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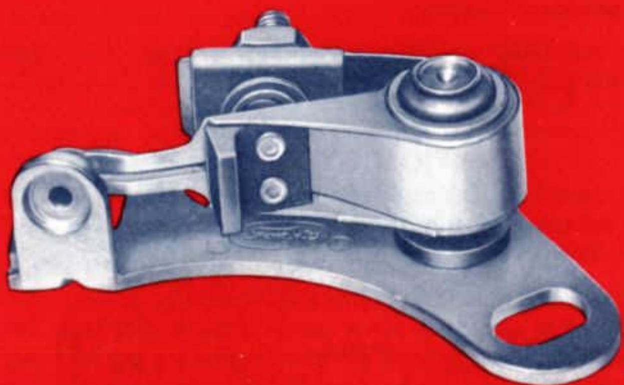
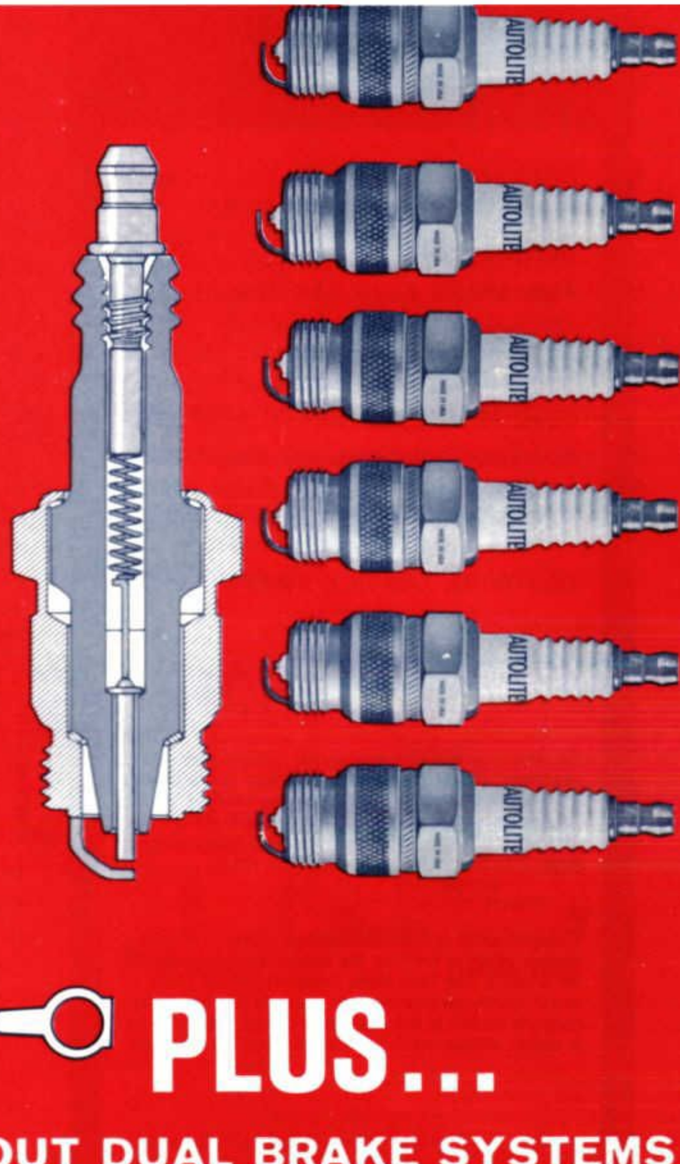
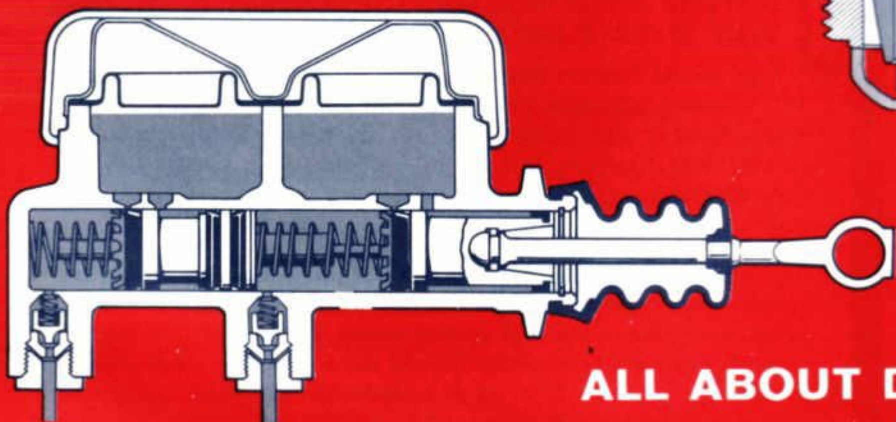




POINTS & PLUGS SERVICE



PLUS...

ALL ABOUT DUAL BRAKE SYSTEMS

Technical parts and service information published by the Autolite-Ford Parts Division and distributed by Ford and Lincoln-Mercury dealers to assist servicemen in Service Stations, Independent Garages and Fleets.

VOL. 5, NO. 7 Ford MARCH, 1967

DISTRIBUTOR POINTS and

IN THIS ISSUE

Be sure and file this and future bulletins for ready reference. If you have any suggestions for additional information that you would like to see included in this publication, please write to: Autolite-Ford Parts Division of Ford Motor Company, Ford Products Merchandising Dept., P.O. Box 3000, Livonia, Michigan 48151.

VOL. 67 PSM 85 LITHO IN U.S.A.

"Points and Plugs" service constitutes an important part of every tune up–be it to clean and regap, or replace them. Apart from cleaning or replacing however, it's equally important that points and plugs be checked for tell-tale signs that may indicate further engine service should be performed. A truly good tune up means performing those *fine* adjustments that will bring the engine as close as possible to like new operating specifications . . . which is near impossible if there exists excessive engine wear or other problems in cooling, lubrication, fuel system, etc. Like the barometer that indicates climatic conditions to the weather man, points and plugs can tell much about engine conditions to the knowledgeable service man.

To better understand why problems or wear in other components show up in the points and/or plugs, lets briefly review a few fundamentals.

IGNITION SYSTEM

The internal combustion engine derives its power by burning a highly compressed, gaseous air-fuel mixture, thereby expanding the gas, and forcing a piston downward in a cylinder.

The combustible mixture is ignited by a spark which is formed when a pulse or surge of electricity jumps across a spark plug gap. The voltage required to push a pulse of electricity across the gap may vary from 4,000 volts at engine idle to above 20,000 volts. Generally, high engine speeds, high compression pressures, lean air-fuel mixtures, high spark plug temperatures and wide spark plug gaps tend to increase voltage requirements. Since the source of electrical power is only 12 volts at the battery, it's obvious that some means is necessary to increase voltage to the necessary requirements. This is the first major function of the ignition system:

- CONVERT LOW-VOLTAGE CURRENT TO HIGH-VOLTAGE CURRENT

The second function is to:

- DISTRIBUTE THE HIGH-VOLTAGE CURRENT TO THE CORRECT SPARK PLUG AT PRECISELY TIMED INTERVALS

This second function times the combustion for best performance so that maximum efficiency is obtained from the combustion regardless of engine speed or load conditions. To see how the ignition system accomplishes these functions let's review ignition system components and their operation.

Components (Conventional System)

The ignition system consists of the following basic components: battery, ignition switch, primary circuit resistor, igniton coil, distributor, spark plugs, and both low and high tension wiring. They are divided into two circuits: a *primary* (low voltage) circuit and a *secondary* (high voltage) circuit. The ignition coil serves as a connecting link and is common to both circuits as shown in the following chart.

The PRIMARY CIRCUIT carries low-voltage current and consists of:

- Battery
- Ignition switch
- Primary circuit resistor
- Breaker points (distributor)
- Condenser (distributor)
- Primary windings of ignition coil

The SECONDARY CIRCUIT carries high-voltage current and consists of:

- Secondary windings of ignition coil
- Rotor (distributor)
- Distributor cap
- High tension (voltage) wires
- Spark plugs

SPARK PLUG SERVICE

PRIMARY CIRCUIT—There are two switches in the primary circuit: the *ignition switch*, which is simply an "off" and "on" switch; and the *breaker points*, which function as an interrupter switch. When the breaker points and ignition switch are both closed, current flows from the battery, through the ignition switch, primary circuit resistor, breaker contact points, primary windings of the ignition coil, and back to the battery ground through the vehicle body and frame (Fig. 1). Current does not flow in the secondary circuit while the breaker points are closed and current is flowing through the primary circuit. However, when a cam lobe on the distributor shaft opens the breaker points, current flow in the primary circuit is interrupted. The secondary circuit is energized and the several thousand volt increase required to jump the spark plug gap occurs within the *ignition coil*.

