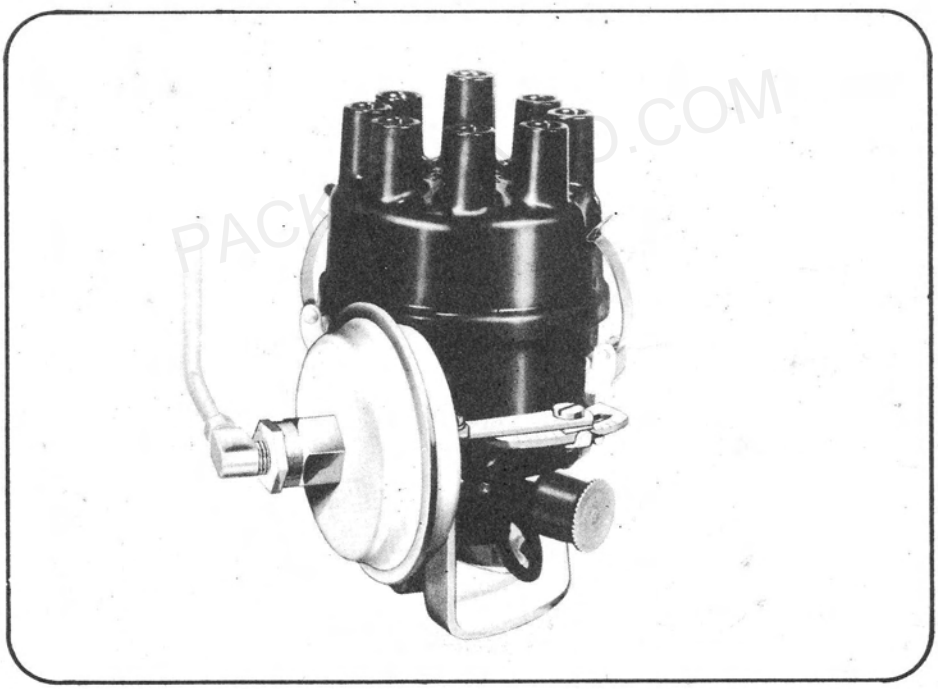
APPROVED Packard SERVICE

SERVICE TRAINING PROGRAM

Serviceman's Training Booklet

IGNITION SYSTEM

19th, 20th, AND 21st SERIES



APRIL...1947

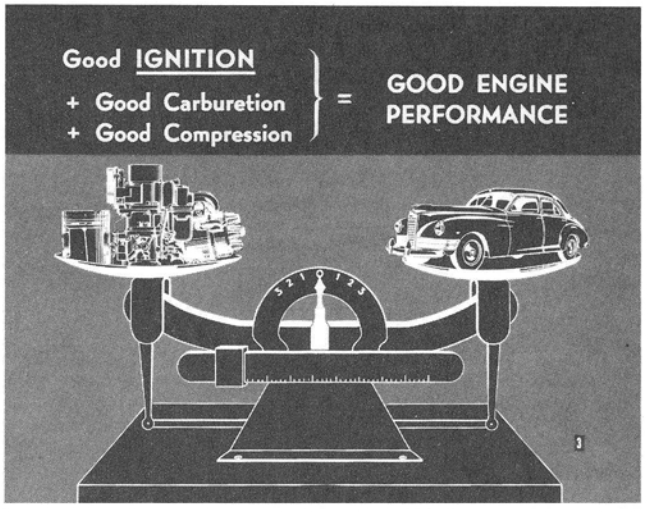
PARTS AND SERVICE DEPARTMENT

PACKARD MOTOR CAR COMPANY

DETROIT · 32 · MICHIGAN

PART I

Construction and Operation

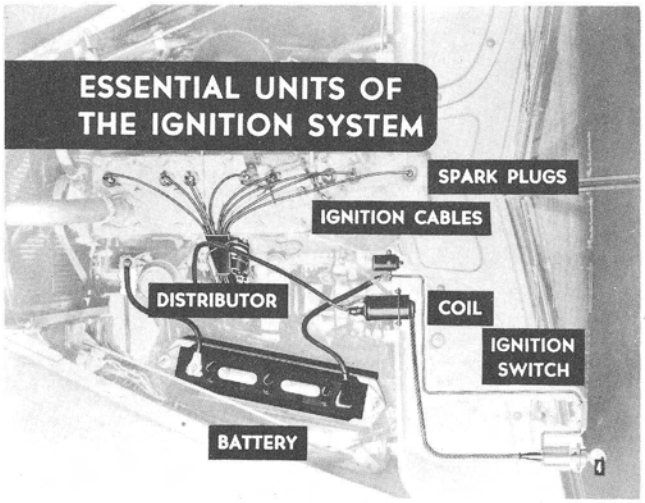


Good ignition, plus good carburetion, plus good compression, equals good engine performance. Good engine performance can be obtained only when all three are functioning properly.

Since good ignition is one of the requirements of good engine performance, the function, construction, and operation of the ignition system must be clearly understood, so that an accurate diagnosis of ignition troubles can be made and the ignition system can be properly serviced.

The function of the ignition system is to provide a spark of the correct intensity at the proper time to ignite the mixture of fuel and air in the cylinder.

Description



The ignition system of Packard cars consists of the following essential units:

(a) A battery and generator as the source of power.

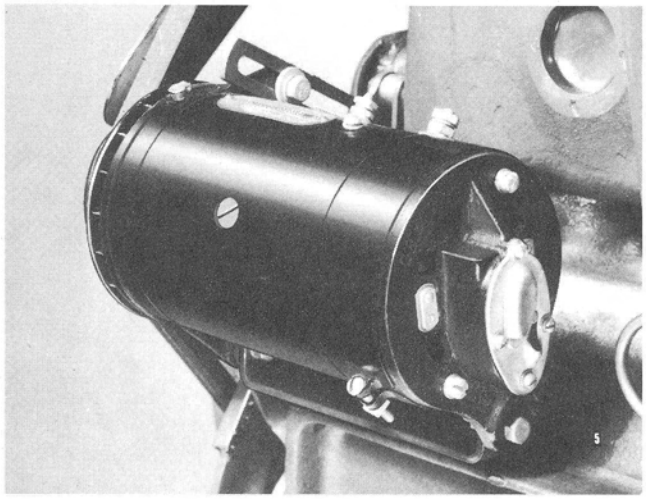
(b) An ignition switch to control the starting and stopping of the engine.

(c) An ignition coil to step up the voltage.

(d) A distributor to direct the spark to the proper spark plugs at the correct time.

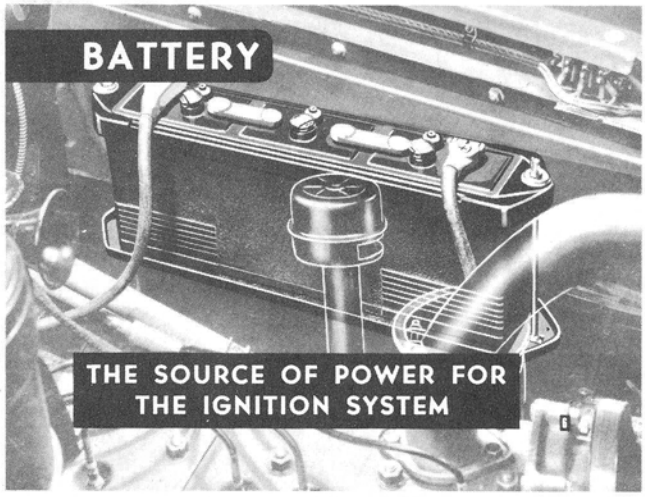
(e) Ignition cables to carry the current to the spark plugs.

(f) Spark plugs to ignite the mixture.

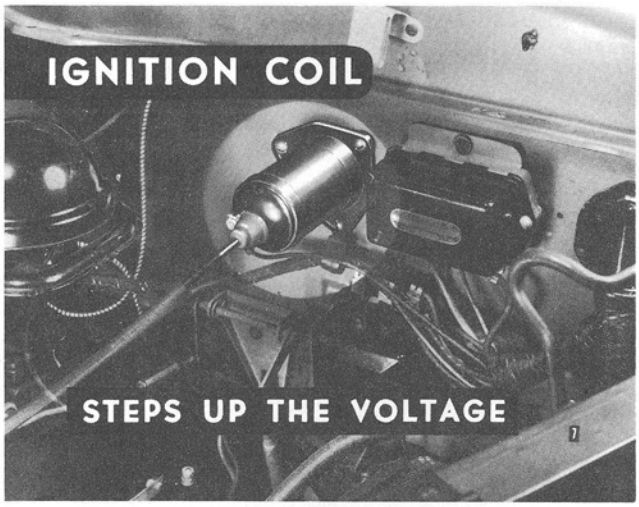


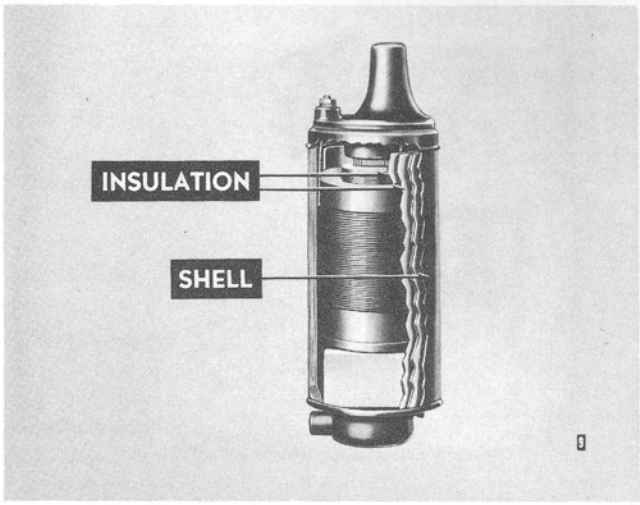
Actually the generator is the source of all electrical energy on the car. It supplies power for the ignition, lights, heater, radio, and other accessories. The battery stores some of the generated energy in chemical form to be used when the generator is not operating.

But, for the purpose of simplifying the ignition circuits, we will assume that the battery is the source of power for the ignition system.



The function of the ignition switch is to close and open the circuit between the battery and the ignition circuit. The voltage of the generator and battery is limited and is not great enough to cause a spark to jump the spark plug gap. Therefore, the voltage must be increased. This is accomplished by the use of an ignition coil.

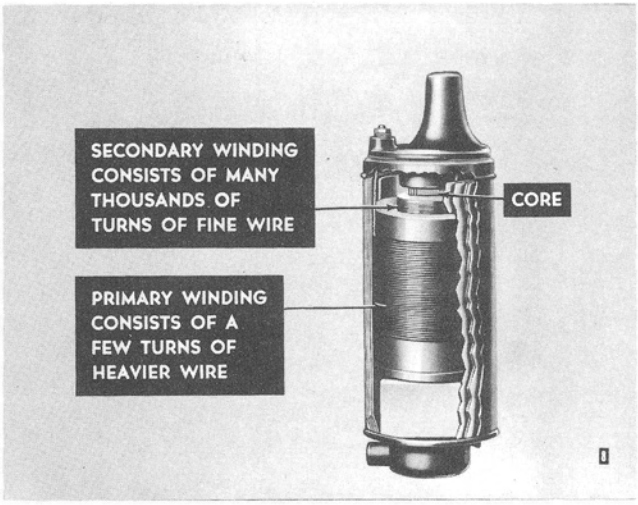


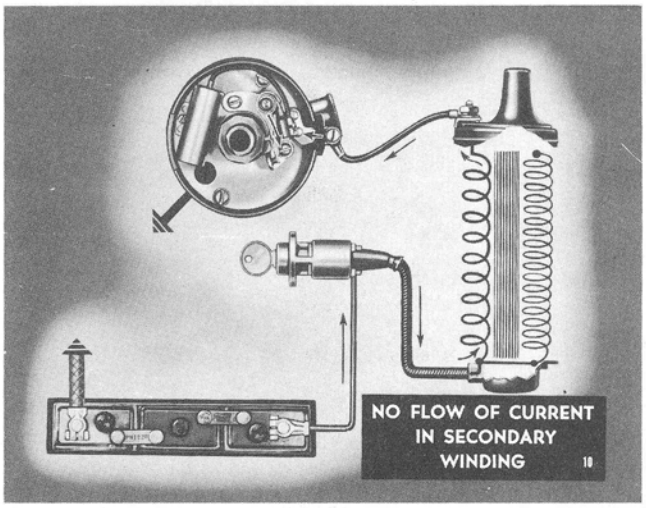


Ignition Coil

The function of an ignition coil is to transform the low voltage supplied by the battery into the high voltage necessary to jump the spark plug gap. In simple language, it is a transformer.

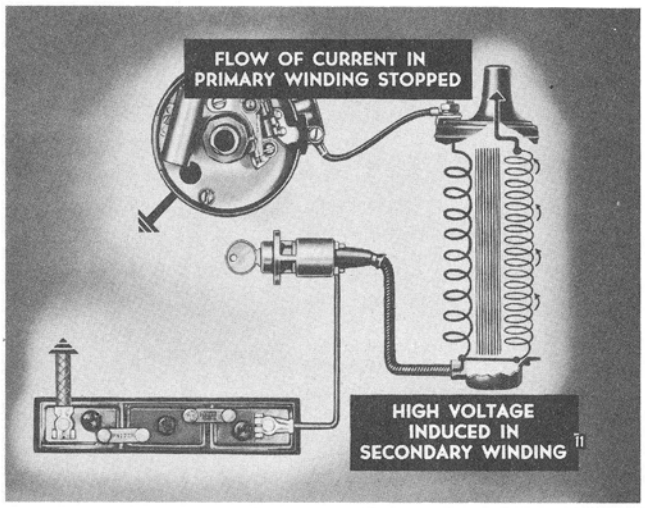
A soft iron shell encloses both windings and provides an outer path for the magnetic field. Thin insulation is placed between the winding layers of the primary and secondary windings and between the outside of the primary winding and the coil outer shell. The coil is a sealed unit to protect the windings from moisture and air.



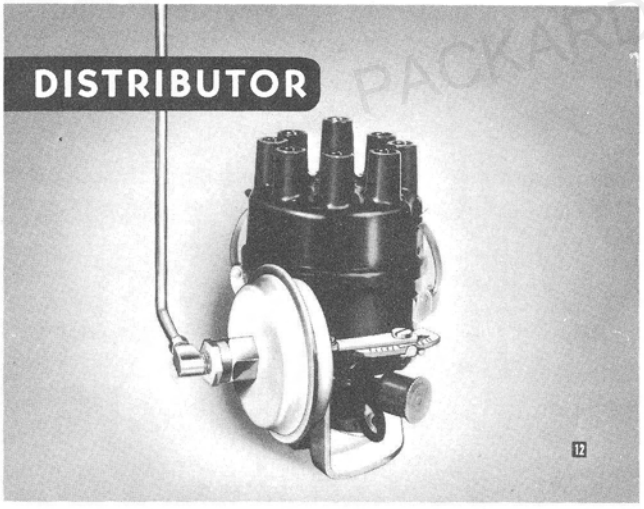


The ignition coil is an electrical unit having two windings, a primary and a secondary winding. The secondary winding, which consists of many thousand turns of fine wire, is wound around a soft iron core. The primary winding which consists of a few turns of heavier wire is wound over the secondary winding.

