Ignition System

General

The ignition system consists of a battery, switch, coil, distributor with centrifugal advance mechanism, spark plugs and wiring. The 6 Volt current supplied by the batterie is converted to high voltage ignition current by the coil. The ignition system is interference suppressed.

Function

The ignition coil is a transformer. The current in the primary winding of the ignition coil is interrupted by the contact breaker points in the distributor. The magnetic flux in the iron core thereby collapses suddenly causing a high voltage impulse in the secondary winding which causes the spark at the spark plugs.

The condenser connected in parallel with the contact breaker points suppresses the arc at the points when they open thereby preserving the contact points and promptly cutting the primary current.

Construction of the coil

The secondary winding consisting of many turns of thin wire is wound on the laminated iron core of the coil. The primary winding consisting of a few turns of heavy wire is wound around the secondary windings. The inner end of the secondary coil is connected to the iron core to the end of which the high voltage output socket is attached. The other end of the secondary winding is attached to the beginning of the primary winding at terminal 15 on the top of the coil. The end of the primary winding is connected to terminal one at the top of the coil and to ground by way of the breaker contacts.
The iron core is supported by a ceramic insulator at the bottom and by the coil cap at the top. The coil is enclosed in a soft iron shell which acts as a magnetic conductor. The plastic coil cap which contains the HT socket and terminals 1 and 15, are secured to the metal housing. The windings of the coil are impregnated with insulating compound which also fills the cavities and empty spaces. The compound insures good heat dissipation from the coil windings to the metal casing and thereby to the surrounding air.

Testing

To test the performance of the ignition coil, the length of the spark it produces is measured. This can be done on a test bench or on the engine.

After first testing the braker points and 6 volt connections, disconnect the center lead from the distributor cap and hold it approx. 7 mm ($^9/_{32}$ in.) from the crankcase. A strong spark should occur.

Maintenance

The ignition coil insulating cap must be kept clean and dry to prevent high voltage leaks.

When the engine is turned by the starter a good spark should jump from the wire to ground.

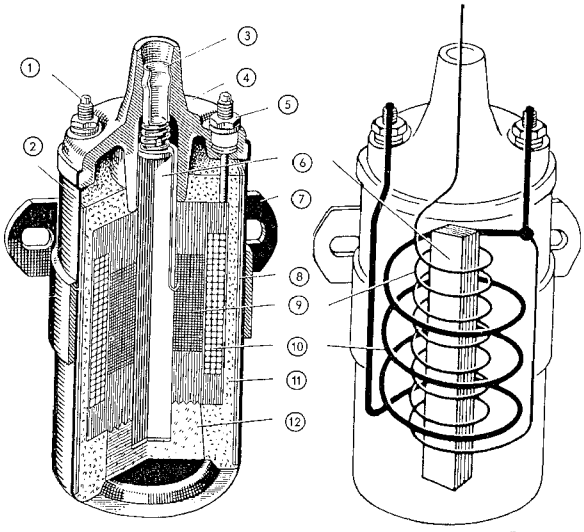

Fig. 40

Section view

Schematic

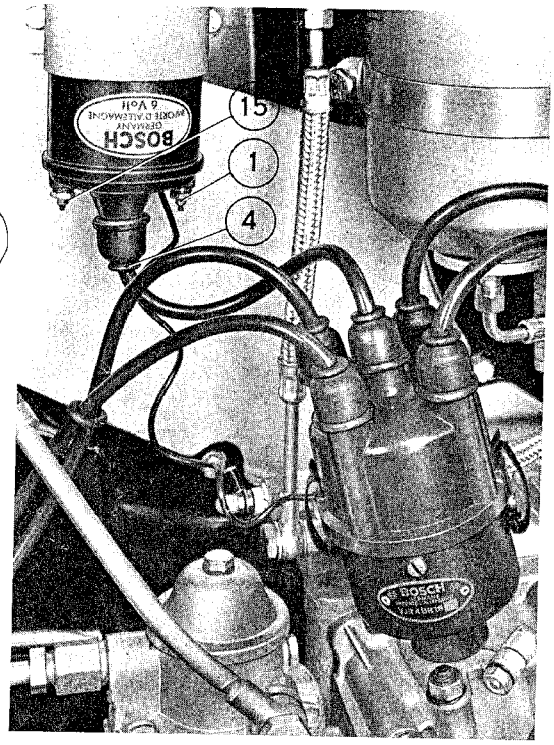

Fig. 41

Ignition coil

① Housing
② Terminal 1
③ Terminal 4
④ Cap
⑤ Terminal 15
⑥ Laminated iron core
⑦ Mounting bracket
⑧ Soft iron shell
⑨ Secondary winding
⑩ Primary winding
⑪ Insulating material
⑫ Ceramic insulator

