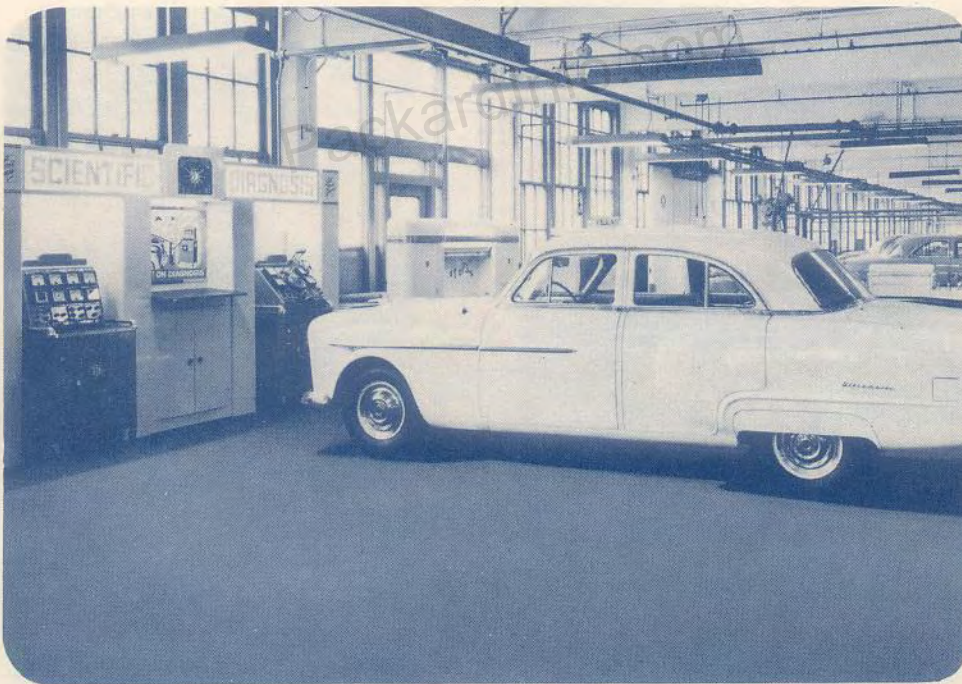




TRAINING PROGRAM

Serviceman's Training Book

SCIENTIFIC DIAGNOSIS



JUNE 1951

PACKARD MOTOR CAR COMPANY

DETROIT 32, MICHIGAN



It has been found in the past where servicemen have resented the idea of diagnosis, believing their guessing was accurate enough. As a result, they were determined not to use instruments, or to belittle the idea of instruments being needed when they believed they knew from experience what service they could sell when the car drove in the service department.



The mechanic would probably locate the cause of the trouble later, either by accident or chance; or he would spend a lot of time experimenting, trying to correct this or that. As a result, either the customer would have to pay for this loss of time, or the mechanic would lose the unproductive time himself.



To protect the mechanic against the loss of unproductive time, and to protect the customer from paying for the guessing and experimentation and for services he did not receive or did not need, the Parts and Service Department of the Packard Motor Car Company has developed the "Scientific Diagnosis" program. This program makes it easy to test and unnecessary to guess.



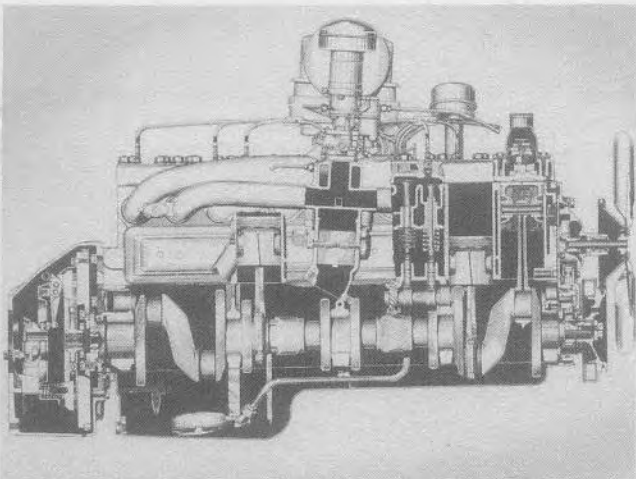
The scientific diagnosis takes the guessing from the service salesman, and trouble hunting from the mechanic. Whenever hydraulic, electrical, or mechanical work is involved, both the dealers' and the customers' interests can best be protected by a scientific diagnosis.



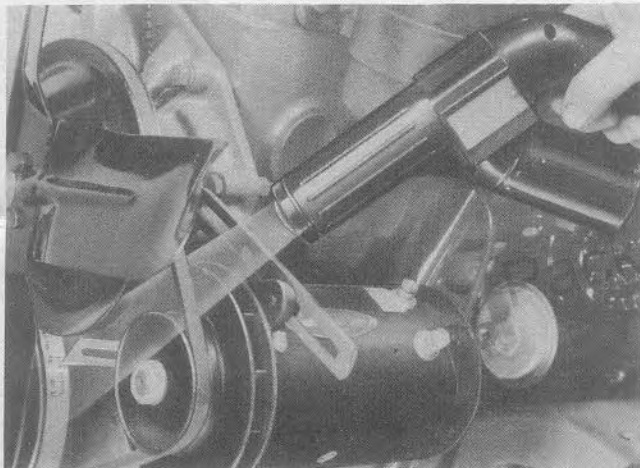
An intelligent repair order stating specifically the needed service operations can only be written after a scientific diagnosis has been performed. The Packard "Scientific Diagnosis" is a group of essential tests arranged in proper sequence so they may be systematically performed, without the loss of time or wasted effort.

To aid the diagnostician so he may perform these tests on actual requirements, the "Scientific Diagnosis" is divided into three parts:

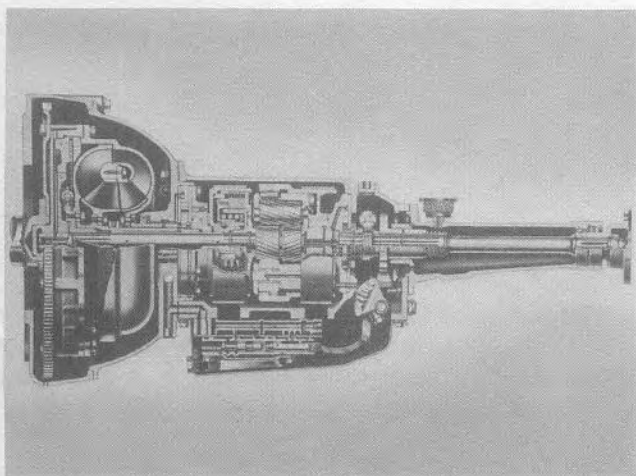
- (1) Engine Diagnosis
- (2) Ultramatic Drive Diagnosis
- (3) Complete Vehicle Diagnosis



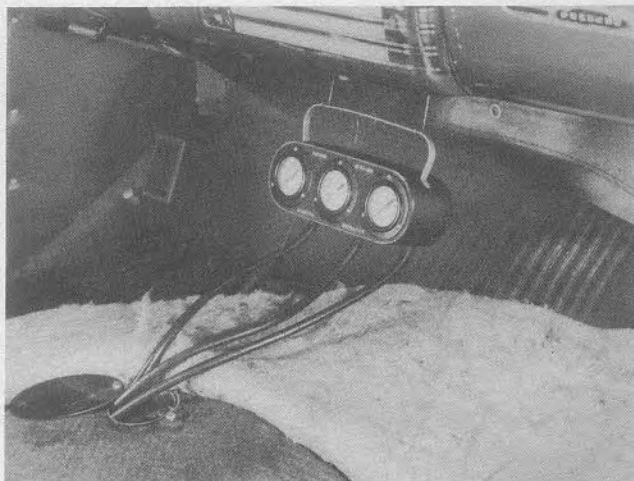
Engine diagnosis is perhaps the most frequently required, because of the precise nature of the Packard engine. Minute changes due to normal usage will affect the compression, ignition, and carburetion systems, which consequently will affect the performance, economy, and dependability of the engine.



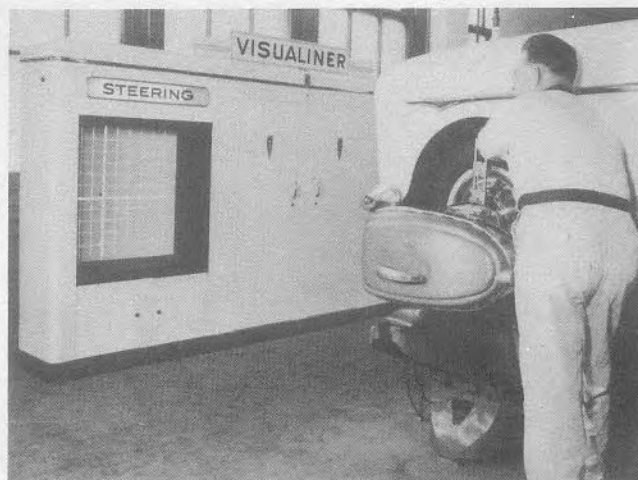
The engine performance can ordinarily be kept at peak efficiency by performing a few necessary minor adjustments. The necessary service operations required can be quickly determined and prescribed after performing an engine diagnosis. It is recommended that an engine diagnosis be performed periodically at 8,000 to 10,000 mile intervals or approximately twice a year.



The design and quality manufacture of the Ultramatic Drive is such that it seldom requires attention under normal usage. However, some units are subjected to abuses, which means they will require service adjustments and maintenance occasionally to keep them in peak operating condition.



It is recommended that the Ultramatic Drive diagnosis be performed periodically on Ultramatic Drive equipped cars at 10,000 to 15,000 miles or at least once a year. The Ultramatic Drive fluid level should be checked regularly at 1,000 mile intervals, and the fluid should be changed at 25,000 mile intervals.

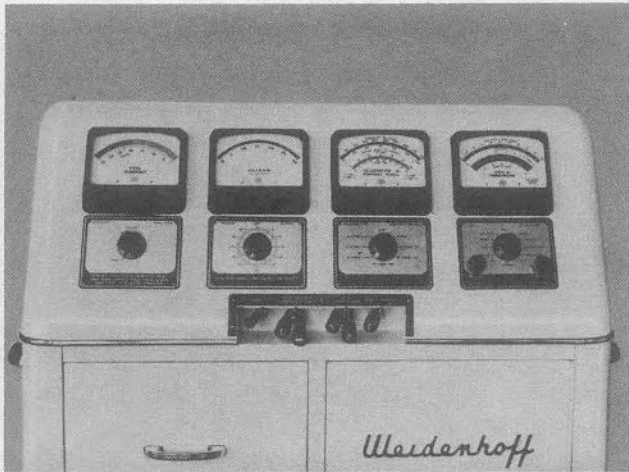


The complete vehicle diagnosis includes, in addition to the engine and Ultramatic Drive diagnosis, the diagnosis and inspection of the front suspension, steering, wheels and tires, brakes, propeller shaft, rear axle, body and sheet metal, and every other unit on the car. It also includes inspection of the lights, controls, and safety signals. It is recommended that the complete vehicle diagnosis be performed periodically at 10,000 to 15,000 mile intervals, or at least once a year.

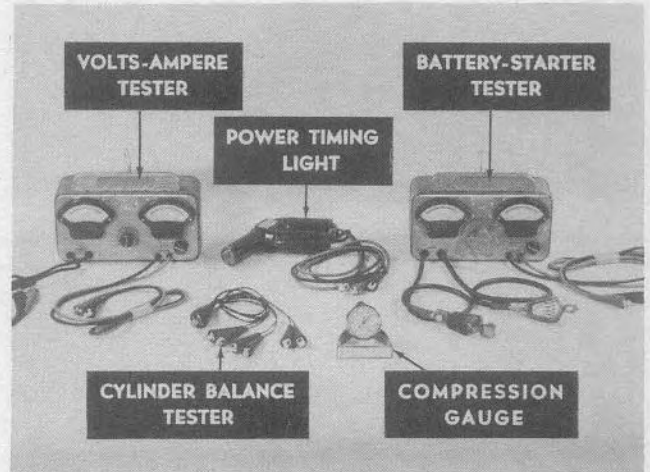
PART II

ENGINE DIAGNOSIS

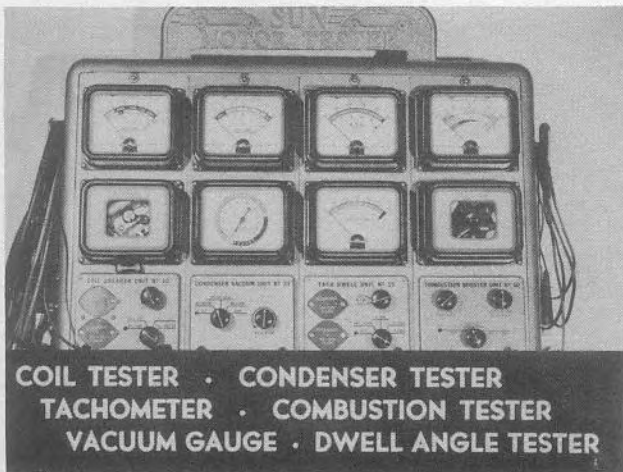
Engine Diagnosis Equipment



There are several reliable makes of engine diagnosis equipment, each of which will make all the tests satisfactorily. No one make is favored nor recommended exclusively. However, for the reason of uniformity, only one make of diagnosis equipment is shown in the illustrations.

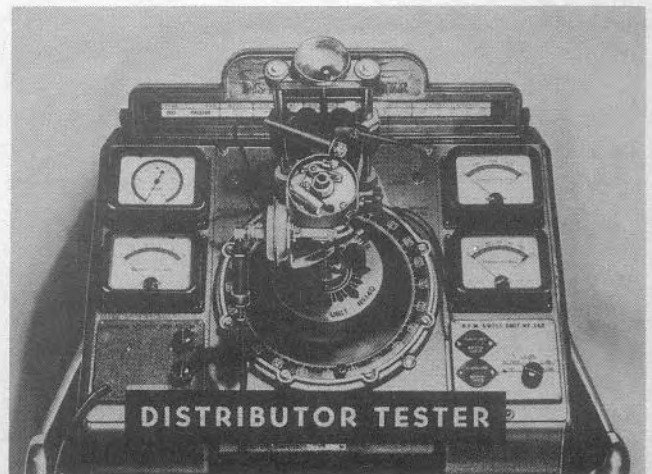


In addition, it should include these portable units: A volts-ampere tester, a power timing light, a battery and starter tester, a cylinder balance tester, and a compression gauge.



**COIL TESTER · CONDENSER TESTER
TACHOMETER · COMBUSTION TESTER
VACUUM GAUGE · DWELL ANGLE TESTER**

Some of the better diagnosis equipment includes the following units: A coil tester, a condenser tester, a tachometer, a combustion tester, a vacuum gauge, and a dwell angle tester.

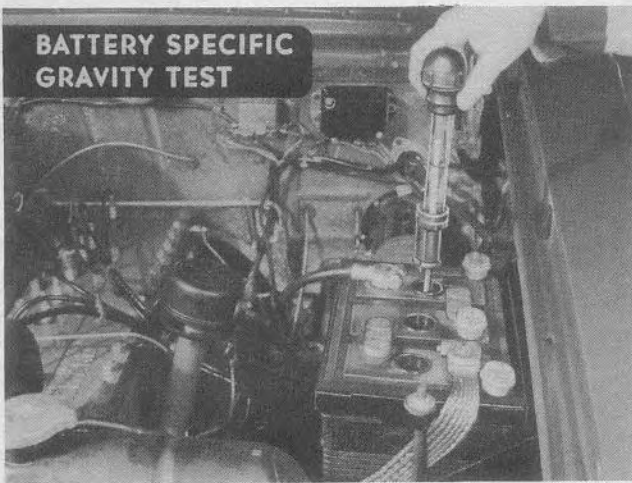


DISTRIBUTOR TESTER

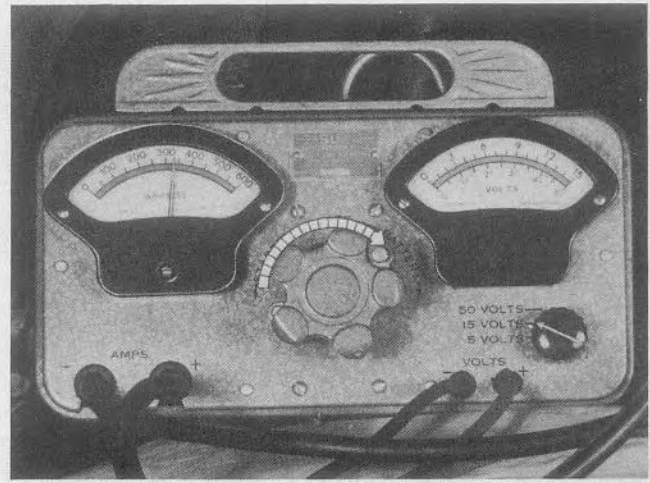
The well-equipped shop will also have a reliable distributor tester. But, in addition to having good test equipment, it is equally important that the equipment be used *properly* to obtain an accurate engine diagnosis.

STARTING MOTOR CIRCUIT

Battery Specific Gravity

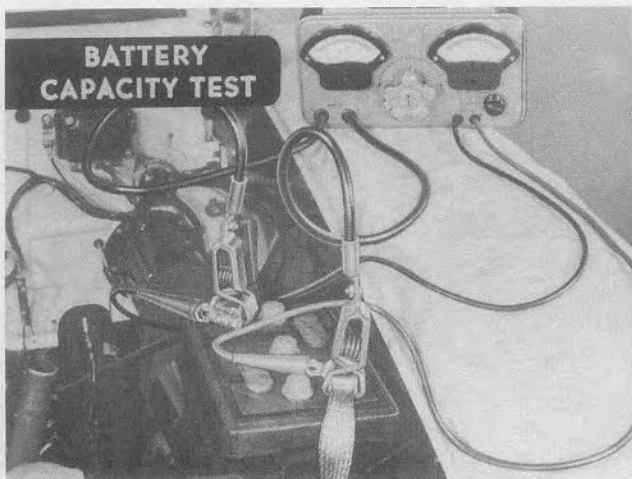


Test the specific gravity of the battery electrolyte with a hydrometer. The hydrometer reading indicates the chemical condition of the battery. If the hydrometer reading is below 1.225, the battery should be recharged. If the specific gravity is above 1.225, the battery is sufficiently charged for normal operation, since the generator will keep the battery charged. The variation in specific gravity readings between cells should not exceed 25 gravity points.