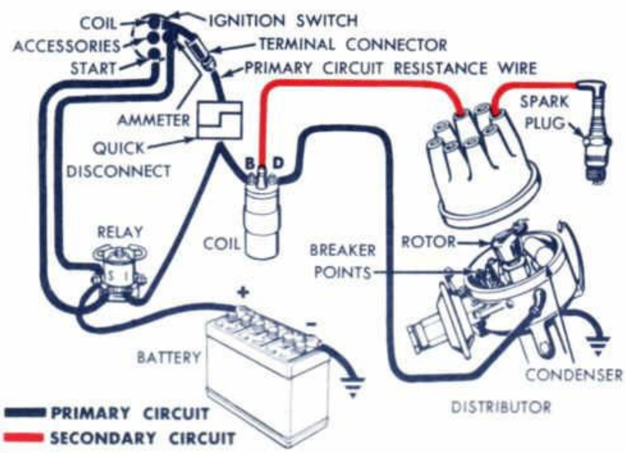


Fig. 1—Primary Circuit (Dist. and Spark Plugs)

IGNITION COIL—Unlike most automotive current producing devices, such as alternators, generators and starters with their rotating armatures, the ignition coil steps up voltage *non-mechanically*. It works something like the transformers on high tension lines that carry electricity over great distances. A few hundred turns of relatively heavy wire—No. 20 gauge or about the size of a paper clip, called *primary windings* are wound over 15,000-20,000 turns of very fine wire—No. 40 gauge or about the size of a human hair, called *secondary windings* (Fig. 2). When current flows through the primary circuit, a strong magnetic field is formed within the coil. When the breaker points open and primary current flow is interrupted, the magnetic field collapses through the many thousands of turns of wire in the secondary windings. This induces a current flow of several thousand volts in the *secondary circuit*.

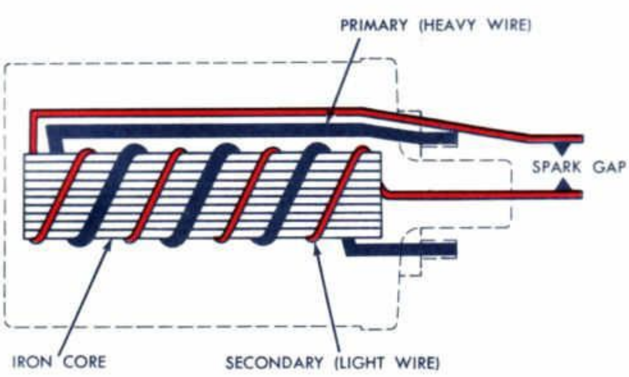


Fig. 2—Ignition Coil Schematic

SECONDARY CIRCUIT—The 4,000 volts to 20,000 volts (depending on engine requirements) produced in the coil, flows out of the center terminal of the coil to the center terminal of the distributor cap (Fig. 3). Current then flows through the distributor rotor, jumps a narrow air-gap from the rotor tip to a distributor high tension terminal, flows back out of the cap through the high tension wiring to the spark plug, where it jumps another air-gap to ground, causing a spark that ignites the compressed air-fuel mixture.

During normal operating conditions, somewhere between 200-300 of these sparks must be produced by the ignition system every SECOND. In other words, on the average of every 1/250 of a second, the distributor breaker points close, the magnetic field builds up, the breaker points

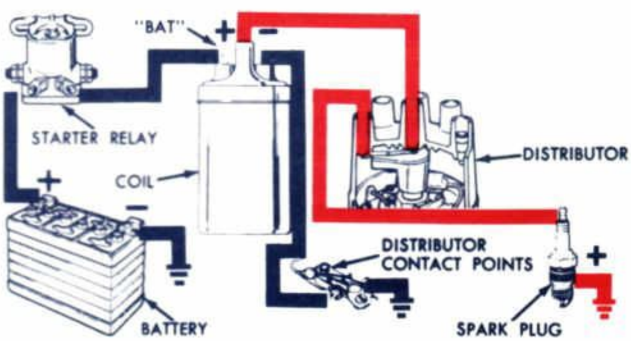


Fig. 3—Secondary Circuit

open, the magnetic field collapses, and a high voltage surge is delivered to the spark plug. Most important is coil "build up" time which determines the strength of the magnetic field and thus the amount of high voltage current produced. Increased "build up" time is achieved with the *condenser*.

CONDENSER—The condenser is connected in parallel across the breaker points. It serves the dual role of controlling arcing, and increasing the speed at which the collapsing magnetic field produces high-voltage current. As the breaker points open, the magnetic field starts to collapse through the primary windings. This induces a higher voltage current flow in the primary circuit in the same direction as battery voltage which tends to keep current flowing. If current con-

Condenser (cont.)

tinues to flow when the breaker points are open, an arc occurs between the breaker points with two very bad effects:

- It causes the breaker points to become burned, or a transfer of metal from one point to the other (Fig. 4)
- Unless the primary current flow is stopped quickly, output voltage from the secondary windings will be less than normal

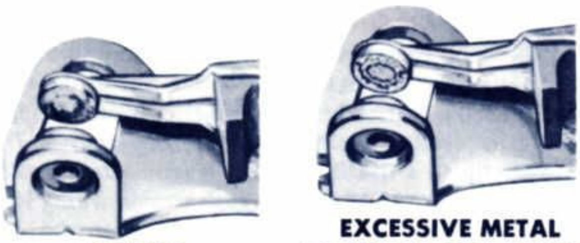


Fig. 4–Burned Breaker Points or Excessive Metal Transfer

To reduce this arcing and to bring the primary current flow to a quick stop, the condenser provides a place for the primary current to flow. When the breaker points open, the primary current flows into the condenser (Fig. 5). By the time the condenser becomes fully charged, the breaker points have separated far enough to prevent an arc, so the primary current flow comes to a very sudden stop. This in turn causes a very sudden collapse of the magnetic field. It is this QUICK collapse of the magnetic field that induces high voltage in the secondary windings.

The current absorbed by the condenser is discharged back through the coil to the battery while the breaker points are open and before the breaker points close again to fire the next plug. The ability of the condenser to absorb current is referred to as the condenser's capacity. It depends on a number of requirements and must be matched to each individual ignition system.

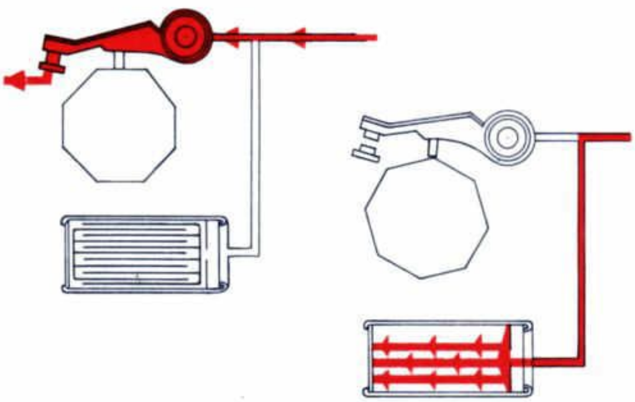


Fig. 5–Condenser Operation

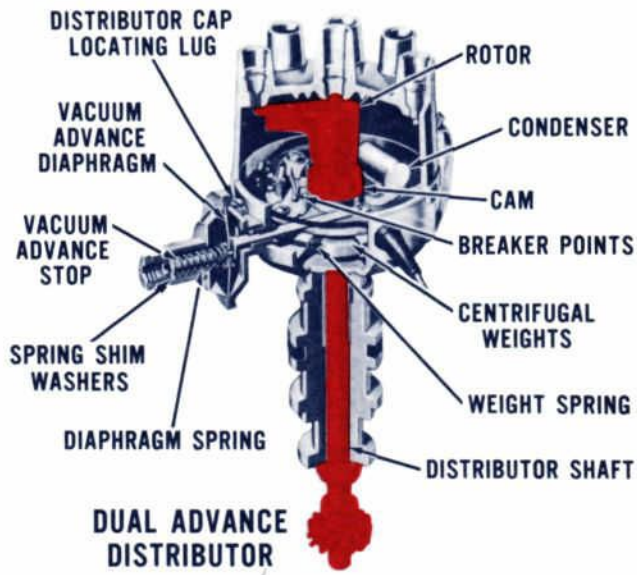


Fig. 6–Distributor

DISTRIBUTOR–The distributor is a timing device to ignite the air-fuel mixture in each cylinder at the most ideal moment during the compression stroke to achieve optimum performance, regardless of engine speed or load conditions. The upper portion houses the breaker points, condenser and other components through which the primary and secondary circuits flow. The upper end also contains a cam on a shaft (Fig. 6). The cam has as many lobes as there are cylinders. The cam lobes open and close the breaker points. The rotor is also indexed to the distributor shaft. The distributor cap, with terminals for each spark plug, is indexed to the distributor housing. When the distributor housing is properly positioned in the engine block, the rotor is always exactly aligned with one of the terminals of the distributor cap when the breaker points open. A gear is attached to the lower end and turns at ½ crankshaft speed. Thus, for each two revolutions of the crankshaft, the distributor shaft makes one complete revolution, firing each spark plug once in the proper order.

The distributor also contains a spark advance mechanism to automatically fire the spark plug earlier in the compression stroke as engine speed increases, to more completely burn all the air-fuel mixture and obtain maximum efficiency.

With this brief look at the more important ignition components and their operation, let's see how they affect points and plug service.

BREAKER POINT SERVICE

Ford breaker points are cross-ventilated and made of 99.3% pure tungsten to resist pitting and burning. Points which have undergone several thousand miles of service may have a slight metal transfer and rough surface. However, this doesn't necessarily indicate the points are worn out. If they are still "greyish" in color, and metal transfer is less than the gap setting, they can be cleaned and adjusted. Ford recommends cleaning with chloroform and a stiff bristle brush. A crocus cloth may also be used. DO NOT USE SANDPAPER OR OTHER ABRASIVES. They may damage point surfaces and leave particles of abrasives which may cause excessive wear.