When the ignition switch is closed, current flows through the primary winding. As long as the flow of current is steady in the primary winding, there is no flow of current in the secondary winding.



But, if the flow of current is suddenly stopped in the primary winding, a high voltage will be induced in the secondary winding. The flow of current in the primary winding is stopped by the use of a set of breaker contacts which are connected in the primary circuit and are located in the distributor.

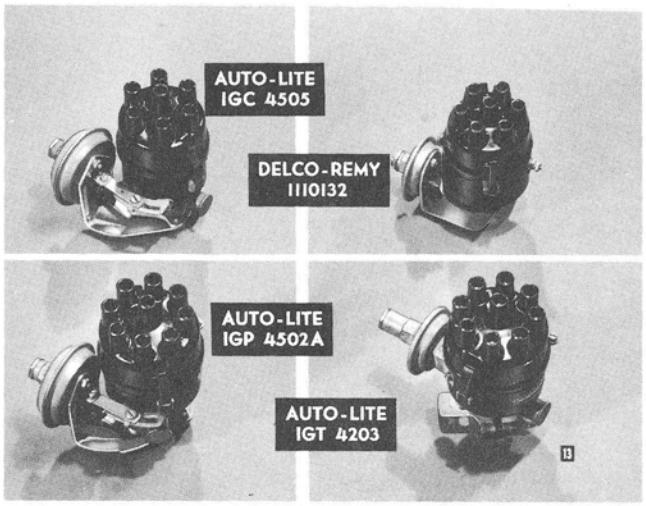


Distributor

The distributor has two functions:

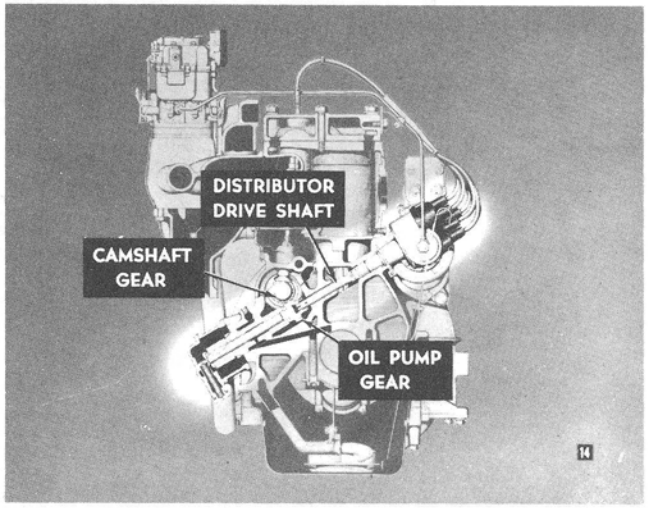
(1) To provide a ground for the primary circuit through the contact points and to interrupt the flow of primary current at the right time.

(2) To distribute the secondary high voltage to the proper spark plug at the proper time.



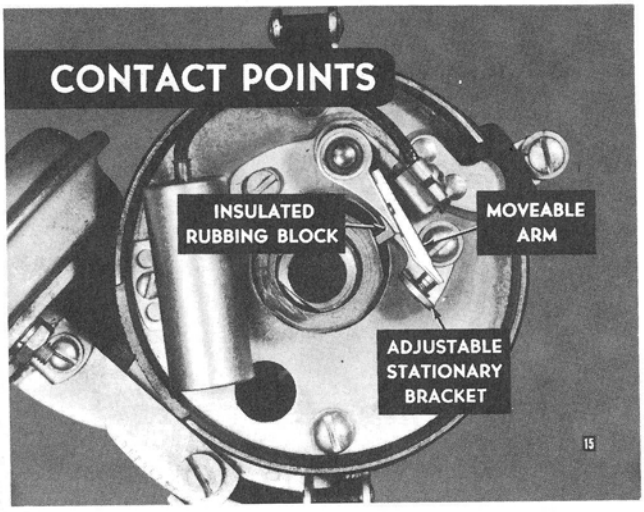
The Packard distributor is of the single breaker type using centrifugal governor advance and vacuum advance for automatic timing control.

Four models of distributors are used on 21st Series Packard cars. The Auto-Lite IGC 4505 and the Delco-Remy 1110132 are used on the Six, the Auto-Lite IGP 4502A is used on the Eight, and the Auto-Lite IGT 4203 is used on the Super Eight.

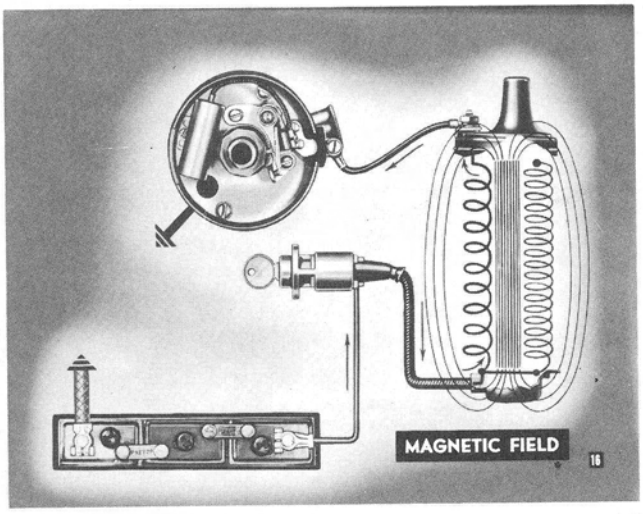


The distributor driveshaft is driven by a slotted coupling of the oil pump gear. The oil pump gear, which meshes with a gear on the camshaft, rotates the distributor shaft at camshaft speed which is one-half engine speed. The other end of the distributor shaft is connected through a governor mechanism to the distributor cam and rotor.

Primary Circuit

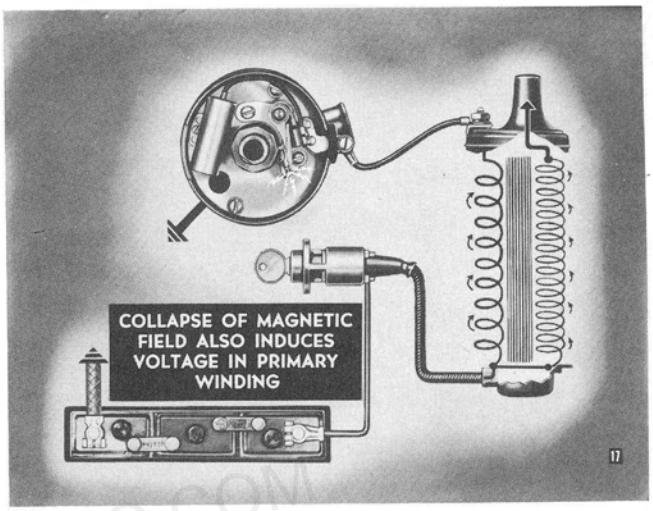


The distributor primary circuit contains a set of breaker contacts, one of which is on a stationary bracket but is adjustable, the other on a movable arm. The contacts are opened by the distributor cam acting against a molded insulated rubbing block attached to the movable arm. The contacts are closed by the action of a flat spring attached to the contact arm. The contacts are mounted on the distributor plate and are connected in the primary circuit.



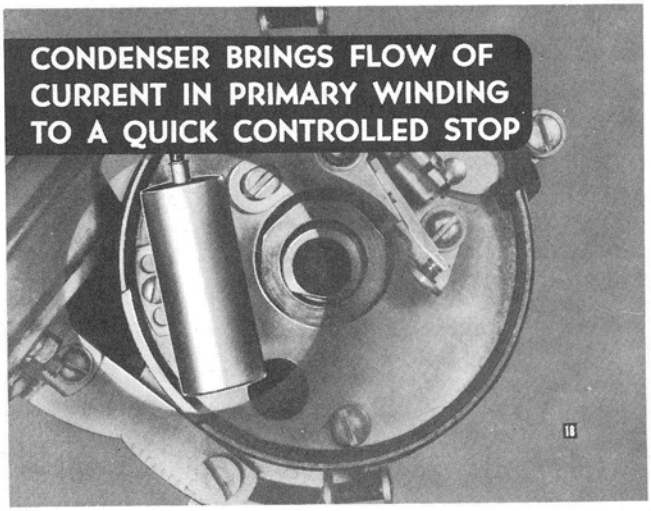
When the breaker contacts are closed, current flows through the primary winding creating a magnetic field around the primary winding. As the cam is rotated, it opens the contacts, breaking the primary circuit. This collapses the magnetic field around the primary winding and induces a high voltage in the secondary winding.

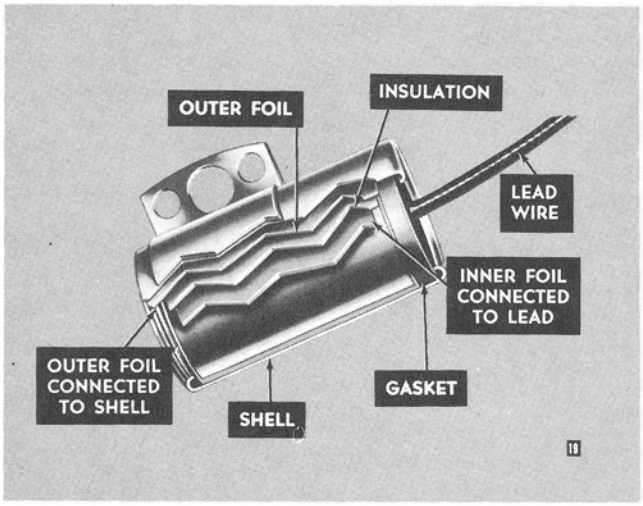
The collapse of the magnetic field also induces a voltage in the primary winding. The effect of this inductance is a tendency to keep current flowing in the same direction in the primary circuit. The voltage induced in the primary winding is great enough to cause an arc at the contact points. If it were not for the condenser, this arc would prevent the sudden collapse of the magnetic field and, consequently, a low secondary voltage.



Condenser

The condenser is provided to bring the flow of current in the primary winding to a quick, controlled stop. The condenser prevents arcing at the contacts by absorbing and momentarily holding a charge of primary current. When the condenser discharges the current, it speeds the collapse of the magnetic field and helps to induce the high voltage in the secondary winding.





The condenser is made up of two layers of metal foil, insulated by two layers of hallo wax impregnated paper. To save space, these layers of foil and wax paper are rolled into a small roll and enclosed in a small metal shell.

The outer layer of foil is connected to the outer shell which is grounded to the distributor plate and the inner foil is connected to a lead wire which is connected to the contact arm terminal. The condenser shell is sealed by a gasket to protect it from moisture and air. The gasket is retained by the crimped edge of the shell.

In addition to closing and opening of the contacts, the purpose of the distributor is to deliver the high voltage to the proper spark plug at the proper time.

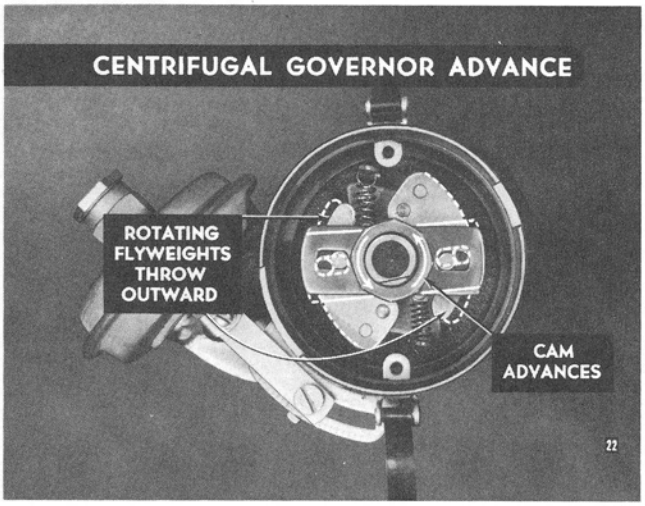
The exact instant at which the spark must occur for most efficient engine operation is determined by the:

(1) Speed of the engine.

(2) Throttle opening of the carburetor.

(3) Engine Load.

The exact ignition timing to satisfy these conditions is accomplished automatically by the centrifugal governor advance and vacuum advance mechanisms.

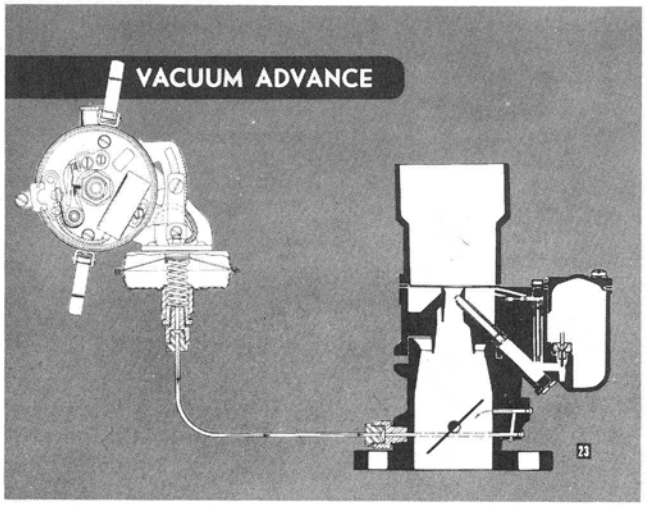


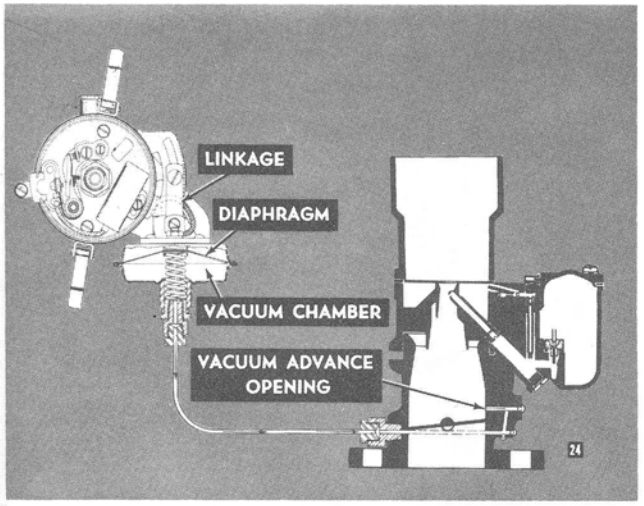
Centrifugal Governor Advance

The centrifugal governor advance is so designed that, as engine speed increases, the centrifugal force of the rotating flyweights will gradually throw the weights outwardly and will automatically advance the distributor cam in relation to the distributor shaft. The rate and amount of advance is controlled by the design and calibration of the flyweight springs and the centrifugal governor flyweights.