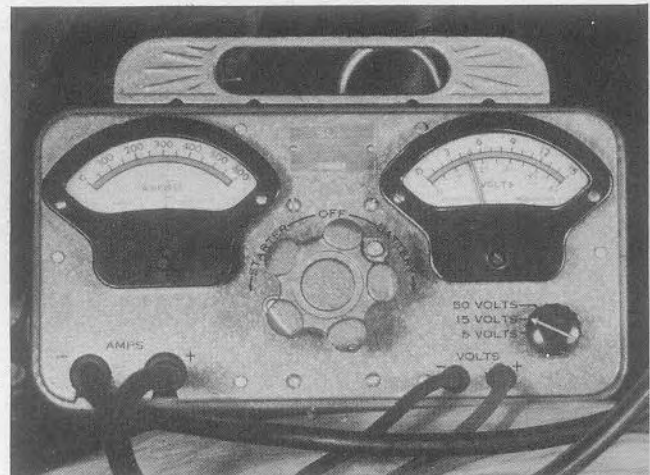


Turn the handle of the battery-starter tester to the battery position until the ammeter reads three times the ampere hour rating of the battery, or 300 amperes, for the "200" and "300" battery, and 330 amperes for the Patrician "400" battery. Quickly note the voltmeter reading.

Battery Capacity

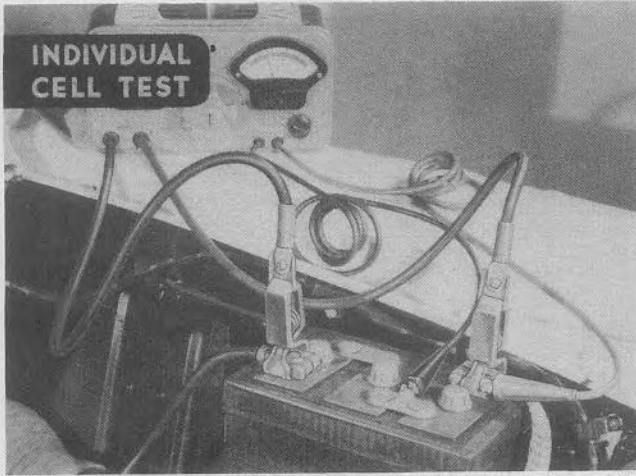


Turn the handle of the battery-starter tester to the "off" position. Connect the positive ammeter cable of the battery-starter tester to the positive battery post. Connect the negative ammeter cable to the negative battery post. Connect the positive voltmeter lead to the positive battery post. Connect the negative voltmeter lead to the negative battery post. Turn the voltmeter knob to the 15-volt scale.

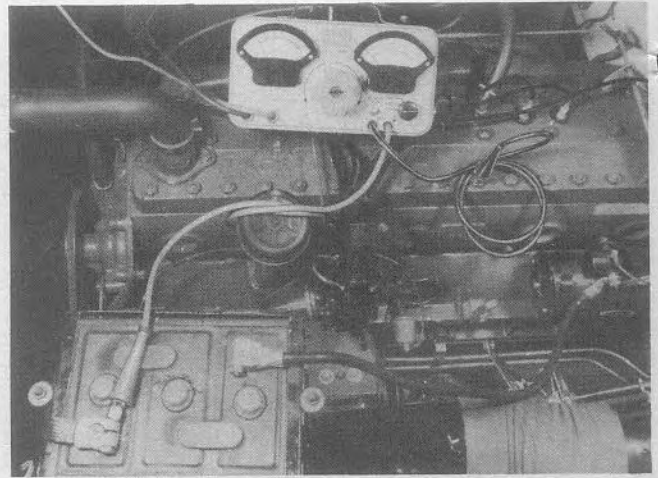


With the ammeter reading 300 and 330 amperes respectively, the voltmeter should read 4.8 volts or more for satisfactory battery capacity. Do not leave the handle of the battery-starter tester in the battery position for more than one minute. After completing the battery test, turn the handle to the "off" position before disconnecting the clips from the battery.

Individual Cell Test (Optional)



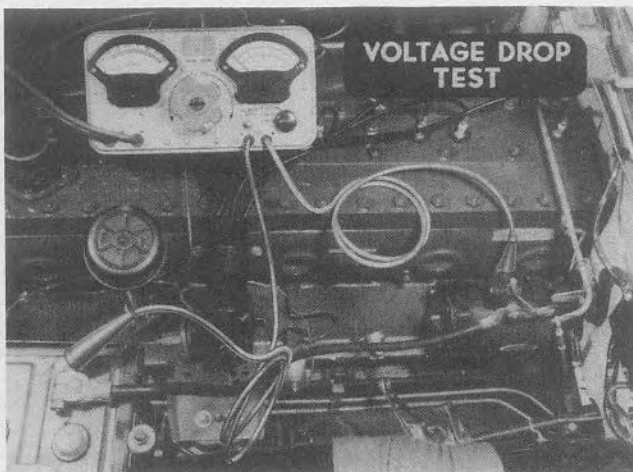
With a load of 300 amperes on the battery, quickly test the voltage of each cell, using the 3-volt scale of the voltmeter. If the voltage of any cell drops below 1.5 volts with a 300 ampere load, or if there is a difference of more than .2 volt between the cell readings, it may indicate possible battery trouble. The battery should be removed and recharged fully. Then it should be given another "high rate discharge" test as before. If the results are the same as before, the battery should be replaced.



Measure the voltage between the positive grounded post of the battery and the car engine or frame. The reading is the voltage drop. A voltage drop of more than .1 volt indicates excessive resistance in the circuit and should be corrected. The high resistance may be caused by loose connections, frayed or corroded cables, or a faulty starting motor solenoid switch.

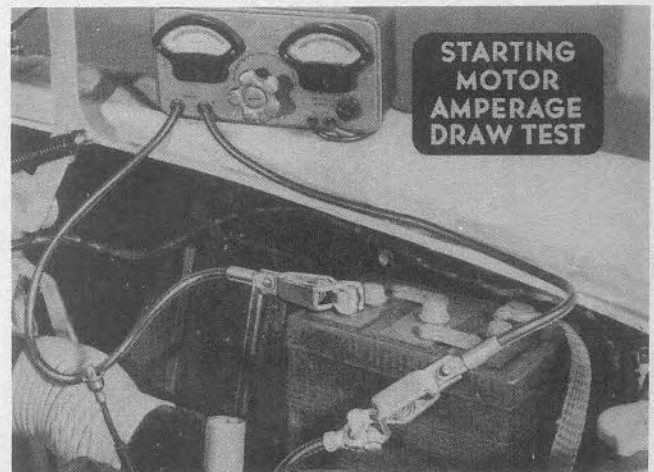
PackardInfo.com

Voltage Drop Test

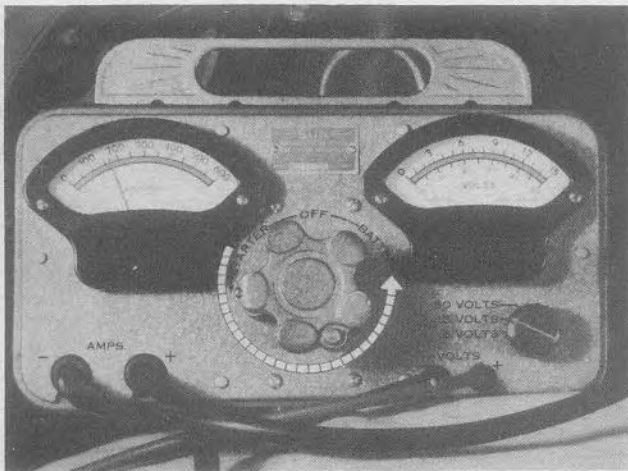


With the starting motor in operation, measure the voltage, using a low scale voltmeter, between the negative ungrounded post of the battery and the starting motor terminal stud. The reading is the voltage drop.

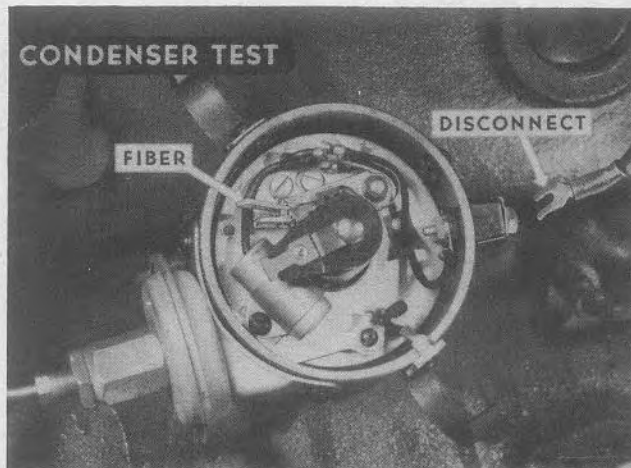
Starting Motor Amperage Draw



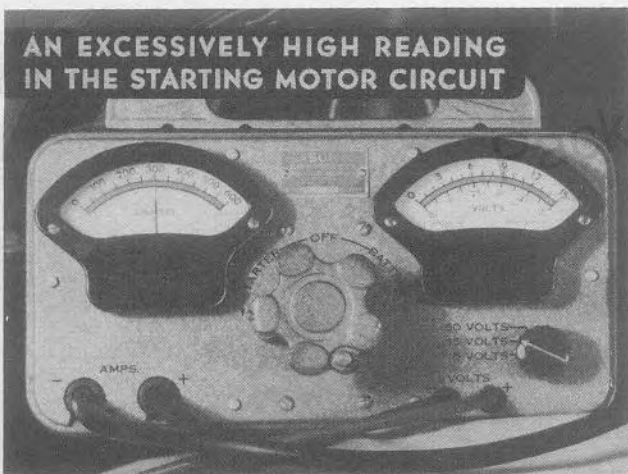
Disconnect the negative ungrounded terminal from the battery. Connect the negative ammeter cable of the battery-starter tester to the negative battery post. Connect the positive ammeter cable of the battery-starter tester to the ungrounded battery cable.



Turn the handle of the battery-starter tester to starter position. With the secondary lead disconnected from the ignition coil, operate the starting motor. Note the reading on the ammeter of the battery-starter tester. This reading will indicate the amount of current required to crank the engine. This reading should come within the test specifications in the Packard Service Manual.



tor cap and block the breaker contact points open with a piece of fiber. Disconnect the primary lead at the distributor.



AN EXCESSIVELY HIGH READING IN THE STARTING MOTOR CIRCUIT

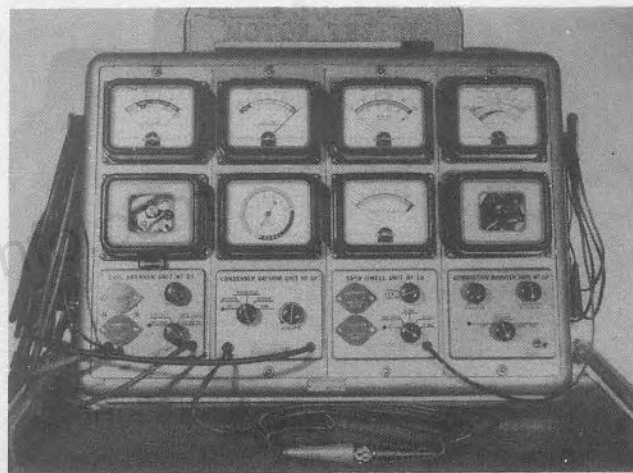
An excessively high reading will indicate a short circuit in the starting motor circuit or abnormal drag on the starting motor due to excessive friction in the engine.

An excessively low reading indicates high resistance in the starting motor circuit, which could be caused by loose connections, worn starting motor brushes, or weak brush springs. If the starting motor circuit is in normal operating condition, proceed with the ignition circuit tests.

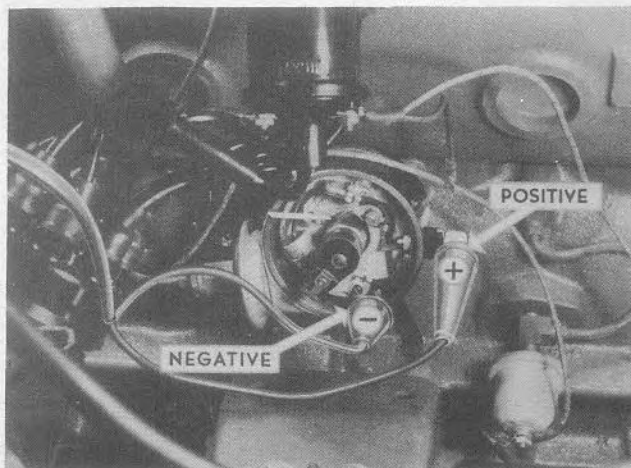
IGNITION CIRCUIT

Condenser Test

To test a condenser on the car: Remove the distribu-

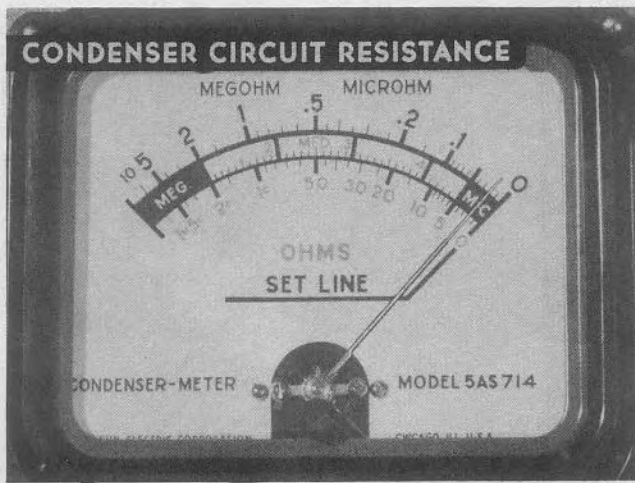


Connect the two condenser test lead clips together. Turn the condenser test unit switch to "microhm" position. Permit the condenser tester to heat for one minute. Turn the regulator knob until the pointer reads on the "set" line.



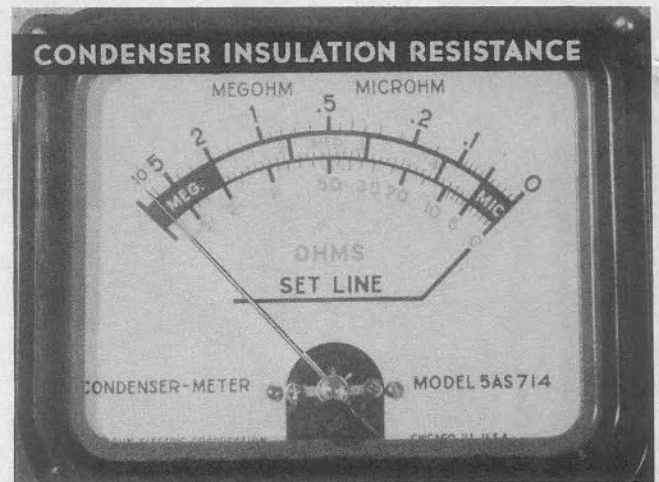
Condenser Microhm Resistance Test

Connect the positive condenser test lead to the distributor primary terminal. Connect the negative condenser test lead to the condenser shell or the distributor base.



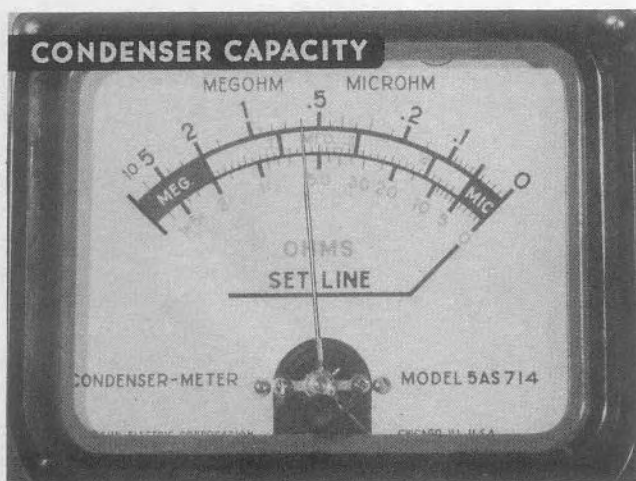
Read the condenser test meter. The meter should read in the "blue" bar marked "microhm" at the right end of the scale for satisfactory condenser circuit resistance.

Condenser Megohm Insulation Test



Turn the condenser test unit switch to the "megohm" test. The meter should read in the "blue" bar at the left end of the scale marked "megohm" for satisfactory condenser insulation. If the meter reads in the "red" bar, or over to the extreme right end of the scale, replace the condenser.

Condenser Microfarad Capacity Test



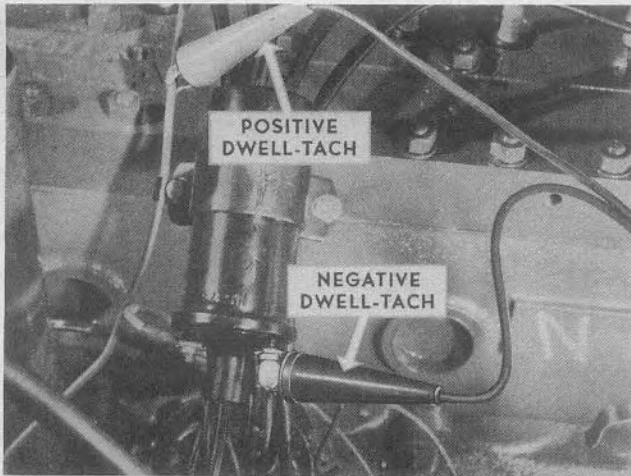
Turn the condenser test unit switch to the "microfarad test." The meter should read .20 to .25 microfarads for the Auto-Lite condenser, and .18 to .23 microfarads for the Delco-Remy condenser.

Distributor Resistance

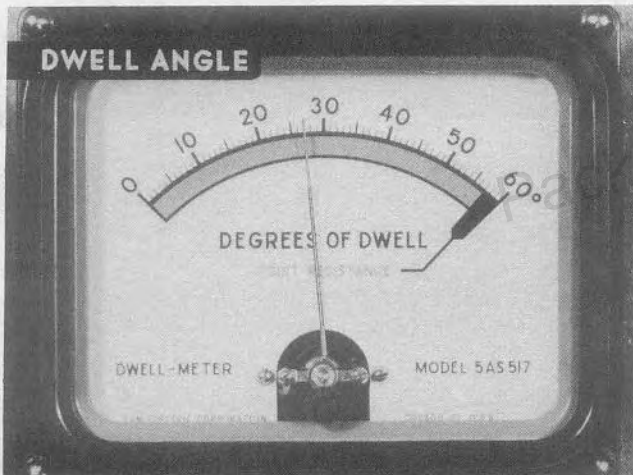


With the condenser test leads connected as before, remove the fiber block holding the breaker contacts open. With the contacts closed and the test switch in the "ohm" position, if the contact point surfaces are in good condition, the reading should be zero ohms. This test will indicate the condition of the breaker contacts and ground connections. Be sure to turn the condenser test unit switch to the "off" position after tests are completed.

Dwell Angle



Connect the distributor primary lead. Connect the "negative" tach-dwell test lead to the distributor primary terminal. Connect the "positive" tach-dwell test lead to the ground. Turn the dwell switch knob to the 8-lobe position. Install the distributor rotor and cap, turn on the ignition switch, and start the engine.



