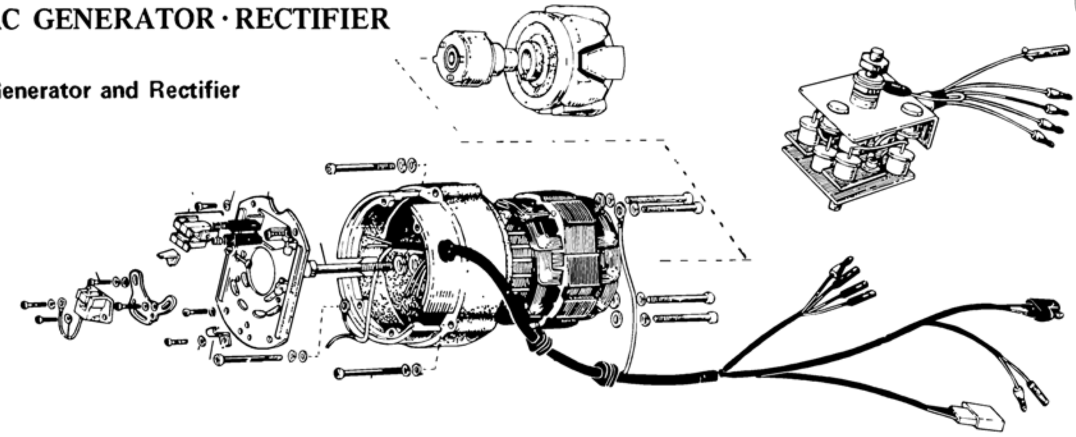
V-a H1 Electrical System

[H2 information begins on page 113.]

1. AC GENERATOR · RECTIFIER

386

H1 Generator and Rectifier

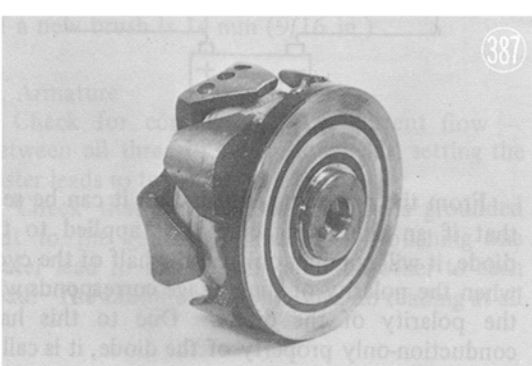


1) Construction and Operation

In the H1 an AC generator supplies all power for the ignition, lighting, charging circuits, etc. This AC generator differs from a DC generator in that it requires a rectifier, but its merit lies in its small size, light weight, and lack of parts liable to failure. In this generator, a magnetic field rotates inside the armature windings, and as the field cuts through the windings it induces voltage in them.

a. Field

The H1 generator has an electromagnetic field, and current to magnetize it is brought to the coils by two brushes which ride on the rotor's slip rings. When starting the engine and during periods of low engine rotation, field current is supplied by the battery. But when generator rotation increases and generated voltage exceeds battery voltage, the generator supplies its own field current (self-excitation method).



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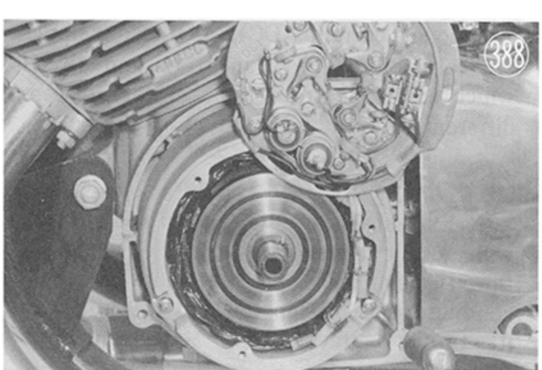

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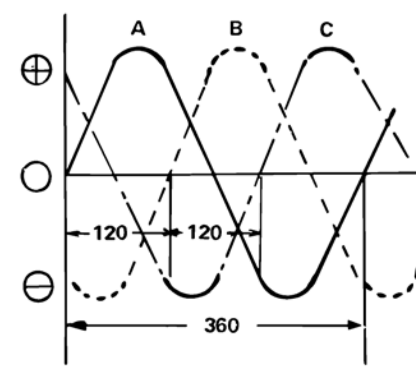
b. Armature

The armature, which is constructed as part of the generator housing, consists of three sets of coils wound on laminated cores. Each of the three coils, and therefore each phase of the three-phase generator output, is set 120° ahead of the next, and the relationship of the three waveform resultants is illustrated in Fig. 399.



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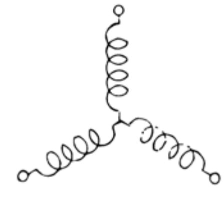
The three windings are "wye" connected for greater voltage output.

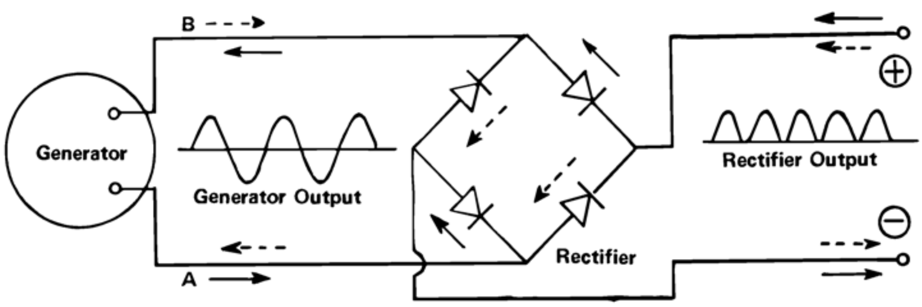
Wye Connected Armature

390



Full-wave Rectification

(391)



c. Rectifier

The alternating current output of the generator must be rectified, i.e. changed to direct current, to charge the battery and supply field current. Fig. 391 is a simplified diagram of the circuit used for efficient full-wave rectification (rectification of both positive and negative halves of the AC generator output. Only one of the three phases is shown in the diagram, but with slightly additional wiring, all three phases can be rectified with this circuit.

The diodes used (four shown here) conduct current in only one direction, and the two different current paths for the first and second halves of each cycle are shown in Fig. 391. The A arrows indicate current flow during the first half of the cycle when the top generator lead is + and the bottom lead is –; the B arrows show current flow for the other half cycle.

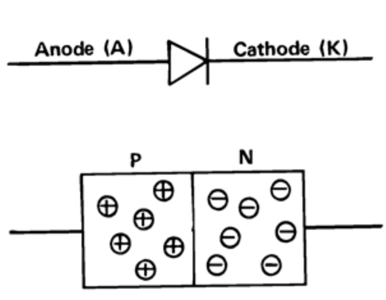
The diodes are manufactured by fitting together two pieces of silicon material. Each of the two pieces is impregnated with a different type of impurity, so that one piece always has a surplus of electrons (the N, or negative piece), and the other has a constant shortage of electrons (the P, or positive piece).

When a voltage is applied to the diode in the direction of the battery in Fig. 393, the surplus, or free, electrons are repelled by the negative voltage and attracted toward the positive voltage, and current flows.

In Figure 394 the voltage source is connected in the reverse direction, but since there are no free electrons in the P material to flow in the reverse direction, no current flows.

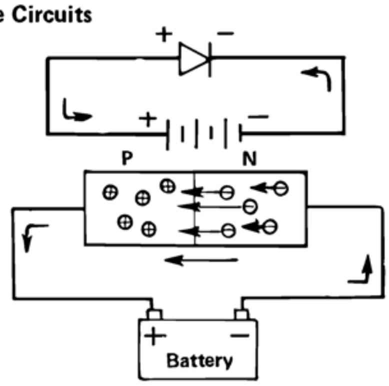
Diode

(392)



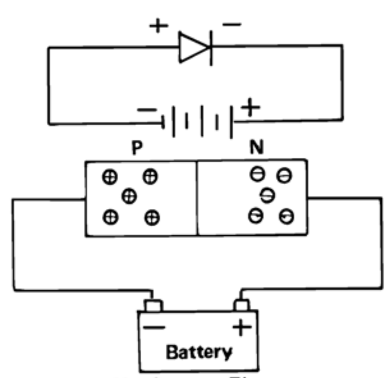
Diode Circuits

(393)



Current Flow

(394)



No Current Flow

From the preceding explanation it can be seen that if an alternating current is applied to the diode, it will conduct only on the half of the cycle when the polarity of the voltage corresponds with the polarity of the diode. Due to this half-conduction-only property of the diode, it is called a "semiconductor", and is used to change current flowing in both directions (AC) to single-directional current (DC). Other examples of semiconductors are transistors and thyristors, which are made from three or four pieces of a different type of semiconductor material.

NOTE:

1. Excessive heat or current in a semiconductor will cause it to break down, and current will then flow through it in either direction. Once a semiconductor has broken down it will not return to its former semiconductor state, and must be replaced.

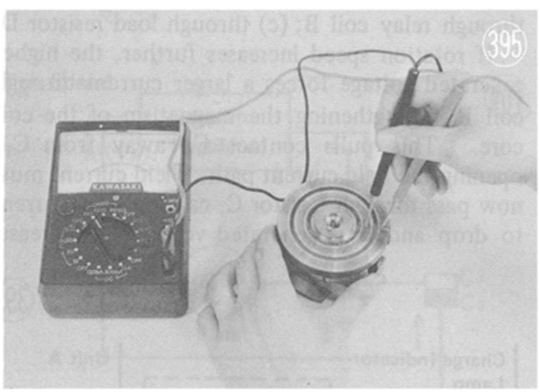
2. When testing diodes or other semiconductors, a very small amount of current may be noted in the reverse direction. This is leakage current and does not usually indicate that the diode is defective.

2) Inspection

To completely test the generator and rectifier, various equipment is required; the tests given here include only those practical with a hand tester, and are usually sufficient for the purpose.

a. Field Windings

As demonstrated in Fig. 395, touch the tester leads one to each slip ring to measure the resistance of the field windings. A resistance of between 3.5 and 5.5 Ω is standard. Less than 3.5 Ω indicates a short somewhere in the windings; no reading indicates an open circuit (a wire in the windings is broken).

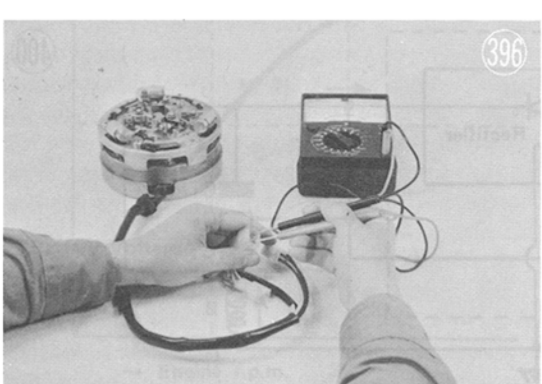

395

Although the carbon brushes in this AC generator last much longer than those in a DC generator, they should be checked periodically for wear. If the brushes are worn down more than 1/3 (2/3 remaining), they should be replaced. The length of a new brush is 14 mm (9/16 in.)

b. Armature

Check for continuity – i.e. current flow – between all three of the yellow leads, setting the tester leads to two wires at a time.

