Chapter 5
Ignition and Lighting Systems

Moped electrical systems are fairly simple, at least in terms of contemporary technology. But the nature of these systems is such that you cannot troubleshoot them or even do much purposeful work on them without some knowledge of the theory. Electrical parts do not make visual sense in the way that mechanical parts do. Almost anyone who looks at a piston comes away with some notion of its function; no one who is blankly ignorant of electricity can understand a capacitor or coil by merely looking.

I have taken some time to explain the theory of these systems in this chapter. Theory may be a bit tedious for someone who has a broken moped, but there are no shortcuts: what is not understood, cannot be repaired.

Here are some ground rules:

- Wiring diagrams are not pictorial. They show what's connected to what as simply as possible, and give you little idea how the actual wires are routed on the chassis.
- Current flows from negative to positive, that is, it moves from the negative terminal of the generator back to the positive terminal. This path is called a circuit.
- For current to flow the circuit must be complete and uninterrupted. A seemingly insignificant break, a few

thousandths of an inch between switch contacts, a film of rust, or a smudge of oil can open the circuit.

- The circuit may consist of insulated wire, or it may combine wire and the engine or frame. The junction between the insulated side of the circuit (called the "hot" or "live" side) and the metal parts of the bike is a ground. In wiring diagrams, ground connections are symbolized ⏚ or ⊥.
- Current will always take the easiest path back to the generator. Each circuit load—coil, horn, lamp, etc.—has resistance to electron flow. If possible, current will find a way to bypass, or short, the load. The problem is particularly severe when part of the circuit is grounded: any uninsulated part of the hot side will short to ground on contact with metal.

I IGNITION SYSTEMS

The ignition system generates a spark with enough voltage to ignite the air-fuel mixture in the cylinder, and times that spark to occur at some preset distance before the piston reaches top dead center.

SPARK PLUG

The spark plug is the final component in the ignition system and is, by far, the most stressed. Combustion temperatures heat the firing tip to 1700 degrees during normal operation; engine vibration can generate forces of as much as 50G; and while it is being heated and shaken about, the spark plug must contain combustion pressure and still do its primary job of releasing a spark across a high-pressure atmosphere of oil, gasoline, and air. A faulty plug can make starting more difficult or prevent it entirely. It may cause the engine to miss, particularly when cold or under heavy load. And a less-than-perfect spark plug can take the edge off performance without causing a noticeable miss: the engine will start easily, accelerate smoothly, yet go flat under full throttle.

It's not surprising that many experienced mechanics change the spark plug before they do anything else to the engine.

Construction

Figure 5-1 illustrates basic spark plug construction and nomenclature. The plug shown is a Japanese NGK which

shares its plated finish with Champion and is otherwise quite similar to most American and German types.

1. Terminal nut—detachable on mopeds and European small engine applications generally.
2. Corrugation—protects against high voltage flashover, the same principle used on insualtors for high-voltage transmission cables.
3. Metal shell—offers purchase for the wrench and support for the spark plug components; 5/8-inch hex is standard.

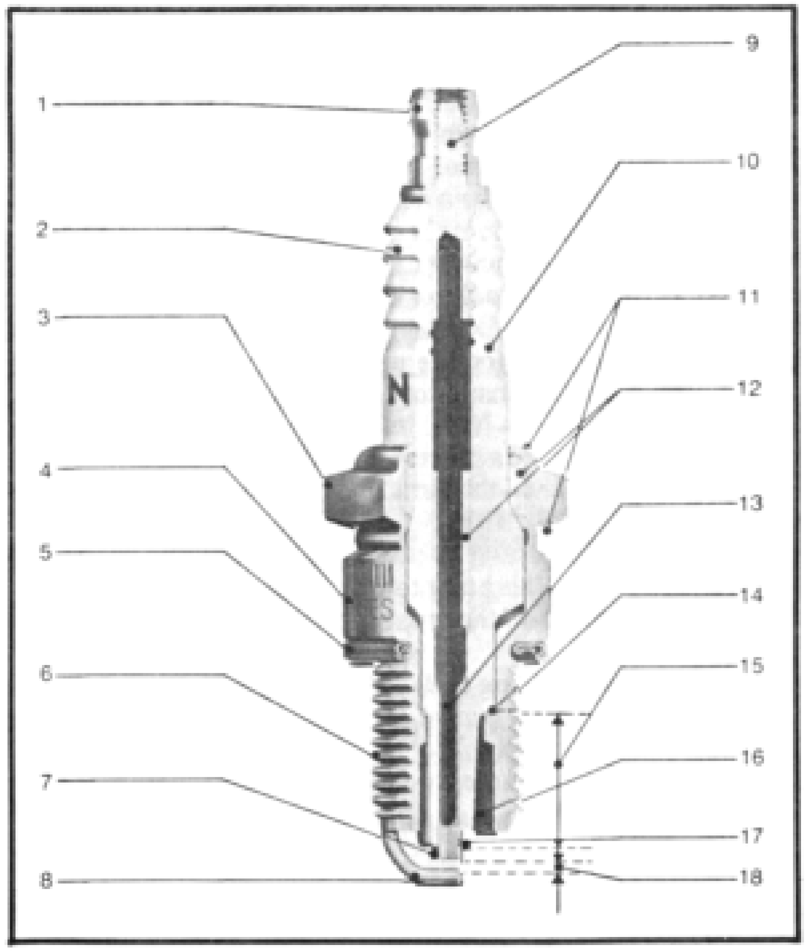


Fig. 5-1. Spark plug nomenclature. (Courtesy NGK Spark Plug Co., Ltd.)

4. Plated finish—for rust protection, generally preferable to a blued finish.
5. Gasket—seals the combustion gas.
6. Thread—the diameter is expressed in millimeters and the reach (the distance from the gasket flange to the end of the threads) is expressed in fractions of an inch. These dimensions are fixed by the engine maker.
7. Center electrode—usually thought of as the "hot" electrode, although in actual fact the direction of the spark is from the ground to the center electrode.
8. Ground electrode—sometimes called the side electrode, this electrode is grounded to the engine.
9. Stud—fixed to the insulator. If the stud is loose, the spark plug must be replaced.
10. Insulator—the part old-line mechanics call the porcelain because that was the material originally used. Today the insulator is made from fused aluminum oxide, a very hard ceramic, akin to rubies and sapphires.
11. Caulked portion—part of the defense against leaks between the insulator and shell.
12. Sealing powder—a kind of self-sealing gasket which compensates for the unequal rate of expansion of the shell and the insulator.
13. Copper core—NGK claims cooling benefits; most manufacturers use a steel core.
14. Inner gasket—the first line of defense against internal leakage.
15. Insulator nose—the part which has the most effect on the plug's operating temperature.
16. Gas volume—the space between the insulator and shell.
17. Insulator (firing end)—the nature and color of deposits on the firing end of the insulator reveal engine and combustion-chamber operating conditions.
18. Spark gap—the only adjustment normally made on a spark plug.

Heat Range

There are three basic variables in spark plug design: thread diameter, reach, and heat range. Thread diameter is hardly worthy of comment, except to say that it is impractical

to salvage a stripped moped head by cutting threads for a larger spark plug. Even if you can obtain a larger plug with the same reach and heat range, the sheer volume of the plug will upset combustion-chamber geometry.

The reach is calculated to bring the firing tip even with the roof of the combustion chamber. A plug with insufficient reach will have its tip buried in the spark plug port, where it is remote from the action. Starting may be difficult and power will be down because of the additional clearance volume in the cylinder. A spark plug with excessive reach is almost sure to be hit by the piston.

Heat range refers to the cooling capacity of the spark plug. As you can see from Fig. 5-2, the ideal temperature for any spark plug is between 750 and 1800 degrees F. Below this temperature the firing tip carbons over and fouls; above it the tip glows and can ignite the mixture early, before the spark occurs.

Figure 5-3 shows four spark plugs in cutaway view. The plugs have identical thread diameters and reaches, but different heat ranges. The spark plug on the far left is the coldest of the lot; the heat range gets progressively hotter to its right. The primary difference is the distance heat travels

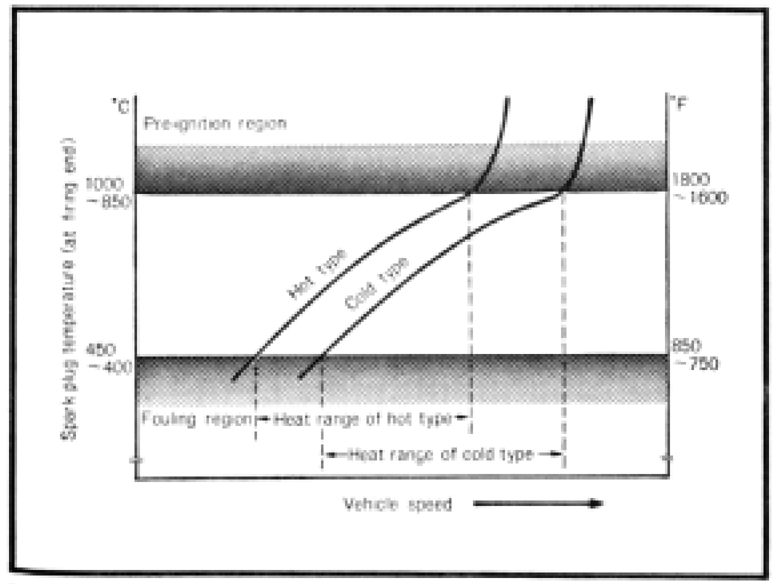


Fig. 5-2. Heat range walks the line between cold fouling and preignition. (Courtesy NGK Spark Plug Co., Ltd.)

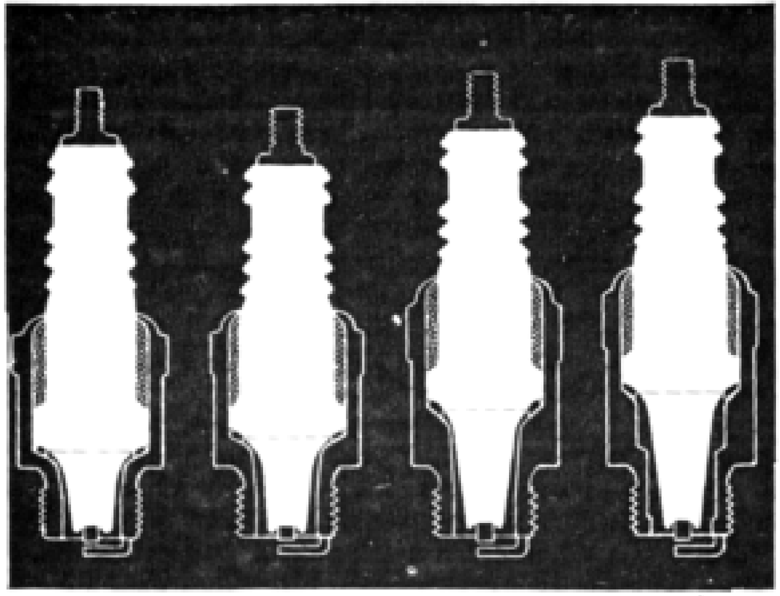


Fig. 5-3. Champion spark plugs in a heat range progression from (L) cold to hot (R).

along the nose of the insulator to the metal shell. Cold plugs have a short thermal path and cool down quickly; hot plugs have a longer thermal path and generally have a greater gas volume between the insulator nose and the inside of the shell.

Spark plugs are available in a wide variety of heat ranges. In general, what determines the choice of heat range for a particular engine is the temperature of the combustion chamber. Hot-running engines need cold plugs, and vice versa.

Heat range selection depends upon:

- The amount of carbon buildup in the cylinder. Carbon deposits can insulate the chamber, trapping heat.
- The air/fuel ratio. The ideal air/fuel ratio, the ratio that delivers the most power, also generates the most heat (Fig. 5-4).
- Ignition advance. Within limits, additional ignition advance means more power. Unfortunately, each degree of advance takes its toll as heat (Fig. 5-5).

