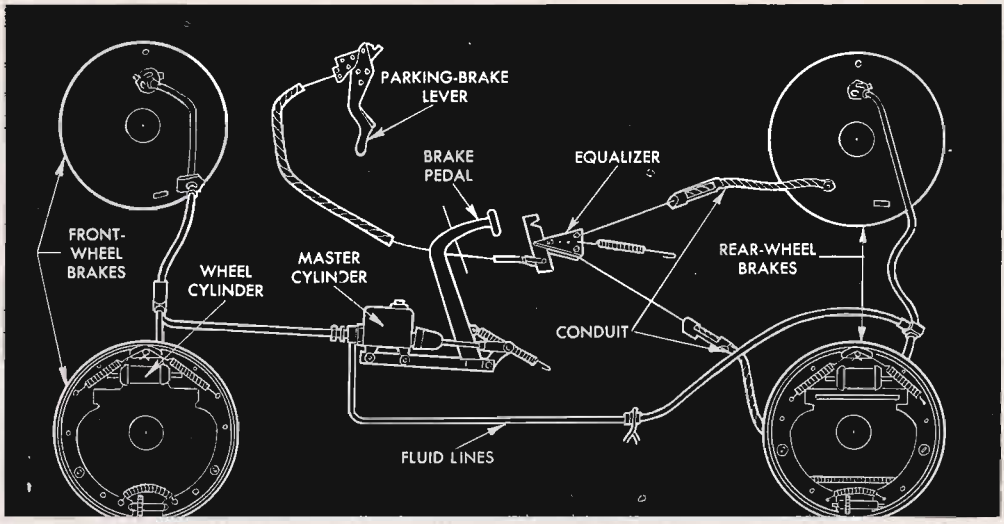
turer for applying lubricant. All leaf springs bend under tension as in the lower detail in Fig. 2 and on nearly all cars more than 10 years old the springs are of the type shown at *A* in Fig. 3, the ends on all the leaves except the top leaf, Fig. 7. On later-model cars, and on some light trucks, the leaf springs either are fitted with steel covers as at *B* in Fig. 3, or are of the nonlubricated type detailed at *C*. On the older-type springs, Fig. 3,*A*, it may be necessary to loosen the rebound clips and pry the leaves apart in order to apply lubricant between the leaves. Whenever such springs are lubricated always make the checks detailed in Figs. 4, 5 and 6. If measurement from the top of the spring to the lower side of the frame varies more than ¾ in., check the low spring carefully for a broken leaf or excessively worn shackle bolts. Renew faulty parts, as otherwise lubrication of the spring may increase leaf deflection and result in breakage of adjacent leaves. If possible, use the lubricant specified by the manufacturer of the car. Otherwise use chassis grease to which a small quantity of powdered graphite has been added, or use penetrating oil. Don't forget to give the spring shackles and spring clips the same care and lubrication.

Lubrication of covered springs is easily done, without removing the metal cover, by the use of the special spring-lubricating fitting detailed in Fig. 8. On some of the late-model cars the need for lubrication of the leaf springs has been eliminated by the use of waxed fabric liners between the adjacent leaves, detail C in Fig. 3. On others, rubber "buttons" are placed under the tips of the spring leaves. The only service required on springs of this type is replacement of worn liners or buttons. This is done by jacking up the car body to take the weight off the springs. Then the leaves are pried apart with a screwdriver or a special spring-spreading tool, and the worn liners or buttons are removed from the depressions in the leaf tips and replaced. On some liners, only the worn ends are renewed. This is done by wedging the leaves apart and cutting off the worn portion of the liner with a hacksaw blade. Replace with new end sections of liner fabric. When the rebound clips are removed for any reason, be especially careful when replacing them to see that they fit with the correct clearance, Figs. 5, 6 and 9. This clearance is important as it allows the main leaf to twist when the car or truck is driven diagonally across a low culvert or onto a ramp.