Check that none of these leads is grounded out to the generator housing by touching one tester lead to the housing and the other to each lead. The ohmmeter should give no reading at all.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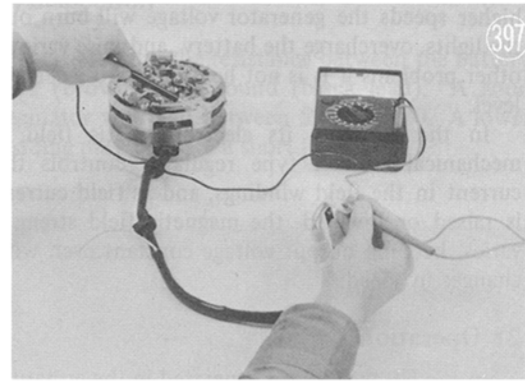
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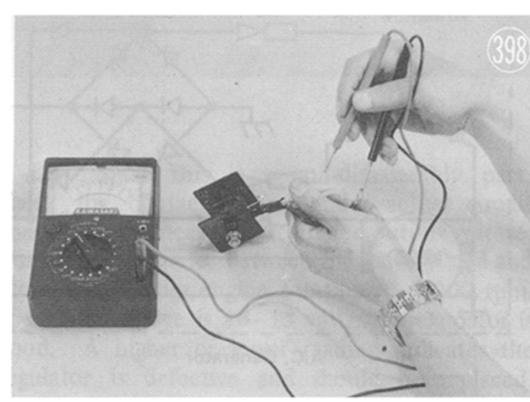
c. Rectifier

The rectifier assembly has three yellow leads, one red, one black and one blue lead, a total of six leads.

Use an ohmmeter as in Fig. 398 and check for continuity in the direction of the arrows only. If there is no continuity, or if there is low resistance in both directions, the rectifier is defective. Where "Yellow" is indicated, three checks must be made each time, one for each yellow wire.

+	Meter leads	−
Yellow	→	Black
Blue	→	Black
Red	→	Black
Blue	→	Yellow
Red	→	Yellow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NOTE: In many ohmmeters (multi-testers) the batteries in the tester are reversed so that the negative lead is actually the positive side of the batteries inside. If this is not the case with your meter, the direction of current flow will appear to be opposite that shown in the table.

2. VOLTAGE REGULATOR

1) General

As generator speed increases with engine speed, the magnetic field cuts through the armature windings faster, and generated voltage increases. In the H1 this increased voltage supplies field current, so the magnetic field becomes stronger and raises voltage even more. If follows that at higher speeds the generator voltage will burn out the lights, overcharge the battery, and raise various other problems if it is not held down to a certain level.

In the H1 with its electromagnetic field, a mechanical contact type regulator controls the current in the field windings, and as field current is raised or lowered, the magnetic field strength varies, keeping output voltage constant even with changes in speed.

2) Operation

In the H1 the current generated in the armature is regulated by limiting the exciter current flow in the rotor field windings with a mechanical contact-type regulator.

Figure 399 is a diagram of the circuit including the regulator. The generated voltage causes current to flow in the relay coil B, magnetizing its iron core. Depending on the amount of this current flow, movable contact C_0 is pulled by the magnet away from fixed contact C_1 and toward C_2, changing the resistance in the field current path and thereby regulating armature voltage.

(1) Low Speed

During periods of slow engine rotation when the generator voltage is lower than the battery terminal voltage, no current flows from the generator to the regulator or the field windings. Instead, field current is supplied by the battery, flowing from the battery negative terminal through ground, up through the field coils, and via contacts C_0 and C_1 and resistor A back to the battery. A small amount of current also flows from the battery through relay coil B, but not enough to move relay contact C_0.

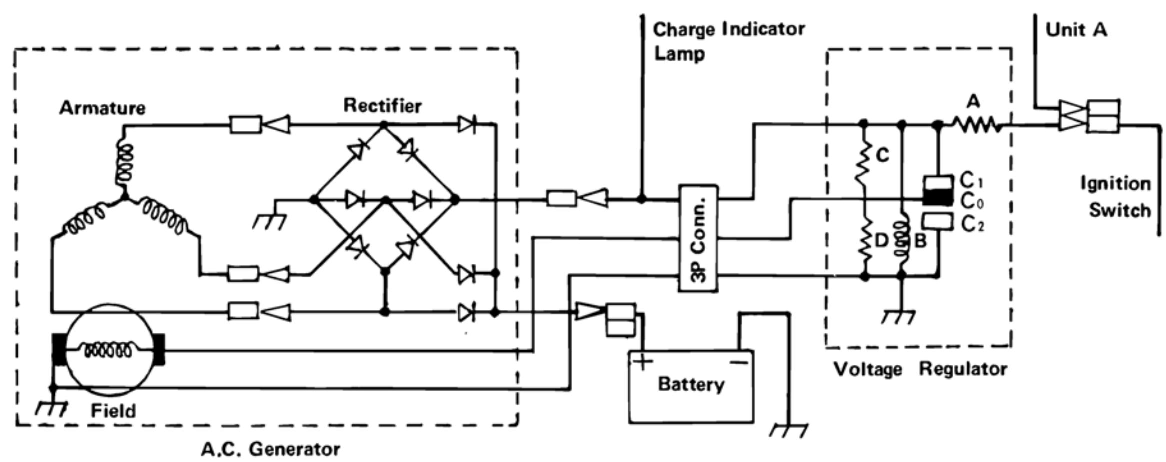
(2) Medium speed

As engine speed increases, there is a corresponding increase in generator rotation and the generator terminal voltage rises above that of the battery. Battery current stops flowing through the field coil and is replaced by generator current. Generator current also flows (a) into the negative battery terminal to charge the battery; (b) up through relay coil B; (c) through load resistor D.

If rotation speed increases further, the higher generated voltage forces a larger current through coil B, strengthening the magnetism of the coil core. This pulls contact C_0 away from C_1, opening the field current path. Field current must now pass through resistor C, causing field current to drop and thus generated voltage to decrease.

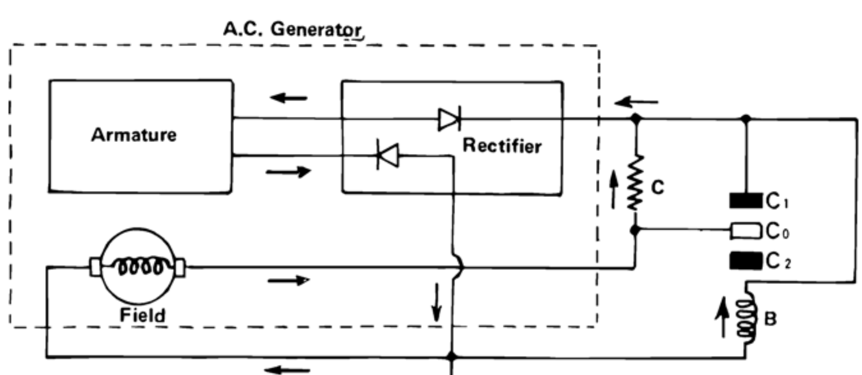
Low Speed

399



Medium Speed

400

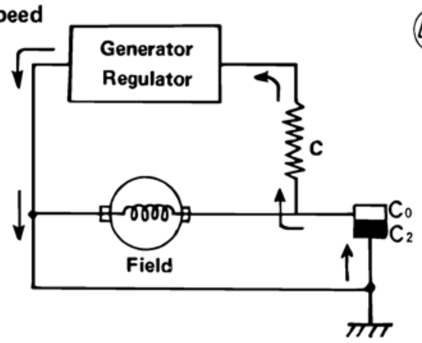


(3) High speed

When rpm increases to the point where generator voltage exceeds 14.5 volts, the increased current through relay coil B magnetizes the coil core enough to pull contact C_0 against C_2. This places a direct short across the field coil and current flows through C_2 and C_0, bypassing the coil. With this sudden loss of field current, there is a corresponding sudden drop in armature voltage, since the armature windings no longer have a magnetic field to cut through.

As soon as the voltage drops below 14.5 volts, current through coil B lowers enough to allow contact C_0 to pull away from C_2. This now lets field current start flowing again, and if high speed continues, the whole operation is repeated again and again. Movement of contact C_0 is fast enough so that for all practical purposes, the generator output voltage is a steady 14.5 volts at high speed.

High Speed



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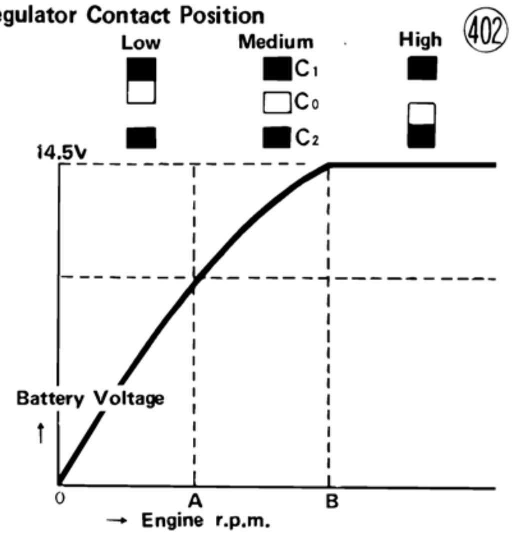
The graph in Fig. 402 shows the relationship among engine speed, generator voltage, and the position of the movable relay contact.

Regulator Contact Position



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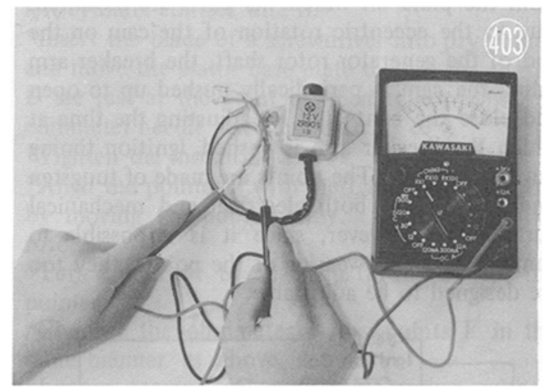
3) Inspection

(1) Measure the resistance between the battery lead (brown) and ground (black lead). A good regulator will read between 53 and 55 Ω. A lower reading may indicate a short in coil B.



