

GENERAL

CIRCUITS AND OPERATION 1963-66 D AND 1963-68 DC MODELS

The Gasoline Car has a 12-volt electrical system utilizing a combination starter motor-generator unit built into the engine crankcase, in conjunction with a control switch-box-regulator unit and a storage battery using a negative grounded system.

Ignition spark is produced by a 12-volt coil through a cam operated circuit breaker with built-in automatic advance mechanism.

Main components of the starter-generator unit are the field stator with 12 radial field coils, and the bell-shaped armature rotor with the commutator formed on its inner vertical face. The armature is mounted directly on the engine crankshaft end taper (right side) and rotates at engine speed. Six alternate field pole shoes of the stator are series wound with heavy gage wire for starting; the other six carry lighter gage shunt field windings for generating. Mounted on the stator housing are four spring loaded carbon brushes which contact the armature commutator.

Components of the control system are the switchbox assembly (containing voltage regulator, cutout relay and starter solenoid), two micro-switches and a key-switch.

Starter (See Figure 5A-7)

When starting the engine, the 6 stator field coils are connected in series with the armature to operate as a series motor. This circuit is controlled by the keyswitch (9) and two micro-switches (8 and 12), which operate a solenoid starter switch in the control box (2), which controls the main starter current. These three control switches (8, 9 and 12) are series connected with the battery and solenoid coil of the main starter switch. With keyswitch (9) turned to "ON", battery current is available at micro switch (8), which is open until accelerator pedal is pushed. When pedal is depressed contact button on micro-switch (8), is released, contacts close, turning on ignition circuit. Battery current also flows through micro-switch (12) to terminal No. 50 on the control box, energizing the solenoid coil of the starter switch closing switch contacts. Battery current flows to the starter motor. Starter motor now functions to crank the engine.

Micro-switch (12) is mounted in a position so that the operating finger roller touches the transmission drive cup cover. This switch is normally closed, however, as the engine starts and operates at driving speed, the drive cup cover moves away from the switch allowing its contacts to open. This interrupts the current flow through the starter relay winding

causing the relay switch contacts to open, stopping current flow to the starter motor which ceases to operate.

The engine can be stopped by turning keyswitch to "OFF" position or by allowing accelerator pedal to come to its full outward position, opening micro-switch (8), which opens ignition circuit. When the engine stops, the outward movement of the transmission drive cup cover pushes on finger of micro-switch (12) closing the switch contacts. When the contacts of either switch (8 or 9) are open, the current flow to the ignition coil (6) is interrupted to stop the engine.

Generator (See Figure 5A-7)

When the generator is driven by the engine, the stator shunt field coils are excited and the current generated in the armature is utilized for the ignition system and charging the battery. The generator output is limited by the voltage regulator, which controls the generator field strength. The generated voltage increases with engine speed and as soon as the rated level (approximately 12 volts) has been reached, the

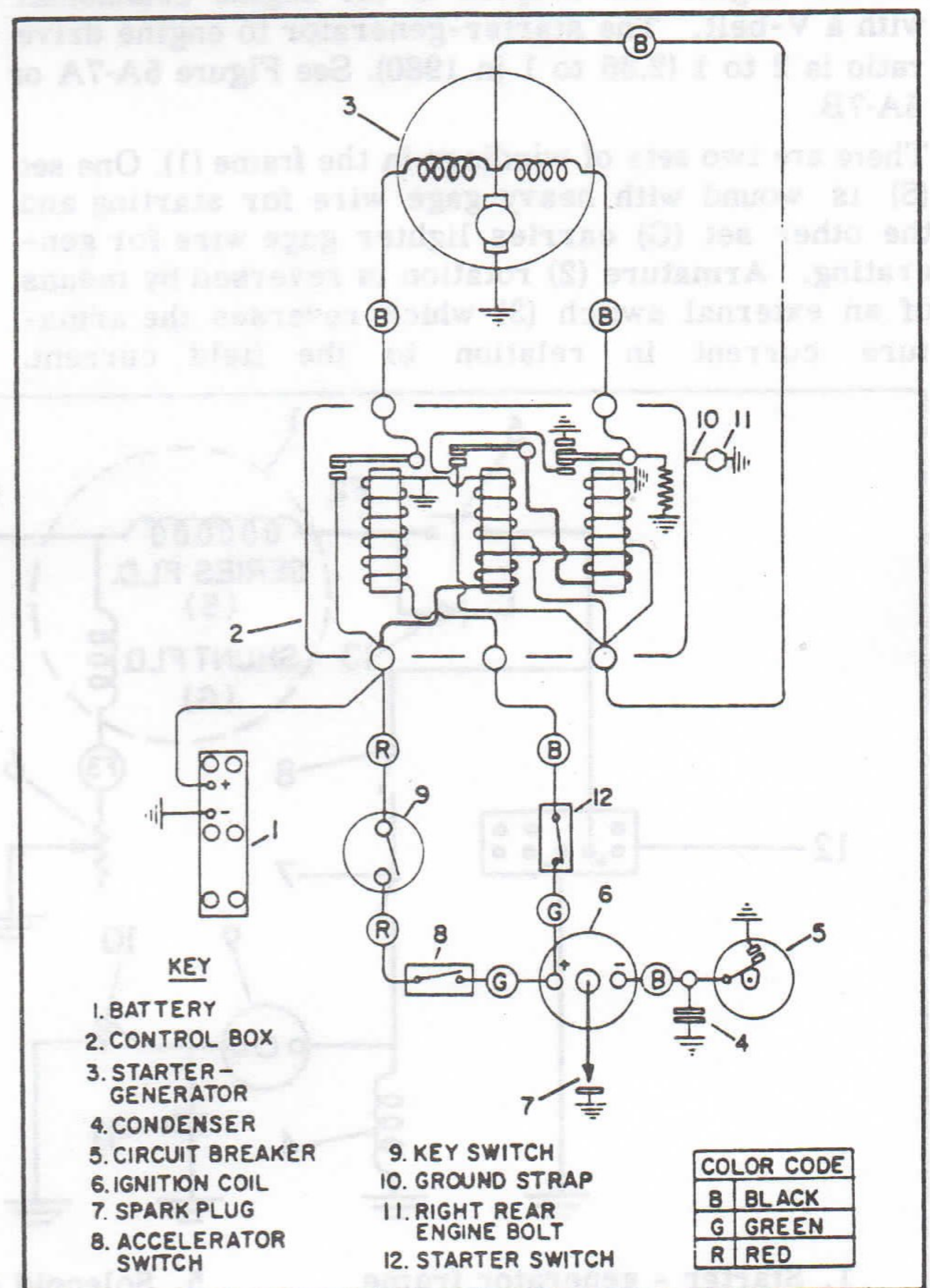


Figure 5A-7. Gasoline Car Schematic Circuit

cutout switch closes and charging of the battery begins. When running, this voltage is maintained nearly constant by the voltage regulator, regardless of engine speed. As current is consumed, the voltage drops in conformity with the output. The prescribed charging rate is reached at speeds varying between 1200 and 1500 RPM and will meet a continuous load of 90 watts thereafter.

As the engine speed is reduced and generated voltage drops below rated level, the cutout relay contacts will open, disconnecting the generator from the battery circuit to prevent discharging of the battery through the armature circuit.

CIRCUITS AND OPERATION 1967 and Later D MODEL

The Gasoline Car has a 12-volt electrical system utilizing a belt drive reversible starter motor-generator unit in conjunction with a fixed field resistor or regulator, starter solenoid, and a storage battery using a negative grounded system.

Ignition spark is produced by a 12-volt coil through a cam operated circuit breaker designed to give correct ignition timing in both forward and reverse engine running directions.

The starter-generator is a separate unit, mounted on the engine and coupled to the engine crankshaft with a V-belt. The starter-generator to engine drive ratio is 2 to 1 (2.36 to 1 in 1980). See Figure 5A-7A or 5A-7B.

There are two sets of windings in the frame (1). One set (S) is wound with heavy gage wire for starting and the other set (G) carries lighter gage wire for generating. Armature (2) rotation is reversed by means of an external switch (3) which reverses the armature current in relation to the field current.

Brushes are mounted on the drive end cover which contact the armature commutator.

Components of the control system are the reversing switch, solenoid switch, adjustable field resistor or regulator, micro-switch and a key switch.

FORWARD

When starting the engine, the heavy field coils (S) are connected in series with the armature to operate as a series motor. This circuit is controlled by the reversing switch (3) and micro-switch (7) which operates a solenoid starter switch (5), controlling the main starter current. With keyswitch (8) turned to "ON", battery current is available at micro-switch (7), which is open until accelerator pedal is pushed. When pedal is depressed contact button on micro switch is released, contacts close, turning on ignition circuit and energizing the solenoid coil of the starter switch closing switch contacts. Battery current flows to the starter motor. Starter motor now functions to crank the engine in direction determined by position of reversing switch (3).

REVERSE

Starting coil (S) and armature coil ends (A1 and A2) (brushes) are connected to the reversing switch (3) which changes direction of armature current in relation to starting field current through switch contacts to ground. This changes the direction of the magnetic field and armature rotation. The starting coils are always connected through the solenoid switch when car is operating, but will have no effect when voltage generated by the field winding is above battery voltage. At this time the direction of current flow instead of coming from the battery, goes to the battery.

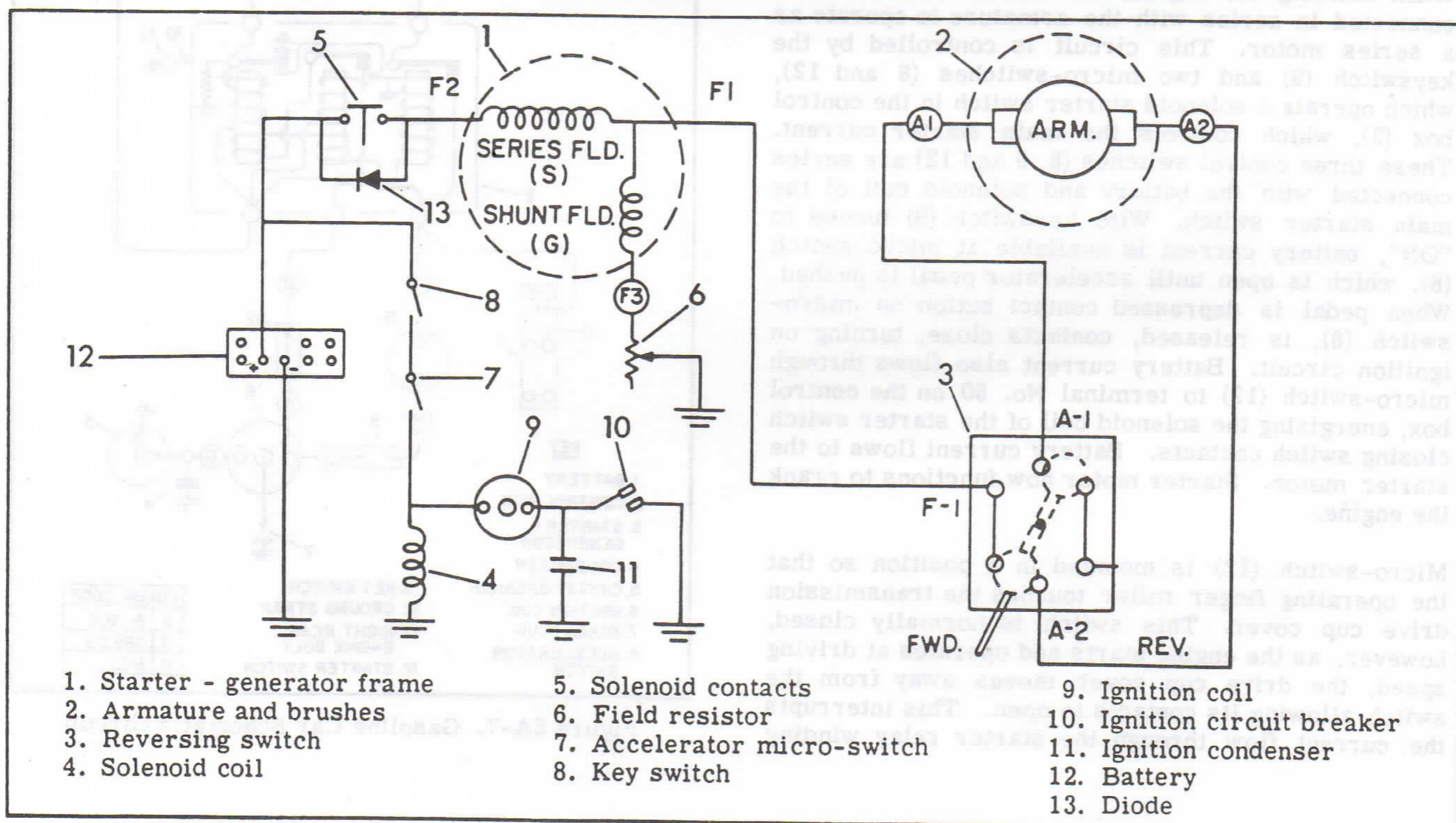


Figure 5A-7A. 1967 - Early 1968 Gasoline Golf Car Schematic Circuit

The engine can be stopped by turning keyswitch to "OFF" position or by allowing accelerator pedal to come to its full outward position, opening micro-switch (7), which opens ignition circuit to stop the engine.

Generator (See Figure 5A-7A or 5A-7B)

When engine speed exceeds starter generator speed, the shunt field coils (G) are excited and the current generated in the armature is utilized for the ignition system and charging the battery. The generator output is limited by the adjustable resistor (6) or regulator (6A), which controls the strength of the magnetic field produced by the shunt field coils (G). The generator voltage increases with engine speed and as soon as the rated level (approximately 15 volts) has been reached, charges the battery and increases with engine speed to its maximum value controlled by the voltage regulator. The prescribed charging rate at governed speed is set by means of variable resistor or is controlled by the voltage regulator.

On models equipped with field resistor, diode (13) acts to bleed off voltage generated by operation of car when coasting with solenoid contacts open (accelerator pedal released).

WIRING

TESTING CIRCUITS

Electrical tests of the car wiring can be made with a continuity tester consisting of a lamp and battery arranged as shown in diagram Figure 5A-8.

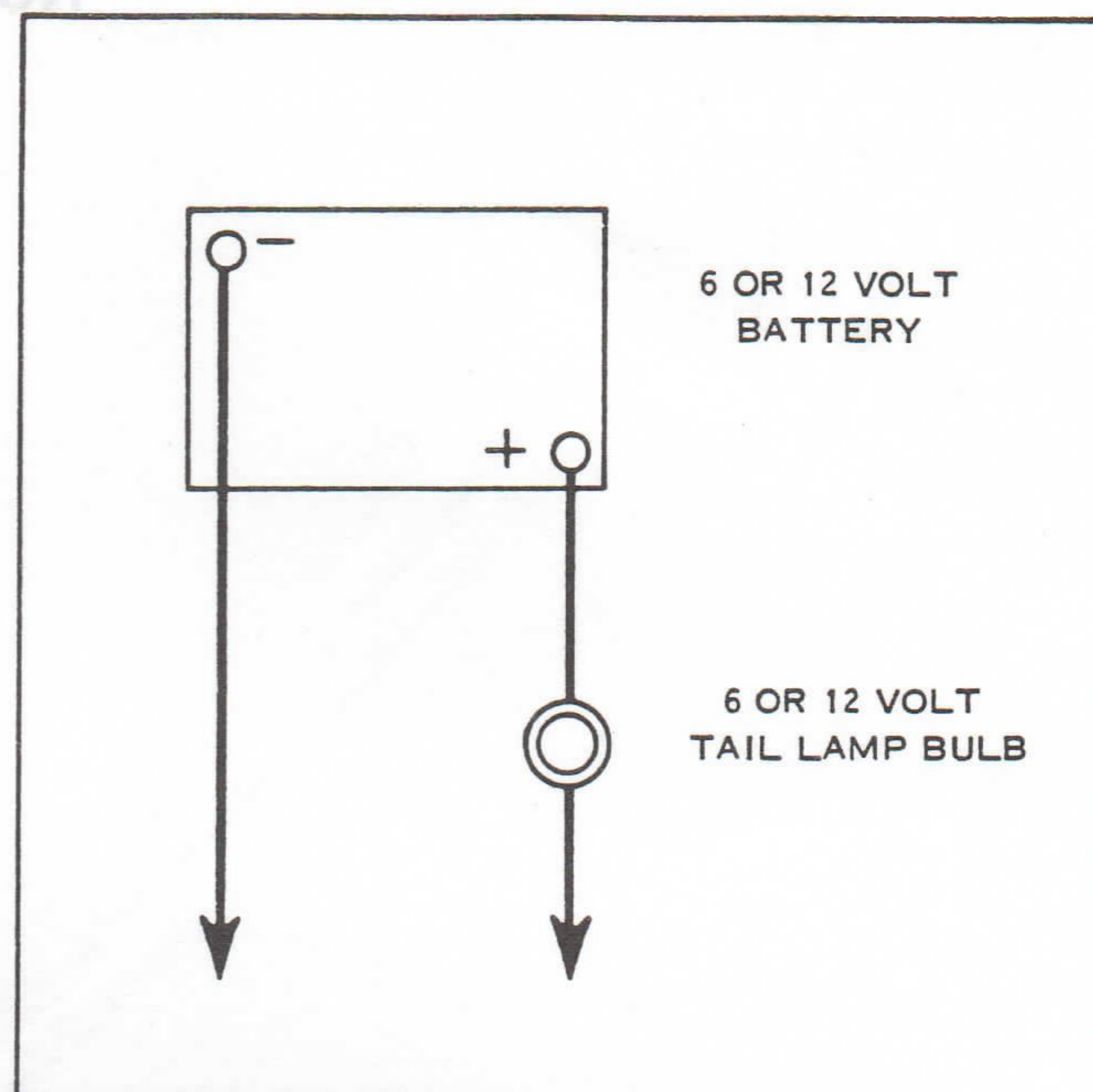


Figure 5A-8. Test Circuit

Parts used are a battery and light bulb in series using jumper wires of adequate length. Be sure battery is same voltage as light bulb.

CAUTION

Disconnect negative battery cable before making any test of individual components.