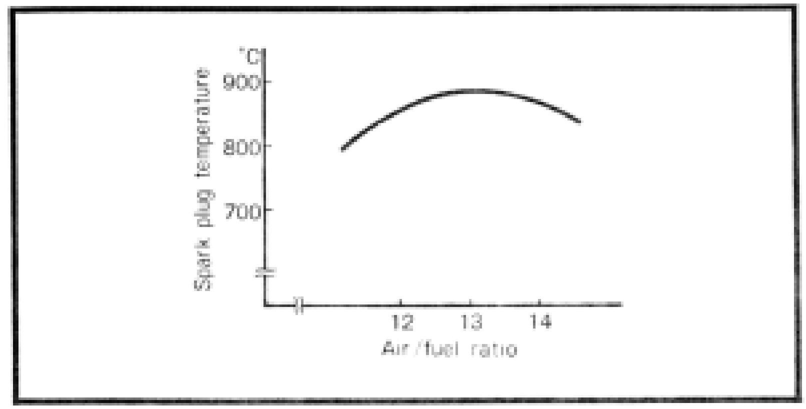


Fig. 5-4. The most power-efficient air/fuel ratio (around 13:1) releases the most heat in the chamber.

- **Compression ratio.** The higher the compression ratio, the more efficient the engine, and the hotter the chamber (Fig. 5-6).
- **Spark plug tightening torque.** Undertorqued spark plugs run hot because heat transfer depends upon the seal between the plug shell and the cylinder head (Fig. 5-7).

The spark plug furnished with the machine is a good choice for average use, but may not be if you've modified the engine for more power. Polishing the cylinder head and piston, smoothing the port profiles, boosting the compression ratio,

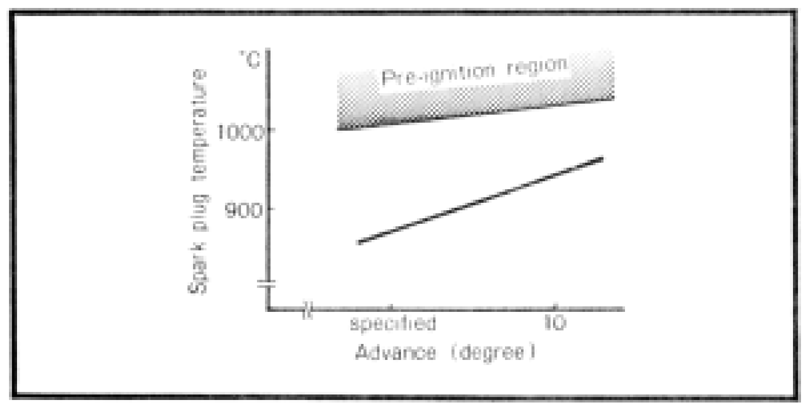


Fig. 5-5. Each degree of ignition advance entails higher chamber temperatures.

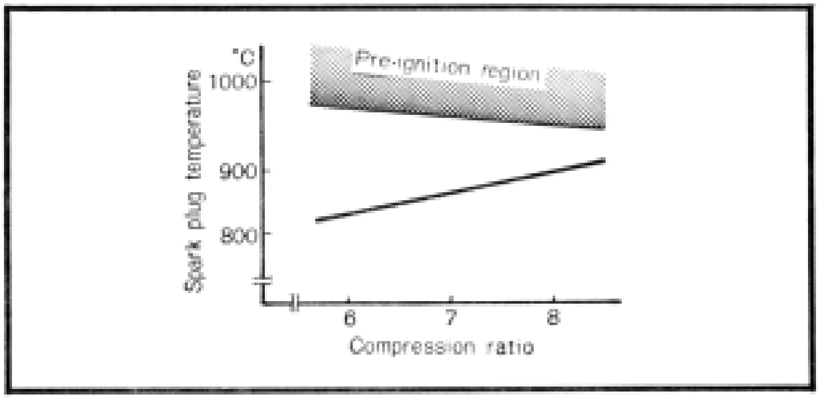


Fig. 5-6. A high compression ratio means power and high temperature.

increasing spark advance, and precision-tuning the carburetor mean higher combustion-chamber temperatures. Depending on the effect of modifications, the original spark plug can become a time bomb, waiting to go into preignition with the result shown in Fig. 5-8.

Service

Disconnect the spark plug cable by grasping the insulating boot and giving it a half-twist (Fig. 5-9). Moped spark plugs accept a 5/8-inch deep-well socket, sized to clear the insulator (Fig. 5-10).

Spark plugs wear out in 3000 miles or so of moped service. The electrodes round off and erode, and eventually become so

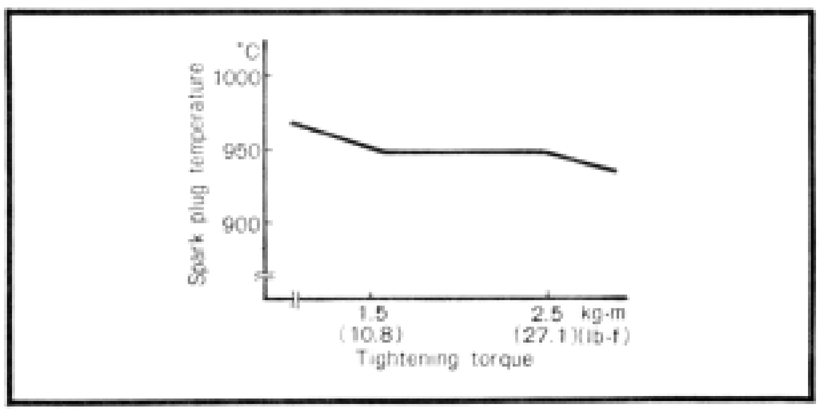


Fig. 5-7. A spark plug that is undertightened overheats.

Fig. 5-8. The woeful result of pre-ignition.

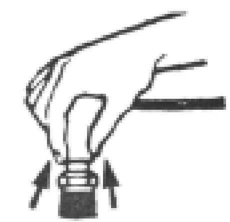


Fig. 5-9. To remove the spark plug cable, give the boot a twist and pull.

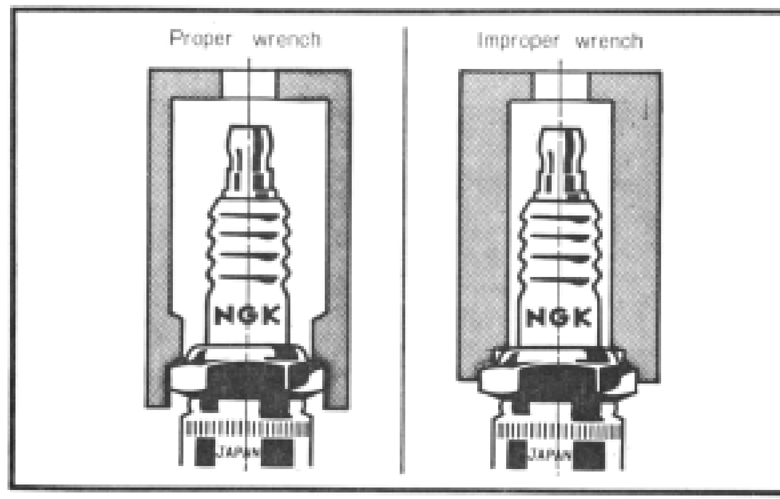


Fig. 5-10. The socket wrench must be in full contact with the hex shell and clear of the fragile insulator. (Courtesy NGK Spark Plug Co., Ltd.)

Fig. 5-11. A worn-out spark plug. (Courtesy Champion Spark Plug Co.)

fine they can overheat and send the engine into preignition (Fig. 5-11). But a slightly worn plug can be cleaned, filed, gapped, and used again.

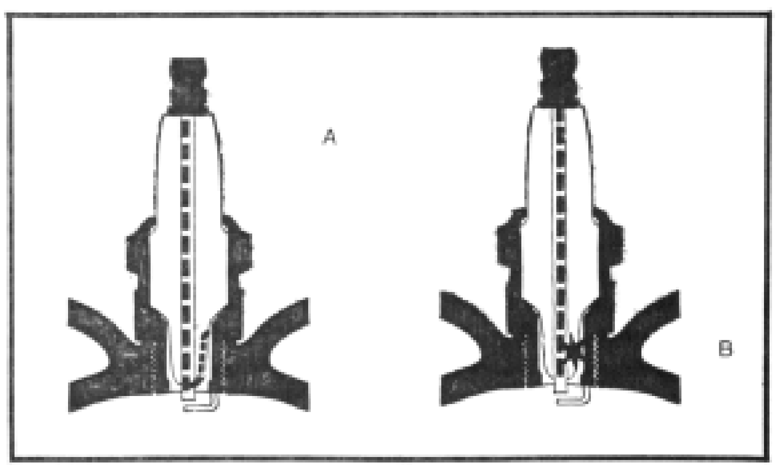


Fig. 5-12. Two maladies that can be corrected by cleaning: fouling (view A) and tracking (view B). (Courtesy Champion Spark Plug Co.)

Cleaning. The purpose of cleaning is to remove carbon deposits. These deposits can short out the spark, shunting it to ground before the plug fires, or build up in the gas volume area, forming a second spark gap deep inside the plug (Fig. 5-12). In either case, engine performance suffers.

Spark plugs may be cleaned by hand with a wire brush and a small screwdriver. Results with this method are reasonably good, but nothing to write home about. The professional approach is to use a sandblaster adapted to spark plug work. The plug is placed in the machine and wobbled under the blast so that the abrasives scrub deposits from the inside of the shell and insulator nose.

In theory, a sandblasted spark plug is as good as new; in practice this may not be the case. Abrasives do not have much effect on lead fouling, a kind of translucent patina that forms on the insulator and causes misfire during acceleation. Nor are plugs cleaned this way compatible with high-strung two-cycle engines. The newly cleaned plug will behave normally for a few miles and then misfire, costing 500 rpm or so at wide-open throttle. In addition, one must be very careful to remove all of the abrasive before the spark plug is put back into the engine. Even a few particles can do serious damage to the piston, rings, and cylinder bore. It's good practice to blow the plug clean and then let it soak for a few minutes in lacquer thinner.

Filing. After cleaning, reform the center electrode by filing it flat. In Fig. 5-13 the side electrode is straightened so

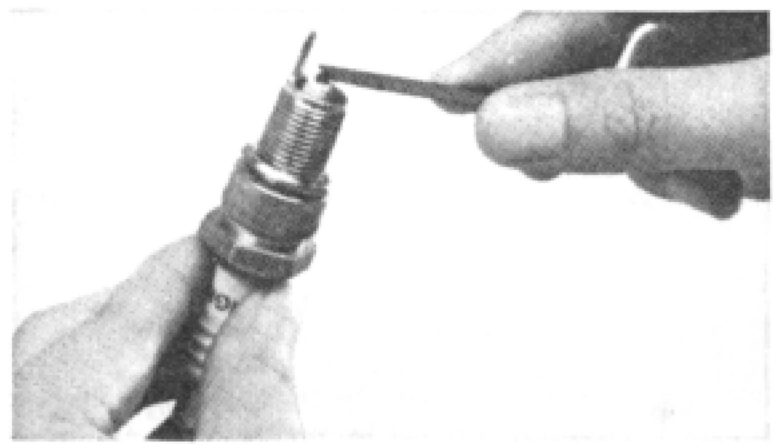


Fig. 5-13. File the center contact flat. (Courtesy NGK Spark Plug Co., Ltd.)

that the sandblast can reach all areas of the insulator nose. This practice is favored by Japanese mechanics, but is frowned on here; bending weakens the side electrode.

Gapping. Using a round feeler gauge, gap the plug to specification (Fig. 5-14). The gauge wire should pass between the center and side electrode with a light drag. If it binds, use the bending tool on the gauge to open the side electrode; if the gauge passes through without touching both electrodes, tap the center electrode on something hard. With a little practice you will be able to correctly gap a spark plug in a few seconds.

Installing. Clean the spark plug threads with a hand-held wire brush, not a power-driven wheel that could deform the thread edges. Wipe any carbon or oil deposits from the spark plug port in the cylinder head. Remember that the temperature of the firing tip depends upon the ability of the shell to pass heat to the head: a layer of carbon or a film of oil interferes with heat transfer.

Run the plug in by hand until the gasket bottoms. If you cannot turn it this far with your fingers, turn the plug at least two full revolutions before you apply the wrench. Otherwise, the spark plug may cross-thread and ruin the cylinder head.

