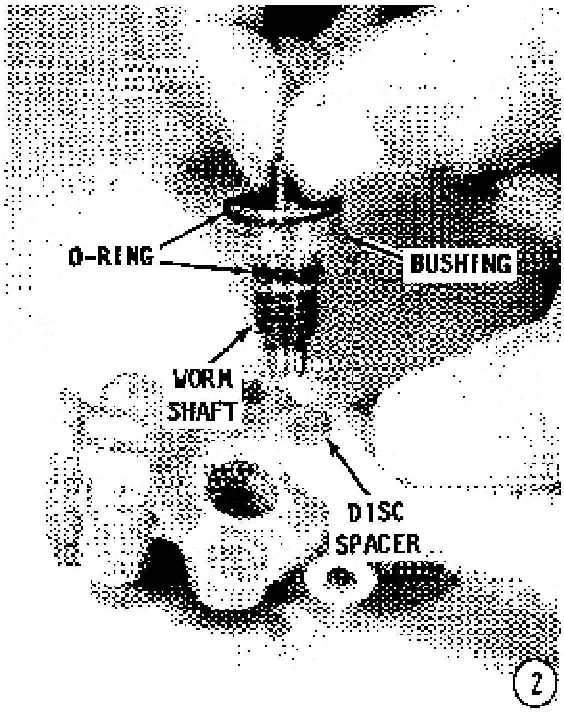
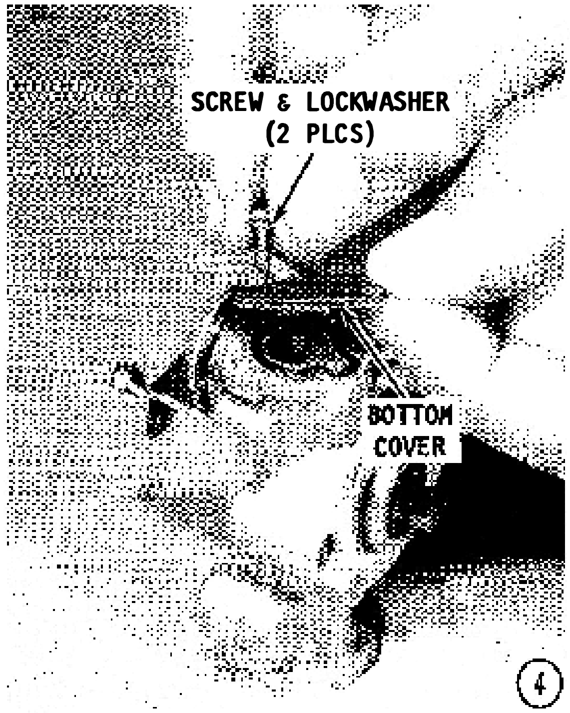


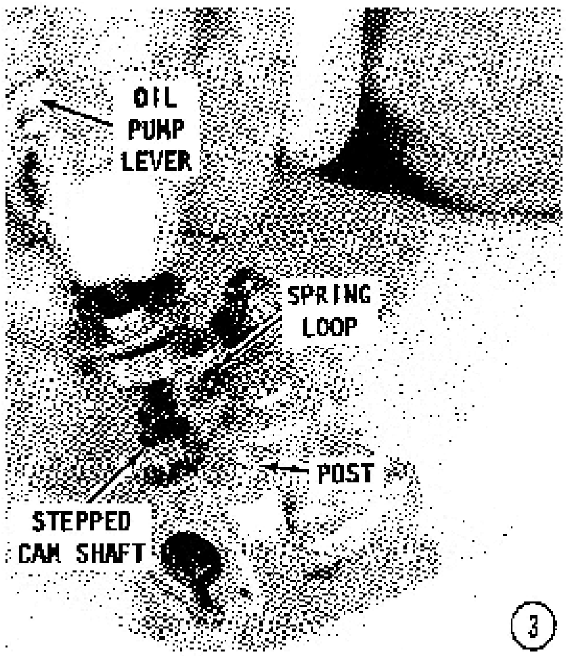


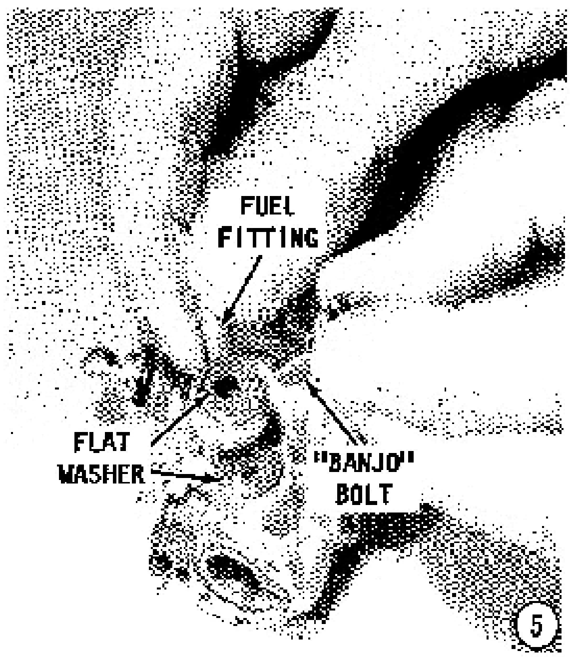
going in first. Line up the gear portion of the cam with the opening for the worm gear.

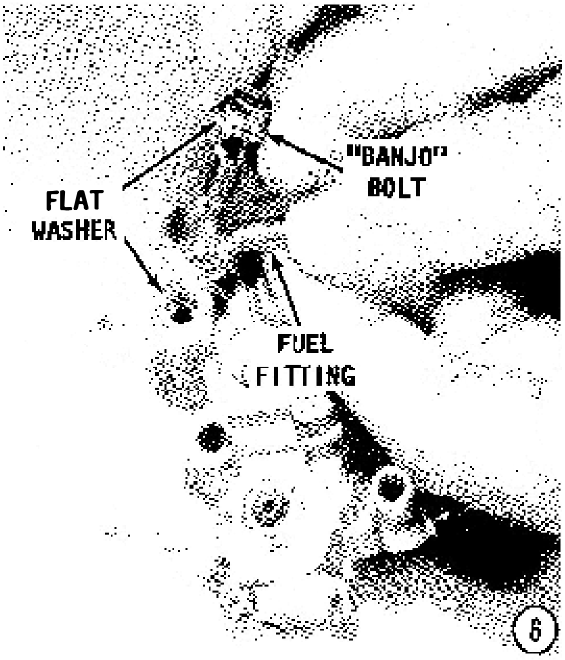
2- If the worm shaft was removed from the large bushing, slide the shaft back into place inside the bushing. Install the two O-rings around the bushing. Place the small disc spacer at the end of the worm shaft. Slide the assembled worm shaft into the pump with the teeth on the shaft indexing with the teeth on the driven cam. Push the shaft in until the shoulder of the bushing seats against the pump body.