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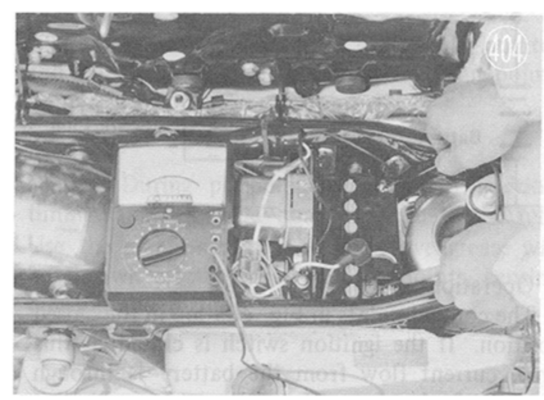


404

(2) Since this is a non-disassembly part, check the contact setting under actual circuit conditions by measuring regulated output voltage. Connect a voltmeter between the battery lead and ground, and raise engine rotation to 5,000 rpm. If output voltage is 14–15 volts, the regulator is good. A higher or lower reading indicates the regulator is defective and should be replaced.

NOTE: Check the generator before replacing a supposedly defective regulator.

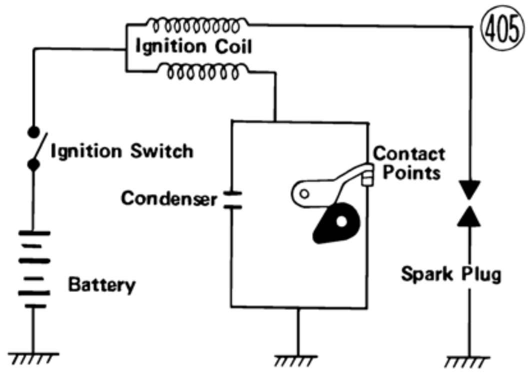
3. IGNITION SYSTEM

This system supplies the spark to ignite the gasoline mixture that is drawn into each cylinder. To enable efficient use of the exploding gas, the ignition system must supply a strong enough spark at the correct moment.

1) Contact Breaker Type Ignition

a. Construction

As the diagram shows, this ignition system consists mainly of the breaker arm, breaker cam, points, spring and condenser. The rubbing end of the breaker arm is formed from bakelite, electrically insulating the points on the other end of it, from the plate on which the parts are mounted. Due to the eccentric rotation of the cam on the end of the generator rotor shaft, the breaker arm riding the cam is periodically pushed up to open and close the contacts. By adjusting the time at which the breaker arm is pushed, ignition timing can be changed. The points are made of tungsten steel, which has both electrical and mechanical durability. However, since it is impossible to completely avoid wearing of the points, they too are designed to be adjustable.



b. Operation

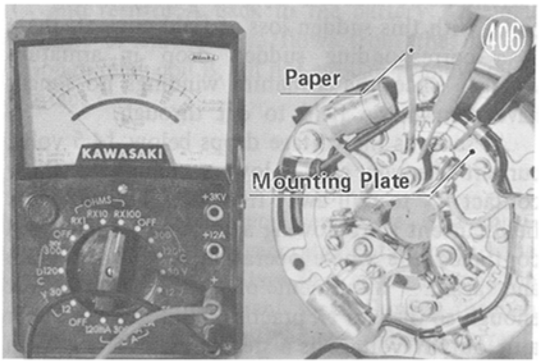
The contact points in Fig. 405 are in the closed position. If the ignition switch is closed at this time, current flow from the battery is through ground, the breaker points, the primary winding of the ignition coil, and via the switch back to the battery.

Current through the primary winding of the coil creates a magnetic field, strengthened by the iron core. As the generator rotor turns, the breaker cam rotating with it pushes against the breaker arm and opens the contacts, suddenly cutting off current through the primary winding. The magnetic field then collapses, and as a result of the high turns ratio between the secondary and primary ignition coil windings, an extremely high voltage is induced in the secondary winding. This high voltage is introduced to the spark plug via the plug cable, and causes a spark to jump across the spark plug point gap and ignite the gasoline mixture in the combustion chamber.

Besides the voltage induced in the secondary winding, self-induction also causes current to continue to flow in the primary winding even after the contacts have opened. This current builds up to a pressure of several hundred volts which, without the condenser, would jump across the breaker contacts and gradually burn them away. To avoid this, a condenser is connected in parallel with the contacts, and the self-induced current charges the condenser instead of sparking at the contacts.

c. Inspection

(1) Check that the breaker arm is insulated from the mounting plate when the points are open. If the breaker arm is not insulated due to poor mounting or damage, it will not be possible to interrupt primary current to produce the spark.



(2) Check the contact points for wear or fouling. The points must be inspected periodically since they become worn after a long period of operation, and the slight sparking at each break gradually burns the surface.

Depending on the extent of point damage, grind the surface smooth with emery cloth or oilstone, or replace the points as set. Oil on the contact surface will prevent proper contact and the ignition spark may be lost, so wipe off any oil with paper or cloth, taking care that no paper or cloth particles remain on the point surface.

The contact point gap, and therefore ignition timing, change due to point wear or grinding down, and must be adjusted. For gap adjustment procedure, see the paragraph on ignition timing adjustment.

(3) Condenser

When the condenser can or the internal insulation deteriorates or becomes punctured, the ignition spark may become weakened or the contacts might not break electrically. If a long blue-white spark can be seen jumping between the breaker contacts, the condenser is most likely to be defective.

(i) Capacity

The condenser capacity is $.22\mu f$. Check the capacity with a condenser (capacitor) tester. If such a tester is not available, and the multitester used gives no instructions on capacitance testing with it, charge the capacitor with a direct voltage source, observing correct polarity. After giving the condenser several seconds to charge, remove the voltage source and short the condenser leads together. If a spark jumps between the leads at this time, the capacity is sufficient.

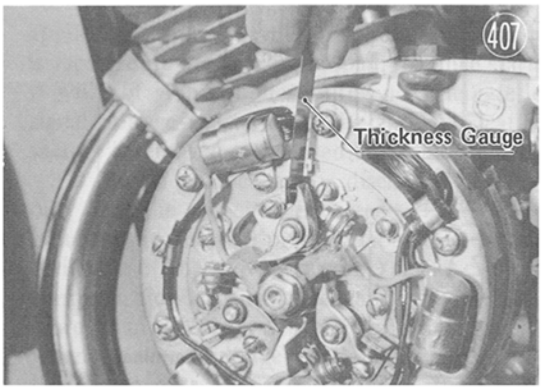
(ii) Insulation resistance

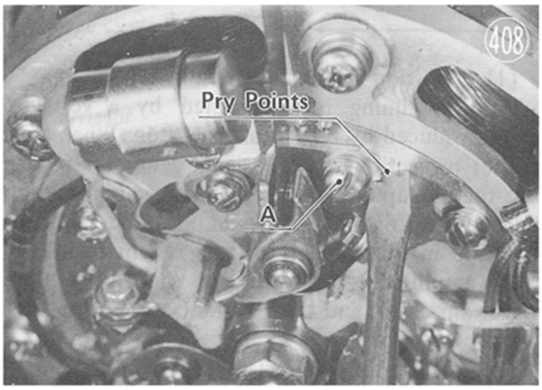
Disconnect the capacitor ground and check for no continuity between the + side and the can. If there is a current path, the condenser is shorted, if no current flows the condenser is probably good.

d. Ignition Timing Adjustment

(1) Point gap

First use a thickness gauge to see if the maximum contact opening for each of the three sets of contacts, is between .012″ and .016″ (0.3-0.4 mm). If the gap is incorrect, loosen screw A and adjust the gap to that value, as illustrated in Fig. 408.



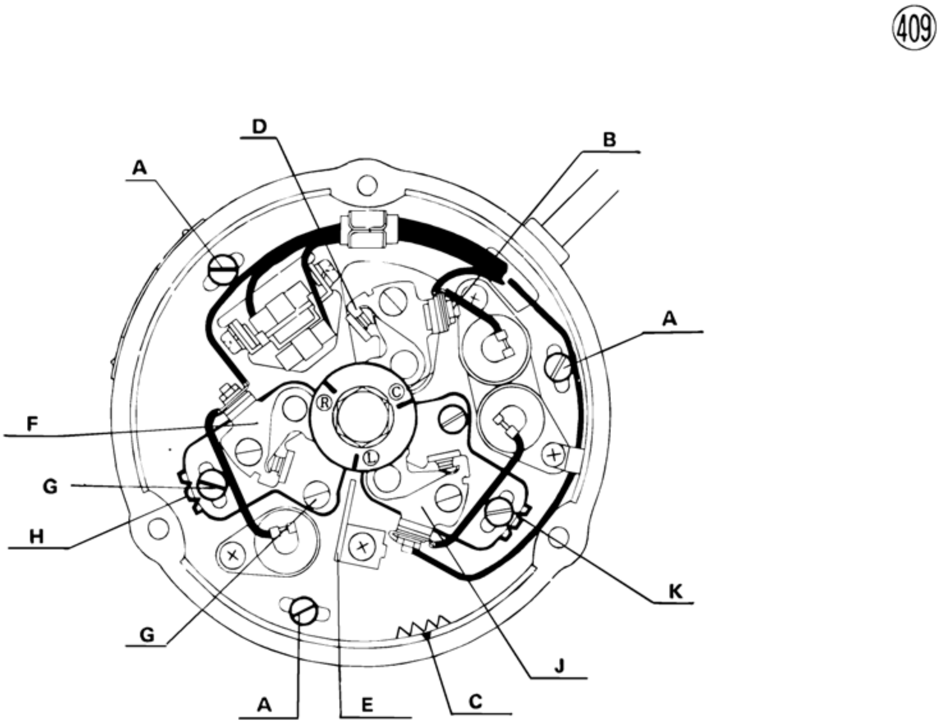


(2) Ignition timing

*Remove the spark plug from the left cylinder and mount a dial gauge in its place.
*Set the left cylinder piston at .1358 inch before top dead center (3.45 mm or 25°). For disc brake H1's, the setting is 20° (.0878″ or 2.23 mm) BTDC.
*Loosen the stator base plate mounting screws A.
*Connect an ohmmeter between ground and the left cylinder contact wire B.
*Insert the blade of a screwdriver into pry points C and move the stator base plate to that the contacts D are just at the point of opening (i.e. where the ohmmeter needle just flicks back to ∞).
*Tighten the mounting screws.
*Align the pointer E with the Ⓛ mark on the rotor by moving the pointer only. Do not turn the rotor.
*Turn the rotor to align the Ⓡ mark with the pointer.
*Connect the ohmmeter across points F in the same manner as above.
*Loosen screws G and set timing with a screwdriver inserted in slots H prying them against the screw.
*Tighten the screws.
*Turn the rotor to align mark Ⓒ with the pointer and adjust the center cylinder timing using points J and a screwdriver in pry points K.
*Set spark plug gap to .020 in. (.5 mm).