Connections:

Terminal 15 to ingnition switch
Terminal 1 to distributor (contact breaker points)
Terminal 4 to distributor cap (high-tension lead)

Distributor

General

The distributor, with its rotor, distributes the high voltage current to the correct spark plug wire while on the same shaft a cam opens breaker points which interrupt the power supply to the coil, thereby producing the high voltage current. A centrifugal mechanism advances the spark timing as engine speed increases.

Construction

The cast iron, cup shaped, distributor housing contains the breaker contacts, breaker cam, centrifugal advance mechanism, and distributor rotor. The extension of the distributor housing provides the plain bearing for the distributor shaft as well as being the mount for the distributor. The housing is held to the crankcase by a clamp which also serves as an adjustment for the timing angle. A slotted coupling connects the distributor to the pinion shaft which is driven by worm drive on the crankshaft. The cam which operates the tungsten tip contacts has four lobes and carries the rotor on its extended end. The contacts are opened by the cam at regular intervals to a gap of 0.4 mm (.016 in.) which can be adjusted by an eccentric screw.

The distributing mechanism consists of contact points, one of which is pivoted and driven by the four lobe distributor cam; an insulated rotor which is mounted on the top of the cam so that its electrode points to the stationary electrode of the correct spark plug wire at the instant the breaker points open; and a cap of high grade insulating material which contains the sockets and electrodes for the four spark plug wires the high voltage wire from the ignition coil and covers the distributor housing. The impulse initiated by the breaker points causes a high voltage current to flow from the coil to the center terminal on the distributor cap and through a spring loaded carbon brush to the rotor from which it jumps over an air gap of approx. 0.3 to 0.7 mm (.118 to .276 in.) to the electrode at the edge of the distributor cap and finally to the spark plugs.

The distributor is ventilated by holes in the bottom of the housing so that the ozone generated by the spark from the rotor to the wire terminals may escape. The harmful effects of the ozone are thereby reduced. The condenser, connected in parallel to the contact points, is located on the outside of distributor housing.

Maintenance

Dirty or slightly burned breaker points should be cleaned with a contact file, which is designed especially for this purpose. Emery cloth should never be used. The contact surfaces must be flat and smooth to insure a parallel contact when closed. This is accomplished by filing with light pressure against the stationary contact while the movable contact presses against the file. It is important to file parallel to the contact surface. Clean the filings from the distributor with compressed air. The cam lobes should be slightly greased to reduce wear of the fiber block to a minimum.

A few drops of engine oil should be applied to the distributor shaft through the contact-breaker plate when carrying out the first service inspection of the car. Care should be taken that no oil gets on the contacts of the breaker points.

The rotor finger and the four electrodes of the distributor cap are subjected to a certain amount of erosion from continuous sparking during operation. Misfiring may occur, if the insulating material of the distributor cap or the rotor is cracked. The cap must be kept clean and dry inside and outside to prevent high voltage leaks. When mounting the cap, insure that the spring loaded brush for the rotor has not been left out and is in good working order. The rotor must be fully seated to insure proper operation.

19 LI

Ignition System Failure

If engine trouble indicates poor ignition performance, the following easy checks may be made to determine the cause. It should be understood that this is not a substitute for a thorough inspection which should be carried out at an auto electric shop.

Starter operates but engine will not start

1. Check HT lead for good contact at the coil terminal. Pull ignition coil HT lead from the distributor cap and hold the wire end about 7 mm ($^{9}/_{32}$ in.) from a clean ground point on the engine. If a good spark occurs when the engine is being cranked, primary and secondary circuits are good to this point; proceed with test 5. If there is no spark:

2. Connect a 6-volt test lamp between the distributor primary terminal 1 and ground. If the light goes on and off as the engine is being cranked, the primary circuit is probably good. Disconnect the test light.

