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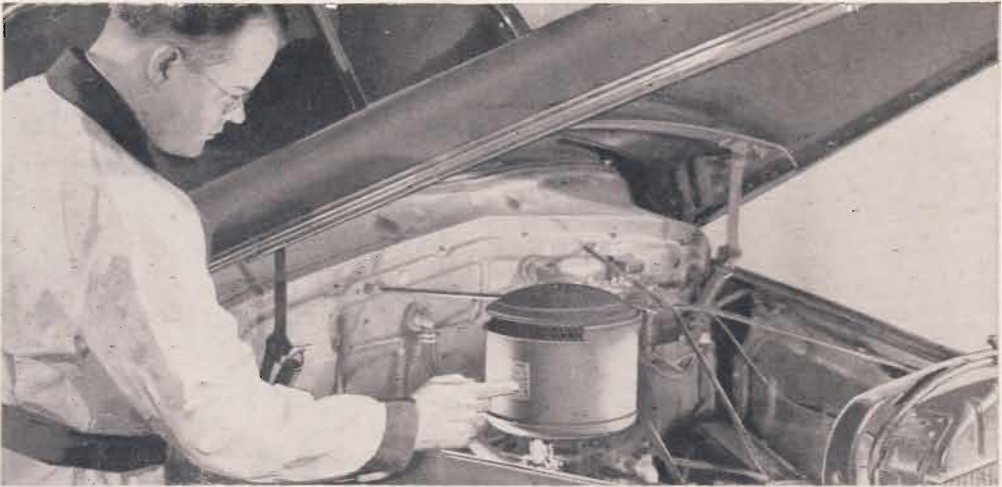
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Periodic engine tune-up is an important item in car care. Regular servicing of the auto engine keeps it in top running condition and results in minimum wear, maximum fuel mileage and greatly reduces repair costs

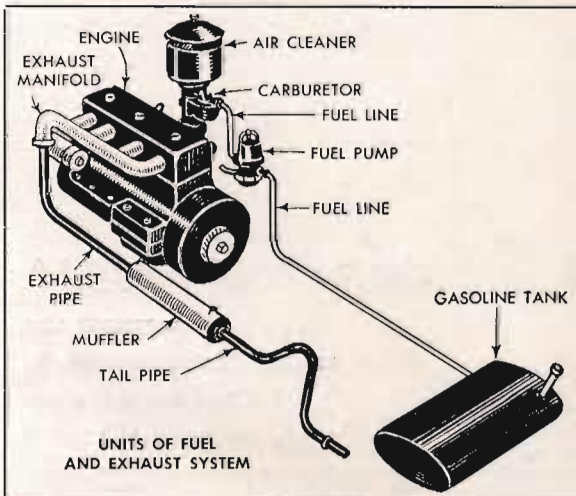
Motor Tune-Up

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

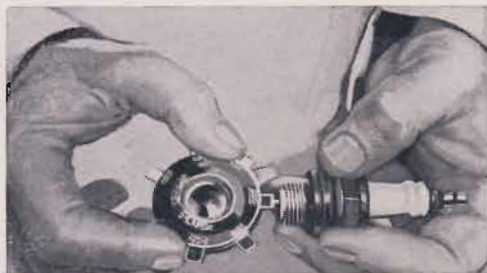
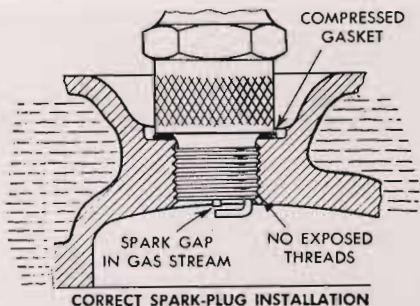
Related parts of the fuel and exhaust system. Gasoline must be vaporized, mixed with air before it can be exploded in cylinder



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.



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.