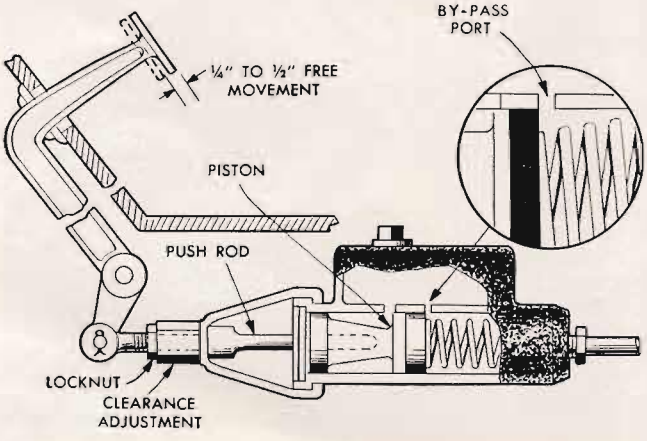
Most cars are equipped with hydraulic brakes. Pressure to operate these brakes is stored in a master cylinder which is mounted under floor of the car and connected to the brake pedal by means of mechanical linkage

Brake Servicing

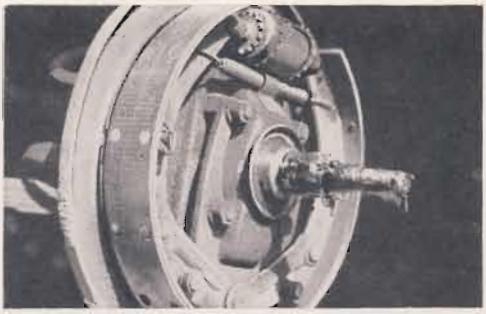
YOU CAN INSPECT the linings on your car in five minutes. You can reline any brakes in a short time for a fraction of the cost of a reline job and save yourself the inconvenience of being without the use of the car for a day or more. Jack up a front wheel and remove the wheel and then the drum. On new linings, the rivet heads are in countersunk holes and if the linings are worn down within less than 1/32 in. of the rivet heads, that's your cue. If wear continues, the rivetheads will score the contact surfaces of the drums.

Brakes vary as to the location of springs, anchor bolts and methods of adjusting the shoes, but the basic principles are the same. Because the application of brakes generates much heat, the bands are usually lined with asbestos friction lining. Before tackling the relining job, the first thing to do is to check the toeboard clearance of the brake pedal, as shown below. It will be noted the specification calls for ¼ to ½ in. of free travel of the pedal, but manufacturer's instructions vary on this adjustment. It's a good idea to consult the instruction book for the recommended pedal movement and also for detailed directions on making the clearance adjustment near the end of the push rod on the master cylinder. Instruction manuals usually will direct you to loosen the locknut and turn the yoke until the required clearance is obtained.

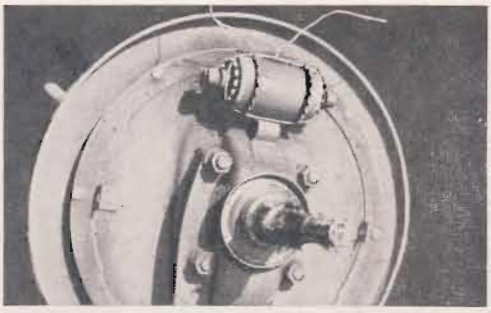
Free movement of the brake pedal will vary on different cars, but in most cases, as shown below, the specification calls for ¼ to ½ in.