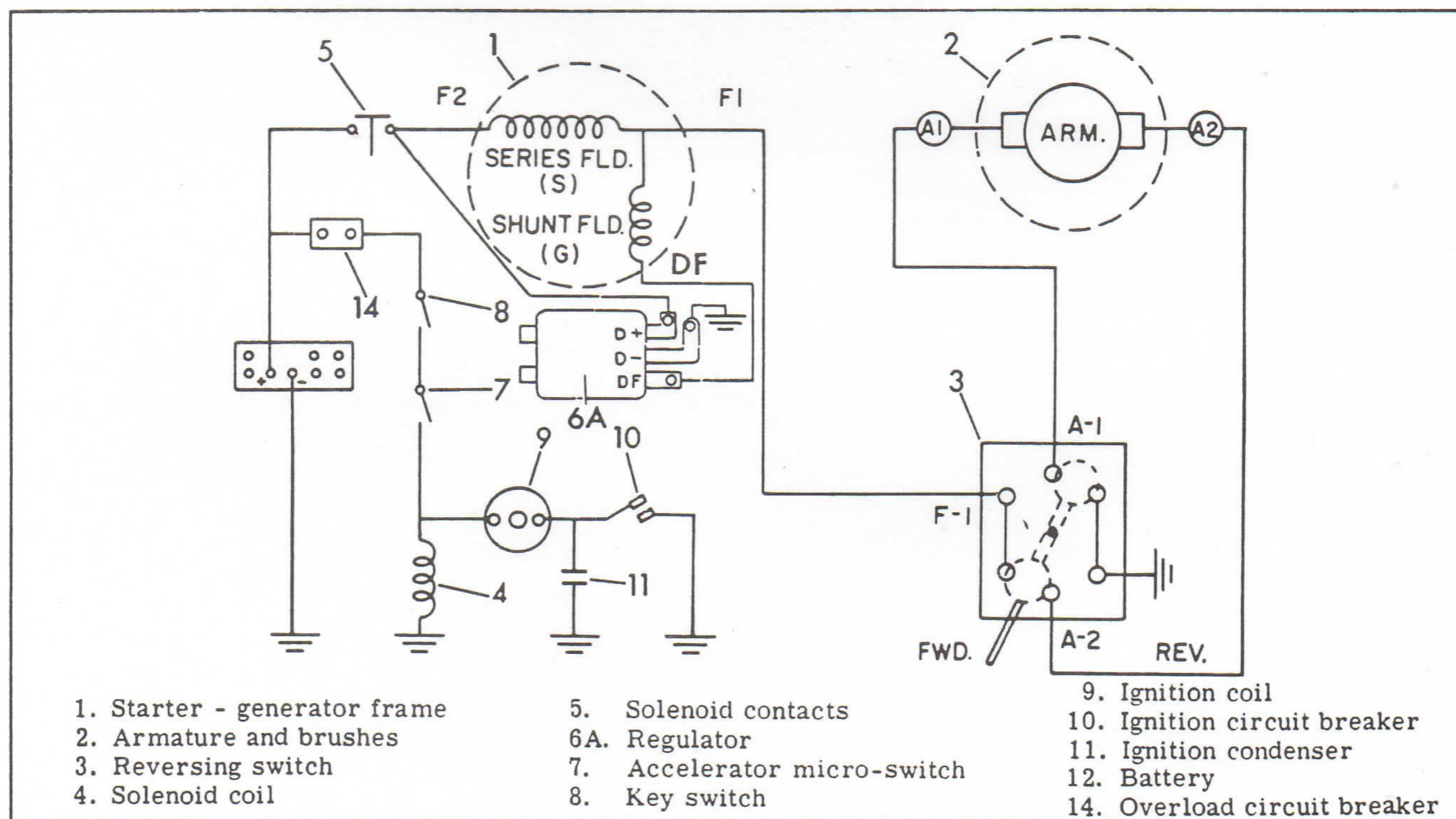


Figure 5A-7B. Late 1968 Golf Car, 1969 Golf and Utilicar Schematic Circuit

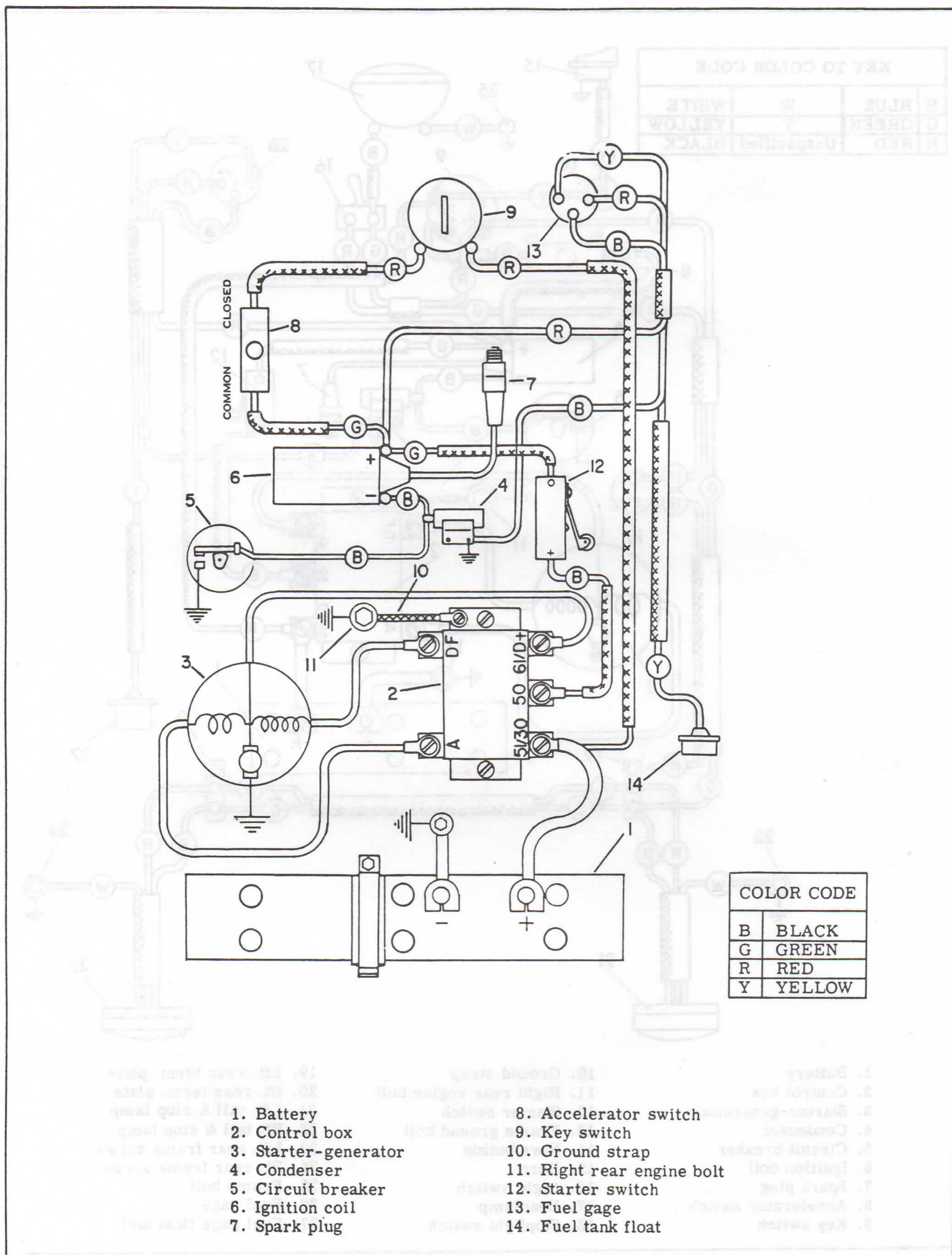
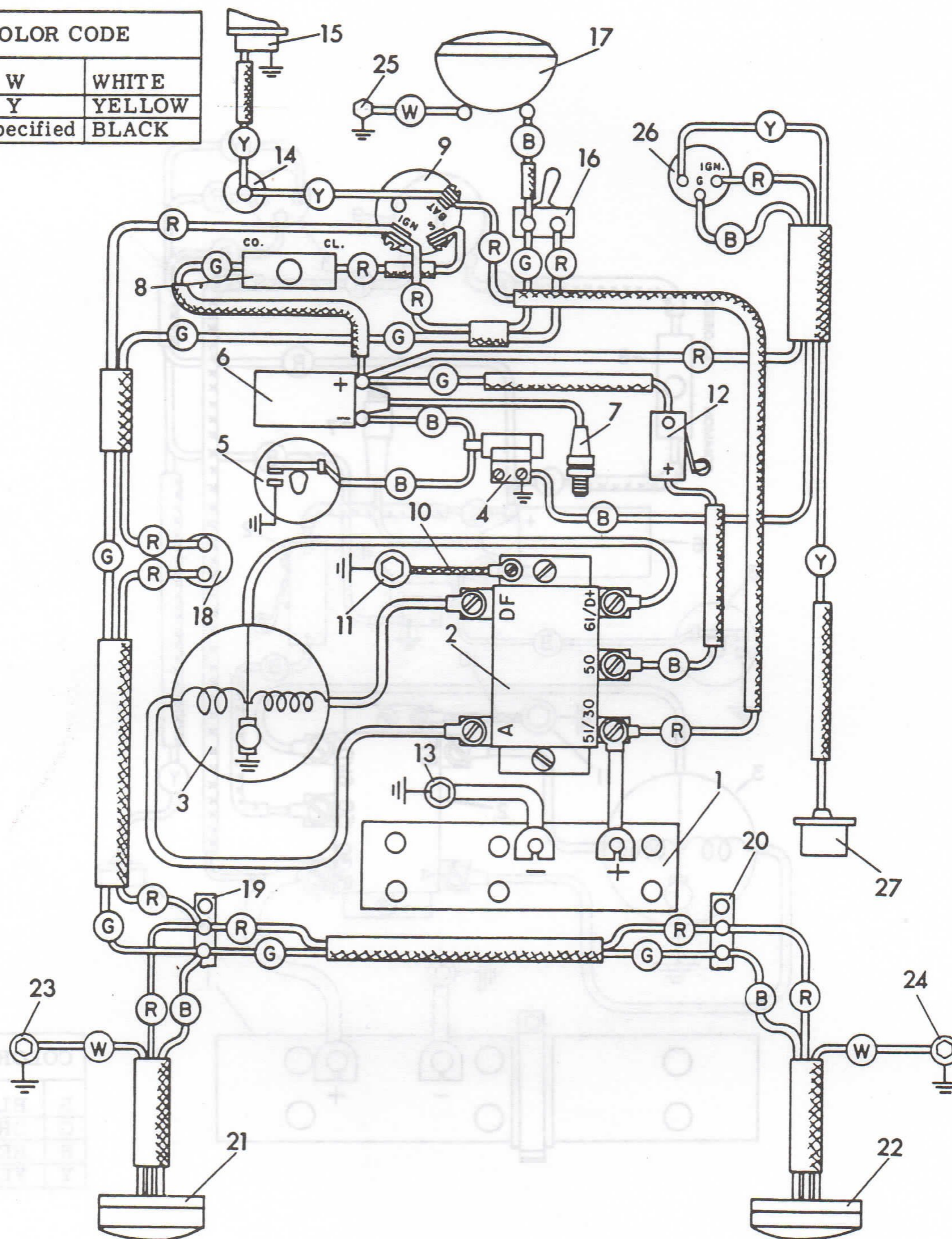


Figure 5B-15. 1963-66 Model D Gasoline Car Wiring Diagram

KEY TO COLOR CODE			
B	BLUE	W	WHITE
G	GREEN	Y	YELLOW
R	RED	Unspecified	BLACK



- | | | |
|-----------------------|----------------------------|---------------------------|
| 1. Battery | 10. Ground strap | 19. Lft. rear term. plate |
| 2. Control box | 11. Right rear engine bolt | 20. Rt. rear term. plate |
| 3. Starter-generator | 12. Starter switch | 21. Lft. tail & stop lamp |
| 4. Condenser | 13. Frame ground bolt | 22. Rt. tail & stop lamp |
| 5. Circuit breaker | 14. Horn button | 23. Lft. rear frame screw |
| 6. Ignition coil | 15. Horn | 24. Rt. rear frame screw |
| 7. Spark plug | 16. Light switch | 25. Frame bolt |
| 8. Accelerator switch | 17. Headlamp | 26. Fuel gage |
| 9. Key switch | 18. Stoplight switch | 27. Fuel gage float unit |