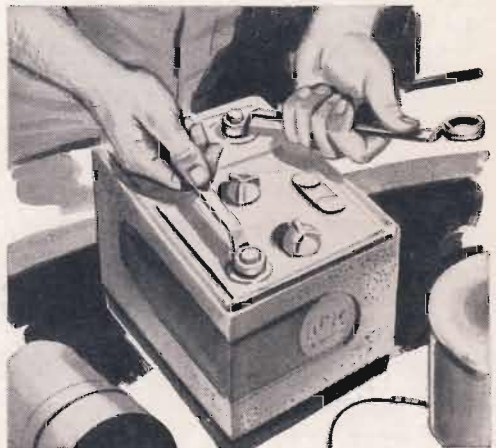
One of the best quick checks of general engine mechanical condition is made with a compression gauge. A variation of more than 10 lbs. pressure between cylinders indicates the presence of mechanical faults which need further investigation. The test always should be made with the engine at operating temperature 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 prob-

ably 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 $\frac{1}{2}$ and $\frac{3}{4}$ 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



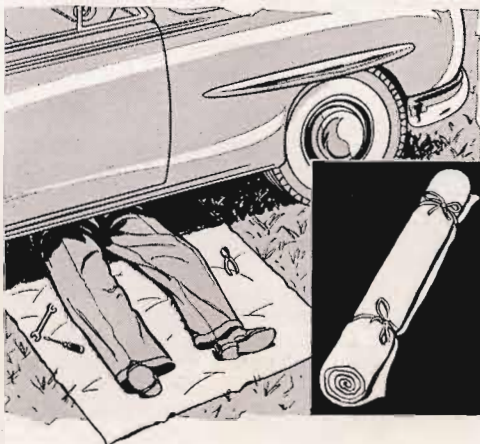
the battery terminals clean and the connections tight and recharge or replace the battery as necessary. The distilled-water level should always be about $\frac{3}{8}$ in. above the top of the battery plates. A fully charged battery cell should have a hydrometer reading of 1.280.

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

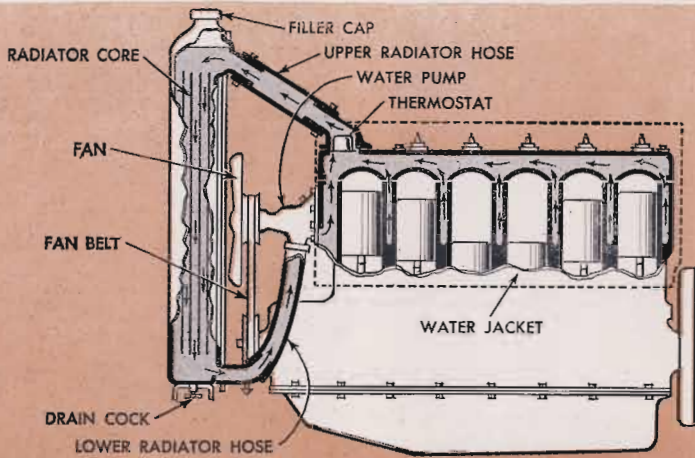
Canvas to protect clothes when doing unexpected repairs can be rolled and stored in trunk compartment



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-trans-

fer 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

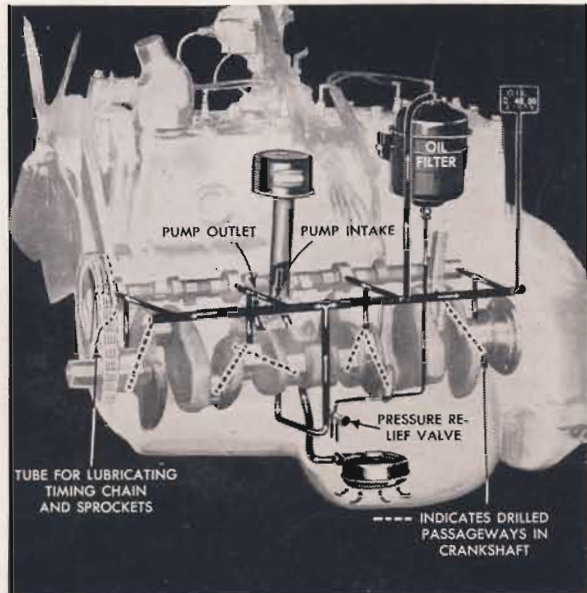


the head overflows. Start the engine and accelerate it 6 or 8 times. If bubbles appear it indicates a combustion leak.

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