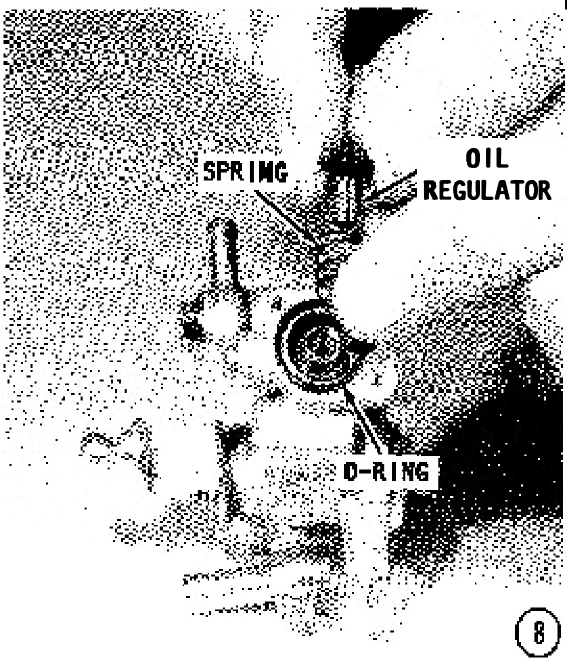
3- Install the O-ring around the stepped cam shaft. Slide the oil pump lever and stepped cam assembly into place. Wind the spring **COUNTERCLOCKWISE** a couple turns, and then hook the loop around the post on the body. The spring tension will be adjusted later when the oil control link rod is installed. Push the driven cam down the oil pump bore until the cam rests against the stepped cam.

4- Install the O-ring into the groove on the base of the pump. Place the bottom cover over the O-ring with the tang on the









cover facing downward. Install and tighten the two Phillips head screws with their captive lockwashers.

5- Install a flat washer, the oil inlet fitting, another flat washer, and the "Banjo" bolt into the lower opening of the pump.

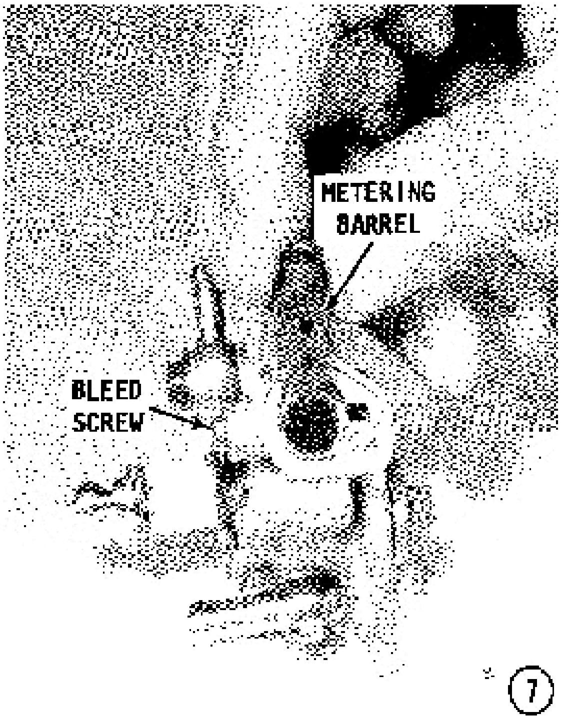
6- Install the flat washer, oil outlet fitting, another flat washer, and the "Banjo" bolt into the upper opening on the pump.

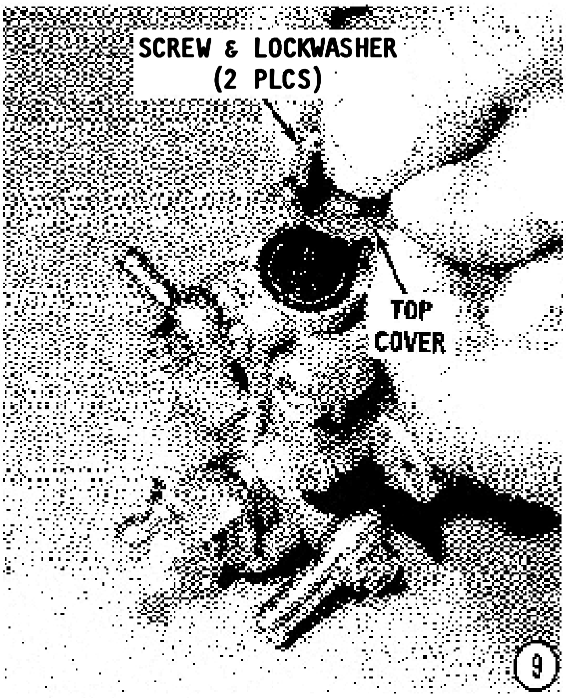
7- Slide the metering barrel into the pump bore with the posts on the driven cam indexing with the holes in the barrel. Install and tighten the bleed screw and the gasket/washer.

8- Install the O-ring into the groove on the top of the pump. Slide the spring down over the metering barrel and insert the oil regulator into the center of the barrel.

9- Place the top cover over the pump with the dimple in the cover facing upward. Install and tighten the two Phillips head screws with captive lockwashers. Tighten the screws securely.

The pump is now ready for installation to the powerhead.