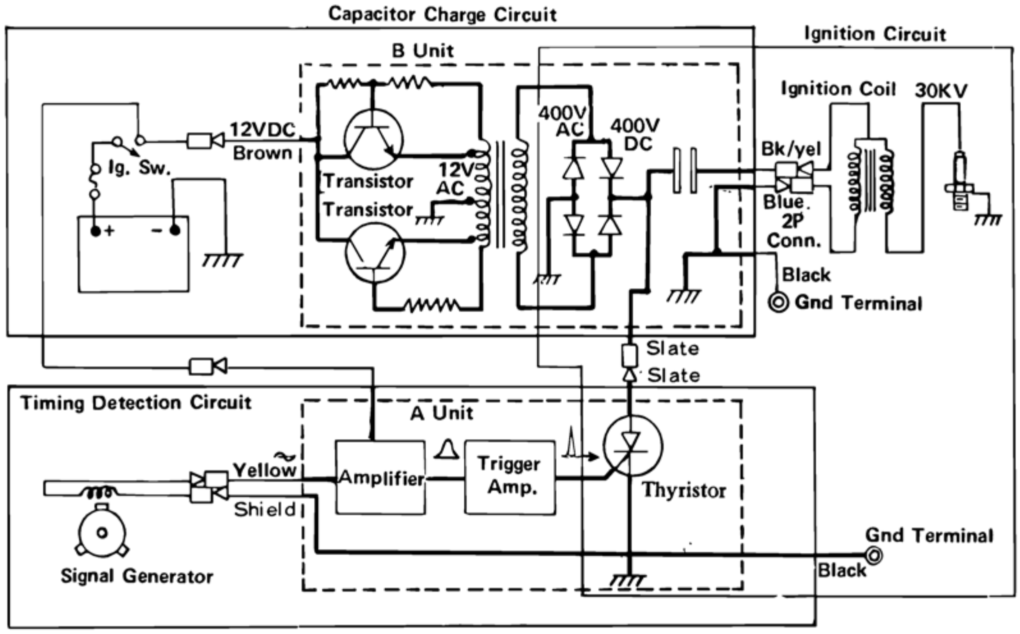
NOTE: During periodic inspection of ignition timing, apply a good quality grease to the felt. Use the grease sparingly, as excessive grease will be thrown off the cam onto the points, causing burning and pitting.

H1 Stator
(without CDI)



Capacitor Discharge Ignition System

410



2) Capacitor Discharge Ignition

a. General

The Capacitor (or Condenser) Discharge Ignition, the CDI, is different in several respects from the contact-type ignition. With the contact breaker ignition, the ignition spark is produced from the high voltage induced in the secondary winding of ignition coil when primary winding current is suddenly interrupted. With the CDI a thyristor is used in place of the contact breaker points. When the thyristor is gated with a signal sent from the signal generator rotor, the thyristor suddenly conducts and sends a pulse to the primary circuit. From then on action is similar to the mechanical ignition in that a high voltage is induced in the coil secondary winding and the ignition spark results.

It can be seen then, that there will be no trouble with fouled or worn points, and no way for ignition timing to become maladjusted. In this manner misfiring, low spark voltage, etc. are avoided, and stable ignition can be achieved. Furthermore, since the primary winding current is cut in and out electrically, the rise time is faster and a stronger voltage and better ignition is provided by the secondary winding.

To send the ignition spark to a different cylinder each time, a distributor is located between the secondary coil and the spark plugs. The rotor distributor is turned through gear and shaft connection to the crankshaft, so that every time a spark is produced and sent to the rotor, the rotor is pointing to the appropriate spark plug wire connection in the distributor cap.

b. Construction and Operation

Figure 410 is a diagram of the Capacitor Discharge Ignition circuit. It can be roughly divided into the timing detection circuit, capacitor charge circuit, and the actual ignition spark producing circuit.

(1) Ignition timing detection

Ignition timing is determined by a voltage signal produced by the signal generator. When the magnet projections on the signal generator rotor pass the pickup coil as they rotate, each magnetic field cuts through the coil windings and induces a voltage in them. This voltage is sent to the A Unit, amplified, the waveform shaped by the trigger amplifier, and the resultant sent to trigger, or gate, the thyristor.

(2) Capacitor Charge Circuit

To charge the capacitor, the 12 VDC from the battery is changed to 400VDC in the DC-DC Converter. To accomplish this, the 12 volts direct current is first changed to AC by a two-transistor oscillator, the AC is stepped up to 400 volts by a transformer, changed back to DC by a full wave rectifier, and the 400VDC resultant is used to charge the capacitor. The charged capacitor is then ready to discharge when the thyristor conducts.

The capacitor charging current path is from the transformer through a diode to ground, up through the primary winding of the ignition coil to one side of the capacitor; and the return path is from the other side of the capacitor through another diode back to the opposite side of the transformer.

(3) Ignition

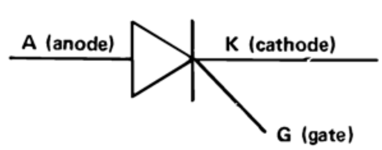
When the thyristor is triggered, i.e. receives a gating pulse, it conducts and acts as a short circuit across the charged capacitor. Consequently, the capacitor suddenly discharges through the ignition coil primary winding. The fast rate of discharge in conjunction with the high turns ratio of the coil windings, produces a 30KV ignition spark across the spark plug gap. The capacitor discharge current path is from the coil side of the capacitor, through the primary winding to ground, and up through the thyristor back to the other side of the capacitor.

(4) Thyristor

The thyristor is made of four pieces of semiconductor material (see page102for an explanation of semiconductors). Current will flow from the cathode to anode but will not flow in the reverse direction. The thyristor differs from a diode in two respects: (a) even though a voltage of the correct polarity – negative to cathode – may be applied, the thyristor will not conduct until a signal is received at the gate input load; (b) once started, it will not stop conducting (even if the gate lead signal voltage stops) until the anode to cathode voltage is removed or reversed.

In the H1 CDI capacitor discharge circuit not only does the capacitor discharge to zero, but self-induction in the coil primary (roughly equivalent to inertia of the moving current) causes current to continue flowing until the capacitor charges to more than 400 volts in the opposite direction. When the reverse charge reaches its peak and stops, the charge puts a reverse voltage on the thyristor and stops it from conducting, and the normal charge cycle begins again.

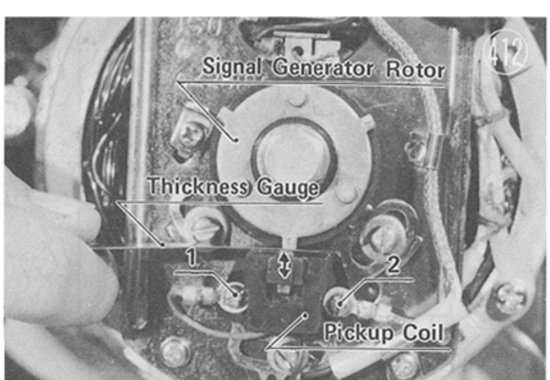
Thyristor (411)



c. Adjustment

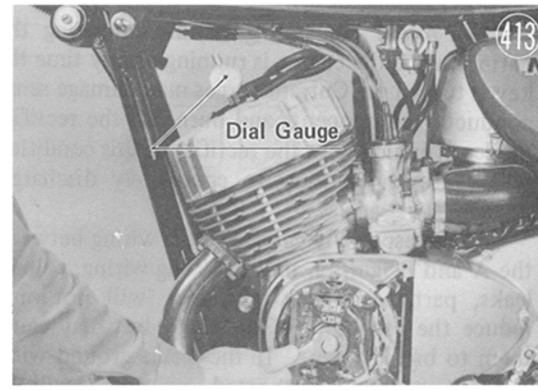
(1) Gap adjustment

Loosen the two pickup coil mounting screws① and②. Move the coil so that all three of the magnet projections from the signal generator rotor are between .016″ and .024″ (0.4–0.6 mm)from the coil.

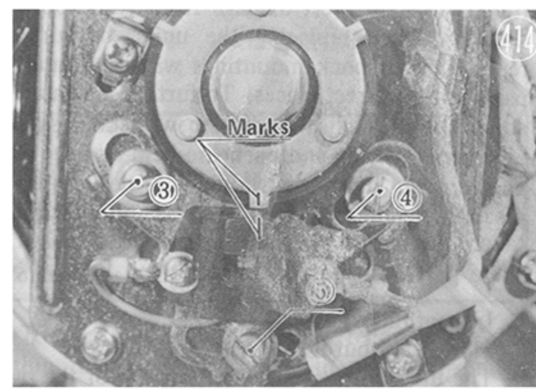


(2) Timing adjustment

(i) Using an adapter (special tool) to mount a dial gauge in the spark plug hole, set the piston at .1358″ (3.45mm, or 25°) BTDC.



(ii) In this position, loosen the three pickup coil base plate mounting screws③④⑤. Align the mark on the SG magnet projection with the mark on top of the pickup coil housing, and tighten the screws back down.



(iii) Align pointer⑥with the next mark on the rotor, and turn the rotor to check that any two points will coincide with the pickup mark and the pointer, respectively. Once the pointer is set correctly, it can be used as a reference mark to restore timing any time the pickup coil is removed or the gap adjusted.

(iv) Last, ascertain that the pickup coil/magnet gap has not changed.

d. Handling Care

(1) Before connecting the battery leads, be certain the polarity is correct. If the battery is installed backwards, the moment the key is turned on, the CDI and the rectifiers will suffer damage, and general wiring damage may also result.

(2) Avoid connecting or disconnecting the battery while the engine is running or any time the key is turned on. Current surges may damage semiconductor components and burn out the rectifier diodes. Running with the rectifier in this condition will cause the battery to completely discharge.

(3) Be especially careful of the wiring between the A and B ignition units. Wrong wiring, voltage leaks, partial contact only, etc., will not only reduce the capability of the units, but may cause them to break down. If the black ground wires are not properly connected, no spark will be produced.

(4) To maintain high performance, the battery and ignition coil should be replaced with standard parts only.

(5) The A and B units are cushioned with rubber to help avert damage from vibration and shock. When replacing the units, be sure to replace these shock mountings with the standard parts in the correct places. To further increase the ability of the delicate parts to withstand shock, all internal wiring and parts are held in place with epoxy, and attempts should be not made to disassemble these units. If disassembly is undertaken during the warranty period, no claim on these parts will be considered.