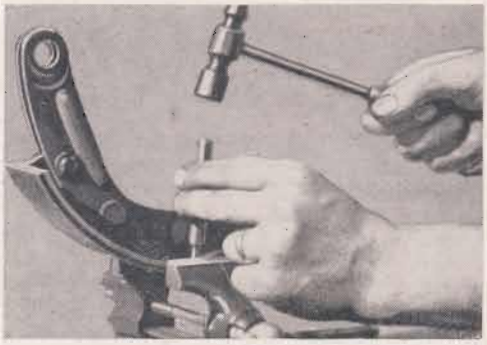
Now, you'll need a complete relining kit, which includes linings for your car and the necessary rivets, a holder fixture for the combination knockout punch and clincher tool, brake-spring pliers and a bleeder hose. With these parts at hand, block the rear wheels securely and jack up the front end of the car so that the front wheels clear. Then remove hub caps, grease cups, cotter pins, spindle nuts and the outer wheel



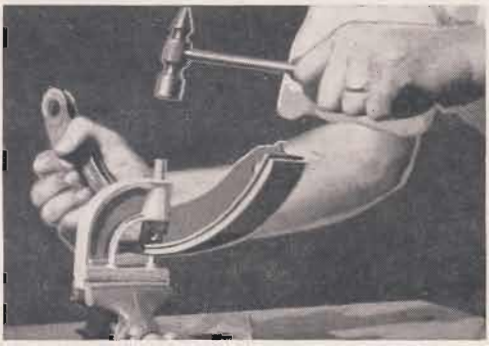
This brake band needs a reline job although lining is not yet worn badly enough to permit the rivet-heads to mar the contact surface of the brake drum



Unless the brakes are provided with piston stops, be sure to wrap a piece of fine wire around the pistons in the retracted position before removing shoes



To remove brake lining, place the shoe in a vise and, using a punch, knock out rivets that hold the lining

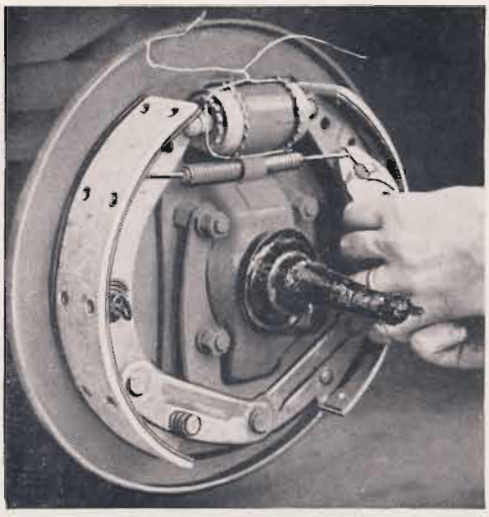


When replacing the new brake lining, begin riveting at the center of the shoe and work toward the ends

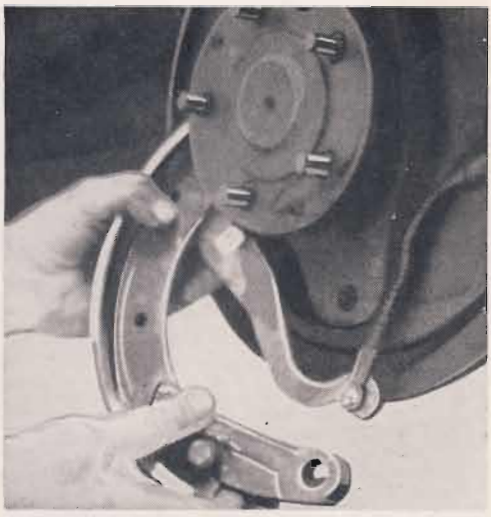
bearings. Pull the wheels from the spindles. Before removing any parts from the brake assembly, upper left-hand photo, wrap a piece of fine wire around the hydraulic brake cylinder, as in the photo at the right, and twist it tight. On some brakes, piston stops are provided, making the wires unnecessary. In most brake assemblies, removal of the retracting springs and anchor pins will release the brake shoes. Keep the parts in order so that you can reassemble them correctly. To remove the worn lining, place the shoe in a vise and knock out the rivets with a punch, as shown in the lower left-hand photo. Be careful not to enlarge or indent the rivet holes in this process. After the old lining has been removed, clean the face of the shoe thoroughly. One lining of each individual set will be marked "forward" and the other "reverse." It is necessary to make sure that you rivet the lining marked "forward" on the forward shoe and the reverse lining on the reverse shoe. These are sometimes referred to as primary and secondary linings. Before riveting, check the alignment of the holes in the lining with those in the shoe. Now place the holder fixture in the vise, as in the lower right-hand photo, insert a rivet in one of the center holes through the lining and place the head of the rivet over the fixture anvil as illustrated. Clinch the rivet tightly by striking the clincher with a hammer. Then turn the shoe and insert the second rivet in a hole opposite the first. Clinch as before, then work outward toward the ends of the shoe, proceeding in the same manner until all rivets have been inserted and clinched. Apply the lining to the second shoe in the same manner. To avoid a mix-up in the right and left forward and reverse shoe it's a good idea to reassemble them on the brake unit from which they were removed as soon as you finish relining each one. Note that the forward lining is shorter than the reverse lining. After replacing the relined shoes in both front brake units, replace the retracting springs, as shown in the upper left-hand photo on the following page, and remove the wire holding the pistons in the wheel cylinder.