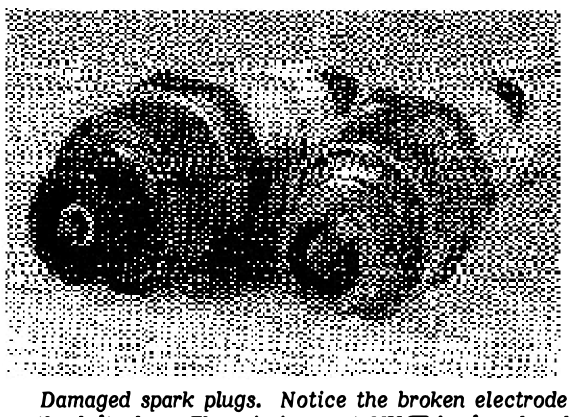
For convenience, each ignition system has been identified with a code numeral from I thru V. These code numerals will be used throughout this chapter and are referenced in the Appendix. To determine the code numeral of the ignition system used on any particular powerhead, simply find the engine and appropriate model year in the Tune-up Specifications, then move across the table to the IGN TYPE column. The ignition system used on that engine will be identified. Once this numeral is determined, refer to the appropriate section in this chapter for detailed troubleshooting and service procedures. The identification code numerals are as follows:

Type I Kiekhaefer -- Distributor --Magneto with points
Type II Thunderbolt -- Distributor --Lightning energizer ignition -- pointless
Also known as Alternator Driver Ignition (ADI)
Type III Thunderbolt -- Distributor -- C.D. ignition -- pointless
Type IV Thunderbolt -- Flywheel -- C.D. ignition -- pointless
Type V Thunderbolt -- Flywheel -- C.D. ignition -- pointless -- coil per cylinder

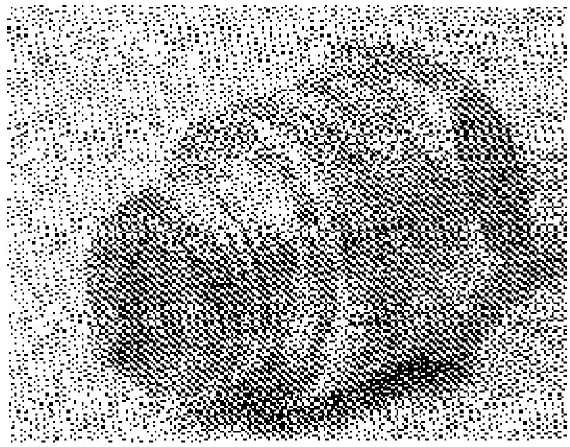
5-2 SPARK PLUG EVALUATION

Removal

Remove the spark plug wires by pulling and twisting on only the molded cap. **NEVER** pull on the wire or the connection inside the cap may become separated or the boot damaged. Remove the spark plugs and keep them in order. **TAKE CARE** not to tilt the socket as you remove the plug or the insulator may be cracked.



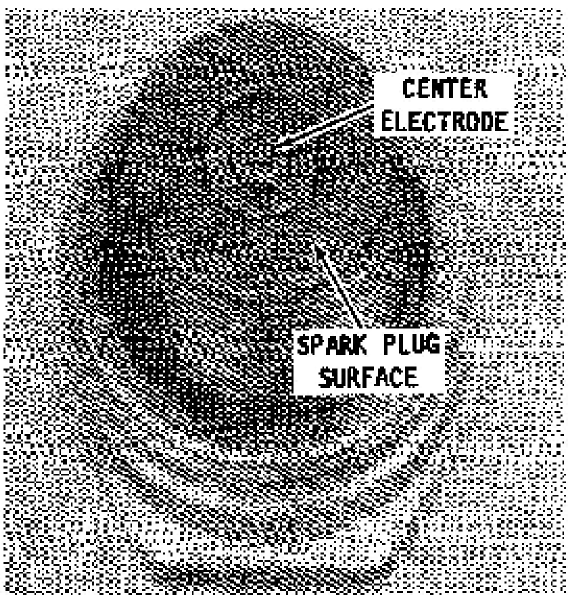
Damaged spark plugs. Notice the broken electrode on the left plug. The missing part MUST be found and removed before returning the powerhead to service, to prevent serious damage to expensive internal parts.



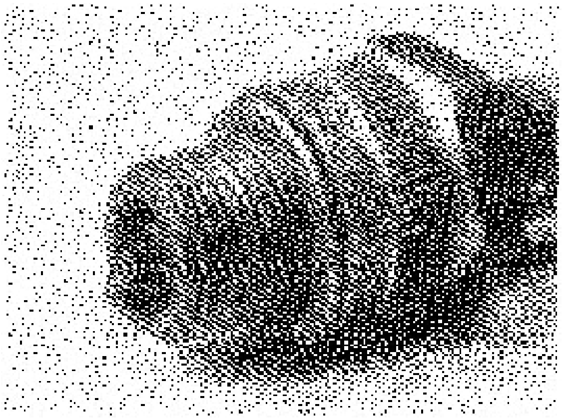
This spark plug is foul from operating with an overrich air/fuel mixture, possibly caused by an improper carburetor adjustment.

Examine

Line the plugs in order of removal and carefully examine them to determine the firing conditions in each cylinder. If the side electrode is bent down onto the center electrode, the piston is traveling too far upward in the cylinder and striking the spark plug. Such damage indicates the piston pin or the rod bearing is worn excessively. In most cases, an engine overhaul is required to correct the condition. To verify the cause of the problem, rotate the flywheel by hand. As the piston moves to the full up position, push on the piston crown with a screwdriver inserted through the spark plug



Example of a non-adjustable surface gap spark plug operated under favorable conditions.

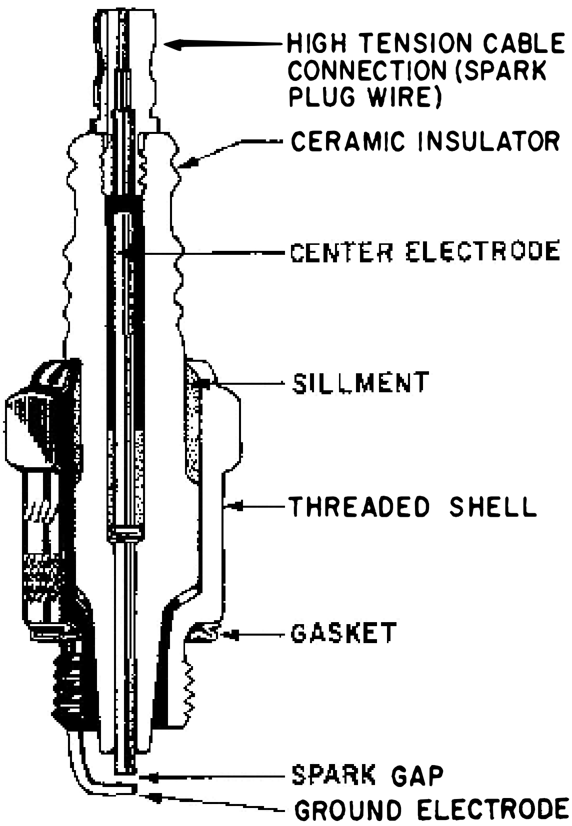


This spark plug has been operating too-cold, because it is rated with a too-low heat range for the powerhead.

hole, and at the same time rock the fly-wheel back-and-forth. If any play in the piston is detected, the engine must be rebuilt.