Vacuum Advance

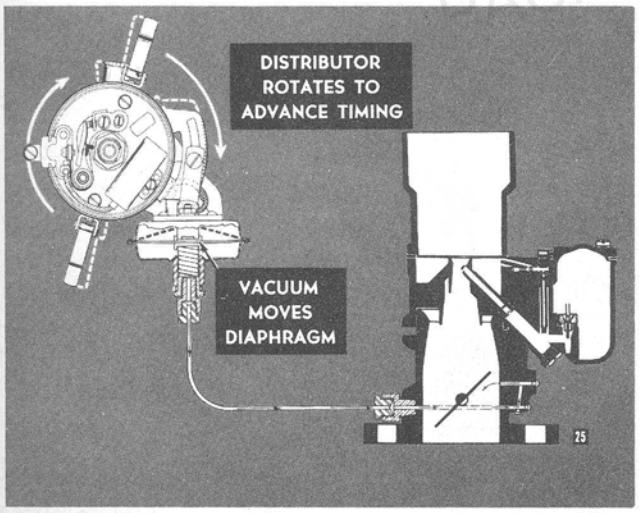
During part throttle (or part load) operation, there is a great vacuum in the intake manifold. Consequently, the charge taken into the cylinder is not so highly compressed as it is when the engine is under heavy load. With this condition, an additional spark advance will increase fuel economy. This is accomplished by the use of the "part load" advance or vacuum advance, as it is commonly known.



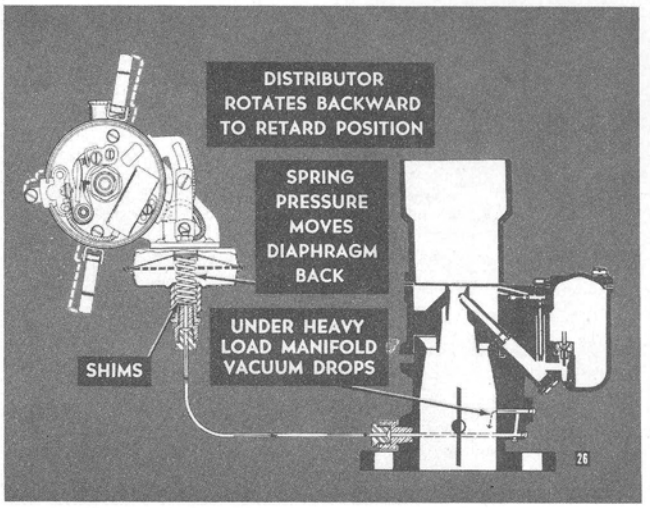


The vacuum advance mechanism consists of a spring-loaded diaphragm operating in a vacuum chamber and is connected through a linkage to a lever on the distributor. The chamber on the spring-loaded side of the diaphragm is air tight and is connected through a vacuum line to a small opening in the carburetor throttle body.

This opening is located just above the throttle valve when the throttle is in idle position. There is no vacuum at this opening during idle and, consequently, no vacuum advance.

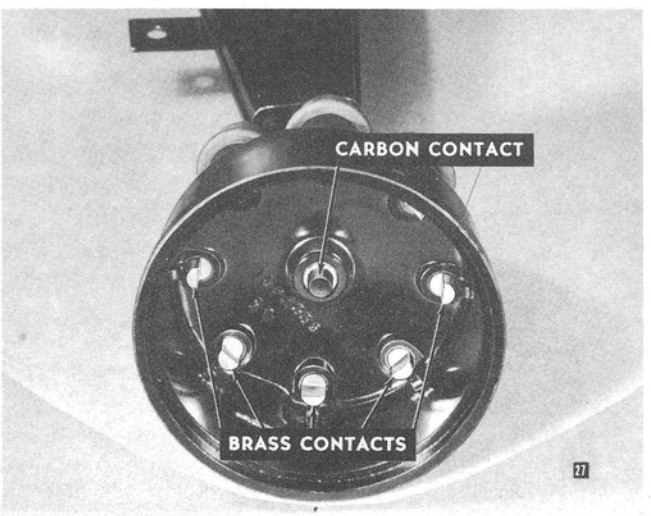


When the throttle is opened, it uncovers the opening of the vacuum passage, which is connected by a vacuum line to the distributor vacuum chamber. The vacuum acting on the diaphragm moves the diaphragm and compresses the spring in the chamber. The diaphragm, connected by a linkage, rotates the distributor in its mounting to advance the timing. On the Super Eight distributor, the vacuum advance mechanism rotates ONLY the breaker plate.



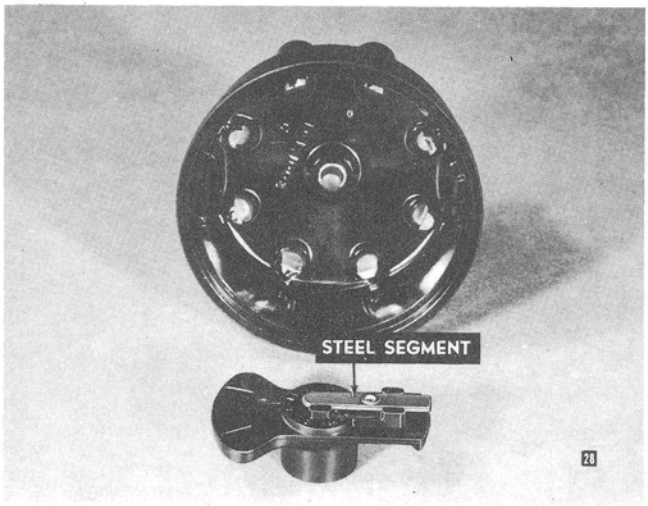
Under heavy load or full throttle operation, when the manifold vacuum drops, the spring pressure on the diaphragm will rotate the distributor backward, retarding the timing to prevent detonation. The spring load is calibrated to give most efficient operation under any operating condition. It is adjustable by the use of shims in the spring seat.

Secondary Circuit



Distributor Cap

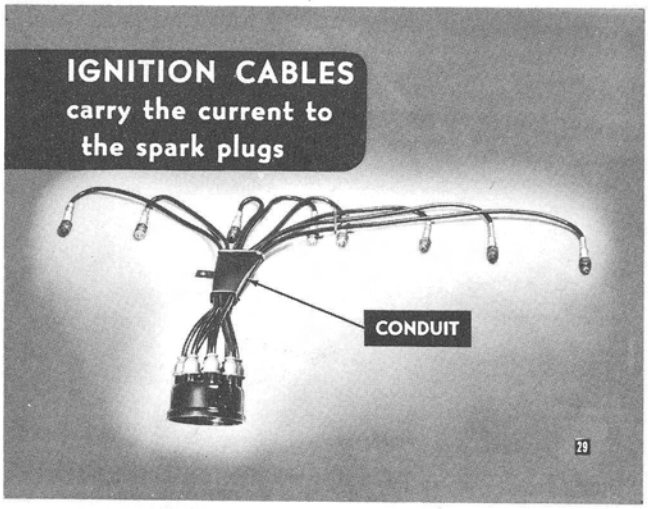
The distributor cap covers the distributor and is molded of a non-conductive material. It contains one center carbon contact, to which the secondary wire from the coil is connected, and a series of brass contacts, each of which is connected to a spark plug by a spark plug cable in the correct sequence of the firing order of the engine.



Distributor Rotor

The rotor also is molded of a non-conductive material. It carries a steel segment that makes contact between the center contact of the distributor cap and the brass contacts. Actually, the segment does not touch the brass contacts, but it comes so near to them that the high tension current can jump an arc to the brass contacts.

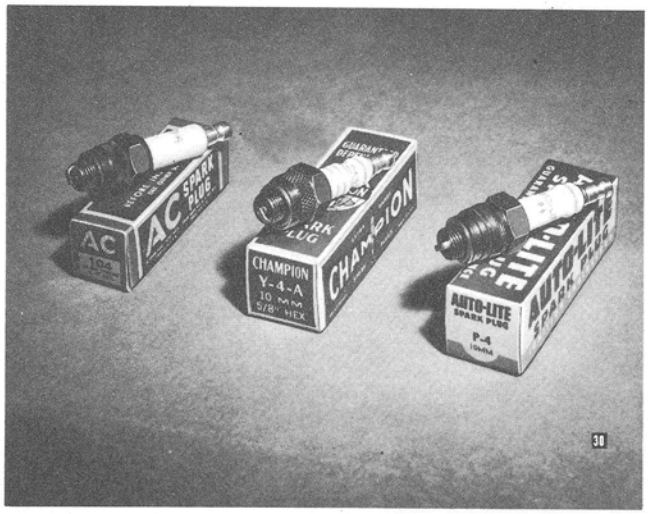
The rotor is rotated by the distributor cam and is so timed that the secondary current from the coil is distributed through the radial contacts and the spark plug cables to each spark plug at the proper time and at each opening of the breaker contact.



Ignition Cables

The ignition cables carry the current to the spark plugs. These cables contain several strands of low resistance wire and are covered by a rubberized insulating material. The insulating material is protected by a cotton braid and a lacquer coating.

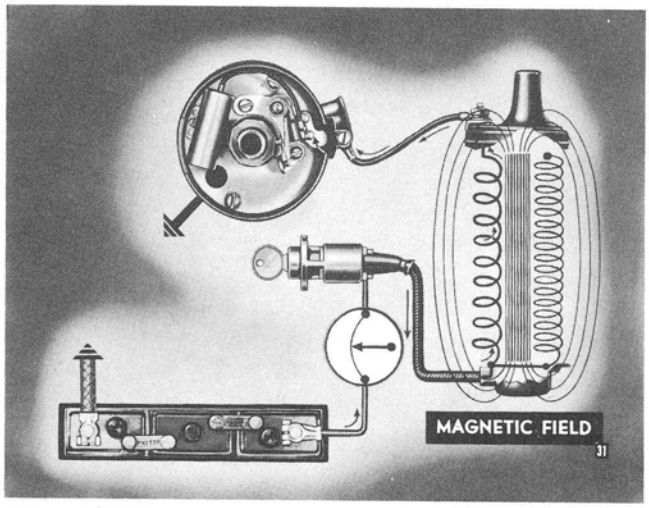
High tension conduit is used to support the cables and keep them from chafing.



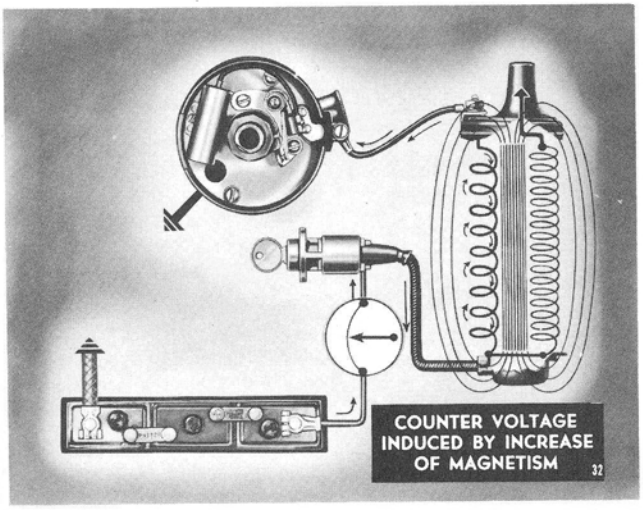
Spark Plugs

The spark plugs are rated according to their temperature range. A plug with a long porcelain exposed to the combustion chamber is "hot" plug. A plug with a shorter porcelain is a "colder" plug. The spark plugs used in Packard cars are the AC-104, the Champion Y4A, and the Auto-Lite P-4. The thread size is 10 mm. Each is of the proper heat range and should always be replaced with the same type plug.

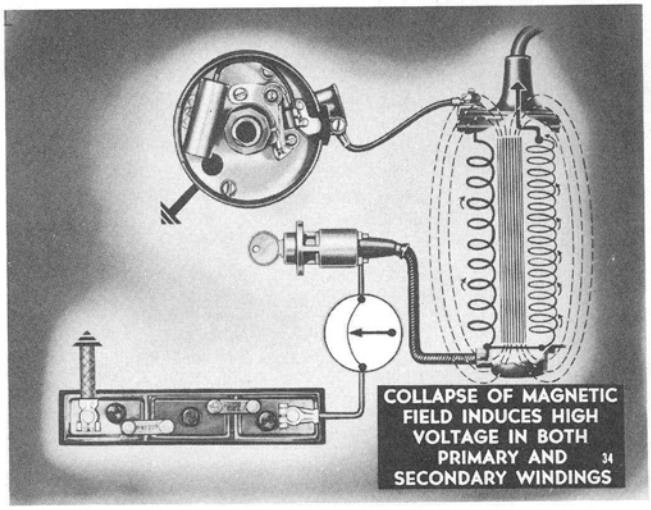
Sequence of Operation



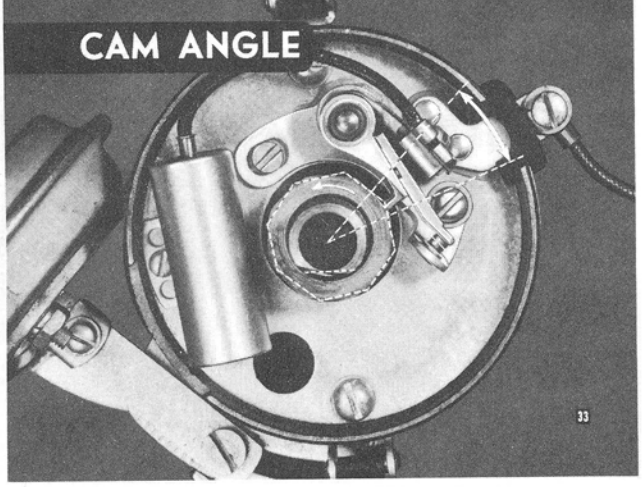
With the ignition key turned on, closing the distributor contact points completes the ignition primary circuit. The current flows from the battery, through the ammeter, the ignition switch, the primary winding of the coil, and the contact points to ground. This flow of current through the primary winding creates a magnetic field around the coil and through the core.



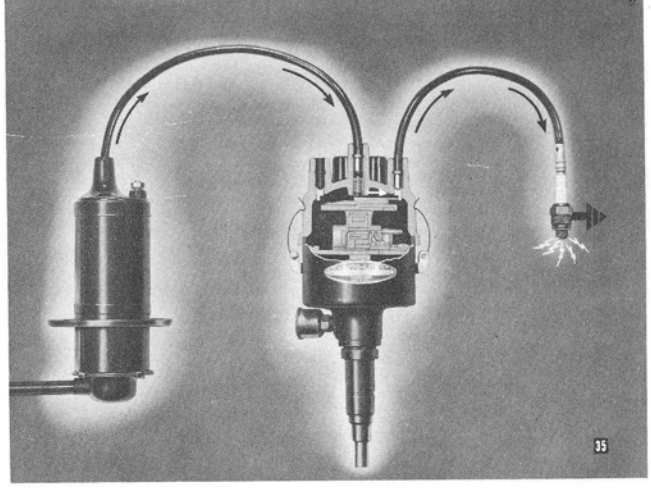
The current flow and magnetic field, however, do not increase to their peak instantly. It takes a small fraction of a second, called the build-up time, for the current flow and the magnetic field to reach their peak. This is due to the counter voltage induced in the winding by the increase of magnetism. The battery voltage, which forces the current through the primary winding, is opposed by the counter voltage.