Note the reading on the dwell meter. This test measures the cam rotation between the time the breaker

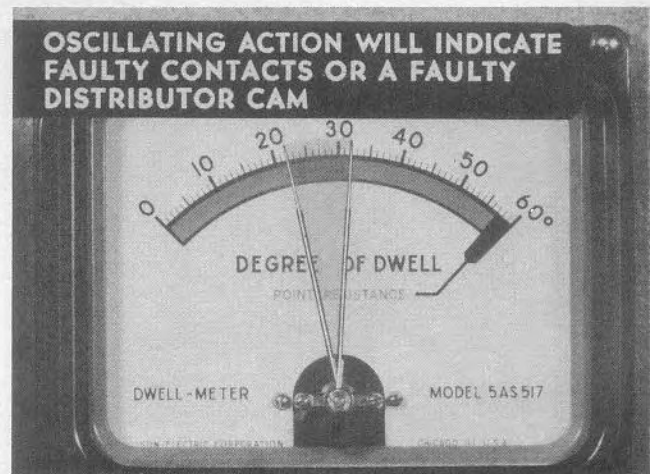
contacts close and when they reopen. The dwell should be 27° for the Auto-Lite distributor, and 26° to 31° for the Delco-Remy distributor. Compare the readings with distributor specifications in the Service Manual.

This test will indicate:

- (1) The breaker contact opening.
- (2) The condition of the breaker cam.
- (3) The condition of the distributor shaft and bearings.
- (4) The condition of the breaker plate bearing and support on the Delco-Remy distributor.



If the dwell angle is too great, this will indicate that the contact point gap is set too close. If the dwell angle is too small, this will indicate that the contact gap is too wide.

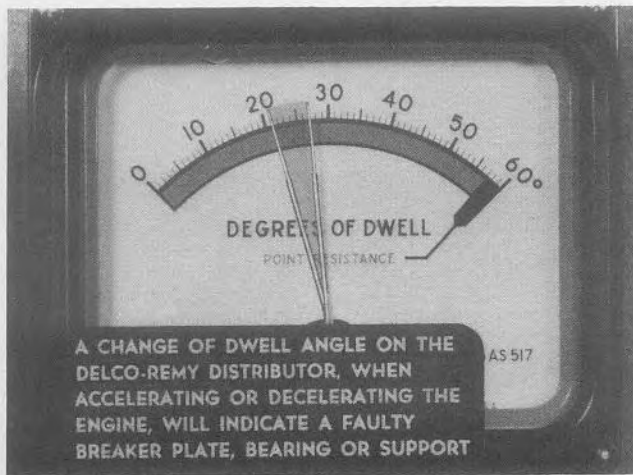


Oscillating action of the dwell angle pointer will indicate faulty contacts, a faulty breaker cam, or a worn distributor shaft and bearings.

THIS TEST WILL INDICATE:

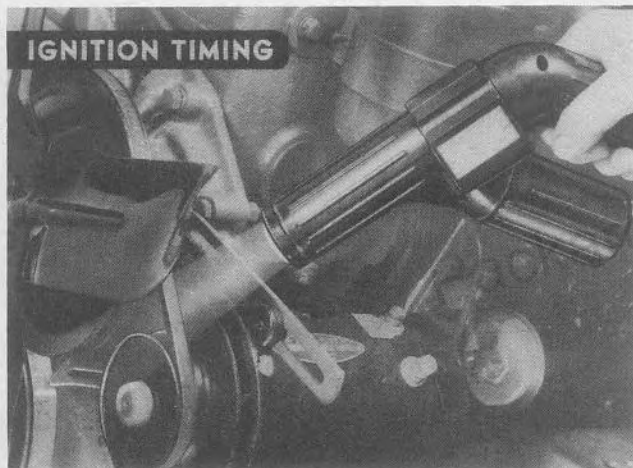
- THE BREAKER CONTACT OPENING
- THE CONDITION OF THE BREAKER CAM
- THE CONDITION OF THE DISTRIBUTOR SHAFT AND BEARINGS
- THE CONDITION OF THE BREAKER PLATE BEARING AND SUPPORT ON THE DELCO-REMY DISTRIBUTOR



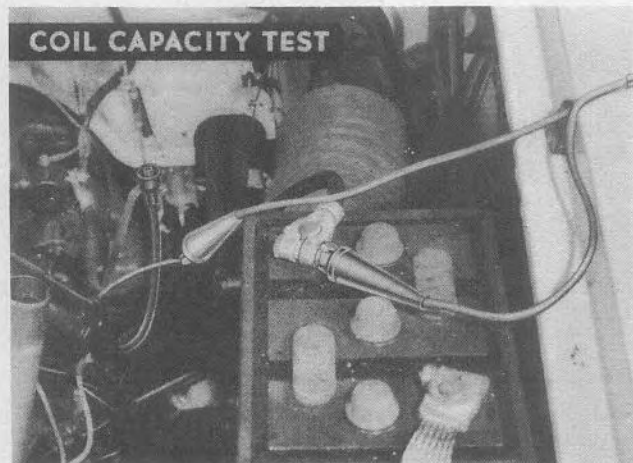


A change of dwell angle on the Delco-Remy distributor, when accelerating or decelerating the engine, will indicate a faulty breaker plate, bearing, or support.

Ignition Timing



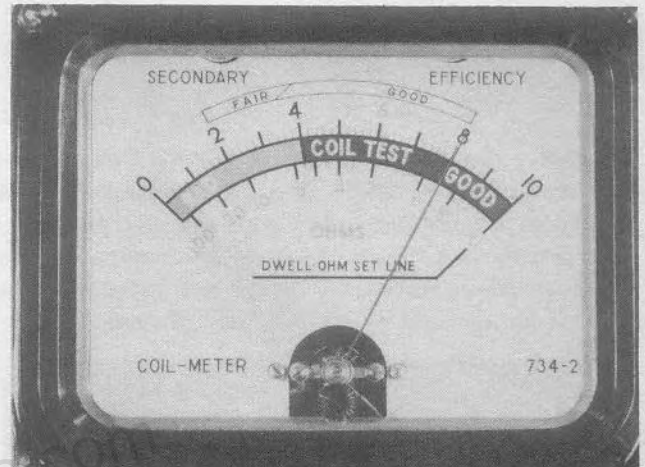
Set the ignition timing, using the power timing light connected to the No. 1 spark plug terminal and the battery. The white chalk mark of the vibration damper will indicate the position in the engine cycle at which the spark occurs at the spark plug. Place the chalk



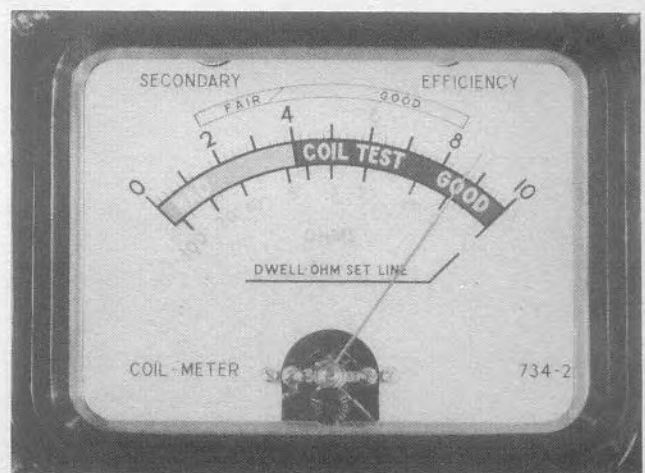
mark on the 6 degree "brdc" mark as indicated by the specifications in the Service Manual. After setting the timing, test the coil.

Coil Capacity Test

Remove the secondary wire from the coil terminal. Remove the primary wire from the distributor terminal of the coil. Calibrate the coil tester according to the manufacturer's recommended procedure. Connect the negative coil test lead to the negative battery post and positive coil test lead to the distributor terminal on the coil.

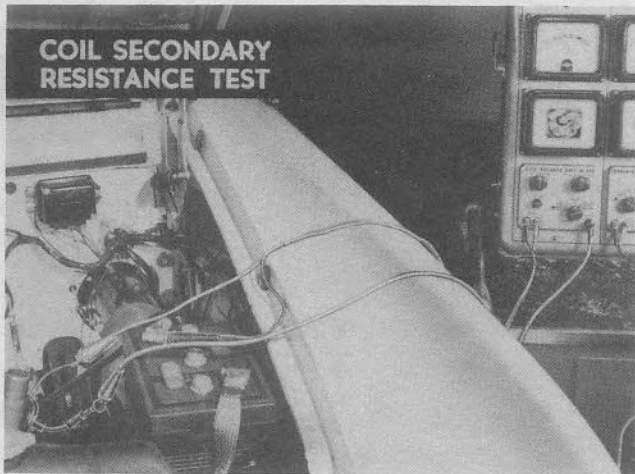


Turn the car ignition switch on. Turn the master motor tester switch on. Turn the coil tester switch to the coil *set* position. Adjust the coil set regulator until the meter reads the setting required for the type and model coil being tested in accordance with the test equipment manufacturers' specifications.



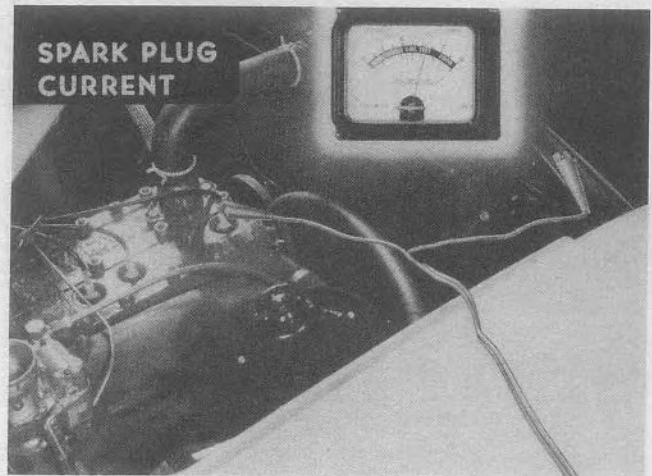
Turn the coil test switch to the coil *test* position. The meter reading must be within the "good" coil band and steady for a "good" coil. A reading outside of the "good" coil band or an erratic reading of three to five divisions inside the "good" coil band indicates a bad coil.

Coil Secondary Resistance Test

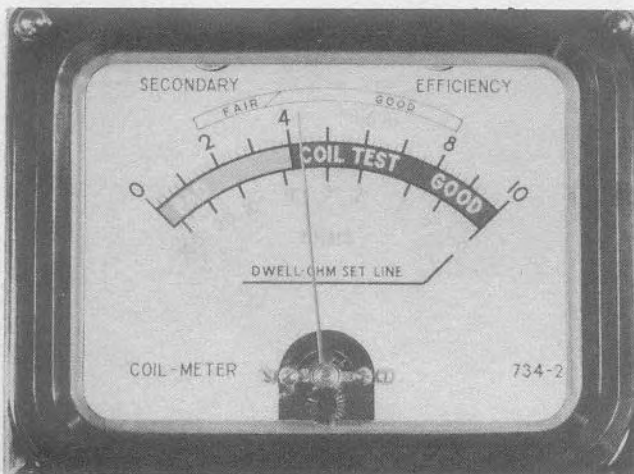


Calibrate the coil tester according to the instrument manufacturers' instructions. Remove the secondary cable from the coil. Insert the short secondary jumper lead into the coil terminal. Connect the coil tester primary lead to the distributor primary terminal on the coil. Connect the coil tester ground lead to the short secondary jumper lead.

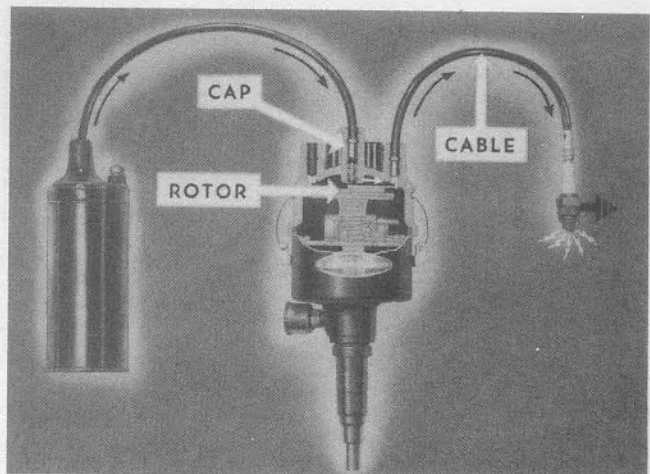
Current At Spark Plugs



Connect the coil tester "positive" lead to the ground. Connect the coil tester "negative" lead to each of the spark plug cables, one at a time, and measure the amount of current flow to each spark plug with the engine running.

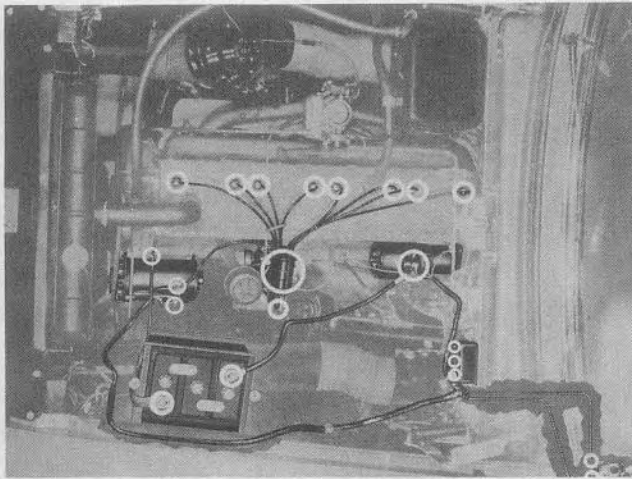


Turn the coil tester switch to the "dwell-ohm" position. The reading on the meter should be 3,900 to 4,300 ohms in the secondary circuit at 75° F. Move the coil tester ground lead to the coil shell. The meter should read at least 100,000 (100M) ohms for proper primary circuit resistance to ground. After the coil tests are completed, disconnect the coil tester. Connect the distributor primary lead and secondary cable at the coil.



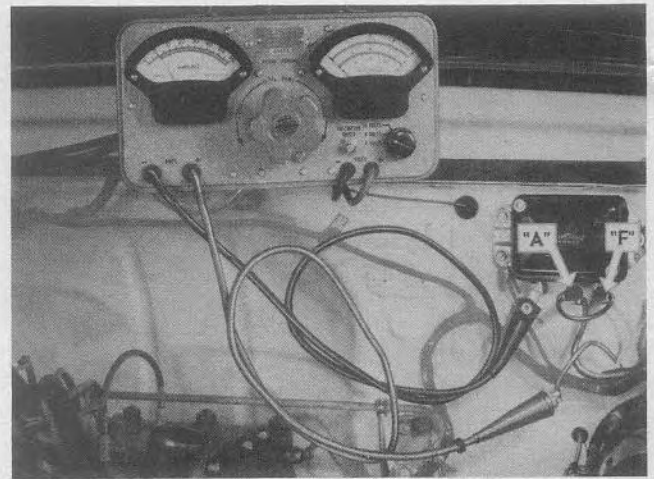
If the reading is not uniform, after the coil tested satisfactory, it may indicate:

- (a) A faulty distributor cap.
- (b) A faulty rotor.
- (c) Faulty ignition secondary cables or terminals.



This completes the diagnosis of the ignition circuit, but to be sure that the job is correct, check the ignition primary and secondary wiring and connections, making sure that they are clean and tight.

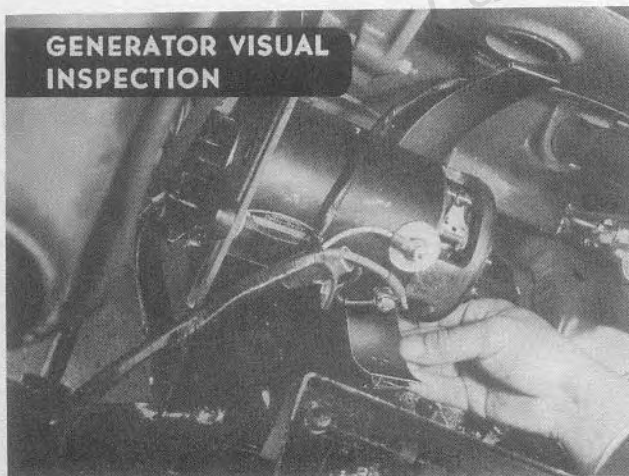
Generator Output Test



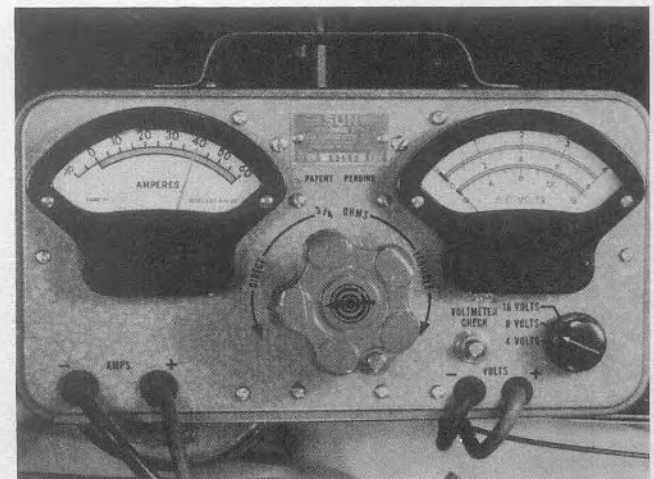
Disconnect the car ammeter lead from the "B" (battery) terminal of the regulator. Connect the (-) negative lead of the volts-ampere tester to the "B" terminal of the regulator. Connect the (+) positive lead of the volts-ampere tester to the car ammeter lead. Turn the resistance knob of the volts-ampere tester to the "out" position.

CHARGING CIRCUIT

Generator Visual Inspection



Remove the generator cover band, and inspect the commutator for being dirty, burned, or glazed. Inspect for high mica between the commutator segments. Inspect the brushes and brush holder for sticky or worn brushes, and test the brush spring tension. Inspect the field and armature for burned insulation or thrown solder. Inspect the wiring in the charging circuit for burned, worn, or frayed insulation. If the generator does not come up to inspection standards, remove and recondition the generator.



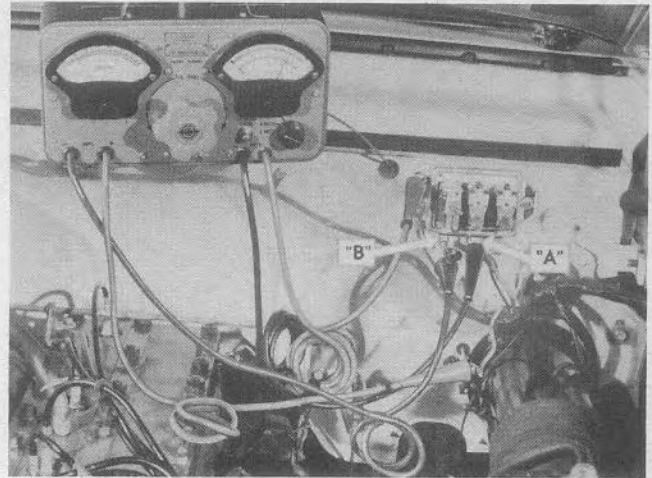
Connect a short jumper lead across the armature and field terminals of the regulator. Turn on all lights and accessories to prevent battery overcharge. Start and operate the engine at 2,000 r.p.m. Read the test ammeter for maximum generator output. If the reading is less than that specified on the generator data plate, check for loose fan belt, broken field or armature windings. Remove the generator and recondition if necessary.