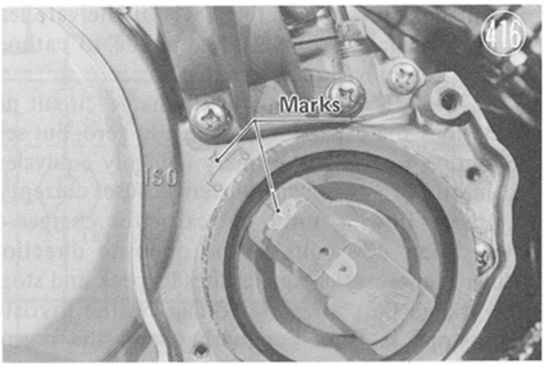
e. Inspection · Testing

(1) Distributor

The distributor is mounted on top of the right cover as illustrated. The distributor rotor is turned by the crankshaft distributor pinion, which meshes with the gear on the distributor shaft. Only the best insulation in good condition can be used to contain the 30KV present in the distributor and high voltage cable. Therefore if the cables or distributor cap are nicked or otherwise damaged and weakened, tape, etc., will not serve as a corrective measure. The damaged part must be replaced.

Whenever the spark to only a single cylinder is weak or nonexistent, the trouble can usually be traced to the area between the distributor and plug. Inspect the insulation minutely to determine the cause.

NOTE: When assembling the right cover, the distributor timing must be set as shown in Fig. 416. The rotor alignment mark should coincide with the timing mark, falling as close to its center possible. For more detailed timing information see page 26.



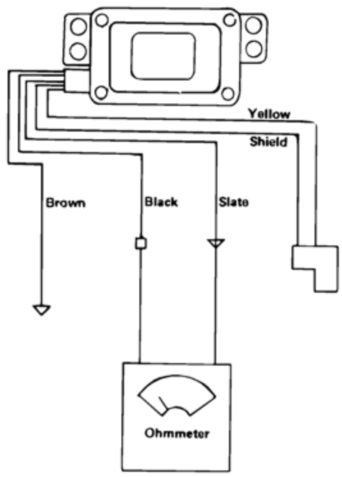
(2) Pickup coil

Touch the tester leads to the pickup coil leads at the connector and measure coil resistance. Standard resistance is 280 – 420 Ω.

Check that the gap between the pickup coil and the signal generator rotor magnets is between .016" and .024" (0.4–0.6 mm). If adjustment is required, see paragraph c.(1) of this section.

CDI Test

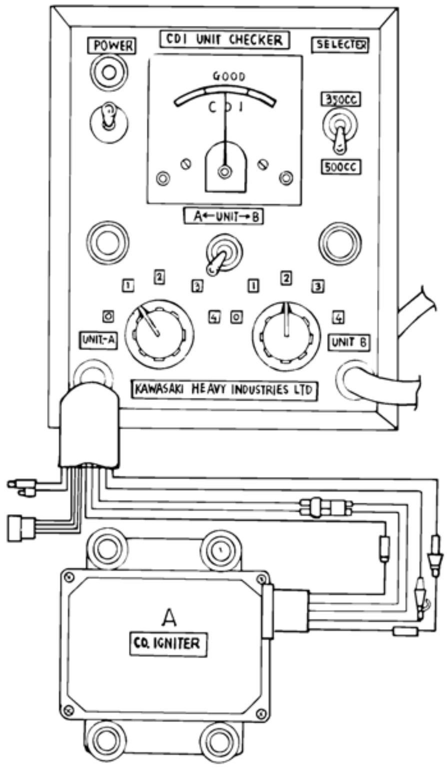
Unit A



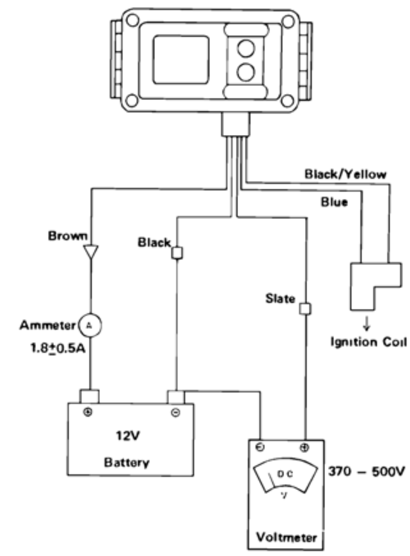
Connection	Reading
Black lead to meter +, gray lead to –	Infinity (No current flow)
Black to meter -, gray to +	Infinity (No current flow)

If a CDI Tester is available:

Connect Unit A to the tester as shown in the diagram and turn the Unit A dial from 1 to 4. Normal meter reading is within the green area for all positions. Position one is a line voltage check only, and does not indicate the condition of the A Unit.



Unit B

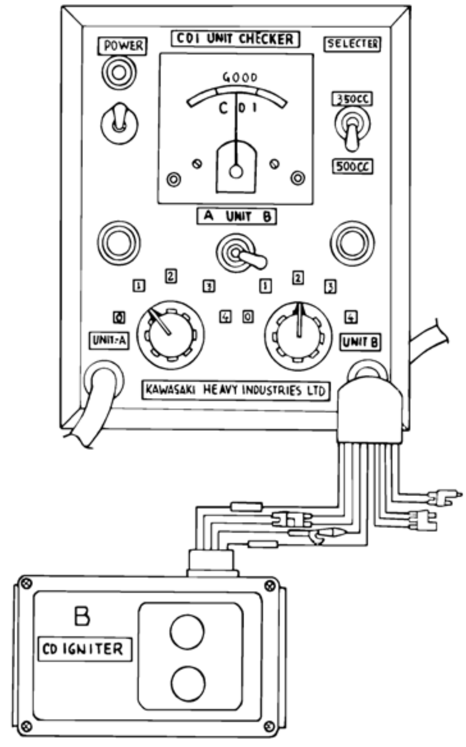


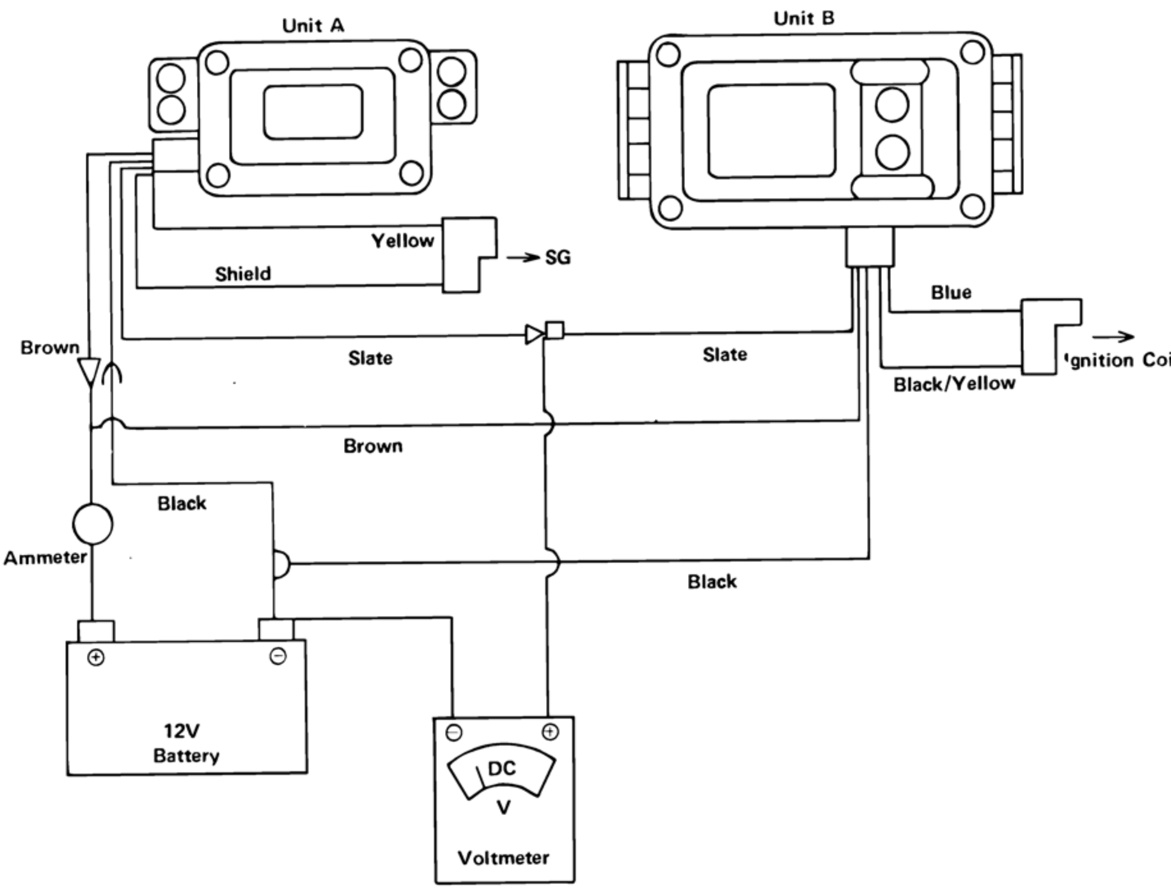
Meter	Reading
DC Ammeter	1.8 ± 0.5A no ocillation of the ammeter needle
DC Voltmeter	370 – 500 VDC

The unit is defective if the readings are not within tolerance, or if the unit does not emit a high-pitched hum.

If a CDI Tester is available:

Connect Unit B to the tester as illustrated, and turn the Unit B dial from 1 to 4. Normal reading is within the green area. Position 1 checks line voltage only.





Meter	Reading
DC Ammeter	2.0 ± 0.5A with no meter needle oscillation
DC Voltmeter	370 – 500 VDC

Unit B should emit a high-pitched hum.

The preceding checks give a general indication of the condition of the CDI units, and are usually sufficient to determine whether the unit is good or not. More precise measurement would require that the waveforms be checked with an oscilloscope while the units are in the vehicle under actual operating conditions.

V-b H2 Electrical System

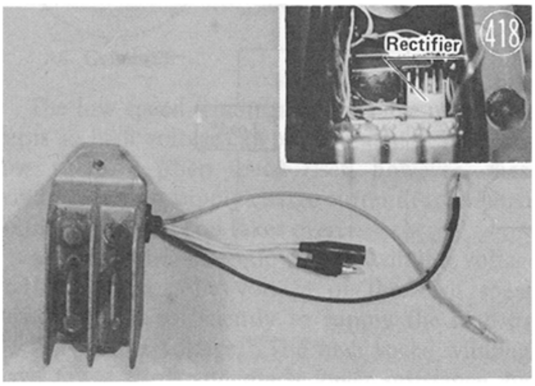
Introduction

This section deals with the rectifier, regulator and ignition system of the H2 only. See Section V-a for H1 information, for general information, or for an explanation of specific terms not explained here (e.g. thyristor, semiconductor, full-wave rectifier, etc.).

Note that the H2 contains two rectifier units. One is a combination rectifier/regulator used for all electrical applications except the ignition. The other rectifier referred to as the "ignition rectifier" is used solely to provide DC for the Magneto CDI ignition units.