3. If the test light remains on as the engine is cranked, the contact points are not closing. Check point opening and ground connections in the distributor. Clean contacts.

4. If the test light remains off while the engine is cranked, the primary circuit is open or the points are not opening correctly. Check for loose connections, broken leads, grounded distributor terminal, and condition of points (severe pitting). Also check the ignition switch and primary winding of the coil. These tests are best performed with a test lamp or voltmeter. A new coil may be installed.

5. Remove distributor cap and check for moisture, severe corrosion, and internal arc paths (burned tracer lines). Check spark plug sockets for moisture and that the contact pins penetrate to the center of the leads.

   Remove and inspect spark plugs; reset gap if necessary 0.5 to 0.6 mm (.020 to .024 in.).

6. If the cause has not been found, check the ignition timing. If this is found to be correct, the fault probably does not lie in the ignition system but in the fuel or carburetor system.

Engine runs poorly

1. Misfiring, loss of power, or hard starting are not necessarely caused by faulty ignition but may be due to various causes. A complete check should be made by a qualified repair shop.

   Spark plugs must be in good condition and relatively new. The coil and condenser can be checked by using replacement units. All leads should be checked for good clean connections. Spark plug wires should be checked in the dark to determine high voltage leaks while the engine is running. In cases of high speed misfiring, check the breaker arm spring tension. Check the distributor on a testing unit if possible.

2. Backfiring and carburetor spitting can be caused by improper timing or a loose or bent distributor shaft. A wobbling shaft will cause continuously changing spark timing. Spark plugs of the wrong heat range may also be the cause along with excessive carbon formation or poor fuel. A faulty breaker point condenser should not be overlooked.

Adjusting Breaker Points

20 LI

The breaker contacts are adjusted in the following manner:

1. Remove distributor cap and rotor.

2. Turn the crankshaft until the fiber block on the breaker arm rests on the highest point of the cam lobe (Fig. 42).

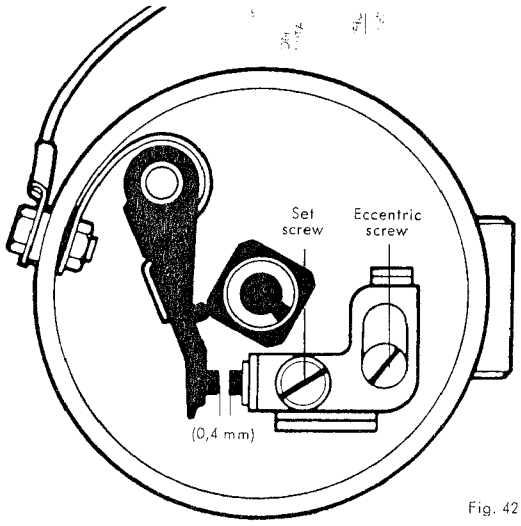

Fig. 42

Distributor, plan view

3. Measure point gap with a feeler gauge (0.4 mm, .016 in.).

4. If the point gap is other than specified, loosen the set screw of the fixed breaker point.

5. Turn the eccentric adjusting screw until the correct gap of 0.4 mm (.016 in.) is obtained. Check with a feeler gauge (make sure gauge is clean).

6. Tighten clamping screw.

7. Recheck the gap on four lobes.

Important

After the contact points have been adjusted, it is absolutely necessary to check the ignition timing, since a 0.1 mm (.004 in.) gap difference alters the ignition timing by approx. 3° crankshaft angle.

The correct opening and closing of the breaker points is obtained only if there is no perceptible clearance between the distributor shaft and bearing.

21 LI

Installing Breaker Points

The breaker points erode during normal service by burning. If the points have reached a stage where an adjustment is no longer possible, or if the breaker points are badly burned, a new set should be installed.

Replacement

1. Remove distributor cap and rotor.
2. Disconnect low voltage wire from terminal 1 at distributor.
3. Loosen nut of terminal screw and remove breaker arm.
   Note proper position of insulator to avoid short circuit at this point when fitting the new breaker arm. Lightly lubricate pivot pin with special grease.
4. Install new breaker arm.
5. Connect low voltage wire.
6. Remove fixed contact by removing clamping screw. Do not let screw fall into distributor housing.
7. Install new contact and install securing screw.
8. Adjust breaker point gap.
9. Adjust ignition timing if necessary.
10. Install distributor cap and check HT wires.