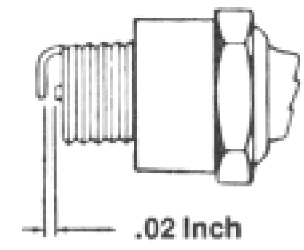
Once the gasket is in contact with the head casting, one-half or three-quarters of a turn with a wrench is enough to secure it. Ideally, you should use a torque wrench to tighten the plug to the following specifications. The specs are for a cold engine, and should be used only if you don't have the specs for your engine.

Spark Plug Thread Diameter	Torque
10 mm	86-104 inch-pounds (1.0-1.2 kilogram-meters)
12 mm	125-175 inch-pounds (1.5-2.0 kilogram-meters)

Reading

Reading the spark plugs is the time-honored way of determining combustion chamber temperature and, by extension, of tuning the engine. The basic principle is that the hotter the chamber, the whiter the spark plug tip. If the plug has the correct heat range, the color of the insulator nose

Fig. 5-14. Bend the side, or ground, terminal to adjust the gap. The specification is for Sachs-powered Columbia mopeds.

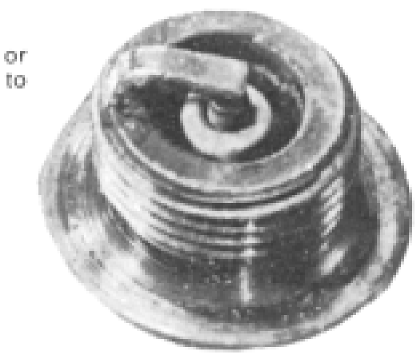


should be neutral—either a rich tan or light brown. If temperatures are too high, the nose will turn white and may blister. In extreme cases, the side electrode can show blue temper marks. On the other hand, low chamber temperatures leave a fluffy black carbon residue on the nose.

The difficulty is getting consistent readings. A perfectly well-behaved spark plug will bleach white on a steep, full-throttle hill. The same plug will carbon during an extended period of idle.

Ignition system operation is usually checked by running the bike wide open for a short period, thereby subjecting the plug to maximum thermal stress, but carburetor tuning is best checked by operating the engine at a number of throttle positions and rpm ranges. In any event, the engine must be brought up to operating temperature and run for a quarter-mile or so at the desired speed. Shutdown must be abrupt in order not to leave false deposits. Chop the throttle, hit the kill button, and brake to a stop. Remove the spark plug and, holding it in the socket wrench to protect yourself from

Fig. 5-15. Normal: light tan or brown, electrode wear limited to the spark zone.



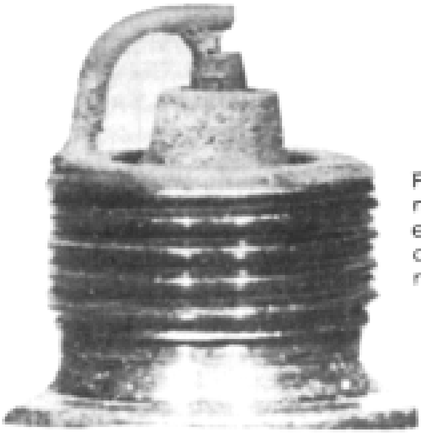


Fig. 5-16. Gap-bridged: a common malady of two-cycle engines, believed to be caused by dust. Wipe the whisker off and restart.

burns, compare the tip with the photographs in Figs. 5-15 through 5-20.

MAGNETO IGNITION

Figure 5-21 illustrates a typical moped magneto. The basic parts are:

- Stator plate that secures the stationary magneto parts to the engine block (3).
- Contact points which trigger the spark (7).
- Exciter coil which generates primary voltage (12).
- Cam that rotates against the movable point arm and separates the contacts (16).
- Rotor which acts as the flywheel and bears permanent magnets (17).
- Spark plug cable (20).
- Ignition coil (21).

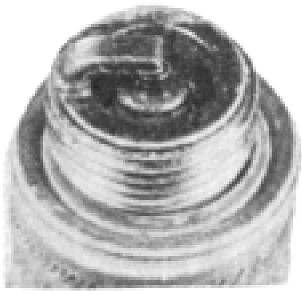


Fig. 5-17. Wet fouling: damp black carbon coating over the entire firing end. May form sludge if the condition is chronic. Check spark plug heat range (the plug may be too cold), air/fuel ratio (too rich), fuel/oil ratio (too much oil), ignition system (misfiring). (Courtesy Champion Spark Plug Co.)

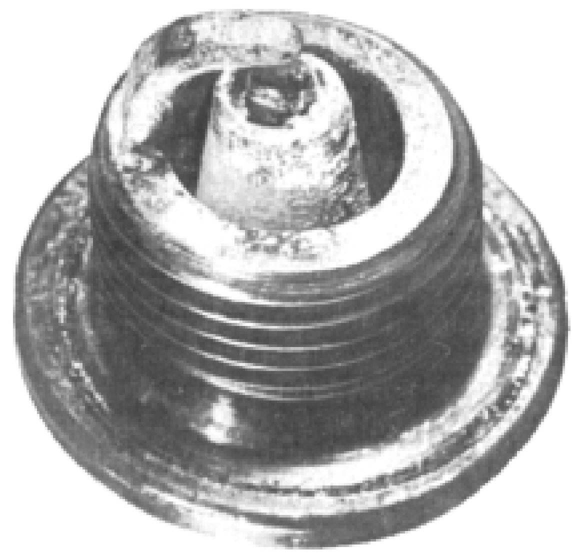


Fig. 5-18. Overheating: electrodes badly eroded, premature gap wear, gray or white insulator. Check spark plug heat range (too hot), ignition timing (too much advance), air/fuel ratio (too lean). (Courtesy Champion Spark Plug Co.)

Fig. 5-19. Preignition: melted electrodes and, in most cases, a white insulator. The insulator may be discolored due to a fog of debris in the overworked cylinder. Check for correct heat range, adequate lubrication, and for overadvanced ignition timing. Correct the problem before the engine is put back into service. (Courtesy Champion Spark Plug Co.)

Fig. 5-20. Scanvenger deposits: brown, yellow, or reddish deposits on the firing tip. These deposits are left by additives in the fuel and are not in themselves dangerous. Clean and return the plug to service. (Courtesy Champion Spark Plug Co.)

Figure 5-22 shows the Robert Bosch magneto, widely used on German and Italian machines. It combines the exciter and ignition coil in a single assembly. The next drawing shows one version of the CEV magneto, which can be interchanged as a unit with the Bosch (Fig. 5-23).

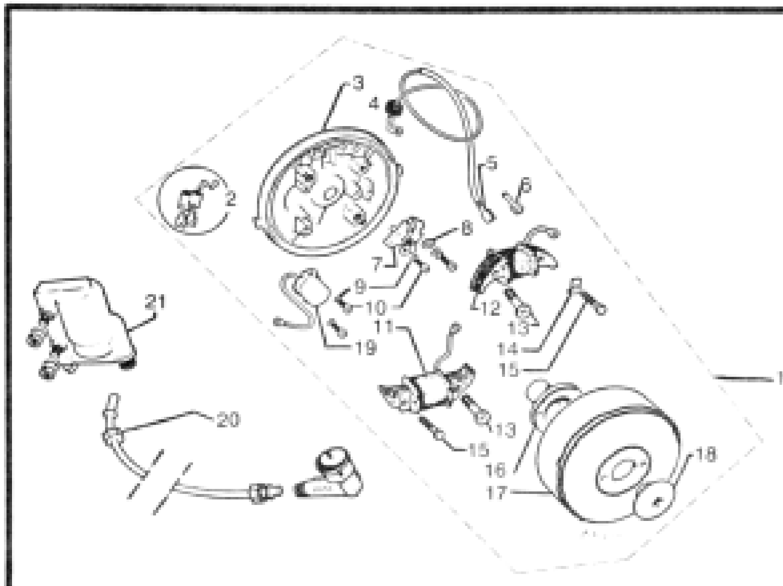
A diagram of the ignition side of the circuit is shown in Fig. 5-24. The exciter, or primary ignition, coil consists of several hundred turns of enameled copper wire, mounted on an iron form. One end of the exciter coil is connected to the ignition coil, which is mounted on the frame, outside of the magneto proper. The other end of the coil is grounded through a circuit that I will discuss under "Lighting Systems."

Operation

The flywheel has permanent magnets bonded to its rim. As the flywheel turns, the magnets sweep part the exciter coil, permeating its windings with magnetic lines of force. When a conductor—and the coil windings are a conductor—is

subjected to a moving magnetic field, a voltage is generated in the conductor. The magnetic field must be moving: when the flywheel is stopped, no voltage is produced. At high speed, the exciter coil delivers as much as 300 volts to the ignition coil. But voltage is not constant. It depends upon the proximity of one of the magnets to the coil and upon the position of the contact points.

The points amount to a switch, connected in parallel with the exciter coil. The stationary contact is grounded to the stator plate; the movable contact is insulated and "hot." When the movable contact rests against the stationary contact,



1—FLYWHEEL MAGNETO, COMPLETE
2—INSULATOR
3—FLYWHEEL STATOR
4—GASKET
5—RUBBER
6—CONNECTOR, FEMALE
7—POINTS, BREAKER
8—BREAKER, ADJUSTMENT LEVER
9—WASHER, 4 mm
10—SCREW
11—COIL, LIGHT
12—COIL, EXCITER
13—BOLT, HOLLOW
14—LOCK, TAB
15—SCREW
16—CAM
17—ROTOR
18—NUT
19—CONDENSER
20—CABLE, SPARK PLUG
21—IGNITION COIL

Fig. 5-21. The Motobecane magneto follows the general moped practice with a single lighting coil and two ignition coils. The exciter coil is housed under the flywheel and provides current for the frame-mounted ignition coil.

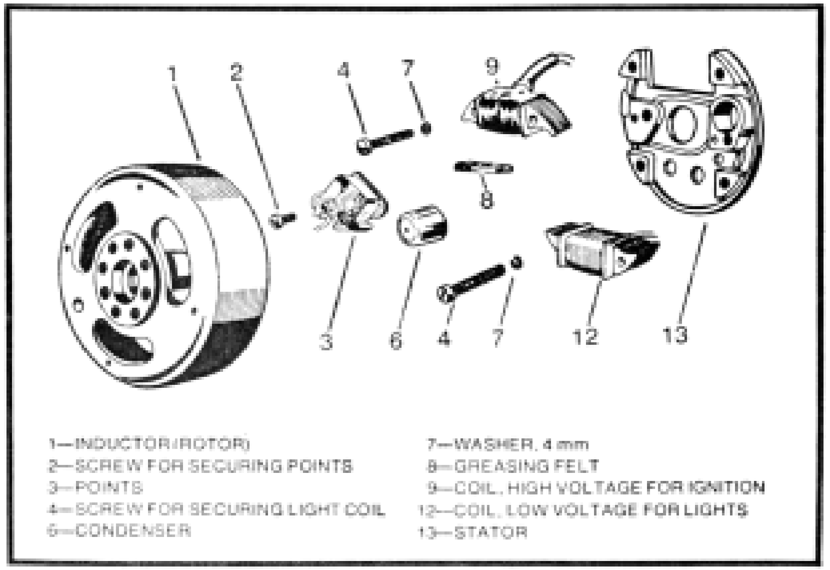


Fig. 5-22. The Bosch Model KB6-B212 magneto is unique among mopeds in that the two ignition coils are wound together. (Courtesy Cimatti Ltd.)