Figure 5B-20. 1965-66 Model DC, 1965 Model DF Wiring Diagram

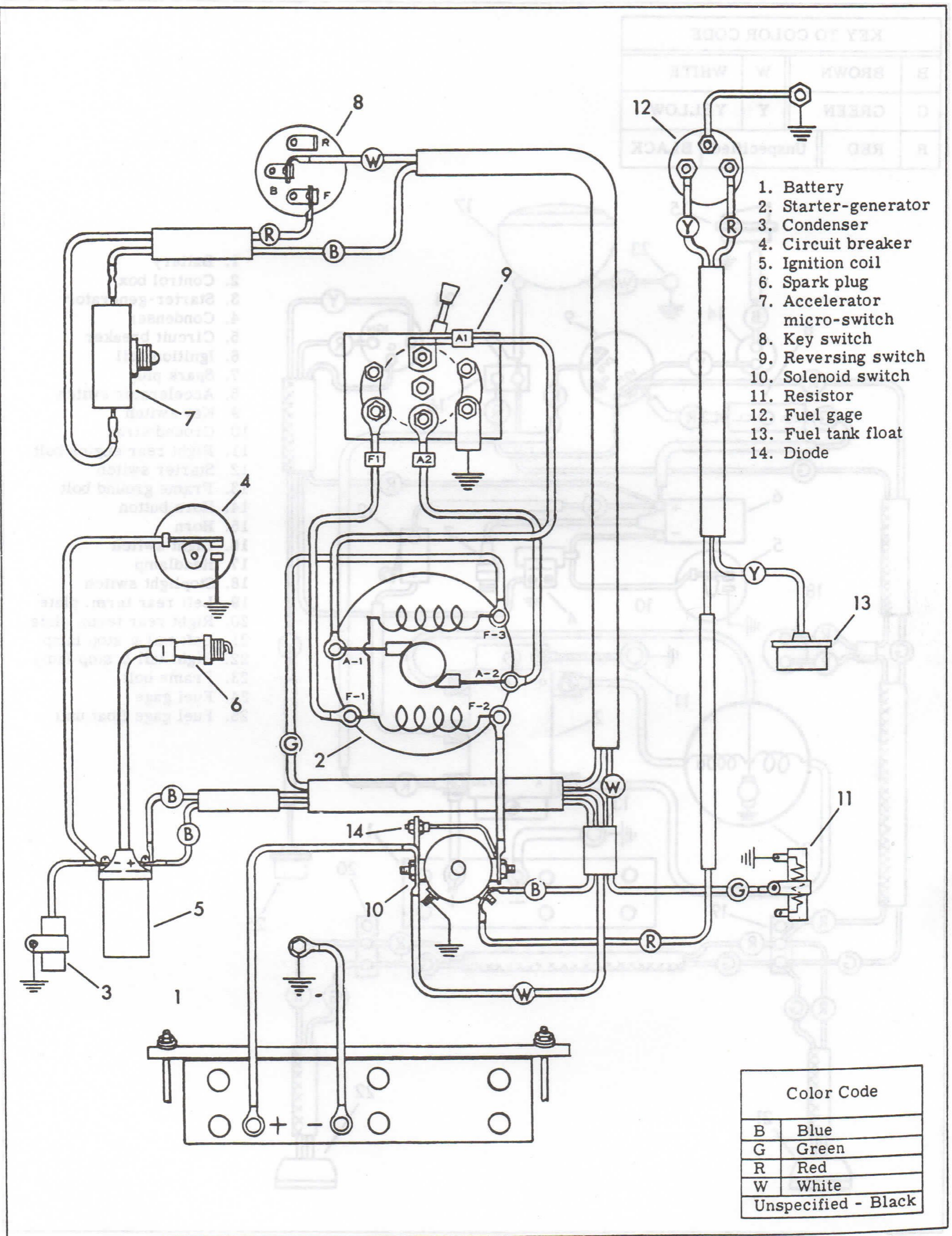


Figure 5B-24. 1967 - Early 1968 Model D Wiring Diagram

KEY TO COLOR CODE			
B	BROWN	W	WHITE
G	GREEN	Y	YELLOW
R	RED	Unspecified	BLACK

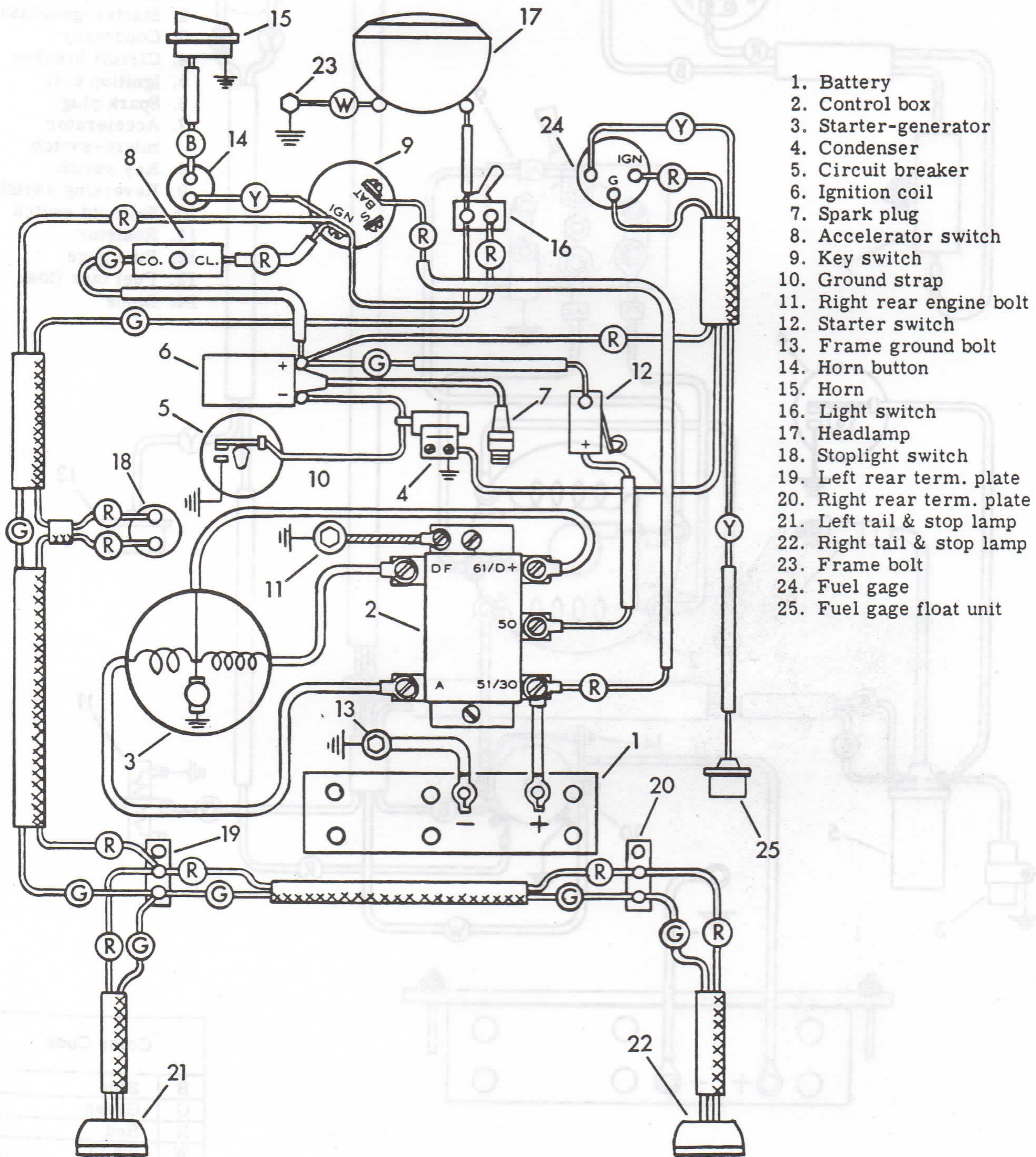


Figure 5B-25. 1967-68 Model DC Wiring Diagram

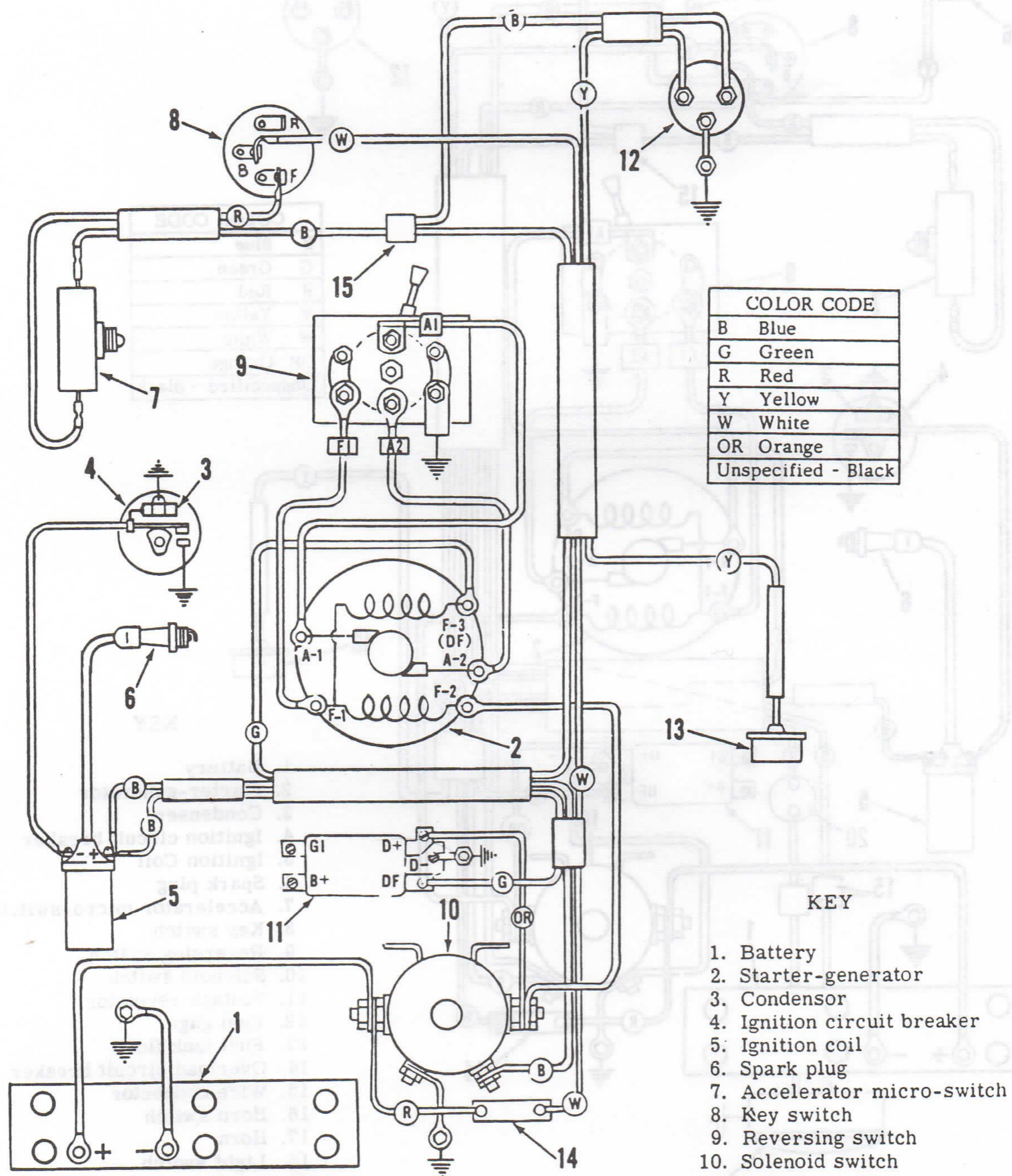


Figure 5B-26. Late 1968 to Early 1972 Model D Wiring Diagram

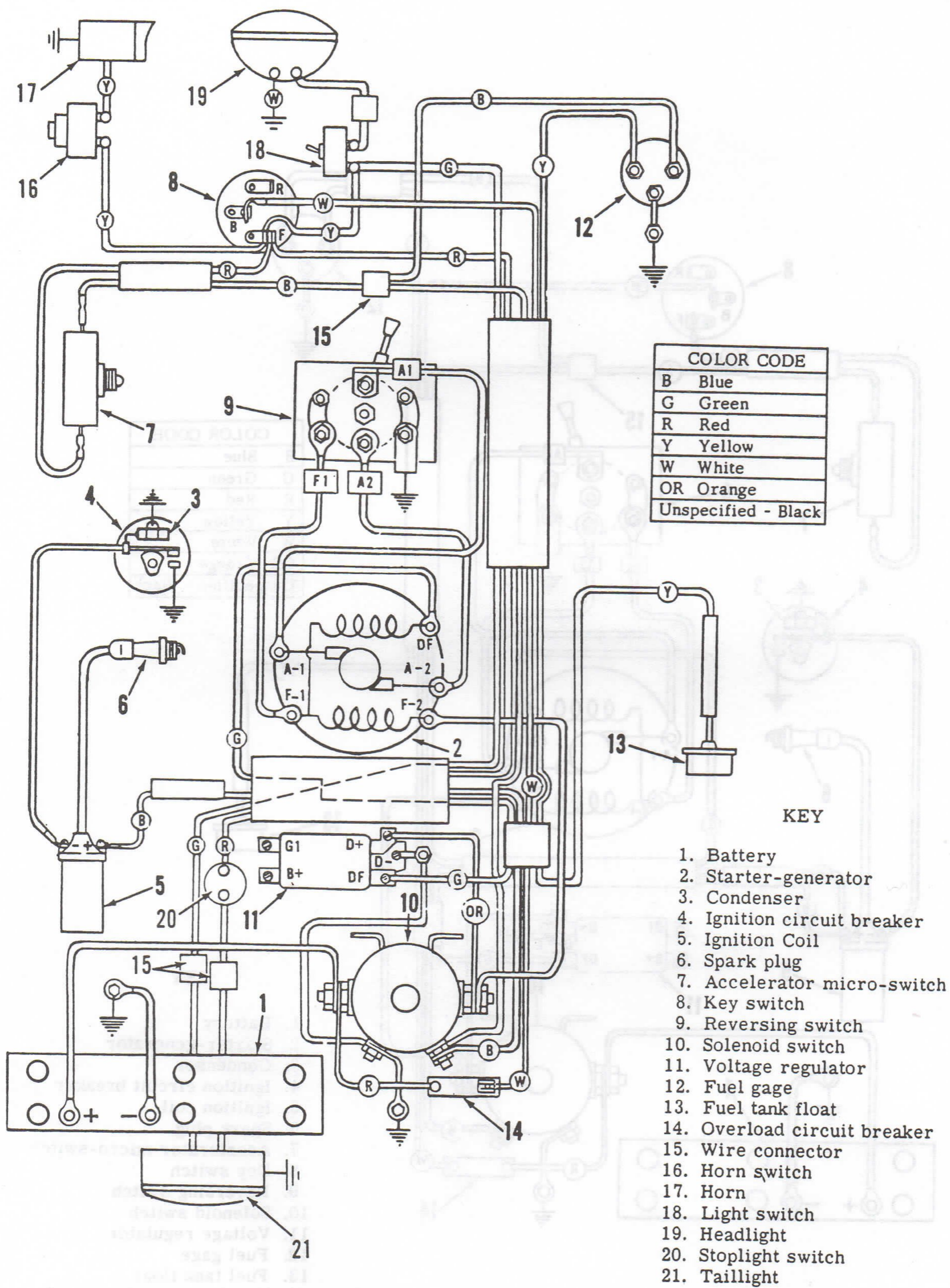
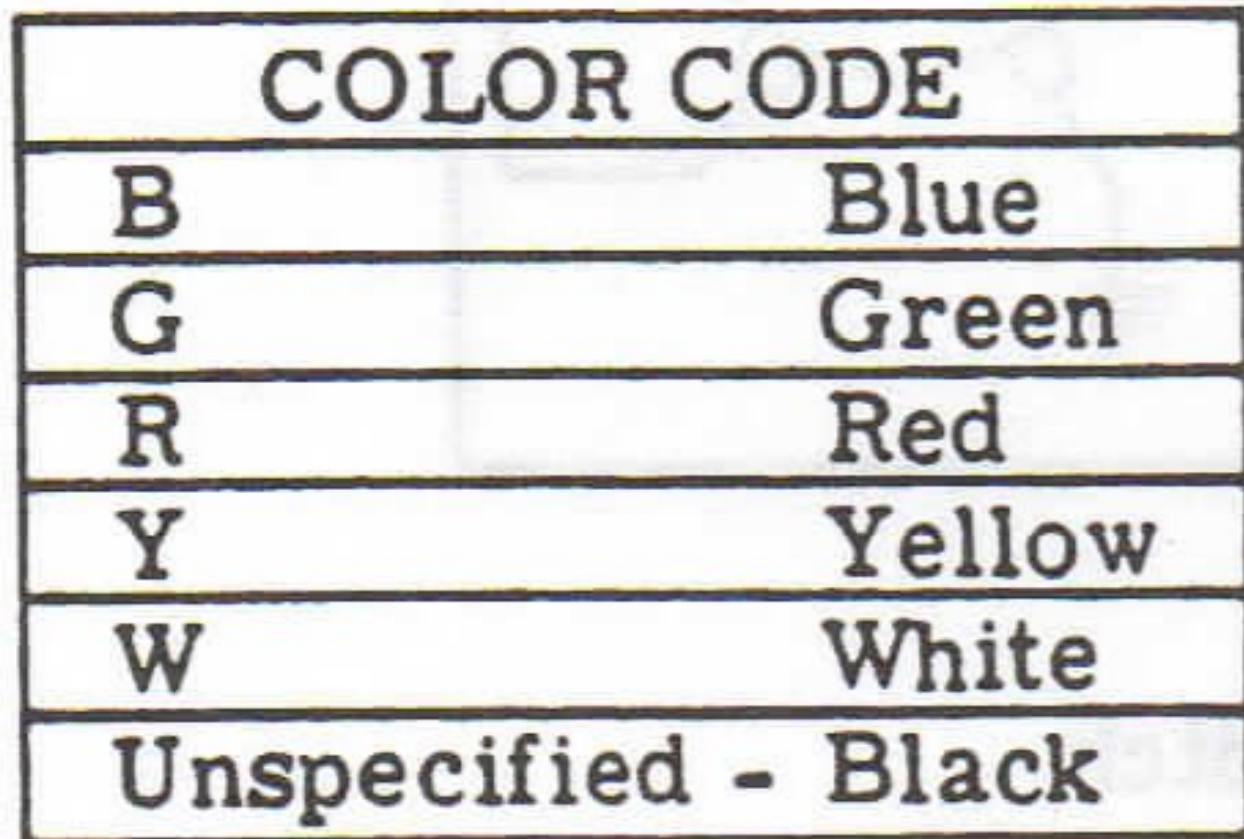


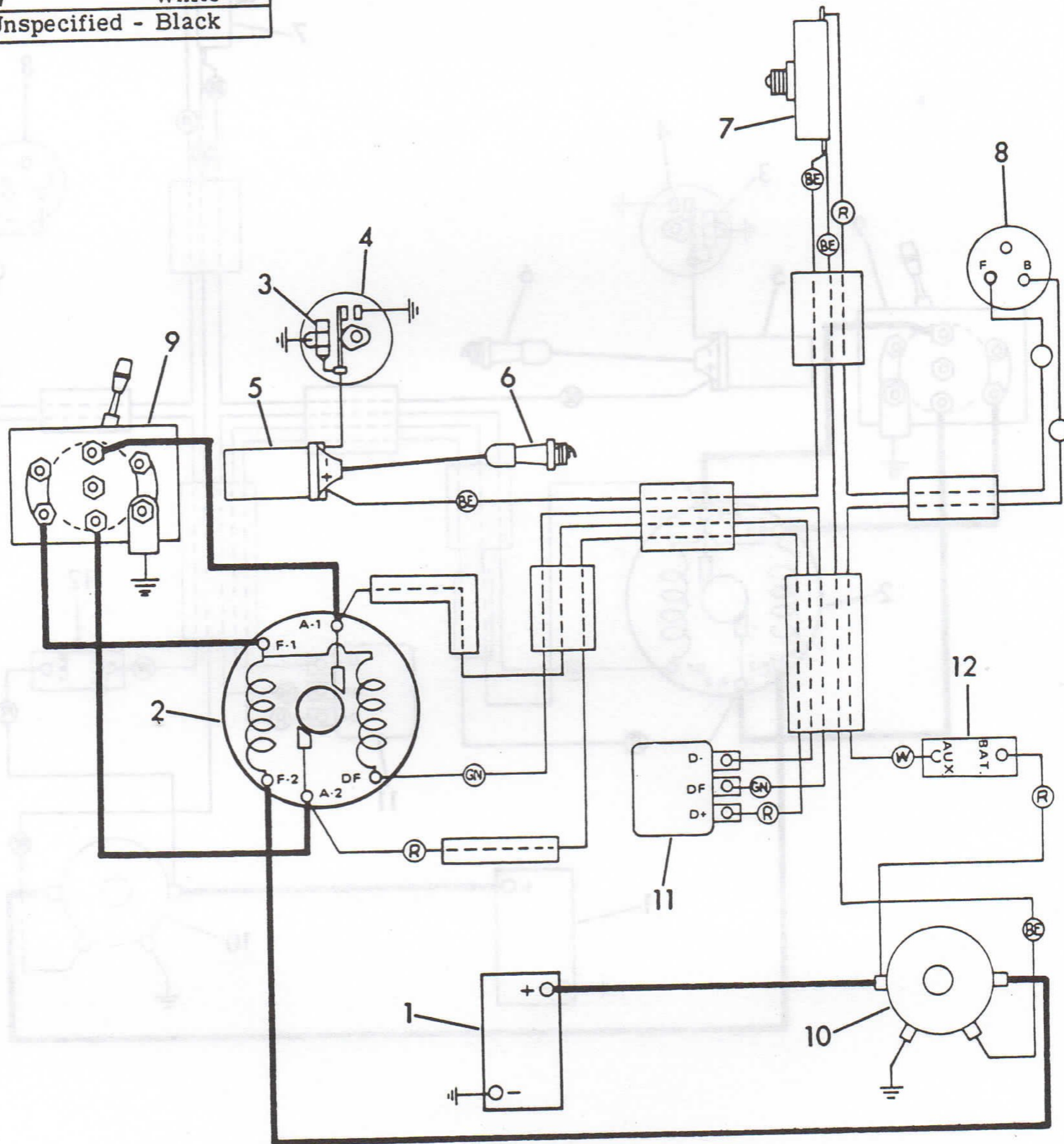
Figure 5B-27. 1969 to Early 1972 Model DC Wiring Diagram

12. Fuel gage
13. Fuel tank float
14. Overload circuit breaker
15. Headlamp
16. Light switch
17. Tail lamp
18. Stop light switch
19. Horn button
20. Horn
21. Connector



COLOR CODE	
BE	Blue
GN	Green
R	Red
Y	Yellow
W	White
Unspecified - Black	

COLOR CODE	
BE	Blue
GN	Green
R	Red
Y	Yellow
W	White
Unspecified - Black	

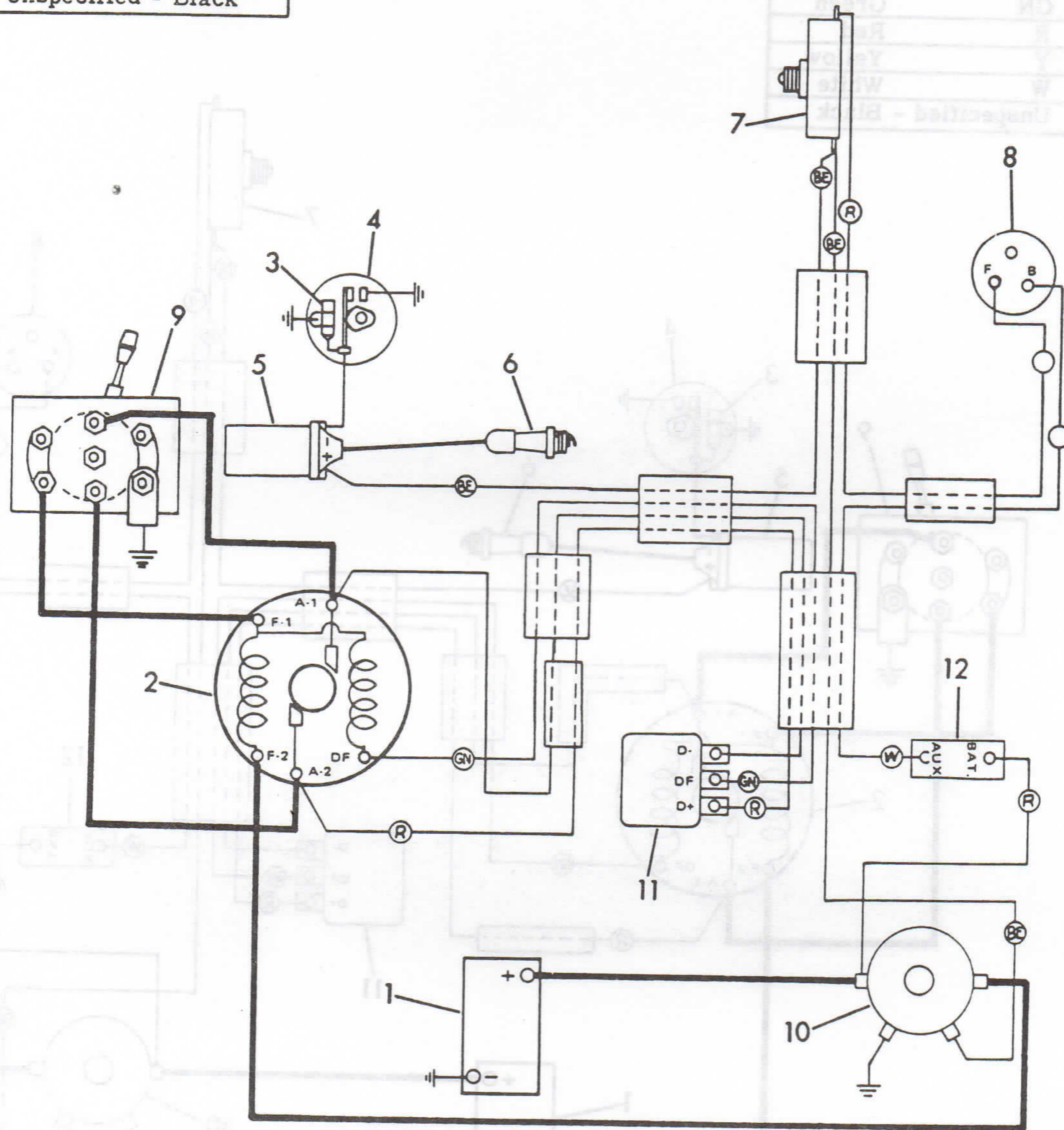


1. Battery
2. Starter-Generator
3. Condenser
4. Ignition circuit breaker
5. Ignition coil
6. Spark plug

7. Accelerator micro switch
8. Key switch
9. Reversing switch
10. Solenoid switch
11. Voltage regulator
12. Overload circuit breaker