Correct Color

A proper firing plug should be dry and powdery. Hard deposits inside the shell indicate too much oil is being mixed with the fuel. The most important evidence is the light gray to tan color of the porcelain, which is an indication this plug has been running at the correct temperature. This means the plug is one with the correct heat range and also that the air-fuel mixture is correct.



Cutaway drawing of a typical spark plug with principle parts identified.

Rich Mixture

A black, sooty condition on both the spark plug shell and the porcelain is caused by an excessively rich air-fuel mixture, both at low and high speeds. The rich mixture lowers the combustion temperature so the spark plug does not run hot enough to burn off the deposits.

Deposits formed only on the shell is an indication the low-speed air-fuel mixture is too rich. At high speeds with the correct mixture, the temperature in the combustion chamber is high enough to burn off the deposits on the insulator.

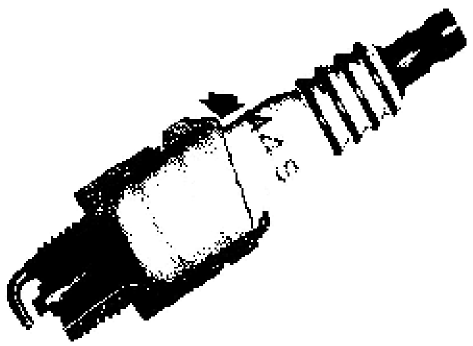
Too Cool

A dark insulator, with very few deposits, indicates the plug is running too cool. This condition can be caused by low compression or by using a spark plug of an incorrect heat range. If this condition shows on only one plug it is most usually caused by low compression in that cylinder. If all of the plugs have this appearance, then it is probably due to the plugs having a too-low heat range.

Fouled

A fouled spark plug may be caused by the wet oily deposits on the insulator shorting the high-tension current to ground inside the shell. The condition may also be caused by ignition problems which prevent a high-tension pulse from being delivered to the spark plug.

The spark plugs should be kept in order as they are removed from the powerhead to enable a proper diagnosis to be made of each cylinder operating condition.



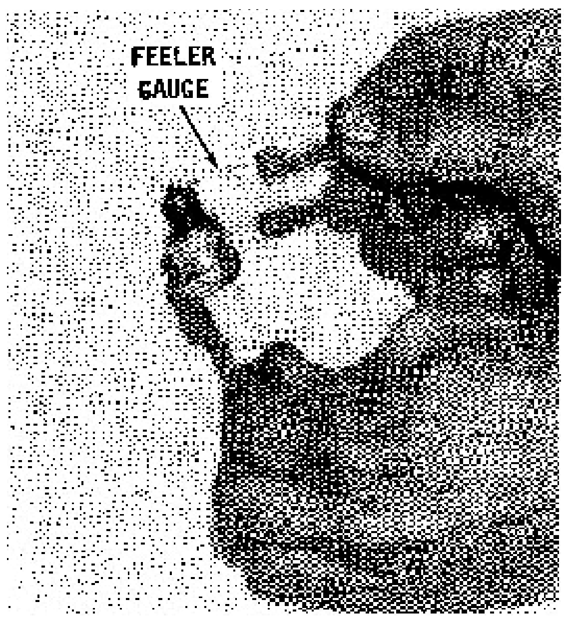
A crack in the porcelain is usually caused by removing or installing the plug using the wrong size wrench. Such damage will cause the spark to be grounded by jumping from the crack to the base of the plug.

Carbon Deposits

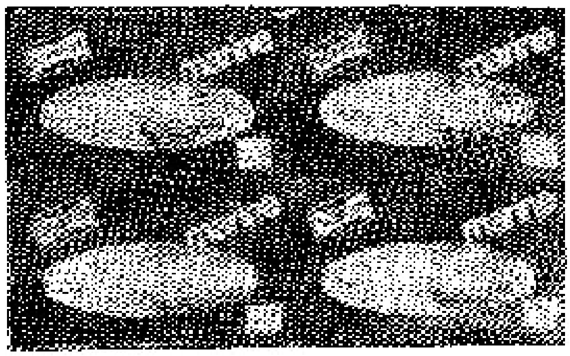
Heavy carbon-like deposits are an indication of excessive oil in the fuel. This condition may be the result of worn piston rings or excessive ring end gap.

Overheating

A dead white or gray insulator, which is generally blistered, is an indication of overheating and pre-ignition. The electrode gap wear rate will be more than normal and in the case of pre-ignition, will actually cause the electrodes to melt as shown in this illustration. Overheating and pre-ignition are usually caused by overadvanced timing, detonation from using too-low an octane



The spark plug gap should always be checked with a wire-type feeler gauge before installing new or used plugs.



*Today, numerous type spark plugs are available for service. **ALWAYS** check with the Specifications or the local marine shop to be sure the manufacturer has not initiated a late-change for the model being serviced.*

rating fuel, an excessively lean air-fuel mixture, or problems in the cooling system.

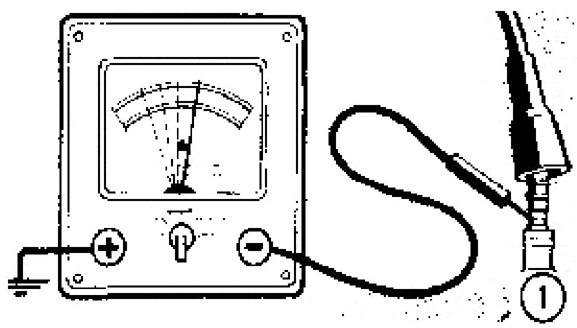
Electrode Wear

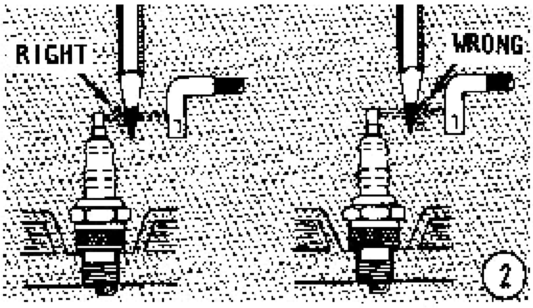
Electrode wear results in a wide gap and if the electrode becomes carbonized it will form a high-resistance path for the spark to jump across. Such a condition will cause the engine to misfire during acceleration. If all of the plugs are in this condition, it can cause an increase in fuel consumption and very poor performance at high-speed operation. The solution is to replace the spark plugs with a rating in the proper heat range and gapped to specification.