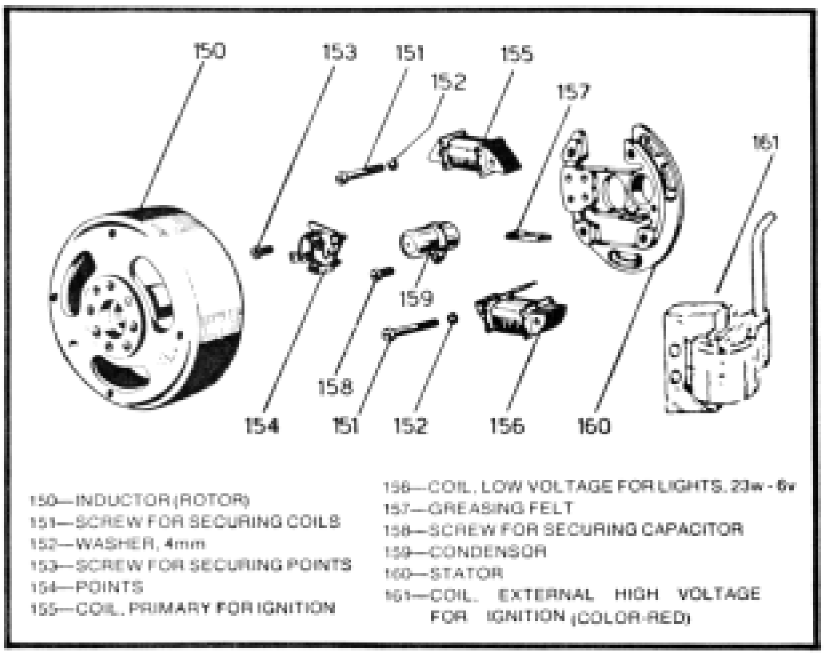


Fig. 5-23. The CEV Model 6932 can be substituted for the Bosch as a complete assembly. (Courtesy Cimatti Ltd.)

exciter coil output passes to ground: no voltage goes to the ignition coil. As the flywheel turns, it cams the movable contact open, denying ground to the voltage impressed on the exciter coil. The voltage goes out "seeking" a ground, and it finds it in the ignition coil. The moment of point opening coincides with (and causes) the ignition pulse and is the reference point for timing the engine.

The cam, contact points, exciter coil, and flywheel magnet work together as a team. The points open when a flywheel magnet is centered above the exciter coil, at the moment of greatest magnetic flux.

The condenser (or capacitor) is an electrical buffer. Electricity has a kind of inertia—once flowing it is reluctant to stop. As the points crack open, this "inertia" would continue current flow, arcing across the open points and burning them in the process. The condenser momentarily absorbs these electrons and releases them back into the circuit when the points close again.

The ignition coil is also known as the pulse generator. It consists of two windings: fairly heavy enameled copper wire is wound around the form some 400 times (the primary winding) and is covered by 20,000 turns or so of extremely thin wire (the secondary winding). The secondary winding terminates at the spark plug cable and delivers a wallop of 15,000-23,000 volts.

The operation depends upon magnetic lines of force. The exciter coil sends in one magneto, 300 volts into the primary winding. As the winding becomes saturated, it sends out

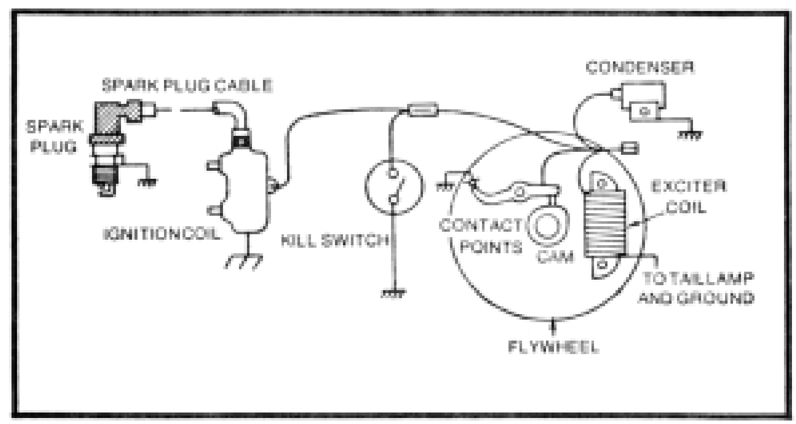


Fig. 5-24. The complete magneto circuit with kill switch and ignition coil.

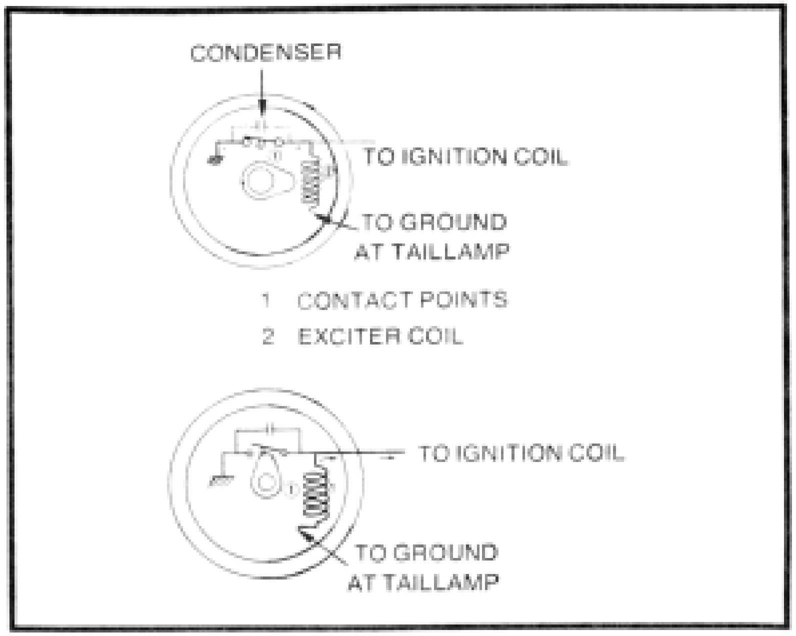


Fig. 5-25. The basic ignition circuit. When the points close, current flows through the exciter coil, its circuit completed through the grounded points at one end and the grounded taillamp at the other (view A). When the points open, current diverts to the ignition coil and the spark plug fires (view B).

magnetic lines of force, that move like the ripples on a pond. These moving lines of force cut through the second winding and generate a voltage in it which is proportional to the ratio of turns in the windings. This ratio—20,000 to 400 or 50:1—transforms the primary's 300 volts to 15,000 volts, plenty to jump the spark gap.

Spark Testing

Disconnect the spark plug cable at the spark plug by giving the boot a quarter twist and pulling. Do not pull on the wire. Insert a screwdriver into the boot so it makes contact with the cable terminal. Holding the screwdriver by its insulated handle, maneuver it to bring the blade within three-eighths of an inch of one of the cylinder fins. Turn the switch on and have a helper turn the pedals. If all is right, the spark will appear between the blade and the fin.

Observe the spark. It should be heavy, thick, and bright blue. A "nervous" spark, one that seems to go in all directions,

means ignition problems, particularly if the spark is red or white. A really healthy system will deliver a spark that you can hear like a miniature thunderclap.

Service

The first step is to remove the flywheel nut. It's a standard thread and backs off when turned counterclockwise, but the flywheel must be held against wrench rotation. In Chapter 6 a universal flywheel-holding tool is described; most flywheels have access ports that accept a pin wrench (Fig. 5-26). In those few cases where the flywheel is closed and shrouded so there is no wrench purchase on its external surfaces, you can hold it with the starting clutch. Since the clutch will slip under wrench torque, shock the nut loose by giving the wrench handle a sharp rap with a hammer. A more sanitary method is to fix the piston with a tool that threads into the spark plug port. Break off the insulator on a discarded spark plug and have an extension brazed on its tip. With the tool in place, the piston contacts the extension at the top of its stroke.

Flywheel. Once the nut and (usually) lockwasher are loose, the flywheel must be withdrawn from the crankshaft stub. There are four ways to do this. In order of preference:

- Purchase the appropriate flywheel puller from your dealer, the moped importer, or from a bicycle shop. Some of these pullers are identical to European bicycle crank tools.
- Run the nut down flush with the end of the crankshaft and shock the flywheel off with the help of a brass bar and a hammer. Position the bar square against the

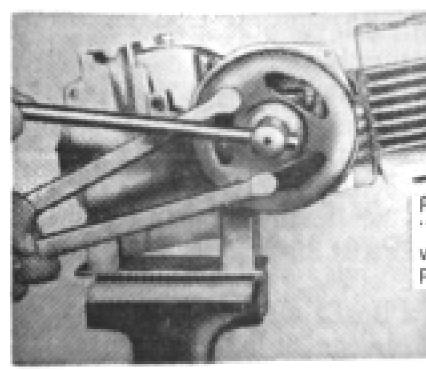


Fig. 5-26. Many flywheels have "windows" that accept a pin wrench. (Courtesy Steyr Daimler Puch.)

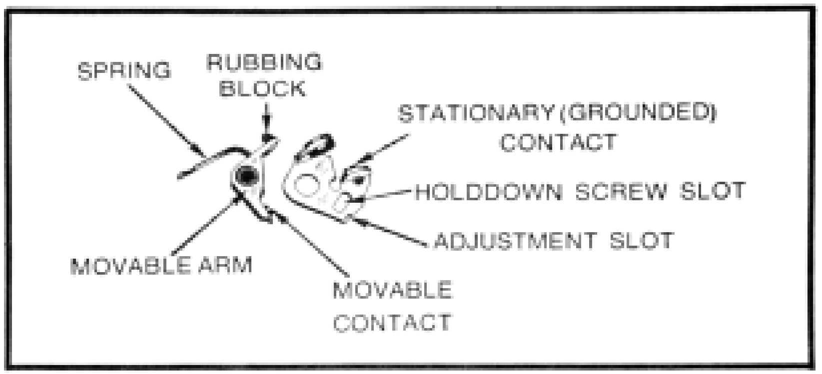


Fig. 5-27. A Bosch two-piece point set. Some sets have the movable arm secured permanently to the pivot post. (Courtesy American Parts Co., Inc.)

end of the shaft and hit it hard. This method is more dangerous than using a threaded knocker, since misalignment of the bar can snap the crankshaft stub.

- Run the nut down flush and strike the crankshaft end with a hammer. This technique is emphatically not recommended, since it does violence to both the shaft and the nut. But people have used it.

Any technique that shocks the flywheel loose involves the possibility of bending or breaking the crankshaft and scrambling the flywheel magnets. If the flywheel is stubborn, stop work until you can obtain a proper puller.

The most critical area of the flywheel is the fit of the crankshaft key. The key must be reasonably tight in both flywheel and crankshaft keyways; play between the key and its mating surfaces allows the flywheel to turn relative to the crankshaft and destroys one aspect of magneto timing. If the wear is relatively minor, the flywheel can be centered over the key and tightened down hard; if keyway wallow is severe, the flywheel and the crankshaft must be replaced.

Not all manufacturers supply crankshaft nut torque limits, but 25 ft-lb is an appropriate figure.

Contact Points. The points are the most vulnerable part of the magneto and should be considered as sacrificial items, with a life of less than 100 hours. Point failure can make starting difficult, cause misfire at high speed, or disable the engine altogether.

Figure 5-27 illustrates a Bosch two-piece point set. The movable arm bears against the cam at the rubbing block and

pivots to contact the stationary arm. The stationary arm is grounded to the stator plate; the movable arm is electrically "hot," and connected to the exciter coil by means of the spring.

Examine the point set for physical damage, looking for breakage, wear on the rubbing block, excessive clearance between the movable arm bushing and its pivot, and for spring misalignment. On some installations, the spring can come into contact with the stator plate, grounding the ignition.

With a screwdriver, pry the movable arm away from the fixed contact. Inspect the contacts very carefully. The tungsten should be dull gray, with the contact faces slightly irregular and puddled. Replace the point set if the contacts look as if they have been torn apart, or if they are any color other than gray. Dark slashes under the points mean that too much grease has been used on the cam or that the crankshaft seal is passing oil into the magneto. Correct these problems before installing new points.

To install a new point set, follow these steps:

1. Remove the screws that hold the contact assembly to the stator plate and magneto side. Do not lose the lockwashers.
2. Lift the point set off the stator and disconnect the wire at the movable arm spring.
3. Wipe the point-mounting area of the stator plate with a rag dipped in laquer thinner. Oil between the point set and the stator can deny the ground connection.
4. Connect the coil wire to the replacement point set.
5. Mount the replacement point set on the stator plate, indexing any pins on the plate with holes in the stationary point assembly.
6. Run in the holdown screw(s) a few turns by hand and snug with a screwdriver. Tighten enough to overcome spring tension, but no so much as to make adjustment impossible.