Figure 5B-30 Wiring Diagram - 1975-1979 - D, D4

COLOR CODE	
BE	Blue
GN	Green
R	Red
Y	Yellow
W	White
Unspecified - Black	



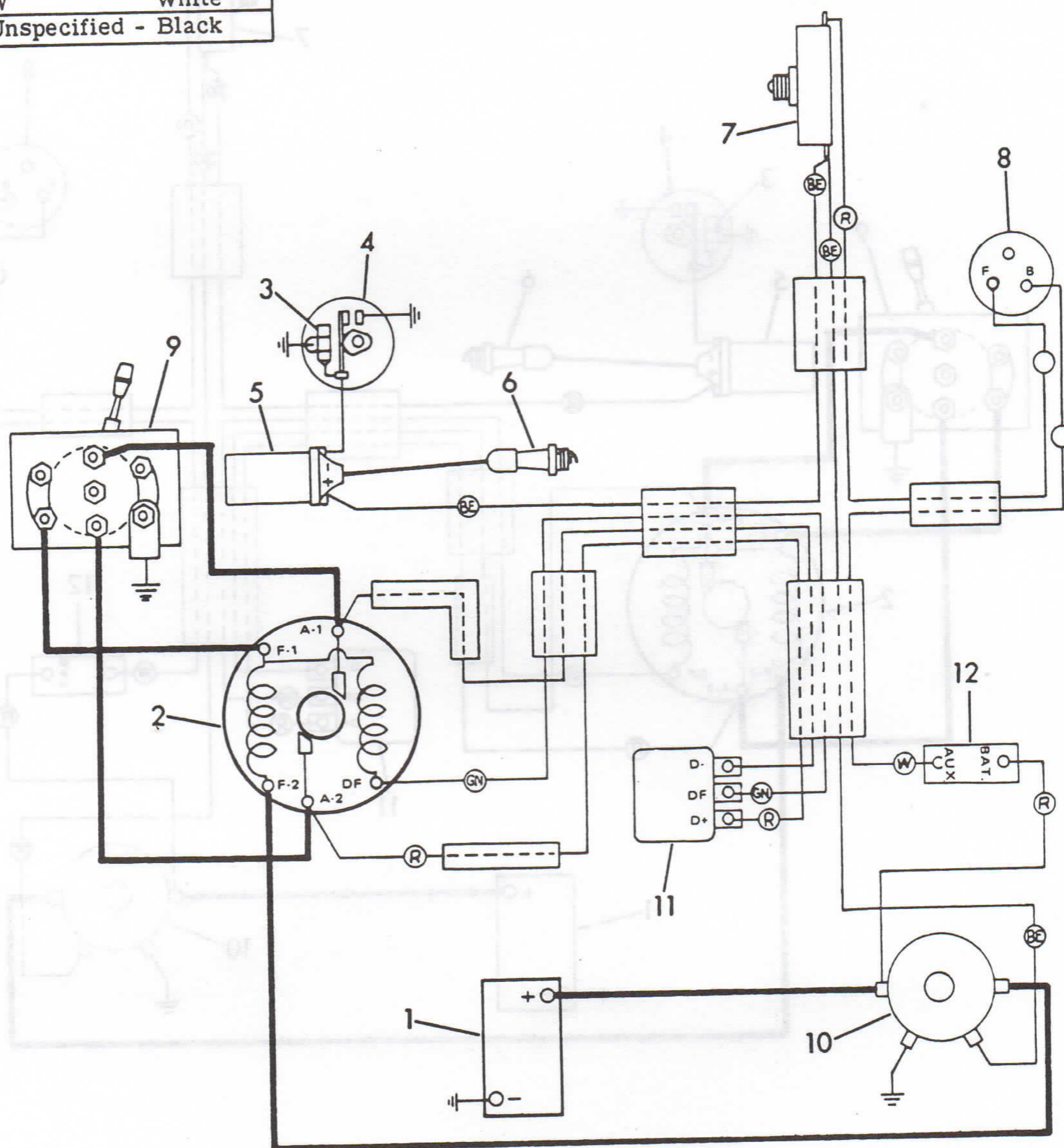
1. Battery
2. Starter-Generator
3. Condensor
4. Ignition circuit breaker
5. Ignition coil
6. Spark plug

7. Accelerator micro switch
8. Key switch
9. Reversing switch
10. Solenoid switch
11. Voltage regulator
12. Overload circuit breaker

Figure 5B-31 Wiring Diagram - 1980 & Later - D, D4

COLOR CODE	
BE	Blue
GN	Green
R	Red
Y	Yellow
W	White
Unspecified - Black	

COLOR CODE	
BE	Blue
GN	Green
R	Red
Y	Yellow
W	White
Unspecified - Black	

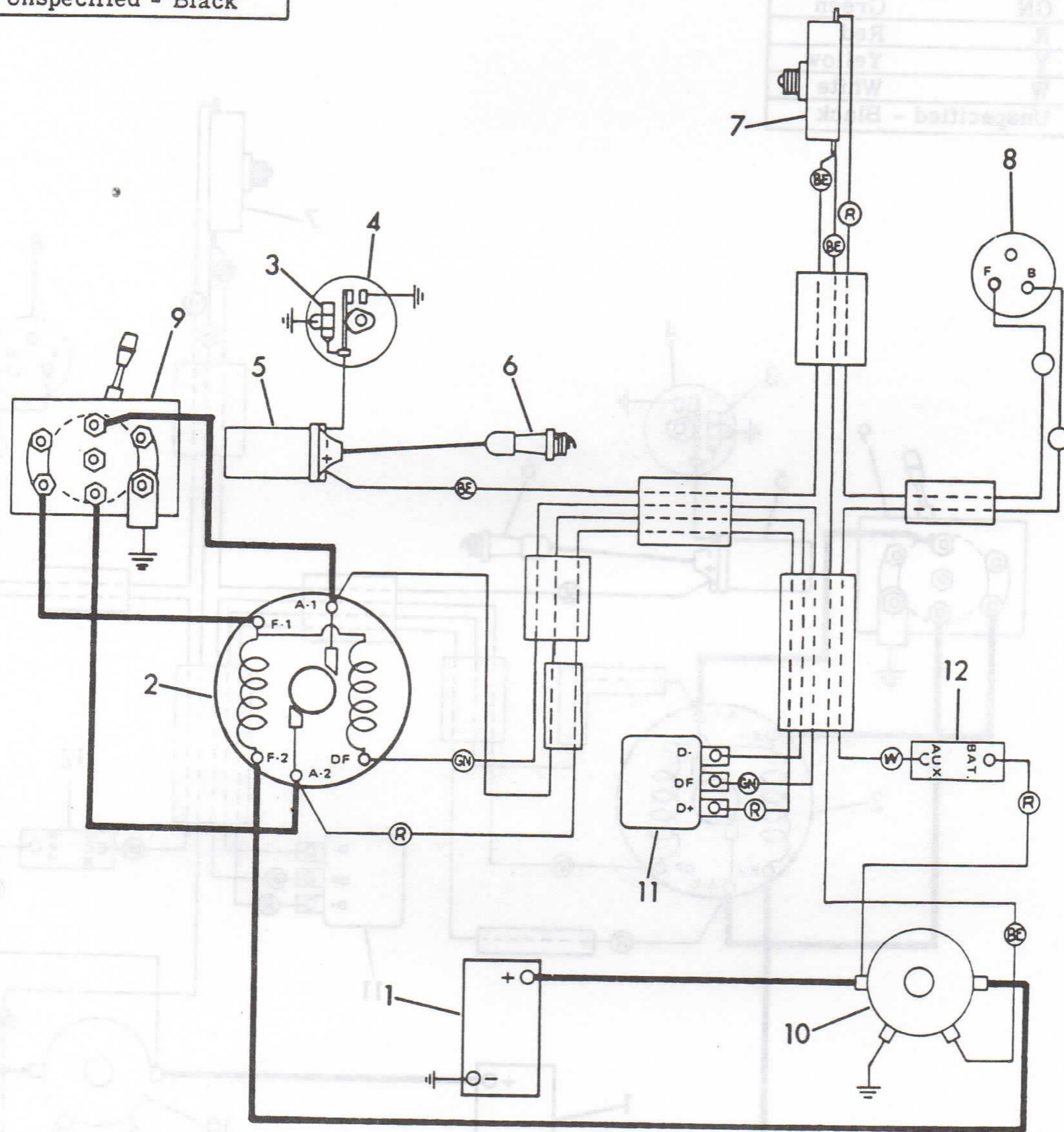


1. Battery
2. Starter-Generator
3. Condenser
4. Ignition circuit breaker
5. Ignition coil
6. Spark plug

7. Accelerator micro switch
8. Key switch
9. Reversing switch
10. Solenoid switch
11. Voltage regulator
12. Overload circuit breaker

Figure 5B-30 Wiring Diagram - 1975-1979 - D, D4

COLOR CODE	
BE	Blue
GN	Green
R	Red
Y	Yellow
W	White
Unspecified - Black	



1. Battery
2. Starter-Generator
3. Condensor
4. Ignition circuit breaker
5. Ignition coil
6. Spark plug

7. Accelerator micro switch
8. Key switch
9. Reversing switch
10. Solenoid switch
11. Voltage regulator
12. Overload circuit breaker

Figure 5B-31 Wiring Diagram - 1980 & Later - D, D4

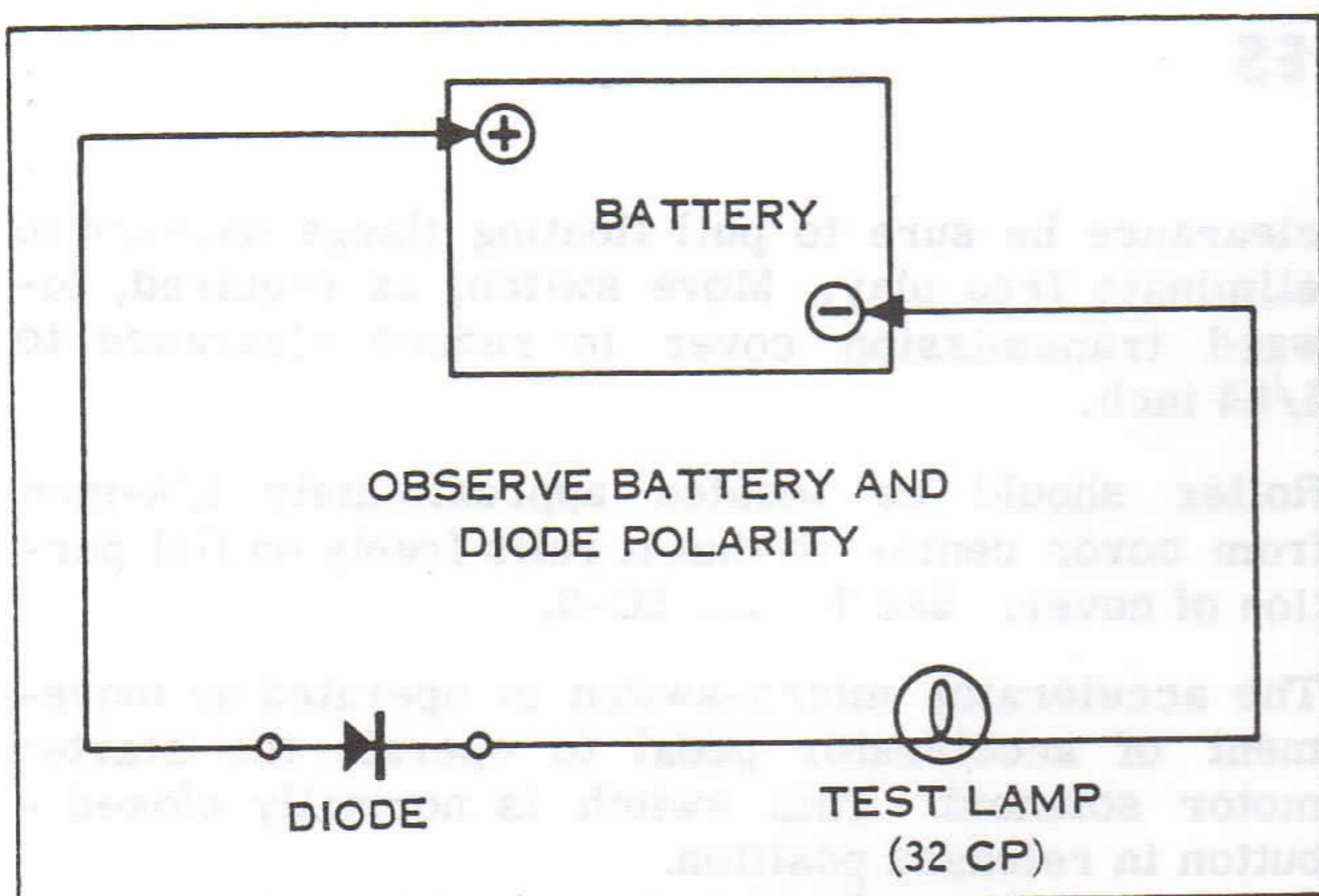


Figure 5C-9B. Test Circuit for Diode

DIODE

In cars using a field resistor to control generator voltage a diode is used in the golf car electrical circuit as a one way "valve" to control the direction of current flow. Function of the circuit is described earlier in this Section.

A simple check to determine if diode is functioning correctly is with the use of a battery and test lamp in series with the diode as shown in Figure 5C-9B. Lamp should light with current flow in one direction only as shown. If lamp lights with battery connections reversed for current flow in opposite direction, diode is shorted. If lamp does not light for current flow in both directions, diode is open.

In either case the diode should be replaced.

TESTING MICRO-SWITCH OUT OF CAR

Use a continuity tester to check micro-switch. To check micro-switch for continuity (Fig. 5C-10) depress plunger. The light should not glow. Release plunger and the light should glow. Replace as necessary.

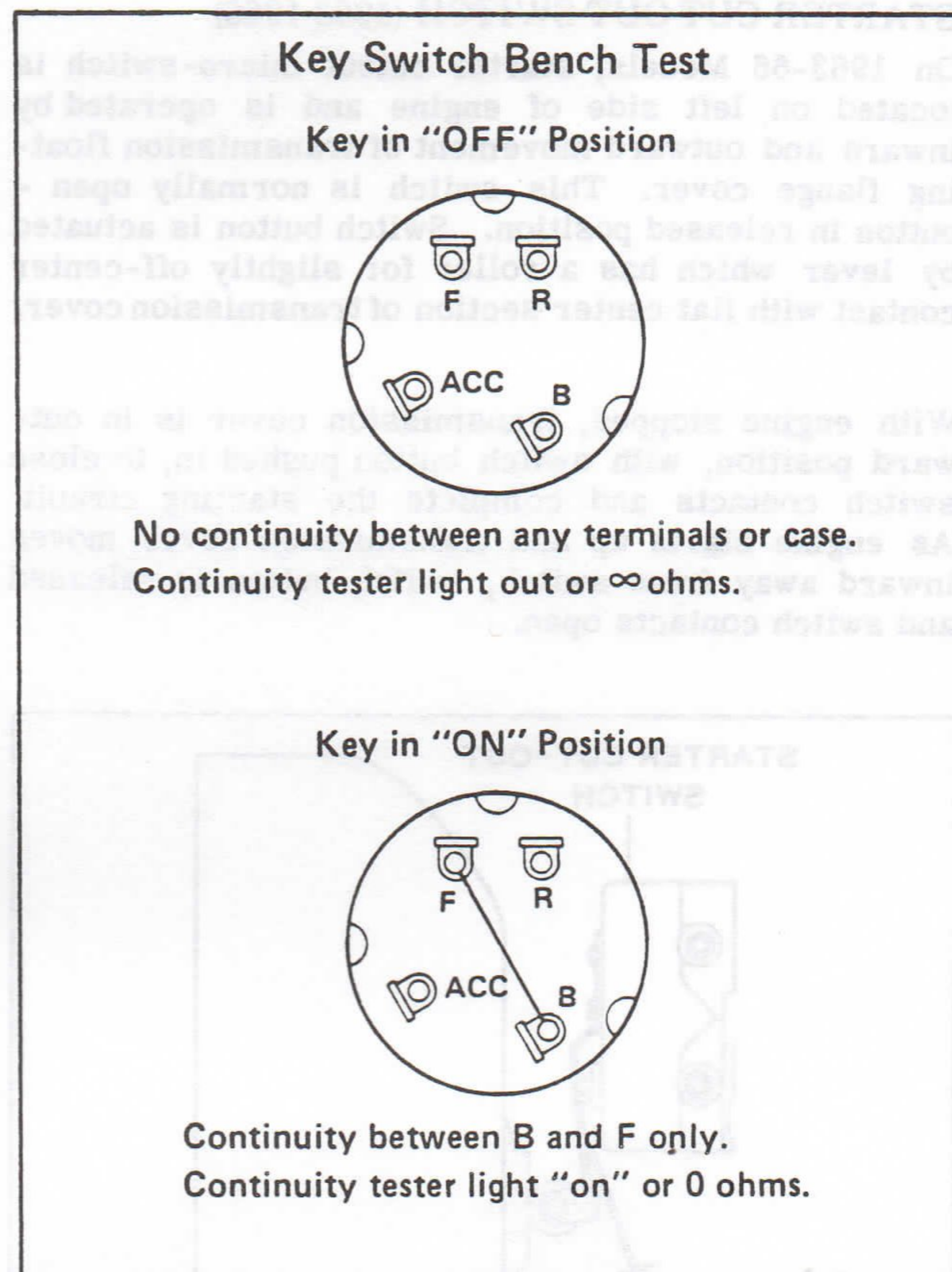


Figure 5C-11. Testing Key Switch for Continuity

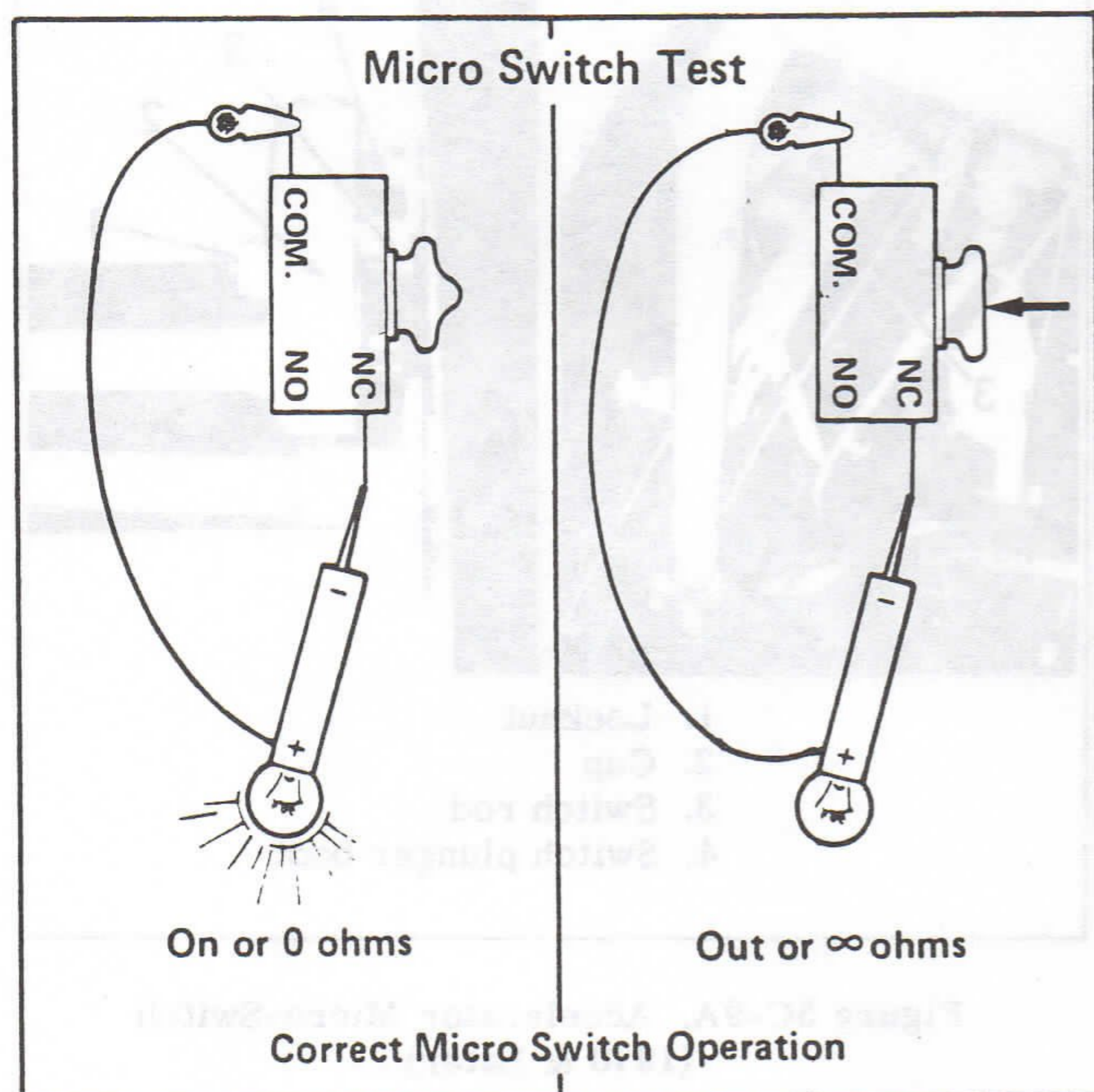


Figure 5C-10. Testing Micro Switch for Continuity

KEY SWITCH

This switch is not repairable. If this switch becomes defective it must be replaced.