1. RECTIFIER & VOLTAGE REGULATOR

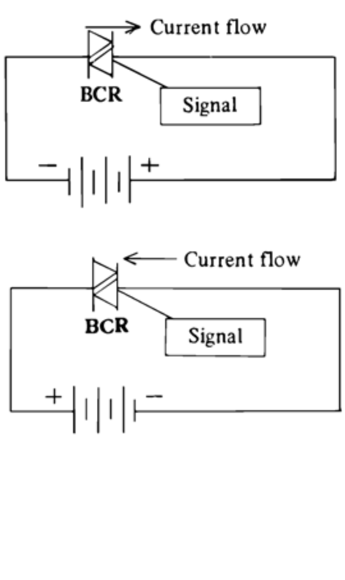
The H2 rectifier unit (Figure 418) performs the dual functions of current rectification and voltage



regulation. This has been made possible by replacing one of the rectifier diodes with a special thyristor, called a Bidirectional Controlled Rectifier.

The BCR will conduct in either direction after either a positive or negative voltage signal is applied to the gate lead; an ordinary thyristor will conduct in only one direction.

BCR 419

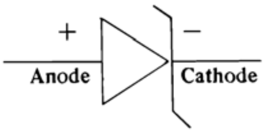


Semiconductors in general are explained on page 102, and thyristors on page 109. One other semiconductor, a zener diode, is used in the regulator circuit. This special type of diode is briefly explained below to help you understand the H2 regulator operation.

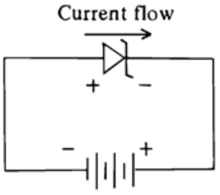
Zener Diode

As in a normal diode, current will flow easily from the cathode to anode, and will not usually flow in the opposite direction. Unlike a normal diode, however, the diode will "break down", or conduct in the reverse direction, if enough voltage is applied in the reverse direction; when the voltage is lowered or removed, the diode will stop conducting and return to its normal state. The voltage at which the diode begins reverse conduction, is called the breakdown voltage, and can be set at the desired level when the diode is manufactured. This property of the zener diode makes it very useful in voltage regulator circuits.

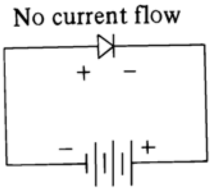
Zener Diode 420



ZD Current Flow 421



Ordinary Diode 422



Operation

a. Rectification

When the Ⓐ generator lead is - and Ⓑ is +, current flows from Ⓐ through D_1 to ground, up through the battery to charge it and up through the load circuits, through D_2 and back to the generator at Ⓑ.

When Ⓑ is - and Ⓐ is +, the positive voltage is felt at the gate of the BCR through R_3 and D_3. (A small gate current flows from Ⓑ → BCR → BCR gate lead → D_3 → R_3 → Ⓐ.) This starts the BCR thyristor conducting and current from Ⓑ goes through the BCR to ground, the battery and load, and Via D_4 back to Ⓐ.

b. Regulation

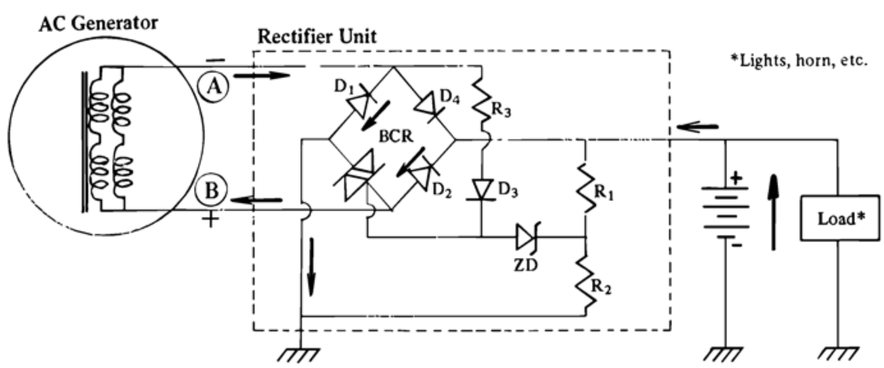
Voltage regulation at high speed occurs only on the half cycle when the generator Ⓐ lead is negative and the Ⓑ lead is positive. As the sine wave voltage rises from zero, current starts out normally through D_1, the load, and back through D_2. A small amount of current also flows through R_2 and R_1.

When 15 volts is reached, a portion of this voltage at the junction of R_1 and R_2 causes the Zener Diode to break down and gate the BCR. A small gate current* flows through the ZD to start the BCR conducting and current from Ⓐ is returned to the generator at Ⓑ via D_1 and the BCR.

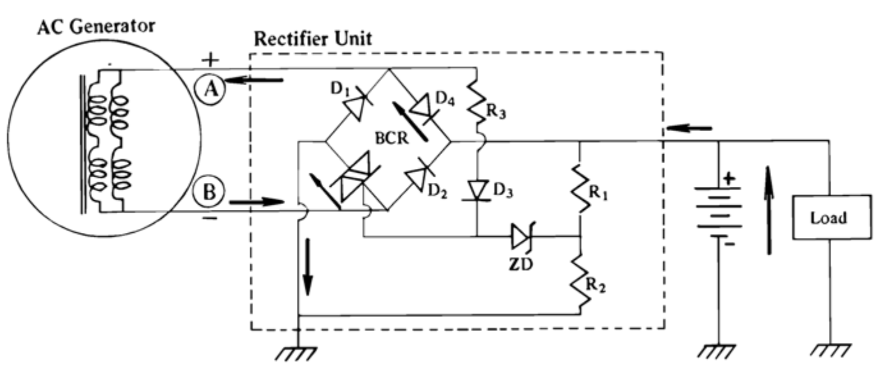
In this manner average voltage is held down to 15 ± .5 volts.

*In the actual circuit the ZD turns on a transistor which gives the thyristor a negative gate from ground.

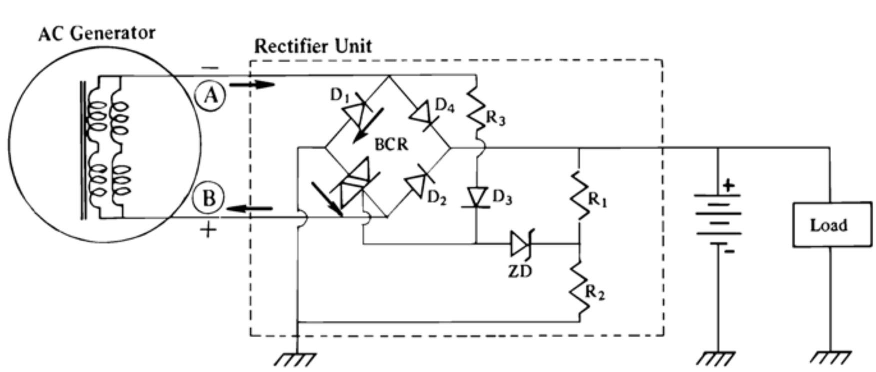
Rectification when A is negative (423)



Rectification when B is negative (424)



Voltage Regulation (425)



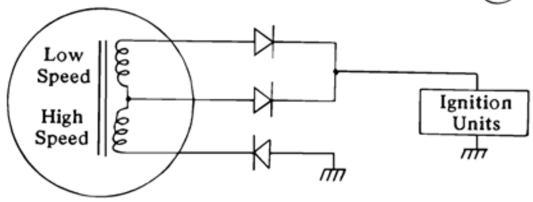
2. IGNITION SYSTEM

The H2 has a Magneto CDI ignition system. This ignition method has been developed for higher performance and greater reliability than other CDI systems.

As shown in Fig. 428-429 both types of CDI ignitions produce the ignition spark as a result of capacitor discharge. But while the CDI takes the low battery voltage and changes it to 370-500 VDC with a converter, the MCDI takes high voltage directly from a special generator winding and rectifies it. The Magneto CDI has another advantage in that it can use the signal generator voltage directly without amplification.

The AC generator contains two high voltage ignition windings. One is used at low speeds, and the other takes over during high speed.

Ignition Windings (426)



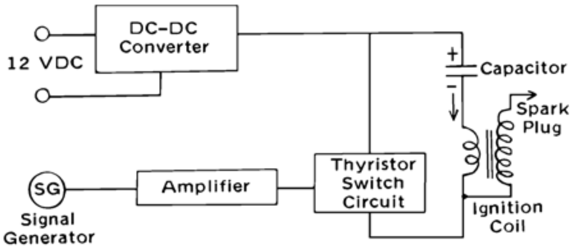
AC Generator

The low speed windings have a large number of turns so high voltage can be generated at relatively low r.p.m. When speed rises, however, these windings cannot supply charge current fast enough, so the high speed coil takes over.

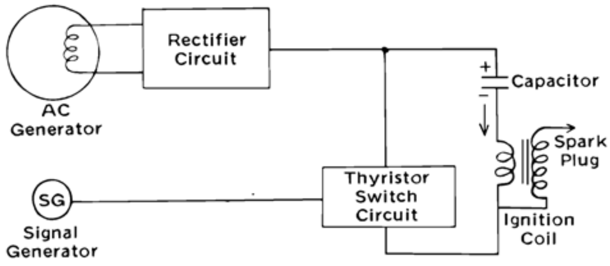
At this point, where low speed winding voltage starts dropping, the voltage of the high speed windings rises sufficiently to supply the high capacitor charge voltage. The high speed windings have fewer turns and much lower resistance and consequently do not become loaded down when supplying charge current.

The two coils are matched so that a steady voltage is supplied to the ignition units at all speeds.

Battery CDI (428)



Magneto CDI (429)



Operation

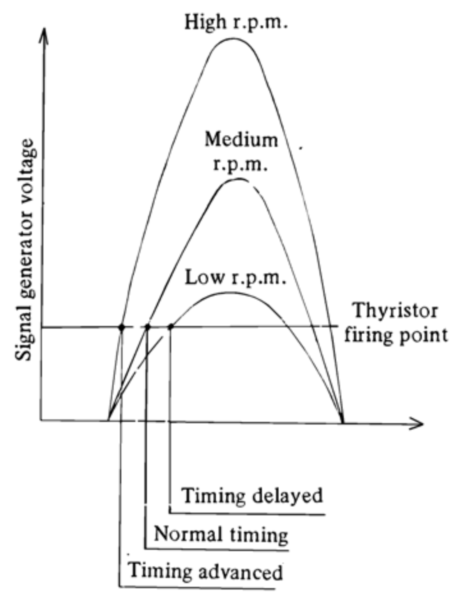
Figure 429 is a simplified diagram of one of the three identical Magneto CDI Units; each unit produces the spark for one cylinder.

Capacitor charge current flows from the rectifier through ground, up through the primary winding of the ignition coil, and charges the capacitor - to + in the direction indicated. When the thyristor receives a signal at the gate lead as sent from the signal generator, it begins to conduct. This completes a current path for capacitor discharge through the ignition coil primary, ground, and up through the thyristor. The sudden discharge in combination with the high turns ratio of the ignition coil, cause a high voltage to be induced in the secondary winding of the coil, and consequently a spark jumps across the spark plug gap.