Red rust-colored deposits on the entire firing end of a spark plug can be caused by water in the cylinder combustion chamber. This can be the first evidence of water entering the cylinders through the exhaust manifold because of an accumulation of scale or defective exhaust shutter. This condition **MUST** be corrected at the first opportunity. Refer to Chapter 3, Engine Service.

5-3 POLARITY CHECK

Coil polarity is extremely important for proper battery ignition system operation. If a coil is connected with reverse polarity,

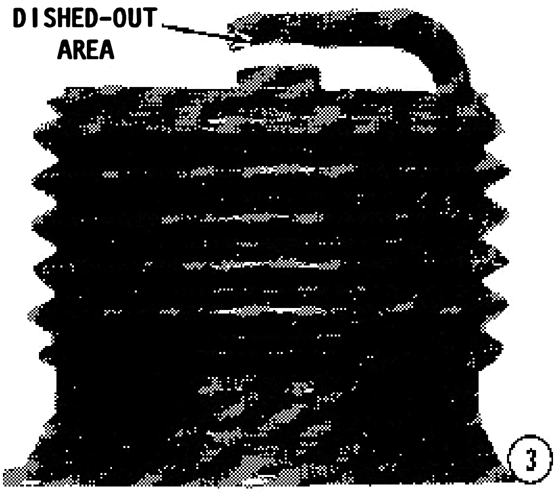




the spark plugs may demand from 30 to 40 percent more voltage to fire, or on most C.D. systems, there will be **NO** spark. Under such demand conditions, in a very short time the coil would be unable to supply enough voltage to fire the plugs. Any one of the following three methods may be used to quickly determine coil polarity.

1- The polarity of the coil can be checked using an ordinary D.C. voltmeter set on the maximum scale. Connect the positive lead to a good ground. With the engine running, momentarily touch the negative lead to a spark plug terminal. The needle should swing upscale. If the needle swings downscale, the polarity is reversed.

2- If a voltmeter is not available, a pencil may be used in the following manner: Disconnect a spark plug wire and hold the metal connector at the end of the cable about 1/4" (6.35mm) from the spark plug terminal. Now, insert an ordinary pencil tip between the terminal and the connector. Crank the engine with the ignition switch ON. If the spark feathers on the plug side and has a slight orange tinge, the polarity is correct. If the spark feathers on the cable connector side, the polarity is reversed.

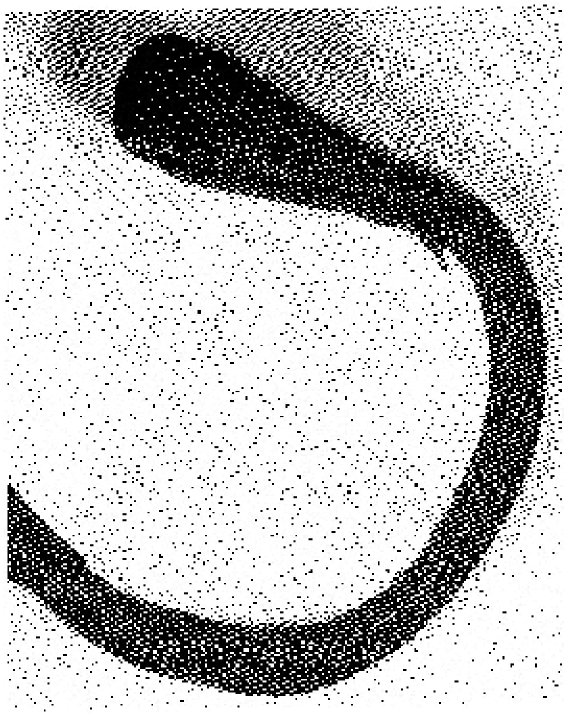


3- The firing end of a used spark plug can give a clue to coil polarity. If the ground electrode is "dished", it may mean polarity is reversed.

5-4 WIRING HARNESS

CRITICAL WORDS: These next two paragraphs may well be the most important words in this chapter. Probably the No. 1 cause of electrical problems with outboard power plants is misuse of the wiring harness.

A wiring harness is used between the key switch and the engine. This harness seldom contains wire of sufficient size to allow connecting accessories. Therefore, anytime a new accessory is installed, **NEW** wiring should be used between the battery and the accessory. A separate fuse panel **MUST** be installed on the dash. To connect the fuse panel, use one red and one black No. 10 gauge wires from the battery. If a small amount of 12-volt current should be accidently attached to the magneto system, the coil may be damaged or **DESTROYED.** Such a mistake in wiring can easily happen if the source for the 12-volt accessory is taken from the key switch. Therefore, again let it be said, **NEVER** connect accessories through the key switch.



*A damaged wiring lead or harness cannot be repaired, it **MUST** be replaced.*

5-5 TYPE I IGNITION SYSTEM KIEKHAEFER — DISTRIBUTOR MAGNETO WITH POINTS

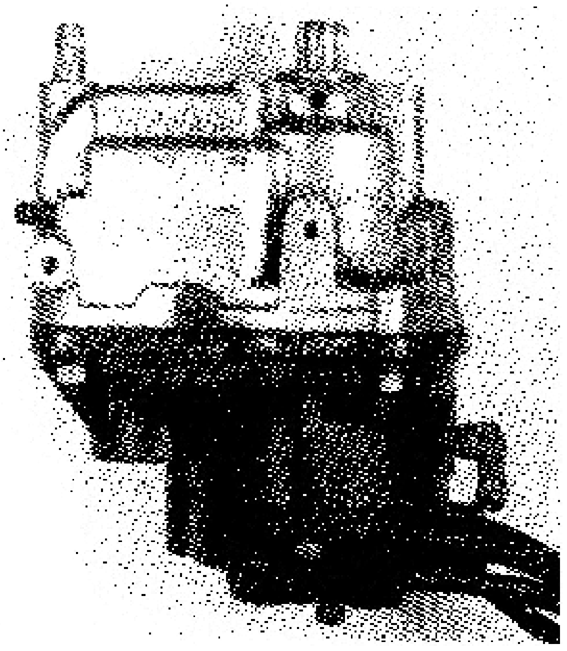
Description

This magneto system is identified as Type I in the Appendix.

