GENERATOR

The standard generator is a direct current two pole, two brush unit with charging rate governed entirely by a voltage regulator. The regulator functions to increase charging rate when the battery charge is low or current is used, and to decrease charging rate when no current is being used and the battery is nearing full charge.

CHECKING GENERATOR

It is possible to troubleshoot faulty generator without removing the generator from the engine or, if necessary to remove it, without completely disassembling the generator. When a generator stops charging or not charging at a satisfactory rate as evidenced by a "dead" battery or signal light on switch panel remaining lighted, it is recommended that unless the trouble is known definitely, the following checking sequence be used:

Make certain the generator signal light circuit is not grounded. Remove the wire or wires from the regulator terminal (on 1977 and earlier models, terminal marked D+ or "GEN") and position so contact is not made with motorcycle. Turn ignition on. If generator light on instrument panel goes on, light circuit is grounded and may be reason for the generator not charging. If this circuit is grounded the condition must be corrected. If the generator signal light circuit tested O.K. or if a grounded condition has been corrected, proceed to testing generator output.

TESTING GENERATOR OUTPUT (See Figure 5-13)

Remove wire from "F" terminal of generator. Connect a short jumper wire from generator "F" terminal to ground on motorcycle. Remove wire or wires from generator "A" terminal and connect the positive lead of a 0-30 ampere ammeter. Start engine and run at a speed of 2000 rpm (approximately 40 mph). Then momentarily connect negative lead of ammeter to motorcycle battery positive terminal. If the ammeter reads 10 amperes or more for a 12 volt generator, generator is not at fault. Therefore, the difficulty is in the regulator or wiring circuit. (See "VOLTAGE REGULATOR"). If generator shows no charge or charge below minimum rate, it must be removed for further checking.

IMPORTANT

Do not ground regulator "F" (XLH) or "BT" (XLCH) terminal to check output without first disconnecting wires from terminal or damage to regulator will result.

Avoid running with generator field grounded for extended periods. Disconnect ammeter lead from battery before stopping engine to avoid discharging battery through generator.

CAUTION — It is advisable to "Flash" field coils whenever wires have been removed from generator or regulator; or after generator or battery has been removed and is reinstalled. This is done to make sure generator has correct polarity. (See "POLARIZING GENERATOR", pages 5-27.)

REMOVING GENERATOR

Disconnect red wires from "BAT" terminal on voltage regulator. Disconnect wires from generator "F" and "A" terminals.

Remove two long screws through timing gearcase cover that secure generator to gearcase.

Remove generator from chassis out left side of motorcycle.

INSPECTING BRUSHES (Figure 5-12)

Inspect brushes to make certain they are not worn out, broken or gummy and sticking in brush holders.

Remove commutator end cover nuts (7), washers (8), and frame screws (9).

Pry or gently tap commutator end cover (10) off frame and armature shaft. Remove brush holder mounting plate (13) from frame. Disconnect both black brush wires and generator positive brush cable from brush holder terminals.

Remove brushes from brush holders and clean brush holders with cleaning solvent. Blow dry with compressed air. Replace brushes when longest side of brush measures 1/2 in. or less. Seat new brushes with a brush seating stone.

TESTING FIELD COILS (Figure 5-13)

Internal connections of generator field coils to brushes and terminals are shown in Figure 5-13.

Arrange an ammeter and battery in series with test points connected to leads.
Figure 5-12. Generator - Exploded View

1. Mounting gasket
2. Gear shaft nut
3. Gear shaft washer
4. Drive gear
5. Drive end oil deflector
6. Brush cover strap
7. Commutator end cover nut (2)
8. Commutator end cover washer (2)
9. Frame screw (2)
10. Commutator end cover
11. Brush cable nut (2)
12. Brush cable washer (2)
13. Brush holder mounting plate
14. Armature
15. Terminal screw nut (2)
16. Terminal screw lockwasher (2)
17. Insulating washer (2)
18. Terminal insulator
19. Terminal bolt clip
20. Terminal screw bushing (2)
21. Bracket insulator
22. Terminal screw (2)
23. Positive brush cable
24. Terminal screw (see item 22)
25. Bearing retainer
26. Armature bearing
27. Bearing retainer
28. Drive end plate
29. Armature oil seal
30. Pole shoe screw (2)
31. Pole shoe (2)
32. Field coil (2)
33. Frame
34. Terminal screw nut (2)
35. Terminal screw lockwasher (2)
36. Brush (2)
37. Brush spring (2)
38. Brush holder plate screw (2)
39. Brush holder plate screw washer (2)
40. Brush holder plate screw washer (3)
41. Brush holder plate rivet (2)
42. Brush holder insulation
43. Brush holder spacer
44. End cover bearing
45. Generator oil wick
46. Commutator end cover oil cup
47. Brush cover screw, lockwasher and nut
48. End locating pin (2)
NOTE

All 12 volt generators are stamped “12V” following model no. on frame. Use a 12 volt battery for testing 12 volt generators. During all tests be particularly careful to avoid overloading or shorting ammeter. An overload is indicated by the needle going beyond range of calibrated scale. A direct short is indicated by needle swinging violently to extreme limit of its travel. In either case, contact must be broken instantaneously to avoid damaging the ammeter. In making the following tests, first make only a flicking, momentary contact to determine if a short is present. If ammeter needle does not go beyond calibrated scale, it is safe to make continuous contact. As added precaution, work on a bench with a nonconductive top. Never touch test points together.

1. Remove brushes or insulate brushes from commutator. Touch one test lead to “F” terminal and the other to any part of the generator frame. There should be no reading. Move first terminal to “A” terminal. A reading at either contact indicates a terminal or field coil is grounded to frame. If no reading was obtained, follow further disassembly procedure and eliminate step 2.

Remove generator drive gear using Gear Puller, Part No. 95715-19A.

Press armature out of ball bearing with arbor press and remove. Disassemble terminals, remove field coil leads, inspect terminal components for cracked or worn through insulating materials and, if parts appear serviceable, reassemble terminal components eliminating field coil leads.

2. Recheck terminal to ground contacts as described in step 1. No reading indicates terminals are properly insulated. If reading was obtained in step 1, but not in step 2, field coils are probably grounded.

3. Touch one test lead to either field coil lead and the other to the generator frame. A reading indicates a field coil is grounded and it is necessary to clip the connection between the field coils. Touch test leads to one field coil lead and ground. Repeat process on other coil. A reading indicates a grounded coil which will have to be replaced. If terminals and field coils are in serviceable condition, proceed to step 4.

4. Test field coils, using a 12 volt battery for 12 volt generator, touching test leads to coil lead terminals. Current value should be 2.3 amp. No reading indicates an open coil, a higher reading indicates a shorted coil.

5. Strip back the insulation at point where two field coil leads are joined and file the insulating varnish off a spot on the splice. Connect one test lead at this point, the other at either coil lead. Without moving first test lead, move second test lead to opposite free lead. Current value should be 4.6 amperes (single coil). No reading indicates an open coil, a higher reading indicates a shorted coil. Faulty parts must be replaced.

6. Touch one test lead to brush holder mounting plate, the other to positive (insulated) brush holder. A reading indicates a shorted holder. Clean thoroughly and recheck. If reading is obtained, replace brush holder mounting plate. Check negative brush holder to be sure it is tight and well grounded.

If field coils, brush holders and generator terminals are serviceable, the trouble is probably in the armature.

Do not remove pole shoes and field coils unless tests previously made proved one or both of the coils to be faulty. When a pole shoe must be removed to replace a field coil, follow the procedure described in “DISASSEMBLING GENERATOR.”

TESTING ARMATURE

Test for Ground (Figure 5-14). If growler with test leads is available, test by touching armature core with one test lead and commutator segments, individually, with the other. If this means of testing is not available, test with battery, ammeter and leads as used for testing field coils. Contact commutator segments with one test point and armature core with the other. If circuit is completed, armature is grounded.
If armature is found to be grounded, make sure commutator is free from carbon and copper dust deposits. After cleaning thoroughly between segments and at ends of commutator and blowing dry with compressed air, repeat test. Armature must be replaced if ground is still present.

Test for Short (Figure 5-15). Place armature in growler and hold piece of hacksaw blade parallel to and in loose contact with armature core. Turn growler on. Rotate armature slowly several turns. The hacksaw blade will be attracted to the armature core and will vibrate at one or more points if armature is shorted.

If short is found, clean commutator segments as described above under “Test for Ground.” If short still exists, armature must be replaced.

Test for Open (Figure 5-16). Place armature in growler. Turn growler on. Insert tip of hacksaw blade between commutator segments that are in horizontal alignment with top of growler “V” shaped cradle. Make and break contact between segments with hacksaw blade. A strong flash should be seen as contact is broken. No flash or a weak flash indicates an open circuit.

Repeat the test between all segments, turning the armature so each test is made in the same position relative to the growler. If an open circuit is found, check for loose or broken wires at commutator connections. If none are found that may be repaired, armature must be replaced. All soldering should be done with rosin flux.

REPAIRING COMMUTATOR

A generator that has been in extended service may fail to deliver enough current to keep the battery in a charged condition although its field coil and armature windings are in serviceable condition. In such cases the commutator and/or brushes are usually at fault. If the commutator has been worn down until the mica separations between segments are no longer undercut or recessed, the commutator probably is grooved noticeably in path of brush travel and no slot between commutator segments exists, causing the brushes to ride high and make only intermittent contact with commutator.

The commutator may be turned down in a lathe and sanded with fine sandpaper until true and smooth. Mount armature in lathe on its bearing seats not on shaft centers. Never sand a commutator with emery cloth. Particles will imbed themselves in the copper surface, holding the brushes off the commutator far enough to cause heavy arcing and burning.

After commutator has been turned down, the mica insulation between segments must be recessed or undercut approximately .025 in. Undercutting is usually done with a special undercutting machine. If one is not available, satisfactory undercutting may be done with a piece of hacksaw blade. Carefully thin down blade width, if necessary, until offset saw teeth are the same width as slots in commutator. Slots must be square-bottomed for good results. See Figure 5-17.

Sand commutator surface on lathe and repeat growler test to be sure there are no copper particles between segments.

Open circuited armatures can often be repaired. The break or opening in the circuit usually occurs at the commutator riser bars, a result of overloading the generator which causes overheating and the melting of solder at the joint. Resolder the leads in the riser bars using rosin flux. Turn down commutator and sand to remove any burn spots as described in previous paragraph.
Polarizing Generator

Assemble generator as described in "ASSEMBLING GENERATOR." After a generator has been repaired, it must be repolarized to make sure that it has the correct polarity for charging in the right direction.