Charging Circuit Resistance Test



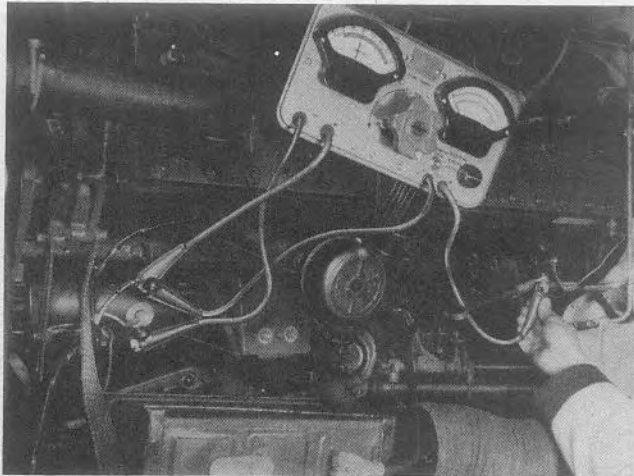
Set the test voltmeter selector switch knob to the 5 volt position. Disconnect the armature lead from the generator terminal. Connect the (—) negative ammeter lead of the volts ampere tester to the generator armature terminal. Connect the (+) positive test ammeter lead to the armature lead disconnected from the generator. (Connect the (—) negative voltmeter lead to the armature lead. Connect the (+) positive voltmeter lead to the ungrounded post of the battery. Turn on lights and accessories.

Circuit Breaker (Cutout Relay)

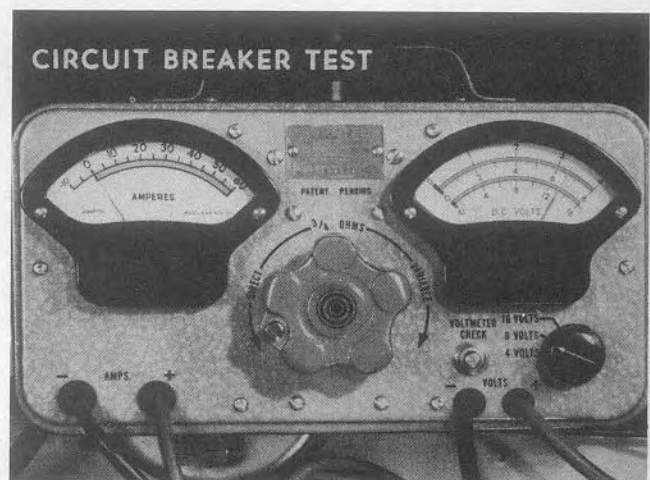


Disconnect the battery lead wire from the "B" terminal of the regulator. Connect the (—) negative ammeter lead of the volts-ampere tester to the "B" terminal of the regulator. Connect the (+) positive ammeter lead of the volts-ampere tester to the battery lead wire disconnected from the regulator.

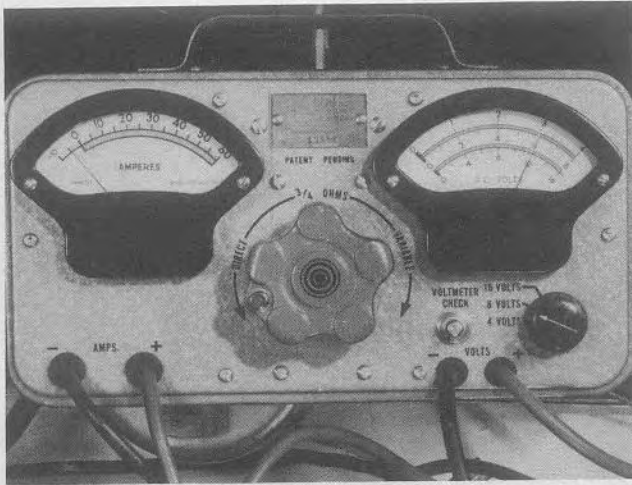
Connect the (+) positive voltmeter lead to the regulator base for ground. Connect the (—) negative voltmeter lead to the "A" terminal of the regulator. Turn the voltmeter switch knob to 15-volt scale.



Start and operate the engine at a speed so the generator charges exactly 20 amperes. The test voltmeter should not read in excess of .3 volt. To locate the high resistance in the charging circuit, starting at the ungrounded post of the battery, consecutively contact all the exposed terminals in the charging circuit with the voltmeter (+) positive test lead until the high resistance connection is found.

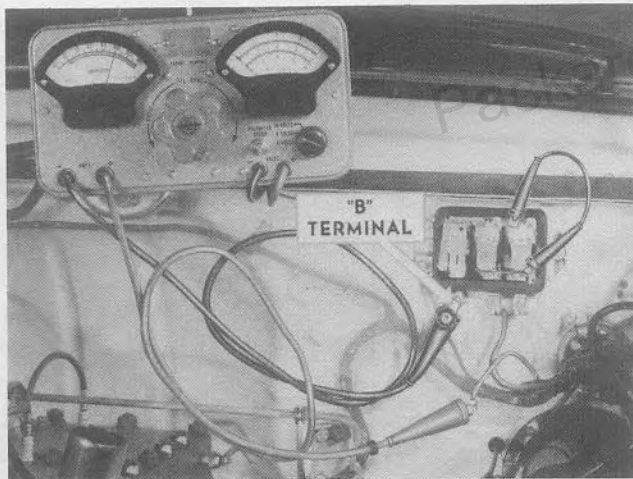


Operate the engine at idling speed and slowly increase the speed until the circuit breaker contacts close. Note the reading on the voltmeter the instant the circuit breaker contacts close. The closing voltage should be between 6.5 and 7.0 volts.



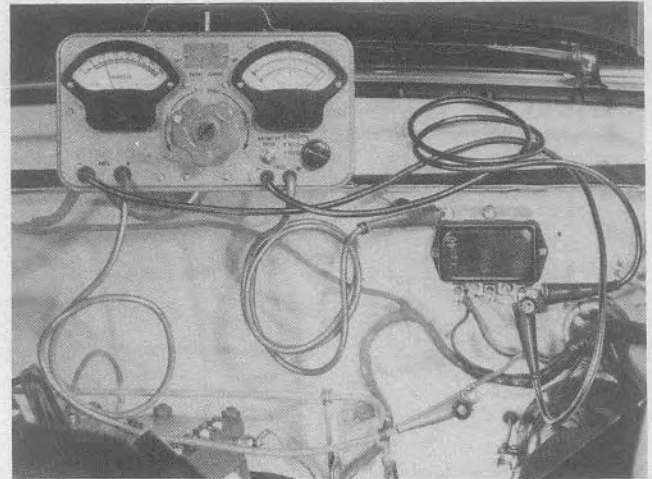
Then slowly decrease engine speed until the circuit breaker contacts open. Note the ammeter reading, which indicates the discharge current necessary to open the contacts. The discharge current should be four to six amperes. If the circuit breaker does not close and open within these limits, adjust the circuit breaker as described in the Packard Service Manual.

Current Regulator



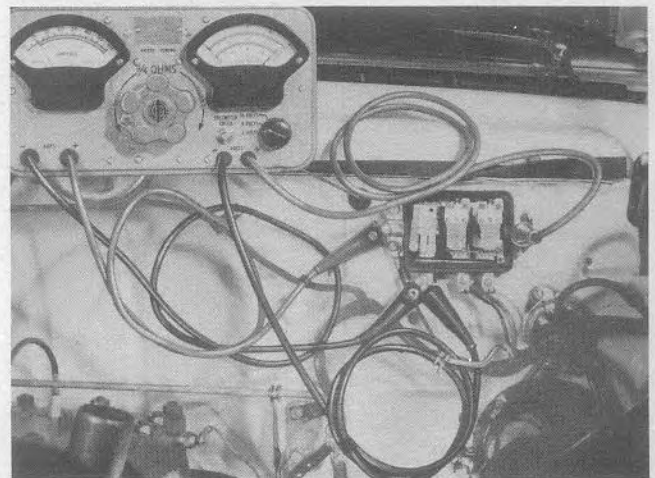
Disconnect the lead at the regulator "B" terminal and connect an ammeter (0-50 scale) into the charging circuit at the "B" terminal. Connect a short jumper lead across the voltage regulator contacts to keep the voltage regulator from operating. Be sure the resistance knob of the volts-ampere tester is turned to the "out" position. Turn on all lights and accessories to prevent battery overcharge. Operate the engine and increase the speed until the ammeter reading reaches its maximum and remains constant. The ammeter should read according to the specifications for the type and model regulator. If the readings are outside the limits, reset the regulator as described in the Packard Service Manual.

Voltage Regulator Test (Variable Resistance Method)



To test the voltage regulator using the variable resistance method: Remove the jumper lead from the voltage regulator. Operate the engine at medium speeds, approximately 1,500 to 2,000 r.p.m. Turn the resistance knob of the volts-ampere tester until the ammeter reading is eight to ten amperes. The voltmeter reading should be 7.2 to 7.4 volts. If the readings are outside these limits, reset the regulator as described in the Packard Service Manual.

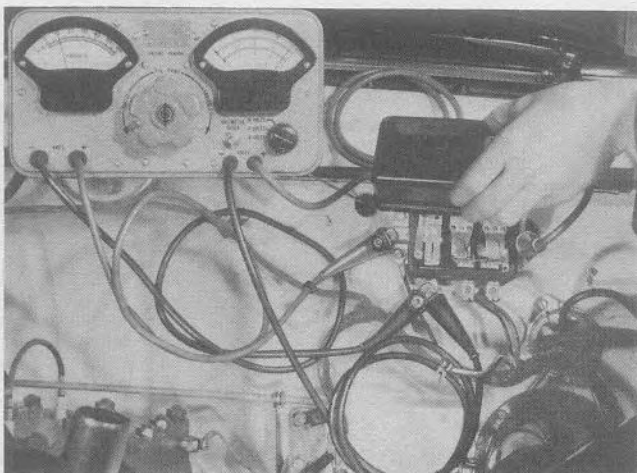
Voltage Regulator Test (Fixed Resistance Method)



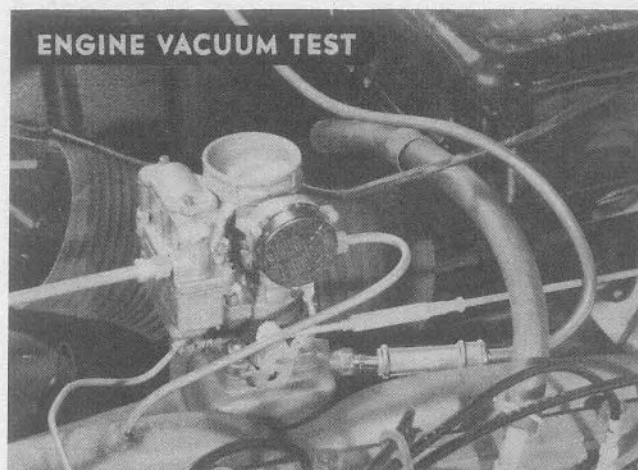
To test the voltage regulator using the fixed resistance method: Disconnect the lead at the regulator "B" terminal. Connect a $\frac{3}{4}$ ohm resistance and a voltmeter from the "B" terminal to the regulator base. Operate the generator at medium speed and observe the voltmeter reading. The voltage regulator should be set from 7.2 to 7.4 volts.

ENGINE VACUUM AND COMPRESSION TEST

Preparation

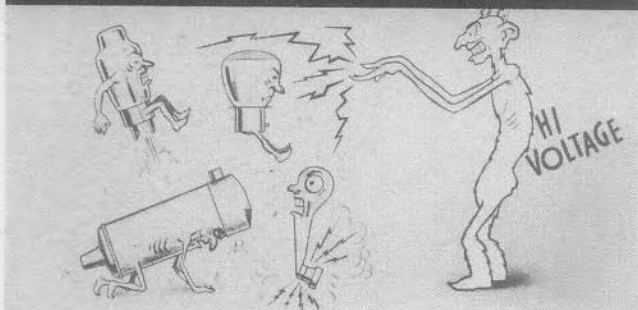


CAUTION: Recheck the setting of each unit after the regulator cover is installed. Cycle the generator after each setting by decreasing the engine speed until the circuit breaker contacts open and then increasing the engine speed as required. Be sure that the regulator is at operating temperature when adjustments are made.

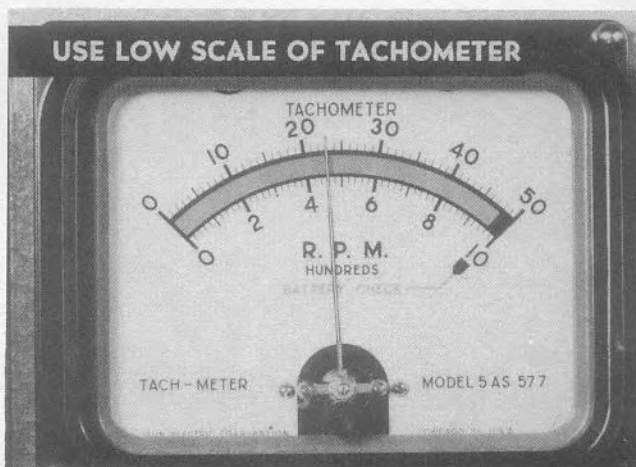


Remove the pipe plug from the intake manifold and insert the nipple furnished in the vacuum test equipment. Connect the vacuum gauge hose to this nipple. Connect the (—) negative tach-dwell lead to the distributor primary terminal and ground the (+) positive tach-dwell lead.

High voltage beyond a safe limit will burn out light bulbs, radio tubes, and shorten the life of ignition contact points, ignition coil and other electrical units

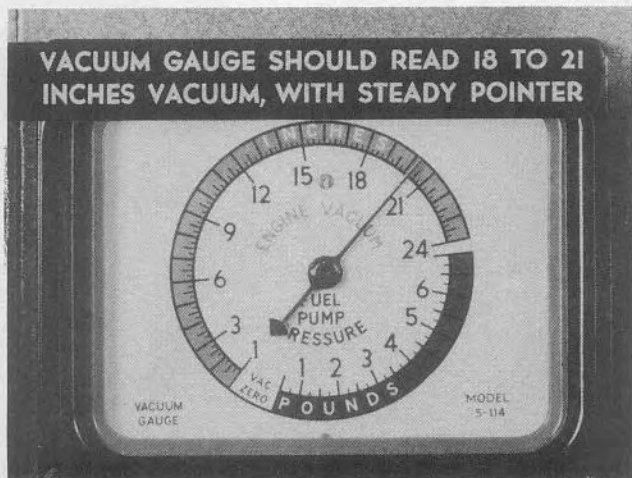


It is important that the regulator be set accurately, as high voltage beyond a safe limit will burn out light bulbs, radio tubes, and shorten the life of ignition contact points, ignition coil, and other electrical units. A voltage regulator that is set too high will overcharge the battery, causing it to over-heat and gas, which eventually will cause premature battery failure.



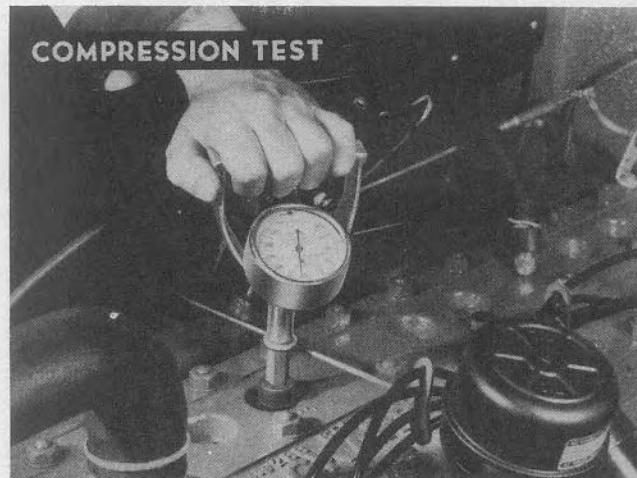
Start and operate the engine until it is warmed up to operating temperature. Check the cooling system, exhaust system, and manifold heat control for proper operation. Using the low scale of the tachometer, check and adjust the idle speed at 400 to 450 r.p.m. (375 r.p.m. in high range on Ultramatic Drive equipped cars). Then note the reading on the vacuum gauge.

Vacuum Test



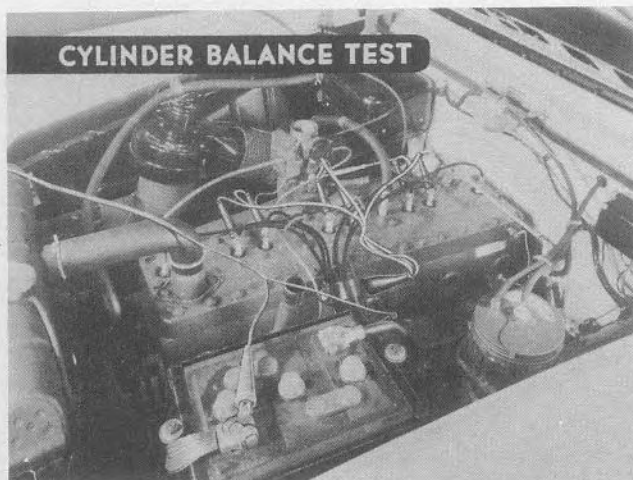
The vacuum gauge should read 18 to 21 inches vacuum with a steady pointer. If the vacuum gauge does not hold steady between 18 to 21 inches vacuum, it indicates that the carburetor idling mixture is too rich or too lean. Excessively low reading of the vacuum pointer indicates late timing or an intake manifold air leak.

Compression Test

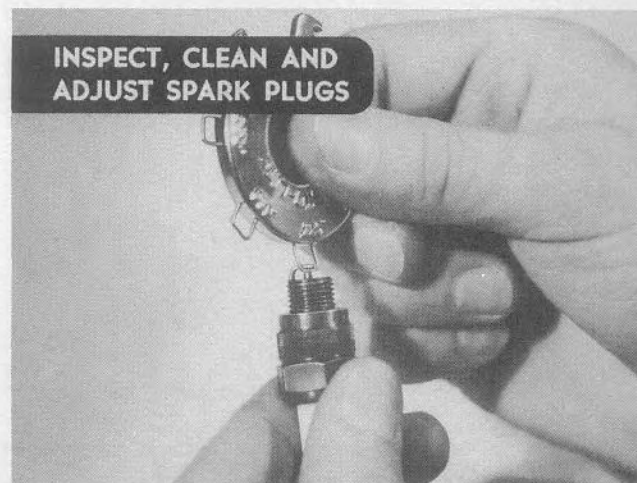


Remove all spark plugs and take a compression reading of each cylinder. The cylinder with the lowest reading should not vary more than 10 pounds per square inch below the average reading of the other cylinders. To make an accurate compression test on each cylinder, the crankshaft must be rotated at least five or six revolutions by operating the starting motor at wide open throttle.