Magnetos installed on outboard engines will usually operate over extremely long periods of time without requiring adjustment or repair. However, if ignition system problems are encountered, and the usual corrective actions such as replacement of spark plugs and breaker points does not correct the problem, the magneto output should be checked to determine if the unit is functioning properly.

The Type I Kiekhaefer and Fairbanks-Morse magnetos are special units for use on the 4-cylinder outboard units covered in this manual. The powerheads have four cylinders in line and like most outboard motors are 2-stroke cycle units. This means they require an ignition spark every 90 degrees of crankshaft rotation. Therefore, the Type I magnetos have a 4-lobe cam to meet the demand of four sparks per revolution of the rotor. The rotor turns at the same speed as the crankshaft.

To understand the basic principles of magneto operation, it would be well worth the time to spend a few minutes to read and understand the principles of magneto operation, as outlined in the following paragraphs.



Belt-driven magneto distributor cleaned and serviced, ready for installation onto the powerhead.

Components -- Type I Ignition

A battery installed to crank the engine does not mean the powerhead is equipped with a battery-type ignition system. A magneto system uses the battery only for cranking the engine. Once the engine is running, the battery has absolutely no effect on engine operation. Therefore, if the battery is low and fails to crank the engine properly for starting, the engine may be cranked manually, started and operated.

The distributor-type magneto system is a self-contained unit. The unit does not require assistance from an outside source for starting or for continued operation. Therefore, if the battery is dead the engine may be cranked manually and started.

The distributor of a magneto ignition system is belt driven and basically consists of two permanent magnets; a set of two pole shoes; a coil; a set of primary windings; a set of secondary windings; a condenser; and a set of conventional points.

The two permanent magnets are pressed onto the distributor shaft and therefore rotate with the shaft. Their position is just below the distributor plate.

The two pole shoes are built into the distributor housing. They form an almost continuous circular body. The magnets rotate inside the shoes and induce magnetism in the pole shoes.

The coil contains the primary and secondary windings. A laminated core extends through the center of the coil. The coil is secured beside the distributor plate.

As with most distributors, the condenser and the set of points are attached to the distributor plate in the usual manner.

Operation — Type I Ignition

The accompanying three-part illustration on this page will be most helpful in understanding the creation and flow of electrical current from its beginning with the magnets to final discharge at the spark plug in the cylinder.

The electrical cycle for the Type I ignition system begins with the magnets rotating on the distributor shaft. Naturally, both magnets have a north and south pole and the magents are installed, one under the other and with their poles shifted 90° on a horizontal plane. As the magnets rotate, they induce magnetism in the pole shoes, as depicted in "A" of the accompanying illustration. The magnetic field extends from one pole shoe through the coil core to the pole shoe on the opposite side . As shown, the magnetic lines of force extend from one shoe to the other.

As the magnets continue to rotate to a neutral position (where both north and south poles are at the openings of the two shoes and with the points closed) as shown in "B", the current flows in the primary circuit. The primary windings induce a magnetic field in the coil core which extends to the poles shoes.

When the rotating magnets have reversed their position and induce a new magnetic field in exactly the opposite direction, "C" of the illustration, an attempt is made to re-establish lines of force in the new direction. The old field built up by the primary windings, will resist this attempt to reverse the field and as a result a tremendous stress is set up in the field.

At the instant the points open, the old field will collapse the lines of force in one direction and will instantly re-establish a new field in the opposite direction. This field change is sufficient to produce a high voltage in the secondary circuit and to jump the gap at the spark plug igniting the fuel/-air mixture in the cylinder. One phase of the ignition cylce is complete.

Another phase has been developing with the other magnet as it rotates and the same pattern continues.

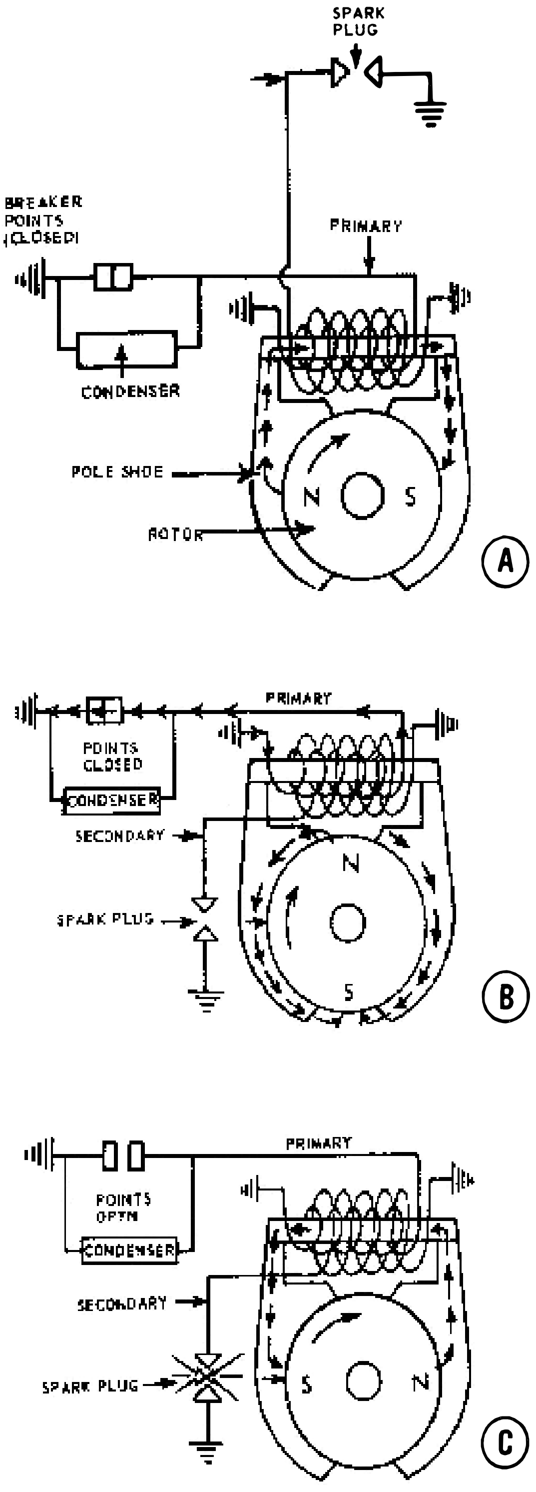
As soon as the north pole magnets reach their orignial position, as shown in "A" of the illustration, another spark plug fires and a new phase begins. A cycle is considered complete once all four spark plugs have fired. A complete cycle is accomplished with each rotation of the crankshaft.