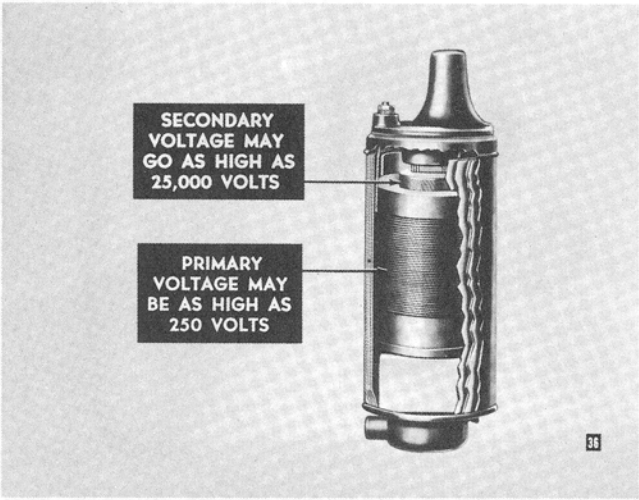
When the distributor contacts open breaking the primary circuit, the current attempts to continue to flow and tends to cause an arc across the points. The condenser prevents the arc by absorbing the sudden shock of the current caused by the opening of the contacts. Therefore, the magnetic field around the primary winding, induced by current flow, quickly collapses. It is this sudden collapse of the magnetic field that induces a high voltage in both the primary and secondary windings.



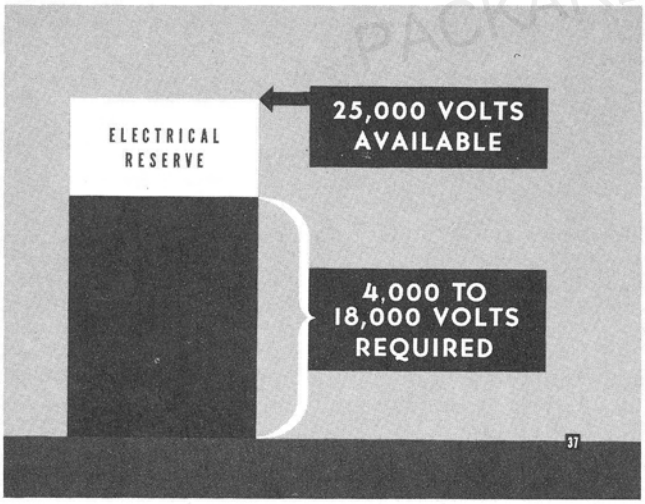
Coil characteristics are so balanced with build-up time that, even at top engine speed when the contact points remain closed for the minimum time, the coil will build up sufficiently for good ignition. The amount of cam rotation between the closing and opening of the contacts controls the build-up time, and is known as the cam angle or dwell angle.



The voltage induced in the secondary winding causes current to flow through the coil to distributor cable, the distributor cap center contact and rotor to the brass contact lined up with the rotor at this time, then through the spark plug cable to the spark plug and across the gap of the spark plug electrodes to ground.



The voltage induced is proportional to the turns of wire in the windings and the resistance at the spark plug gap. The induced voltage in the primary winding may be as high as 250 volts; and, consequently, the induced voltage in the secondary winding may go as high as 25,000 volts.

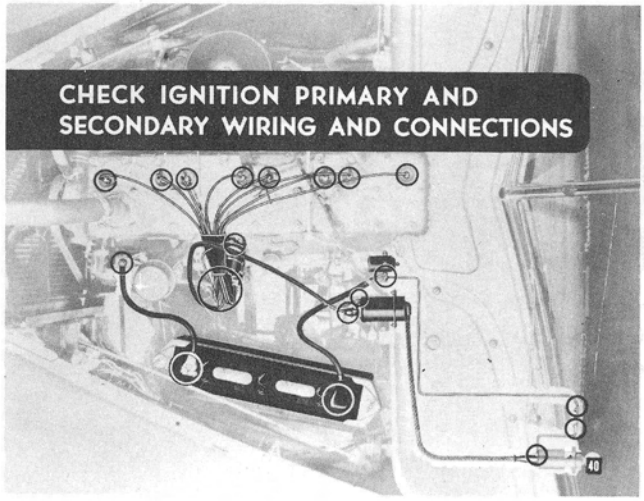


The voltage necessary to cause an arc at the spark plug gap is somewhere between 4,000 and 18,000 volts. The extra voltage represents the electrical reserve built into the ignition system. The voltage required to fire the plug varies with conditions including engine compression, engine speed, mixture ratios, spark plug gap, temperature, and many other conditions. These conditions must be taken into consideration when diagnosing ignition troubles and servicing the ignition system.

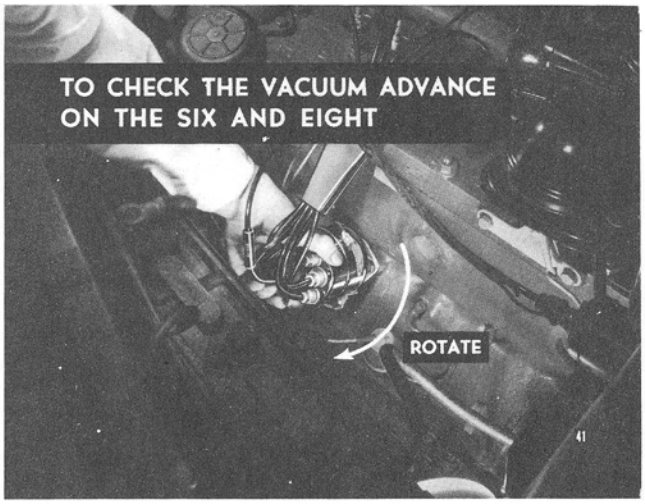
Servicing the Ignition System

Although good ignition is one of the requirements for good engine performance, it must also be remembered that good carburetion and good compression are equally essential.

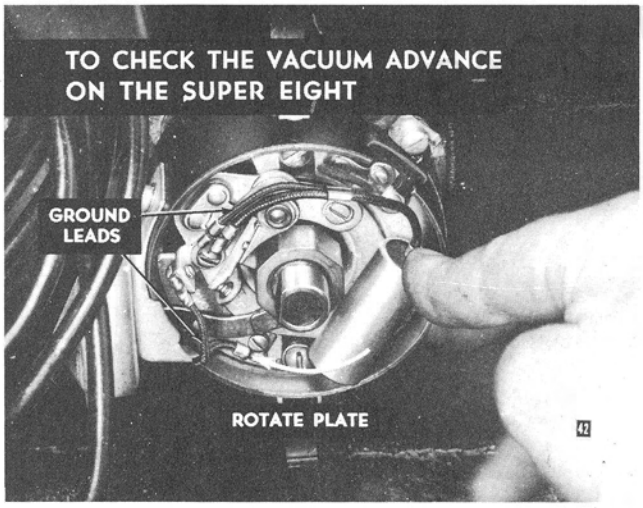
The ignition system often is blamed for engine failures and poor performance when the source of the trouble may be either the carburetor and fuel system or compression. To make a correct diagnosis, the procedure for checking the ignition system is outlined as follows:



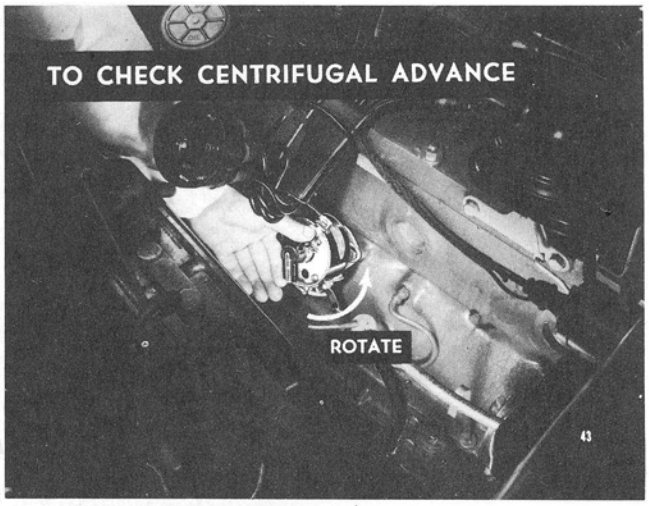
Check the ignition primary and secondary wiring and connections. Replace any leads that are frayed, have broken strands, or have defective or deteriorated insulation. Clean and tighten all connections.



Check the distributor vacuum advance on the Six and Eight by rotating the complete distributor in the direction opposite that of the normal rotation of the breaker cam. The distributor should turn freely and the vacuum advance spring should return the distributor to its original position when released.



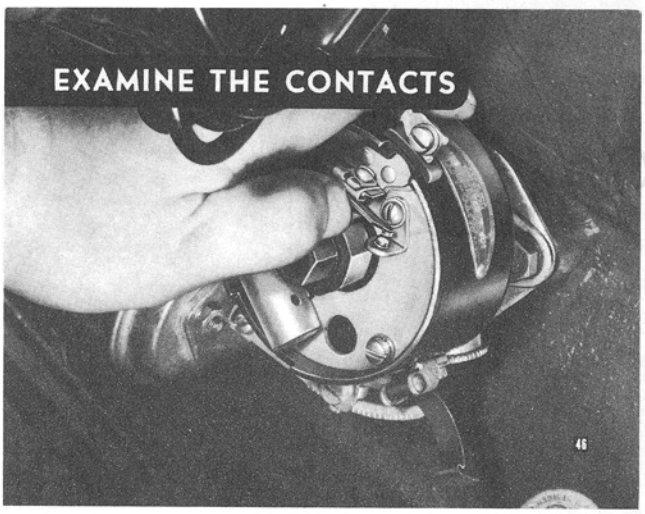
On the Super Eight distributor, rotate the breaker plate clockwise to check the vacuum advance operation. The plate should rotate without binding, it should not wobble, and should return to its original position when it is released. On this type unit be sure to check carefully the ground leads, known as "pigtail" leads, for fraying, broken strands, or broken terminal connections.



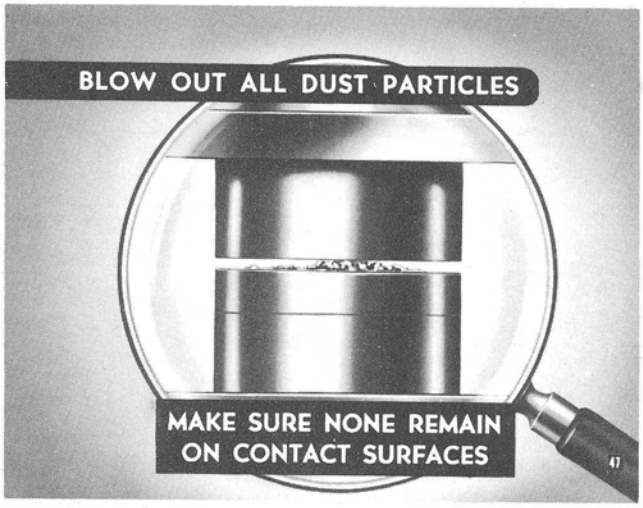
The centrifugal advance can be checked by rotating the breaker cam in the direction of its normal rotation. It should rotate freely and the centrifugal advance springs should return the cam and rotor to their original position without binding.

These quick checks indicate whether the advance mechanisms are working or not. However, for accurate testing of these units, the distributor should be removed and tested with a reliable distributor tester and instruments under various speeds and vacuum conditions.

While the distributor cap is off, wipe out the cap with a soft cloth. Inspect the cap and rotor for chips, cracks, and carbon paths which would allow secondary current leakage to ground.



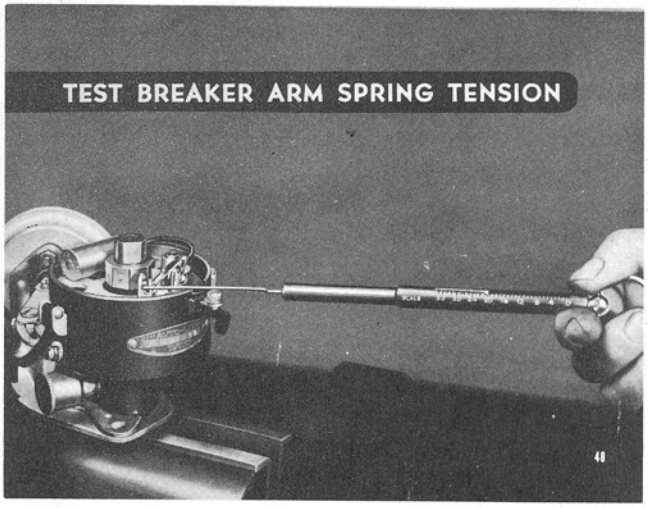
Examine the contacts by holding them apart with the finger or thumb. Contacts that have been in service will not appear to be smooth and bright. This does not necessarily mean that they are not operating satisfactorily. On the contrary, they may be making contact over a greater area than could be obtained with new contacts. Clean the contact points with a fine-cut file.



Blow out all the dust particles. Make sure none remain on the contact surfaces.

If the contacts are burned or pitted they should be replaced.

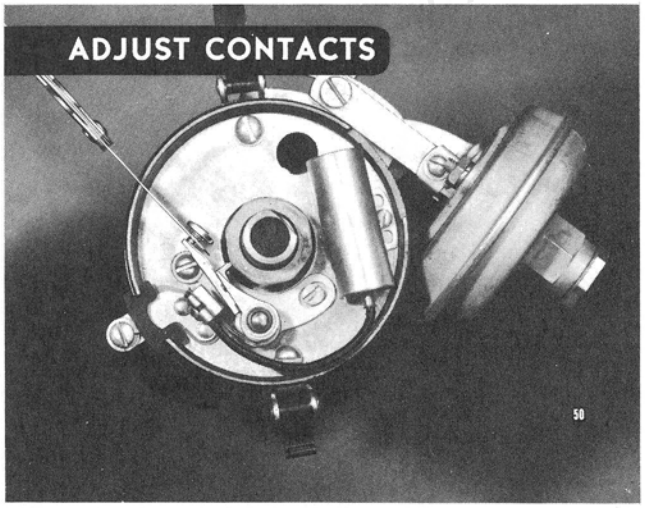
Caution: Never use emery cloth or sandpaper to clean the contacts as the particles of these abrasives will be embedded in the contact surfaces and cause the contacts to burn.



Test breaker arm spring tension using the spring scale. The spring tension should be 19 to 23 ounces on the Delco-Remy distributor, 17 to 20 ounces on the Auto-Lite distributors. The correct tension may be obtained by shifting the breaker arm spring in its slot.