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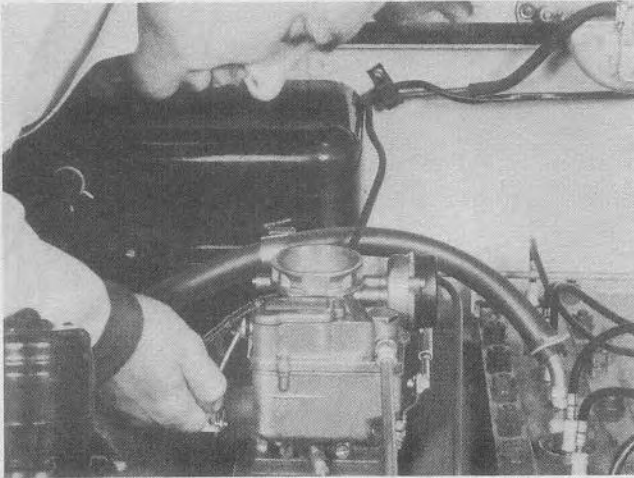
If the vacuum reading is irregular, make a cylinder balance test. Operate the engine on two cylinders (by grounding out the remaining spark plugs), at about 1,500 r.p.m., using related combinations such as 1-8, 2-7, 3-6, 4-5. Low vacuum readings on any two cylinders will indicate a faulty spark plug, intake manifold leaks, valves not seating, or a bad piston ring condition.



Inspect, clean, and adjust the spark plugs. If visual inspection indicates that the porcelains are burned, blistered, or cracked, or if the electrodes are burned excessively, the spark plugs should be replaced with new ones of the same type.

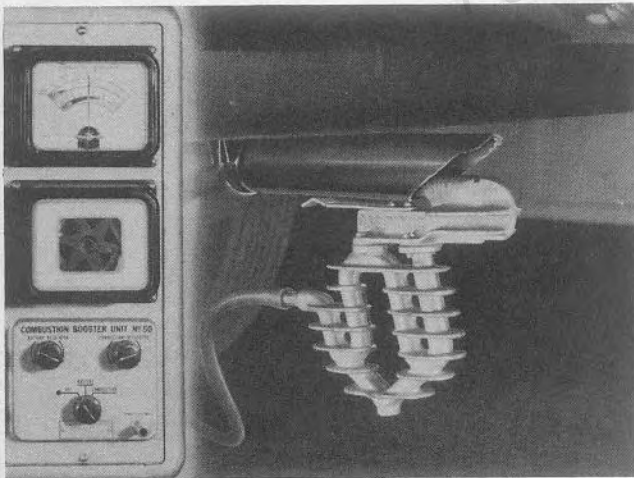
CARBURETION

Fuel System Visual Inspection



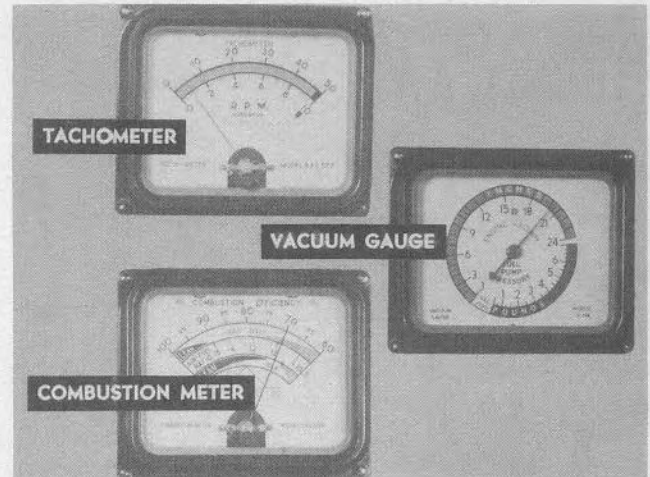
Inspect the carburetor for normal wear, dirt, carbon deposits and correct size parts. Test the operation of the starter switch. Inspect the fuel pump bowl for dirt and the condition of the bowl gasket. Inspect the condition of the flexible fuel hose. Test the operation of the manifold heat control. Inspect the air cleaner filtering element. Correct any unsatisfactory conditions.

Preparation



Connect the vacuum hose and tachometer leads as described in the vacuum test. Start and operate the engine at idling speed. Turn the knob of the combustion tester to the "battery" position; adjust the battery regulator knob until the pointer aligns with the "set" line. Turn the knob of the combustion tester to the "combustion" position. Adjust the combustion regulator knob to align the pointer with the "set" line. After the engine has idled for a few minutes to warm up, insert the exhaust unit in the tail pipe. The combustion tester is now ready for the tests.

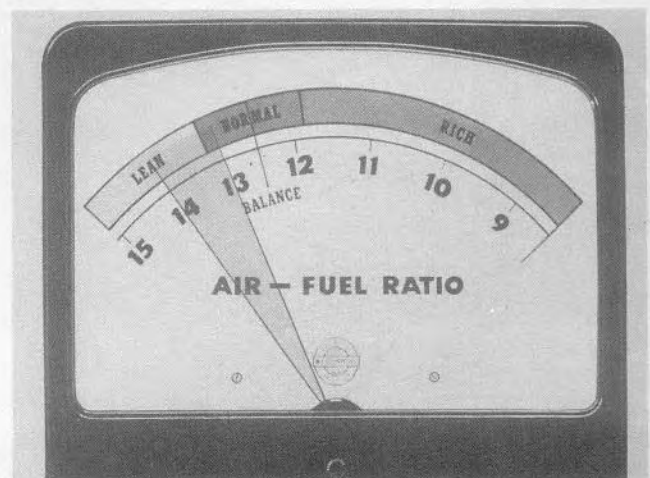
Engine Idling Test



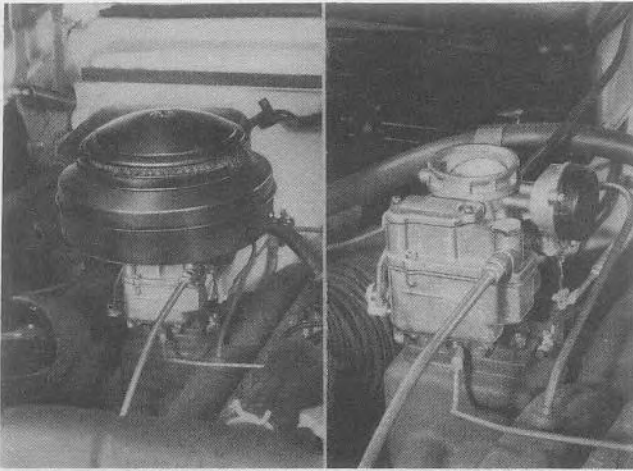
Adjust the idle speed screw until the tachometer reads 400 to 450 r.p.m., (or 375 r.p.m. in high range in Ultra-matic Drive equipped cars). The vacuum gauge should read between 18 and 21 inches and should hold steady. Floating motion of the vacuum pointer indicates idling mixture is too rich or too lean. Adjust the idle mixture until the vacuum gauge reads between 18 and 21 inches and the pointer holds steady.

The combustion meter should read in the rich range of about 12.5:1 air-fuel ratio, plus or minus 3%.

Main Metering System Test

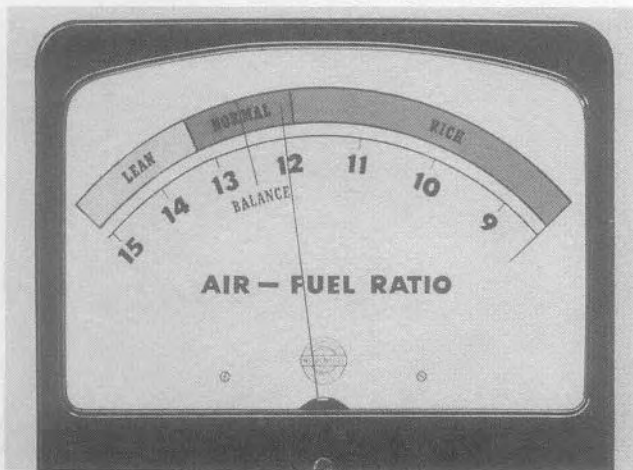


Set the engine throttle so that the engine will be operating at approximately 2,000 r.p.m., which is equivalent of about 45 to 55 m.p.h. For maximum power, the meter should read in the air-fuel ratio range of approximately 13.2:1 to 14:1, and 14:1 to 15:1 for maximum economy.

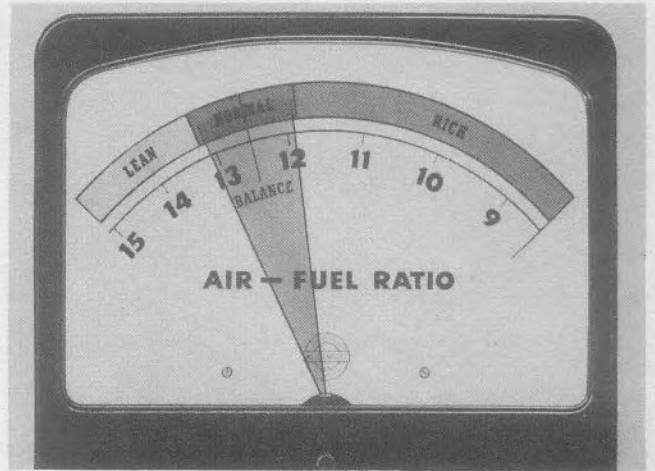


If the combustion reading is out of range, before condemning the carburetor, remove the air cleaner to eliminate any restriction that may be caused by the air cleaner. If the reading is still out of the range, the carburetor is at fault. If the air cleaner restriction is normal, the combustion efficiency will increase 2% to 5% when the air cleaner is removed.

Accelerating System Test

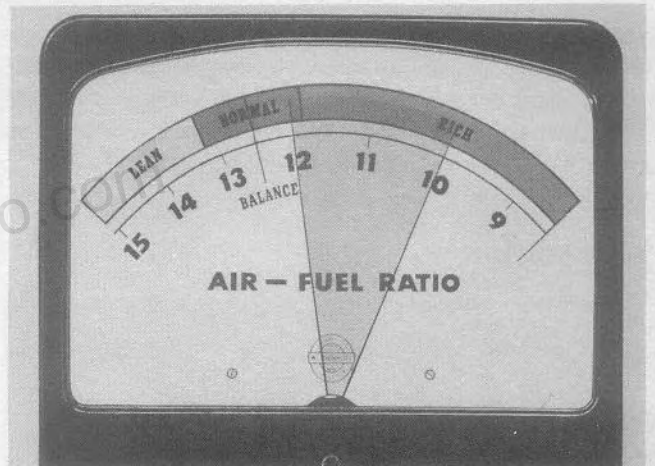


With the throttle set so that the engine is operating at about 2,000 r.p.m., quickly open the throttle wide and then release it and allow the engine speed to return to about 2,000 r.p.m. If the accelerating system is operating properly, the combustion meter pointer will move toward the rich band to approximately 12:1 air-fuel ratio to indicate the extra discharge of fuel going into the carburetor on sudden acceleration.



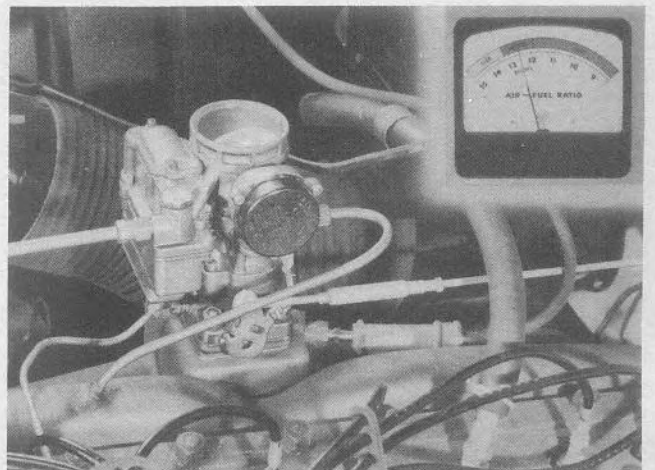
The pointer should return to the normal air-fuel ratio range of about 14:1 when the engine is operated at 2,000 r.p.m. But if the combustion meter reads toward the lean side on acceleration, it indicates that the accelerating system is not working properly.

Climatic Control Test



The combustion meter should read between 10:1 to 12:1 air-fuel ratio while the engine is being warmed up and the climatic control has the choke partially closed.

Air Cleaner Test



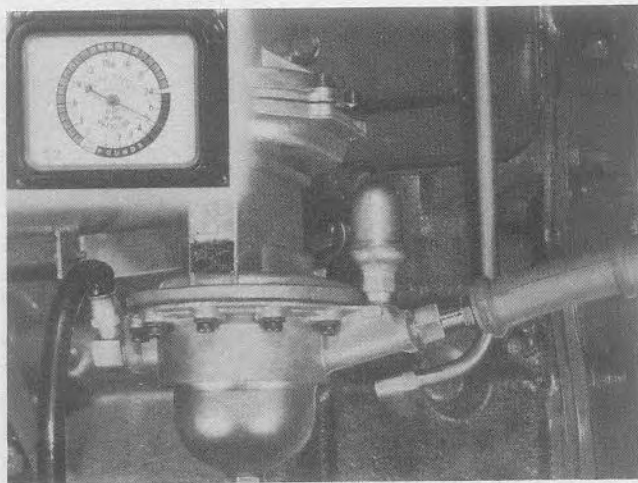
The removal of the air cleaner should not change the combustion meter reading in excess of 5%. A change in reading in excess of 5% will indicate restriction in the air cleaner. After these tests are made, close the throttle and shut off the ignition switch.

Gas Mileage Test



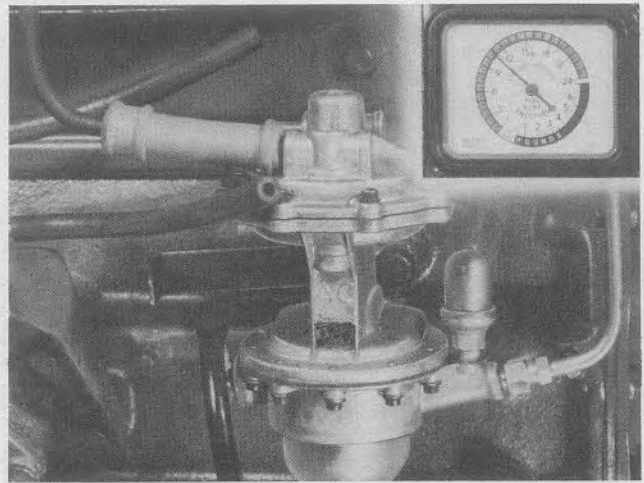
Before performing any corrective repairs on gas mileage complaints, perform a gas mileage test according to the gas mileage tester manufacturer's instructions. This is to determine if the gas consumption is actually excessive, or if it is caused by driving conditions.

Fuel Pump Pressure Test



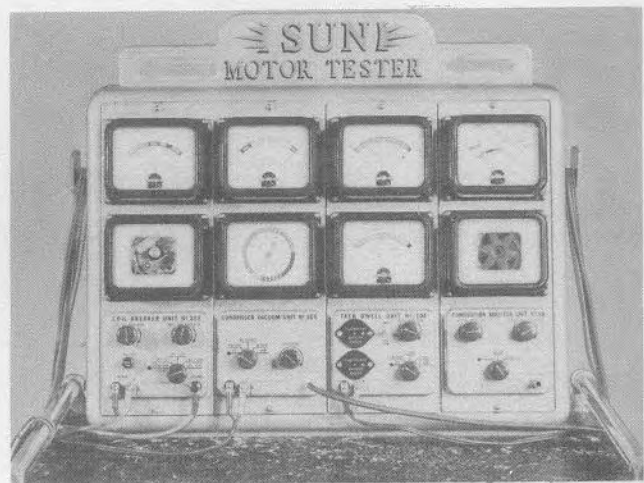
Disconnect the fuel line from the carburetor side of the fuel pump. Insert special fitting furnished with the test instrument into the fuel pump connection. Push the rubber fitting of the fuel pump tester hose over the special fitting on the carburetor side of the fuel pump. Start and operate the engine at idling speed. The reading should be 4 to 5 p.s.i. for satisfactory fuel pump operation. Stop the engine. If the readings are below the values shown, the fuel pump should be removed and reconditioned.

Vacuum Booster Test



Disconnect the inlet and outlet lines of the vacuum booster unit of the fuel pump. Insert the special fitting in the inlet connection and push the vacuum gauge hose over this fitting. Start and operate the engine at approximately 1,000 r.p.m. The vacuum gauge should show 7 to 12 inches of vacuum. If less than 7 inches of vacuum is obtained, the fuel pump should be removed and reconditioned. If fuel pump vacuum booster test is satisfactory, remove the special fitting and connect the lines to the vacuum booster.

Securing Test Instruments



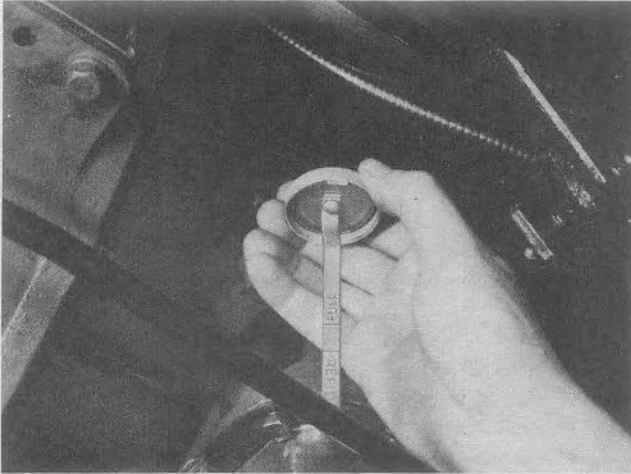
After all tests have been made, remove the exhaust unit hose from the panel fitting and permit the combustion booster to operate for 10 minutes with the hose off to clear out any condensation of exhaust gases. Turn all control switches to the "off" position. Roll up the test hose and test leads and place them in their proper location.

The engine may now be corrected to peak performance efficiency by performing the service operations found necessary through the engine diagnosis.