① Primary contact (terminal 2)
② Condenser
③ Breaker point spring
④ Insulation
⑤ Insulator washer
⑥ Insulator block
⑦ Clamp plate
⑧ Terminal screw
⑨ Breaker arm
⑩ Clamp screw
⑪ Breaker point
⑫ Eccentric screw

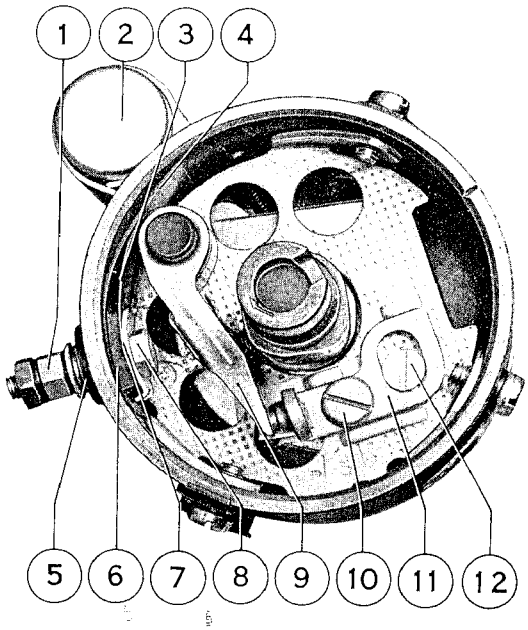

Fig. 43

Adjusting Ignition Timing

22 LI

Note

Before beginning the adjustment, adjust the breaker point gap as outlined in section 20 LI. The timing mark must be marked on the V-belt pully 5° or 6.3 mm (.248 in.) before TDC for 1600 and 1600 S engines.

Adjustment

1. Mark timing point 5° before TDC.

2. Remove distributor cap.

3. Align the timing mark (5° BTDC) with the line on the crankcase so that the distributor rotor is in line with the cylinder I mark on the distributor housing.

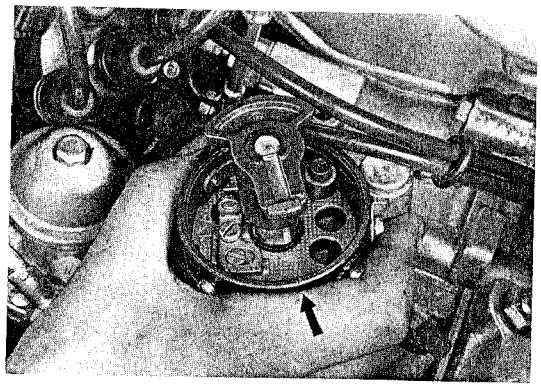

Fig. 44

4. Loosen distributor clamping screw.

5. Connect a 6 volt test lamp to terminal 1 on the distributor and ground.

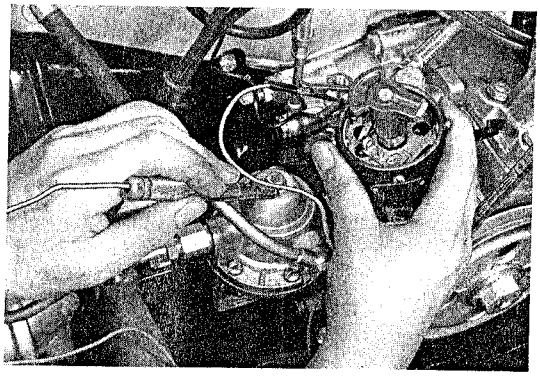

Fig. 45

6. Switch on ignition and rotate the distributor clockwise until the breaker points close. Then rotate the distributor counter-clockwise very slowly until the test lamp lights.

7. Carefully tighten distributor clamp without moving the distributor.

8. Re-check adjustment and install distributor cap.

The ignition timing of all four cylinders is correct if, when the crankshaft is turned in the normal direction of rotation, the test lamp lights each time when the timing mark comes in alignment with the mark on the crankcase and when it is straight downward.