A generator that is put into service with the wrong polarity may result in burned relay points, a dead battery and damage to the generator.

**Note**

For 1977 and earlier models, polarize the generator by momentarily connecting the "BAT" and "GEN" terminals with a jumper wire.

Polarize the generator by momentarily connecting the "BAT" and "GEN" terminals with a jumper wire.

1. Generator on bench: Connect the positive terminal of a battery to the armature terminal of the generator. Then, momentarily connect the negative battery terminal to the generator field terminal.

2. Generator on motorcycle and connected to regulator: Connect one end of a jumper wire to the generator armature terminal. Momentarily touch the other end of the jumper wire to the positive terminal of the battery. This restores the magnetism. Remove jumper.

3. Loss of remnant magnetism: Sometimes a DC generator loses its remnant magnetism. This manifests itself by a total lack of output current. Remedy as in 2 above.

**Caution — Do not ground the generator field terminal for longer than 10 seconds when the engine is running as this may damage the regulator or generator.**

**Generator Charging Rate**

After a generator has been repaired, assembled, installed on motorcycle, connected and polarized, it may be checked for maximum output. That is, the maximum, uncontrolled amperage output range may be checked to determine the success of the repair work. This test is described in previous paragraph "TESTING GENERATOR OUTPUT." This test will not, however, indicate if the battery and generator are being protected by proper regulator function. See "VOLTAGE REGULATOR."

**Disassembling Generator**

(Figure 5-12)

Remove generator from engine gearcase as described in "REMOVING GENERATOR."

Remove gasket (1). Remove gear shaft nut (2) and washer (3). Remove generator drive gear (4) using Gear Puller, Part No. 95715-19A or All Purpose Claw Puller, Part No. 95635-46, and Wedge Attachment, Part No. 95637-46. Slip drive end oil deflector (5) off armature shaft.

Remove brush cover strap (6). Turn off commutator end cover nuts (7) and remove washers (8). Pull frame screws and washers (9) out of frame. Tap commutator end cover (10) gently with small mallet and remove. Remove nuts (11) and washers (12) to free positive brush cable and brush leads. Remove brush holder mounting plate (13).

Press armature (14) out of bearing on arbor press or by clamping generator frame between copper jaws in vise and tapping gear drive shaft end with rawhide mallet.

Remove terminal screw nuts (15), lockwashers (16), and insulating washers (17). Remove terminal screws (22 and 24) from inside generator frame and remove from them terminal insulator (18), terminal bolt clip (19), terminal screw bushings (20), bracket insulator (21) and positive brush cable (23).

Remove two pole shoe screws (30). Use large, heavy, screwdriver. Screws are turned extremely tight. Remove pole shoes (31) and field coils (32) from frame (33). Do not remove pole shoe screws, pole shoes and field coils unless necessary to replace faulty parts.

CLEANING, INSPECTING AND REPAIRING (Figure 5-12)

Clean all parts except gasket, armature, field coils and brushes in cleaning solvent and blow dry with compressed air. Wipe rest of parts clean with cloth dampened in Harley-Davidson Safety Solvent, Part No. 99631-77 and blow dry with compressed air.

Examine all parts carefully for wear. Give close attention to condition of insulators, armature windings, field coil wrapping and surfaces of pole shoes nearest armature. If armature had oily appearance before cleaning, replace oil seal. Replace any part of brush holder mounting assembly that is bent.

Disassemble parts as far as necessary in order of numbers shown in Figure 5-12, lowest number first.

Check play in armature ball bearing. If any play can be detected, replace part.

Check fit of armature shaft in roller bearing (44). If fit is obviously too loose, replace as follows:

REMOVING ROLLER BEARING (Figure 5-12)

Press out worn bearing. Support end cover and press on closed end of new bearing until it is flush with surface of end cover.

ASSEMBLING GENERATOR (Figure 5-12)

1. Assemble all parts to the brush holder mounting plate (13).

2. Position pole shoes (31) in field coils (32) and insert in frame. Turn in pole shoe screws until snug. Place frame in vise and use very large screwdriver to securely tighten screws. Use a wrench to turn screwdriver while bearing down with considerable force to keep screwdriver from slipping out of slots. Shoes will align themselves in frame.

3. Place bearing retainer (27) in inner groove in drive end plate (28). Press in bearing (26) to seat against retainer. Compress bearing retainer (25) with needle nose pliers and insert in outer groove.

4. Turn drive end plate back side up and press oil seal (29) in place. Insert armature (14) drive end shaft and press in until shoulder seats.

5. Slip “A” terminal field coil lead on positive terminal screw (24), followed by positive brush cable (23), a terminal screw bushing (20), bolt clip (19) and the terminal insulator (18). Insert the assembly through “A” terminal frame hole from inside. Assemble the insulating washer (17), lockwasher (16) and nut (15) over terminal screw.

6. Slip “F” terminal screw (22) into “F” terminal field coil lead, bracket insulator (21) and screw bushing (20). The assembly is then slipped into “F” terminal frame hole through the bolt clip and terminal insulator. An insulating washer (17), lockwasher (16) and nut (15) are assembled over terminal screw.

7. Slip frame assembly over armature, locating pin (48) in hole in drive end plate. Bend loose end of positive brush cable out commutator end of generator. Push brushes back in brush holders to clear commutator and assemble brush holder mounting plate over commutator so pin (48) registers in small slot and brush cable passes through large slot almost directly opposite.

8. Connect positive brush cable and positive brush lead to insulated brush holder terminal with washer (12) and nut (11). Connect grounded (negative) brush to its terminal in same manner.

9. Install commutator end cover (10) over armature shaft end so notch in edge registers over pin (48) in frame. Slip internal lockwashers over frame screws (9) and feed them through generator from drive end. Assemble lockwashers (8) and nuts (7) to frame screws and tighten securely. Turn armature shaft to see if it is bound or if armature core strikes pole shoes. Shaft should be reasonably difficult to turn but there should be no tight spots. If armature core strikes pole shoes, generator ends are not seated properly or pole shoes are not drawn up tightly.

10. Slip drive end oil deflector (5), drive gear (4) and washer (3) over shaft and turn on nut (2) until gear is seated against oil deflector. Install brush cover strap (6) with connection at bottom as positioned on motorcycle. Coat gasket (1) with gasket sealer and position on generator. Install in reverse order of disassembly as described in "REMOVING GENERATOR."
CIRCUIT BREAKER

DESCRIPTION

The ignition system has two circuits, the primary circuit and the secondary circuit. The primary circuit consists of the battery, switch, primary coil, breaker points, condenser and associated wiring. The secondary circuit consists of the secondary coil, the spark plugs and associated wiring.

The circuit breaker has two functions. First, the breaker cam and contact points open and close the low tension circuit between the battery and ignition coil causing the coil to produce high voltage discharge to the spark plugs. Second, the circuit breaker times discharge for proper engine firing.

The breaker points are operated by a cam with a narrow and wide lobe. The narrow lobe times the front cylinder and the wide lobe times the rear cylinder. A single ignition coil fires both spark plugs at the same time, but one spark occurs in the exhaust stroke of one cylinder and the other spark fires the combustible gases in the other cylinder to produce the power stroke.

The spark timing cam is advanced automatically as engine speed increases through action of the flyweights in the circuit breaker base. This ensures correct spark timing to suit both starting and running requirements.

OPERATION

In tracing the current through the ignition system the initial current comes from the battery. The current flows from the battery through the primary coil to ground and back to the battery while the points are closed. When the cam opens the points, the circuit is broken so that a high voltage surge is produced from ignition coil primary to secondary. This voltage will cause a spark to jump the air gap of the plugs.

The condenser is connected to the circuit breaker points and functions to produce a quick collapse of the magnetic field in the coil so that high voltage will be produced. In doing this, the condenser acts to prevent current from continuing to flow across the contact points after points open.

The engine must be timed to fire at the proper point before top dead center on the compression stroke of each cylinder. This procedure is covered under subsequent headings.

TROUBLESHOOTING

Disengage spark plug cable and insert a metal rod, screw or nail into each spark plug cable. Arrange cable end so tip of inserted metal object is 1/4 in. away from the cylinder head. Turn on the ignition, break the points by hand. See if a "hot" or "blue" spark is obtained between inserted metal object and cylinder head. If not, it is an indication of a weak coil, dead battery, broken or loose wires, etc. Arcing of the points and hard starting indicates a faulty condenser.

Circuit breaker point contacts should be checked for gap and surface condition initially at 500 and 1000 miles, and every 2000 miles thereafter. Point contacts that have undergone considerable use, may not appear bright and smooth. However, this should not be interpreted as meaning points are worn out. Circuit breaker points that are burned or pitted should be replaced.

ADJUSTING POINTS

1970 MODELS

See Figure 5-18 and proceed as follows:

Check the gap between the contact points (5) with a feeler gauge (wire preferred). Point gap should be exactly .020 in. when lever fiber (2) is on the highest point of cam (1). Incorrect point gap spacing affects ignition timing. To adjust the points, loosen lock screw (6) and move the eccentric adjusting screw (7) to provide correct contact point gap. Retighten lock screw (6) and again check the gap to be sure it remains correct.

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![Figure 5-18. Circuit Breaker (1970)](image-url)

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5-29
ADJUSTING POINTS
1971 & LATER MODELS

See Figure 5-19 and proceed as follows:

Remove spark plugs to permit engine to turn easily and rotate flywheels so that cam follower (4) is on highest point of wide cam lobe (5). Check the gap between the contacts (10) with a .018 in. gauge (wire preferred). If it is not exactly .018 in. when the cam follower (4) is on highest point of cam, adjustment is necessary. Incorrect point gap spacing affects ignition timing. To adjust the points, loosen the lock screw (3) and move stationary contact plate, using screwdriver in adjusting notch (1) to provide correct contact point gap. Retighten the lock screw (3) and again check the gap to make sure it remains correct. Points in pitted or worn condition should be replaced.

IMPORTANT

Point gap should be the same for both small and large cam lobes. If variation exceeds .004 in., it is an indication that the cam is running eccentric and the condition should be corrected. See "ASSEMBLING."

CHECKING AND ADJUSTING TIMING
1970 MODELS

Remove spark plugs to permit engine to turn easily. Remove screw plug from timing inspect hole in left side of crankcase. Telescope front push rod cover so that opening and closing of valve can be observed. Remove circuit breaker cover and set circuit breaker point gap as described in "ADJUSTING POINTS."