Now, turn the adjusting screw all the way in to retract the shoes so that the drum will slide over them. The adjusting screws, usually fitted with star wheels, are turned with an ordinary screwdriver inserted through a port in the backing plate. Generally it is possible to turn the star wheels by hand when the brake drum has been removed.

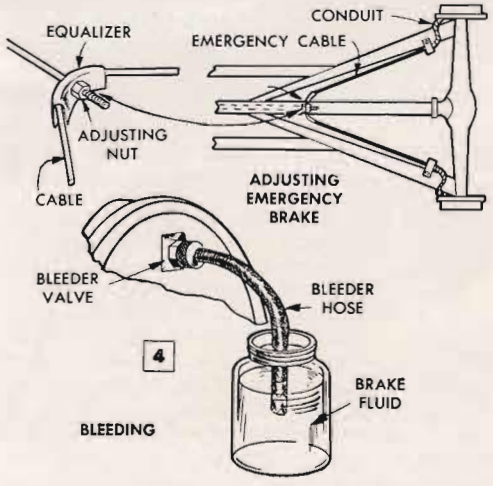
Replace bearings, drums, washers, castle



After relining the shoes, replace them in the same order as they were removed. Replace the retracting springs and don't forget to remove wire from cylinder



Cable-operated emergency brakes should be checked for free movement of the cables before relined shoes are replaced. Note point of linkage on backing plate



Adjust the emergency brake and check brake-pedal action to see whether air has to be bled from system

nuts, cotter pins, grease caps and the wheels and hub caps. If grease has been wiped off the wheel spindles it will be necessary to replenish the lubricant, using the type specified by the manufacturer of the car. Adjust the relined brakes by turning each adjusting star wheel until both shoes drag uniformly. This can be determined by turning the road wheel in opposite directions. Then back off the adjustment until the shoes just release the wheel and permit it to turn freely. Relined brakes should always be adjusted a second time after a short period of use.

Now, block the front wheels and jack up the rear axle so that the wheels clear. Remove the wheels and then take off the drums with a puller. Then remove the brake shoes and wire the wheel cylinder, if necessary. If your car has a cable-operated emergency brake, disconnect the cable from the rear shoes, as shown in the upper right-hand photo. Reline the shoes in the same manner as the front shoes but, before reassembling them, have a helper tighten the emergency-brake lever. If both cables move uniformly, the linkage is probably in good working order.