Automatic Ignition Advance

The ignition is advanced automatically by a centrifugal mechanism located in the distributor housing under the breaker point plate. Its basic parts include a carrier frame, flyweights, and return springs.
The flyweights are mounted on pivots attached to the drive plate and cause the driven plate to advance by their outward movement. With increasing speed of the drive plate, the flyweights move outward against the force of the return springs and advance the driven plate to which the distributor cam and rotor are attached. The breaker points are thereby opened earlier and effect the required ignition advance. The correct automatic advance is 30° of crankshaft rotation not including the 5° basic advance. As the engine speed decreases the flyweights are pulled back to their original position by the return springs whereby the basic timing point is obtained.

23 LI

Testing Automatic Advance Mechanism

A simple test to determine whether the advance mechanism is functioning can be made by removing the distributor cap and turning the rotor clockwise until it stops. When the rotor is released it should return to its original position freely by itself. If it does not return, the springs are faulty or the bearing surfaces are gummed. An unexplained "pinging" noise in the engine can be caused by a defective advance mechanism. The exact operation of the advance mechanism can be tested with an ignition test set.

To test the movement of the advance mechanism while the engine is running, a timing light and degree markings on the pulley are necessary. The degree markings are best made by making a sheet metal pattern as described in Fig. 46. Carefully mark degree markings on the rim of the pulley and connect the timing light. If available, a degree wheel with a 23 mm (.905 in.) dia. center bore may be used by mounting it between the spring washer and bolt head of the V-belt pulley. Mount the degree wheel so that the 0° marking is in line with the OT slot on the pulley.

Incorrect timing or faulty advance mechanism operation can easily be detected and corrected by testing at various engine speeds. The correct timing adjustment can be adjusted very accurately in this manner.

A pattern for marking degree markings on the V-belt pulley can be fabricated in the following manner:

1. Select a piece of sheet metal 80 x 50 mm ($3^1/_8$ x $1^{31}/_{32}$ in.).

2. Mark degree lines and radii and cut slots using a saw or tin shears. The slots should be approx. 10 mm (½ in.) deep and just wide enough to allow a pencil to enter.

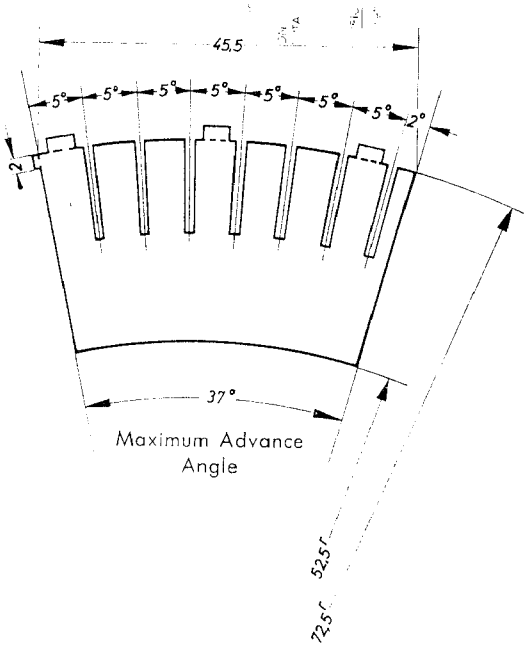

Fig. 46

3. The three tabs at the upper rim are to be bent back to act as guides. The small tab at the left edge, when bent back, fits into the OT slot on the pulley and acts as an index. The index tab should be not more than 0.5 mm (.197 in.) high when bent over.

The timing can now be tested with a stroboscopic test light as follows:

Testing

1. Turn the crankshaft so that the timing (OT) mark is upward.

2. Using the fabricated pattern, mark the timing degrees on the pulley with a pencil.

3. Using a quick drying lacquer, paint black segments as shown in Fig. 47.

4. Connect a strob-light in series with the spark plug wire of No. 1 cylinder.

5. Darken the marking on the generator base with black paint.

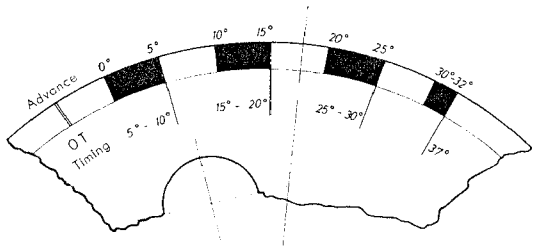

Fig. 47

6. Start the engine and test the automatic advance at various speeds.

As the engine speed increases the timing point should move slowly and evenly to a greater advance while remaining within the range specified in Fig. 48. The maximum permissible advance is 37° total or 35 ± 2°.