Turn engine in direction in which it runs until front piston is on compression stroke (just after front intake valve closes), and continue turning engine very slowly (less than 1/2 revolution) until advanced timing mark on flywheel is aligned in inspection hole, as shown in Figure 5-18.

Note that cam must be turned clockwise with flyweights against stops, and held in this position while checking timing.

With cam turned clockwise against stop, timing mark (3) on top edge of circuit breaker cam (1) should align perfectly with breaker arm fiber cam follower (2). If it does not, shift circuit breaker head to attain alignment as follows:

Clamp (16) is located on circuit breaker stem to allow 360° adjustment range. Loosen clamp bolts (15) and shift circuit breaker head (10) clockwise (retard) or counterclockwise (advance) to attain alignment.

Circuit breaker cam must be fully advanced clockwise against stop when checking alignment of mark (3) with fiber cam follower (2).

NOTE

Cam (1) engages flyweights on camshaft in either of two positions 180° apart, but only one of these positions will give correct ignition timing. If cam (1) is removed for any reason and engagement with flyweight is lost see subsequent paragraph, "INSTALLING CIRCUIT BREAKER."

CHECKING TIMING WITH CIRCUIT TESTER

Timing mark (3, Figure 5-18) on cam is the approximate point at which contacts (5) open and front cylinder ignition spark occurs. When the wide cam lobe opens the points, rear cylinder ignition spark occurs. Connect a circuit tester such as a light bulb across the contact points to determine the exact point of contact opening. Loosen circuit breaker clamp nuts just enough to shift circuit breaker head (10) so

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**Figure 5-19. Circuit Breaker (1971 & Later)**

1. Contact point adjusting notch
2. Moving contact point
3. Stationary contact point
4. Cam follower
5. Breaker cam
6. Circuit breaker plate screw (2)
7. Condenser
8. Circuit breaker plate
9. Circuit breaker plate adjusting notch
10. Contacts
11. Timing inspection hole
12. Advance timing mark on flywheel for front cylinder piston 1971 & later 40° BTC
contacts will open exactly when flywheel advanced timing mark (18) is aligned in center of inspection hole (17). Be sure to rotate cam clockwise as far as it will go and hold in this position when checking timing. (This procedure will result in approximate timing and engine can be operated in an emergency for a short period until the following accurate timing procedure can be followed.)

NOTE
The above timing will be approximate (slightly retarded) because of circuit breaker drive gear lash and end play which exist when engine is not operating. To set ignition timing accurately, it must be checked with a strobe light timing gun with the engine running according to the procedure in the following paragraph.

CHECKING TIMING WITH STROBE LIGHT
With engine running cam will automatically advance above idle speed. To check advanced spark timing, operate engine at 2000 rpm using Strobe light timing light to view advanced timing mark (see Figure 5-20). Timing light leads should be connected to front spark plug, ground, and positive red wire to battery terminal. A clear plastic Timing Hole Plug, Part No. 96295-65 is available for screwing into the crankcase hole for viewing the flywheel timing mark to prevent oil spray while the engine is running. Adjustment in timing is made with the engine running by loosening circuit breaker stem clamp slightly and rotate head into correct position as described previously.

![Strobe Light Checking Timing](image)

Acceptable range of timing front and rear cylinder

Figure 5-20. Checking Timing with Strobe Light

CHECKING AND ADJUSTING TIMING 1971 & LATER MODELS

CHECKING TIMING WITH STROBE TIMING LIGHT (Figure 5-20)
Use a strobe flash timing light (timing gun) to view front cylinder advance timing mark (12) on flywheel through accessory plastic view plug screwed into timing inspection hole (11) while engine is running at 2000 rpm. Timing light leads should be connected to front spark plug, ground and positive red wire to battery terminal. Light will flash each time front cylinder spark occurs. Loosen circuit breaker plate screws (6) just enough so circuit breaker plate (8) can be shifted using a screwdriver in notch (9) as light aimed into inspection hole (11) stops timing mark (12) in center of hole.

NOTE
Rear cylinder advance timing mark is a double dot which should appear on or near the front cylinder advance timing mark while viewing with timing light. See Figure 5-20.

Timing will retard 30° automatically when engine is stopped.

Accurate advanced ignition timing cannot be obtained except with use of a strobe timing light. However, in an emergency, when one is not available, circuit breaker plate can be adjusted so screws (6) are in center of slots where engine will operate satisfactorily at low speed until more accurate timing can be obtained with a strobe timing light.

DISASSEMBLING AND ASSEMBLING 1970 MODELS

REMOVING CIRCUIT BREAKER FROM ENGINE (Figure 5-18)
Thoroughly clean area around circuit breaker and blow all loose dirt from crankcase with compressed air, and remove stem clamp bolts (15) and clamp (16) to free entire circuit breaker from crankcase.

INSPECTING AND REPLACING PARTS (Figure 5-21)
Remove cover screws and lockwashers (2) and cover (1). Using cloth dampened with Harley-Davidson Safety Solvent, Part No. 99631-77, wipe circuit breaker clean and inspect parts.

Inspect circuit breaker contact points (5, Figure 5-18). If lever fiber (2) is badly worn, replace points. Points that are burned or pitted should be replaced or dressed with a clean, fine cut contact point file. Do not attempt to remove all roughness nor dress point surfaces down smooth; merely remove scale or dirt. Contact point file should not be used on other metal and should not be allowed to become greasy or dirty.

Never use emery cloth or sandpaper to clean points, since particles will embed themselves and cause arcing and rapid burning of points.

Circuit breaker points should be replaced, if contact point pressure is not within prescribed limits of 14 to 18 oz. Check pressure with a spring gauge. The scale should be hooked to the breaker lever at an angle of 90 degrees with the point surface and reading taken just as points break. Excessive pressure causes rapid wear of fiber block, cam, and contact point. Insufficient pressure will permit high speed point bounce which will, in turn, cause arcing and burning of the points and missing of the engine.

Point faces must seat squarely against each other. If bent, square up by bending contact plate.
To replace a set of circuit breaker points, loosen screw (11, Figure 5-18) and slip condenser wire and connection from screw. Lift circuit breaker lever (12) from screw (11) and pivot stud (13). Remove screw (8) and circuit breaker contact point and support (14). Install new points in reverse order of disassembly. Position circuit breaker lever (12) lever notch registered with screw (11), between brass washer and condenser wire end. Be sure point faces seat squarely against each other. Adjust point gap as previously described in “ADJUSTING POINTS.”

Lubricate breaker cam with a trace of Harley-Davidson Hi-Temp Grease, Part No. 99962-72 when points are replaced or every 5000 miles. Also remove cam and lubricate shaft. Replace cam in correct position.

Check circuit breaker advance flyweight action by moving cam in direction required to advance weights to their fully extended position. Then release the cam and see if springs return to the fully retarded position. Correct causes for faulty action by cleaning and lubricating shaft, cam and flyweights and replacing weak springs.

Be extremely careful to avoid excessive lubrication. If too much grease is used, the excess is apt to get on the contact points and cause them to burn.

For maximum operating efficiency it is recommended practice to replace circuit breaker points when pitted, burned or worn excessively.

The condenser (4) is a relatively long life part and will not require frequent replacement. However, if the condenser is suspected of being defective simply replace with a proven new condenser and note whether engine performance is improved. A condenser that is defective will have either an open or short circuit. An open circuit will be evident by excessive arcing at breaker contact points and a shorted circuit will have no noticeable spark at the contact points.

Examine the circuit breaker base pivot stud (13) for wear or damaged condition. Try circuit breaker base (10), Figure 5-21 in stem (16) for free turning, but not loose fit. If base is found excessively worn or damaged in any way, renew it.

Examine the coil to circuit breaker low tension wire (12, Figure 5-21) for brittle or cracked insulation and broken strands and replace if defective. Inspect circuit breaker wire stud insulator (15) and fiber washer (13) for brittle or cracked condition. Unless inspection shows insulation defective, it is not necessary to remove stud, insulator and washers.

Examine cam advance mechanism on automatic advance circuit breakers to see that flyweights (20) move outward freely and springs (22) return them inward against stops. Check for looseness of cam (18) on spindle (24) and wear on sides of flyweight (20) ears which engage slots in cam. Check springs (22) and replace if stretched or distorted.

To disassemble mechanism pry clips (19) from grooves in pivot pins on stem plate (24). Inspect teeth on worm gear (26) for excessive wear and damage. Check the amount of end play and side play of shaft (24) in stem. End play in excess of .008 in. or excessive side play of shaft in stem bushings will affect ignition timing and also allow oil from cam gear base to enter breaker assembly base to contaminate ignition points.
If renewal of shaft or stem parts is necessary remove pin (25) from gear and lift or press circuit breaker camshaft from gear. Withdraw camshaft from base. If bushings have excessive wear, timer stem assembly can be replaced or stem assembly can be rebushed by drilling out old bushings and installing new bushings. New bushings should require no reaming. When reassembling gear and breaker camshaft use spacer washer (27, Figure 5-21) (.062 thick), (.086 thick), (.072 thick) or (.076 thick) to obtain a .001 to .007 in. shaft end play.

When assembling circuit breaker shaft in breaker stem, always secure gear and spacer washer to shaft with new steel pin riveted in place. Rotate shaft to be sure it is free in stem.

INSTALLING CIRCUIT BREAKER (Figure 5-21)
Remove spark plugs to permit engine to turn easily; remove screw plug from timing inspection hole in left side of crankcase. Telescope front push rod cover so that opening and closing of valve can be observed. Turn engine in direction in which it runs until front piston is on compression stroke (just after front intake valve closes) and continue turning engine very slowly (less than 1/2 revolution) until advance timing mark (Figure 5-18) on flywheel is aligned in the inspection hole.

Assemble circuit breaker as follows: Lubricate camshaft end of shaft and stem assembly (24) and install breaker cam (18) on camshaft so that notches in cam engage with flyweights (20). Place breaker base (10) on stem and shaft assembly. Install nuts and washers (21). Do not overtighten. Install new seal (17). Before installing circuit breaker, turn shaft gear to approximately align cam mark (3) with cam follower (2) as shown in Figure 5-18. Insert circuit breaker into gearcase with wire toward rear of engine. This will position circuit breaker points to outside of engine permitting access to adjusting screws when cover is removed.

With flywheel ignition timing mark in center of timing hole in crankcase, observe how close timing marks on cam lobe lines up with breaker lever fiber. If fiber is not close to cam lobe timing mark, lift circuit breaker assembly and turn shaft gear in correct direction so engagement with driving gear is changed one tooth and reinstall circuit breaker in gearcase to get approximately close alignment of fiber and cam mark. Reinstall stem clamp (29, Figure 5-20) and tighten clamp bolts (30) being sure cam mark and fiber are still in alignment.