After reassembling the shoes, drums and wheels, adjust the road brakes as before. Then adjust the emergency brakes, tightening the adjustment until the shoes drag, and backing off the adjustment until the wheels turn freely, as shown in illustration at left. After all adjustments have been made, try the brake pedal. It should take up firmly after passing the clearance point of free movement. If the pedal feels soft, or spongy, it will be necessary to bleed the air out of the system. Bleeding is done on each brake unit, shown in the illustration. First, fill the master cylinder with brake fluid, attach the bleeder hose to the bleeder valve at the top of the backing plate and insert the other end of the hose in a glass jar half filled with brake fluid. Then open the bleeder valve about ½ turn. Have a helper pump the brake pedal several times, until bubbles no longer appear on the surface of the fluid in the jar. Then close the valve and remove the hose. Repeat on the other three brake units.

On cars having Bendix or Lockheed brake units, it is necessary to use a special shock-type puller to remove drums.

Tires

If you drive a car, of course, there'll be a time when you will wish you knew how to repair a tire. It's really no trick to dismount, repair and remount a tire on a drop-center rim. Remember to keep the necessary tools and tire-repair equipment in the car at all times. You'll need a jack, tire irons, air pump and a tire-patch kit. The kit consists of various sizes of rubber patches, scraper and rubber cement. The kit patches will take care of small punctures and slow leaks.

First of all when you get a "flat" be sure to pull clear off the road so you won't be a hazard to traffic. Block the wheels and set the emergency brake to keep the car from rolling off the jack. Make sure the jack is on a good solid base and raise the one end of the axle so the tire clears the ground. Remove the nuts that hold the wheel onto the brake drum and then slip off wheel assembly from the axle.

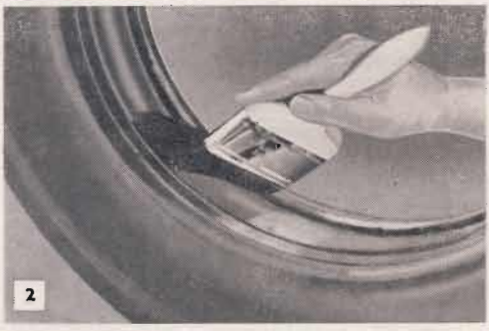
Lay the wheel flat on the ground. The inner tube should be deflated as low as possible. This is accomplished by pressing on the valve stem with a pointed tool or by removing the valve core, using the slotted end of the valve cap, as shown in Fig. 1. Loosen the beads on both sides of the tire by inserting a tire tool under the edge of the rim and exerting downward pressure to force the bead into the drop center. Pry one bead over the flange, using two tire tools alternately. At this point make certain that the valve body has been pressed out of the hole in the rim. Turn the wheel over and force the other bead off the rim. Remove the flap covering the tube and then pull the tube out of the casing.

When the inner tube is punctured, but the casing practically uninjured, as in the case of puncture by a nail or tack, satisfy yourself that the tack or nail is not sticking in the casing.

A hole caused by a nail or tack can be

1

The first step when removing a tire from the rim is to deflate tube completely by removing the valve core

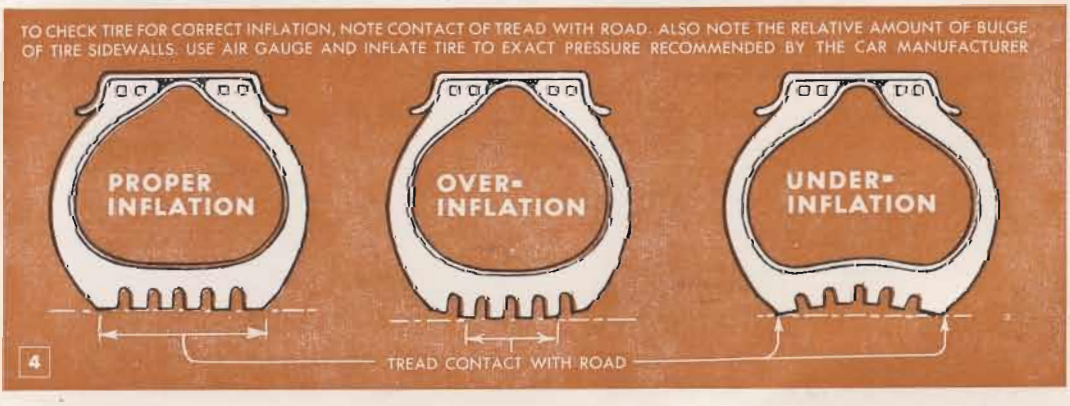


2

Before remounting the tire, lubricate the beads with a vegetable-oil soap. Do not use oil or cup grease