Adjusting the point gap is a critical operation and must be done with precision (Fig. 5-28). The adjustment is by way of an eccentric screw or, more commonly, a screwdriver slot on the stationary contact assembly. The ignition cam may be secured to the crankshaft stub as shown in Fig. 5-29, or it may be integral with the flywheel (on the Bosch pattern). In the latter

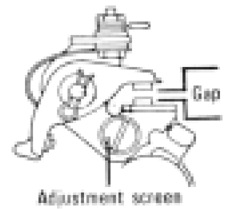


Fig. 5-28. The point gap is the distance contacts open at full extension. The gap on this point set is adjusted by means of an eccentric screw, a slightly more sophisticated arrangement than the slot shown in the previous figure.

case, when the cam is part of the flywheel, the adjustment is made after the flywheel is installed (Fig. 5-30). Place the wheel on the crankshaft stub, aligning the key. Working

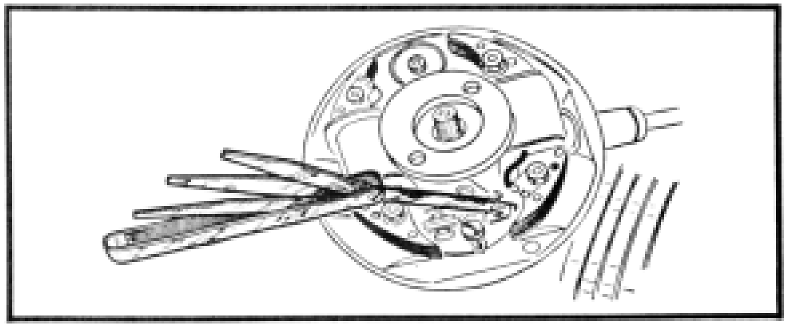
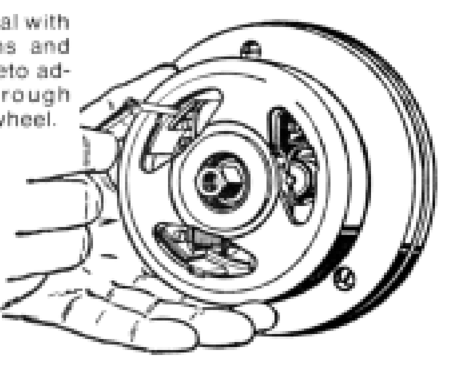


Fig. 5-29. The cam on the Motobecane magneto is located on the hub, allowing easy access to the points.

through one of the flywheel windows with a screwdriver, raise the movable contact so that it can ride on the cam: otherwise the contact may be jammed as you push the flywheel home.

Fig. 5-30. The cam is integral with the flywheel on the Sachs and most other engines. Magneto adjustments are made through "windows" cut into the flywheel.



Watch the point contacts as you turn the flywheel: near the end of piston travel the points will part, reach their full extension, and begin to close. The interval at full extension is the point gap.

Point gap specifications are listed in Table 5-1. Select the appropriate feeler gauge blade and wipe it with a shop towel. Do not run the blade between your fingers. The oil on your skin, transferred to the blade and then to the contacts, is enough to disable the ignition. Insert the gauge between the points—the correct gap will produce a slight drag on the feeler. Adjust with the slot or screw provided, holding the feeler gauge in place as you move the stationary point towards or away from the movable point.

Table 5-1. Ignition System Specifications

MAKE	POINT GAP	IGNITION ADVANCE BEFORE TDC	SPARKING GAP
Batavus M-48	0.35-0.45 mm (0.014-0.018 in.)	2.0-2.2 mm (0.079-0.087 in.)	0.016 in.
Velosolex	N.A.	N.A.	0.015-0.020 in.
Garelli Eureka, Katia Kick, Katia M, Eureka Matic	0.30-0.50 mm (0.014-0-0.020 in.)	1.5 mm (0.059 in.)	0.020-0.024 in.
Fichtel & Sachs (engine) 505/1A 505/1ANL 505/1B 505/1C	0.35-0.45 mm (0.014-0.018 in.)	2.5-3.0 mm (0.098-0.118 in) see text for clarification	0.020 in.
Jawa Babetta	N.A.	1.5 mm (0.059 in.)	
Minarelli (engine) V1	0.35-0.40mm (0.014-0.018 in.)	1.67 mm (0.066 in.)	0.024 in.
Motobecane all models	0.35-0.40 mm (0.014-0.016 in.)	N.A.	0.015 in.
Peugeot 103 LS-U1, 103 LVS-U2, 103 LVS-U3	0.30-0.50 mm (0.012-0.020 in.)	1.5 mm (0.059 in.)	0.016 in.
Puch Maxi	0.40-0.50 mm (0.016-0.020 in.)	0.8-1.2 mm (0.031-0.047 in.)	0.020 in.
Tomas Automatic 3, A3	0.35-0.45 mm (0.014-0.018 in.)	1.8-2.0 mm (0.071-0.079 in.)	0.019 in.

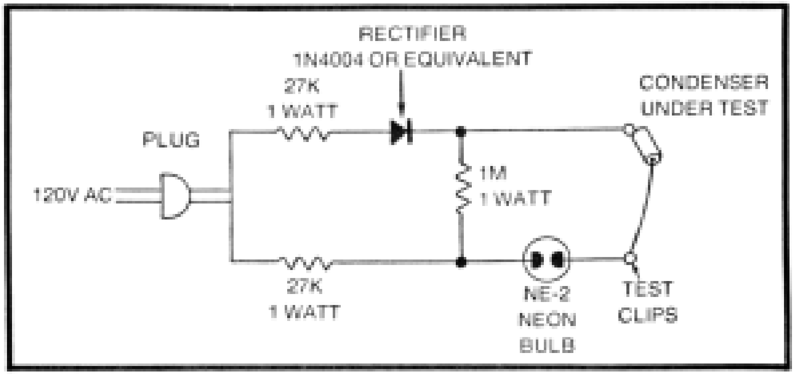


Fig. 5-31. Condenser checker. House the assembly in a clear plastic box.

Once you are satisfied that the gap is set, tighten the holddown screw. Recheck the gap, since it will have moved a few thousandths of an inch, the direction of movement depending upon the location of the holddown screw. Loosen the screw slightly and set the gap to compensate.

Condenser. Complete failure will keep the engine from operating, its ignition current grounded through a shorted condenser or the point set burned to a nub by an open condenser. But most failures are partial: the engine may be hard to start, may misfire, or may develop a large appetite for point sets. Occasionally a condenser will fail when hot, after a quarter hour or so of operation and, once cool, behave normally.

Condensers open, short, or change capacitance. Change in capacitance is a gradual process, caused by metal migration from one plate to the other or a deteriorating dielectric.

Opens and shorts can be detected by the device shown schematically in Fig. 5-31. Power is supplied by the line cord; about 150 volts DC appears at the test clips. One clip is connected to the condenser case, the other to its lead. Reducing the value of the two 27 kilohm resistors makes the device more sensitive, but increases the hazard of electrical shock. At their present value the output is less than lethal, although you should connect the clips *before* you plug the device in and leave the clips in place until you disconnect power. The 1 megohm resistor in parallel with the condenser is a discharge path for the condenser. If you take the condenser out of the circuit with power on, the condenser will "bite." Nothing lethal, but discombooberating.

The condenser is serviceable if the neon blub flickers once when power is connected. If the bulb does not react or if it continues to glow or blink, replace the condenser. Check the replacement before you install it; new condensers can also be faulty.

If you do not want to build or purchase a tester, the best course of action is to replace the condenser each time the points are serviced. The condenser is secured to the stator plate by a screw and strap arrangement. Remove the holddown screw (two on the Motobecane) and disconnect the lead between the condenser and the point set. On a few elderly mopeds the condenser lead is soldered. Heat the connection and pull the wire free.

Remove any oil accumulation under the mounting strap and install the replacement condenser. Snug the screw down tight, but not so tight that it pulls out the threads: remember, you are dealing with aluminum. Connect the lead to the point set. If the lead must be soldered, use a pencil-type gun and low-melting-point, rosin-core solder. Heat the connection until the solder melts and flows into the wires: too little heat leaves a lumpy, unreliable joint; too much can damage the condenser. And, however the wire is connected, check that it is routed away from the flywheel and the movable point arm.

Coils. Exciter and ignition coils, whether combined or in two separate units, are best tested by substitution. Generally, the exciter section fails first, for it is subject to engine heat and vibration.

External Circuit. Failure of the external circuit can also disable the ignition. Check the taillamp for continuity by disconnecting its lead and grounding it to the engine. If this solves the problem (the engine will run), the taillamp is burnt out or the taillamp ground is open. Take the kill switch out of the circuit by removing it physically from the handlebar. If the engine runs with the switch ungrounded, the difficulty is in the switch.

In rare instances the spark plug cable or the radio suppressor fitted between the cable end and the spark plug may fail. Again, the best test is by means of substitution.

SOLID STATE IGNITION

At present, Jawa's Tranzimo is the only solid-state ignition available on mopeds. The manufacturer is reticent about the

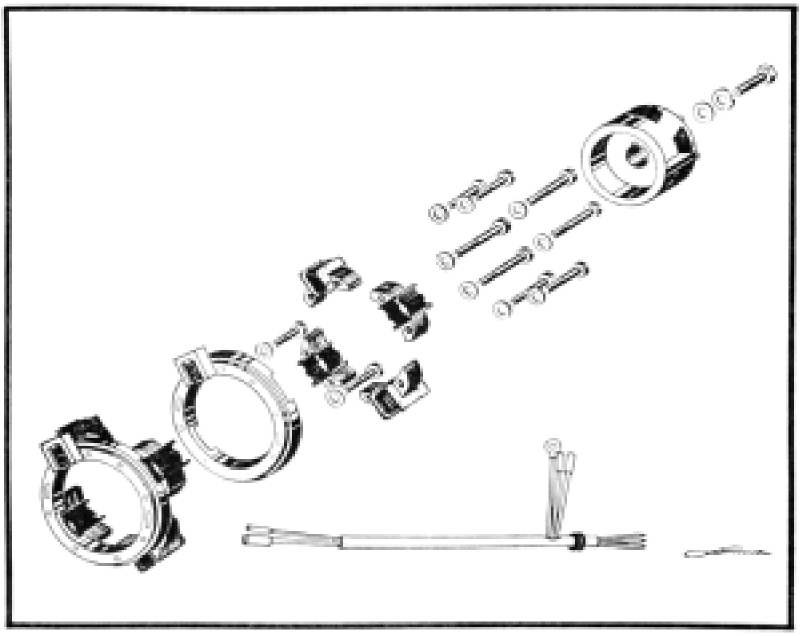


Fig. 5-32. The generating section of the Jawa Tranzimo. One large coil provides energy for the spark; the small coil atop the stator plate signals the transistor to conduct.

technology involved, but it appears to be quite unsophisticated. A transistor replaces the contact points; without points the engine should remain in time longer and tune-ups should be simpler. On the other hand, failure is absolute and unrepairable by the side of the road, unless you have a spare transistor.

Figure 5-32 illustrates the alternator, less the rotor. One coil, the uppermost in the drawing, generates power for ignition; the other three feed lights and accessories. The small coil on the stator plate is a trigger, generating a small command voltage for the transistor.

Figure 5-33 is a schematic of the circuit. The Tranzimo unit (2) houses the transistor and the secondary ignition coil. The transistor is connected to the primary ignition coil, the trigger coil, and the kill switch (8) on the handlebar. Internal connections are not shown, but a resistor is in series with the signal lead, and the output side of the transistor connects to the secondary coil. The rotor is keyed to the crankshaft and has permanent magnets in its rim. As the crank turns, one magnet generates voltage across the primary ignition coil. This voltage is blocked by the transistor until a second rotor magnet excites the trigger coil. The coil signals the transistor to conduct, and ignition voltage goes to the secondary ignition coil. There it is boosted to fire the spark plug.

In other words, the transistor is no more than a solid-state switch, under the command of the trigger coil.

Service

The following comments pertain to the Tranzimo, but, with some interpretation, can be applied to other makes.