If only a general test is required, a black mark from 5° or 6.3 mm (¼ in.) from OT mark, to 35° or 47.3 mm (⅛ in.) should be painted on the pulley. At idling speed the timing should be at the left end of the mark and at speeds above 3100 rpm at the right end of the mark.

Automatic Advance Curve

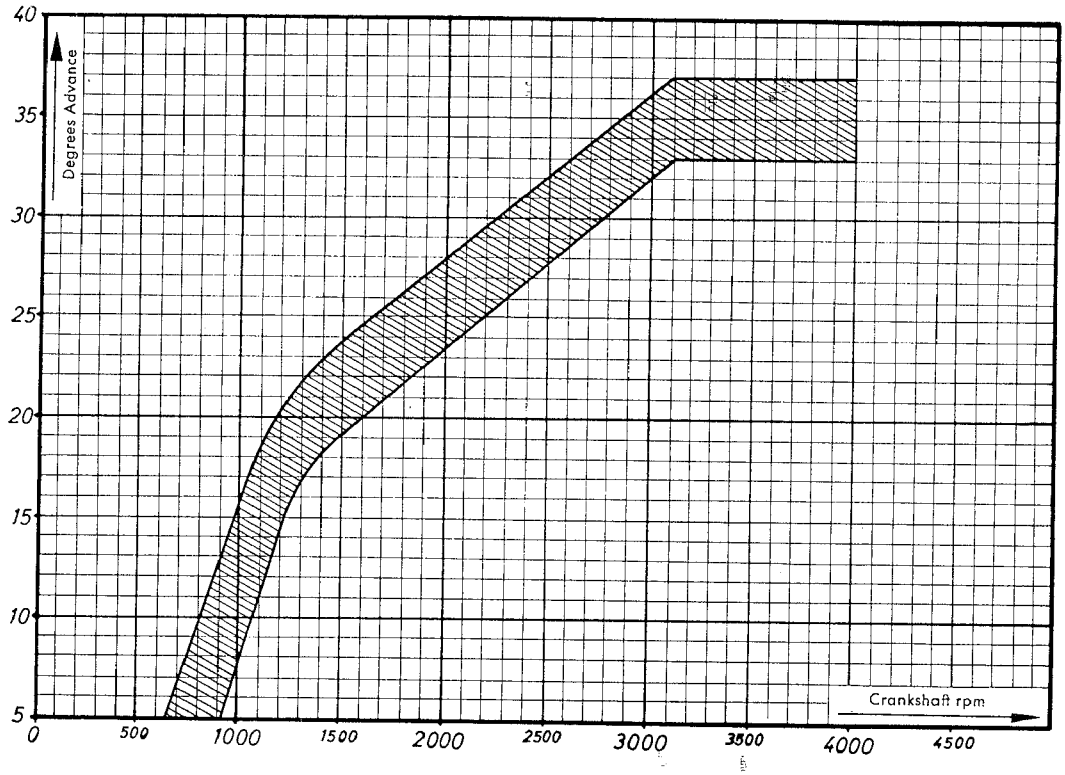

Fig. 48

Testing Condenser

24 LI

The condenser is essential in producing the required high voltage for the ignition. It suppresses the spark which occurs when the points separate, reducing contact wear.

A defective condenser is indicated by burned breaker points and a weak spark as well as difficult starting. Also when no spark, even across a short gap from a plug lead, can be obtained the condenser can be at fault.

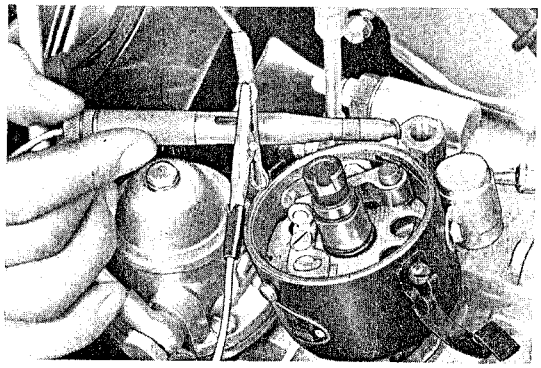

Fig. 49

Testing

It is possible to check a condenser for high resistance, insulation leakage, and capacity on a testing device. If a condenser tester is not available, proceed as follows:

1. Disconnect cable 1 from terminal of breaker arm.

2. Connect one lead of a 6 volt test lamp to cable 1 at the ignition coil and the other to the condenser cable (Fig. 49).