Spark voltage ranges up to 36KV but a minimum of 20KV is always available, more than sufficient to supply the 13 kilovolts necessary to fire the spark plug.

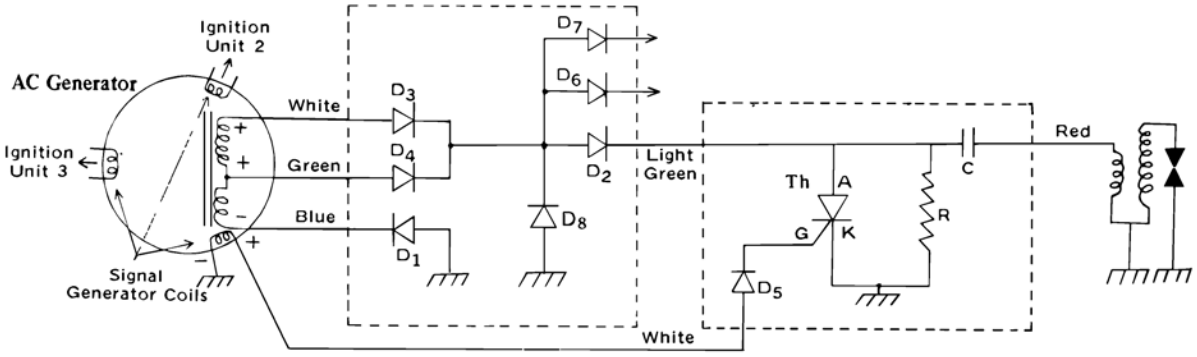
The SSM ignition system also incorporates automatic timing advance. The thyristor is turned on at the same voltage level regardless of engine speed. But as speed increases, the voltage from the signal generator rises faster and the thyristor switch voltage point is reached sooner, thereby advancing ignition timing.

Magneto CDI Timing Advance (427)



Magneto CD Ignition System

430



Detailed Operation

When the ignition winding voltage is at the polarity indicated in Fig. 430, capacitor charge current flows through D_1, ground, up through the ignition coil primary, and to the capacitor (C). Return current is from the other side of the capacitor is through D_2 and through either D_3 or D_4 (depending on r.p.m.) back to the generator.

When the signal generator winding is at the indicated polarity, signal voltage is felt at the gate of the thyristor and the thyristor starts conducting to discharge the capacitor. Signal current is from the signal generator winding through ground, from cathode (K) to gate (G) of the thyristor (Th), and via D_5 back to the generator.

After the thyristor starts conducting, the capacitor discharges through the primary winding of the ignition coil to ground and up through the thyristor. In case the motorcycle is turned off just when the capacitor is charged, bleeder resistor (R) slowly discharges the capacitor. The resistance of R is high enough (390KΩ) so that it has negligible effect on the ignition circuit while the engine is running.

Unit #2 and #3 operate in the same manner as above, with charge current flowing through D_6 and D_7 respectively.

Diode D_8 is used to increase the effectiveness of the capacitor charge circuit. As the generator turns and charge voltage from the armature goes back to zero, the inductance of the primary winding of the ignition coil keeps charge current flowing into the capacitor for a short period. The charge path at this time is: Coil → C → D_2 → D_8 → ground → coil.

Troubleshooting

The first step in troubleshooting is to narrow down the failure to the smallest possible area. The following short guide is divided into three main categories, and each category can be broken down by, further testing until the possible trouble area is traced to the defective part. Testing of the Magneto CDI components is explained after the guide.

CAUTION: Battery failure is not listed as a possible source of ignition trouble since the motorcycle will start and run without the battery. However, running without the battery should be avoided as it will eventually cause failure of the Ignition Units.

H2 Ignition Troubleshooting Guide

Engine will not start at all

First pull off the spark plug wires and use a good plug to test the spark for each cylinder.

★Strong spark all cylinders
- ☆Trouble outside ignition system
- ☆Plugs firing in wrong order due to wrong wiring
- ☆Plugs bad

★Weak spark all cylinders
- ☆AC generator bad
- ☆Ignition rectifier unit bad

★No spark any cylinder
- ☆AC generator bad
- ☆Ignition unit bad
- ☆Ignition rectifier unit bad
- ☆Wiring faulty

Hard to start or no power

★Strong spark all cylinders
- ☆Trouble outside ignition system
- ☆Plug(s) dirty or bad
- ☆Timing incorrect

★Weak spark all cylinders
- ☆AC generator bad (especially low-speed winding)
- ☆Ignition rectifier unit bad

★Weak spark one cylinder only
- ☆High voltage insulation leak
- ☆Ignition coil going bad
- ☆Signal generator bad

★No spark one cylinder
- ☆Wiring faulty
- ☆High voltage insulation leak
- ☆Ignition coil bad
- ☆Ignition unit bad
- ☆Ignition rectifier unit bad
- ☆Signal generator bad

No power or missing at high speed
★Strong spark all cylinders
☆Trouble outside ignition system
☆Spark plug(s) dirty or bad
☆Timing maladjusted
☆AC generator high speed coil bad
★Weak or no spark one cylinder
☆AC generator bad
☆Ignition unit bad
☆Ignition coil bad
☆Wiring bad
☆Signal generator bad

3. TEST PROCEDURES

PART I

Part One outlines tests that can be made without test equipment. To check the ignition units, generator, regulator, etc. using test equipment, see Part Two of this section.

Spark
To check the ignition spark, pull off the plug wire and fit it to a plug known to be good. Rest the plug against the engine to ground it, and kick the engine over. If a strong blue-white spark jumps across the plug gap, the ignition spark is good.

Spark Plug
If you suspect a spark plug to be bad, first check the spark as above then substitute the suspect plug and check its spark. If there is no spark or if the spark is weak, visually inspect the plug. Dirt or oil around the electrodes or on the ceramic insulation inside the electrode end of the plug will prevent a good spark from jumping. Clean off the plug well or replace it.

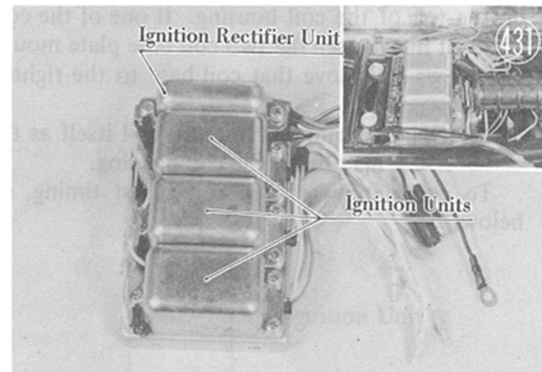
Wiring
The engine will not start if the plug wires are connected to the wrong spark plug, or if one of the ignition unit red or white wires is reversed with another of the same color. These wires are clearly marked as to left, right or center cylinder connection.

If the spark appears to be grounding out somewhere, examine the high voltage wires and replace any that have broken or cracked insulation. If no cracks are visible, run the engine in a dark place to see where the spark is jumping. **But don't run the engine inside a closed area!**

Any time wiring mistakes are suspected, in the ignition system or otherwise, check the wiring against the H2 wiring diagram in the back of this manual.

Ignition Units
When there is no spark for any of the cylinders, the trouble can sometimes be caused by a single ignition unit. In this case the trouble can be located without test equipment: (a) Disconnect the three light green wires going from the ignition rectifier unit to the ignition units; (b) Connect one wire at a time to its ignition unit and check the spark for that cylinder. If two of the cylinders will spark when connected alone, the ignition unit for the non-sparking cylinder is bad.

When there is no spark for one of the cylinders or when the spark is weak the first step, of course, is to make sure the spark plug is good and that the wiring is not at fault. Proceeding from that point, there are only four possible places for the trouble to be: the coil, the ignition unit, the ignition rectifier unit, or the signal generator. By following the steps below it will be easy to pinpoint the defective part. "BC" means the cylinder that is bad; "GC" means either one (pick one) of the two remaining good cylinders.



1. (a) There are three light green wires coming from the ignition rectifier unit, and one goes to each ignition unit. Take the two of these which go to the BC ignition unit and the GC ignition unit and reverse them.
   (b) Check the spark for the two cylinders. If the trouble has shifted from the BC to the GC, the ignition rectifier unit is bad. If the trouble remains in the BC, go on to Step 2.

2. (a) Reverse the BC and GC plug wires so that the BC wire goes to the GC plug, and the GC wire goes to the BC plug.
   (b) There are three red wires, one from each ignition unit to each coil. Reverse the BC and GC red wires. This can be done at either the junction near the coil or near the ignition unit.
   (c) Now check the spark for both cylinders. If the trouble has switched to the GC, the BC ignition coil is bad. If the trouble is still in the BC go on to the next step.

3. (a) Return the spark plug wires to normal but leave the red wires reversed.
   (b) Each ignition unit has a white wire coming from it. Reverse the BC unit and GC unit white wires.
   (c) Check the spark for both cylinders. If the trouble is now in the GC, the BC ignition unit is bad. If the trouble remains in the BC, the BC signal generator coil is bad.

Once the defective part has been located, return all wiring to normal.

Timing

After replacing a signal generator coil, or if you suspect timing of one of the cylinders is incorrect, check it as follows.

Remove the **two** screws to take off the left engine cover. There are three sets of marks on the outside of the rotor: an **L** (Left) and an **S** mark for the left cylinder timing, **R** and **S** marks for the right cylinder, and **C** and **S** marks for the center.

Check timing by aligning the pointer with the **S** mark, and seeing if the trailing edge of the rotor magnet projection coincides with the timing mark on the top of the coil housing. If one of the coils is out of line, loosen the two coil base plate mounting screws and move that coil base to the right or left.

CAUTION: **Do not pry on the coil itself as this may break the coil housing.**

To completely recheck and adjust timing, see below.

TEST PROCEDURES

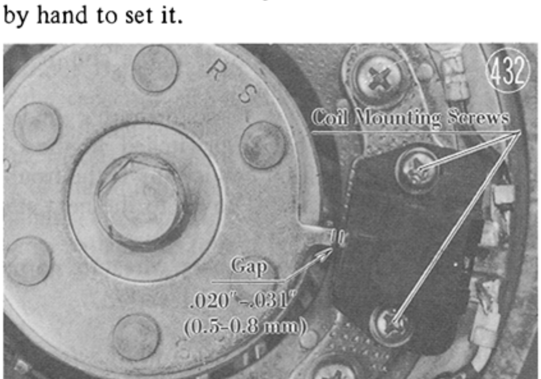
PART II

Part Two covers detailed test and adjustment procedure.