PART III

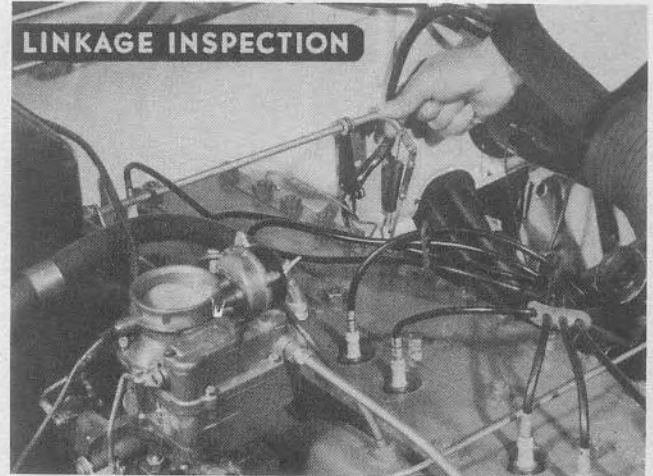
ULTRAMATIC DRIVE DIAGNOSIS

Fluid Level



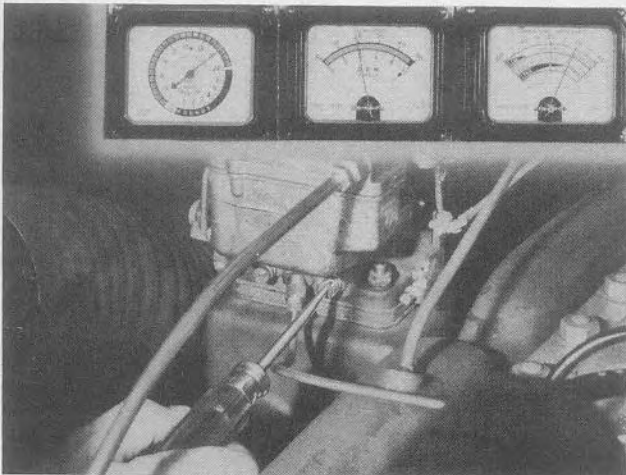
The fluid level should be checked and brought up to the full mark before any further diagnosis is made. Notice the condition of the fluid. Low fluid level can be the cause of many complaints ranging from excessive noise to a noticeable slip in any or all operating ranges. If frequent addition of fluid is required, inspect the torque converter and transmission to locate the leak.

Linkage Inspection



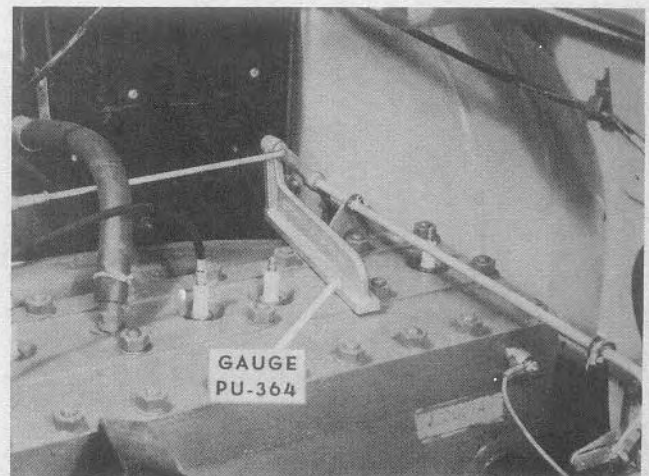
The control linkage and throttle valve linkage should operate freely. Correct adjustments cannot be made with worn or binding linkage. Replace the linkage with new parts if they are worn, and free up all points of pivot before attempting to make a correct adjustment.

Engine Idle



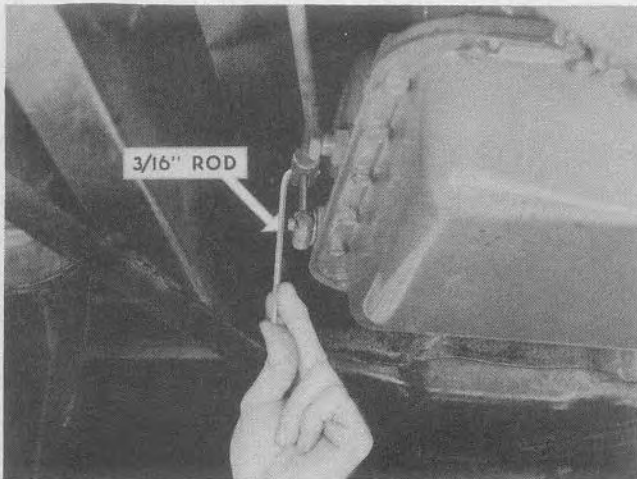
The engine and transmission should be properly warmed up. The engine should be idling properly at 375 r.p.m. in high range ("H") with the hand brake on, before checking the adjustments and performing pressure tests on the Ultramatic Drive.

Throttle Cross Shaft to Carburetor Rod Adjustment



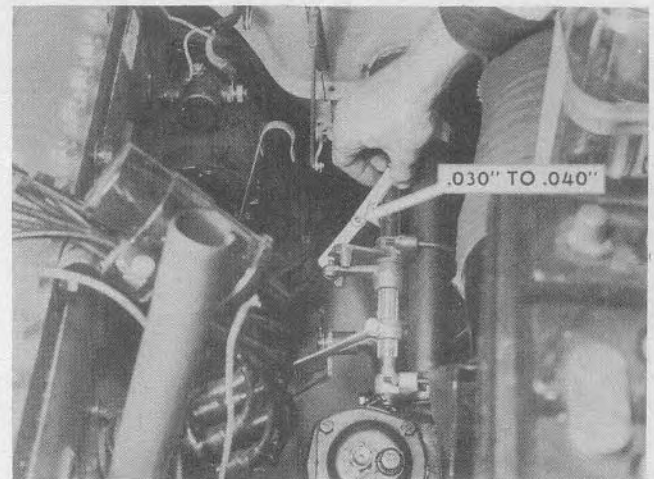
After the engine has been warmed up and properly idled, place the gauge PU-364 on the milled surfaces of the cylinder head, directly ahead of the bracket supporting the cross shaft. When the carburetor throttle rod is properly adjusted, the rear end of the rod will protrude through the cross shaft lever and enter the hole in the gauge.

Throttle Valve Adjustment



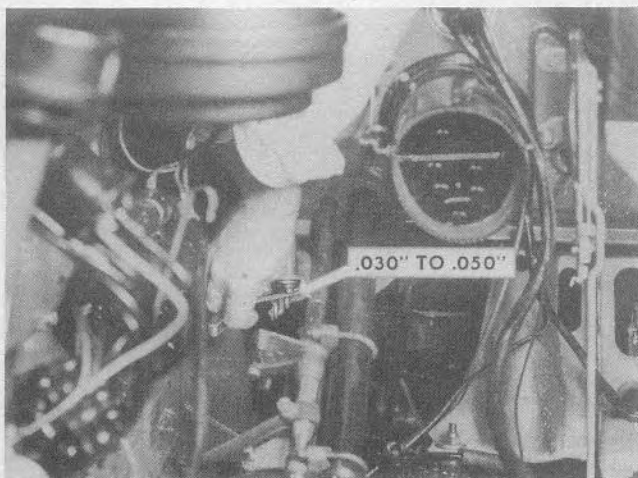
Disconnect the relay rod from the throttle valve lever at the rear of the right side of the transmission. Rotate the lever counterclockwise (toward the rear of the car) until the valve is closed against the spring. *Do not compress the spring.* If the adjustment is correct, a piece of rod or pin $\frac{3}{16}$ " diameter can be inserted snugly through the holes in the lever and relay rod.

Selector Control Linkage Adjustment



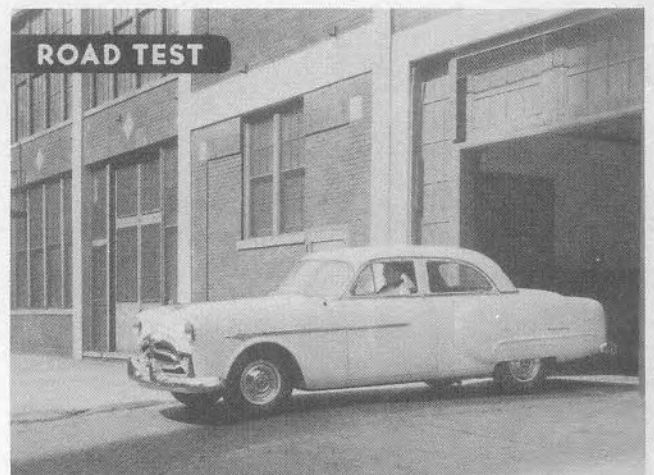
Place the steering column selector lever in the low range ("L") position. Be sure the detent plunger going into the well can be felt. When the selector rod is properly adjusted, the steering column lower selector lever stop will be .030" to .040" away from the stop on the bracket. Recheck the selector lever in the other positions. ("N") Neutral, ("R") reverse, and ("P") park should be possible without permanent overtravel when contacting stops.

Accelerator Relay to Cross Shaft Lever Rod Adjustment

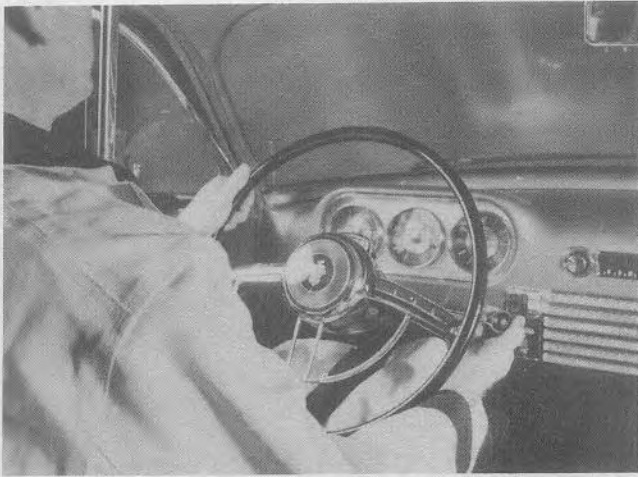


Depress the accelerator until the throttle valves in the carburetor are wide open. *Do not compress the spring in the spring loaded rod.* Holding the throttle wide open, measure the clearance between the accelerator cross shaft lever and the spring loaded stop. When the rod is properly adjusted, this clearance will be .030" to .050".

Road Test

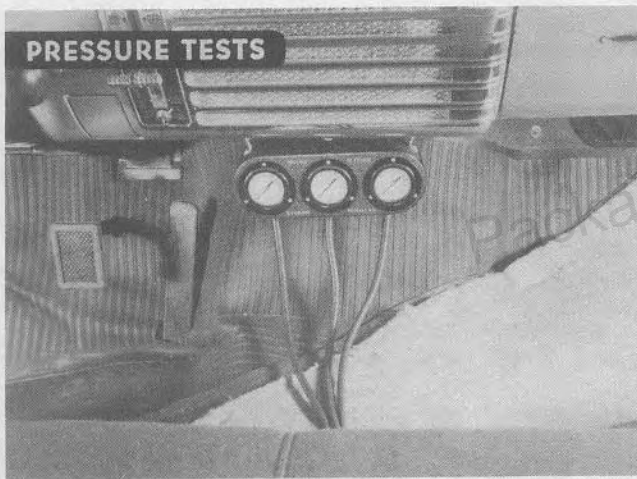


Drive the car with frequent stops and starts, at low speed, accelerating and medium speeds, similar to the conditions that would exist in driving in heavy traffic and highway driving. Note the engagement and disengagement of the direct drive clutch.

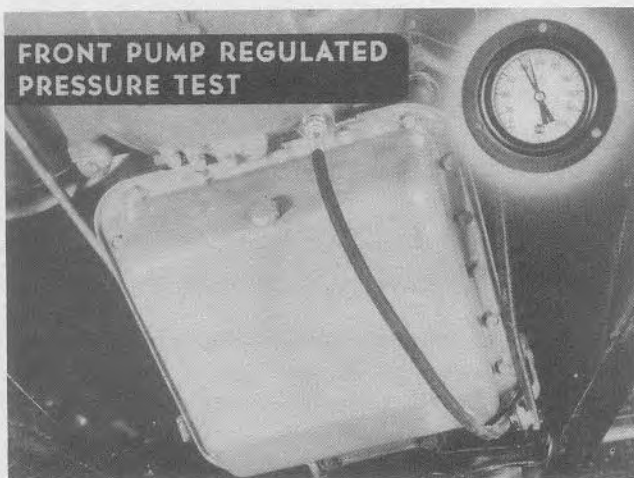


Make several shifts from low range to high range and vice versa, at part throttle, half throttle, and full throttle. Note the smoothness of range change, and the operation of the timing valve. The road test will also warm up the engine and transmission necessary to perform an accurate hydraulic pressure test.

Hydraulic Pressure Test Preparation



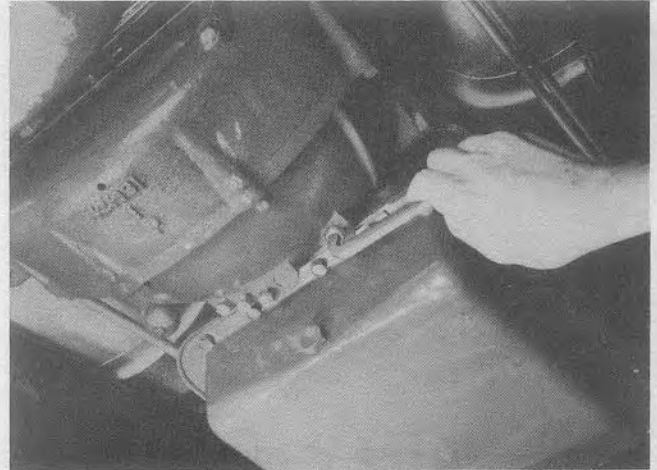
Raise the front floor mat and remove the transmission filler plug cover from the floor panel to permit entry



of pressure gauge lines into front compartment where the pressure gauges can be seen while driving. Support the gauges on the lower edge of the instrument panel.

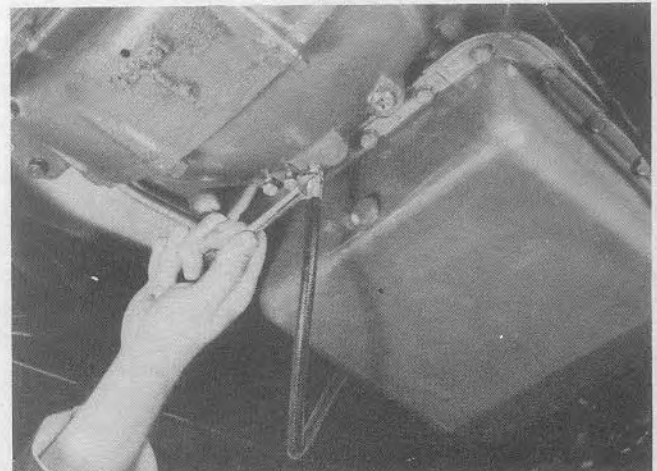
Front Pump Regulated Pressure Test

Remove the $\frac{3}{8}$ " pipe plug from the lower left side of the transmission bell housing. Insert a $\frac{3}{8}$ " to $\frac{1}{8}$ " pipe reducer. Connect the flexible pressure line from the gauge to the reducer. Start the engine and operate at 600 r.p.m. Observe the pressure reading on the gauge; the reading should be 80 to 90 pounds per square inch.



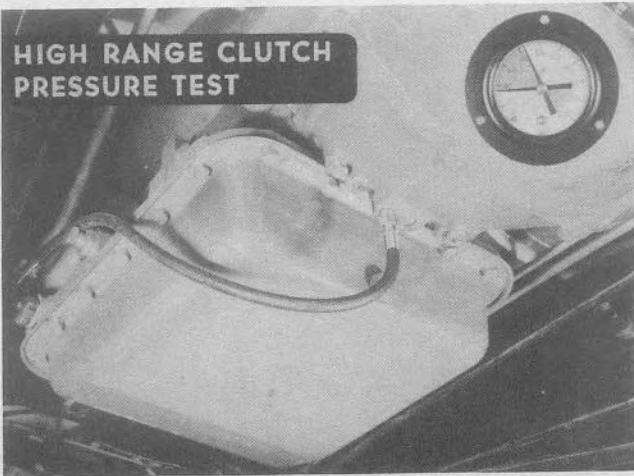
If the reading does not come within this range, correct the condition as described in the Trouble Shooting and Corrective Measures section of the Service Manual. If the pressure reading is correct, remove the pressure gauge, flexible line and reducer. Install the $\frac{3}{8}$ " pipe plug and continue with the other tests.

High Range Clutch Pressure Test



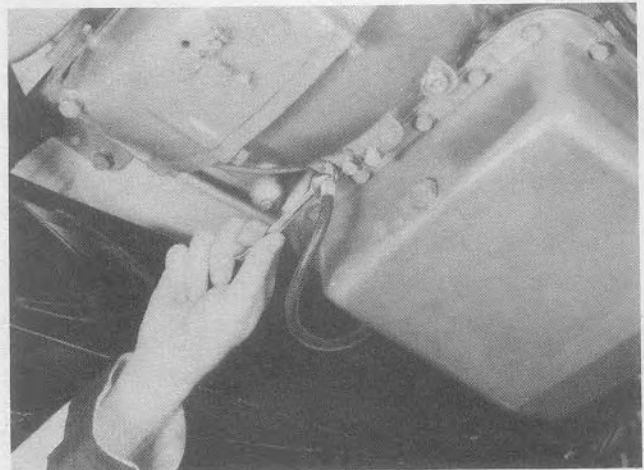
With the pressure gauge supported inside the front compartment, remove the $\frac{1}{8}$ " pipe plug at the center of the lower rear end of the transmission bell housing. This plug is located just to the right of the front pump outlet passage plug. Connect the pressure gauge flexible line to this opening.

HIGH RANGE CLUTCH PRESSURE TEST



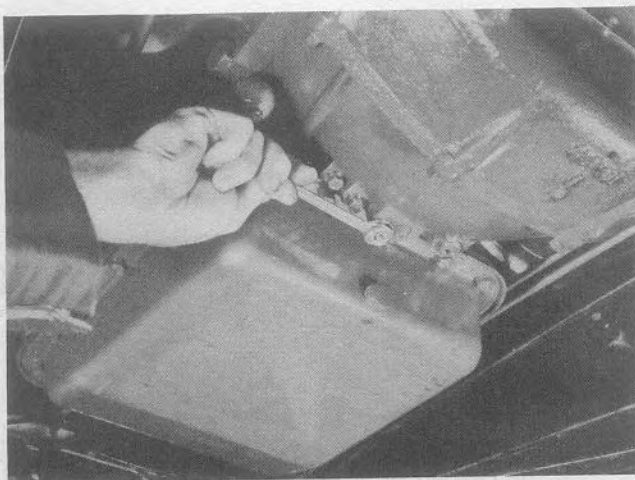
Road test the car. With the engine running at idle, place the control lever in the ("H") high range position. Observe the reading on the gauge. The pressure should be approximately 35 to 43 p.s.i. with the throttle closed, and approximately 85 p.s.i. with the throttle wide open. Repeat this test, operating the car in low range at first and then shifting to high range.

Front Pump Relief Valve Boost Pressure Test



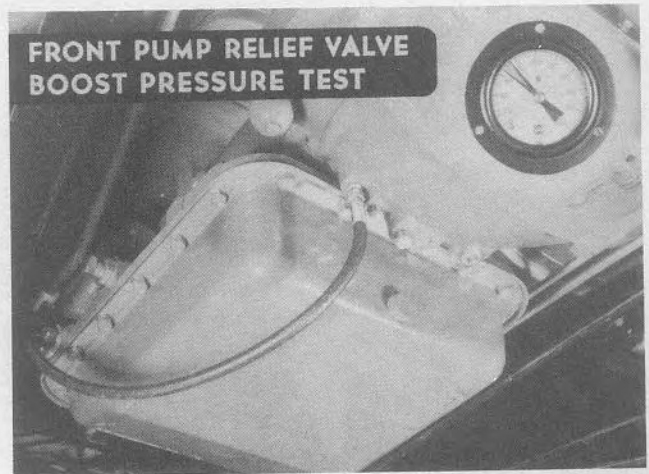
With the pressure gauge supported inside the front compartment, remove the $\frac{1}{8}$ " pipe plug at the lower right rear end of the transmission bell housing. Connect the pressure gauge flexible line to this opening.