BURNED POINTS—Points that are burned (Fig. 4) should, of course, be replaced. If the burning is premature, the cause of the burning should also be corrected or the customer likely will return with another set of burned points. Most cases of burned points are caused by some fault in the electrical system allowing an abnormal amount of current to pass through the points—usually high voltage.

Some of the more common reasons for high voltage are:

1. Loose or corroded terminals in the battery or generating system causing a high resistance.
2. Improperly adjusted voltage regulator allowing too high voltage in the primary circuit.
3. Shorted primary circuit by-pass resistor, allowing *full* battery voltage in the primary circuit at all times, instead of just during cranking.
4. Faulty condenser, or a condenser with loose mounting or lead. This either eliminates or greatly reduces the QUICK stoppage of current flow in the primary circuit when the points open.
5. Point opening too small (cam angle too large). As shown in Fig. 7, this means the points are closed too long during the total operating time allowing excessive current flow. There are several things that can cause a diminishing breaker point gap (increased dwell). Among these are worn cam lobes, rubbing block and distributor shaft bushings. Misaligned points (Fig. 8) can also cause similar problems, since the current flows only through a portion of the face. They can be corrected by bending the *stationary* breaker point bracket. DO NOT BEND THE MOVEABLE BREAKER POINT ARM.

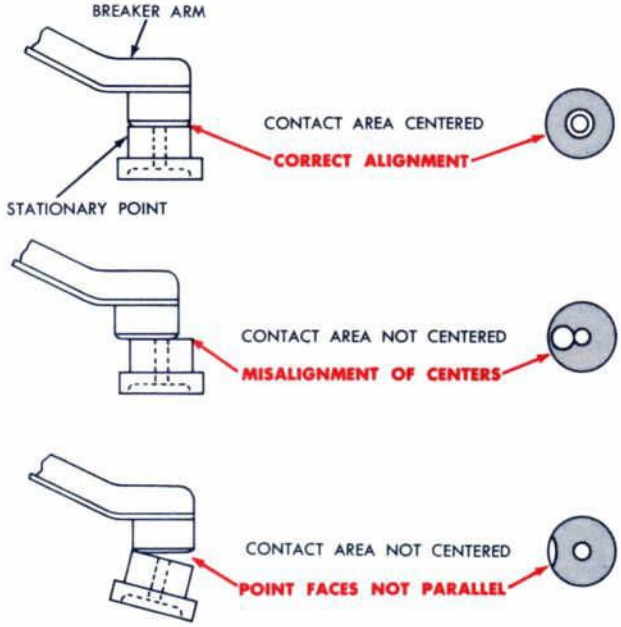


Fig. 8—Breaker Point Alignment

Burned points can also be caused by lubricants or crankcase fumes getting on the points and causing a black insulating film. If caught early, it can be scraped or wiped off, and the points saved. To avoid this problem apply a *light* film of distributor cam grease (Ford part number C4AZ-19D530-A) to the cam. NEVER USE ENGINE OIL, or similar lightweight lubricants.

PITTING—Many of the conditions that cause point burn also contribute to pitting. However, the major cause is arcing, brought about by a condenser whose capacity does not match the vehicle's ignition system. A condenser with too high a capacity will cause metal to transfer to the negative ignition point, leaving a crater in the positive point (Fig. 9). An under capacity condenser causes a buildup of metal on the positive point and a crater in the negative point (Fig. 9).

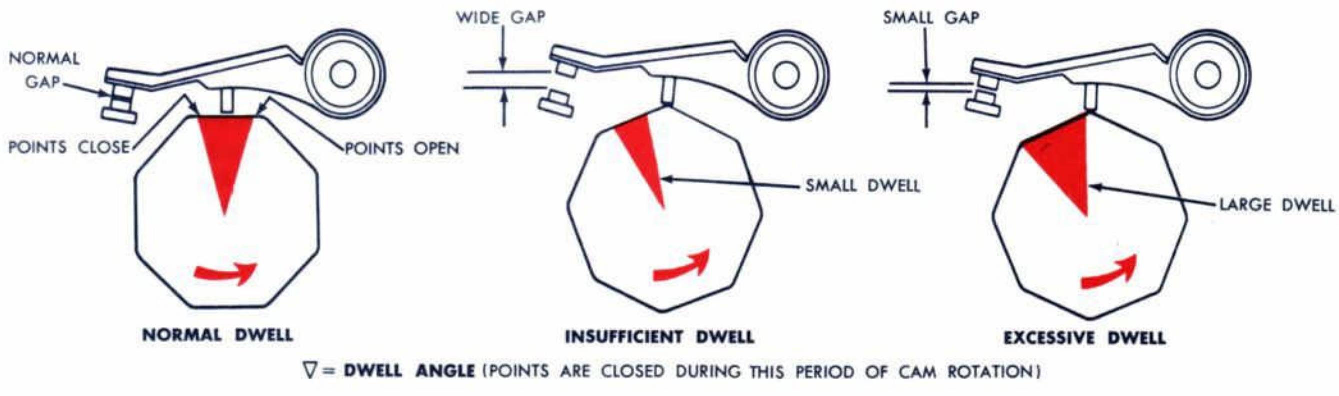


Fig. 7—Breaker Point Dwell

Pitting (cont.)

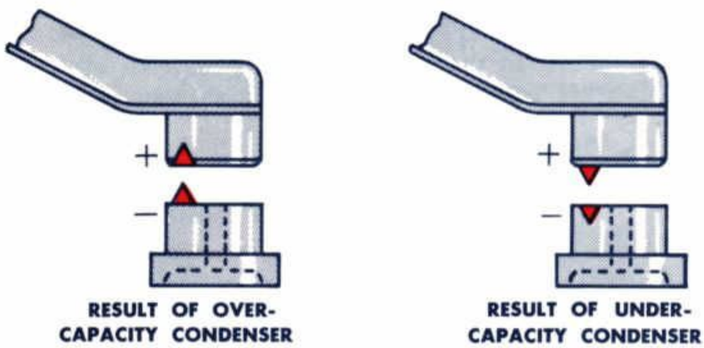


Fig. 9–Condenser Capacity Affects Metal Transfer

This can be remembered as . . . *the minus, minus, minus rule* . . . which means minus capacity causes minus material on the minus point. Specifications for condenser capacity in a specific ignition system depend upon a number of things, but chief among the many influencing factors are:

- Excessive primary or secondary resistance will upset the balance of the ignition system, so that the points will pit even though the specified capacity condenser is used.
- If a replacement coil is used that has electrical specifications that differ from the original coil, the original capacity of the condenser is no longer suitable.
- A high voltage regulator setting will upset the balance of the ignition system, resulting in point pitting in addition to the overheating and burning that is caused by the increase in primary circuit current flow.
- If the point dwell is not maintained within specifications, the specified condenser capacity will not be suitable.

ADJUSTING GAP OR DWELL–The gap is the maximum breaker point opening obtained when the rubbing block is on a cam lobe. The dwell is the period during which the distributor points remain closed. Therefore, if the point gap is increased the dwell will be decreased. On the dual advance distributor (vacuum and centrifugal advance), as the pivot plate is rotated from retard (no vacuum) position to the full vacuum position, the dwell decreases slightly (point opening increases). This is because the breaker point rubbing block and cam rotate on a different axis. The centrifugal advance distributor used with the conventional ignition system has a dual set of breaker points. The transistorized ignition system has one set of breaker points.

USED BREAKER POINTS–If the gap of used breaker points is being checked, use a dwell meter since the roughness of the points makes an accurate gap reading or setting impossible using a feeler gauge (Fig. 10). Clean the breaker points, then check and adjust the dwell as follows:

1. Calibrate the dwell meter to the set line and connect the leads from the tach-dwell unit (the black lead goes to ground and the red lead goes to the distributor side of the coil).
2. Set the selector switch to the position that corresponds to the number of cylinders in the engine being tested.
3. Operate the engine at idle speed and note the reading on the dwell meter.
4. Stop the engine and adjust the gap (decreasing the gap increases the dwell). Now, check the dwell again. NOTE: On the centrifugal advance distributor with dual points, after the individual dwell has been set to specifications, the combined dwells should be checked. To check individual dwell, block one set of breaker points open with a piece of insulating material and check the dwell of the other set. The individual dwells should be the same.

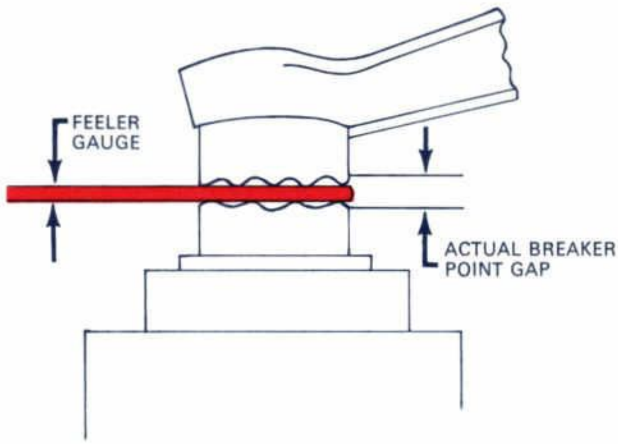


Fig. 10–Inaccurate Breaker Point Measurement

NEW BREAKER POINTS–New breaker points can be adjusted with a feeler gauge, or a dwell meter. To adjust with a dwell meter, refer to the procedure for "Used Breaker Points." To adjust the breaker points with a feeler gauge:

1. Check and adjust the breaker point alignment. Rotate the distributor cam until the rubbing block rests on the peak of a cam lobe.
2. Insert the correct blade of a clean feeler gauge (a smaller blade will result in burned points and a larger blade will result in ignition failure at high speeds) between the breaker points. The gap should be set to the larger specified dimension because the rubbing block will wear down slightly while seating to the cam.
3. Apply a light film of distributor cam grease (Ford Part Number C4AZ-19D530-A) to the cam when new points are installed. DO NOT USE ENGINE OIL TO LUBRICATE THE DISTRIBUTOR CAM.
4. If the dwell of the new points is to be adjusted, set the contact dwell to the low specified setting. New points must be set to the low dwell as the rubbing block will wear down slightly while seating to the cam.
5. Set ignition timing.