Test the output as described under "Ignition System Troubleshooting." If the spark is weak, nonexistent, or erratic, begin with the obvious—the mechanical integrity of the generating section and its wiring. Remove the rotor cover and measure the clearance between the rotor and field coils. In the case of the Tranzimo, the specification is 0.012 inch. You can use a steel feeler gauge as long as you turn the rotor magnets away from the check points. Nonferrous gauges, used for

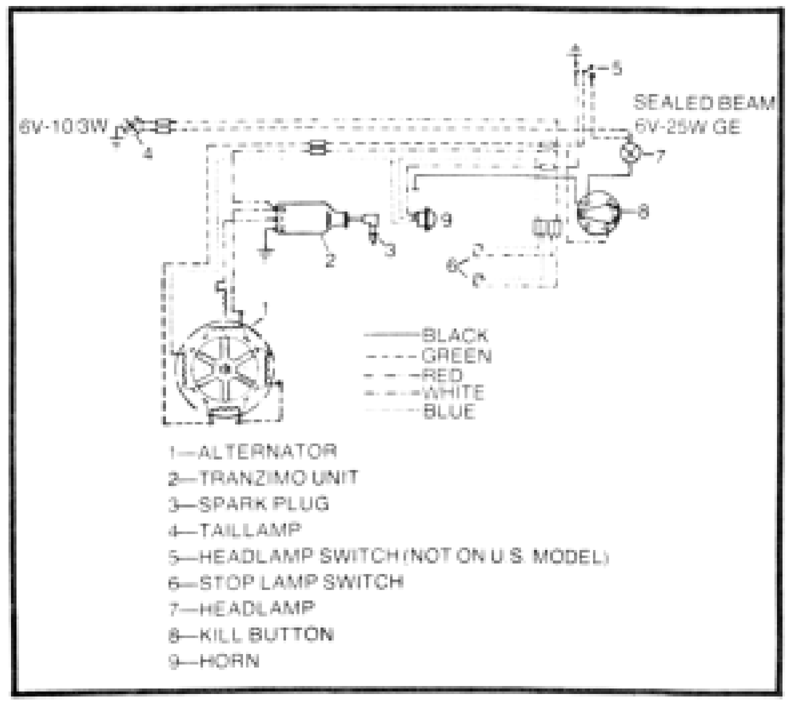


Fig. 5-33. The Tranzimo in schematic.

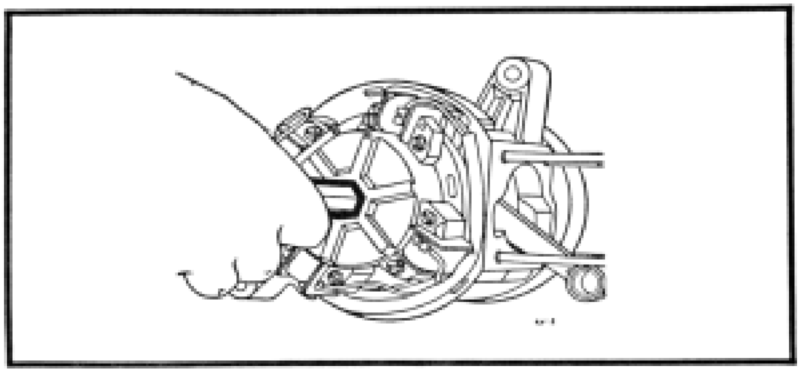


Fig. 5-34. Using a socket wrench for purchase, move the rotor up and down to detect main bearing wear.

air-conditioning clutch work, are available from auto supply houses, and give more consistent readings. If adjustment is necessary, loosen the coil holddown screws a few turns. The screws must be tight enough to hold the coils against the magnetic attraction of the rotor but no so tight that the coils cannot be gently tapped into place. Use a light hammer and a wooden dowel, positioning the dowel against the laminated iron coil shoes. Tighten the screws fully when clearance is correct.

Wear marks on the rotor edges, showing that the rotor has touched the coil shoes, mean that rotor-coil clearance is insufficient. This may be a simple matter of adjustment, or it may mean that the main bearings—the two bearings that support the crankshaft and the rotor—are worn. To determine if this is so, check the adjustment and then, using a socket wrench for purchase, bear bown hard on the rotor (Fig. 5-34). If the rotor moves down into contact with the coil shoes, the main bearings are no longer up to the job of locating the crankshaft and should be replaced, together with the crankshaft seals.

Hard starting and misfiring at high speed can sometimes be corrected by withdrawing the rotor from the crankshaft and polishing the rotor magnets and coil shoes (Fig. 3-35). Use fine sandpaper to brighten these parts; a thin patina of rust is enough to scatter the magnetic fields.

The wiring should be tucked clear of the rotor, well out of harm's way, and soldered to the field coils. Trace the circuit out of the alternator and to the Tranzimo switching unit on the

frame. Make and break the bayonet connectors several times to reestablish solid contact. Heavy corrosion can be removed with television tuner cleaner, available in aerosol cans from electronic parts houses and large hardware stores.

The Tranzimo switching unit has several unique features, features that are not found on other solid-state systems. The back of the unit is sealed with a Bakelite cap, reminiscent of the distributor cap on an automobile. Remove the cap and scrutinize its inner and outer surfaces under a strong light. Not all defects are obvious to the eye; some appear as if someone had penciled marks on the cap. These carbon tracks glisten as the cap is turned under the light, and mean that there is a current path between the high voltage terminal and ground. But the path may be internal and hidden. When in doubt, replace the cap with a known-good one.

Another special feature of the Tranzimo is the external transistor, secured to the switching unit by its three soldered leads. Should the transistor fail, it will fail completely, like a light bulb. There will be no ignition output. Test by substitution: unsolder the leads and, using a small, pencil-type iron, solder in a new transistor. Carefully note the lead connections, since a wiring error may destroy the new part. Use rosin-core solder and protect the transistor with a heat sink. Commercial heat sinks are available, or you can fabricate a substitute by wrapping a rubber band tightly around the jaws of a pair of needle-nosed pliers. The rubber band clamps the jaws together and the steel pliers absorb and dissipate heat. Position the heat sink between the transistor and the joint to be soldered.

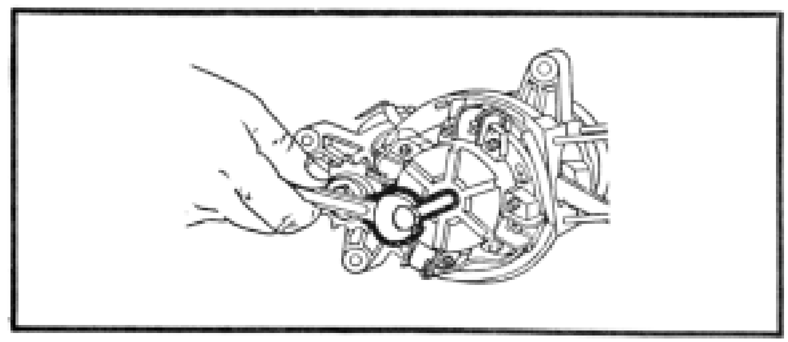


Fig. 5-35. Tranzimo rotor is extracted with Jawa special tool No. 16 65672 4. 3.

If these gambles fail—and replacing the transistor and an apparently good cap are gambles—then it is time to break out the voltmeter and do some serious troubleshooting. One must determine whether the fault is in the generating section or in one of the buried components of the switching circuit. The presence or absence of voltage is the diagnostic indicator.

The red wire is connected to one of the main generating coils and supplies current for the ignition pulse; the white wire is connected to the trigger coil and signals the transistor to conduct. Disconnect the red wire at the Tranzimo unit, and connect one probe of the voltmeter to it and the other to ground. Crank the engine to starting speed (some 600 rpm)—the meter should show at least 40 volts AC. If it does not, replace the generating coil and recheck. Make the same test with the white wire, expecting to find no less than 3 volts between it and ground. In the unlikely event that the trigger coil is defective, replace it, together with the stator plate. These parts are not available separately.

Suppose that both voltages are within specification. What then? By elimination, the fault is somewhere inside the Tranzimo switching unit. Since the circuits are buried in epoxy, the whole unit must be replaced.

IGNITION TIMING

As mentioned at the beginning of this chapter, the ignition system determines when the spark occurs. On all gasoline engines, the moment of sparking occurs early, before the piston has reached top dead center. This is to allow time for the air/fuel mixture to ignite, burn, and generate pressure. By the time the piston has gone past top dead center, pressure is at its maximum.

While some ignition advance is needed, too much is deadly—pressure peaks before the piston "goes over the top" and the piston is stressed by opposing forces. The inertia of the flywheel and the forward motion of the machine send it up, toward the top of the bore. At the same time, the explosive forces above it attempt to send the piston down, reversing the engine. The piston does not suffer long—it simply melts.

If the spark occurs late, the brunt of combustion energy is lost against the already sinking piston: most of the energy escapes out the exhaust port. The engine may be difficult to start and, once started, will produce little power.

Moped timing is fixed; once set it remains at a specific advance regardless of engine speed or load. Some readers who are familiar with the centrifugal and vacuum advance mechanisms on automobiles may wonder about the advisability of fixed timing. Some performance is lost, since the time required for combustion is almost independent of piston speed. At high speed a moped spark occurs late relative to peak combustion pressure. On the other hand, two-cycle engines are more tolerant of fixed timing than are automotive, four-cycle engines, and will run slightly retarded without much fuss.

Ignition occurs at the precise moment the contact points separate on conventional systems. Breakerless systems fire when the trigger coil and sensing magnet are in opposition. The purpose of timing is to match the moment of firing with a specified position of the piston, expressed as millimeters of travel before top dead center.

There are several ways to determine when the points break. The most accurate method is to use a continuity lamp, a buzzer, or an ohmmeter (Fig. 5-36). Connect one test lead to the movable arm of the point set, the other to a good, paint-and-oil-free engine ground. Turn the flywheel in the direction of normal rotation and watch the lamp or meter. The lamp should dim and the meter needle should drop as the points part. A more precise reading will result if you disconnect the lead between the point set and the exciter coil; the coil is grounded and fuzzes the results a bit.

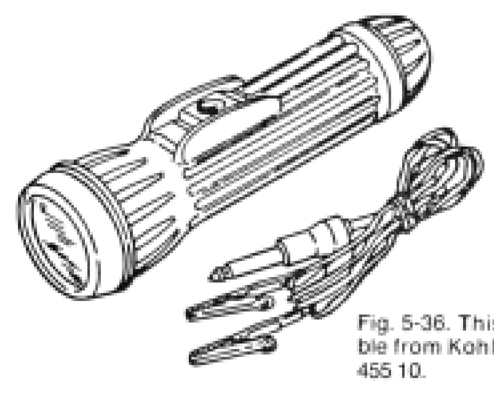


Fig. 5-36. This test lamp is available from Kohler under part No. 33 455 10.

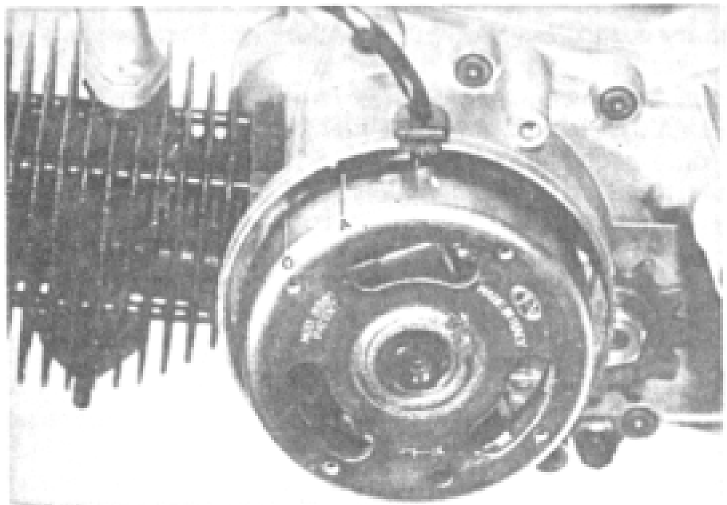


Fig. 5-37. Minarelli engines have timing marks.

Another, less accurate way to determine when the points open, is to place a piece of cellophane between the contacts and turn the wheel until the cellophane is released. This is an emergency procedure only, since the timing will be off by the thickness of the cellophane.

Tranzimo rotors and stator plates carry timing marks. When these marks are in line with each other, the unit fires.

With magneto or solid state systems, the moment of firing can be adjusted by turning the stator plate in its elongated mounting holes. Turning the plate against the direction of crankshaft rotation advances the timing; turning it with crankshaft rotation retards the timing. Magneto systems have a second variable—the point gap. The wider the gap, the earlier the contacts open, and the more advanced is the ignition. Narrowing the gap has the reverse effect, which is why gapping the points to specification can do wonders for engine power.