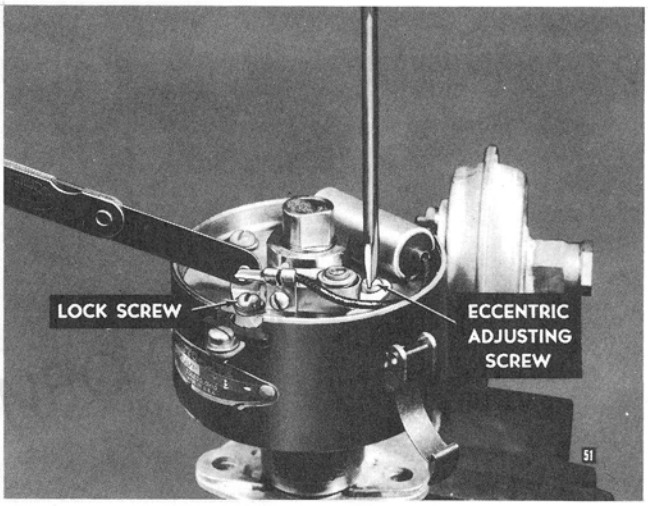
When contacts require cleaning or replacement, remove the distributor from the engine, since the job can be done more easily and more accurately on the bench.

Notice the position of the rotor and the distributor before removing it, so that it can easily be installed in the same approximate position and will require only a slight adjustment to complete the timing.



After the contacts are cleaned or replaced, adjust them, preferably by setting the cam angle on a synchroscope according to the data on page 23 or, using a feeler, adjust them to the correct opening of .020 inch on the Six distributor, and .017 inch on the Eight and Super Eight distributors.

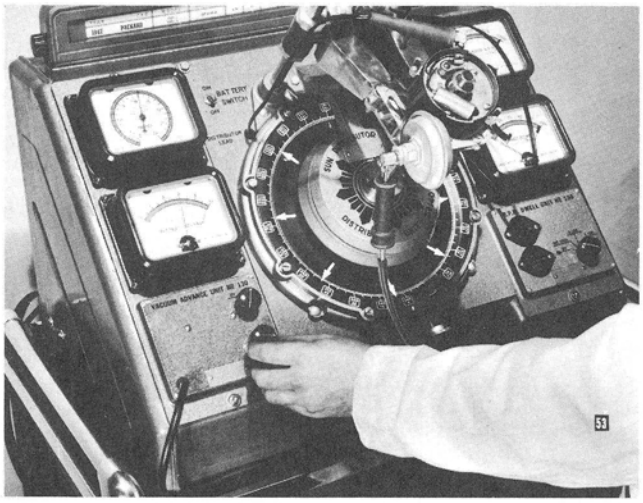
Be sure that all contacts are aligned and have maximum contact area.



On the late type distributors the stationary contact is adjustable by loosening the lock screw and turning the eccentric screw for adjustment. The earlier type contacts are adjusted by loosening the lock nut and turning the contact in or out.

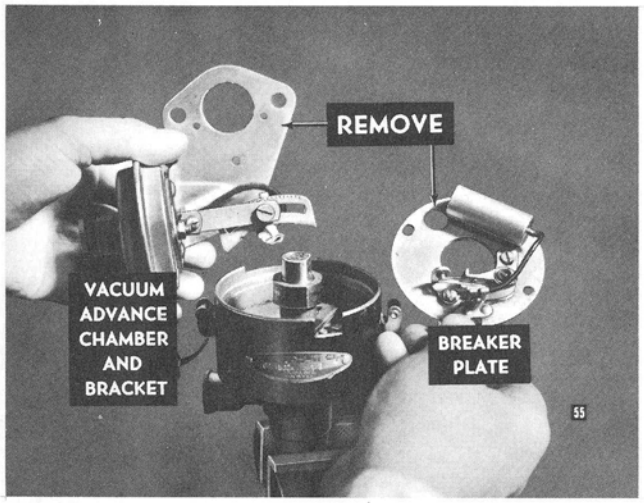
Be sure to tighten the lock nut or lock screw after adjustment is made.

Whenever a synchroscope or some other good distributor tester is available, check the operation of the centrifugal advance throughout the entire distributor speed range. There are several reliable makes of synchroscopes and testers any of which will test distributors satisfactorily.

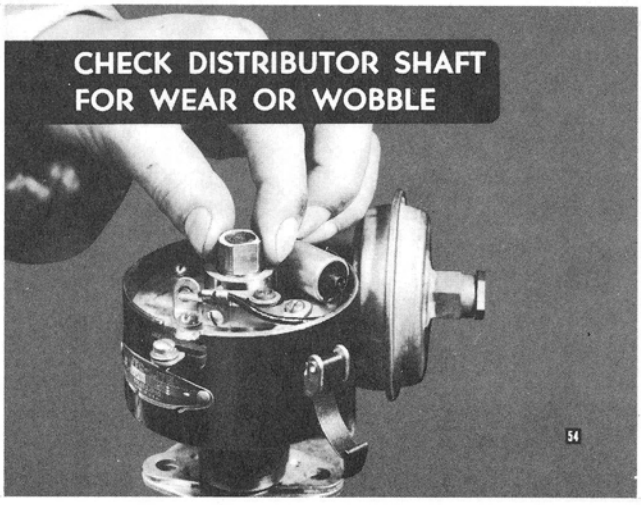


The synchroscope will check the cam angle and will detect excessive distributor shaft wobble and bushing wear. The vacuum attachment will also check the operation of the vacuum advance against the specifications throughout the entire range and vacuum conditions. See page 23 for specifications.

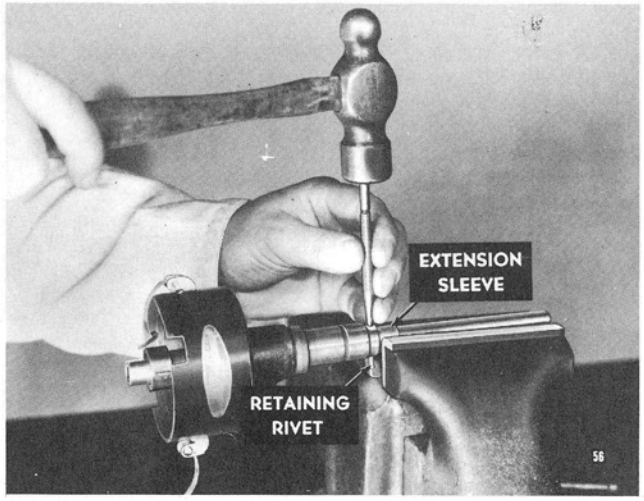
Occasionally several new parts may have to be replaced to return the centrifugal advance and vacuum advance to good operating condition. If the vacuum unit is faulty, replace the whole unit. Do not attempt to repair the unit.



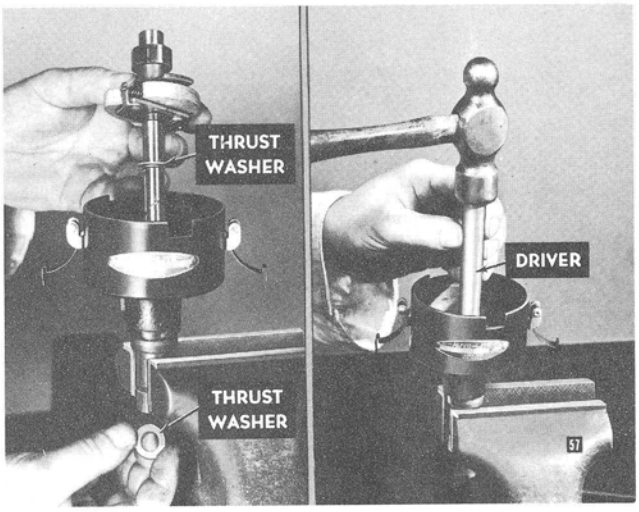
To replace the distributor shaft and bushings: Remove the vacuum advance chamber and bracket. Remove the breaker plate assembly. Remove the lubricating grease cup assembly.



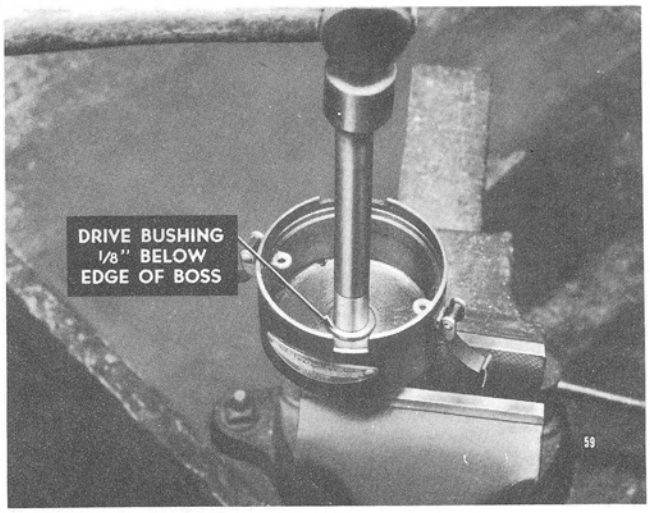
Check the distributor shaft for wear or wobble by gripping the breaker end of the shaft and rocking it back and forth. If excessive movement of the shaft is noticed, it indicates that the distributor shaft and bushings are worn and should be replaced with new parts.



Grip the distributor driveshaft extension sleeve in a soft-jawed vise and drive out the drive shaft extension sleeve retaining rivet. Remove the extension sleeve from the drive shaft. Drive out the extension shaft pin and remove the extension shaft.



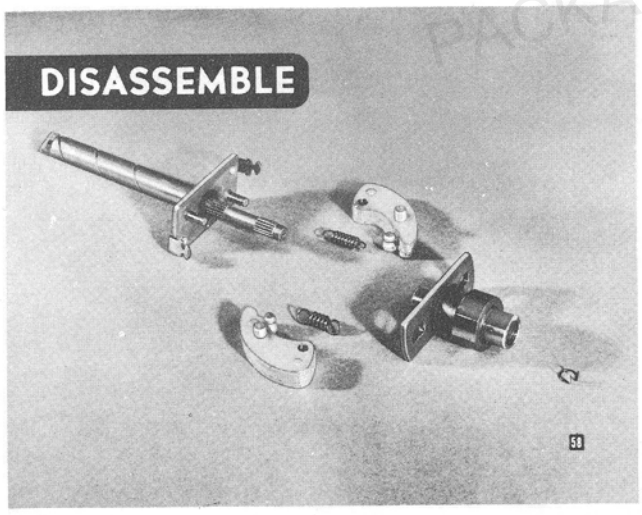
Push the drive shaft from the base. Be careful that the driveshaft thrust washers are not lost. The driveshaft bushings may be pressed out or driven out, using a driver of slightly smaller diameter than the outside diameter of the bushings.



Carefully press or drive the new bushings into place. Be sure the drift is smooth and will not burr the bushings.

Note: The upper bushing must be pressed 1/8 inch below the top edge of boss.

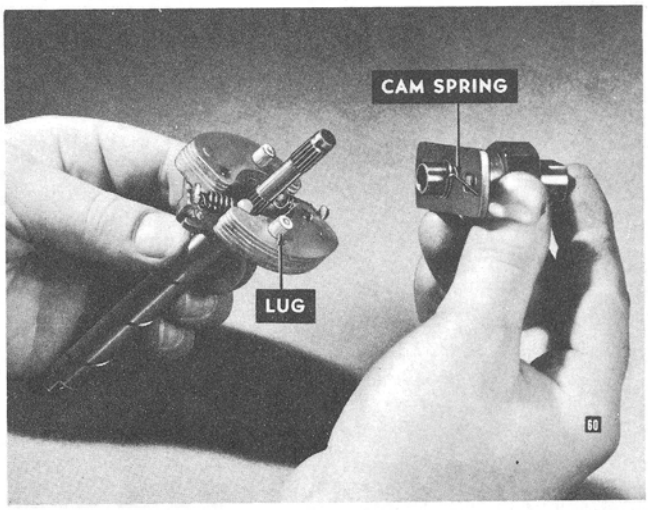
Drill a 3/16-inch hole through the upper bushing by drilling through the lubricant passage.



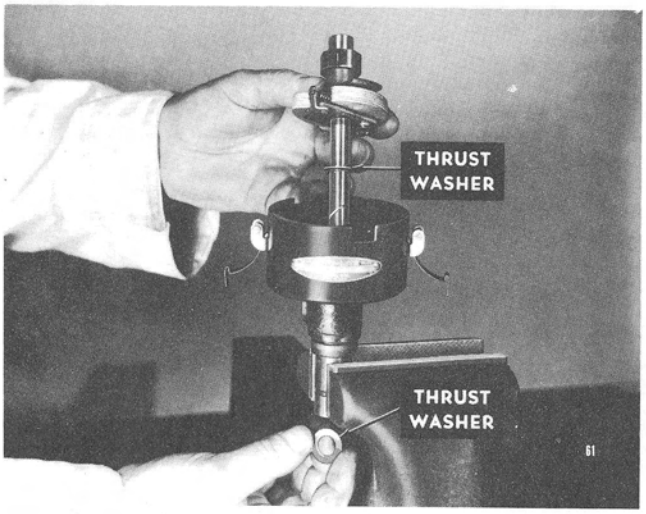
Disassemble the breaker cam and the governor weights and springs from the driveshaft.

Caution: Be careful that governor weight springs are not stretched excessively.

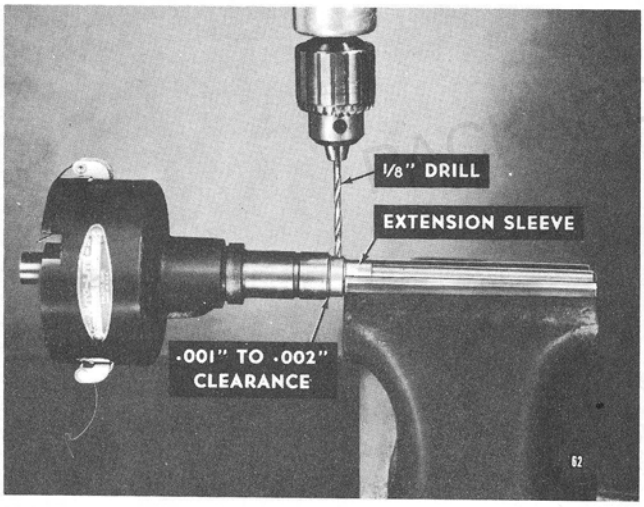
Examine the driveshaft and breaker cam for scores, wear, and pits. Replace any parts that do not come up to inspection specifications.



Assemble the governor weights, governor springs, and breaker cam to the driveshaft. Make sure cam spring end is to the left of the driving lug on the governor weight. Install the cam spring lock and the cam wick and put a few drops of SAE 30 oil on the cam wick. Make sure the breaker cam does not bind on the driveshaft. Lubricate the outer surface of the cam with a light film of vaseline or light cup grease.

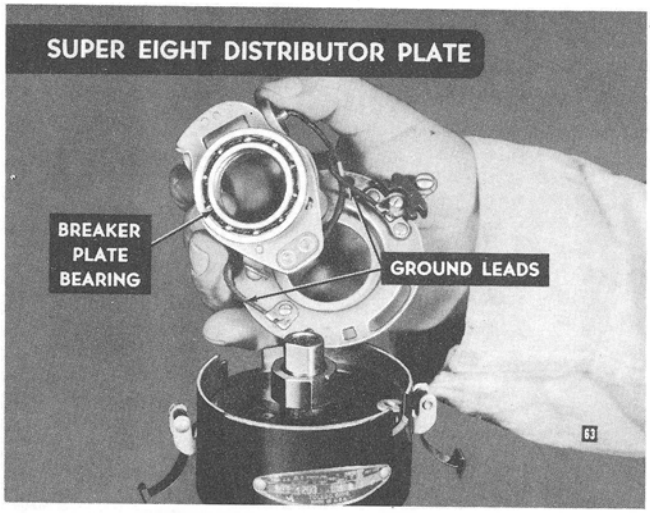


Install the new driveshaft assembly into the distributor base. Be sure the thrust washers are in place. Install the extension shaft and attach it with the retaining pin.