Adjust ignition timing. See previous paragraph “CHECKING AND ADJUSTING IGNITION TIMING.”

DISASSEMBLING AND ASSEMBLING 1971 & LATER MODELS

REMOVING CIRCUIT BREAKER PARTS (Figure 5-22)
Remove circuit breaker cover screws (1), cover (2) and gasket (3). Pull wire terminal (4) from breaker contact assembly (12) terminal post. Remove circuit breaker cam bolt (5). Remove breaker plate screws (6, 6A or 6B) and lockwashers and washers (7) or retainer (7A), free breaker plate assembly (8).

Remove cam (9) from advance assembly (10) and remove advance assembly from gearcase cover.

To remove circuit breaker contact assembly (12) from circuit breaker plate (13), pull condenser (15), terminal from breaker contact terminal post. Also unhook flat spring from terminal post. Remove screw (11) to free point set from breaker plate (13). To remove condenser (15), remove screw and lockwasher (14) from breaker plate (13).

To disassemble advance mechanism, unhook spring (16) loops from grooves in pivot pins and slip flyweights (17) with spring from pivot pins on advance base (18). Do not remove springs from flyweights unless they are to be replaced. Roll pins (18, 19 and 20) are pressed in and can be replaced if necessary.

INSPECTING AND REPLACING PARTS (Figure 5-22)
Using cloth dampened with Harley-Davidson Safety Solvent, Part No. 99631-77, wipe circuit breaker clean and inspect parts.

Inspect circuit breaker contacts (12). If lever rubbing block is badly worn, replace. Contacts that are burned or pitted should be replaced or dressed with a clean, fine-cut contact point file. Do not attempt to remove all roughness nor dress contacts surfaces down smooth; merely remove scale or dirt. Contact point file should not be used on other metal and should not be allowed to become greasy or dirty. Never use emery cloth or sandpaper to clean contacts since particles will embed themselves and cause arcing and rapid burning.

Circuit breaker contact assembly (12) should be replaced, if contact point pressure is not within prescribed limits of 14 to 18 oz. Check pressure with a spring gauge. The scale should be hooked to the breaker lever at an angle of 90 degrees with the point surface and reading taken just as contacts break. Excessive pressure causes rapid wear of rubbing block, cam, and contacts. Insufficient pressure will permit high speed bounce which will, in turn, cause arcing and burning of the contacts and missing of the engine.

Contact faces must seat squarely against each other. If bent, square up by bending plate on levers.

Inspect lip of cam seal (21) and replace it if worn or rough. Also replace seal if there is evidence of oil leakage into circuit breaker arm.

When installing contacts, be sure contact faces seat squarely against each other. Adjust gap as previously described in “ADJUSTING POINTS.”

Check flyweight springs, and if bent or stretched, replace them. When installing, be sure that bent end of each spring is hooked through bottom of hole, and that upper looped end grips groove in pin tightly. (See Figure 5-23.)

Lubricate breaker cam with a trace of Harley-Davidson Hi-Temp Grease, Part No. 99862-72, when contact set is replaced or every 5000 miles. Also remove cam and lubricate shaft and flyweight bearing surfaces with Harley-Davidson “Anti-Seize.” Part No. 99632-77, spray type lubricant. Replace cam in correct position so that it engages both flyweights and flat side is next to roll pin (19).
1. Circuit breaker cover screws (2)
2. Circuit breaker cover
3. Circuit breaker cover gasket
4. Wire terminal and wire
5. Circuit breaker cam bolt
6. Breaker plate screw (2) (early 1971)
6A. Breaker plate screw (2) (late 1971 to 1972)
6B. Breaker plate screw (2) (1973 & later)
7. Breaker plate screw lockwasher and washer (2) (early 1971)
7A. Retainer (late 1971 to 1972)
8. Breaker plate assembly
9. Breaker cam
10. Advance assembly
11. Breaker contact screw (early 1972 & earlier)
12. Breaker contact assembly
13. Breaker plate
14. Condenser screw and lockwasher (2, late 1972 & later)
15. Condenser
16. Flyweight spring (2)
17. Flyweight (2)
18. Flyweight roll pin (2)
19. Cam stop roll pin
20. Register roll pin
21. Camshaft seal
22. Gearcase cover

Figure 5-22. 1971 & Later Circuit Breaker - Exploded View
Check circuit breaker advance flyweight action by moving cam in direction required to advance weights to their fully extended position. Then release the cam and see if springs return to the fully retarded position. Correct causes for faulty action by cleaning and lubricating shaft, cam and flyweights and replacing weak springs.

Be extremely careful to avoid excessive lubrication. If too much grease is used, the excess is apt to get on the circuit breaker contacts and cause them to burn.

For maximum operating efficiency it is recommended practice to replace circuit breaker contacts when pitted, burned or worn excessively.

The condenser (15) is a relatively long life part and will not require frequent replacement. However, if the condenser is suspected of being defective simply replace with a proven new condenser and note whether engine performance is improved. A condenser that is defective will have either an open or short circuit. An open circuit will be evident by excessive arcing at breaker contacts and a shorted circuit will have no noticeable spark at the contacts.

Examine the coil to circuit breaker low tension wire (4, Figure 5-22) for brittle or cracked insulation and broken strands and replace if defective.

Examine cam advance mechanism on automatic advance circuit breakers to see that flyweights (17) move outward freely and springs (16) return them inward against stops. Check for looseness of cam (9) on spindle (10) and wear on sides of flyweight (17) ears which engage slots in cam. Check springs (16) and replace if stretched or distorted.

ASSEMBLING

Assemble circuit breaker parts in reverse order of disassembly. Refer to “REMOVING CIRCUIT BREAKER PARTS” in this section.

Advance assembly (10, Figure 5-22) must seat squarely and firmly on end of camshaft.

Assemble circuit breaker plate (8, Figure 5-22) so that screws are centered in slots (for approximate timing).

Adjust circuit breaker point gap to .018 in. and set ignition timing as described under “CHECKING AND ADJUSTING IGNITION TIMING.”

IMPORTANT

Circuit breaker point gap should be within .016 to .020 in. limits on both cam lobes. If not within this range, the cam (9, Figure 5-22) or advanced assembly (10, Figure 5-22) may be assembled incorrectly on camshaft, or parts may be damaged, causing eccentric operation. Generally, loosening bolt (5) and repositioning advance assembly (10) toward widest point gap will equalize gap satisfactorily.
IGNITION COIL

DESCRIPTION
The ignition coil is a pulse transformer that transforms or steps up low battery or generator voltage to high voltage necessary to jump the electrode at the spark plug in the engine cylinder head. Internally, coil consists of primary and secondary windings with laminated iron core and sealed in waterproof insulating compound. Case cannot be taken apart or coil repaired.

TROUBLESHOOTING
When hard starting or missing indicates a faulty ignition system, first, check condition of battery. If lamps light with full brilliance and horn blows, indicating current source is in at least fair condition check, clean or replace spark plug. If this does not correct performance, inspect circuit breaker points and install new condenser. If condition persists, check primary and secondary resistance of ignition coil with an ohmmeter. Resistances should be within the following limits: Primary resistance 4.7 to 5.7 ohms, secondary resistance 16,000 to 20,000 ohms (16k to 20k).

If an ohmmeter is not available, temporarily substitute a new ignition coil by attaching it at any convenient point near old coil (coil will function without being securely grounded). Transfer terminal wires to new coil. Attach new coil cables to spark plugs. If ignition trouble is eliminated by the temporary installation of new coil, carefully inspect old coil for damaged cables and insulation. The insulation on cables or coils may be cracked or otherwise damaged allowing high tension current to short circuit. This is most noticeable in wet weather or when motorcycle has been washed.

Replacing plug cable is the only repair that can be made to an ignition coil. If this does not correct faulty coil performance, coil is defective and must be replaced.

REPLACING SPARK PLUG CABLE (Figure 5-24)

Remove old cable (1) from coil terminal and install new cable. Always be certain that cable boot or cap (2) is securely tightened to the coil tower to prevent moisture and dirt from contacting the high tension lead. Replace boot or cap if damaged or loose fitting.

Resistor type high tension cables are used. This type cable has a carbon impregnated fabric core instead of solid wire for radio noise suppression and improved reliability of electronic components. For this reason it is recommended that the exact replacement cable is used.

CAUTION — When disconnecting cable connector from spark plug terminal, do not pull on cable itself because carbon core will become damaged. Always pull on rubber boot as close as possible to the spark plug terminal.
GENERAL

Harley-Davidson spark plugs (Figure 5-25) have been designed to give maximum life and efficient combustion of fuel. They are available in various “heat ranges,” each for a particular service application. Plugs are labeled with numbers 2, 3, 4, 4A or 5 the lowest number indicating the “hottest” plug. Designations 3-4 and 5-6 are special purpose plugs.

For normal service after break-in, the No. 5 spark plug is recommended. However, for special service conditions, a “colder” or “hotter” plug may be desired. The number 4 plug is used on original equipment for break-in service, but the number 3 plug could be used for slow speed service. The number 5 plug is recommended for normal highway travel and maximum throttle operation. The 4R plug has a resistor element to reduce radio interference originating in the motorcycle ignition system. The resistor element will not affect engine performance or fuel economy. It is not uncommon for best results to be obtained with plugs of different heat ranges in front and rear cylinders, with the front usually the colder.

![Figure 5-25. Spark Plug Heat Range](image)

REMOVING SPARK PLUGS

Disconnect wires from plugs, as described earlier. Use a deep socket wrench or special spark plug wrench to loosen plugs. Blow away all dirt from plug base with compressed air before removing plug.

CLEANING, INSPECTING AND REPAIRING (Figure 5-26)

Examine plugs as soon as they have been removed. The deposits on the plug base are an indication of the correctness of the plug heat range and efficiency, as well as a guide to the general condition of rings, valves, carburetor and ignition system.

A wet, black and shiny deposit on plug base, electrodes and ceramic insulator tip (A) indicates an oil fouled plug. The condition is caused by burned rings and pistons, loose valves, weak battery, faulty ignition wires, circuit breaker trouble, weak coil or a cold plug.

A dry, fluffly or sooty black deposit (B) indicates plug is gas fouling, a result of a too rich carburetor air-fuel mixture, long periods of engine idling or a cold plug.