The moment of firing must be coordinated with piston movement. Minarelli engineers have simplified matters by providing timing marks on the flywheel (Fig. 5-37). The mark identified by the letter "A" is the timing mark; it is 23 degrees in advance of "0," or top dead center. Timing these engines is simple:

- Set the point gap to specification—0.35-0.40 mm (0.014-0.018 inch).
- Loosen the stator plate holddown screws so that the plate can be turned.
- Mount the flywheel, but do not thread on the nut.
- Hook up a lamp or some other point-break indicator, with one lead on the movable point arm and the other lead grounded.
- Turn the flywheel in the direction of engine rotation—clockwise when facing the wheel—until the indicator shows point separation.
- If the "A" mark is not aligned with the pointer at the instant the points open, move the stator plate. Chances are the engine will not be far out of time and a few taps on the stator will be enough.
- Once you are satisfied that the "A" mark and point opening are synchronized, disconnect the timing indicator, tighten the stator plate holddown screws, and assemble the flywheel and nut. There are no torque specs for this nut; the manufacturer assumes that you will use the stubby 15-mm wrench supplied with the bike which, because of its length, has a built-in torque limit.

Flywheel marks are convenient, but not entirely accurate. Most manufacturers prefer to specify timing directly from piston position. timing becomes a matter of measurement, although there is a compromise available, represented by factory tools indexed for specific mopeds. The Motobecane is bottomed in the spark plug port and the flywheel turned against normal rotation. When the advance is correct the tool registers it.

The classic timing drill is more demanding; it begins with the search for true top dead center. You can use a plunger like the one shown in Fig. 5-38 or a dial indicator. The latter is the

Fig. 5-38. A timing plunger is an alternative to a dial indicator, although an inferior one.

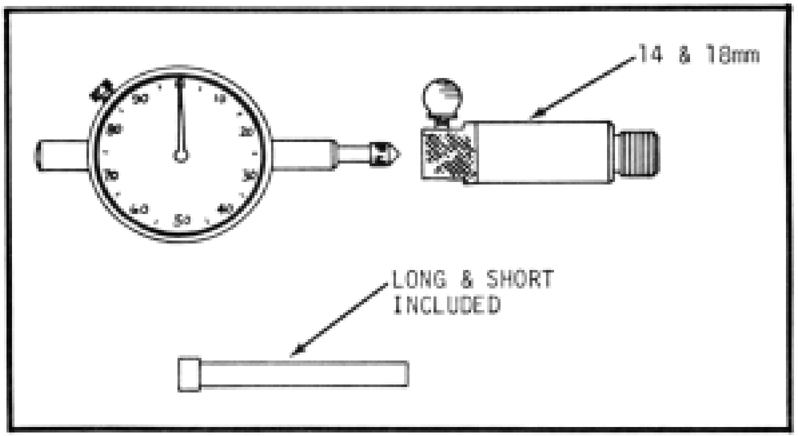


Fig. 5-39. This dial indicator and adapter kit is available from Kohler.

more precise instrument, with scale divisions of 0.01 mm. Several engine manufacturers offer mounting fixtures—bosses that thread into the spark plug port, with or without the dial indicator. Kohler, Suzuki, and Yamaha offer the complete kit (Fig. 5-39) under parts numbers 33 755 03, 09931 00111, and 908 90030 02 00, respectively. The spark plug port adapter is available from Puch as part number 905 6 32 101 0.

To time the engine with a dial indicator, gap the points to specification and follow this procedure:

1. Mount the indicator on the cylinder head, threading it solidly into the spark plug port.
2. Find top dead center by bracketing, i.e., move the crankshaft back and forth in progressively smaller increments.
3. Once you are satisified that the piston is at its high point, set the dial indicator at zero.
4. Connect an ohmmeter or test lamp to the points.
5. Determine the engine advance from Table 5-1 or by consultation with the dealer.
6. Turn the crankshaft against normal rotation to a point well beyond advance specification.
7. Turn the shaft in the direction of engine rotation to bring the piston to the advance specification. The points should just crack open.

If they don't, move the stator plate so they do, and tighten the holddown screws.

Most Fichtel & Sachs engines have timing marks on the flywheel and crankcase. "0" represents top dead center and "M" is the firing mark. However, some engines have come off the line withot these marks,and it is necessary to make them.

1. Find top dead center as before.
2. Mark the flywheel and crankcase at some visible spot to indicate TDC.
3. Turn the crankshaft against the direction of ratiotion. The spark advance on this engine is 2.5–3.0 mm. *Translated by the angle of the spark plug port this dimension is 3.5–4.0 mm (0.138-0.165 inch).*
4. Indicate this advance on the flywheel, adjacent to the previously made crankcase mark.
5. Gap the points at 0.35–0.45 mm (0.014–0.018 inch)
6. As described earlier, move the stator plate so that the points break with the flywheel firing and crankcase reference marks aligned.

Peugeot magnetos employ a rotor which is free to move relative to the crankshaft. This changes the timing drill somewhat: on other magnetos we can disregard the position of the flywheel magnetos, since they are part of the wheel, and keyed to the crankshaft. Follow this procedure with Peugeot engines:

1. Find true top dead center as before.
2. Turn the crankshaft (by means of the clutch drum) to bring the piston well in advance of top dead center.
3. Turn the drum to bring the piston 1.5 mm before top dead center.
4. Without moving the crankshaft, turn the rotor to align its timing mark "2" with the "1" mark on the stator.
5. Secure the rotor with Peugeot special tool No. 69646 or a pin wrench adapted to fit the holes.
6. The rotor is secured by a 16 mm capscrew. Torque it to 18 ft-lb.
7. Recheck the timing marks to be sure they have not slipped out of alignment.
9. Loosen the point holddown screw a bit. Insert a screwdriver blade in the adjusting slot on the stationary point assembly.

10. Adjust the gap until the points crack open. Tighten the holddown screw and recheck.

The nominal point gap is 0.40 mm (0.016 in.) but this consideration is secondary to the need for accurate timing. So long as the gap falls between 0.30 and 0.50 mm (0.012–0.020 inch), the magneto will function.

II LIGHTING CIRCUITS

Mopeds use 6-volt lighting systems. Three coils in the Tranzimo unit provide energy for the lights and horn; conventional magneto systems employ a single lighting coil for the headlamp and use the exciter to operate tail and brake lamps. The coils and magnets that generate energy for the system are known collectively as the alternator. Since the Tranzimo alternator is distinct from the ignition section (sharing only the rotor magnets), it has few problems for the serviceman. Magneto systems are another matter.

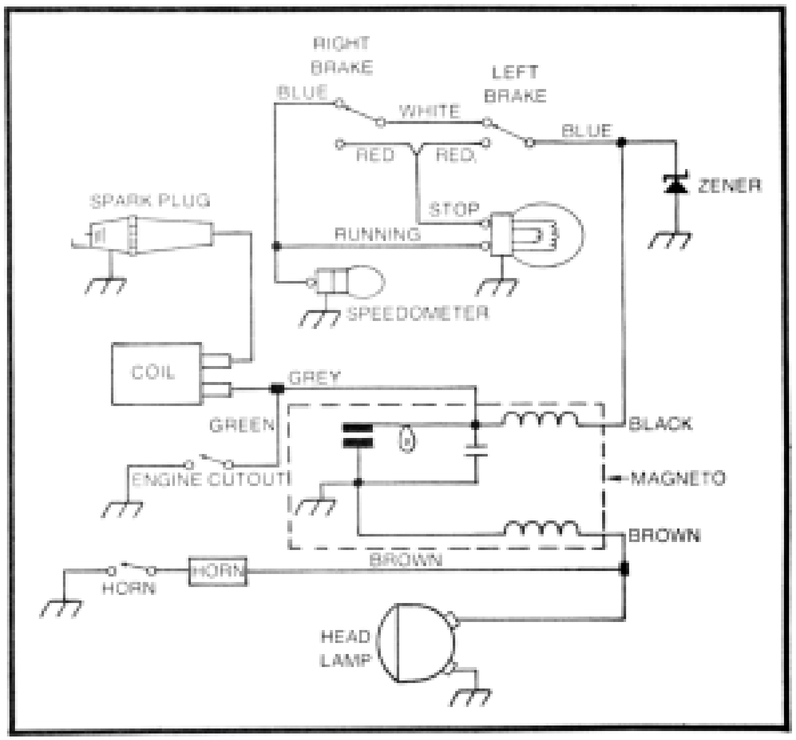


Fig. 5-40. A typical (magneto-fired) lighting and ignition system.

MAGNETO CIRCUITS

Figure 5-40 is a typical schematic. One side of the exciter is grounded when the contact points close; the other side is connected to the black wire, which joins the blue wire at a point near the handlebars. Both left and right brake levers incorporate stop-lamp switches; tripping either one operates the stop filament in the taillamp by way of the red wires. The blue wire continues through the tandem switches and provides power for the running filament.

Ignition Ground

Both the stop and running filaments are grounded at the lamp and provide a ground return for the ignition circuit. Current generated in the exciter flows through the closed points to ground and completes its circuit (or "circle," which is what the word means) at the taillamp. As long as this circuit is completed, there is ignition voltage. But if either of the tail lamp filaments open, there will be trouble. A broken or burned out stop filament will disable the ignition *when* the brakes are engaged; a broken running filament will disable the ignition *unless* the brakes are engaged.

Circuit Refinements

The *zener diode* in the upper right-hand corner of Fig. 5-40 limits voltage to the taillamp. The lamp is rated at 6 volts, a much lower voltage than the exciter coil delivers at high rpm. The zener "spills" the additional voltage to ground, protecting the lamp filaments. Should the zener short, all exciter current goes to ground, and there is no voltage available for the lamp or for the ignition coil. Should the zener open—the usual mode of failure—the taillamp burns out as soon as the throttle is opened.

In order to meet U.S. Department of Transportation standards, mopeds must be electrically clean; that is, the ignition system cannot transmit signals that interfere with radio and television reception. Most manufacturers meet this requirement by incorporating a resistor in the spark plug cable, usually at the terminal.

Peugeot has a fairly unique system: high-frequency oscillations, the oscillations that produce pips on TV screens and static in radio sets, are dampened by means of a *choke*, or *reactance coil* (Fig. 5-41). This coil has little effect on

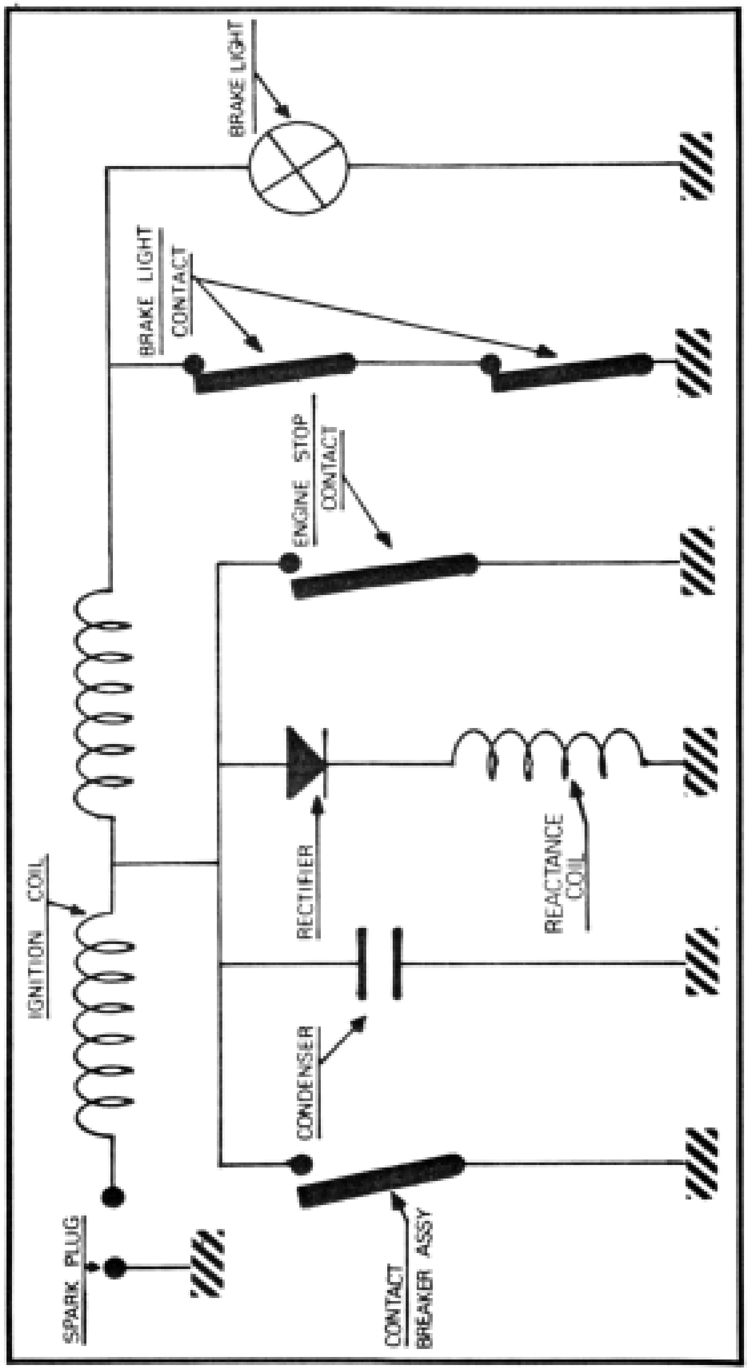


Fig. 5-41. The Peugeot ignition and taillamp circuit features a rectifier and reactance coil.

low-frequency oscillations. The current produced by the exciter coil alternates;this is,it moves to-and-fro in the circuit, peaking in one direction, falling to zero, and peaking in the other. The rectifier is a kind of traffic cop; it blocks half of the alternations to keep electrical traffic moving in one direction. Without it, exciter output would short to ground through the reactance coil, and there would be no ignition. Should the rectifier open, the circuit will continue to function, although it will radiate interference. Your TV-watching neighbors will know when you ride by.