In the very simplest terms, two spark plugs will fire each time each magnet makes one complete revolution.

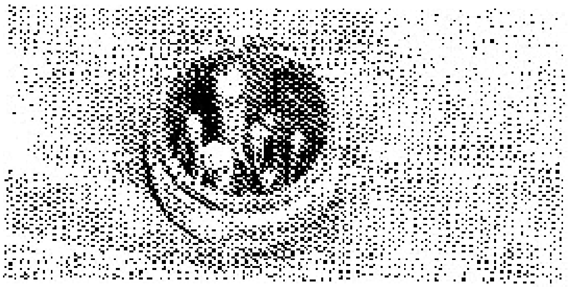
Adjustments of the Type I magneto are seldom necessary. When adjustments are required, they are simple, but must be performed according to the following instructions.

Other areas affecting poor engine performance should be thoroughly checked before the magneto is blamed for engine trouble. Since a brief engine inspection will often uncover the problem before the magneto is reached, maladjustment of magneto parts in good condition is thereby prevented.

The magneto should only be opened after there is no question but that the spark produced is unsatisfactory for proper engine operation. The magneto condition may be determined by following the procedures outlined in the next section -- Troubleshooting.



Functional diagram depicting operation of the Type I ignition system, as explained in detail in the text. Notice the direction of the magnetic field through the coil core as the magnets on the rotor revolve.



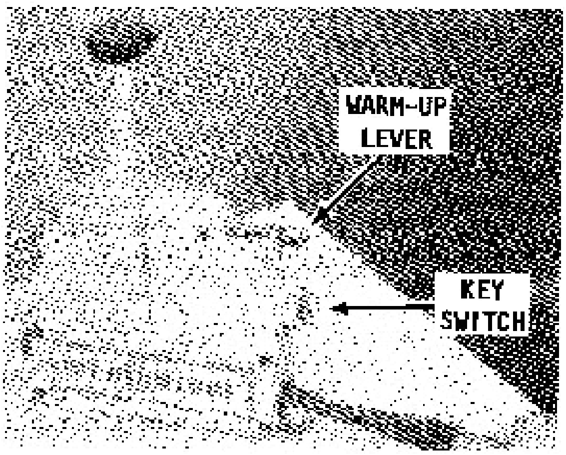
The side-mounted electrical connector is exposed and vulnerable to dampness and corrosion. Therefore, the terminals should be inspected and cleaned each season.

TROUBLESHOOTING TYPE I IGNITION SYSTEM

Always attempt to proceed with the troubleshooting in an orderly manner. The "shot-in-the-dark" approach will only result in wasted time, incorrect diagnosis, replacement of unneccessary parts, and frustration.

Begin the ignition system troubleshooting with the spark plugs and continue through the system until the source of trouble is located.

Remember, a magneto system is a self-contained unit. Therefore, if the engine has a key switch and wiring harness, remove them from the engine and then make a test for spark. If a good spark is obtained with these two items disconnected, but no spark is available at the plug when they are connected, then the trouble is in the harness or the key switch. If a test is made for spark at the plug with the harness and switch connected, check to be sure the key switch is turned to the **ON** position.



Key switch located in the shift box. The shift box must be disassembled to service the key switch.

Key Switch

A magneto key switch operates in **REVERSE** of any other type key switch. When the key is moved to the **OFF** position, the circuit is **CLOSED** between the ignition and ground. For this reason, an automotive-type switch **MUST NEVER** be used, because the circuit would be opened and closed in reverse, and if 12-volts should reach the coil, the coil may be **DESTROYED.**

CRITICAL WORDS: These next two paragraphs may well be the most important words in this chapter. Probably the No. 1 cause of electrical problems with outboard power plants is misuse of the wiring harness.

A wiring harness is used between the key switch and the engine. This harness seldom contains wire of sufficient size to allow connecting accessories. Therefore, anytime a new accessory is installed, **NEW** wiring should be used between the battery and the accessory. A separate fuse panel **MUST** be installed on the dash. To connect the fuse panel, use one red and one black No. 10 gauge wires from the battery. If a small amount of 12-volt current should be

accidently attached to the magneto system, the coil may be damaged or **DESTROYED.** Such a mistake in wiring can easily happen if the source for the 12-volt accessory is taken from the key switch. Therefore, again let it be said, **NEVER** connect accessories through the key switch.

Spark Plugs

1- Check the plug wires to be sure they are properly connected. Check the entire length of the wires from the plugs to the magneto in the distributor. If the wire is to be removed from the spark plug, **ALWAYS** use a pulling and twisting motion as a precaution against damaging the connection.

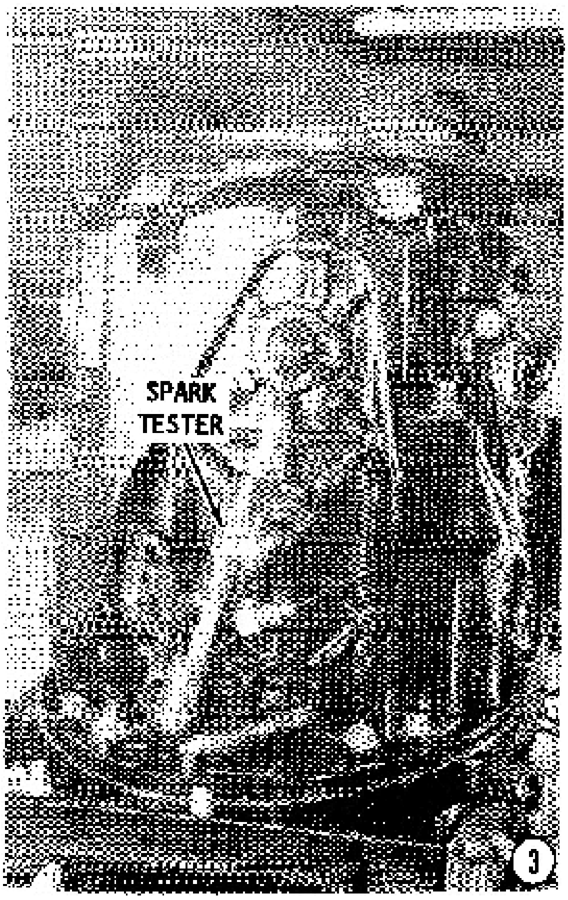
2- Attempt to remove the spark plugs by hand. This is a rough test to determine if the plug is tightened properly. You should not be able to remove the plug without using the proper socket size tool. Remove the spark plugs and keep them in order. Examine each plug and evaluate its condition as described in Section 5-2.