![Figure 5-26. Type of Plug Base Deposits](image)

An overheated plug (C) can be identified by a light brown, dry, glassy looking deposit. This condition may be accompanied by cracks in the insulator tip and is caused by too lean an air-fuel mixture, a hot running engine, valves not seating, improper ignition timing or too hot a plug for the service. The oxide deposit on the spark plug is a conductor when hot. It will cause plug to misfire, especially at high speed.

A plug with a rusty brown to tan powdery deposit (D) indicates a balanced ignition and combustion condition. With leaded gasolines the deposits may be white or yellow. In either case, ignition functions through the deposits if only light and the deposits should be cleaned off at regular intervals to keep them from building up.

When spark plug electrodes have become eroded away (C) to the point where gap setting is difficult or impossible, the plug should be replaced. Plugs with cracked insulator should also be discarded.
Clean plugs with an abrasive blast spark plug cleaner. Rotate plug top while applying sand blast to clean insulator and electrodes. Cleaning time should be carefully limited to just what is necessary to clean deposits from insulator nose. Prolonged use of abrasive blast will wear away insulator. Normally three to five seconds of sand blasting is sufficient. Never use metal instruments to remove deposits from plugs.

**SETTING SPARK GAP**

Before setting spark gap on used plugs, pass a thin point file between electrodes to produce flat, parallel surfaces to facilitate accurate gauging.

Use only a wire type gauge. Bend the outside or grounded electrode so only a slight drag on the gauge is felt when passing it between electrodes. Never make adjustments by bending the center electrode. Set gap on plugs at .025 to .030 in.

**TESTING SPARK PLUGS**

Check the sparking ability of a cleaned and regapped plug on a sparking comparator if possible. An inability to withstand rapid firing under cylinder compression conditions can be discovered.

**INSTALLING SPARK PLUGS**

Before turning spark plugs into cylinder heads, check condition of threads in head and on plug. Soften deposits in cylinder head with penetrating oil and clean out with tap or old plug.

Install spark plug finger tight and then torque to 26 to 30 ft-lbs. If a torque wrench is not available, tighten finger tight and then using a spark plug wrench, tighten an additional 1/4 to 3/8 turn.

Check and adjust engine idle speed and mixture setting after installing plugs if necessary.
REGULATOR - 1977 & EARLIER

GENERAL

Two unit voltage regulators and three unit current and voltage regulators are used to control generator output to the electrical system.

Normally the regulator does not require attention at regular service intervals; however, point cleaning, point setting and air gap adjustments may be necessary if regulator is not functioning correctly.

Four basic tests are required:
1. Test the generating system to determine whether the generator or regulator is at fault.
2. Test the cutout unit closing voltage.
3. Test the voltage control unit setting.
4. Test the current control unit setting.

Voltage and current settings for regulators are listed in the following table of specifications.

Before making any checks or adjustments, the charging circuit must be operated approximately 15 minutes to bring regulator to normal operating temperature. Regulator cover and gasket must be in place.

Two methods are used for making regulator tests, the method used depending upon the type of equipment available.

METHOD I employs separate voltmeter, ammeter, fixed resistances of 1/4 ohm and 1-1/2 ohm, and 25 watt variable field resistor. This is the method outlined in detail in the Delco-Remy Service Bulletins.

METHOD II employs single test instrument incorporating the same components as Method I, and in addition has a variable load resistance. The equipment used is a VAT 26 voltage-ampere tester manufactured by the Sun Equipment Corporation.

REGULATOR TEST SPECIFICATIONS - 1977 & EARLIER

<table>
<thead>
<tr>
<th>Model</th>
<th>Regulator Part Number</th>
<th>Manufacturer’s Number</th>
<th>For Testing Procedure See Delco-Remy Service Bulletin Number</th>
<th>Regulator Type</th>
<th>Adjustment and Range Amps</th>
<th>Adjustment and Range (Volts)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Current Regulator Setting</td>
<td>Cutout Relay Closing Voltage</td>
<td>Voltage Regulator Setting</td>
</tr>
<tr>
<td>XLH</td>
<td>74510-64</td>
<td>1119 614 Delco-Remy</td>
<td>1R 119A</td>
<td>3 Unit Current Voltage</td>
<td>10 (9.0-11.0)</td>
<td>12.4 (11.8-13.0)</td>
<td>14.3*</td>
</tr>
</tbody>
</table>

(*Upper contact operation. Operation on lower contacts must be .1 to .3 volt lower.)

Current Regulator Air Gap .075 in. Voltage Regulator Air Gap Varies with Setting

Cutout Relay Air Gap and Point Opening .020 in. Voltage Regulator Point Opening .015 in.

<table>
<thead>
<tr>
<th>Model</th>
<th>Regulator Part Number</th>
<th>Relay Cut-In Voltage</th>
<th>Regulator Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No Load</td>
<td>Load</td>
</tr>
<tr>
<td>XLCH</td>
<td>74511-65</td>
<td>12.4-13.1</td>
<td>12.7-14.5 @ 10 amp.</td>
</tr>
</tbody>
</table>

5-41
A. TESTING THE GENERATING SYSTEM (See Figure 5-27)
1. Disconnect wires from regulator "BAT" terminal and connect these wires to the negative lead of an ammeter (0-30 amperes). Connect positive ammeter lead to regulator "BAT" terminal.

2. Connect the positive lead of a voltmeter (0-20 volts) to the regulator "GEN" terminal. Connect voltmeter negative lead to ground on motorcycle.

3. Disconnect the wire from the regulator "F" terminal and connect this wire to a lead of a field control variable resistor. Connect other lead of field control variable resistor to ground on motorcycle. Set field control knob to open position.

4. Operate engine at 2000 rpm (approximately 40 mph).

5. Slowly turn field control knob toward direct position until the ammeter reads 10 amperes.

If ammeter reading is as specified, generator is not faulty and difficulty is in regulator. Make regulator tests B, C and D.

6. If there is no ammeter reading or reading is low, observe voltmeter reading. If voltmeter reading is below 12 volts, generator requires service.

7. If voltmeter reading is high, over 15 volts, the cutout relay is not closing. Make tests B, C and D.

NOTE

Before making adjustments or servicing regulator, identify by number stamped on regulator base, or mounting bracket, then refer to "REGULATOR TEST SPECIFICATIONS" Pg. 5-41 which contains service information for desired regulator. Delco-Remy Bulletins listed in table may be obtained from a Delco-Remy service station or the Harley-Davidson Motor Co. Inc.

B. TESTING CUTOUT RELAY UNIT CLOSING VOLTAGE (THE SAME CONNECTIONS ARE USED AS IN TEST A (Figure 5-27)

1. Turn field control variable resistor to open position.

2. Operate engine at 1500 rpm (approximately 30 mph).

3. Slowly turn field control knob toward direct position to decrease resistance in field circuit. Voltmeter reading will increase slowly until cutout points close. Closing voltage will be highest voltmeter reading before meter pointer "kicks" to read battery voltage. After cutout points close, ammeter will indicate a current flow.

If closing voltage is not within specifications, adjust setting according to manufacturer's service bulletin. (See table Pg. 5-41)

C. TESTING VOLTAGE CONTROL UNIT SETTING (Figure 5-28)

1. Remove battery wire from regulator battery "BAT" terminal. Connect a 1/4 ohm resistor (not less than 25 watts) in series with the removed battery wire and the regulator battery "BAT" terminal.

2. Connect the positive lead of a voltmeter (0-15 volts) to the regulator "BAT" terminal, connect the negative lead to ground.

3. Remove wire from regulator field "F" terminal and connect a 25 watt variable resistance field control in series with the removed wire and the regulator field "F" terminal, turn control knob to direct position (no resistance). Operate engine at 2000 rpm (approximately 40 mph). Turn field control resistor knob to "Open" position then to "Direct" position to cycle regulator. Check voltmeter reading. Reading indicated on voltmeter is the voltage regulator setting of the upper contacts (shorting contacts). Voltmeter reading should be within manufacturer's specifications as shown in the table on Pg. 5-41. Maintain engine speed, slowly rotate field control resistor toward "Open" position to increase resistance until voltmeter reading drops slightly and then remains steady. This indicates the voltage setting of the lower contacts (series contacts). The voltage difference between the settings of the two sets of contacts should be within specifications listed in table.
All final readings should be taken with cover in place.

If voltage readings are not within specifications, replace regulator or service and adjust settings (see "SERVICING REGULATOR").

CAUTION — Never ground the generator or regulator field terminal while these two units are connected and operating. This will burn up the upper set (shorting set) of contacts of the voltage control unit.

D. TESTING CURRENT CONTROL UNIT SETTING (Figure 5-29)

1. Remove battery wire from regulator "BAT" terminal and connect to negative lead of ammeter (0-30 amps). Connect positive lead of ammeter to regulator "BAT" terminal.

2. Connect positive lead of voltmeter to regulator battery "BAT" terminal and negative voltmeter lead to ground.

3. Turn on light and connect additional load to the battery to drop the voltmeter reading to one volt below voltage regulator setting.

4. Operate engine at 2000 rpm (approximately 40 mph) and note reading on ammeter. If reading is not within regulator specifications shown in Table replace regulator or adjust according to manufacturer's Service Bulletin.

METHOD I — TESTING BOSCH REGULATOR FOR XLCH MODEL (1977 & EARLIER)

NOTE

This regulator is a sealed unit and no servicing or adjusting is necessary or recommended. When some difficulty arises, checks can be made to determine if the regulator is controlling generator output within specifications. If voltage readings are not within specifications, regulator should be replaced.

A. TESTING GENERATING SYSTEM (Figure 5-30)

1. Disconnect wire from regulator battery terminal "B+.

2. Connect one lead from 1-1/2 ohm resistor (not less than 100 watt rating) to the regulator "B+" terminal. Connect the other lead from the resistor to the positive terminal of an ammeter (0-15 amp). Connect the negative ammeter lead to ground on motorcycle.

3. Connect the positive lead of a voltmeter (0-15 volts) to regulator "D+" terminal, connect the negative lead to ground on chassis.

4. Disconnect wire from regulator field "DF" terminal and connect this wire to one lead of a field control variable resistor, connect other lead of the field control to ground on motorcycle chassis. Turn field control to "Open" position.

5. Operate engine at 2700 rpm (approximately 45 mph).

6. Slowly rotate field control resistor knob toward the "Direct" position until ammeter reads 10 amperes, then immediately turn the control knob to "Open" position. If a reading of 10 amperes is obtained, generator is O.K. and any difficulty in the charging circuit is caused by a faulty regulator or defective wiring. Inspect wiring and make regulator tests B and C. If a reading of 10 amperes cannot be obtained and voltmeter reading is below 12 volts, generator is in need of service.