3. Switch on ignition. If the lamp lights, the condenser is grounded and should be replaced. If it does not light proceed as follows:

4. Remove test light and reconnect coil and condenser leads.

5. Disconnect high tension lead from coil at distributor cap and hold it approx. 7 mm ($^{9}/_{32}$ in.) from the crankcase.

6. Crank engine with ignition switched on. If no spark occurs at the prescribed distance, the inspection should be repeated with a new condenser. If still no spark occurs the fault is elsewhere.

For replacement, use only condensers of the prescribed type, since condensers of incorrect capacities will seriously affect breaker point life.

25 LI

Removing and Installing Distributor

Removal

1. Disconnect lead from terminal 1 at distributor (breaker point terminal).

2. Remove distributor cap.

3. Remove retaining screw of distributor holder at the crankcase.

4. Remove distributor.

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Rotate the crankshaft until No. 1 cylinder is at TDC with both valves closed. The slot of the distributor drive pinion must then be offset toward and parallel to the V-belt pulley, while the pulley mark is in line with the mark on the generator support.

2. Make sure the spacer spring is properly seated in the distributor drive head.
   Warning. Do not allow the spring to fall into timing case.

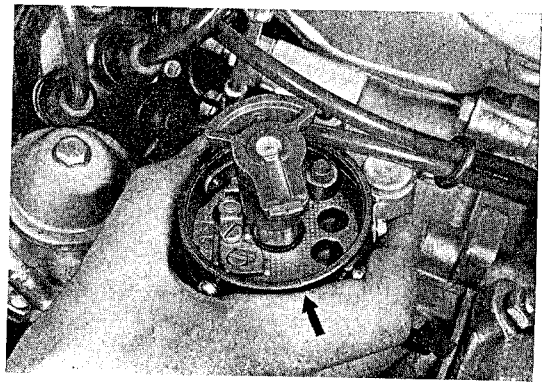

Fig. 50

3. When installing the distributor, turn the shaft until the rotor points to the mark for cylinder No. 1 on the rim of the distributor body. Install the distributor turning the rotor back and forth until the coupling engages.

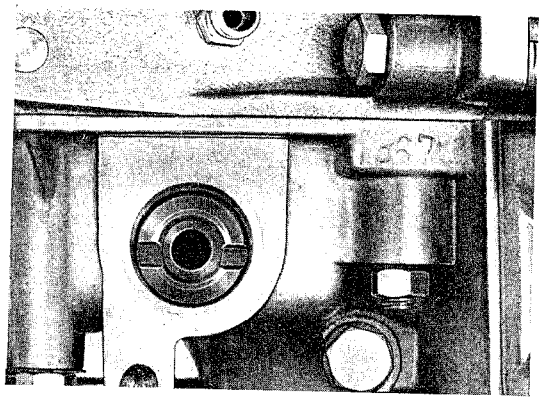

Fig. 51

4. Secure distributor mounting plate and check ignition timing.

Spark Plugs

General

The spark plugs bring the ignition current into the combustion chamber. The current flows through the insulated body to the electrodes in the combustion mixture where the current spans an air gap in the form of the ignition spark.

Construction

The basic parts of a spark plug are:

Center electrode

Insulator

Spark plug body.

The center electrode conducts the high voltage current through the insulator to the combustion chamber. The upper end is usually steel and is threaded to carry the ignition cable contact. A shoulder below the top threads seats against the insulator. Below the shoulder a set of threads holds the electrode in the ceramic. The end of the electrode which enters the combustion chamber is made of a special alloy section bonded to the upper shaft of the electrode. This alloy tip is designed to operate under high temperatures and is corrosion resistant. The metal is not easily affected by the lead content of the fuel or the sulphur compounds of the burned gases.

The insulator is made of a high grade ceramic material which retains its good insulating qualities even at high temperatures. The ceramic is very hard and is a good thermal conductor. For these reasons a spark plug of the correct heat range will not foul or oil up, nor will it pre-ignite the mixture by glow ignition. The thermal coefficient of expansion of the ceramic is very close to that of steel and can therefore operate through a large temperature range. Small differences in expansion are absorbed by the bonding cement in the spark plug base. The upper portion of the insulator is glazed to protect the ceramic from moisture and dirt.