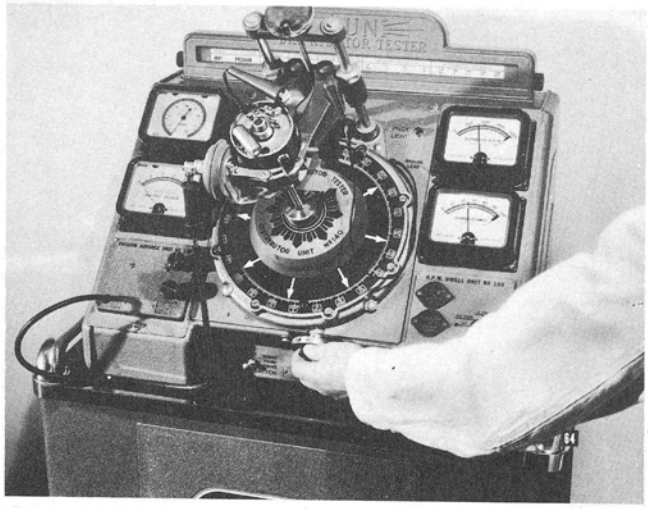


Install the extension sleeve so that it rests snugly against the thrust washer. Drill a 1/8-inch hole through the extension sleeve and the driveshaft. Drive the extension sleeve retaining rivet into place and peen it over on both ends.

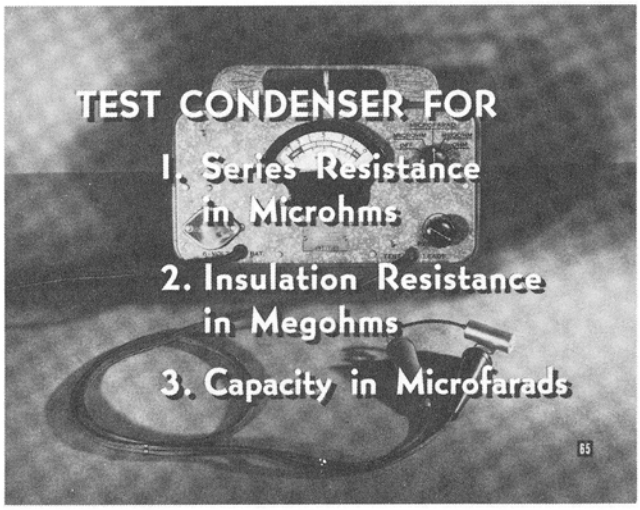
Be sure that there is .001 to .002 inch clearance between the extension sleeve and the thrust washer.



Install the breaker plate assembly. On the Super Eight distributor, inspect the ground leads and inspect and lubricate the breaker plate bearing with light cup grease. Reset the contact gap according to specifications. Install the vacuum advance chamber and bracket. Be sure the ground lead is attached correctly. Install the lubricating grease cup assembly and lubricate according to lubrication chart specifications.

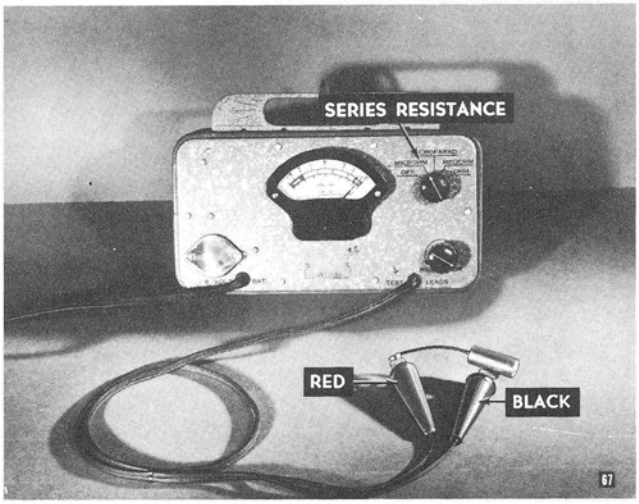


Recheck the distributor on a synchroscope. Check the governor and vacuum advance characteristics and reset the cam angle according to specifications by adjusting the contact point gap.



While the distributor is off the car, the condenser should be removed and tested on a reliable condenser tester which checks for: (1) series resistance (microhm), (2) insulation resistance (megohm), (3) capacity (microfarad). All these conditions affect ignition performance. To test a condenser proceed as follows:

Connect the six-volt battery test leads to a six-volt battery. Clip the red lead to the positive post and the black lead to the negative post.



Connect the condenser tester leads together. Turn the tester selector knob to the "microhm" position and permit the unit to heat for one minute.

Turn the regulator knob until the meter reads on the "set" line.

Connect the red lead of the tester to the condenser lead.

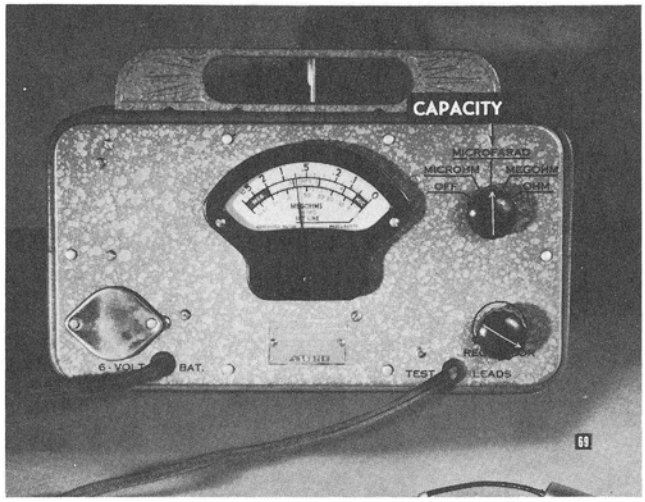
Connect the black lead of the tester to the condenser shell.

The meter should read in "blue" bar marked "microhm" for satisfactory condenser circuit resistance, which is known as "series resistance."

Turn the tester selector switch to the "megohm" test.

The meter will indicate insulation resistance of the condenser. The meter should read in the "blue" bar marked "megohm" at the left side of the tester scale.

If meter reads in the "red" bar or toward the extreme right side of the scale, replace the condenser with a new one.

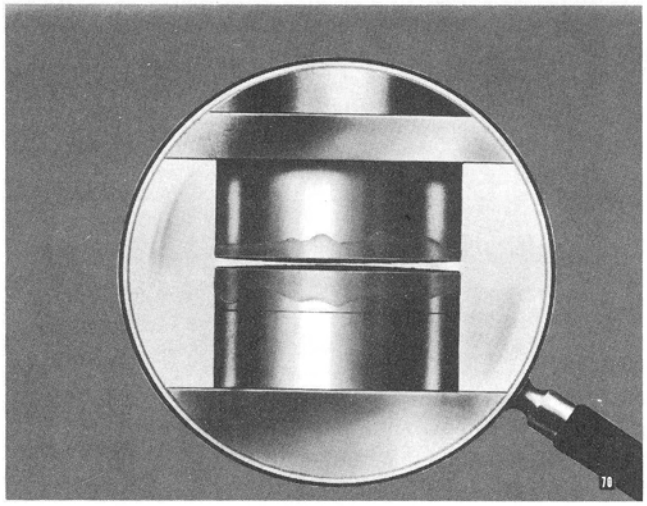


Turn the selector knob to the "microfarad" test.

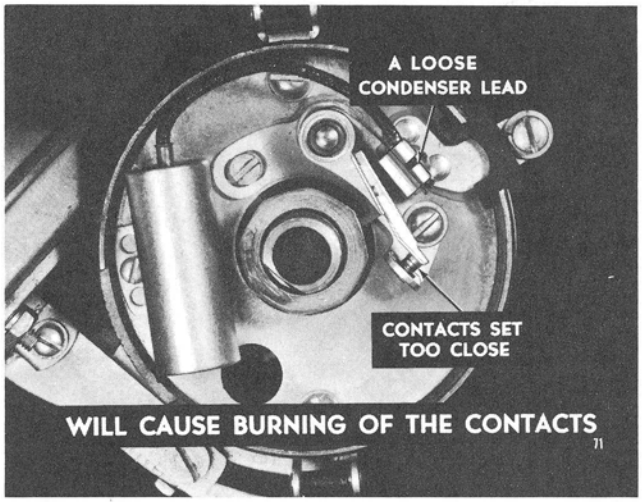
The meter will show the microfarad capacity of the condenser. The meter should read in accordance with test specifications on page 23.

Condenser capacities are specified for normal driving conditions and are fixed. Do not attempt to correct burning of the contacts by trying to select a condenser of a different capacity. Locate and correct the cause.

If condenser replacement is necessary, a condenser of correct capacity must be used.



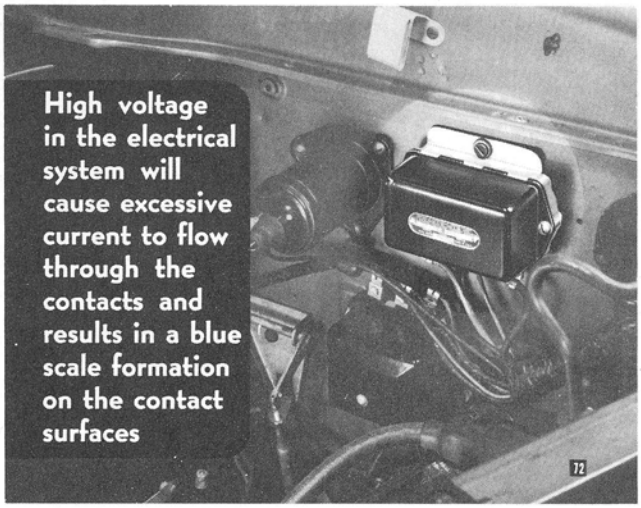
Oil on the contact surfaces is the most common cause of burned contacts. The carbon formed by the burning of the oil will embed in the contact surfaces. This will cause the contact points to arc and, consequently, to burn. Clean or replace the contact points and adjust the gap. Locate and eliminate the source of the oil. Do not overlubricate the breaker cam surface or the cam wick.



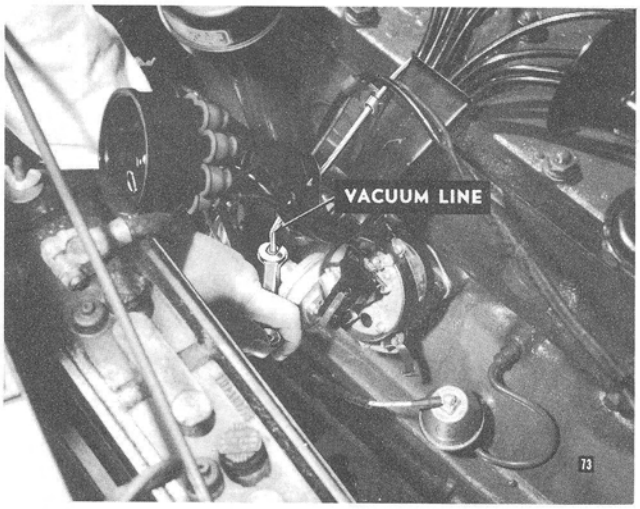
Other conditions that will cause burning of the contacts include:

Contacts set too close will cause burning of the contacts, in which case they should be checked and reset.

A loose condenser lead will cause high resistance in the condenser circuit and cause an arc at the contacts, resulting in burning of the contacts.



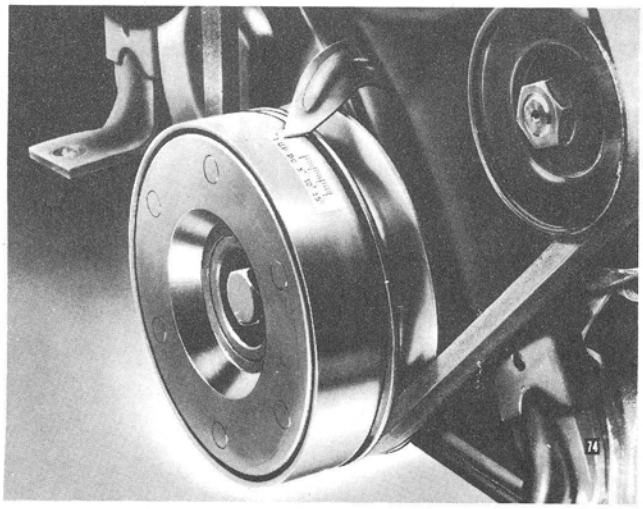
High voltage in the electrical system will cause excessive current to flow through the contacts. This results in a blue scale formation on the contact surfaces. When this condition is found, all electrical connections of the ignition circuit should be tightened and the voltage regulator should be checked and reset if necessary.



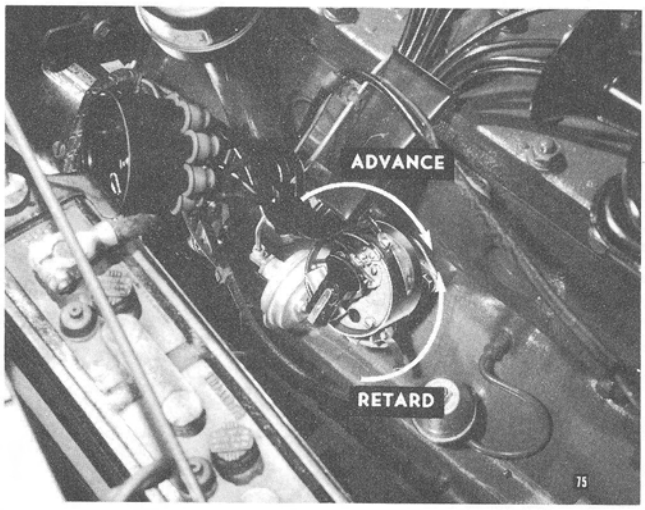
After the distributor is tested accurately and the condenser is reinstalled, install the distributor on the engine with the rotor and distributor in the same position they were when the distributor was removed. Make sure the distributor is all the way down in its mounting and that the hold-down clamp or screw is tight.

Be sure the vacuum line is tightened securely.

Turn the grease cup in one turn. The ignition timing should then be adjusted to conform with the distributor timing data found on page 23.