3

After the tire is fitted on the rim, inflate the tire to press the beads tightly against the rim flanges

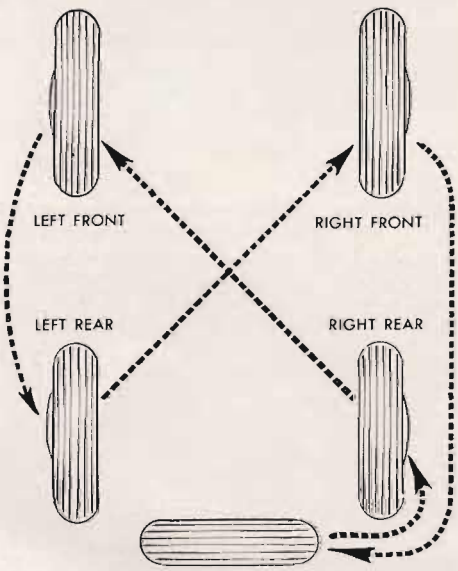


mended with a cold patch that you'll find in the tire-patch kit.

Select a patch of the right size, that is, large enough to extend ¾ in. or an inch beyond the puncture in each direction. Wipe off every trace of moisture and roughen the surface to be patched. To roughen the area use the scraper included in the kit, or a piece of emery paper. Apply two coats of cement to the tube surface and to the patch, removing all superfluous cement with the fingers. The less of it there is, the quicker the repair. Allow the cement to dry for at least five minutes or until it adheres strongly to the fingers. Then apply the patch and press it down firmly making sure the edges are tight. Never try to join two surfaces while they are still damp, for rubber-cement joints are of no value unless everything is dry.

Even though a sound tube has been inserted on the road, the punctured tube should be vulcanized promptly to be ready for another emergency. There is scarcely a limit to the number of repairs a tube will bear, but patches applied with cement cannot safely be considered permanent repairs. It is a paying investment to make vulcanized repairs as soon as possible.

After the repair has been made, inflate the tube slightly and insert it in the casing. Position the tube so that the valve registers with the red dot on the sidewall. Place the casing and tube on the rim and insert the valve body through the hole in the rim. Then force one bead over the rim flange into the drop center. Be careful at this point that the tube is not pinched between the bead and the rim. Then force the other bead over the rim flange with the tire tools. Inflate the tire slowly so that it will center and seat correctly, as shown in Fig. 3. Place the wheel back on the axle and tighten the nuts alternately to enable a safe fit.



TIRES SHOULD BE SWITCHED AT LEAST TWICE A YEAR TO UTILIZE SPARE TIRE AND ALSO TO EVEN UP WEAR BY REVERSING DIRECTION OF ROTATION OF THE TIRES

Fig. 4 shows graphically why proper inflation is of the greatest importance. Always test the tire pressure when the tires are cool. As shown in Fig. 4, overinflation causes rapid wear in the center of the tread. It places excessive strain on both casing beads and sidewalls and lessens the ability of the tire to resist cuts and snags and also breaks due to severe impact. An overinflated tire has less resiliency, and restricted tread contact with the road surface means reduced traction and less resistance to skidding.

On the other hand, underinflation, Fig. 4, is the cause of excessive wear on the shoulders of the tread. When the car is driven at moderately high speeds the tires heat up fast and the excessive bending of the sidewalls at the point where the tread meets the road results in ply separation and rapid breakdown of the sidewalls.