If no reading is obtained on ammeter but voltmeter reading is 15 volts or higher, cutout relay is defective and regulator should be replaced.

B. TESTING CUTOUT RELAY UNIT CLOSING VOLTAGE — SAME CONNECTIONS ARE USED AS IN TEST A (Figure 5-30)

1. Turn field control resistor knob to "Open" position.

2. Operate engine at 2000 rpm (approximately 35 mph).
3. Slowly turn field control toward "Direct" position. As the resistance is decreased, the voltmeter reading will increase. Note the highest reading on the voltmeter before the pointer "kicks." This will be the relay closing voltage. Repeat operation a few times, each time returning the field control resistor to "Open" position. If the closing voltage is not within specifications, replace regulator.

C. TESTING VOLTAGE CONTROL UNIT SETTING (Figure 5-31)

Two tests are required:
1. Testing regulator voltage setting under load.
2. Testing regulator voltage setting under no load.

Testing Voltage Setting Under Load (Figure 5-31)

1. Make same connections as used to make previous Test B, except move positive voltmeter lead to regulator "B+" terminal.
2. Turn field control resistor to "Direct" position (no resistance in field circuit).
3. Operate engine at 2700 rpm (approximately 45 mph) and note reading on voltmeter. This reading will be the voltage under load.

Testing Voltage Setting Under No Load

1. Remove 1-1/2 ohm resistor used in previous load test from circuit by disconnecting grounded ammeter lead. Place field control resistor in Direct position (no resistance).
2. With engine running at 2700 rpm, note voltmeter reading. This reading will be the voltage at no load.

Readings taken in Load and No Load tests must be within specifications or regulator should be replaced. See Table (Pg. 5-41) for specifications.

METHOD II — TESTING DELCO-REMY REGULATOR FOR XLH MODEL (1977 & EARLIER) (VAT 26) TESTER

A. TESTER CONTROLS

Turn ground polarity selector to negative; load control knob to direct; ammeter selector to 100A position; and voltage selector to 16V position.

B. TESTER CONNECTIONS (See Figure 5-32)

![Figure 5-32](image)

1. Remove "BAT" leads from voltage regulator.
2. Connect Regulator lead "R" of tester to "BAT" terminal of regulator.
3. Connect Battery lead "B" of tester to wires removed from regulator B+ terminal.
4. Connect Ground lead "G" of tester to ground of motorcycle.
5. Connect Positive voltmeter lead to "GEN" terminal of regulator.
6. Connect Negative voltmeter lead to ground of motorcycle.
7. Remove wire connected to regulator field "F" terminal and connect this wire to a lead of the field control variable resistor, the other lead of the field control resistor is connected to ground on motorcycle. Turn field control to "Open" position.

C. TESTING GENERATING SYSTEM

1. Operate engine at 2000 rpm (approximately 35 mph).
2. Slowly turn field control resistor knob to "Direct" position until ammeter reads 10 amperes.

If ammeter reading is as specified, generator is not at fault and difficulty is in voltage regulator or wiring. Make regulator Tests D, E and F.

3. If there is no ammeter reading or reading is low, observe voltmeter reading. If voltmeter reading is below 12 volts, generator requires service.
4. If voltmeter reading is over 15 volts, the cutout relay is not closing. Make following Test D.
NOTE
Before making adjustment or servicing regulator, identify regulator by Delco-Remy number stamped on regulator base or mounting bracket. Then, see table (Pg. 5-41), which contains service information for the desired regulator. Delco-Remy Bulletins listed in table may be obtained from Delco-Remy service station or the Harley-Davidson Motor Co.

D. TESTING CUTOUT RELAY UNIT CLOSING VOLTAGE
(Figure 5-32)

Use same tester connections as previous Test C. (Figure 5-32)

1. Turn field control variable resistor to “Open” position.
2. Turn load control knob to “Direct” position.
3. Operate engine at 1500 rpm (approximately 30 mph).
4. Slowly turn field control resistor knob toward “Direct” position observing voltmeter.

As resistance is decreased in field circuit, voltage will rise. Note highest reading before meter pointer “kicks” to read battery voltage. Repeat operation several times, each time turning field control to “Open” position. Highest reading observed is the cutout relay closing voltage.

If closing voltage is not within specifications listed in table, replace regulator or adjust according to manufacturer’s service bulletin.

E. TESTING VOLTAGE CONTROL UNIT SETTING
(Figure 5-33)

Same connections are used as in previous Test D except move Positive voltmeter lead to regulator battery “BAT” terminal and remove grounded lead of the field control variable resistor and connect to regulator field “F” terminal.

1. Turn field control knob to “Direct” position.
2. Turn load control to the 1/4 ohm position.

Operate engine at 2000 rpm (approximately 40 mph). Turn field control resistor knob to “Open” position then to “Direct” position to cycle regulator. Check voltmeter reading. Reading indicated on voltmeter is the voltage regulator setting of the upper contacts (shorting contacts), Voltmeter reading should be within manufacturer’s specifications.

Maintain engine speed, slowly rotate load control knob clockwise to increase load until voltmeter reading drops slightly and then remains steady. This indicates the voltage setting of the lower contacts (series contacts). The voltage difference between the settings of the two sets of contacts should be within specifications.

All final readings should be taken with regulator cover in place.

If voltage readings are not within specifications, replace regulator or service and adjust settings (see “SERVICING REGULATOR”).

CAUTION — Never ground the generator or regulator field terminal while these two units are connected and operating. This will burn up the upper set (shorting set) of contacts of the voltage control unit.

F. TESTING CURRENT CONTROL UNIT SETTING
(Figure 5-33)

Use same connections as previous Test E. Voltage Control Test.

1. Turn field control to “Direct” position.
2. Operate engine at 2000 rpm.
3. Turn load control clockwise until maximum reading is obtained on ammeter.

This reading will be equal to the current limiter setting. If not within specifications listed in table (Pg. 5-41), replace or adjust according to manufacturer’s service bulletin and retest. Take final reading with regulator cover in place.

METHOD II — TESTING BOSCH REGULARS FOR XLCH MODEL (1977 & EARLIER) (VAT 26 TESTER)

A. TESTER CONTROLS

Turn ground polarity selector to Negative; load control knob to Direct; ammeter selector to 100A position; and voltage selector to 16 volt position.

B. TESTER CONNECTIONS (See Figure 5-34)

1. Remove wire from regulator “B+” terminal.
2. Connect Regulator lead “R” of tester to regulator terminal “B+”.
3. Connect Ground lead “G” of tester to ground on motorcycle.
4. Connect Positive voltmeter lead to regulator terminal “D+” and connect Negative lead to ground on motorcycle.
5. Remove wire from regulator terminal “DF” and connect wire to a lead of the field control variable resistor. Connect the other lead of the field control to ground on motorcycle. Turn field control to “Direct” position. Turn load control to “Direct” position.

Battery lead “B” of tester is not connected for this test.

Figure 5-33.
C. TESTING GENERATING SYSTEM

1. Operate engine at 2700 rpm (approximately 45 mph).

2. Slowly rotate load control clockwise until a reading of 10 amperes is observed.

3. If a reading of 10 amperes is obtained, generator is not at fault and difficulty is due to faulty regulator or defective wiring. Inspect wiring and make Tests D and E.

4. If a reading of 10 amperes cannot be obtained and voltmeter reading is below 12 volts, generator is defective.

5. If no reading is obtained on ammeter but voltmeter reading is 15 volts or higher, cutout relay is defective. Regulator should be replaced and circuit retested.

D. TESTING CUTOUT RELAY UNIT CLOSING VOLTAGE

Make same connections as in previous Test C, except connect battery lead “B” of tester to 1-1/2 ohm connection on side of tester.

1. Turn load control to “Direct” position.

2. Turn field control variable resistor to “Open” position.

3. Operate engine at 2000 rpm (approximately 35 mph).

4. Slowly turn field control variable resistor toward “Direct” position while observing the voltmeter. As resistance is decreased in field circuit, voltage will rise.

Observe highest voltmeter reading before voltmeter pointer kicks back. Repeat operation several times, each time returning field control to “Open” position. Highest reading observed is the cutout relay closing voltage.

If closing voltage is not within specifications listed in table, replace regulator.

E. TESTING VOLTAGE CONTROL UNIT SETTING (Figure 5-35)

Two tests are required:

1. Testing regulator voltage setting under load.

2. Testing regulator voltage setting under no load.

Testing Voltage Setting Under Load

1. Make connections as in previous Test D, except switch positive voltmeter lead to regulator “B+” terminal, disconnect tester battery lead “B” from 1-1/2 ohm connector on tester, disconnect field control lead from ground connection on motorcycle and connect this lead to regulator “DF” terminal.

2. Turn field control resistor to “Direct” position (no resistance in field circuit).

3. Operate engine at 2700 rpm (approximately 45 mph).

4. Turn load control knob clockwise to load circuit until ammeter reads 10 amperes.

5. Voltmeter reading will be voltage setting under load.

Testing Voltage Setting Under No Load

1. Return load control knob to “Direct” position.

2. Turn field control resistor to “Direct” position.

3. Operate engine at 2700 rpm.

4. Voltmeter reading will be voltage setting at no load.

Both load and no load voltage readings must be within specifications listed in table or regulator should be replaced.

CAUTION — It is advisable to “flash” field coils whenever wires have been removed from regulator; or after generator or battery has been removed and is reinstalled. This is done to make sure generator has correct polarity. If polarity of generator is reversed, relay points will vibrate and burn. “Flash” field coils by momentarily touching a jumper wire between “BAT” terminal and “GEN” terminal on regulator, after all wires have been properly connected and before starting engine.
SERVICING REGULATORS
(1977 & EARLIER)

DELCO-REMY REGULATOR

Faulty operation of Delco-Remy regulators may be due to one or more of the following conditions:

1. Contact points dirty, oxidized or pitted - To clean contacts, refer to manufacturer's service bulletin, listed in table (Pg. 5-41).

After cleaning contacts, the air gaps and contact spacing must be adjusted. See table for information on the voltage regulator and cutout relay air gap and contact opening setting.

2. Ground wire broken (short braided wire between regulator base and mounting bracket).

3. Defective resistor (underneath regulator).
4. Corrosion contamination on regulator internal parts.

After any faults have been corrected, regulating units must be adjusted according to manufacturer’s service bulletin, see table.