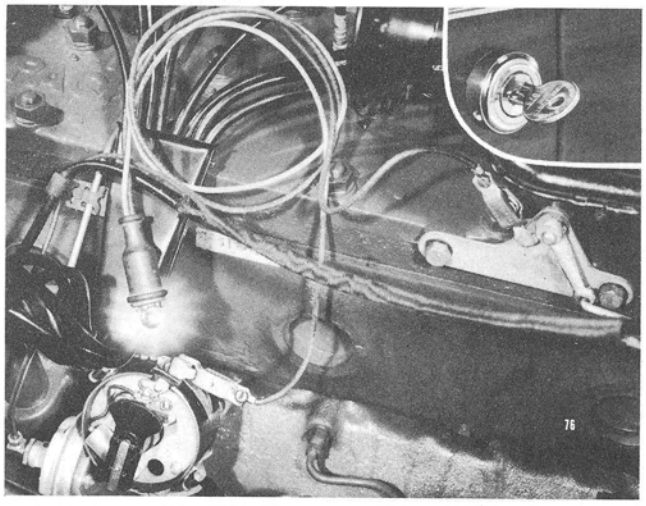


With the distributor cap removed and using the timing marks on the vibration damper to check crankshaft rotation, rotate the crankshaft in the direction of normal rotation until #1 piston comes up on the compression stroke and the marks on the vibration damper align with the pointer, according to the timing data on page 23.



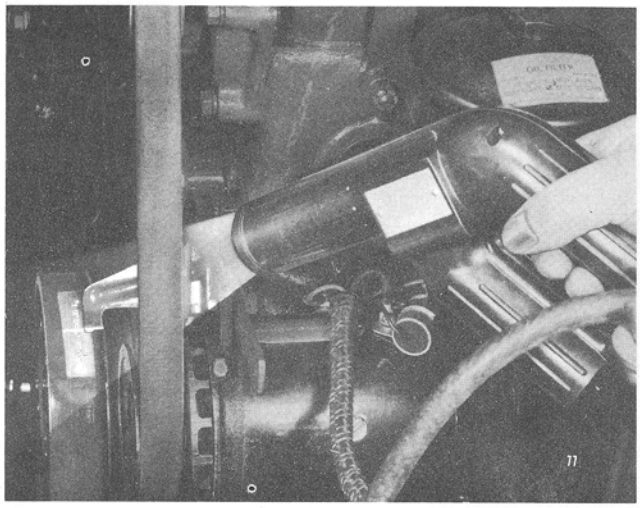
Loosen the clamp screw and rotate the distributor base clockwise to advance the timing, or rotate it counterclockwise to retard the timing, until the breaker contacts just start to open with the rotor aligned with the #1 electrode of the distributor cap.

Be sure to tighten the clamp screw when timing is completed.

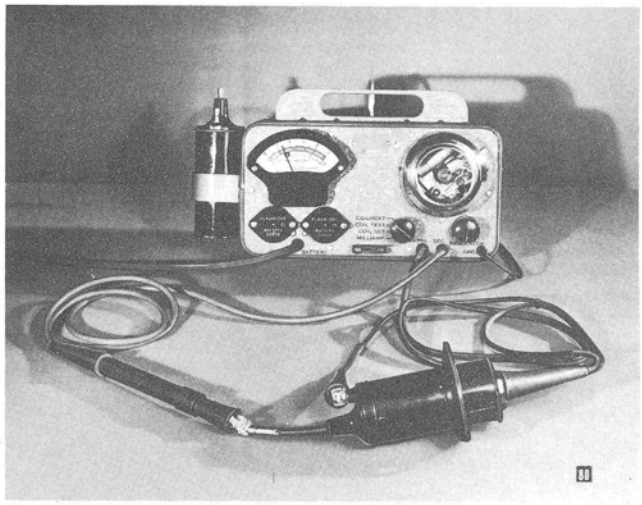


The timing may be checked by means of a six-volt test lamp connected from the distributor primary terminal to ground.

When the ignition switch is turned on the light WILL NOT BURN when the contacts are closed and WILL GO ON just as the contacts break. Press the distributor cam lightly AGAINST the direction of normal rotation to remove all backlash.

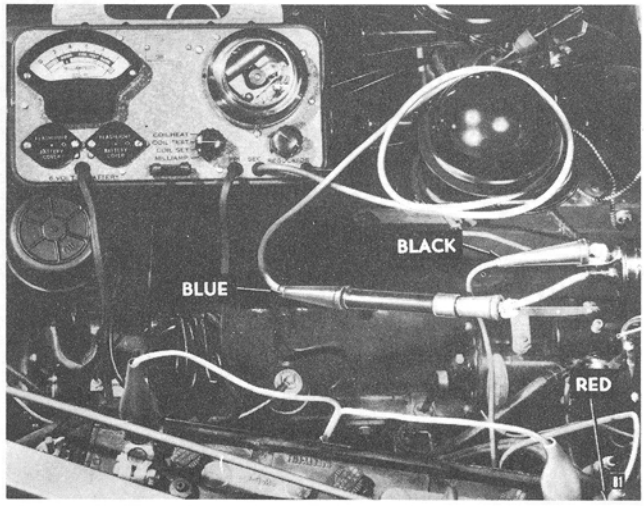


A neon tube ignition timing light which operates on the current from the distributor to the #1 spark plug may be used to adjust ignition timing. By putting a chalk mark on the pointer and the correct timing mark on the vibration damper, the stroboscopic effect of the timing light with the engine idling will cause these two chalk marks to appear to line up when the ignition timing is correct.

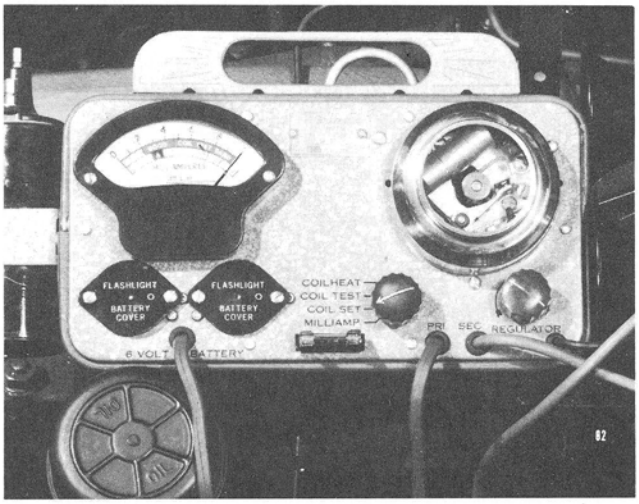


The ignition coil should be tested with a reliable coil testing instrument which will detect open circuits, insulation breakdown, and magnetic losses. Any of these conditions will affect ignition performance. The coil may be tested on the bench or it may be tested on the car without removing it.

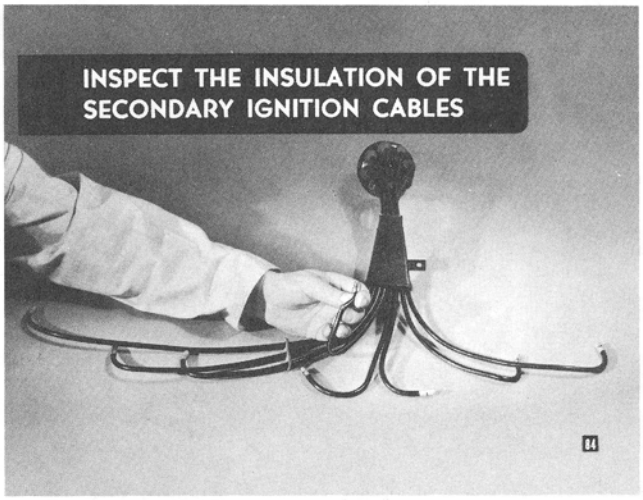
Caution: Be sure that the engine is idling no faster than 450 to 500 rpm when setting the timing with a neon tube timing light. An engine that is operating above 500 rpm may cause the centrifugal advance to come into operation and give inaccurate timing setting. With the correct timing there may be a slight trace of spark ping when accelerating with wide open throttle from ten to thirty miles per hour in high gear.



When testing the coil on the car, the primary current is obtained through the ignition switch when the key is turned on. Connect the black tester lead to the exposed primary coil terminal and the red tester lead to the ungrounded post of the battery. Connect the blue secondary tester lead to the secondary post of the coil.



Turn the car ignition switch to the "on" position. Turn the tester switch to the "coil set" position. Turn the regulator knob until the coil meter reads on the "set" line.

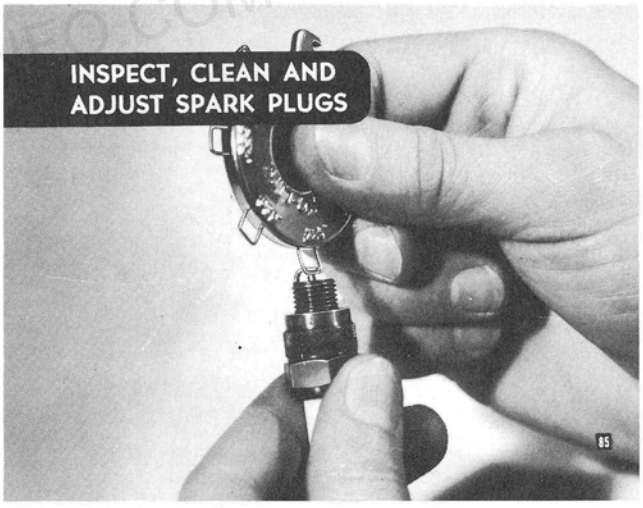


Inspect the insulation of the secondary ignition cables and the primary wiring for cracks, worn insulation, frayed insulation, and brittleness. Check the wires and cables for broken strands. Examine the terminals and connections for corrosion and looseness. Replace the wiring and clean, repair, or replace the terminals if necessary.

Then turn the tester switch to the "coil test" position.

Coil meter must read in "blue" band marked "good" for satisfactory coil capacity.

Replace the coil if it does not meet test requirements.



The spark plugs should be inspected, cleaned, and adjusted or replaced if necessary. Gap should be .028 inch + or - .002 inch and is adjusted by bending side electrode only.

★ ★ ★

PART II

Test Specifications

Distributor Contact Gap, Cam Angle, Condenser and Timing Data

PACKARD MODEL	DISTRIBUTOR MAKE	DISTRIBUTOR MODEL NO.	CONTACT GAP	CAM ANGLE	SPRING TENSION	CONDENSER CAPACITY	TIMING SETTING	
Some 1900	Delco-	1110092	.020"	35°	19-23 oz	.28-.32 mfd	6°+0°-1-1/2°	btdc
2000, 2010, 2100	Remy	1110132	.020"	35°	19-23 oz	.28-.32 mfd	6°+0°-1-1/2°	btdc
Some 1900, 2000, 2010, 2100, 2130	Auto-Lite	IGC4505	.020"	38°	17-20 oz	.28-.32 mfd	6°+0°-1-1/2°	btdc
1901	Auto-Lite	IGP4502	.017"	27°	17-20 oz	.20-.25 mfd	7°+0°-1-1/2°	btdc
1951, 2001, 2011, 2101, 2111	Auto-Lite	IGP4502A	.017"	27°	17-20 oz	.20-.25 mfd	7°+0°-1-1/2°	btdc
1903, 1906, 2003, 2006	Auto-Lite	IGT4102	.017"	27°	17-20 oz	.20-.25 mfd	6°+0°-1-1/2°	btdc
2103, 2106, 2126	Auto-Lite	IGT4203	.017"	27°	17-20 oz	.20-.25 mfd	6°+0°-1-1/2°	btdc

Distributor Centrifugal Governor Control Data, Distributor RPM and Degrees Advance

PACKARD MODEL	DISTRIBUTOR MAKE	DISTRIBUTOR MODEL NO.	RPM	ZERO ADV.	RPM	ADV.	RPM	ADV.	RPM	ADV.	FULL RPM	FULL ADV.
Some 1900	Delco-	1110092	---	--	300	1-1/2°	700	5°	----	--	1600	10°
2000, 2010, 2100	Remy	1110132	---	--	300	1-1/2°	700	5°	----	--	1600	10°
Some 1900, 2000, 2010, 2100, 2130	Auto-Lite	IGC4505	300	0°	590	3°	780	5°	1150	7°	1600	9-1/2°
1901	Auto-Lite	IGP4502	250	0°	525	3°	800	5°	1210	9°	1550	11-1/2°
1951, 2001, 2011, 2101, 2111	Auto-Lite	IGP4502A	325	0°	600	3°	800	5-1/4°	1175	8°	1550	10-3/4°
1903, 1906, 2003, 2006	Auto-Lite	IGT4102	250	0°	475	3°	700	6°	1300	9°	1800	11-1/2°
2103, 2106, 2126	Auto-Lite	IGT4203	250	0°	475	3°	700	6°	1300	9°	1800	11-1/2°

Distributor Vacuum Advance Data

PACKARD MODEL	DISTRIBUTOR MAKE	DISTRIBUTOR MODEL NO.	IN. HG.	ADV.	IN. HG.	ADV.	IN. HG.	ADV.	IN. HG.	ADV.	IN. HG.	ADV.
Some 1900	Delco-	1110092	6"	0°	9"	2°	12"	4°	15"	6°	17"	7-1/2°
2000, 2010, 2100	Remy	1110132	6"	0°	9"	2°	12"	4°	15"	6°	17"	7-1/2°
Some 1900, 2000, 2010, 2100, 2130	Auto-Lite	IGC4505	6"	0°	9"	2°	11-7/8"	4°	14-7/8"	6°	17"	7-1/2°
1901	Auto-Lite	IGP4502	10"	0°	11-1/8"	1°	13-1/2"	3°	15-7/8"	5°	17"	6°
1951, 2001, 2011, 2101, 2111	Auto-Lite	IGP4502A	10"	0°	11-1/8"	1°	13-1/2"	3°	15-7/8"	5°	17"	6°
1903, 1906, 2003, 2006	Auto-Lite	IGT4102	7"	0°	8-1/8"	1°	12"	3°	13-1/2"	4°	16"	5-1/2°
2103, 2106, 2126	Auto-Lite	IGT4203	7"	0°	8-1/8"	1°	12"	3°	13-1/2"	4°	16"	5-1/2°

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PART III

Trouble Shooting and Corrective Measures

Condition	Cause	Correction
1- Engine fails to start. Ammeter pointer does not show discharge and does not move with the ignition switch ON while starting motor is cranking the engine. This condition is an indication of an OPEN PRIMARY CIRCUIT.	a- Burned or oxidized contact points.	a- Remove distributor cap. Dress contact points or replace. Adjust contact points to correct gap.
	b- Contact points incorrectly adjusted, not closing to permit contact.	b- Adjust contact points to correct gap.
	c- Contact arm binding on pivot post, preventing closing of contact points.	c- Free up contact arm, or replace contact points, and adjust gap.
	d- Contact arm spring weak or broken.	d- If spring is broken, replace contact points and adjust gap. If spring is weak, readjust tension by shifting the breaker arm spring in its slot.
	e- Contact arm distorted or bent.	e- Replace contact points and adjust gap.
	f- Dirt or foreign matter on contact points.	f- Clean and dress contact points and adjust gap.
	g- Primary lead connection loose at distributor or coil.	g- Tighten primary lead connections.
	h- Primary windings in coil broken.	h- Replace coil.
	i- Open ignition switch circuit.	i- Check all leads and connections from starter switch to ammeter, from the ammeter to the ignition switch, and from the ignition switch to the coil. Check switch contacts. Tighten connections, or replace leads or ignition switch if necessary.
2- Engine fails to start. Ammeter pointer shows a slight discharge with the ignition switch ON, but does not move while the starting motor is cranking the engine. This condition is an indication of a GROUNDED PRIMARY CIRCUIT. Caution: A grounded coil primary winding, a grounded ignition switch or a grounded switch to coil primary lead will cause excessive current flow and in most cases will cause wires to burn.	a- Contact points incorrectly adjusted, not opening.	a- Adjust contact points to correct gap.
	b- Contact points not opening, due to worn insulator block (rubbing block) on contact arm.	b- If insulator block is slightly worn, adjust contact points to correct gap. If insulator block is worn excessively, replace contact points and adjust gap.
	c- Faulty insulating bushing in contact arm.	c- Replace contact points and adjust gap.
	d- Cracked or faulty insulator at distributor primary terminal.	d- Replace insulator.
	e- Contact arm (copper) lead strap grounded.	e- Adjust breaker arm lead strap so that it does not touch the breaker plate.