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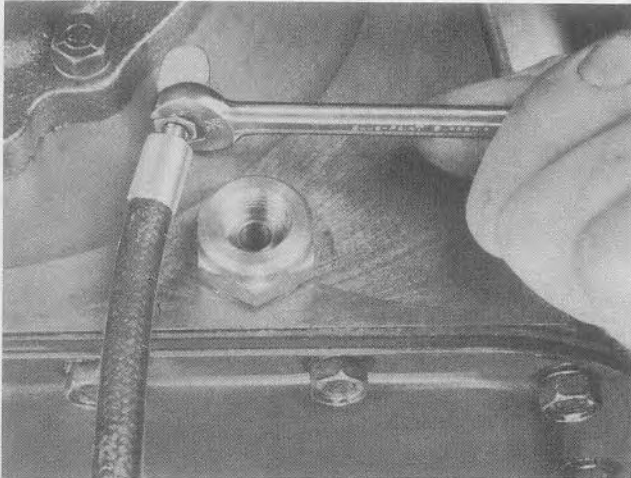
If the readings do not come within this range, correct the condition as described in the Trouble Shooting and Corrective Measures section of the Service Manual. If the readings are correct, disconnect the flexible line and install the $\frac{1}{8}$ " pipe plug. Continue with the other tests.

FRONT PUMP RELIEF VALVE BOOST PRESSURE TEST

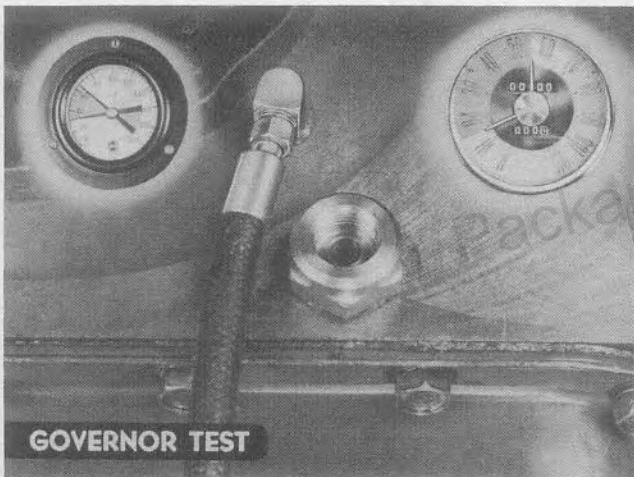


Start and operate the engine at 600 to 1,000 r.p.m. Observe the reading on the gauge. The pressure should be 65 to 75 p.s.i. If the reading does not come within this range, correct the condition as described in the Trouble Shooting and Corrective Measures section of the Service Manual. If the reading is correct, disconnect the flexible line and install the $\frac{1}{8}$ " pipe plug. Continue with the other tests.

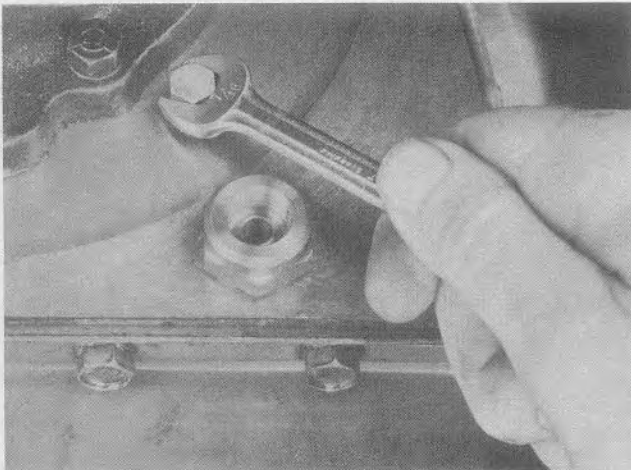
Hydraulic Governor Pressure Test



With the pressure gauge supported inside the front compartment, remove the $\frac{1}{8}$ " pipe plug at the right rear end of the transmission case, just to the rear of the hydraulic governor. Connect the gauge flexible line to this opening.



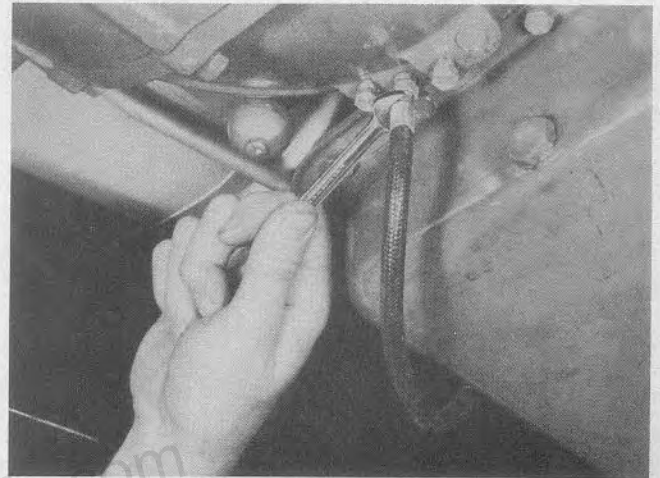
Road test the car at various speeds above 15 m.p.h. Observe the reading on the pressure gauge. The readings at the various speeds should be in direct proportion to the car speed, and should come within the range



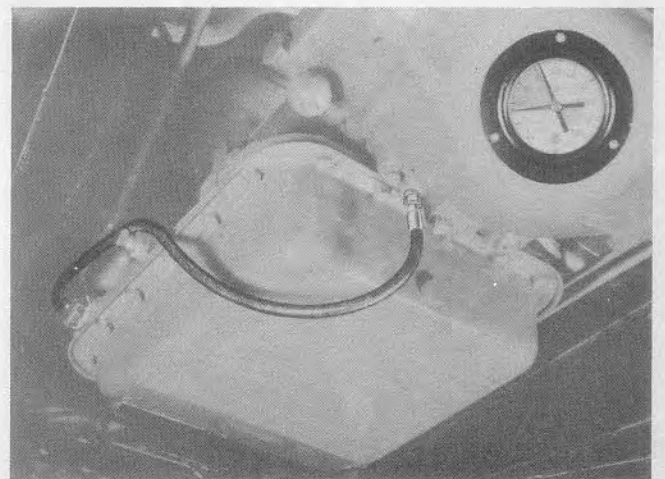
of approximately 31 p.s.i. at 15 m.p.h., and 65 p.s.i. at 56 m.p.h.

If the readings do not register in direct proportion to car speed, or if they do not come within the specified range, correct the condition as described in the Trouble Shooting and Corrective Measures section of the Service Manual. If the readings are correct, disconnect the flexible line and install the $\frac{1}{8}$ " pipe plug. Continue with the other tests.

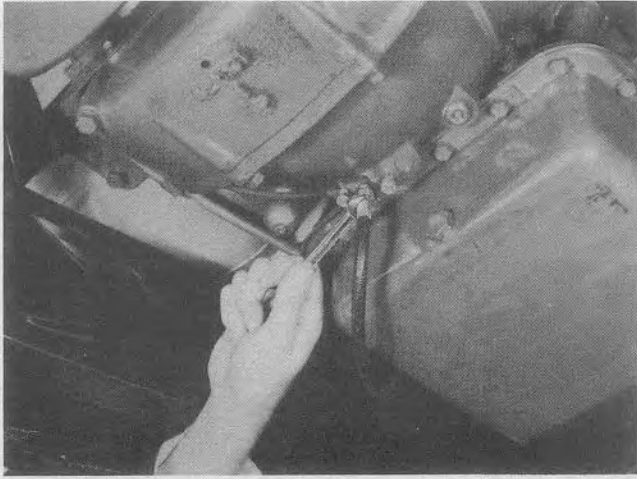
Direct Drive Clutch Pressure



With the pressure gauge supported inside the front compartment, remove the $\frac{1}{8}$ " pipe plug, just to the right of the center of the lower rear end of the transmission bell housing. This plug is located to the right of the high range passage plug. Connect the pressure gauge flexible line to this opening.

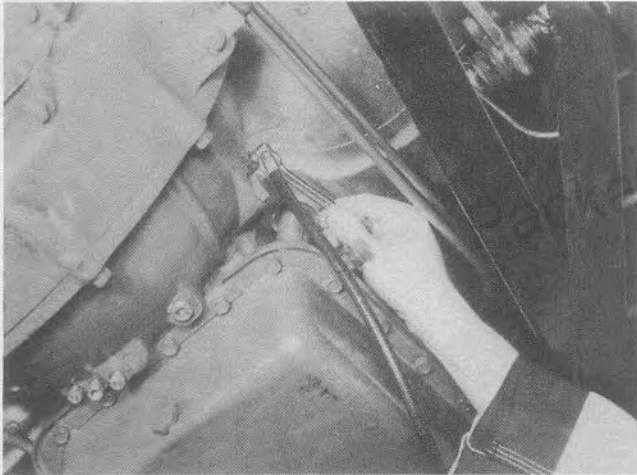


Road test the car at light throttle opening. At speeds between 15 to 18 m.p.h. steady driving and light engine load when the clutch engages, the reading on the gauge should be approximately 33 to 41 p.s.i. At full throttle engagement at approximately 56 m.p.h., the reading on the gauge should be approximately 85 p.s.i.

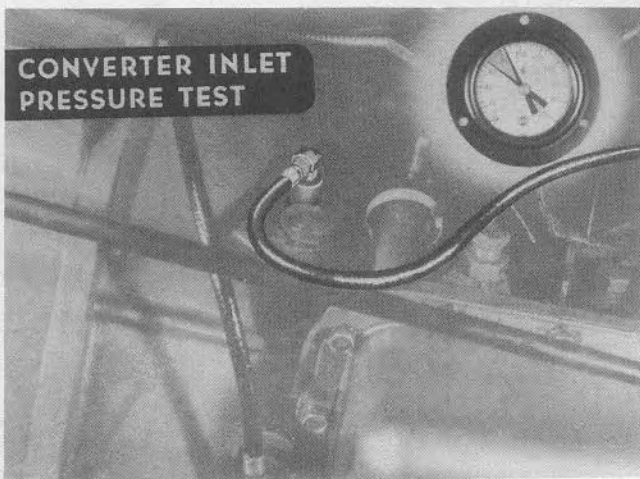


If the readings do not come within this range, correct the condition as described in the Trouble Shooting and Corrective Measures section of the Service Manual. If the readings are correct, disconnect the flexible line and install the $\frac{1}{8}$ " pipe plug. Continue with the other tests.

Converter Inlet Pressure Test



With the pressure gauge supported inside the front compartment, remove the $\frac{1}{8}$ " pipe plug at the upper

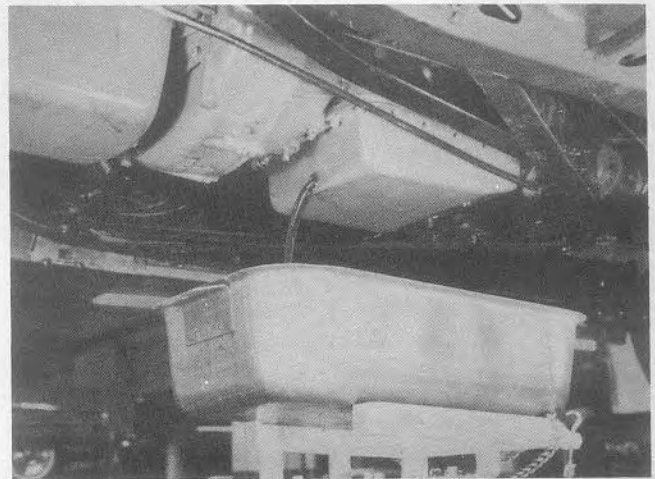


left side of the bell housing. Connect the pressure gauge line to this opening. Because of the related operation of the governor, direct drive clutch, and converter "in" pressure, these three pressure readings should be taken at the same time.

Start and operate the engine at 600 r.p.m. Observe the reading on the gauge. The pressure should be 65 to 80 p.s.i. in converter operation in "L" or "H" range, but should drop to 8 to 15 p.s.i. when the direct drive clutch engages. The converter "in" pressure should be 40 to 45 p.s.i. during reverse ("R") operation. If the reading does not come within this range, correct the condition as described in the Trouble Shooting and Corrective Measures section of the Service Manual. If the reading is correct, disconnect the flexible line and install the $\frac{1}{8}$ " pipe plug. Continue with the other tests.



NOTE: The next three tests, including the throttle valve pressure, low range application pressure, and reverse application pressure, require the removal of the transmission oil pan to connect the flexible gauge lines. It is recommended for this test to use a three gauge panel and to make all three tests at the same time.

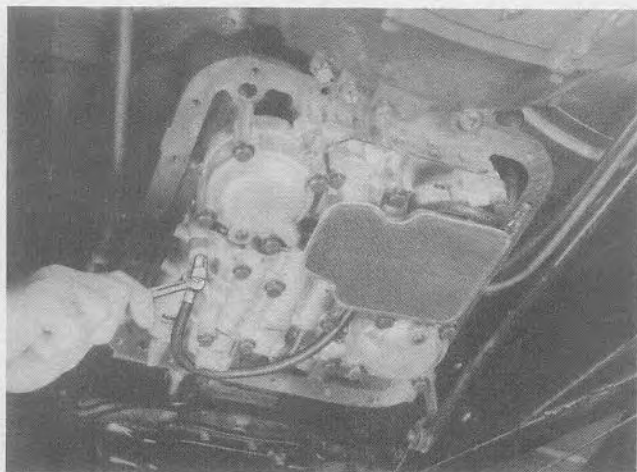


However, a single gauge may be used, removing and installing the pan for each test. The pressure gauge

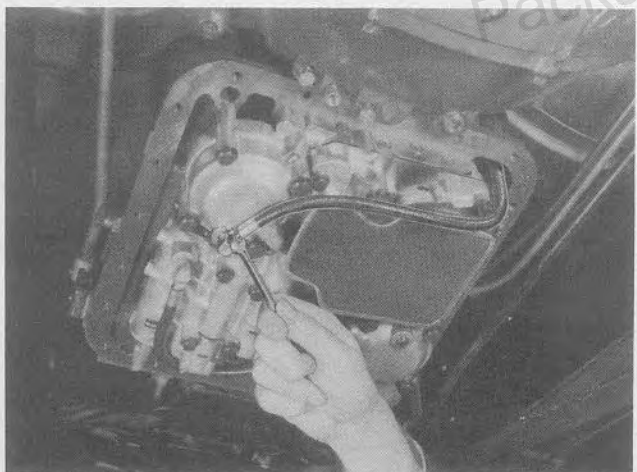
flexible lines may be inserted into the transmission through the oil filler tube, and the test pan installed after they are connected to their respective openings. Drain the transmission and remove the oil pan.

CAUTION: Be sure to use a gauge of 0-200 p.s.i. scale or over for the reverse application test.

Throttle Valve, Low Range, and Reverse Pressure Tests

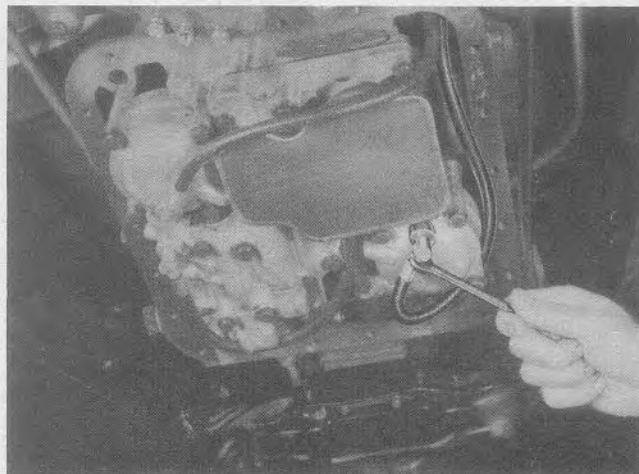


Remove the $\frac{1}{8}$ " pipe plug from the throttle valve body and install the gauge line 90° fitting. Insert the gauge lines through the oil filler tube and connect the number 1 gauge line to this fitting.



Remove the $\frac{1}{8}$ " pipe plug from the low range cylinder body located at the right front end of the control valve upper body. Install the 90° fitting into the opening and turn it so that it will align with the indentation in the test pan. Insert the number 2 gauge line through the oil filler tube and connect it to the fitting.

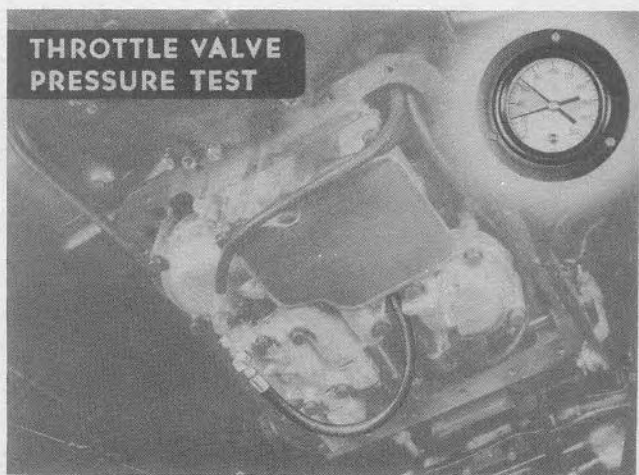
Remove the $\frac{1}{8}$ " pipe plug from the reverse cylinder body located at the left rear end of the control valve upper body. Install the 90° fitting into the opening and turn it so that it will align with the indentation in the test pan. Insert the number 3 gauge line through



the filler tube and connect it to the fitting. Be sure to use a test gauge of 0-200 p.s.i. minimum scale.

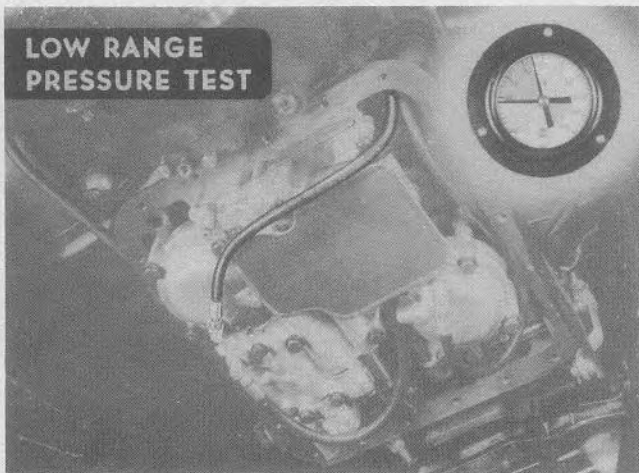


Install the test pan using a new gasket. Install the Ultramatic Drive fluid in the transmission. Road test the car under conditions similar to those driving in heavy traffic, parking, using low range, reverse, etc. Observe the readings on the gauges.