TESTING KEY SWITCH

WARNING

Before making any tests, disconnect spark plug wire to prevent engine from running.

Use a continuity tester or ohmmeter to test key switch. If key switch is good, the light will glow, or the ohmmeter will show "0" ohms resistance as checked between "F" and "B" terminals with key in on position.

SWITCHES

MICRO-SWITCH

This switch is a permanently assembled snap action switch. If this switch becomes defective, it must be replaced.

STARTER CUT-OUT SWITCH (1963-1966)

On 1963-66 Models, starter cutout micro-switch is located on left side of engine and is operated by inward and outward movement of transmission floating flange cover. This switch is normally open - button in released position. Switch button is actuated by lever which has a roller for slightly off-center contact with flat center section of transmission cover.

With engine stopped, transmission cover is in outward position, with switch button pushed in, to close switch contacts and complete the starting circuit. As engine starts up and transmission cover moves inward away from switch, switch button is released and switch contacts open.

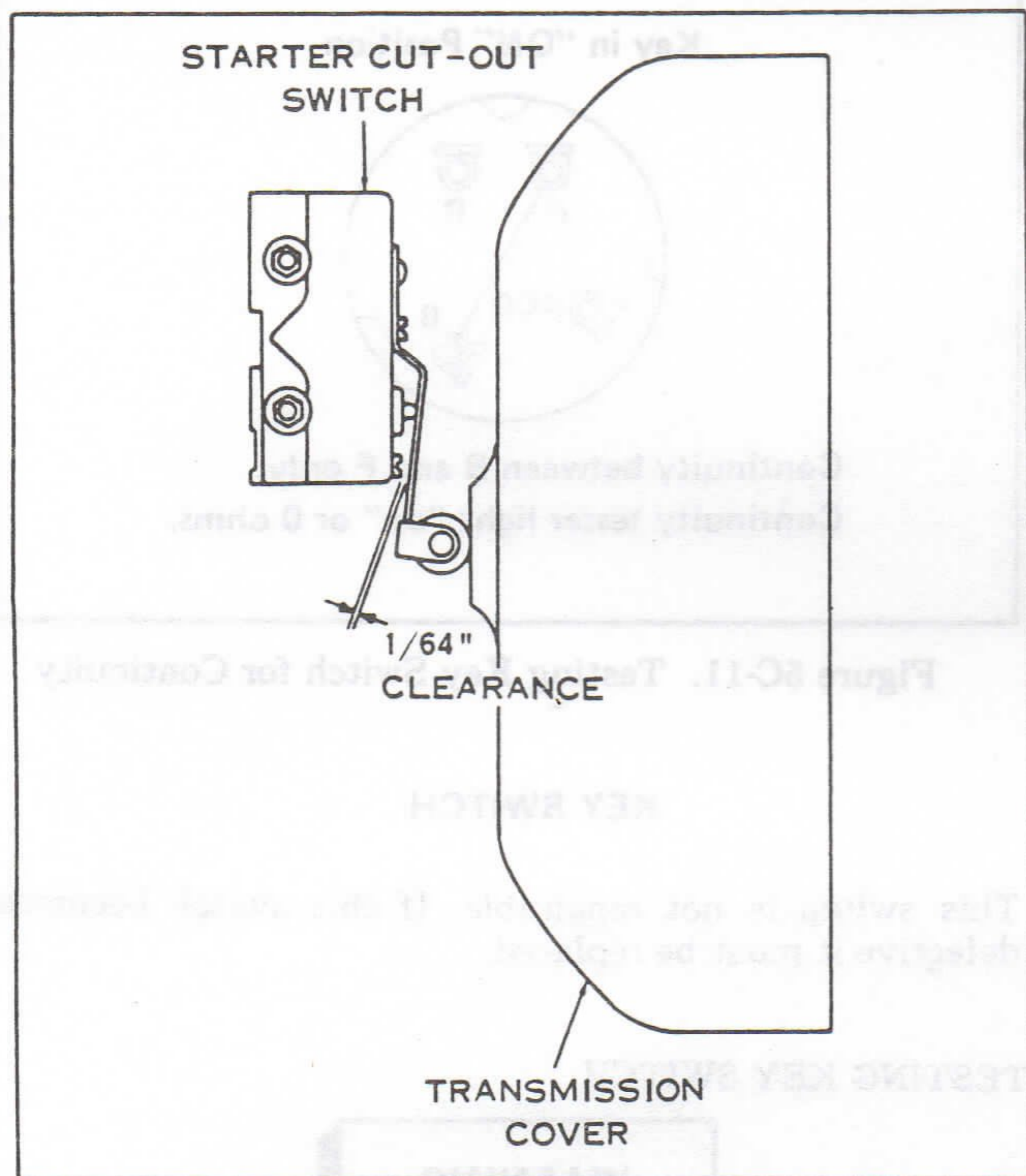


Figure 5C-9. Starter Cut-Out Switch Adjustment (1963-66 D, 1967 DC)

Switch is adjustable on mounting bracket. To adjust away from, or closer to transmission cover, loosen two mounting bolt nuts on bracket. Switch is correctly adjusted when no more than $1/64$ -inch clearance exists between actuating lever and screw directly underneath switch lever. When checking

clearance be sure to pull floating flange outward to eliminate free play. Move switch, as required, toward transmission cover to reduce clearance to $1/64$ inch.

Roller should be located approximately $1/4$ -inch from cover center so that it rolls freely on flat portion of cover. See Figure 5C-9.

The accelerator micro-switch is operated by movement of accelerator pedal to operate the starter motor solenoid. This switch is normally closed - button in released position.

With accelerator pedal in released position, switch button is pushed in to open switch contacts. When pedal is depressed approximately half of free play distance, switch button releases to close switch contacts.

ACCELERATOR MICRO-SWITCH (1963 & Later)

On 1969 & earlier models the accelerator micro-switch is located at the base of the accelerator pedal and is fixed by its location in the mounting hole in the accelerator pedal bracket.

On 1970 and later models, the accelerator micro-switch is mounted under the left side frame cross-channel. The switch is operated by a rod running from the accelerator pedal through the frame cross-channel, and has a cup to actuate the micro-switch plunger (See Figure 5C-9A).

Cup (2) is adjustable by turning on rod (3) threads after loosening locknut (1). Adjust switch so that it clicks (CLOSES) when pedal is pushed down approximately half of free play distance. Retighten locknut against cup.

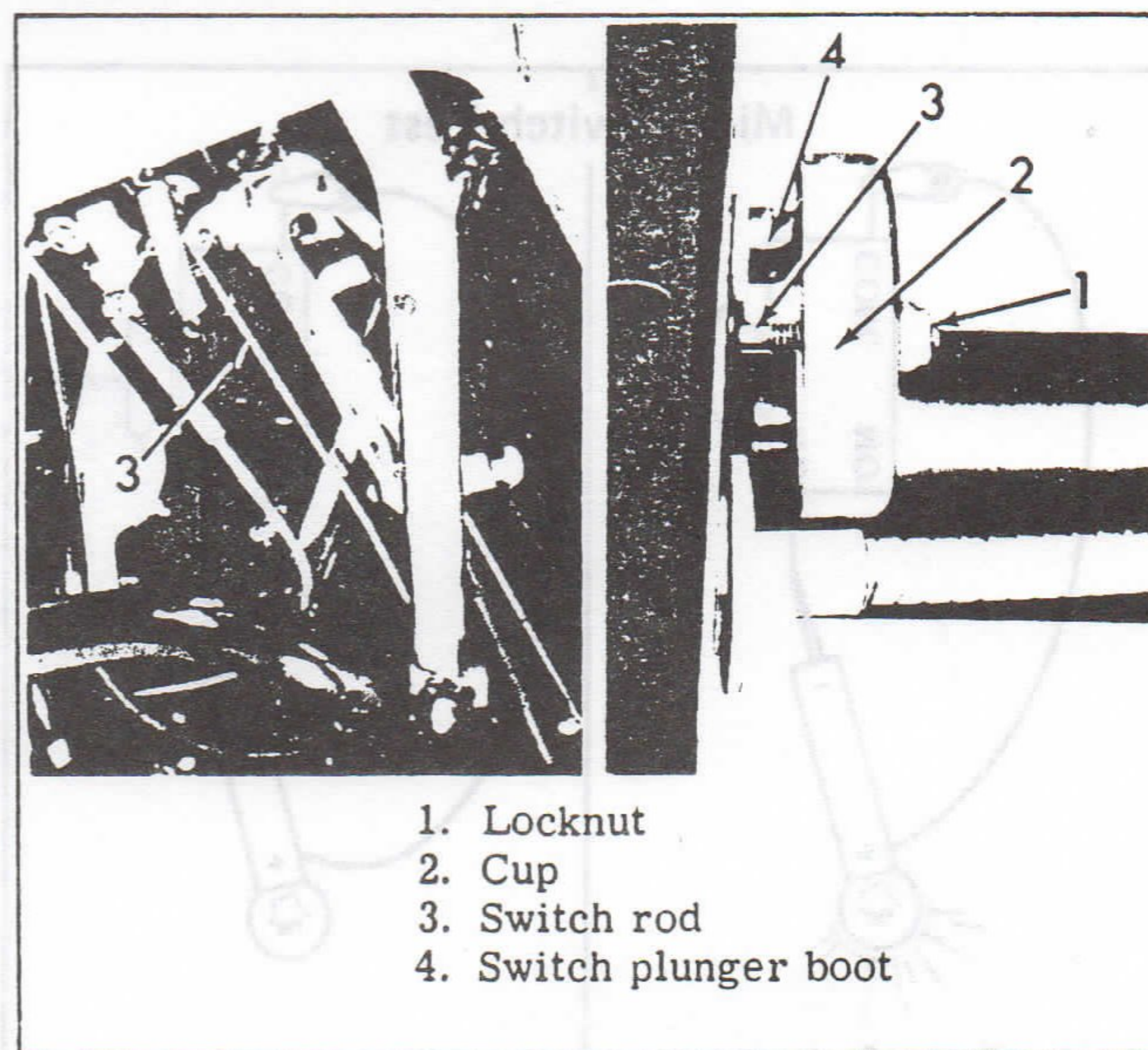


Figure 5C-9A. Accelerator Micro-Switch (1970 & Later)