Tires should be switched regularly on the wheels as in the chart shown at the bottom of this page. The condition of brakes, springs and shock absorbers affects tire wear materially. Brakes that grab on application, or lock one wheel, will cause rapid tread wear on the tires that are affected. Keep the brakes correctly adjusted and shock absorbers and springs in good condition.

Driving habits have a direct effect on tire mileage. Fast getaways, fast driving on the turns and squealing stops are especially ruinous to tires. Such practices not only grind rubber off the treads, but place severe strains on the entire structure of the casing and tube. The careful driver avoids bumping or scuffing against curbs when parking, driving rapidly over obstructions and driving at high speeds on rough pavement or unsurfaced roads. All these special precautions must be carried out on schedule if tires are to give maximum service.

Retreading of tires can be recommended as an economical and safe practice when the casing is still in good condition without any major breaks. If the job is correctly done, using good materials, the usable life of the casing can be extended as much as 50 percent. Minor cuts or breaks in the sidewalls and treads usually can be satisfactorily repaired by vulcanizing before the tire is retreaded. Always install a new tube in a retreaded casing, even though the old tube appears to be in serviceable condition.

Body Care

You can keep up the appearance and, in turn, the resale value of your car simply by protecting the body from rust. This may be done in two ways. The first, and preferable, way is to prevent rust by careful attention to the body and to control rust once it starts. The second way is to repair the damage after rust holes have actually appeared. Undercoating the car affords excellent basic protection from rust, and the undercoater can be applied with a brush. Even though you may not wish to do a complete job of undercoating, it is well worthwhile to coat at least the underside of the fender joints and also the areas where impact from road gravel is greatest.

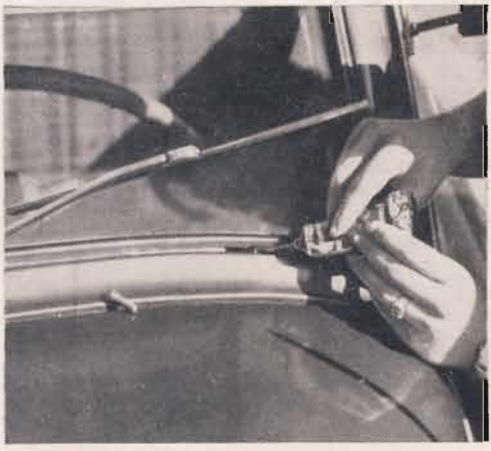
If rust blisters appear in the enamel around the headlights, it is not sufficient to scrape off the blisters and touch up the exposed areas. The damage usually extends under the headlight rim. With the headlight removed, all traces of rust should be sanded from the body, and the bare metal coated with a primer especially made for this purpose. After the primer dries, it is sanded lightly, painted with a matching car finish and then "blended" with rubbing compound.

Sealing any windshield leaks between the glass and the molding provides further protection from rust and also helps to keep the body watertight. Cement for this purpose can be obtained in tubes and is simply applied under the edge of the molding, if the latter is metal, or along the joint formed by the glass and rubber molding. If there is still evidence of leakage, check the fit of the windshield-wiper shafts in their bushings and lubricate them if necessary.

To control rust at the cowl-ventilator drains, check them periodically for clogging and, if required, blow out the drain tube with compressed air. Also, replace a worn ventilator gasket with a new one or cement sponge rubber around the opening.

In addition to keeping the car snug and quiet, weather stripping on the doors prevents water, which enters at the top, from rusting out the door sills. The weather stripping should be replaced when it apparently is no longer serving its purpose. Drain-hole plugs that have not been removed from the underside of the door should be pried loose. If the door is not fitted with drains, punch two or three holes in the bottom edge of the door. Use a sharp punch and work it around the edge of the hole to draw the metal downward, as an edge projecting upward will not permit the water to drain out. Coat the edges of the holes with red lead, working it well up onto the inside surfaces.