SPARK PLUG SERVICE

Introduction

The spark plug is the "business end" of the ignition system—where voltage built up in the coil surges across the gap to ignite the air-fuel mixture. While the ignition system is designed to put out in excess of 20,000 volts, the coil only builds up that voltage necessary to jump the gap, which is usually between 4,000 and 10,000 volts. High voltages, of course, always seek an easy path to ground, so the center electrode and the ground electrode must be well insulated from each other.

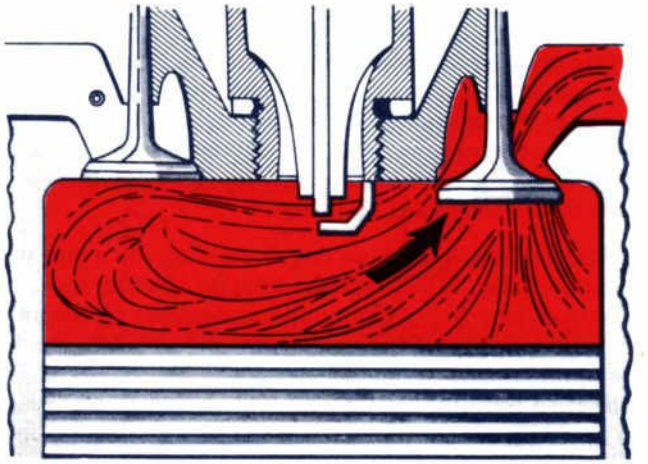
Additionally, spark plug electrodes are subjected to high combustion chamber temperatures, combustion deposits, and sparking erosion. To keep "gap growth" to a minimum, special nickel-chrome alloys are used. Even so, a natural wearing-away (erosion) of electrode material is encountered which can never be stopped entirely. As the spark continues to arc across the electrode gap, erosion and deposits change the spark gap until the ignition coil is unable to create enough voltage to jump the gap. It is this normal wear condition which requires that spark plugs be replaced.

Autolite "Power Tip" Spark Plug

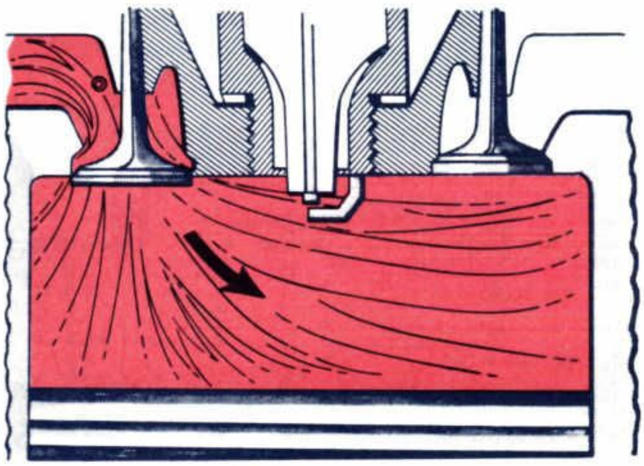
All Ford vehicles are equipped with a special "power tip" design which affords maximum service life, under the wide range of driving conditions encountered today. Spark plugs must operate satisfactorily without fouling during low-speed, light-load conditions, as well as during high-speed, full-load conditions, without causing pre-ignition. The power tip plug fulfills these requirements because it is a "self-cleaning" plug.

The power tip spark plug is designed so that the insulator firing tip and the electrodes protrude beyond the end of the spark plug shell, extending into the combustion chamber. This design feature provides a longer insulator tip on the plug which, in turn, provides a longer fouling path that is subsequently cleaned by the swirling gases in the combustion chamber (Fig. 11). The tip temperatures of power tip plugs are higher than those encountered in spark plugs of conventional design during light-load, low-speed operation. This enables the plug to "burn-off" the combustion deposits.

Under wide-open throttle conditions, tip temperatures of power tip plugs are lower than those of conventional design. The lower temperatures are created by the incoming air-fuel mixture passing over the insulator tip and cooling it during each intake stroke (Fig. 11). This cooling effect is even more pronounced at higher speeds and heavier loads due to the greater velocity of the incoming, richer air-fuel mixture. In this manner, the power tip plug combines the advantages of both hot and cold plugs which separately satisfy the demands imposed by heavy-traffic conditions, as well as the cooler temperatures needed during high-speed operation.



EXHAUST STROKE



INTAKE STROKE

Fig. 11–Power Tip Cleaning Action

Spark Plug Heat Range

To provide proper engine performance, spark plugs must operate within a certain temperature range. If they operate at too cold a temperature, soot and carbon will deposit on the insulator tips which causes fouling and missing. If the plugs run too hot, the insulator will be damaged and the electrodes will burn away rapidly. In extreme conditions, hot plugs cause premature burning (pre-ignition) of the air-fuel mixture.

The ability of a spark plug to transfer heat from the insulated center electrode tip is controlled by spark plug design.

Spark Plug Heat Range (cont.)

The only path for heat to escape is through the insulator tip, spark plug shell, through the cylinder wall to the cooling liquid in the engine. Figure 12 illustrates typical heat transfer patterns.

The heat range of a spark plug is controlled by the length of the insulator tip and the ability of the spark plug to transfer heat to the cooling system. In addition to its length, the shape of the insulator tip and its location with respect to the shell, the thermal conductivity of the insulator material and cement, and the thermal conductivity of the electrode are also factors controlling heat range.

Keeping this in mind, we find that a plug with a long tip is a "hot" plug. It transfers heat from the insulator tip very slowly. A plug with a shorter tip transfers heat rapidly and is known as a "cold" plug. Accordingly, a "cold" plug is generally used in a high-compression engine where high-operating temperatures are encountered, and a "hot" plug is used in a low-compression engine where lower operating temperatures prevail.

The heat range of spark plugs can be determined by means of a code system that works like a thermometer—the higher the code number, the hotter the plug. Typical Autolite spark plugs are shown in the following chart.

AUTOLITE SPARK PLUG HEAT RANGE CHART

Heat Range	Heat Range Number	Code Number
HOT PLUGS	11	A 11
	10	AR 10
	9	A 9
MEDIUM PLUGS	8	AT 8
	7	A 7
	6	AT 6
COLD PLUGS	5	A 5
	4	A 42
	3	AR 32
	2	A 21

SPARK PLUG INSPECTION

Removal

1. Remove the wire from each spark plug by grasping the moulded boot of the wire only, and twist to free the boot from the spark plug. Do not pull on the wire because the wire connection inside the cap may become separated, or the weather seal may be damaged.
2. Clean the area around each spark plug with compressed air; then remove the spark plugs with a spark plug wrench containing a rubber insert to prevent damage to the spark plug insulator.
3. Inspect the spark plug.

Cleaning

Clean the spark plugs on a sand blast cleaner, following the instructions of the cleaner manufacturer. Make certain the cleaner has clean sand, as the plugs can be fouled by dirty sand. Do not prolong the use of the abrasive blast as it will erode the spark plug insulator. Remove carbon and other deposits from the threads with a stiff brush. Any deposits will retard the heat flow from the spark plug to the coolant.

Clean the electrode and ground surfaces with a small file. Dress the electrodes to secure flat, parallel surfaces. A pointed center electrode requires considerably more voltage to cause a spark across the gap than a flat electrode.

After cleaning, examine the plug carefully for cracked or broken insulators, badly pitted electrodes, or other signs of failure. Replace as required.

Adjustment

Set the spark plug gap to specifications by bending the ground electrode. Use a wire gauge (Fig. 13) because a flat gauge cannot measure the curved contour of used electrodes. Too small a gap will result in a rough idle, uneven power, and poor performance in general. Too large a gap will cause poor performance at high speeds, and hard starting.