BOSCH REGULATOR

Service or adjustment to internal parts of Bosch regulators is not recommended since contact spacing and air gaps are factory set. If tests indicate that the regulator is defective, it should be replaced.

NOTE

If a new regulator is installed, it should be checked out in operation on the vehicle.
REGULATOR - 1978

GENERAL

The solid state voltage regulator manufactured by Tympanium (patents pending) controls the output of the DC generator. It incorporates the electronic equivalents of the cut-out relay, the voltage relay and the current relay of its electromechanical predecessor. It is, however, insensitive to dust, dirt or vibration but has a more sensitive electronic circuit which holds the output to closer tolerances than before possible.

Figure 5-36 shows a simplified schematic diagram.

Diode D1 prevents current flow from the battery into the regulator and generator, but permits charging current to pass from the generator to battery and load.

Transistor Q1, through the voltage divider consisting of R1, Z1, and R2, senses the generator output voltage. When the output voltage rises, Q1 draws more current through R1, causing the voltage at the base of Q3 to drop. The generator field current I1, which flows into the collector of Q1, is thus reduced. This in turn causes the generator output voltage to drop. An equilibrium condition is reached whereby the generator supplies just enough current to the electrical load to maintain a constant preset output voltage.

When the output voltage drops through increased load or reduced rpm the reverse happens. Q1 draws less current which causes Q3 to draw more, which increases the output voltage.

Transistor Q2 senses the voltage across R1, which is a measure of the generator current. When the current exceeds a predetermined value Q2 turns on. This turns on Q4, which turns off Q5. The field current is reduced and so is the output current.

CHECKING CHARGING SYSTEM - 1978

GENERAL

When the charging system fails or is not charging at a satisfactory rate, as is visually evidenced by a weak battery, dim lights, or excessive battery water usage. It is recommended that the following checks be made.

PRELIMINARY CHECKS

Battery: Check for weak or bad battery. See Battery Section. Battery must be fully charged for following electrical tests.

Wiring: Check for corroded or loose connections in charging circuit. Particularly check for worn or pinched wires in the generator-to-regulator harness. Also check for corroded or loose terminals at generator. Remove rubber regulator connector plug and check for burned or corroded terminals. Regulator base must have a good, clean, tight connection for proper grounding.

ELECTRICAL CHECKS

If the preliminary inspection shows components to be in good condition, make the following electrical checks:

Regulating Voltage Check: (See Figures 5-37 and 5-38.) Connect an ammeter in series with the regulator output. Connect load rheostat (carbon pile) and voltmeter across battery. Check regulating voltage while running engine at 2000 rpm.

Adjust load rheostat (or carbon pile) to 2-7 amperes output. The voltage readings then should conform to the values given by the curves shown in Figure 5-39 at the temperature measured at the time of testing. For example, if the

Figure 5-36. Schematic Diagram - 1978
regulator temperature was +75°F, the upper voltage (from upper curve) would be 15.0 volts and the lower voltage (from lower curve) would be 13.8 volts.

If voltage exceeds upper limit of curve, check for ground in field circuit of generator (see "GENERATOR") or in regulator to generator field wire (green). If no ground is found, defect is probably in regulator - replace with known good unit.

If voltage is below lower limit on curve, proceed with output check. If system passes output check, regulator is out-of-specification - replace with known good unit.

Output Check:
Run engine at 2000 rpm and adjust load rheostat (carbon pile) to obtain a constant 12.5 volts. The output current should be 10 amperes minimum, 11 amperes maximum.

If no generator output current is obtained in the output check, polarize generator (see "POLARIZING GENERATOR").

Again check output at 2000 rpm per "Output Check." If still no generator output current is obtained, momentarily ground generator "F" terminal with engine running at 2000 rpm. (CAUTION — Do not ground "F" terminal for longer than 10 seconds - damage to generator or regulator can occur). With "F" terminal grounded, generator output should be 18 amps minimum. If output is O.K. with "F" terminal grounded, problem is most likely in regulator - replace with known good unit and retest. If output is low, check generator (see "GENERATOR"). If no output current is obtained, problem could be in regulator or generator. Check regulator as follows: Disconnect rubber regulator connector and connect ohmmeter between battery and generator wires (orange and tan wires on regulator). Re-
verse ohmmeter connections. Ohmmeter should show continuity (low resistance) with one set of ohmmeter connections, and open circuit (high resistance) with the other connection. If regulator checks O.K., check generator (see "GENERATOR"). If regulator does not pass ohmmeter test, replace with a known good regulator and retest.

If charging system operates properly, and generator warning light still glows, check diode in wiring harness. Also check for missing or bad regulator ground.

Check the Regulator:

If the regulator appears to be the defective component, check it by replacing it with a unit that is known to be good and check again. Electrically disconnect the unit to be checked, then temporarily connect in the new unit. If the output is now okay, the original rectifier-regulator was defective and should be replaced. If the output is still unsatisfactory, the original unit was probably okay and the problem lies elsewhere.

Figure 5-39. Regulating Voltage
GENERAL

The battery serves as a storage place for current used in starting the motorcycle; to operate accessories when the engine is not running and to provide additional current, when necessary, over the amount being generated. For a battery to remain in good condition, the current draw must be balanced by a current input. All Harley-Davidson batteries have lead plates and sulphuric acid electrolyte units of capacities suitable for load requirements under intended use.

BATTERY CARE

Prompt and correct battery care determines the life span of the unit. Therefore, for a longer useful life, the battery solution level must be checked at weekly intervals. Add only pure distilled or approved water.

With a hydrometer or syringe, add water to each cell to raise level of solution up to level for type of battery as follows:

- **XL** - Fill to triangle or circle at base of hole.
- **XLCH** - Maintain level between upper and lower limits shown on battery.

Be careful not to overfill. Overfilling will result in some of the electrolyte being forced out through cap vent holes, diluting or weakening the solution strength. An overflow of battery solution will cause cables to corrode and motorcycle parts near the battery to be damaged.

**WARNING** — Batteries contain sulphuric acid. Avoid contact with skin, eyes or clothing.

**ANTIDOTE** -
- **External** — Flush with water.
- **Internal** — Drink large quantities of milk or water followed by milk of magnesia, vegetable oil, or beaten eggs. Call doctor immediately.
- **Eyes** — Flush with water and get immediate medical attention.

Clean battery and terminals when necessary with a baking soda-water solution. Be careful to avoid getting any of the solution into the cap vent holes. When solution stops bubbling, flush off battery with clean water.

Coat terminals with grease or oil felt terminal post washers after wires have been attached to retard corroding.

TESTING BATTERY

Use the following instructions for testing battery condition. As a guide for determining when to start or stop charging, check charge state in all cells (Tests A and B). As a guide for determining battery condition, use load test C.

**HOW TO TEST**

Discharged, or less than 1/2 charged batteries (1.210 gravity) must be recharged in order to have charge sufficient for testing. Use hydrometer (A) or load tester (B) as follows:

A. Use of Hydrometer: (Refer to chart below)

1. Be sure to correct reading for temperature extremes. For each 10° above 80°F add 4 points, or deduct 4 points for each 10° below 80°F.

**NOTE**

Harley-Davidson Hydrometer, Part No. 96802-63, has built-in thermometer and correction chart and is recommended for testing all batteries.

2. Read gravity of each cell and record.

3. If any 2 cells very more than 50 points, replace battery

4. If cells are even or vary only slightly, battery is generally not "suspect."

**BATTERY CHARGE CONDITION**

<table>
<thead>
<tr>
<th>State of Charge</th>
<th>Specific Gravity (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>1.250-1.270</td>
</tr>
<tr>
<td>75%</td>
<td>1.220-1.240</td>
</tr>
<tr>
<td>50%</td>
<td>1.190-1.210</td>
</tr>
<tr>
<td>25%</td>
<td>1.160-1.180</td>
</tr>
</tbody>
</table>

B. Use of Load Tester (Figure 5-40)

1. Never use on discharged batteries or batteries under 3/4 charged (1.240 sp. gr.).

![Figure 5-40. Testing Battery Capacity](image)
NOTE

The Sun VAT-26 Tester (or equivalent) is recommended for load testing the battery.

2. Fully charge the battery before testing. Load battery to 3 x amp hr rating using the Sun VAT-26 Tester. (The Harley-Davidson 32 amp hr battery should be loaded to 96 amperes, the 19 amp hr battery to 57 amperes and the 7 amp hr battery to 21 amperes.) Voltage reading after 15 seconds should be 9.6 or more. Note: Voltmeter leads must be connected directly to battery posts.

CHARGING BATTERY

Never allow a battery to stand in a discharged condition. Start charging it at once at the recommended continuous charge rate.

To determine the amount or condition of a battery charge, check solution in each cell with a battery hydrometer as outlined in paragraph titled "TESTING BATTERY." When hydrometer reading is 1.200 or less, battery is considered discharged and should be removed from motorcycle and charged at 2.0 amperes maximum continuous charge rate, using appropriate 12 volt charger.

A higher battery charge rate will heat and damage the battery. For this reason, do not allow the small motorcycle battery to be charged in the same line with large batteries. Hydrometer reading of a fully charged battery in good condition, with full strength electrolyte will be 1.270 or higher.

WARNING — Hydrogen gas, formed when charging, is explosive. Avoid open flame or electrical spark near battery.

Allowing a battery to remain in a discharged condition will shorten its life. It is important that a battery be kept well charged during below freezing weather.

RECLAIMING SULPHATED BATTERY

If a battery has been allowed to stand in a discharged condition for a period of time, the lead sulphate in the plates will crystallize and not take a charge at normal rates. Such batteries should be charged at half the specified continuous rate for twice the computed time. A longer charging time at a slower rate will many times break down the crystalline structure into active materials and restore the battery.

CHANGING ELECTROLYTE

In normal service with average care, it is never necessary to change electrolyte for the lifetime of the battery. However, if the battery solution is spilled, diluted as a result of careless water addition, or neutralized by the addition of an alkaline substance, the battery solution may be changed and in some cases near full capacity restored.

A weak acid solution may be detected by charging the battery until all cells gas freely and the gravity has not shown a rise for three successive readings taken at hourly intervals. "Gassing" is evidenced by a bubbling action in the electrolyte that may be detected by sight or sound. Do not change electrolyte in a battery with one or more cells that fail to gas. Such a condition indicates a structural failure.

Pour solution out of charged battery and fill with water. Charge battery again until maximum specific gravity is reached. Pour out this solution and add prepared battery electrolyte to specified level and charge again for a short length of time for full capacity.