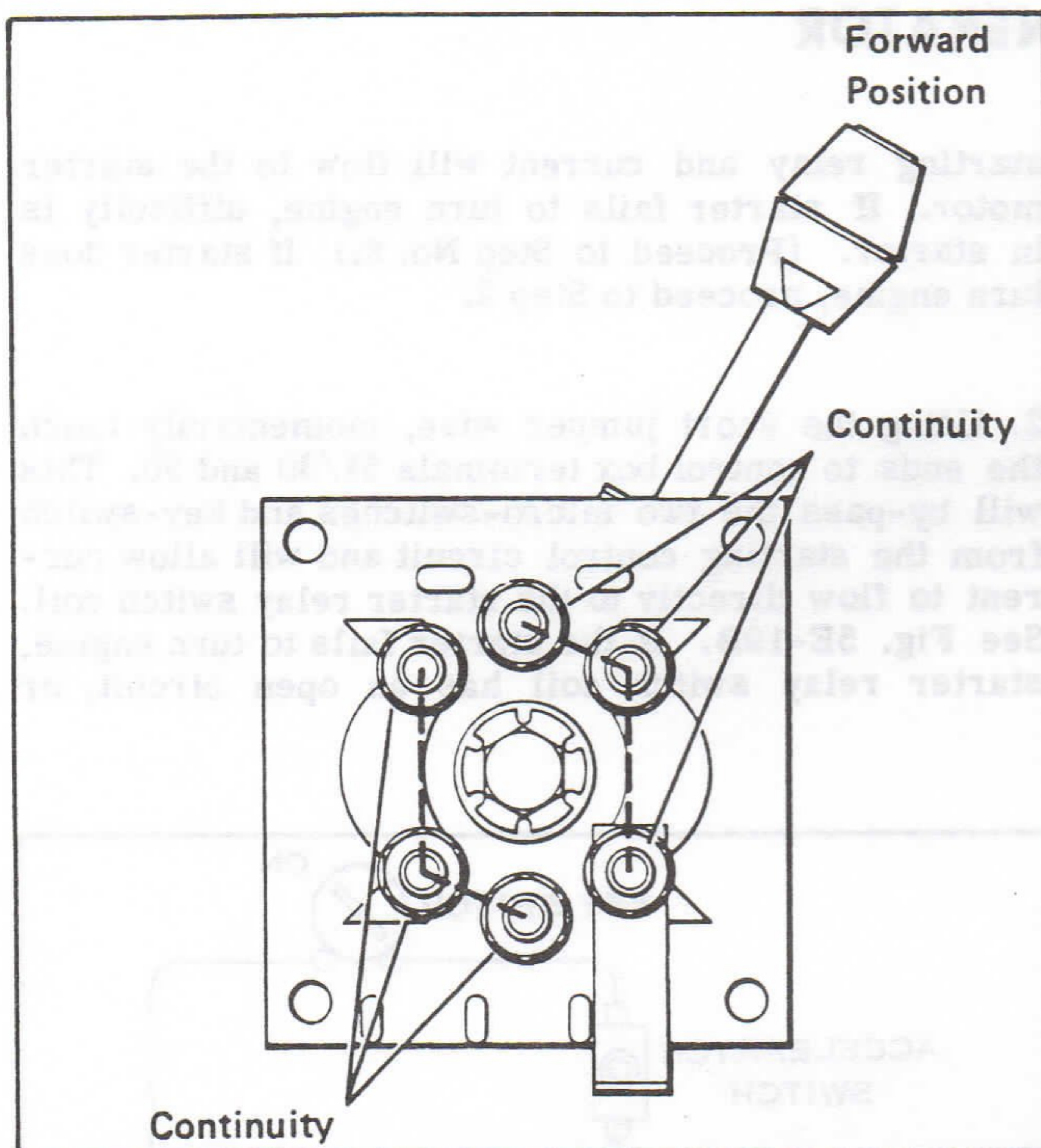


Figure 5C-12. Correct Continuity in Forward Position

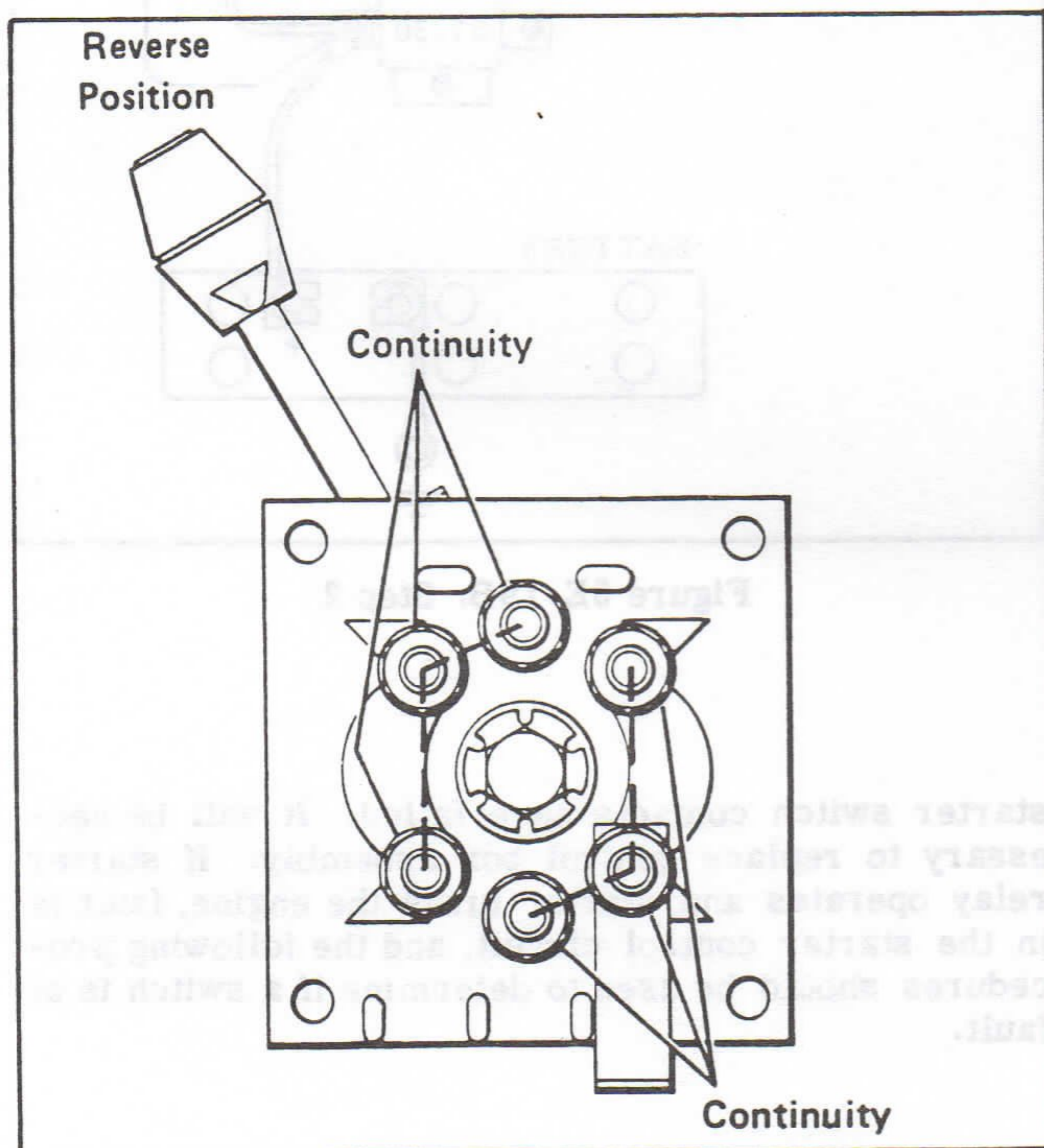


Figure 5C-12A. Correct Continuity in Reverse Position

REVERSING SWITCH

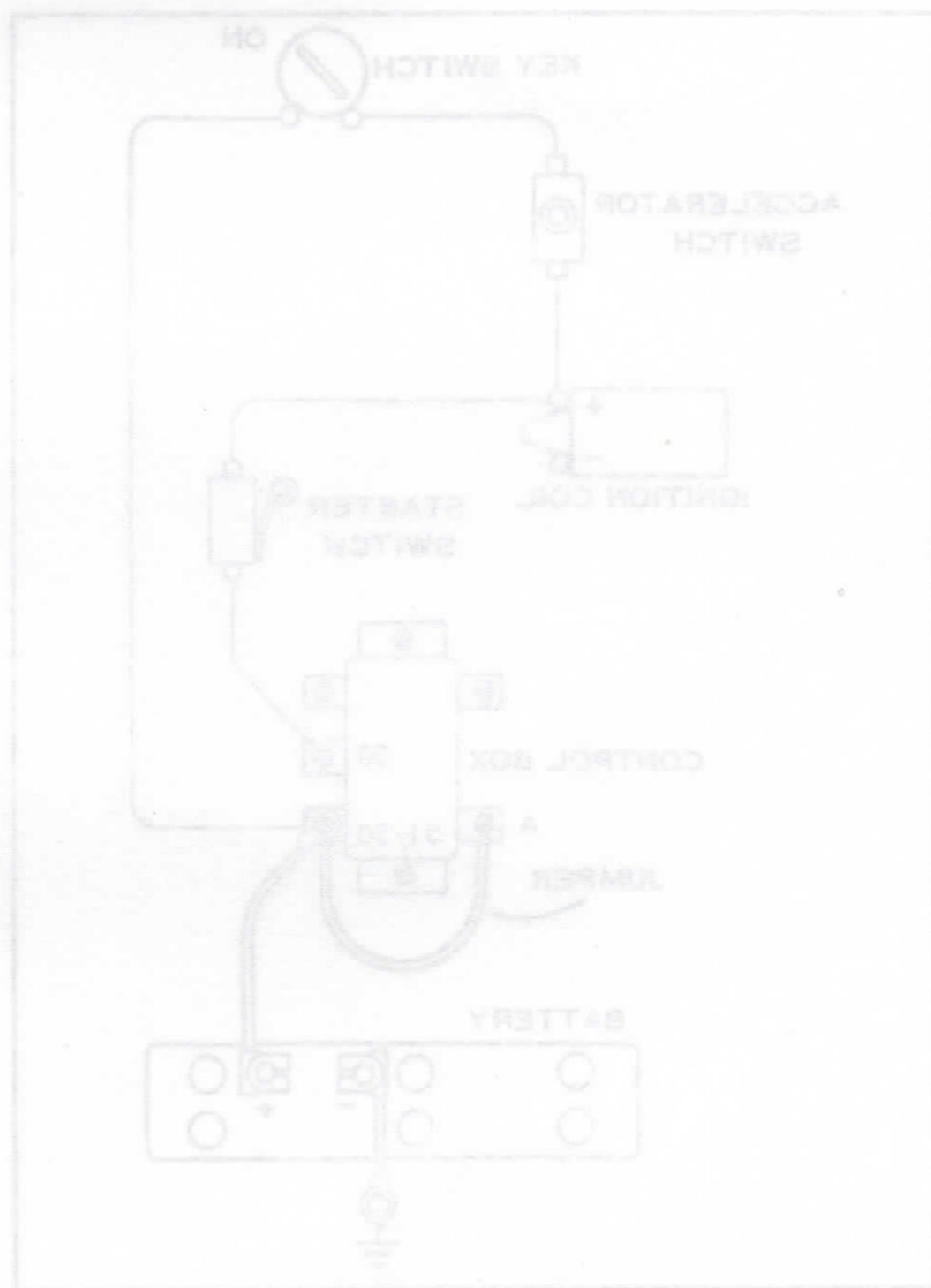
The reversing switch is a built-up assembly which can be taken apart for cleaning and replacement of contact screws, connecting strips, floating contact buttons, etc., if defective. Normally cleaning with fine emery paper is all that is required to correct imperfect contact.

Apply a light coat of high quality chassis grease to contacts when reassembling switch. Check for continuity with handle in forward position as shown (Fig. 5C-12). For reverse position, check continuity at indicated points (Figure 5C-12A).

WARNING

For all subsequent tests, remove spark plug wire from spark plug to prevent engine from running.

1. Use a short jumper of heavy gauge wire, and momentarily touch the ends to control box terminals 21-30 and A. See Fig. 5B-18A. This will bypass



STARTER-GENERATOR

SHAFT DRIVE TYPE (1963-66 D MODELS, ALL DC MODELS)

CHECKING STARTING CIRCUIT

If starter motor fails to turn engine over with key-switch in ON position and the accelerator pedal depressed, the following checks should be made in sequence to find the cause. These checks should be made only after eliminating other possible causes such as a discharged battery, loose or corroded battery cables, faulty wiring connections, or some mechanical failure within the engine.

WARNING

For all subsequent tests, remove spark plug wire from spark plug to prevent engine from running.

1. Using a short jumper of heavy gauge wire, momentarily touch the ends to control box terminals 51/30 and A. See Fig. 5E-19A. This will by-pass

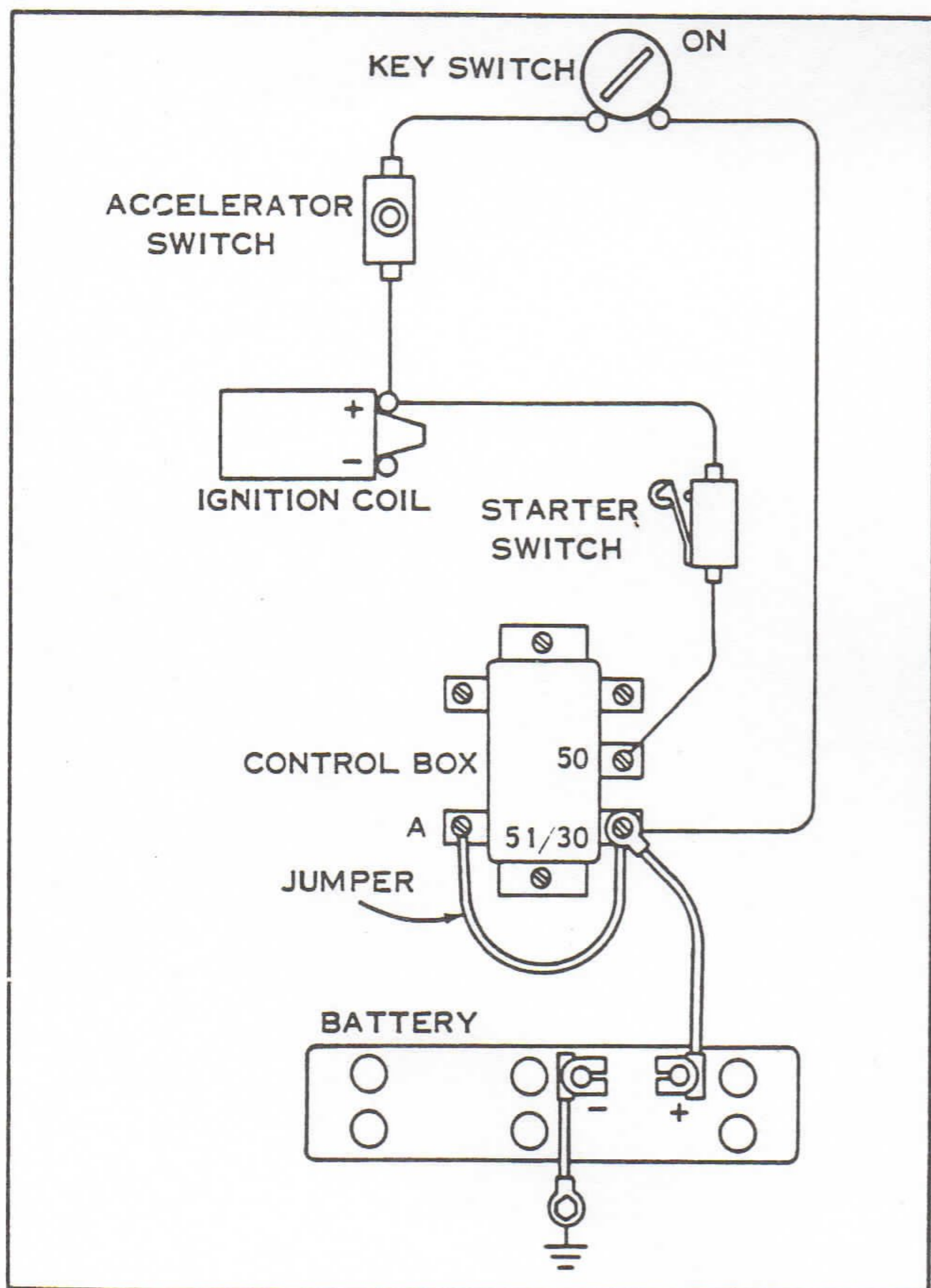


Figure 5E-19A. Step 1

starting relay and current will flow to the starter motor. If starter fails to turn engine, difficulty is in starter. (Proceed to Step No. 6.) If starter does turn engine, proceed to Step 2.

2. Using the short jumper wire, momentarily touch the ends to control box terminals 51/30 and 50. This will by-pass the two micro-switches and key-switch from the starting control circuit and will allow current to flow directly to the starter relay switch coil. See Fig. 5E-19B. If the starter fails to turn engine, starter relay switch coil has an open circuit, or

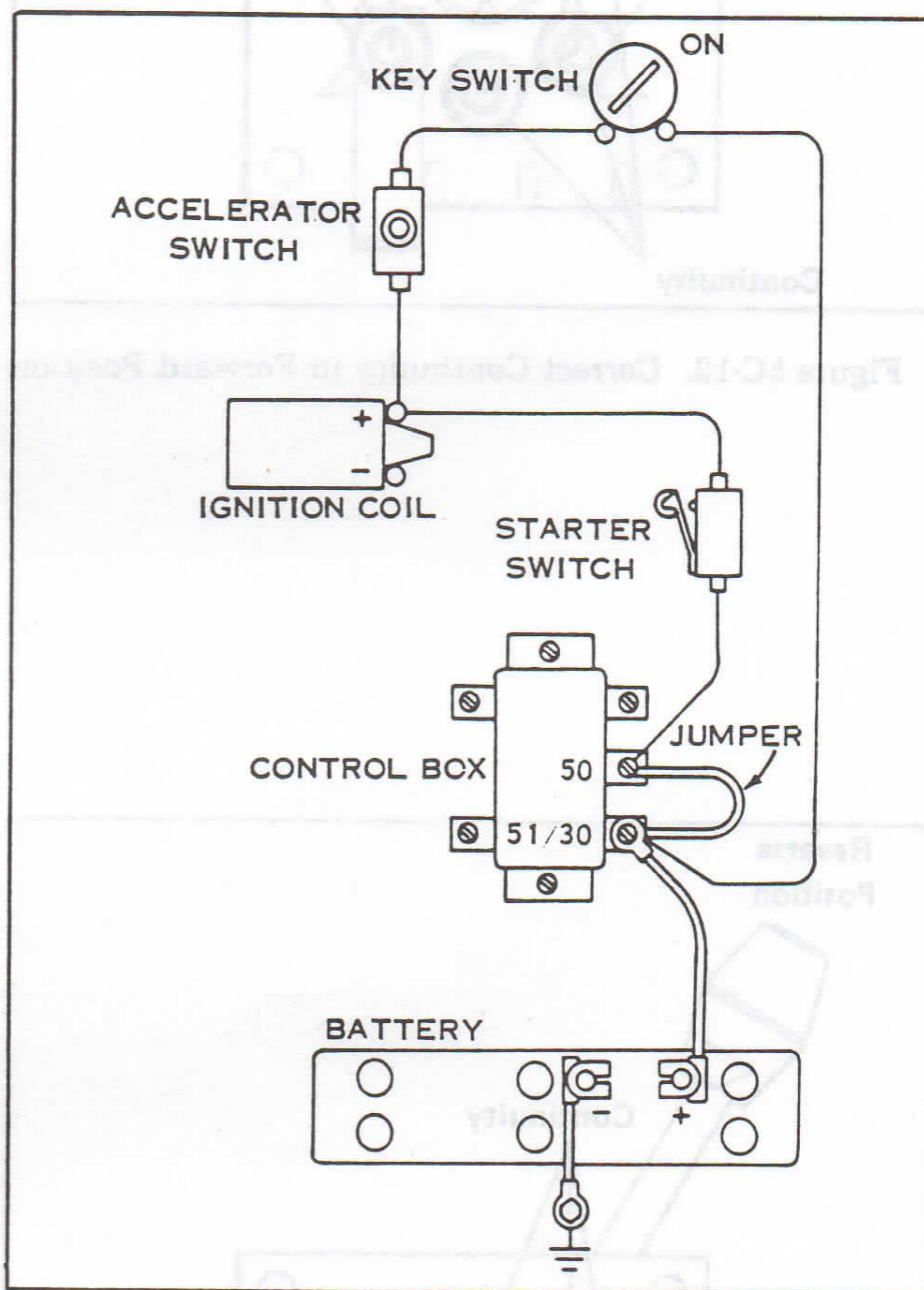


Figure 5E-19B. Step 2

starter switch contacts have failed. It will be necessary to replace control box assembly. If starter relay operates and starter turns the engine, fault is in the starter control circuit, and the following procedures should be used to determine if a switch is at fault.

3. To test continuity of switch circuit to ignition coil use a 12-volt test lamp of 4-candlepower or less with test leads approximately one foot long. Connect one lead of test lamp to positive terminal of the ignition coil (identified by two green wires) and the other lead

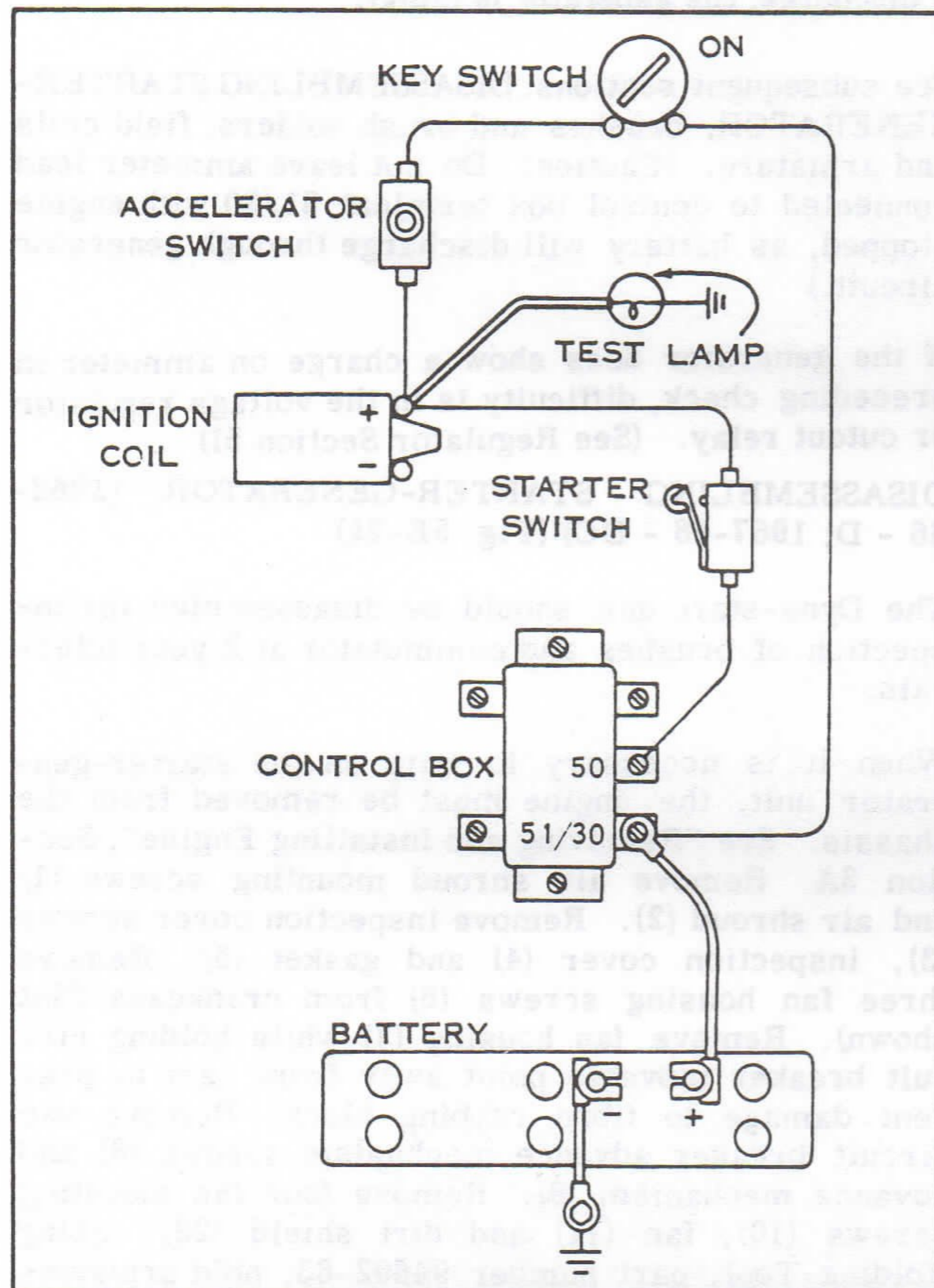


Figure 5E-19C. Step 3

to ground on chassis or motor base. See Fig. 5E-19C. With the key-switch in ON position, press accelerator pedal far enough to close accelerator switch. If test bulb glows, battery current is passing through key-switch and accelerator switch, and fault is in either starter switch, green wire to switch or blue wire from switch to terminal 50 on control box. Proceed directly to step No. 5.

4. If test bulb does not glow, fault is in either key-switch, accelerator switch, or wiring. Using two short wires jump across the terminals of switches. Test light will glow and starter may crank engine. With test light glowing or with engine turning, remove jumper wires alternately from switches to find which is defective. See Fig. 5E-19D. Replace switches as necessary. If test lamp fails to light when switches are jumped, fault is in the wiring circuit which connects the switches. If test lamp lights but engine does not start, proceed directly to step 5 to test the starter switch.