Deteriorated weather stripping on all doors can be replaced with sponge rubber to assure a tight seal



Sealing compound packed in tube is easily applied to the joint between windshield glass and molding

Worn floor mats can be repaired by applying patches of mat material with rubber cement used as adhesive

Inside

To prevent rusting of the steel car floor and also the edges around the base of the body, the rubber mat on the floor of the front-seat compartments must be kept in good condition. The mat can be repaired easily by applying patches of mat material with rubber cement. After the patch is cut to shape, it is positioned on the worn mat and outlined with a pencil or chalk. The area of the mat within the outline is cleaned with a wire brush and white gasoline, and after it has dried, both this surface and the back of the patch are covered with a thin, uniform coat of rubber cement. When the cement dries, press the patch to the mat.

Car-door sills which have rusted through can be patched easily. First, the metal around the break is cleaned thoroughly with a wire brush, or with emery cloth and steel wool. Then a cardboard pattern for the sheet-metal patch is made, and this is transferred to a sheet of body steel. The metal can be clamped between strips of hardwood and bent to shape with a mallet. The surface of the car body to be covered and the inside surface of the patch are coated with red lead, and the metal is fastened to the body with self-tapping sheet-metal screws.

Cleaning the interior: You can do most of the job with a vacuum cleaner by attaching the flexible nozzle and giving the rug and upholstery a thorough going over. It will aid the work of the vacuum cleaner if you first brush these parts thoroughly to loosen embedded dirt. Next, go over all the fabric in the interior with mild soap-

Scrub the fabric with a sponge and mild soapsuds. Remove all the lather with a windshield-wiper blade

A thin mixture of drop black and turpentine makes a good dressing for the rubber mats and running boards

suds or a shampoo such as is supplied for this purpose. There also are available rug dyes, fabric finishes, cements and specially prepared materials that renew rubber mats and running boards. However, for coating rubber you also can use a solution of drop black and turpentine. Refinishing kits for the worn steering wheel and window sills come in pressurized containers for use in spraying the finishing material into hard-to-get-at places. Mask adjacent fabric before spraying. Use cement to secure the edges of the rug.

For cleaning cloth upholstery such as plush, velour and mohair which has become dirty from use, wash with soap and warm water. Rub the solution with the nap, not against it. Keep the suds heavy for best results. Rinse the suds with a cloth dipped in clean water and wrung out fairly dry. Wipe with a dry cloth. When the upholstery is dry, give it a light brushing.

Another method is to use clear water and a mixture of ¾ oz. salt and 2 oz. of either grain or wood alcohol. Sponge the material to be cleaned with this mixture.

Removing grease or oil stains: These stains may be removed by an application of a solution of lukewarm water and a mild soap. Any of the approved methods for cleaning woolen cloth may be used on this type of upholstery.

Enamels, lacquers and paints: Use the solvent recommended for thinning the material.

Fruit stains: First scrape off pulp with dull knife and sponge the area with hot water.

Tar: Moisten the spot with carbon tet and work loose with a dull knife or a wide wall scraper.

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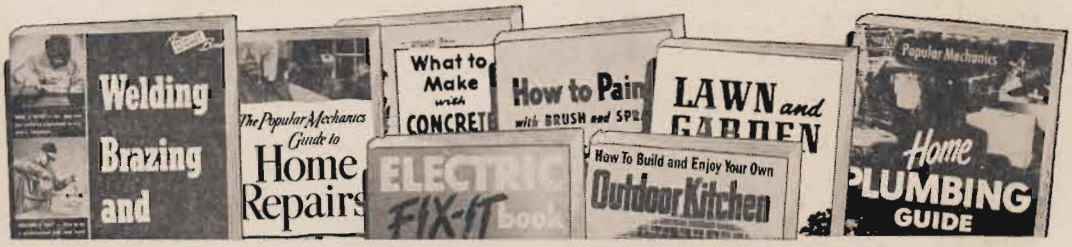

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