3- Use a spark tester and check for spark at each cylinder. If a spark tester is not available, hold the plug wire about 1/4" (6.35mm) from the engine. Turn the flywheel with a pull starter or electrical starter and check for spark. A strong spark over a wide gap must be observed when testing in this manner, because under compression a strong spark is necessary in order to ignite the air-fuel mixture in the cylinder. This means it is possible to think you have a strong spark, when in reality the spark will be too weak when the plug is installed. If there is no spark, or if the spark is weak, the trouble is most likely in the magneto.

Compression

Before spending too much time and money attempting to trace a problem to the ignition system, a compression check of each cylinder should be made. If the cylinder does not have adequate compression, troubleshooting and attempted service of the ignition or fuel system will fail to give the desired results of satisfactory engine performance.

Remove the spark plug wires by pulling and twisting **ONLY** on the molded cap. **NEVER** pull on the wire because the connection inside the cap may be separated or the boot may be damaged. Remove the spark plugs. Insert a compression gauge into



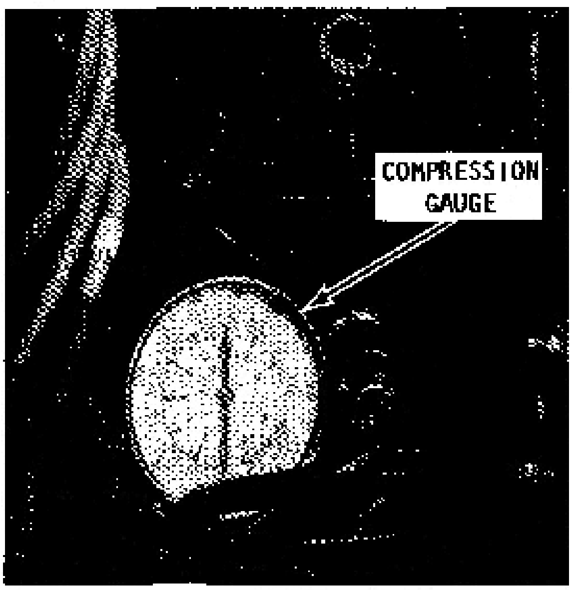
the cylinder spark plug hole. Crank the engine through several revolutions and note the final compression reading. Repeat the procedure for each cylinder.

A variation in reading between the cylinders is far more important than the actual individual readings. If a particular cylinder varies more than 20 psi from the others, the cylinder may be scored, the rings frozen, or the piston burned. In-line powerheads covered in this manual do not use a cylinder head. Therefore, low compression in one cylinder **CANNOT** be attributed to a blown head gasket.

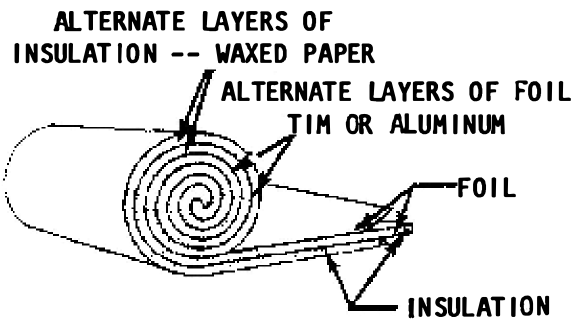
Condenser

In simple terms, a condenser is composed of two sheets of tin or aluminum foil laid one on top of the other, but separated by a sheet of insulating material such as waxed paper, etc. The sheets are rolled into a cylinder to conserve space and then inserted into a metal case for protection and to permit easy assembling.

The purpose of the condenser is to prevent excessive arcing across the points and to extend their useful life. When the flow of primary current is brought to a sudden stop by the opening of the points, the magnetic field in the primary windings collapses instantly, and is not allowed to "fade away", which would happen if the points were allowed to arc.



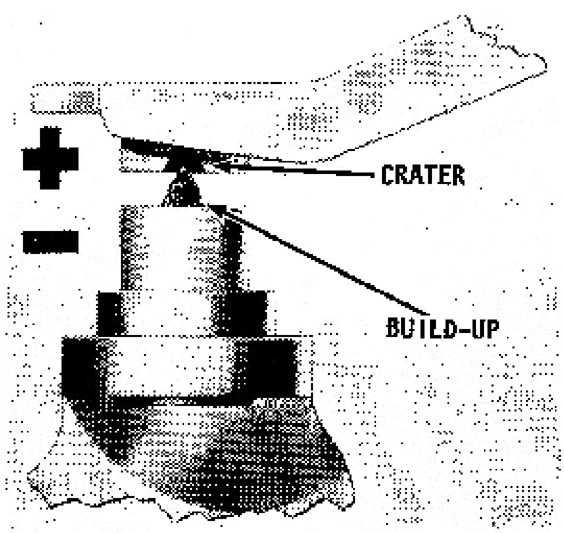
*When a compression check is performed, the spark plug leads **MUST** be grounded to the powerhead to prevent excessive strain on the coil. If the leads are not grounded, and simply left hanging, the coil will attempt to match the demand created by the spark trying to jump from the plug shell to nearest ground.*



Rough sketch to illustrate how the waxed paper, aluminum foil, and insulation are rolled in the manufacture of a typical condenser.

The condenser stores the electricity that would have arced across the points and discharges that electricity when the points close again. This discharge is in the opposite direction to the original flow, and tends to "smooth out" the current. The more quickly the primary field collapses, the higher the voltage produced in the secondary windings and delivered to the spark plugs. In this way, the condenser (in the primary circuit), affects the voltage (in the secondary circuit) at the spark plugs.

Modern condensers seldom cause problems, therefore, it is not necessary to install a new one each time the points are replaced. However, if the points show evidence of arcing, the condenser may be at fault and should be replaced. A faulty condenser may not be detected without the use of special test equipment. Testing will reveal any defects in the condenser, but will **NOT** predict the useful life left in the unit.



If the point set is heavily oxidized, it should be replaced.