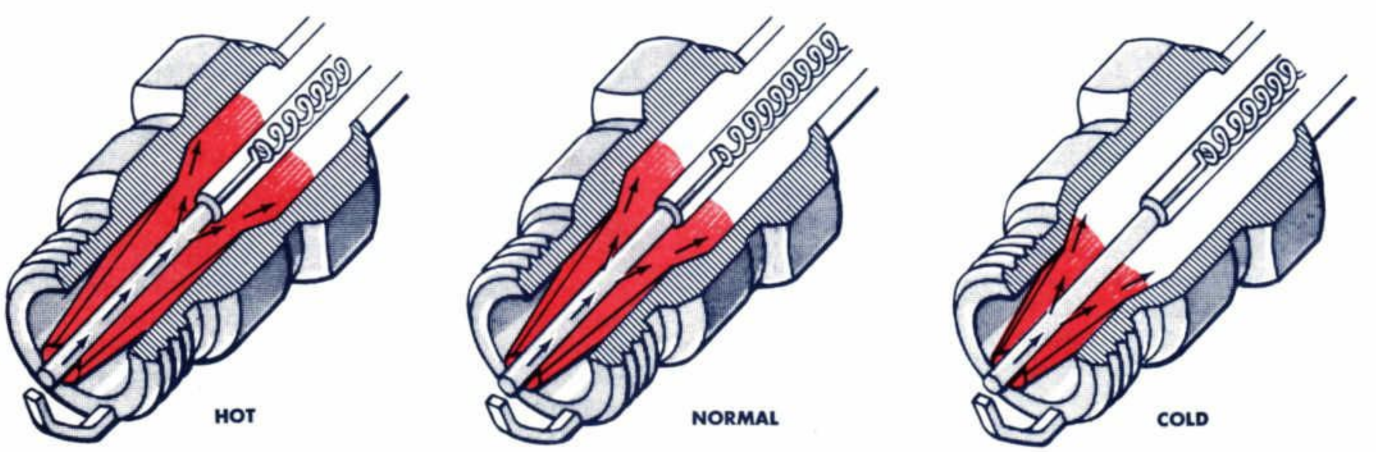


Fig. 12—Spark Plug Heat Range

SPARK PLUG SERVICE

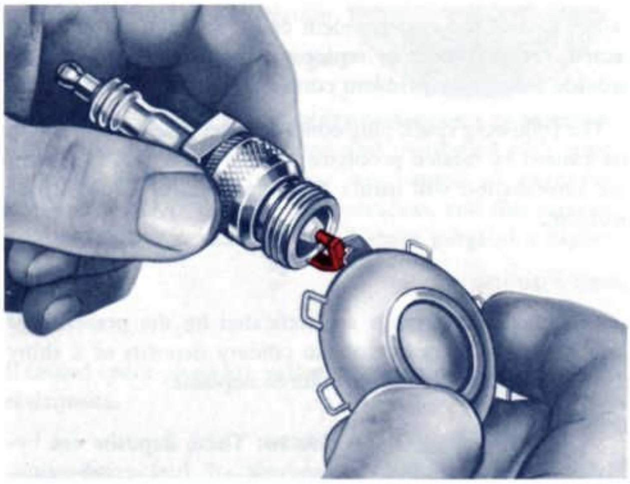


Fig. 13–Checking Spark Plug Gap

Spark Plug Testing

Spark plug testers operate with dry air whereas the atmosphere in the engine utilizes a volatile air-fuel mixture. This mixture acts as an ionization agent between the electrodes and promotes spark discharge.

Engine ignition normally occurs before the piston reaches top center in the cylinder, thus the spark actually occurs before peak cylinder pressure is reached.

Some spark plug testers employ a vibrator type ignition source that produces a voltage of an entirely different wave from that produced by automotive ignition coils. The voltage of a vibrator type ignition source decreases after the first few minutes of use and the voltage pulses vary in amplitude to cause intermittent misfiring.

One of the phenomena observed in analyzing spark plugs in the tester is that a spark plug with sharp cornered electrodes will fire under an appreciably greater pressure than one with rounded electrodes. The compression tester will therefore indicate that a plug with rounded electrodes is faulty. Since such a plug may function satisfactorily in the engine, the correlation between the spark plug tester and actual operating conditions is not realistic. The following procedure will help provide a more honest evaluation of spark plug capabilities when checked in a compression tester.

1. Be sure all reconditioned spark plug electrodes have been filed properly so that the electrodes have sharp corners.
2. Clean and dry all spark plug insulators.
3. Check the operation of a new spark plug in the tester and note the pressure at which the plug no longer sparks.
4. Check the pressure at which the reconditioned spark plug no longer sparks.
5. If the difference in the two readings does not exceed 30%, the reconditioned spark plug is suitable for reinstallation and will provide good service.

Voltage Flashover

Many spark plugs checked in compression testers are condemned because of voltage flashover (Fig. 14). (Sparking from the plug terminal down the insulator to ground on the shell.) This flashover condition does not indicate a faulty spark plug. In fact, it proves that the plug insulator is in good condition, meaning the plug has no cracks or pin hole punctures that could cause misfire. Installed in an engine, the spark plug insulator is covered by an insulating boot to insure against flashover. A similar boot should be installed during a spark plug compression test to accurately duplicate actual operating conditions.

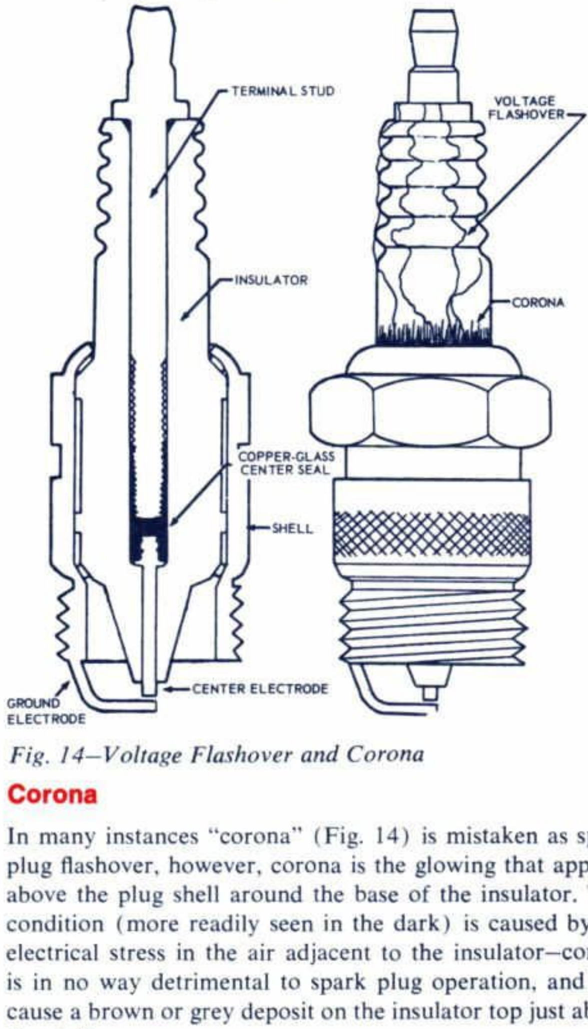


Fig. 14–Voltage Flashover and Corona

Corona

In many instances "corona" (Fig. 14) is mistaken as spark plug flashover, however, corona is the glowing that appears above the plug shell around the base of the insulator. This condition (more readily seen in the dark) is caused by the electrical stress in the air adjacent to the insulator–corona is in no way detrimental to spark plug operation, and will cause a brown or grey deposit on the insulator top just above the shell.

Installation

1. Be sure the spark plug and spark plug seats are clean to ensure proper heat flow.
2. Install the spark plugs and torque each plug to specifications (15-20 Ft. Lbs.).
3. Connect the spark plug wires. Push all the weather seals into position.

DISTRIBUTOR POINTS and SPARK PLUG SERVICE

SPARK PLUG DIAGNOSIS

While performing the spark plug inspection, the service man should look for tell-tale signs that indicate:

1. Spark plugs are operating normally.
2. The spark plug ONLY should be replaced.
3. The spark plug AND related components require repair.

Let's first discuss conditions which indicate the spark plug only needs replacement. These usually fall under the category of some type of external or internal damage.

External and Internal Damage

Electrode Shape. A spark plug with an electrode not properly bent or trimmed should be replaced. This does not refer to improper gap adjustment.

Shell Seal. An improper shell seal can be detected by the insulator being loose in the shell, or by signs of gas leakage around the shell crimp. Do not confuse this leakage with the tan or gray deposits on the insulator resulting from corona.

Center Seal. An inadequate internal center seal can be detected by checking the continuity from the center electrode to the terminal with an ohmmeter. A spark plug without this continuity should be replaced. Also, a terminal not fully pressed into the insulator will identify an inadequate center seal.

Threads. Damaged external threads are self evident. Be sure the mating threads in the cylinder heads are not damaged.

Center Electrode Insulator. A chipped or broken center electrode insulator can be detected by visually examining the spark plug at the firing end.

External Insulator. A cracked external insulator is most often caused by improper installation. Using a socket with an internal rubber sleeve can reduce this type of damage.

Normal Spark Plug Operation

Normal operating spark plugs are indicated by the presence of light tan to brown deposits and a normal gap increase of approximately 0.001 inch per thousand miles of operation. If electrodes do not show excessive wear, they can be cleaned and reinstalled. If replacement is necessary, use the same type spark plug.

Spark Plug Conditions Caused By Related Components

Premature spark plug failures are most often caused by related component problems or unusual vehicle operating conditions. Service personnel are normally aware of the visual conditions which appear on spark plugs of this type but are unable to relate these conditions to the real problem cause. Unless the real problem cause is identified and corrected, reconditioned or replacement spark plugs will only provide temporary problem correction.

The following spark plug conditions represent those which are caused by related problems. Use of the included corrective information will insure the correction of a spark plug problem.

Lead Fouling

Lead fouled spark plugs are indicated by the presence of dark grey, black, yellow or tan cindery deposits or a shiny glaze coating of these same colored deposits.

Cause: These deposits are by-products of fuel combustion. The shiny glaze coating is formed during periods of high speed and heavy load conditions following extended periods of city type operation.

Correction: Lead fouled spark plugs can be cleaned and reinstalled with good results. Spark plugs with a shiny glazed deposit can generally be cleaned, however plugs with heavy deposits lodged in the shell bore that cannot be removed by cleaning should be replaced. If this condition continues to occur after short periods of service it may be necessary to install spark plugs of a different heat range.