Another interesting feature of the Peugeot circuit is that the stop lamp switches are connected in series and normally grounded. Because the resistance of the switch contacts is lower than the resistance of the stop lamp filament, no current passes through the filament unless one or both switches are opened. Any condition that denies ground will affect operation. For example, if the switch contacts are dirty, the stop lamp will burn continuously; if the stop lamp burns out, the engine will stop when the brakes are applied; if there is a break in the wire ahead of the switches, the engine will not run at all.

The usual European practice is to stop the engine with a compression release. To meet American standards, manufacturers have added and, in some cases, substituted a kill switch on the right handlebar. The kill switch is shown in Figs. 5-40 and 5-41. It is a simple grounding switch, wired to the ignition-coil side of the exciter. A mechanic should remember that a faulty kill switch can disable the ignition.

TROUBLESHOOTING

The bike's wiring diagram should be the basic tool for troubleshooting, and would be if we could trust them.Figure 5-42 is the wiring diagram for the U.S. version of the Cimatti City Bike. While the main outlines of the circuits are clear, things get a little fogged at the switch (2). But this is characteristic of all automotive diagrams, for these drawings combine schematic with pictorial elements, and do justice to neither. The wiring layout is quite functional, in straight lines from connection to connection, with no attempt to reproduce the tangle of wires on the actual machine. The lamps, ignition coil, and stop switches are pictorial, intended to call to mind the actual appearance of the object. The circuitry inside these pictures is incomplete or ignored.

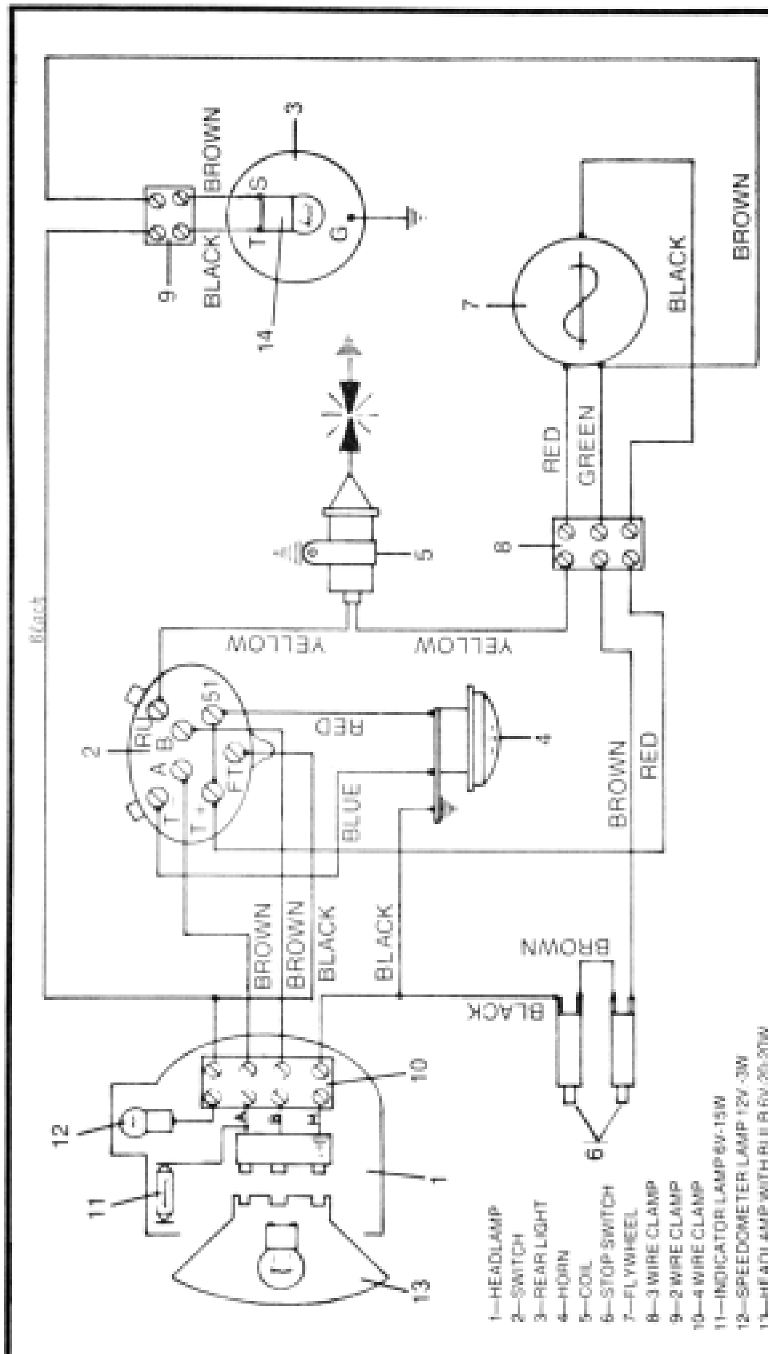


Fig. 5-42. Cimatti City-Bike wiring diagram (U.S. version).

Other moped manufacturers do worse. Some publish the European version of the diagram which includes a headlight switch. No moped sold in this country has such a switch, since DOT insists that the headlamp burn continuously. Certain circuit elements are forgotten, particularly circuit grounds. And the diagram may be deliberately incomplete, without the caption mentioning the fact.

The moral of all this is that wiring diagrams may add to the confusion. The diagram *will* tell you the color code and should give you an idea of the basic circuit components, but that's about it. In no way can a diagram substitute for a careful examination of the wiring on the machine.

After all is said and done, troubleshooting comes down to three basic techniques: *jumping*, *continuity testing*, and *substitution*.

Jumping

Jumping is a way of isolating a suspect component or circuit branch by shunting it out of the main circuit. An example—keyed to the diagram in Fig. 5-42—will make this clearer. Suppose that the engine has no spark and that you suspect the trouble is outside the magneto. Connect one end of a short length of wire to the brown/green terminal at the magneto clamp (8) and ground, and the other end to a clean, paint-free surface on the engine or frame. (Any fairly heavy-gauge wire with its ends bared will do, but if you expect to use such as jumper cable often, make one using gauge stranded wire and fit the ends with alligator clips or test probes.) If the tail light or its associated circuit is defective, the engine will start since the jumper has ground to the exciter coil.

The same technique can be used to test a switch; a jumper connected between switch terminals bypasses the switch. If the switch is faulty, the circuit will work with the jumper in place.

Continuity Testing

Continuity testing requires a test lamp (like the one shown in Fig. 5-26) or an ohmmeter (Fig. 5-43). The circuit inside the component must be complete; otherwise there can be no current through it. Some components are isolated from ground; others are grounded to their cases. If a kill circuit is always grounded, the engine will not run; on the other hand,

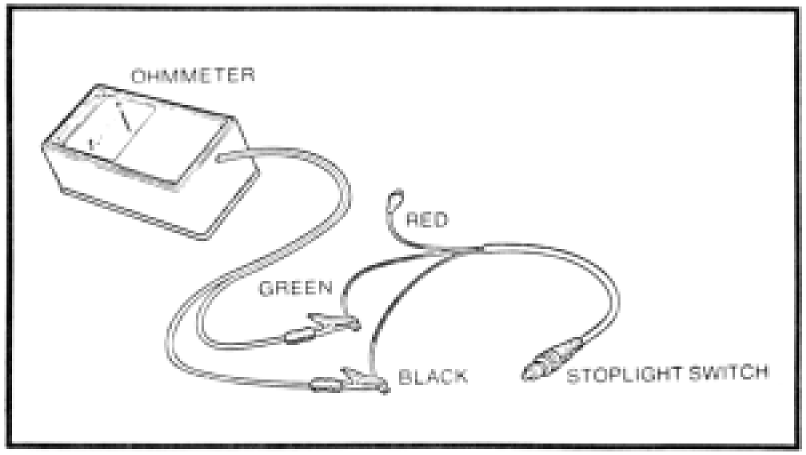


Fig. 5-43. Checking a Motobecane stoplight switch with an ohmmeter.

coils and many horns use the case as part of the current path. There should be continuity between a hot terminal and ground

Continuity checks also involve the ground side of the circuit. There should be an unbroken path from all ground connections to the engine block. An open ground circuit is just as disabling as a break in the insulated side of the circuit.

Subtitution

Substitution can be used as a crutch; when a mechanic doesn't know what else to do, he buys parts. But even the most knowledgeable mechanics must rely upon substitution at some point. For example, there are no coil testers that are calibrated to moped specifications; substitution is often the only way out. Horns can sometimes be disassembled and repaired, but horns are safety-related items and it is better to purchase a new one than take a chance fixing it. Even lamps are better substituted than checked. Filament breaks are not always obvious, and an ohmmeter does not say much about a defective lamp base.

REPAIRS

Once the trouble is spotted, electrical repairs are simple. Most involve defective grounds caused by rust, oil, or paint at the connections. Scrape the connections down to bare metal and make certain that they are secured by holddown screws or, in the case of lamp sockets, by spring pressure. The insulated side of the circuit usually fails because of dirty

connections or broken wires. The most vulnerable wiring runs under the rear fender to feed the taillights.

Broken wires or wires that have lost their insulation and short can be replaced on one-to-one basis. This is, you can open the wiring harness, cut out the faulty wiring, and splice in new lengths. Use stranded wire, known in the automotive trades as primary wire, of at least the same gauge (thickness) as the original.

Gauge refers to the cross-sectional area of the conductive part of the wire, not to the thickness of the insulation. Mopeds generally use No. 16 or slightly heavier No. 14 wire. Hair-thin 20-gauge wire is sometimes used at the instrument nacelle. What is important to remember is that you can always go to heavier wire, but you're asking for trouble if you use thinner. Also remember that gauge number and thickness are inversely related: the higher the number, the thinner the wire (and the less current it will safely carry).

These connectors are fairly expensive and you have to purchase the crimping tool, but the speed and convenience is worth the investment. If you wish to use solder, purchase a roll of 60-40 rosin-core solder and some vinyl tape. Vinyl seems to hold up better than cloth friction tape and, since it can be stretched over the joint, makes a neater job. If the ends of the wires are to be joined, strip the insulation from both for about half an inch. Unwind the exposed strands so they are straight, and butt one wire against the other, interleaving the strands. Twist the strands together and heat the joint until solder melts and flows through it. Bend the resulting stub parallel with and against the wire and finish the job with several layers of vinyl tape.

If the wiring harness was opened, you can gather the wires with a good grade of vinyl tape. The tape ends should be protected from road splash and oil, or the whole thing will unravel. A better solution is to use spiral cable wrap, a precoiled plastic insulation that can be installed with the wires connected. Once in place, the plastic coils grip the wires in a tight, abrasion-proof bundle. Cable wrap can be purchased from electronics supply hose

The nice thing about the electrical system is that many components—wire, connections, switches, lamp sockets—can be purchased from nondealer sources. Six-volt sealed-beam headlamps are a standard item, used on small tractors and