Trouble Shooting and Corrective Measures-Cont.

Condition	Cause	Correction
2- Grounded Primary Circuit – Cont.	f- Grounded condenser.	f- Remove condenser. If removing condenser corrects the grounded condition, install a new condenser. Whenever possible use a reliable condenser tester to test the condenser.
	g- Distributor to coil primary lead grounded.	g- Locate faulty insulation of lead and repair.
	h- Primary winding of the ignition coil grounded.	h- Remove and test coil on a reliable coil tester. Install a new coil if necessary.
3- Engine fails to start. Ammeter pointer oscillates from zero to approximately three amperes discharge, with the ignition switch ON, while starting motor is cranking the engine. This condition is generally an indication of a normal ignition primary circuit, but a FAULTY IGNITION SECONDARY CIRCUIT. To further check the secondary circuit, remove one of the spark plug cables from the spark plug and hold the terminal about 1/4 inch from the cylinder head. A sharp blue-white spark approximately 1/16 inch wide should occur regularly while the engine is being cranked. If a good sharp spark occurs, check the spark plugs, timing, carburetion, and compression for cause of failure to start. If no spark occurs, or if the spark is weak and thin, the ignition secondary circuit is most likely at fault.	a- Dirty or corroded secondary coil to distributor cable connections. A broken or faulty secondary cable from coil to distributor cap.	a- Clean connections and push the cable ends all the way into coil and distributor cap. Replace secondary cable if broken or faulty.
	b- A cracked distributor cap or a burned carbon track from distributor cap center terminal to the distributor housing.	b- Clean and examine distributor cap. Replace cap if it is cracked or has a burned carbon track.
	c- Broken contact on rotor, cracked or grounded rotor.	c- Replace rotor.
	d- Open secondary circuit in coil.	d- Test coil, replace if necessary.
	e- Open condenser, or under capacity condenser.	e- Test condenser, replace if necessary.
	f- Broken or burned out radio suppressor in distributor cap.	f- Replace radio suppressor.
4- Burned ignition contact points.	a- High voltage in the electrical system will cause the contacts to burn, forming a blue scale on the contact surfaces.	a- Replace contact points and adjust gap. Check voltage regulator setting and reset if necessary.
	b- Loose condenser lead at contact arm terminal bracket, or excessive resistance in condenser.	b- Test condenser, replace if necessary. Be sure lead is tight at terminal bracket.

Trouble Shooting and Corrective Measures-Cont.

Condition	Cause	Correction
4- Burned ignition contact points.—Cont.	c- An UNDER capacity condenser will cause material transfer build-up on the positive (+) contact (bracket). An OVER capacity condenser will cause material transfer build-up on the negative (-) contact (breaker arm).	c- Test condenser for capacity. Replace condenser if necessary.
	d- Contacts set too close.	d- Readjust contact point gap.
	e- Oil on contact points will cause them to pit and burn. This condition is generally indicated by the contacts burning black.	e- Correct source of oil. Clean and dress contacts, or replace points if necessary. Adjust contact point gap.
5- Miss in engine on acceleration or hard pull.	a- Faulty spark plug or plugs.	a- Clean and reset plug gap. Install new plugs if necessary.
	b- Crack in distributor cap.	b- Examine distributor cap, replace if necessary.
	c- Faulty ignition cables.	c- Examine cables, clean terminals, replace cables if necessary.
	d- Burned or pitted contact points.	d- Dress contact points or replace if necessary. Adjust contact point gap and reset ignition timing.
	e- Loose connection in primary circuit or broken distributor ground lead (pigtail lead).	e- Check and tighten all connections, replace any faulty leads.
	f- Faulty carburetion or compression.	f- Make sure carburetor and fuel system are operating normally and that compression is normal.
6- Miss or skip in engine on idle.	a- Faulty spark plugs or gap too small.	a- Clean and regap spark plugs. Replace if necessary.
	b- Dirty or corroded secondary circuit connections or faulty ignition cables.	b- Clean secondary circuit connections and replace faulty ignition cables.
	c- Cracked or faulty distributor cap. Radial contacts in cap burned or worn.	c- Clean and inspect distributor cap. Replace if necessary.
	d- Faulty carburetion or compression.	d- Make sure that carburetor and fuel system are operating normally, and that compression is normal.

Trouble Shooting and Corrective Measures-Cont.

Condition	Cause	Correction
7- Loss of power. Loss of top speed.	a- Ignition timing incorrect.	a- Reset ignition timing.
	b- Centrifugal governor advance not operating properly.	b- Remove distributor, check centrifugal advance against specifications on distributor test stand, and make necessary repairs to get correct advance.
	c- Vacuum advance not operating properly.	c- Remove distributor, check vacuum advance against specifications on distributor test stand, and make necessary repairs to get correct advance. Make sure vacuum line connections are tight at the carburetor and the distributor.
	d- Ignition contact points burned and pitted.	d- Dress contact points or replace if necessary. Adjust contact points to correct gap and reset ignition timing.
	e- Faulty spark plugs.	e- Clean and regap spark plugs. Replace plugs if necessary.
	f- Faulty ignition cables.	f- Examine and replace cables if necessary.
	g- Faulty ignition coil.	g- Test coil, replace if necessary.
	h- Faulty carburetion or compression.	h- Make sure carburetor and fuel system are operating normally, and that compression is normal.
8- Detonation (Spark Knock).	a- Ignition timing incorrect.	a- Reset ignition timing.
	b- Centrifugal governor advance not operating properly.	b- Remove distributor, check advance against specifications on distributor test stand, and make necessary repairs to get correct advance.
	c- Vacuum advance not operating properly.	c- Remove distributor, check vacuum advance against specifications on distributor test stand. Make necessary repairs to get correct advance.
	d- Faulty spark plugs.	d- Clean and regap spark plugs. Replace plugs if necessary.
	e- Low octane fuel, faulty carburetion, faulty cooling, and carbon formation in combustion chamber can cause detonation.	e- Diagnose trouble and make appropriate correction.

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PACKARD SERVICE TRAINING PROGRAM

IGNITION SUPPLEMENT

GENERAL TERMINOLOGY USED IN IGNITION

AND ELECTRICAL SYSTEMS

Ammeter: An instrument used to measure the flow of current or amperes along a conductor. An ammeter must always be connected in series with a circuit.

Ampere: A unit for measuring the rate of flow of current. An ampere represents the quantity of electricity flowing along a conductor at a given point in one second of time.

Ampere Turns: Ampere turns represents the magnetizing force of a coil. It is the number of amperes of current flowing through a coil multiplied by the number of turns of wire in the coil.

Arc (Spark): The sudden discharge of an electrical charge through an air space or gap.

Armature: A moving part operating within a magnetic field. Examples: generator and starting motor armatures, cut out relay armature, voltage and current regulator armatures.

Battery: A unit that stores energy in a chemical form, and converts this chemical energy into electrical energy when it is used in a closed electrical circuit.

Capacitance (or Capacity):

a. That property of a system of conductors and dielectrics which permits the storage of electrical charges.

b. When a change of one volt per second across a condenser produces a current flow of one ampere, the condenser is said to have a capacity of one farad. The unit of measurement known as a "farad" is much too great for any practical use. For that reason the "microfarad" (one-millionth farad) is used to measure condenser capacities.

Circuit: The entire course through which an electric current flows.

a. Parallel Circuit: A circuit offering two or more paths for current to flow through and ending at one point.

b. Series Circuit: A single continuous circuit, in which the flow of current would stop, if broken at any point.

Important: "Parallel," "shunt," and "across the circuit," are terms used in the explanation of electrical circuits and connecting test equipment. All three are alike in their definition and mean the same.

"Grounds" and "Shorts" in an electrical system are two distinct and different conditions. Become familiar with each term, as it will help to understand trouble shooting of the electrical system. A simple way to remember accidental grounds and shorts is: A ground is one wire, whose insulation is worn through and is making contact with the frame, housing, or engine. A "short" is two wires, whose insulation is worn through and they are making contact with each other.

Coil: An electrical Conductor (wire) wound around or upon, a spool or core to save space, as in a resistance coil; or to concentrate or multiply the magnetic effect of an electrical current, as in an induction coil or armature winding.

Condenser: An electrical unit used to absorb and store electrical energy.

Conductor: A material through which electricity will readily flow.

Core: An iron mass, either a single piece of metal, or is made up of laminated strips. It is generally used as the central portion of an electromagnet, or an armature around which the conductor is wound.

Corona: Generally speaking, corona is an electrical spark that does not follow a direct straight line from one electrode to another. It can be readily recognized by it's spherical shaped illumination. Corona is produced when the ionization of one section of gas (air) between the electrodes does not produce an ionizing stress in all other sections. This is often the condition on high voltage transmission lines, and at times it can be seen around spark plug terminals in the dark.

Cranking Motor (Starting Motor): A device which by means of electromagnetic induction converts electrical energy into mechanical energy. The cranking motor is often referred to as the starter.

Cycle: A complete act of recurrent values. A complete series of events, that return to the original position or starting point.

Dielectric: An insulating medium which intervenes between two conductors and permits electromagnetic attraction and repulsion to take place across it. Usually a dielectric is air, mica, glass, rubber, ebonite or bakelite.

Electrolyte: A conducting liquid which is decomposed by passage of an electrical current. Example: battery electrolyte (sulphuric acid and water).

Electromagnet: A magnet formed by passing an electrical current through wire wound around a core.

Electromotive Force (EMF) Electrical pressure, potential or voltage.

Electron: An electron is a negative unit of electricity, which is an indivisible material particle.

Field (Magnetic field): A space influenced by magnetic lines of force, as in a generator field.

Flux (Magnetic flux): The total group of magnetic lines leaving or entering a magnetic pole.

Frequency: The number of cycles completed in one unit of time.

Generator: A device which, by the means of electromagnetic induction, converts mechanical energy into electrical energy.

Ground: Connection of an electrical unit or conductor to the engine or frame, either purposely or accidently made, to complete an electrical circuit.

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Hysterisis: The lagging of magnetism, in a magnetic metal, behind the magnetizing flux which produces the magnetism.

Induction (or Inductance): When the flow of current in a circuit is interrupted, the collapse of the magnetic field through a coil of wire produces a voltage in such a direction that it opposes the change in flow of the current.

Ionization: The process of removing or adding electrons to neutral atoms causing them to become positively or negatively charged.

Lines of Force: Invisible magnetic lines in a space (field).

Magnet: A material that has the ability to attract or repel iron.

Magnetism: That property possessed by some substances, especially iron or steel, by virtue of which they exert forces of attraction or repulsion upon each other.

Magnetic Field: The space around a magnet, influenced by magnetic lines of force. A magnetic field exists around every conductor which has current flowing through it.

Magnetic Flux: The flow of magnetism.

Mutual Inductance: The property which causes a voltage to be induced in a second circuit, by interrupting, or changing the flow of current in the first circuit. For example as in the secondary winding of an ignition coil.

North Pole: The pole of a magent from which the magnetic lines of force are said to emanate (or leave).

Ohm: A unit of measurement of electrical resistance.

Ohmeter: An instrument used to measure resistance in an electrical circuit.

Ozone: A faint blue gas with characteristic smell, produced when an electrical discharge is passed through the air changing oxygen into ozone (O_3).

Permeability: The magnetic quality of a material. The ease with which a material can be magnetized.

Potential: Electrical pressure measured in volts.

Residual Magnetism: The magnetism retained by a material after all magnetizing forces have been removed.

Resistance: That property of an electrical circuit which tends to stop, or reduce the flow of current through the circuit.

Self-Inductance: That property which caused a voltage to be induced in the same circuit in which the flow of current is interrupted, or change of current is taking place.

Short Circuit: A circuit, purposely or accidentally made, which reduces the resistance of the circuit and thereby increases the flow of current (amperes).

Spark (Arc): The sudden discharge of an electrical spark through an air space or gap.

Specific Gravity: A unit of measurement of the weight of a substance compared to the weight of an equal volume of chemically pure water.

Sulphation: A crystalline formation of lead sulphate on storage battery plates.

Volt: A unit of measurement of potential or electrical pressure.

Voltmeter: An instrument used to measure voltage or electrical pressure in a circuit. A voltmeter must be connected in parallel, or across the circuit.

Watt: A unit of electrical power or energy. Its value is determined by multiplying the volts times the amperes in a circuit.

WHY THE CONDENSER IS NECESSARY

The strength of the secondary current set up in an ignition coil depends on the speed at which the lines of force pass through the coil. However, the lines of force in collapsing, not only cut through the secondary coil, but they also cut the turns of the primary coil and this tends to increase the voltage of the primary coil.

When the points separate or open, the current tends to stop in the primary winding. This causes the lines of force to collapse, and in collapsing, they generate a high voltage in the primary coil as well as in the secondary coil. Thus, if the voltage at the points is 6 volts at the time of opening, it immediately drops and then rises to a very high point, tending to form an arc which would allow the current to continue to flow across the breaker points.

However, when the condenser is connected across the points and the arc producing voltage starts to build up, on the opening of the points, the condenser absorbs this voltage. In other words, the condenser collects the energy and becomes charged. This action prevents an arc from forming and protects the points from being burned.

It is important that condensers be of the correct capacity. A condenser capacity that is too small will cause the negative breaker point to be pitted. Too much capacity will build a hump on the negative point. An easy way to remember this is, "Too much metal on negative breaker point - too much condenser capacity and vice versa."

The average capacity of most automobile condensers is .20 - .28 of a microfarad. In some cases, where an engine is run at idling speed much of the time, such as in taxi-cab service, a capacity of as high as .40 of micrafarad may be required.

CONDENSER LEAKAGE

It is a known fact that no matter how good any condenser may be, if it is given enough time, it will eventually lose its charge. In other words, EVERY condenser leaks. Some condensers will not hold a charge more than a very small fraction of a second which others may hold it for days.

Due to the tremendous speed of condenser action in an ignition circuit, a condenser must leak badly before it will materially affect engine performance. The condenser charges and discharges very quickly so there is almost no time for it to leak. It is important to know how much leakage there is however, because after the leakage reaches a certain point the engine will not function properly.

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