Fused Spot Deposits

Spark plugs with spot deposits have melted or fused spotty deposits on the insulator resembling bubbles, or a blistered insulator.

Cause: During periods of sudden acceleration deposits are blown from the combustion chamber and thrown against the hot insulator—melting and fusing to form these globule type deposits.

Correction: Spark plugs can usually be cleaned and reinstalled with good results. However, in cases where the fused deposits cannot be removed by cleaning, discard and replace with new plugs of the same type.

Carbon Fouling

Carbon fouled spark plugs are indicated by the presence of black dry fluffy deposits:

Cause:

A. High Tension Leads—open circuit, high resistance, deteriorated or hardened insulation.
B. Valves—burnt or sticking.

If the complete set is carbon fouled, check the following component areas:

A. Carburetor–rich air-fuel mixture.
B. Improper automatic choke operation.
C. Dirty or clogged air cleaner.
D. Improper heat riser operation.
E. Excessive idling–stop and go type operation.

Correction: Correct unsatisfactory components as required; spark plugs can then be cleaned and reinstalled with good results. If the fouling condition was caused by excessive idling and/or stop and go type operation, and this type of operation will be continued, install spark plugs of a higher heat range.

Carbon Fouling—Oil

Oil fouled spark plugs are indicated by the presence of black wet deposits.

Cause: This type of fouling can occur in new or rebuilt engines before the piston rings become properly seated and oil control is achieved. However, oil fouling in older engines generally indicates that one or more of the following conditions prevail:

A. Worn piston rings.

B. Worn cylinders.

C. Worn pistons.

D. Worn valve guides.

E. Worn valve guide seals.

Correction: If this condition occurs on new or rebuilt engines, the spark plugs can be dried with an air hose, cleaned, and installed with good results. In older engines where excessive oil consumption is prevalent, the faulty condition must be corrected, otherwise the cleaning or replacement of spark plugs will only be a temporary cure. The use of a hotter spark plug in engines with excessive oil fouling will provide longer periods of satisfactory service.

Gap Bridging

Gap bridged spark plugs are indicated by the presence of deposits lodged between the side and center electrodes.

Cause: Improper fuel combustion with the accumulation of unburned carbon molecules forms a thread like chain which lodges between the center and side electrodes; or combustion chamber deposits may be shed during rapid acceleration of high speed operation and thrown against the hot center and side electrodes, fusing on contact to short out the plug.

Correction: The bridged deposit can be removed and the plug cleaned and reinstalled with good results.

Overheated

Overheated spark plugs are indicated by an extremely white insulator tip with small black deposits, bluish-burnt cast on center or side electrodes, general lack of insulator deposits, and premature electrode erosion.

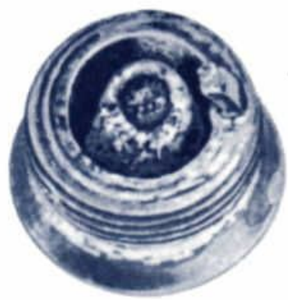
Cause: Incorrect spark plug heat range or a related problem such as:

A. Distributor–over advanced ignition timing.
B. Carburetion–very lean air-fuel mixture.
C. Cooling system–inoperative or partially clogged.
D. Improper spark plug seating.

Correction: Be sure correct heat range spark plugs were in use. If the condition was caused by a related component, replace or repair as required and install new spark plugs if necessary.

Pre-Ignition

Pre-ignition spark plugs are indicated by melted or very severely burnt center and/or side electrodes, blistered insulator and aluminum or metallic deposits on the insulator.



Cause: Incorrect spark plug heat range or a related problem such as:

A. Burnt valves–low compression.
B. Distributor–over-advanced ignition timing.
C. Cooling system–inoperative or partially clogged.
D. Carburetion–lean air-fuel mixture.
E. Detonation–improper octane fuel, low grade fuel.
F. Improper spark plug seating.

Correction: Be sure recommended spark plugs were in use. If this condition was caused by a related component, make necessary repairs and replace the spark plugs as required.

Split Insulator Tip

Spark plugs with a split insulator tip are indicated by a cracked or chipped insulator at the firing tip.

Cause: Cracked or split insulators are caused by improper timing or use of improper fuel, resulting in excessive center electrode temperatures or severe engine detonation. However, defects of this nature are usually caused by incorrect gapping tools (plier type) and/or procedure.

Correction: Replace with new spark plugs. If the cracked or chipped insulator has resulted during engine operation, check and set ignition timing to the recommended specification. Be sure the proper octane fuel is being used. If this condition continues to occur, it may be necessary to replace with spark plugs of a colder heat range.

DUAL HYDRAULIC BRAKE SYSTEM .

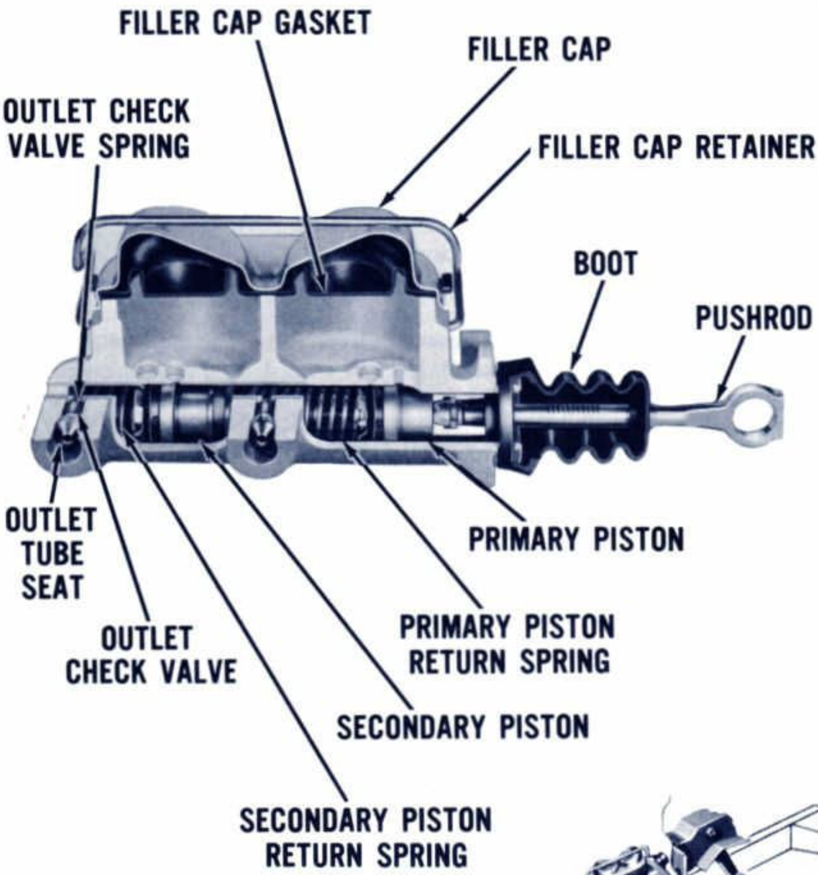


Fig. 1—Dual-Master Cylinder for Standard Brake Drums

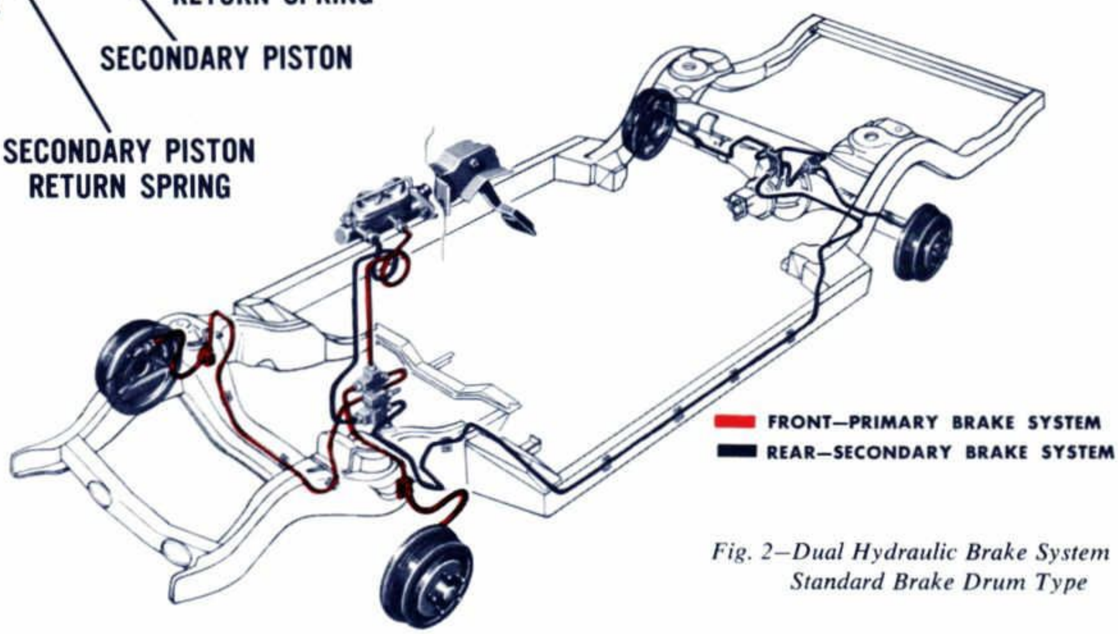


Fig. 2—Dual Hydraulic Brake System Standard Brake Drum Type

DESCRIPTION

All 1967 Ford-built cars and light-duty trucks are standard-equipped with a dual hydraulic brake system. The system consists of a dual-master cylinder (Fig. 1), pressure differential valve assembly (Fig. 3) and a switch on the valve that triggers a warning light on the instrument panel.