The spark plug base contains the ceramic insulator, holds the spark plug in the cylinder head, and has the side electrode attached to its lower rim. The insulator is secured with spacers and washers by crimping the upper rim of the housing under high pressure. The side electrode is made of a special alloy and is attached to the rim of the housing by welding or by being forced into a bore in the side of the bottom edge.

Function

The high voltage current flows through the center electrode into the combustion chamber where it spans the air gap to the side electrode in the form of a spark. The resulting spark ignites the combustible mixture.

Service

Spark plugs should be checked every 3000 mi. (5000 km) for appearance, spark gap, and proper operation. The appearance indicates whether they are of the correct heat range, whether the engine is using too much oil, and whether the carburetors are correctly adjusted. The color of the spark plug insulator around the electrode indicates the following:

Light Brown

correct carburetor adjustment, heat range, and combustion.

Black

mixture too rich, spark plug too cold.

Light Grey

mixture too lean, spark plug too hot.

Oil coated

excess oil in cylinder, bad piston rings or worn intake valve guides.

Fuels with lead compounds cause a grey-brown tone in contrast to other fuels. This should be taken into account when inspecting the spark plugs.

During operation the electrode gap will become larger from the burning of electrode metal. Since this action does not burn the material away uniformly, it is best to measure the gap with a wire type gap gauge. The proper electrode gap can be obtained by bending the side electrode until a gap of 0.5 to 0.6 mm (.020 to .024 in.).

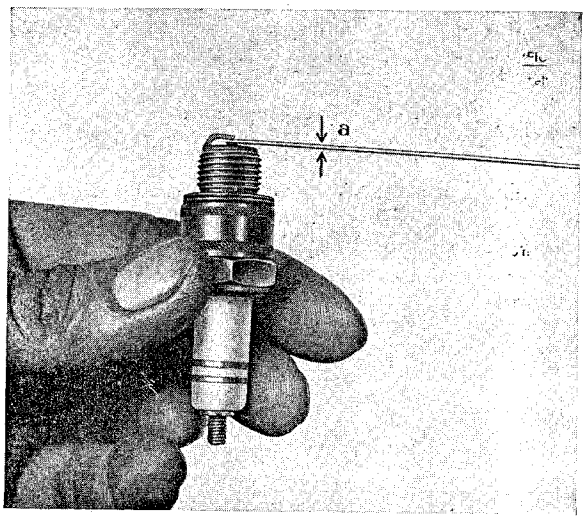

Fig. 52

The proper operation of the spark plugs may be tested on a spark plug tester. The spark should be observed under a pressure of 6 to 8 kg/cm² (85 to 114 psi.). Spark plug gaskets must be used when installing the spark plugs in the tester in order to obtain correct results.

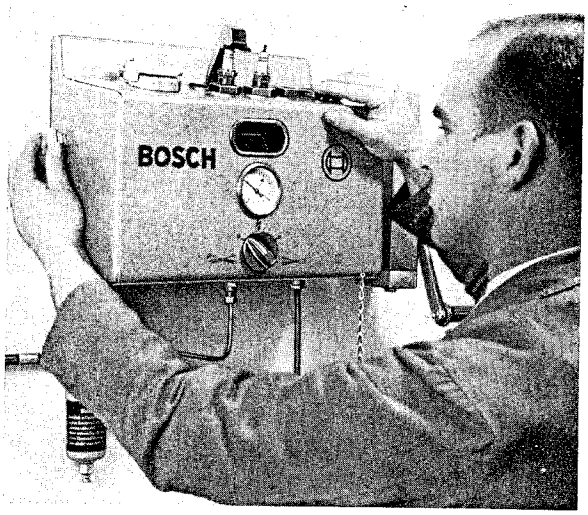

Fig. 53

It is advisable to install new spark plugs every 15 000 km (10 000 mi.). Spark plugs may be cleaned with a spark plug sand blasting device.

Oiled spark plugs should be first cleaned with solvent and dried with a blast of compressed air before cleaning in a sand blasting device. It is important that no sand particles remain in the spark plug. Clogged sand will become free during operation and damage the engine. The glazed portion of the insulator should be clean and dry for proper ignition.