Timing

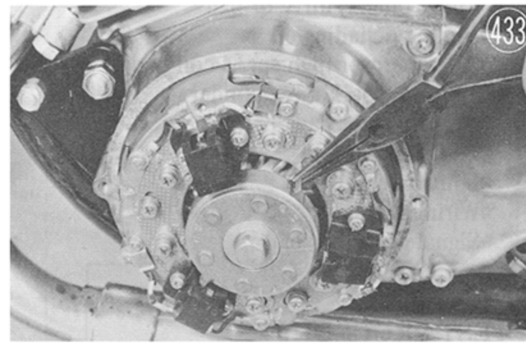
To completely readjust the timing follow these steps:

1. Set the spark plug gap to .035-.039 in. (.9-1.0 mm). The standard plug is an NGK B-9HS-10. Plug installation torque is 18.0 - 22.0 ft-lb (2.5-3.0 kg-M).
2. Take out the **two** screws and remove the left cover.
3. Using a feeler gauge, check the gap between each signal generator pickup coil and the magnet projection on the rotor. The correct gap is .020-.031 in. (0.5-0.8 mm). If the gap is incorrect, loosen the two mounting screws and move the coil by hand to set it.

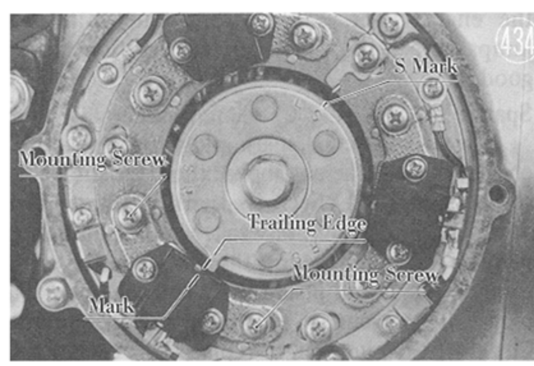


CAUTION: **Do not pry on the coil with a screwdriver or any other tool since this may break the coil housing.**

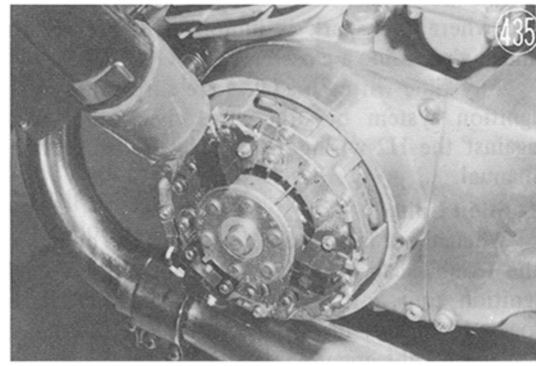
4. Remove the spark plugs and insert a dial gauge into the left cylinder. Set the piston to .1231 in. (3.13 mm) BTDC.
5. Bend the pointer on the generator stator to coincide with the **L** mark on the rotor.



6. Turn the rotor slightly to align the **S** mark with the pointer.
7. See if the trailing edge of the rotor magnet projection coincides with the mark on top of the left cylinder signal generator coil housing. If it does not, loosen the two coil base plate mounting screws and move the base plate right or left, again taking care not to pry on the coil itself.



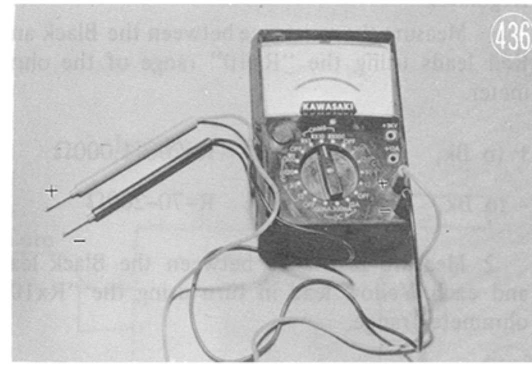
8. Repeat steps and for the right and center cylinders, aligning the right and center **S** marks with the pointer.
9. Reinsert the spark plugs, connect a strobe to the left cylinder plug, start the engine and see if the rotor **L** mark coincides with the pointer at 4,000 r.p.m. If it does not, readjust left cylinder timing.



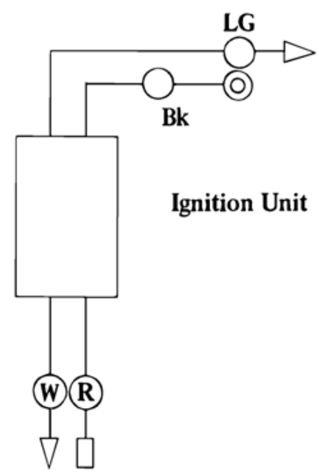
10. Repeat step 9 for the right and center cylinders, seeing that the **R** and **C** marks coincide with the pointer.

NOTE:

1. In the following tests using an ohmmeter, some meters will have to be connected in reverse to obtain the correct readings.
2. "+" and "–" indicate the positive and negative meter leads, respectively.
3. All resistance measurements where an ohms (Ω) valve is indicated are approximate. This is especially in the case of the Ignition Rectifier Unit and the Regulator, the resistance reading varies with each unit and also varies with different ohmmeters.



437



Ignition Unit

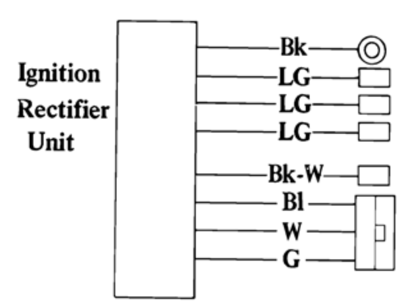
1. Check resistance between the Black and Light Green wires using the "Rx10" range of the ohmmeter.

+ to Bk, - to LG	R=infinity (no reading)
- to Bk, + to LG	R=infinity

2. Check resistance between the Light Green and Red wires using the "Rx100" range of the ohmmeter.

+ to LG,	- to R	For either measurement the meter needle should jump and then return to infinity (no reading).
- to LG,	+ to R	

438



Ignition Rectifier Unit

1. Measure resistance between the Black-White lead and the Blue, White and Green leads, one at a time, using the "Rx10" ohmmeter range.

+ to Bk-W,	- to B1	R=20–35Ω
	- to G	R=20–35Ω
	- to W	R=70–250Ω
- to Bk-W,	+ to B1	R=infinity, all three readings
	+ to G	
	+ to W	

2. Measure the resistance between the Black-White lead and each Light-Green wire in turn, using the "Rx10" ohmmeter range.

+ to Bk-W,	- to LG	R=infinity (no reading)
- to Bk-W,	+ to LG	R=25–250Ω

Regulator

1. Measure the resistance between the Black and Red leads using the "Rx10" range of the ohmmeter.

+ to Bk,	- to Red	R=700-1,000Ω
- to Bk,	+ to Red	R=70-200Ω

2. Measure resistance between the Black lead and each Yellow lead in turn using the "Rx10" ohmmeter range.

+ to Bk,	- to Y	R=1,000-1,200Ω
- to Bk,	+ to Y	R=25-100Ω

3. Measure resistance between the Red lead and each Yellow lead using the "Rx10" ohmmeter range.

+ to R,	- to Y	R=25-90Ω
- to R,	+ to Y	One Y lead: R = under 2KΩ Other Y lead: R = under 6KΩ

4. Connect the battery voltage indicated - to the Black lead and + to the Red lead. Then measure resistance between the two Yellow leads.

Fig. 440 –
R = infinity (no reading)
with test leads reversed R = 500Ω

Fig. 441 –
R = infinity (no reading) either direction

AC Generator

Generator resistance readings should be taken with the generator at normal temperatures, not when it is excessively hot from running.

1. Resistance between the Two Yellow leads is 0.4 Ω

2. Resistance between either Yellow lead and ground should be infinite (no reading).

3. Resistance between the Blue and Green leads is 5.0 Ω.

4. Resistance between the White and Green leads is 200 Ω.

5. Resistance between the Black lead and each White lead is 200 Ω. (Signal generator test)

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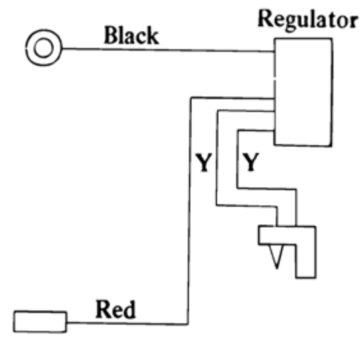
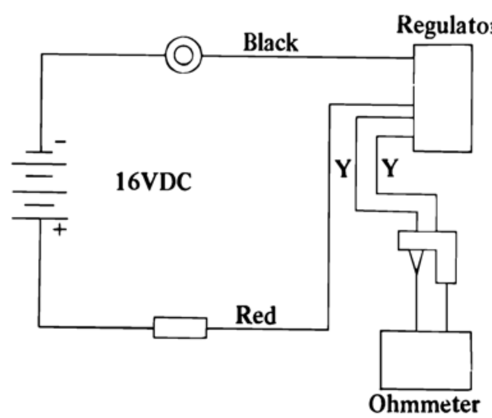
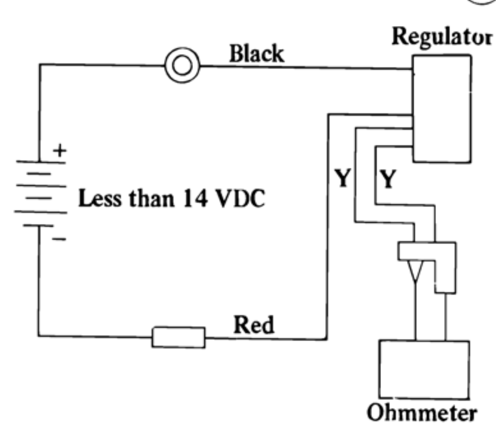


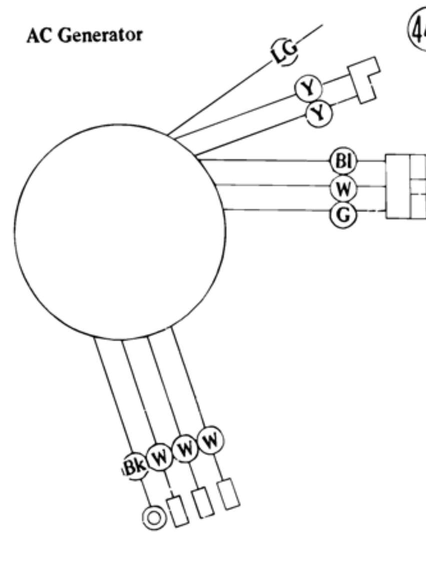
440



441



442



Ignition Coil

1. Resistance between the White lead and the core is 0.64~0.96Ω.

2. If an inductance tester is available, inductance between the White lead and the core is 2.5 mh, and between the plug wire and core it is 14h.

The preceding tests are usually sufficient to locate a defective part. Further tests, however necessitate the use of an oscilloscope and other electronic equipment and are not explained in this manual.

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Ignition Coil