The new dual-master cylinder brake system is similar to previous design single brake master cylinder system, except that the dual system has two master cylinders combined in a single, dual-cylinder body casting. Each master cylinder has its own separate piston and fluid reservoir. The primary chamber on the right (Fig. 1) actuates the front brake system. The secondary chamber on the left actuates the rear brake system. Leakage or failure of either half of the system does not impair operation of the other half. In other words, should the front brakes develop a leak, the rear brakes will still function to stop the vehicle, or vice versa. A warning light on the instrument panel signals a failure of either the primary (front) or secondary (rear) brake system. This is accomplished by a pressure differential valve and a mechanically operated switch that triggers the warning light.

The dual-master cylinder used on Thunderbird, Ford, Fairlane, Falcon, Lincoln, Mercury and Comet cars equipped with power disc brakes and on Fairlane, Comet and Falcon cars equipped with power drum brakes have the master cylinder outlet ports for the rear (secondary) brake system located on the bottom. The bleed screws for these master cylinders are located in the outboard side. All power drum and standard drum brake equipped Ford cars, all Fairlanes, Mercurys, Comets and Falcons with standard drum brakes, and all Mustangs and Cougars equipped with standard drum, power drum and power disc brakes have both the front-primary and rear-secondary brake system outlet ports located on the outboard side of the dual master cylinder body casting. These dual-master cylinders do not require bleed screws.

Dual-master cylinder covers also differ in size and appearance for the various car lines. For example, all cars with standard drum brakes and Mustangs with power disc brakes have primary and secondary master cylinder cover domes of equal size. The covers for all other car lines equipped with power disc or power drum brakes have a larger dome over the primary chamber as compared to the size of the dome of the secondary chamber.

Figure 2 illustrates a typical standard drum dual hydraulic brake system. Note that the brake tubes from the dual-master cylinder are connected to the pressure differential valve. The front-primary brake system is colored red and the rear-secondary brake system is colored blue.

The brake pressure differential valve for Ford and Thunderbird cars is mounted vertically on the frame side rail as illustrated. Fairlane, Falcon and Mustang cars have the valve mounted horizontally on the fender apron near the master cylinder.

OPERATION

When the brake pedal is pressed down, both the front primary and rear secondary master cylinder pistons move forward and exert hydraulic pressure to their respective hydraulic brake sub-systems. Should the rear-secondary system leak or fail, the unrestricted secondary piston bottoms out in the master cylinder bore. At the same time, the primary piston displaces the hydraulic fluid in the primary section of the dual-master cylinder to actuate the front brake system. Should the primary system fail, pressing the brake pedal down causes the primary piston to bottom out against the secondary piston while the forward movement of the pedal displaces the hydraulic fluid in the secondary section of the master cylinder to actuate the rear brakes.

The increased pedal travel and effort needed to compensate for the loss in the failed section triggers a warning light and signals the driver that a partial brake system failure has occurred. In the event of failure of either the front or rear brake sub-systems, a pressure differential valve senses the pressure loss of the failed brake system and forces the valve toward the low pressure area (Fig 3). This causes the plunger in the mechanically operated electrical switch to locate and move up onto the valve ramp or shoulder. The switch contacts close and light the warning light on the instrument panel. Normally, when both brake sub-systems are operating satisfactorily, the spring-loaded plunger of the switch remains centered (Fig. 4) when the hydraulic pressure is equalized.

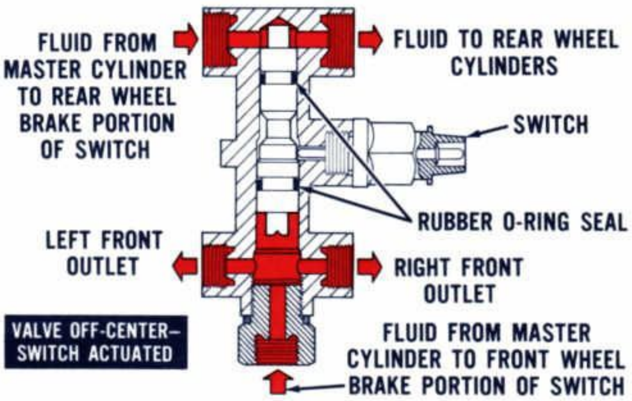


Fig. 3–Valve Piston Moved To Low Pressure Area with Plunger Closing Switch Contacts to Light Warning Light

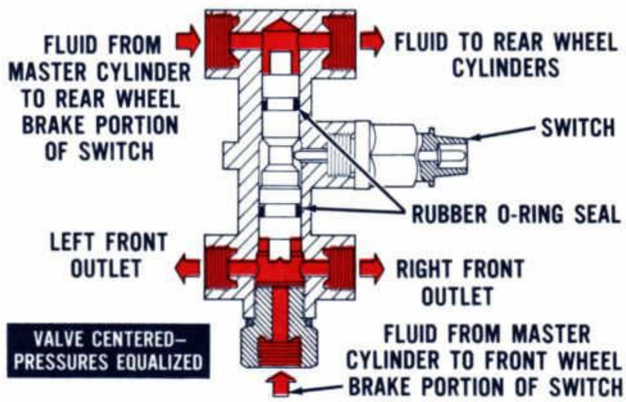


Fig. 4–Valve Piston is Centralized When Primary and Secondary System Pressures Are Equalized

DISC BRAKE HYDRAULIC SYSTEM
(Description and Operation)

Disc-type front wheel brakes are available on all passenger cars. Rear wheel brakes are drum-type. The disc brake dual master cylinder operates the same way as the drum brake master cylinder except that the fluid flow to the rear brakes is restricted by means of a proportioning valve which is located between the pressure differential valve and switch assembly and rear drum brakes.

The proportioning valve provides balanced braking action between the front and rear brakes under a wide range of braking conditions. For example, at the higher master cylinder pressures, the proportioning valve reduces the front brake line pressure for the rear brakes. Reducing the pressure for the self-energizing type rear brakes brings about a balanced condition with the non-self-energizing front disc brakes.

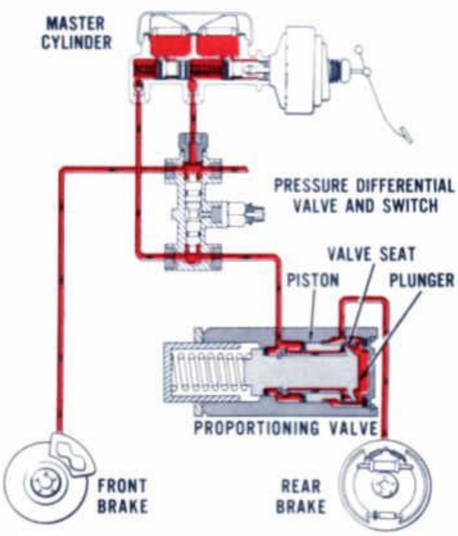


Fig. 5—Schematic Of Power-Disc Brake Hydraulic System With Proportioning Valve (All Passenger Cars except Lincoln-Continental)

DIAGNOSIS

Before trouble shooting the system, always check the fluid level in the master cylinder. If the fluid level is not within ¼- to ½-inch from the top of the reservoirs, add Rotunda brake fluid or equivalent as follows:

- For 1965-66 models with disc brakes and all 1967 models with disc or drum brakes:
  Use—Rotunda Extra Heavy Duty Brake Fluid (high temperature type colored blue) Part No. C6AZ-19542-A or B
- For 1966 and prior models with drum brakes:
  Use—Rotunda Super Duty Brake Fluid Part No. B7A-19542-B or C or B7AZ-19542-A

BRAKE WARNING LIGHT DIAGNOSIS

For operational checkout purposes, the warning light goes on momentarily each time the ignition switch is turned to the "on" or "accessory" postion. But if the brake warning light stays on, the differential pressure valve is not centered indicating the possibility of a failure in either the primary-front or secondary-rear brake systems. Look for leaks at each wheel, at hose connections, junction fittings, and on the frame or body and make the needed repairs. Next, bleed the system and re-center the pressure differential valve (instructions for bleeding and centering to follow).

If the warning light remains on after centering the pressure differential valve, check the switch connector and wire for a grounded condition. If not grounded, replace entire warning light switch.

If the warning light does not come on, the light bulb may be burned out, the light switch may not be working, or the switch-to-lamp wiring may have an open circuit. First replace the bulb; check the switch-to-lamp wiring for an open circuit and repair or replace them. If still no light, replace the switch.

DIAGNOSIS GUIDE

PROBLEM	CONDITION
One Section Of Dual Brake System Is Inoperative	Brakes chatter. Brakes for the respective system do not apply. Warning lamp stays lit. Pedal gradually moves toward floor or dash panel.
Differential Pressure Valve Is Not Centered	Warning lamp stays lit.
Wiring To Warning Lamp Or Switch Is Grounded	Warning lamp stays lit.
Warning Lamp Switch is Grounded	Warning lamp stays lit.
Warning Lamp Is Burned Out	Warning lamp does not light.
Warning Lamp Or Switch Has An Open Circuit	Warning lamp does not light.
Warning Lamp Switch Is Inoperative	Warning lamp does not light.