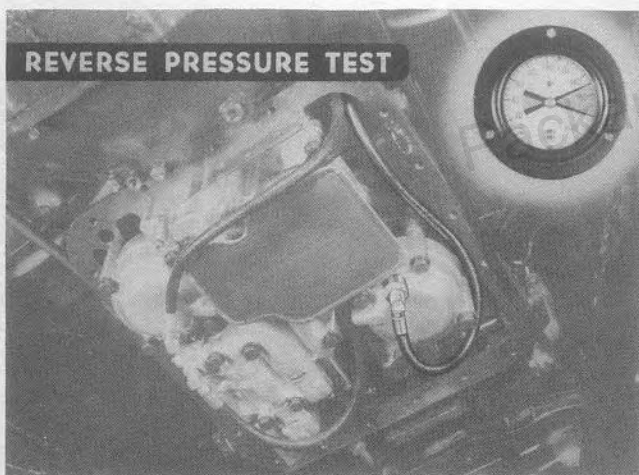


The reading on gauge number 1, which is connected to the throttle valve, should read in direct proportion

to throttle opening, ranging from 24 to 28 p.s.i. at closed throttle, to 54 to 63 at full throttle, and 80 to 90 p.s.i. during kick-down.

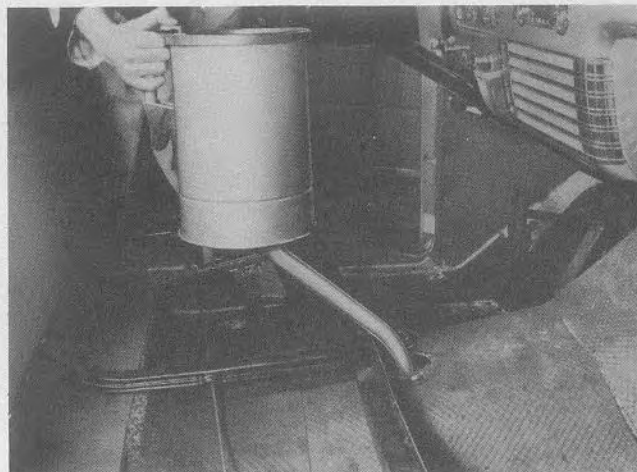


The readings on the number 2 gauge, which is connected to the low range cylinder body, should be from approximately 35 to 45 p.s.i. when the low range band application starts, to 80 to 90 p.s.i. at full throttle.

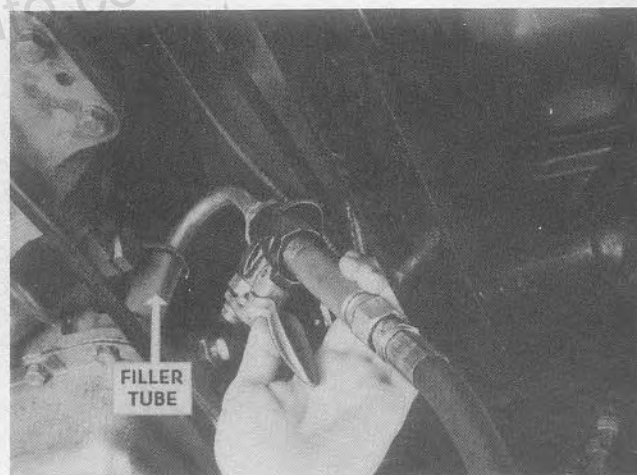


The reading on gauge number 3, which is connected to the reverse cylinder body, should read approximately 150 to 180 p.s.i. when operating in reverse at 1,500 engine r.p.m. If the readings on the gauges do not come within limits, recommend the necessary operations to correct this condition as outlined in the Trouble Shooting and Corrective Measures Section of the Service Manual.

After Completing the Tests



If the readings are correct, drain the fluid and remove the test pan. Disconnect the gauge lines and remove the fittings. Remove the test gauges. Install the $\frac{1}{8}$ " pipe plugs and tighten securely. Install the transmission pan using a new gasket. Pour the fluid back into the transmission, provided the fluid is clean. If the fluid is dirty, has a lot of particles in it, or the car has been driven approximately 20,000 to 25,000 miles on the fluid, recommend a fluid change.

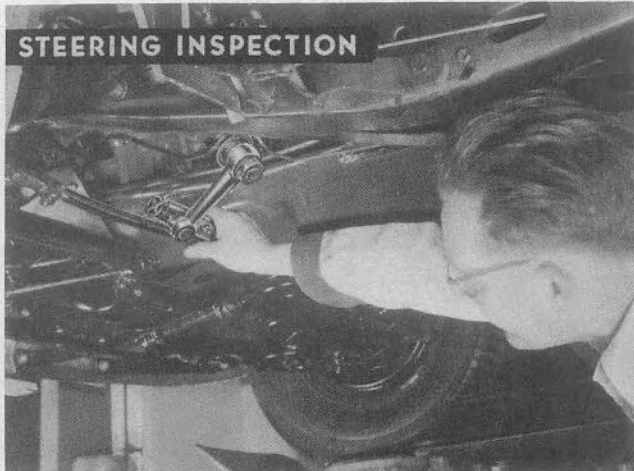


Fill the Ultramatic Drive to the proper level with the fluid. Install the transmission filler plug cover. Install the front mat or carpet. Be sure the Ultramatic Drive is operating normally and that all service recommendations are made to the owner when the car is delivered to the owner.

PART IV

COMPLETE VEHICLE DIAGNOSIS

Suspension and Steering Inspection



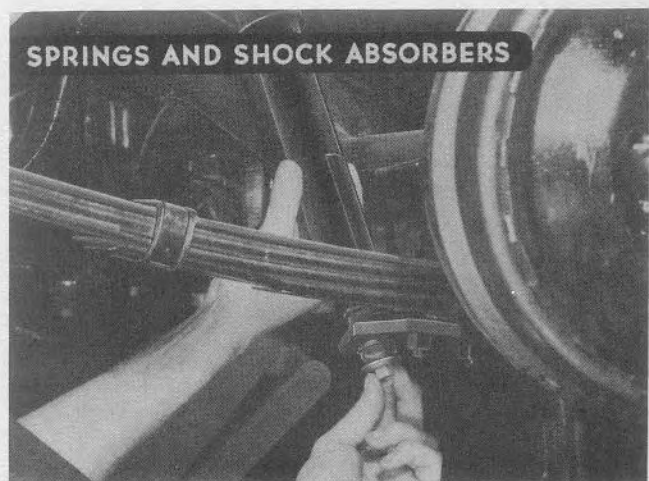
Jack up the front end of the car and check the front wheel bearing adjustment. Check the steering gear for adjustment and high spot in the straight ahead position. Check the steering rods and connections for binding, looseness or wear. Note any unsatisfactory conditions. Inspect all tires for inflation, cuts, bruises, cups, scuffing, gouges and abnormal wear. Note any unsatisfactory condition.



Test the wheel balance of all wheels, using a wheel spinner, or an electronic balance tester. Inspect the condition of the universal joints, propeller shaft, and rear axle.



Place the car on a level floor or alignment rack. Check the caster, camber, and toe-in according to the alignment equipment manufacturers' instructions. Compare these readings with the specifications in the Packard Service Manual.

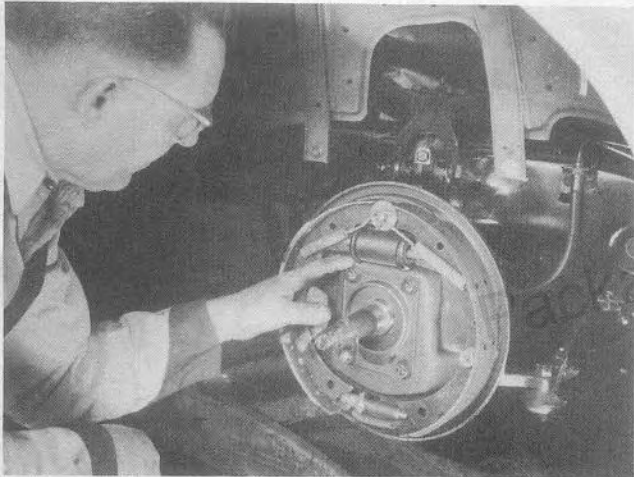


Test all shock absorbers. Check for normal resistance in pairs. Install new shock absorbers if necessary. Check the condition of all springs. Examine to see that front springs are seated in the lower support arm seat. Note any unsatisfactory or non-standard conditions.

Brake Inspection



Remove one front wheel and inspect the brake drum and lining for wear, scores, glaze, and grease on the linings. Note any unsatisfactory or non-standard condition.

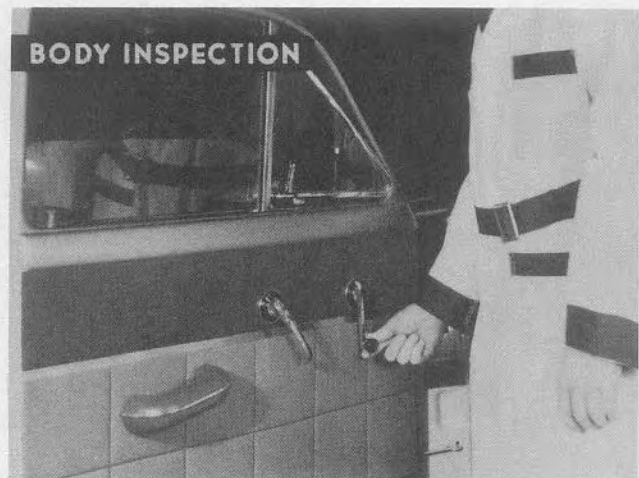


Inspect the condition of the wheel cylinders, brake tubes, cables and master cylinder. Fill the master cylinder with brake fluid.

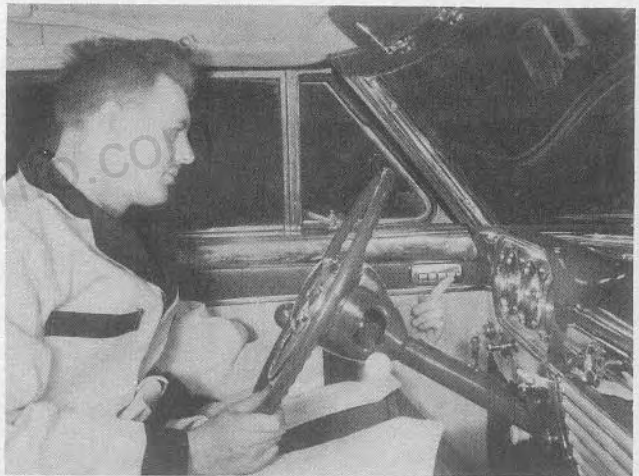


Inspect the condition of the front wheel bearings and oil seals. Relubricate the front wheel bearings. Note any unsatisfactory or unsafe condition.

Body Inspection



Test the operation of all window regulators by running them up and down. Test the vent wings for proper operation and locking. Test the operation of all door locks, and the operation of the inside and outside lock handles. Test the operation of all lock cylinders and keys. Note any unsatisfactory conditions.

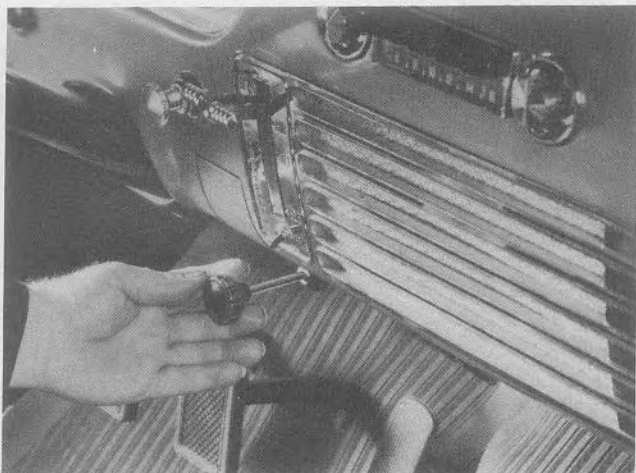


On all convertibles, test the operation of all the units of the electro-hydraulic system. Test the operation of the top and the seat adjustment. Inspect the system for leaks. Note any unsatisfactory conditions.



Inspect the fit of all doors. Inspect the fit of the bonnet to the cowl and fenders. Test the operation of the bonnet locking mechanism. Inspect the car interior and exterior appearance. Note the condition of the sheet metal parts and paint condition. Note any protective requirements.

Road Test



Test the engine performance during curb idle, acceleration and steady driving. Test for over-all silence of operation. Test the operation of the overdrive. Note the operation from standing start, during acceleration, engagement, disengagement and lock-out operation.



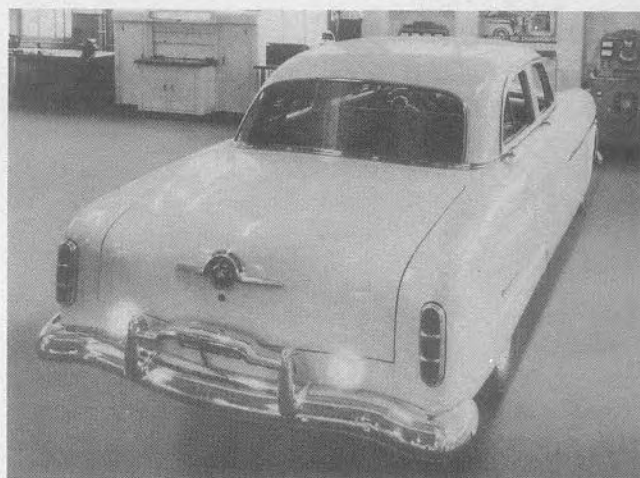
Test the illumination of the tail and stop lights. Test the illumination of the license light and parking lights. Test the operation of the directional signal lights and switch. Install the necessary new bulbs, and note any faulty electrical connections if found. Test the illumination of the instrument panel lights and the ignition switch locating light. Test the operation of the body dome light, courtesy lights, and switches.

COURTESY INSPECTION

Lighting System



Test the illumination and aim of the headlights, so the center of the headlight beam hot spot drops 3 inches below the bulb level at 25 feet, when the foot dimmer switch is in the upper beam position.



Test the illumination of the backing light, fog lights, driving lights, and spot light. Replace any burned out bulbs and note any faulty wiring connections.

Test the operation of all the instruments. Note the operation of the speedometer charging indicator, oil pressure indicator, temperature gauge, fuel gauge, and clock.

Accessories



Test the operation of all accessories. Note the tuning and tone of the radio, and check the operation of the push buttons as well as the operation of the antenna. Test the operation of the heater, defroster, and controls.



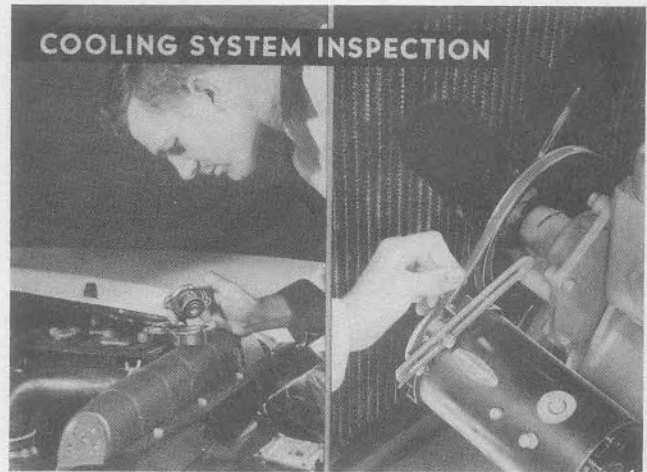
Test the windshield wipers for satisfactory and normal operation. Make sure the blades wipe a clean sweep across the windshield without striking at either end. Note any abnormal lash in the operating cables. Test the horns for satisfactory operation and suitable tone. Check the clearance between the horn blowing ring and the steering wheel.



Exhaust System

Test the entire exhaust system for leaks and alignment. Note the condition of the exhaust pipe, muffler, and tail pipe. Test the operation of the manifold heat control.

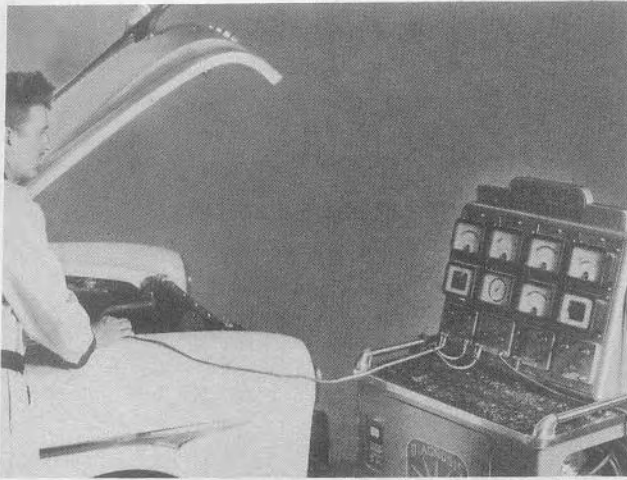
Cooling System



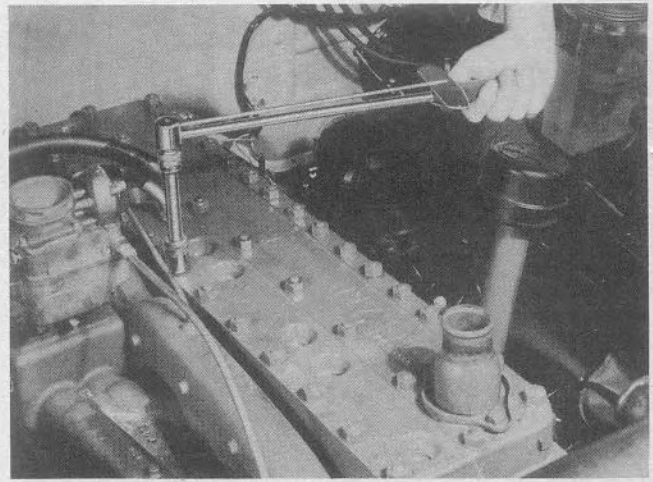
Inspect the condition of the cooling system for scale and rust formation inside the radiator. Examine the condition of the radiator and heater hoses. Inspect the condition and adjustment of the fan belt. Note if the belt is worn, cracked, or frayed. Recommend any necessary corrective repairs.



To maintain good customer relations and an ever increasing service volume: The service department must be clean and adequately equipped.



Make accurate diagnosis according to Factory recommendations.



Perform the service operations according to the recommended procedure in the Packard Service Manual.



Recommend and sell the service operations actually needed. Write the repair order clearly and completely.



Make sure that the steering wheel, gear shift lever, and driving controls are *clean* and that the upholstery, fenders, and bonnet are not soiled when the car is delivered to the owner. The use of steering wheel, seat, and fender cover helps to keep the car clean.

This bit of courtesy and consideration goes a long way toward maintaining Packard owner good-will and assuring the owner's return for future service.



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