Check specific gravity and add a little water if necessary to bring solution down to desired maximum limits.

The value of changing electrolyte in a fairly old battery is questionable. By tipping over such a battery to drain the solution, the sloshed-off waste materials accumulated by repeated charging and discharging actions might be dislodged from the sediment chambers in the bottom of the battery and deposited in the separators. This material is an electrical conductor and thus may "tree" or catch in the separators and cause a short circuit.
Horn is shown in Figure 5-41. If the horn fails to blow or does not blow satisfactorily, check for loose, frayed or damaged wiring leading to horn terminals, discharged battery, etc. If these steps do not correct the trouble, turn in contact point adjusting screw, located back of horn, until horn just gives a single click – then retard screw until best tone is obtained. If horn fails to operate after moving adjusting screw, entire horn must be replaced because it is permanently riveted together. Mounting parts are replaceable.

Figure 5-41. Horn
STATER MOTOR

DESCRIPTION

The starter motor is a 12 volt, series field 4-pole drive motor which engages the clutch ring gear through a Bendix type drive and a reduction gear unit. A solenoid relay provides battery current directly to the motor. The solenoid is controlled by a switch on the handlebar. On some models control circuit has a cut-out switch in the transmission cover. Switch plunger contacts a nut on the shifter cam only when transmission is in neutral to complete the starting circuit. This prevents starter operation when transmission is in gear.

NOTE

Starter motor should never be operated continuously for more than 30 seconds without pausing to let it cool for at least two minutes. The motor is not designed for continuous operation and serious damage may result.

TROUBLESHOOTING

GENERAL

The starter motor is designed to be corrosion resistant and requires very little maintenance. However, to ensure satisfactory operation, periodic inspection of brushes and commutator should be made. In the event starter motor fails to operate satisfactorily, the following checks should be made before removing motor for inspection.

WIRING

Make sure the mounting and wiring connections are tight and in good condition. The solenoid switch should be firmly mounted and all wiring connections should be clean and tight. Also inspect the connections to the battery and return circuit, as loose or dirty connections anywhere in the circuit will cause high resistance and reduced motor efficiency.

BATTERY

If the connections and wiring are found to be satisfactory, the battery should be checked to determine its state of charge (see "CHARGING BATTERY"). If the battery is charged and battery voltage is reaching the motor without any excessive losses in wiring or connections, the trouble may be attributed to either the engine or the starter motor itself.

SWITCHES

If the battery is charged but there is no current flow to motor at all, trouble is probably in handlebar switch, transmission cutout switch or the solenoid switch. This can be determined by bypassing each switch with heavy jumper (refer to "WIRING DIAGRAM").

ENGINE

Excessive friction in the engine from tight bearings or pistons or from heavy oil obviously makes engine harder to crank. However, if engine is known to be in normal condition and the rest of the starting system is satisfactory, the starter motor should be removed for further checking.

NOTE

Electrical tests to locate cause of starting system failures can be made using the Sun VAT-26 Tester and applicable service bulletins.

STATER MOTOR AND DRIVE

REMOVING AND INSTALLING STARTER MOTOR (Figure 5-42)

Disconnect solenoid cable from starter motor terminal. Remove starter motor clamp bolt and lockwasher (1) from crankcase. Unscrew motor thru bolts (4) from starter shaft housing (3). Remove starter motor and clamp (2) as an assembly.

NOTE

To prevent brushes from escaping holders, insert a spool of slightly larger diameter than the commutator underneath brushes when brushes are half exposed as armature is withdrawn from frame. In this way armature can be reinstalled without removing brushes from holders.

Figure 5-42. Removing Starter Motor
PRESTOLITE STARTER MOTOR

DISASSEMBLING AND ASSEMBLING (Figure 5-43)
Remove thru bolts (1) with washers and lockwashers (2). Remove commutator end cover (3) holding brush plate (4) in place if necessary.

NOTE
End cover is marked with a double line next to the motor terminal. Also brush holder has a positioning notch which registers on the motor terminal insulator. See Figure 5-43. Parts must be located correctly when reassembled.

Armature (5) and drive end cover (6) with bearing (7) are removed as an assembly. Bearing (7) is a light press fit on armature shaft and is staked in end cover (6).

Reassembly is essentially the reverse of the disassembly procedure. If brushes (9 and 10) and springs (8) have been released from holder, use clips or clamps as shown in Figure 5-45 to hold them in place while installing armature. Note that drive end of frame is notched to fit drive end cover. Line up positioning mark on commutator end head with motor terminal. Install thru bolts, tightening to 20-25 in-lbs torque.

HITACHI STARTER MOTOR

DISASSEMBLING AND ASSEMBLING (Figure 5-46)
Remove terminal nut, washer and lockwasher (1). Remove nuts and lockwashers (2) from thru bolts (3). Remove thru bolts with lockwashers (3). Remove two screws and lockwashers (4) fastening the rear cover.

Separate the rear cover (5) from the starting motor frame as follows: tap the rear cover with a soft hammer to make an opening between the rear cover and the frame. Next insert a screwdriver into the opening and push out the rear cover taking care to see that terminal and insulator (6) remain in place next to motor frame.

Lift the brushes from the commutator. As shown in Figure 5-47, pulling up the brush spring with a steel wire and pull out the brushes. Note that two negative brushes (7) have to be withdrawn slightly to be held in the brush guide, making use of the action of the brush spring. The other two positive brushes (8) should be completely removed from the brush holder assembly (9) as shown in Figure 5-48.

Remove front cover (10), armature (11) with ball bearing (12) and thrust washer(s) (13).

Assemble starting motor in reverse order of disassembly; noting the following:

Figure 5-43. Prestolite 4-Pole Starter Motor - Exploded View

1. Thru bolt (2)
2. Washer and lockwasher (2)
3. Commutator end cover
4. Brush plate and holder assembly
5. Armature
6. Drive end cover
7. Drive end ball bearing
8. Brush spring (4)
9. Terminal and brush assembly
10. Ground brush (2)
11. Frame and field coil assembly
1. To determine the proper position of frame and front cover, align notch in cover with projected part of the frame.

2. After installing positive brushes in the brush holder and covering with the rear cover, align and fasten the brush holder to the rear cover with screws and lockwashers from the outside of the rear cover.

3. Thru bolt nuts should be tightened to 20-25 in-lbs torque.

---

**Figure 5-46. Hitachi Starter Motor - Exploded View**

1. Terminal nut, lockwasher and washer
2. Thru bolt nut and lockwasher (2)
3. Thru bolt and lockwasher (2)
4. Rear cover screws and lockwashers (2)
5. Rear (commutator end) cover
6. Terminal and insulator
7. Negative brush (2)
8. Positive brush (2)
9. Brush holder assembly
10. Front (drive end) cover
11. Armature
12. Armature ball bearing
13. Thrust washer (2)
14. Frame
to determine grounded or shorted field coils. If field coils are required on either Prestolite or Hitachi motors it is necessary, due to the method of installing field coils in this assembly, to replace the frame and field assembly. To test for field coils, using a test lamp, place one probe of test light against the frame. Place the other probe against each of the brushes attached to the field coils to indicate open or closed circuit.

REPAIRING ARMATURE

If commutator is dirty it can be cleaned by polishing with No. 00 sandpaper—not emery cloth. If commutator is worn, out of round or has high mica insulation between segments, commutator can be turned down in a lathe. Mica should then be undercut 1/32 in. deep with an undercutting machine and slots cleaned out to remove dirt or copper dust. If undercutting machine is not available, undercutting can be accomplished satisfactorily using a hacksaw blade. Commutator should then be sanded lightly with No. 00 sandpaper to remove any burrs left from undercutting procedure. Inspect commutator end cover bushing. If bushing is worn, replace complete commutator end cover assembly. Inspect drive end cover and bearing and replace bearing if worn to excessive looseness.

REPLACING BRUSHES

To replace the Prestolite insulated brushes (9, Figure 5-43) remove the terminal and brush assembly from slot in frame and install new terminal and brush assembly. To replace brushes attached to the field coils, first cut off old brush lead wire where it is attached to the field coil lead. Thoroughly clean coil lead by filing off old connection. Insulation on field coil lead should be removed only as far back as necessary to make new solder connection. Using rosin flux, solder brush lead to field coil lead, making certain brush lead is in the same position as the original brush lead. On Hitachi model negative brush leads must be unsoldered from brush holder to replace. Do not overheat brush leads or solder will run on wire strands and brush leads will no longer be flexible. Before reassembling motor, check brush connections for sufficient clearance from frame and from armature.

Replace brushes when worn down close to the following minimum lengths.

Prestolite 1/4 in.
Hitachi 7/16 in.
TOOLS

Order from Sun Electric Corp., Chicago, Ill.

Sun Power Timing Light Model PTL-45

Removes generator drive gear.

Part No. 96715-19A Gear Puller

Clear plastic plug threads into crankcase timing hole for accurate ignition timing with strobe light timing.

Part No. 96295-65 Timing Mark View Plug

For testing state of charge of storage batteries. Specific gravity of electrolyte can be corrected for temperature extremes by means of built-in thermometer.

Part No. 96802-63 Battery Hydrometer - with Temperature Correction Feature
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INSTRUMENTS

SPEEDOMETER

GENERAL
Lubricate cable core every 5000 miles with graphite grease.

REMOVING AND SERVICING
To lubricate the speedometer drive core or replace a damaged or broken core, proceed as follows:

With a pliers remove speedometer case coupling nut from speedometer head and withdraw core from casing. To free a broken core from casing, disconnect lower case coupling nut from speedometer drive unit located under transmission sprocket cover or on front wheel (1973 and later). Withdraw core from lower case end.

Install core in upper end of casing, applying a light coat of graphite grease to the core as it is inserted into position. Engage squared lower end of core in speedometer drive shaft. Connect case coupling upper end to the head, engaging squared end of core in shaft. Be sure to tighten both case coupling nuts securely.

TACHOMETER

GENERAL
Lubricate cable core every 5000 miles with graphite grease.

REMOVING AND SERVICING
To lubricate the tachometer drive core or replace a damaged or broken core proceed as follows:

With a pliers remove case coupling nut from tachometer and withdraw core from casing. To free a broken core from casing, disconnect lower case coupling nut from drive unit. Withdraw core from lower case end.

Install core in upper end of casing, applying a light coat of graphite grease to the core as it is inserted into position. Engage squared lower end of core in drive shaft. Connect case coupling upper end to the head, engaging squared end of core in shaft. Be sure to tighten both case coupling nuts securely.
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