After making repairs and bleeding the brake system, the warning light will usually stay on when the ignition switch is turned to ON. This is due to a pressure differential created during the bleeding operation that causes the differential valve to move off-center and to activate the light switch. To centralize the differential valve, a pressure differential must again be created in the other sub-system to force the valve back to its center position.

1. Loosen the valve inlet tube nut of the system that had not failed (the side *opposite* the system that was bled last).
2. Operate the brake pedal slowly and gradually to help return the differential valve to its central position and to turn the warning light off.
3. When the light goes out, tighten the tube nut.
4. Check fluid level in the master cylinder reservoirs and refill to ¼ to ½ inch from the top.

And should the warning light stay on when neither system has failed and the system has not been bled, it may be necessary to loosen both system inlet tube nuts on the pressure differential valve, one at a time, to center the differential valve.

MANUAL BLEEDING PROCEDURE

Bleeding the new dual-master hydraulic brake system is not too different from bleeding the previous design single system.

Since each sub-system is complete in itself, each is bled separately. Bleed the longest line first of the sub-system being bled. AND DO NOT ALLOW THE RESERVOIR TO RUN DRY! Also do not intermix brake fluids, such as adding extra-heavy duty brake fluid with heavy duty brake fluid or vice versa, or use low temperature brake fluid with the specified fluid.

1. Bleed the master cylinder at the outlet port of the sub-system being serviced. (Fig. 1).
2. On master cylinders with bleed screws located on the outboard side, loosen the bleed screw. (This is a master cylinder whose secondary-rear outlet port is on the *bottom* of the master cylinder.) *Warning!* Do not use the secondary piston stop screw that is located on the bottom for bleeding as this could damage the secondary piston or stop screw.
3. On master cylinders, without bleed screws, loosen the outlet port tube nut. Operate the brake pedal slowly until fluid is free of bubbles, then tighten the tube nut.
4. Next, position a ⅜ inch box wrench on the bleeder fitting on the brake wheel cylinder and connect a drain tube to fitting.
5. Submerge drain tube in container partly filled with clean fluid.
6. Push brake pedal down slowly through its full travel. Close bleeder fitting, then let pedal return to its released position. Repeat this until all air bubbles disappear in bleeder-container. Close fitting and remove bleeder tube.
7. Repeat this procedure for the opposite brake wheel cylinder.
8. Repeat bleeding procedures 1 through 7 for the other brake sub-system.
9. Centralize the pressure differential valve as previously outlined.

PRESSURE BLEEDING PROCEDURE

As recommended in manual bleeding, bleed the longest lines first. Make sure the bleeder tank contains enough of the right type of brake fluid to do the job. Use extra-heavy duty brake fluid for all disc brake systems and heavy duty brake fluid for power drum and standard brake systems. Do not intermix types of brake fluids. *Never reuse brake fluid drained from any brake system.*

1. Clean the master cylinder reservoir cover.
2. Remove the master cylinder cover and gasket and fill reservoir with specified fluid.
3. Install pressure bleeder adapter tool to master cylinder outlet port and attach bleeder tank hose to adapter fitting.
4. Position ⅜ inch box wrench on bleeder fitting on right, rear brake wheel cylinder. Attach bleeder hose securely to bleeder fitting on wheel cylinder.
5. Open valve on bleeder tank to pressurize brake fluid to master cylinder reservoir.
6. Submerge bleeder hose in a container partially filled with clean fluid, and loosen bleeder fitting at wheel cylinder.
7. When air bubbles stop coming into the container, close the bleeder fitting and remove the tube.
8. Repeat steps 4 through 7 at the opposite wheel cylinder of the system being bled.
9. When bleeding operation is completed, close bleeder tank valve and remove tank hose from the adapter fitting.
10. Remove the pressure bleeder adapter tool. Fill the master cylinder reservoir to within ¼ to ½ inch from the top and install gasket and cover.
11. If repairs were made to both sub-systems, repeat pressure bleeding procedures, and then centralize the pressure differential valve using the procedure previously described.

BRAKE PEDAL ADJUSTMENT

The brake systems of all Ford-built cars are designed to provide a full stroke of the master cylinder piston when the brake pedal is fully depressed. A brake pedal height adjustment is not required. If the brake pedal mechanism is properly installed, the brake pedal should never touch the floor.

However, each car model has a specified minimum to maximum brake pedal free height measurement which is the distance from the dash panel floor to the pedal's fully-released position. Also maximum pedal travel is specified for each car model as listed in the chart below.

VEHICLE	TYPE	PEDAL FREE HEIGHT A		PEDAL TRAVEL B
		MAX.	MIN.	MAX.
FORD–MERCURY	NON-POWER DRUM	7.47	6.53	2.90
FORD–MERCURY	POWER DRUM	5.08	3.92	2.33
FORD–MERCURY	POWER DISC	4.51	3.32	2.33
FORD–MERCURY	NON-POWER DISC	7.47	6.53	2.08
FALCON–MERCURY INTER.–F'LANE	NON-POWER DRUM	8.03	6.81	2.74
FALCON–MERCURY INTER.–F'LANE	POWER DRUM	5.04	3.74	1.82
FALCON–MERCURY INTER.–F'LANE	POWER DISC	6.39	4.90	2.08
FALCON–MERCURY INTER.–F'LANE	NON-POWER DISC	8.03	6.81	2.08
MUSTANG–COUGAR	NON-POWER DRUM	6.98	6.03	2.68
MUSTANG–COUGAR	POWER DRUM	5.61	4.60	1.82
MUSTANG–COUGAR	POWER DISC	5.61	4.60	1.82
THUNDERBIRD	POWER DISC	5.24	4.35	2.34
LINCOLN	POWER DISC	6.50	5.50	2.34

Fig. 6—Pedal Free Height and Pedal Travel Specifications for all 1967 Model Ford-built Passenger Cars

TECHNICAL SERVICE BRIEFS

DISTRIBUTOR VACUUM THERMAL SENSING UNIT

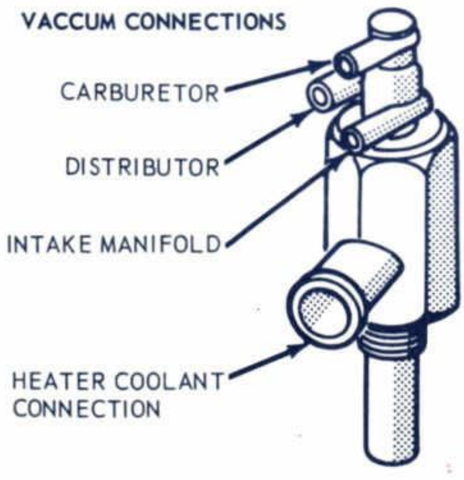
On some 1967 Thermactor-equipped engines (See Application Chart), the distributor vacuum is obtained from either the intake manfold or carburetor vacuum port. A thermal sensing valve, installed in the heater water system, determines the source of distributor vacuum.

Description and Operation

Normally, the distributor advance mechanism operates on carburetor vacuum. However, at approximately 230°F engine coolant temperature, the thermal sensing valve closes the carburetor vacuum pickup and opens the intake manifold *full* vacuum pickup. The increase in vacuum activates the vacuum advance mechanism and advance ignition timing. The advance in ignition timing or spark advance increases engine idle speed. This helps to reduce engine operating temperatures under hot idle conditions.

Therefore, under no conditions should any attempt be made to reduce the idle speed by adjustment. When the coolant temperature lowers sufficiently, the idle speed will automatically be reduced.

The thermal sensing distributor vacuum control valve consists of a thermal capsule, similar to the type used in the engine water thermostat. A valve covers and uncovers ports in a valve body thereby switching the vacuum source between the carburetor and the intake manifold, depending on coolant temperature. The vacuum valve mechanism is an integral part of the heater water takeoff connection and is located on top of the intake manifold at the water outlet fitting. It incorporates three (3) .42 inch diameter vacuum hose connections for the carburetor, distributor and manifold vacuum hoses respectively.



Idle Speed Adjustment Procedure

The following procedure for adjusting idle speed must be followed to avoid erroneous settings on vehicles equipped with the thermal sensing valve.

1. Disconnect the distributor and manifold vacuum hoses at the thermal sensing valve. This is *mandatory* when reading or adjusting the engine ignition timing.
2. Plug the manifold vacuum hose.
3. Adjust the engine idle speed in the normal manner.
4. Reconnect the distributor and manifold vacuum hoses to the thermal sensing valve.

REMOVAL AND INSTALLATION

Removal

1. Drain the cooling system.
2. Remove the air cleaner.
3. Disconnect the heater hose and the three vacuum lines at the thermal sensing valve.
4. Remove the Thermal Sensing Unit.

Installation

1. Coat the Thermal Sensing Unit threads with water-resistant sealer and install the Thermal Sensing Unit. Torque to 23-30 ft. lbs.
2. Coat the heater hose fittings with water-resistant sealer. Install the heater hose.
3. Install the appropriate vacuum lines as shown in the illustration.
4. Fill the cooling system. Start the engine and check for leaks.
5. Install the air cleaner.

THERMAL SENSING UNIT APPLICATION CHART

ENGINE	VEHICLE	ACCESSORIES
289	Mustang, Cougar	Thermactor and Air Conditioning
390	Fairlane, Comet, Mercury	Thermactor and Air Conditioning
390, 428	Thunderbird	Thermactor
410	Mercury	Thermactor and Air Conditioning
428	Mercury	Thermactor and Air Conditioning
428 Police	Ford, Mercury	Air Conditioning