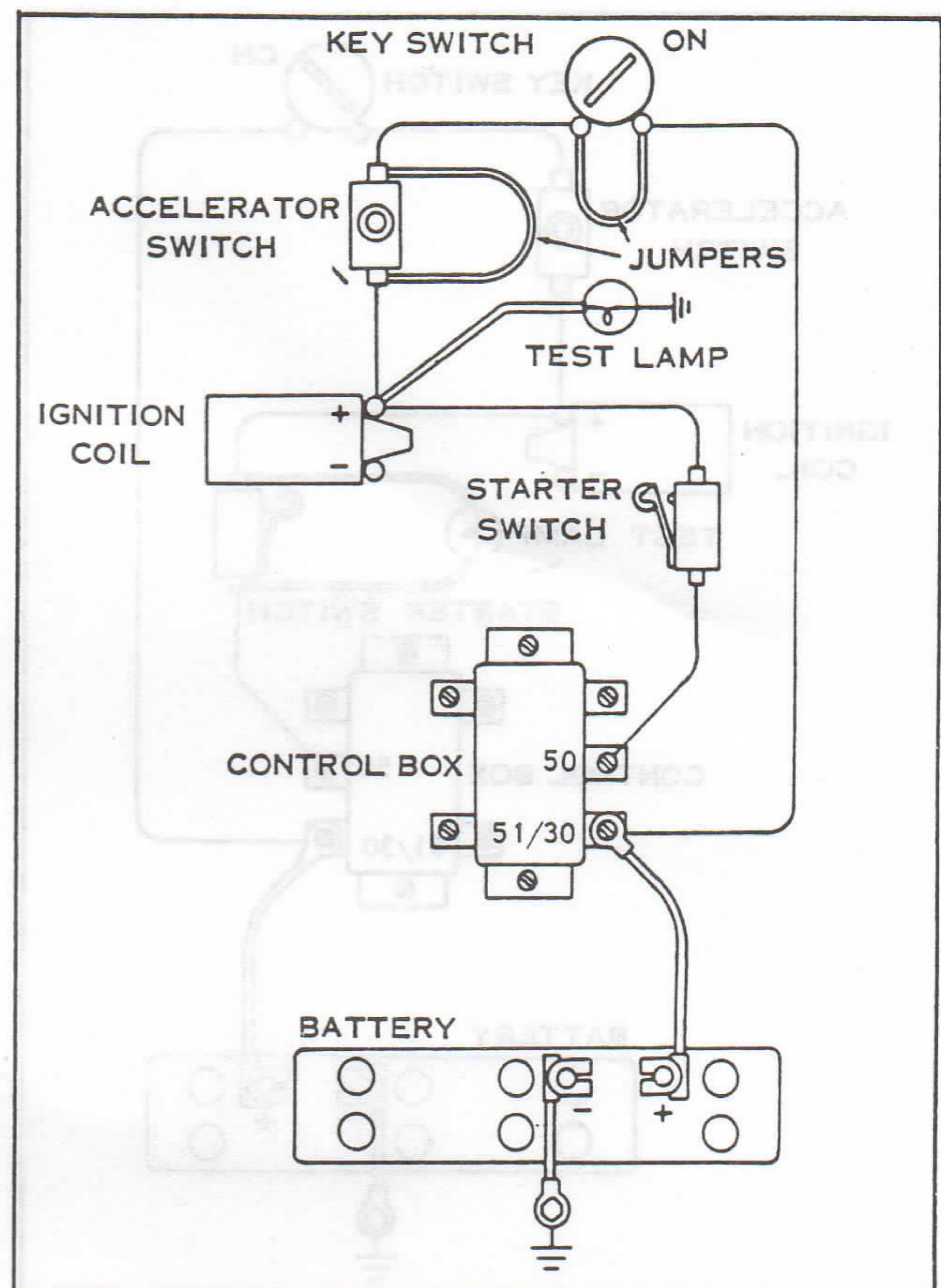


Figure 5E-19D. Step 4

5. Starter switch is located on the left side of the engine and is actuated by the inward and outward movement of the transmission cover. With key-switch in "ON" position and accelerator pedal pressed to close accelerator switch, touch test light leads to terminals of starter switch. See Fig. 5E-19E. Be sure to keep hand free of transmission moving parts. If the test light glows, switch is either defective or out of adjustment. Using a small screw driver, press on switch lever to press plunger farther into switch. If the engine now fails to turn over, switch is defective. See MICRO-SWITCH Section 5-C. If engine turns over when switch plunger is depressed, readjust micro-switch on mounting bracket closer to transmission cover. See MICRO-SWITCH Section 5-C.

6. If starter fails to turn engine as determined in Step 1, difficulty is in the starter. See subsequent sections: DISASSEMBLING STARTER-GENERATOR, BRUSHES AND BRUSH HOLDERS, FIELD COILS AND ARMATURE.

CHECKING GENERATOR CIRCUIT

When the battery becomes discharged during normal operation, it can be suspected that either the generator or regulator or both are faulty.

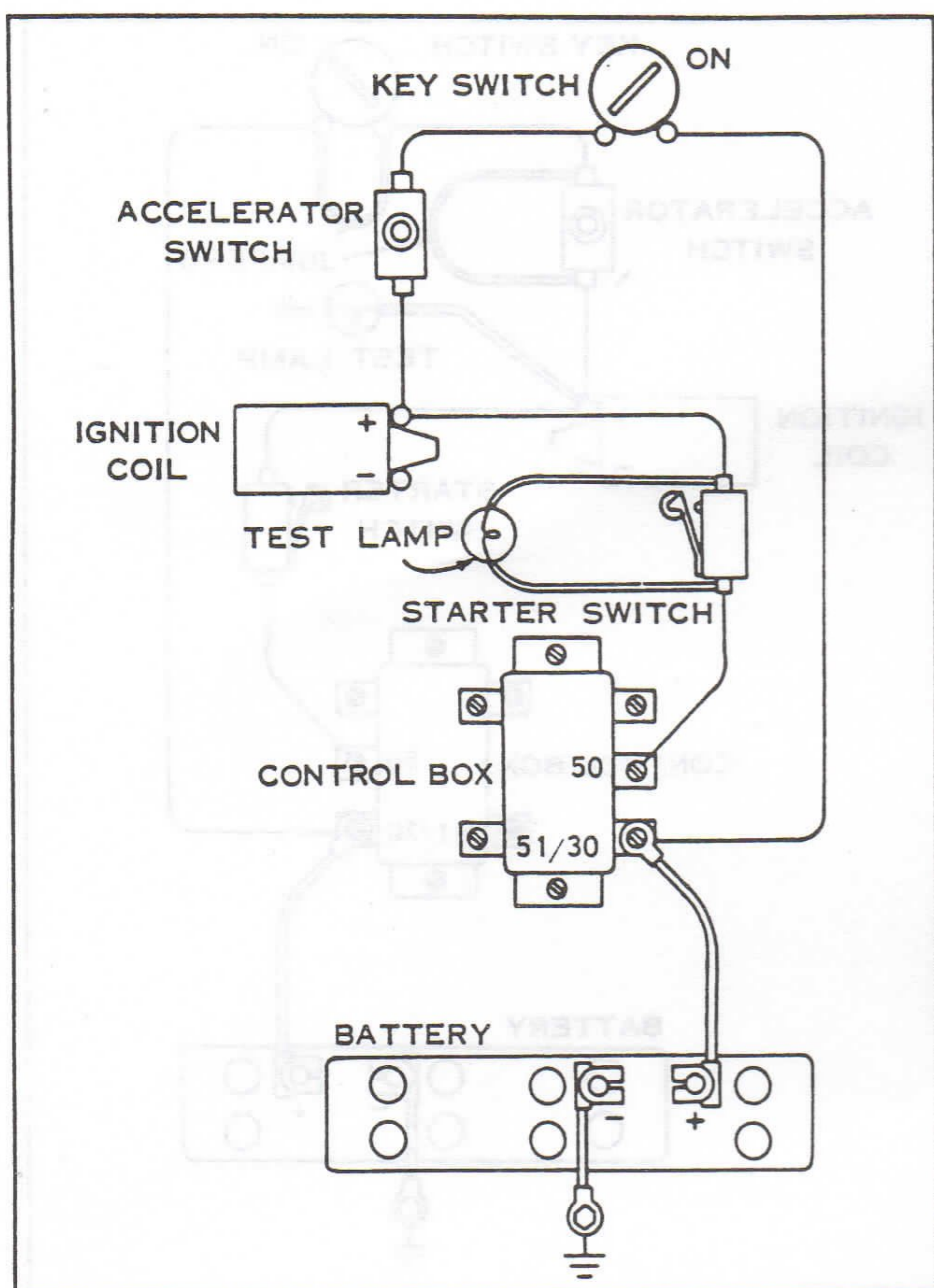


Figure 5E-19E. Step 5

The generator can be checked in the following manner. (Refer to Figure 5E-20.)

Remove black wire connected to control box terminal DF and attach to ground strap. CAUTION: Do not ground black wire while connected to DF terminal or serious damage to regulator points will result. Remove black wire connected to control box terminal 61/D+ and connect to the positive (+) lead of a 0-15

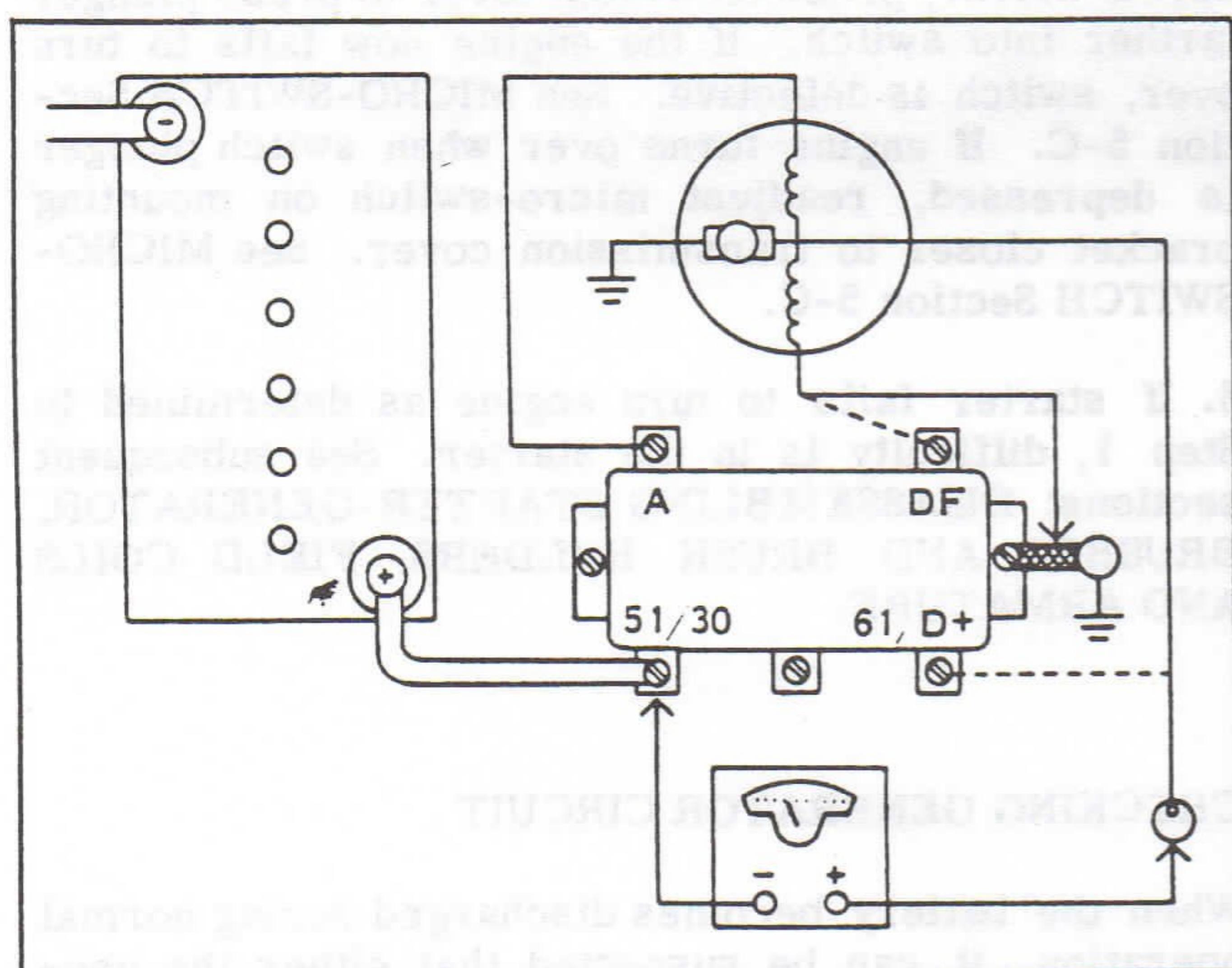


Figure 5E-20. Generator Test Circuit

D.C. ammeter. Start engine and run in neutral at 1200 to 1500 rpm. (It may be necessary to use jumper leads from another 12 volt battery to golf car battery, if discharged.) With engine running at recommended speed, touch negative lead of ammeter to control box terminal 51/30. Ammeter should now show a charge of 5 to 10 amperes. If ammeter shows no charge or a discharge, the generator is faulty.

See subsequent sections: DISASSEMBLING STARTER-GENERATOR, brushes and brush holders, field coils and armature. (Caution: Do not leave ammeter lead connected to control box terminal 51/30 with engine stopped, as battery will discharge through generator circuit.)

If the generator does show a charge on ammeter in preceding check, difficulty is in the voltage regulator or cutout relay. (See Regulator Section 5I)

DISASSEMBLING STARTER-GENERATOR (1963-66 - D; 1967-68 - DC) (Fig. 5E-21)

The Dyna-start unit should be disassembled for inspection of brushes and commutator at 2 year intervals.

When it is necessary to work on the starter-generator unit, the engine must be removed from the chassis. See "Removing and Installing Engine", Section 3A. Remove air shroud mounting screws (1) and air shroud (2). Remove inspection cover screws (3), inspection cover (4) and gasket (5). Remove three fan housing screws (6) from crankcase (Not shown). Remove fan housing (7) while holding circuit breaker movable point away from cam to prevent damage to fibre rubbing block. Remove two circuit breaker advance mechanism screws (8) and advance mechanism (9). Remove four fan mounting screws (10), fan (11) and dirt shield (22). Using Holding Tool, part number 94692-63, hold armature rotor (12) and remove nut (13) and lock washer (14). (See Fig. 5E-22.) Thread Armature Puller, part number 95563-63, into armature and turn press screw inward until armature breaks free of shaft taper. NOTE: Early Model D shafts have a large center in end of shaft. A 3/16 inch ball comes with puller which should be inserted into such large centers for the puller screw to bear against. Carefully slide armature off stator (15) and remove puller. (See Fig. 5E-23.) After removing armature rotor from crankshaft, note carefully whether the armature commutator area has an oil-wet or sticky carbon deposit. This would indicate a leaking oil seal behind the field stator. (Dry carbon dust is o.k.) To remove field stator (15) from right crankcase, remove armature key (16) from shaft. Remove three stator mounting screws (17) and washers (18). Remove rubber or plastic grommet (19 or 19A) from crankcase to permit withdrawal of wires through crankcase. CAUTION: Normally the stator (15) will be held tightly to the crankcase with gasket sealer. To break stator free from crankcase use two large screwdrivers to pry between the stator pole pieces and the crankcase. (See Fig. 5E-24.) Extreme care must be taken to avoid prying against the field coils and thereby damaging them. Remove stator gasket (20). Crankcase seal (21) can then be pushed out of stator (15).

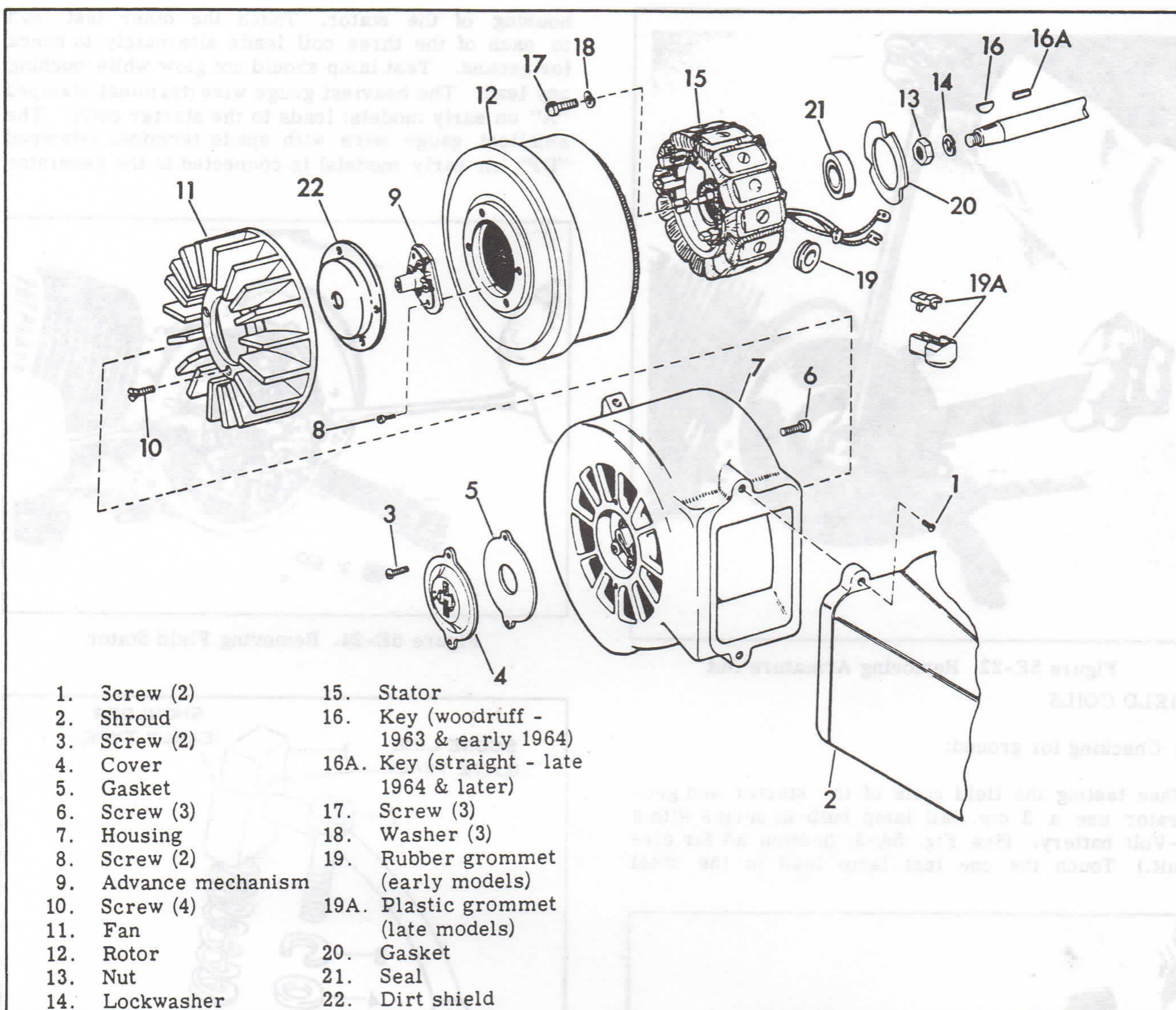


Figure 5E-21. Starter-Generator (1963-66 Model D, 1967 & 68 Model DC) - Exploded View

BRUSHES AND BRUSH HOLDERS

Brushes must be replaced when worn down to shoulders on their flanks (early models) or score line on side of brush (later models) as indicated in Fig. 5E-25.

Some starter generators have wire brush stops, to limit brush travel. If this type unit is being serviced, remove brush stops at this time.

If brushes are still serviceable, check the tightness of the pig-tail leads in the brush material and test for continuity by using test lamp circuit. If a brush surface which contacts the commutator is chipped new brushes should be used. Brush spring pressure should be checked and if found weak, brushes should be replaced. Brushes should be replaced in sets only. Set includes 4 brushes with springs.

Remove all carbon dust or sludge from the brush holders so brushes move freely. The two positive

(+) brush holders are insulated from stator housing. They can be identified by their red paint markings and by insulating material found under them. Using the test lamp circuit, check for possible grounding. Test lamp should not glow when touching one lead to stator and one to insulated brush holder. If a positive (+) brush holder is grounded, replacement of the insulating material may be necessary. Refer to the exploded view of insulated brush holder in 5E-25. The two positive brushes have large holes in terminals to fit over insulating bushings. After reassembling, brush holder should again be checked to see that it is insulated. Using test lamp circuit also check negative (-) brush holders to see that they are grounded to stator housing.

If oil or grease is found on the commutator, coils, brushes or within the armature the seal in the stator housing should be replaced. Use H.D. Seal-All on outside of seal to cement firmly in place in stator bore.

Rigid Tension Adjustment (Late 1978 & Later)
(Figure 5A-27Fa)

1. Install belt on starter/generator. Adjust belt tension to 6 lbs. with 1/8" deflection and torque nut (4) to 12 ft.-lbs. using Tool Part No. 97320-67 and spring scale (Figure 5E-27A).
2. Torque nut (5) to 6 ft.-lbs.
3. Torque front and rear mounting nuts (4) to 12 ft.-lbs.
4. Drive car for short time and readjust belt tension following Steps 1, 2 and 3.

CAUTION

Belt tension must be rechecked at least within the first hour of operation to account for any initial stretch or seating of components. The new belt tensioner could allow the use of a non-standard belt, or a belt that is too long could result in the starter/generator being pivoted to such a point that the "DF" terminal of the starter/generator could come in contact with the air cleaner and short out the voltage regulator.

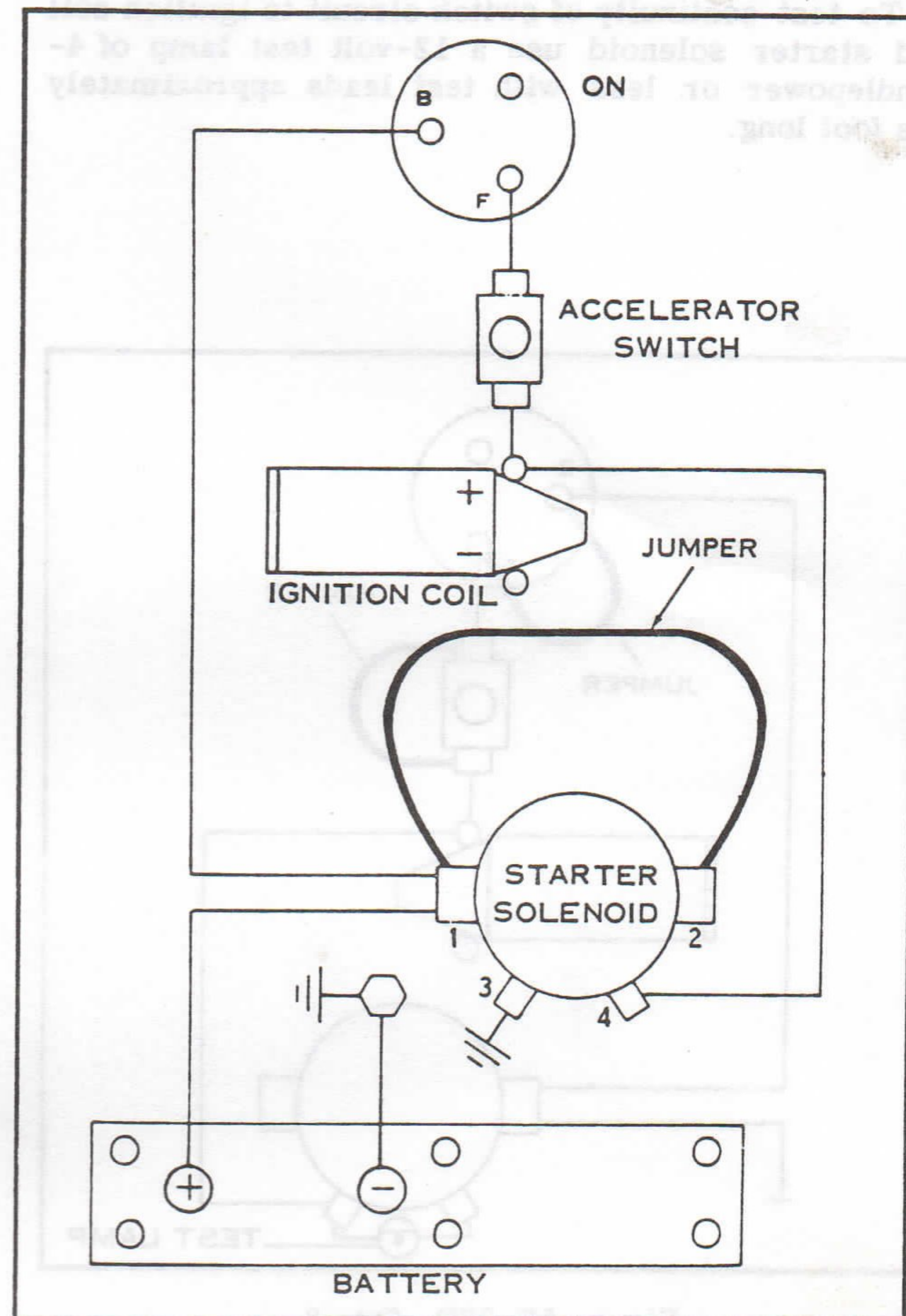


Figure 5E-27B. Step 1

CHECKING STARTING CIRCUIT

WARNING

For all subsequent tests, remove spark plug wire from spark plug to prevent engine from running.

1. Using a short jumper of heavy gage wire, momentarily touch the ends to large solenoid terminals. See Fig. 5E-27B. This will by-pass starting solenoid and current will flow to the starter motor. If starter fails to turn engine, difficulty is in starter or reversing switch (See Step 4). If starter does turn engine, proceed to Step 2.
2. Using the short jumper wire, momentarily touch the ends to solenoid terminals 1 and 4. This will by-pass the micro-switch and keyswitch from the starting control circuit and will allow current to flow directly to the starter solenoid coil. See Fig. 5E-27C. If the starter fails to turn engine, starter solenoid coil has an open circuit. It will be necessary to replace starter solenoid. If starter relay operates and starter turns the engine, fault is in the starter control circuit, and the following procedures should be used to determine if a switch is at fault.

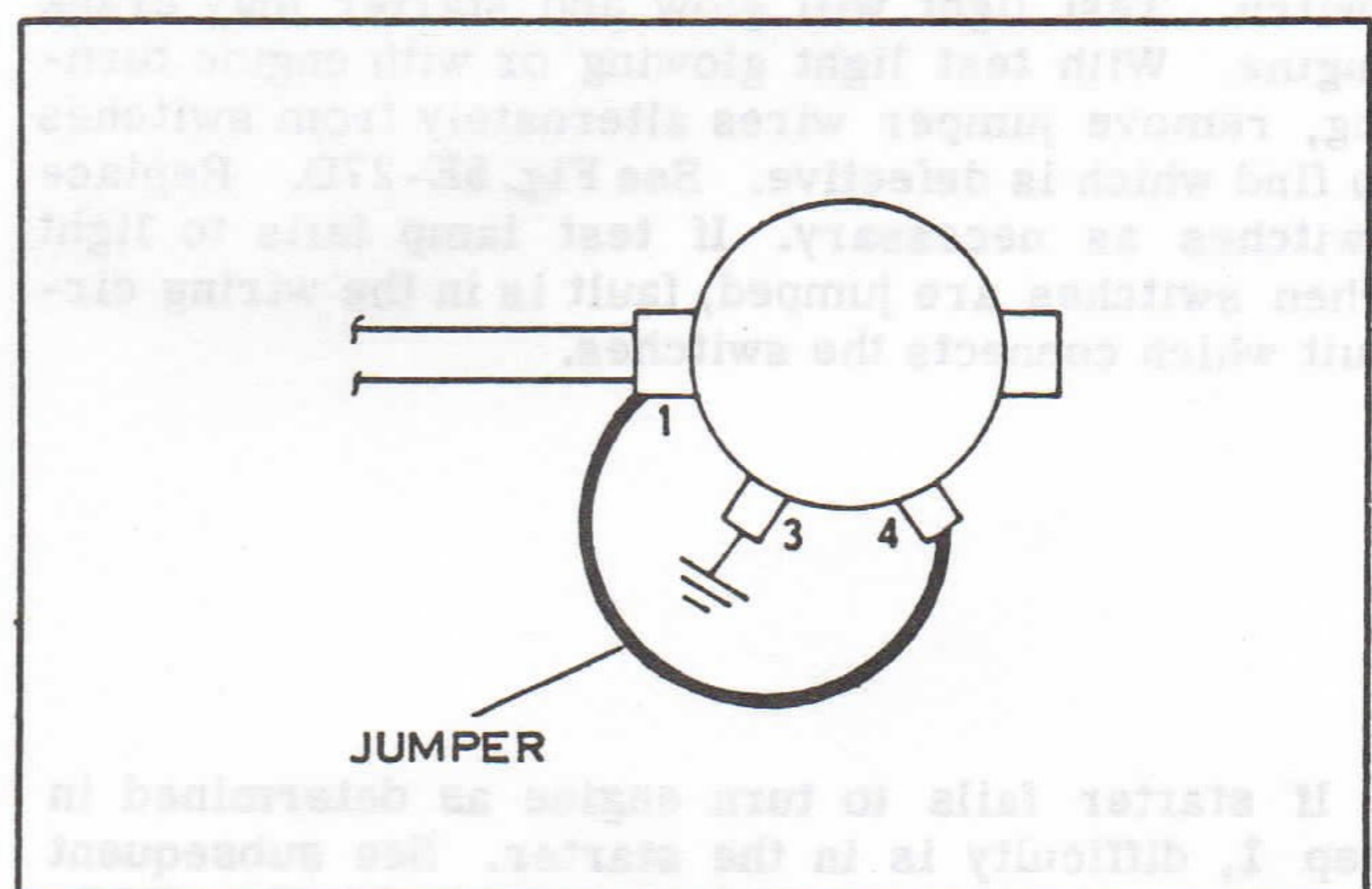


Figure 5E-27C. Step 2

3. To test continuity of switch circuit to ignition coil and starter solenoid use a 12-volt test lamp of 4-candlepower or less with test leads approximately one foot long.

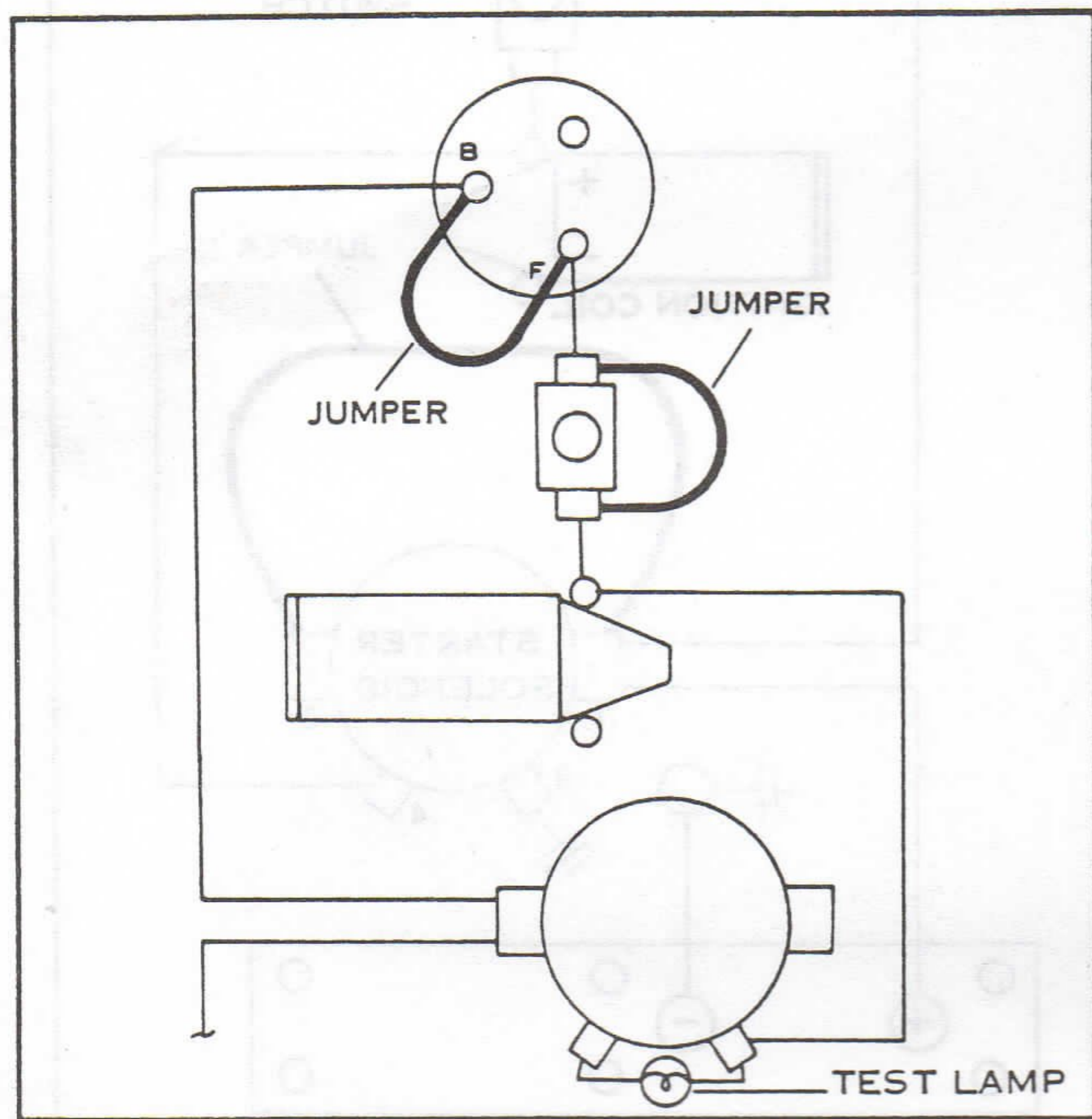


Figure 5E-27D. Step 3

Connect one lead of test lamp to solenoid terminal No. 4 and the other to solenoid terminal No. 3.

Using two short wires jump across the terminals of key switch terminals B and F and accelerator micro-switch. Test light will glow and starter may crank engine. With test light glowing or with engine turning, remove jumper wires alternately from switches to find which is defective. See Fig. 5E-27D. Replace switches as necessary. If test lamp fails to light when switches are jumped, fault is in the wiring circuit which connects the switches.

4. If starter fails to turn engine as determined in Step 1, difficulty is in the starter. See subsequent sections: **DISASSEMBLING STARTER-GENERATOR, BRUSHES AND BRUSH HOLDERS, FIELD COILS AND ARMATURE.**

CHECKING GENERATOR CIRCUIT

1. Two types of charging circuits are employed: the first one, used on 1967 and early 1968 golf cars, has a field resistor to control the charging rate, the second one used on 1968 and later golf cars and 1969 utilicars has a regulator controlled charging system.

A. TESTING 1967 - EARLY 1968 CIRCUIT (RESISTOR TYPE CIRCUIT).

To test components, disconnect ground cable from car frame and connect an ammeter between these points as shown in Fig. 5E-27E.

IMPORTANT

Use a low range ammeter (below 20 amps) and observe polarity as shown.

Raise left rear wheel of car above ground so it can turn freely. Place reversing switch in forward position. Start engine and run at governed speed. Set governor as necessary to regulate speed (See "Checking Charge Rate" below). Temporarily use jumper wire between battery and frame when starting engine as shown. (It may be necessary to use jumper leads from another battery to golf car battery if discharged.)

If ammeter shows no reading proceed to step 1 below. If ammeter reads between 5.5 to 6.5 amperes charge rate, system is O.K. If ammeter reads over 6.5 amps or under 5.5 amps correct by adjusting generator field resistor. See "Checking Generator Charge Rate".

1. Connect heavy jumper wire between starter-generator F1 terminal and A2 terminal, and between A1 terminal and ground on frame. If ammeter shows that generator is charging, reversing switch or wiring is at fault.

2. If generator does not charge, add another jumper wire from center top of resistor (green wire), at right side frame cross channel end, to ground on frame. If generator charges, resistor is at fault and should be replaced.

If generator does not charge in Steps 1 or 2 above, remove it from the car for further checking as described under "Disassembling Starter-Generator".

Checking Generator Charge Rate

The field resistor is set at the factory to produce a generator output of 5.5 to 6.5 amperes at 3000 RPM governed speed. Field resistor adjustable clamp set 3/16 in. above bottom end of winding is the normal setting for this speed and can be used as a guide when tachometer and ammeter are not available. Field resistor is located on right side frame cross channel end.

To check and adjust generator output accurately with instruments, run engine with left rear wheel raised

off the floor so wheel can turn freely. Control carburetor throttle with accelerator foot pedal or by hand at carburetor to give 3000 RPM engine speed using an electric tachometer. This is equivalent to 10 MPH (or 100 yards in 20 seconds).

Adjust the clamp on variable resistor to obtain a 6 ampere reading with engine running at 3000 RPM with a fully charged battery (1.250-1.270 specific gr.).

B. TESTING LATE 1968 AND LATER CIRCUIT (REGULATOR TYPE CIRCUIT).

To test components, disconnect ground cable from car frame and connect an ammeter between these points as shown in Fig. 5E-27E.

IMPORTANT

Use a high range ammeter of at least 40 amperes maximum current (60 preferred).

Raise left rear wheel of car above ground so it can turn freely. Place reversing switch in forward position. Start engine and run at governed speed. Temporarily use jumper wire between battery and frame when starting engine as shown.

1. With engine running at governed speed (approximately 3000 RPM), disconnect wire from DF (field) terminal of regulator and momentarily touch D- (ground) terminal of regulator.

CAUTION

Never ground regulator DF terminal with wire connected to generator field terminal because this will damage the regulator.

If ammeter shows no reading (generator does not charge) proceed to step 2 below. If ammeter reads above 12 amperes, generator is O.K. and regulator is probably defective and should be checked. See "Regulator."

2. Connect heavy jumper wire between starter-generator F-1 terminal and A-2 terminal and between A-1 terminal and ground on frame. Again run engine at governed speed with one rear wheel off the ground and momentarily touch disconnected regulator DF wire to ground. If ammeter shows that generator is charging, reversing switch or wiring is at fault.

REMOVING STARTER-GENERATOR FROM CAR

The belt drive starter-generator should be removed from the car and end cover removed for inspection of brushes and commutator every year (before each season).

Remove mounting bolt from support arm or spring tensioner, remove V-belt, remove lower mounting bolt or bolts to free starter-generator (See Figure 5E-27F or 5E-27Fa).

DISASSEMBLING STARTER-GENERATOR (Fig. 5E-27G SIBA, 5E-27H BOSCH AND 5E-27I HITACHI)

BRUSHES, BRUSH HOLDERS AND COMMUTATOR

Siba:

Remove thru bolts (1) and use tool part No. 97294-61B to pull end cover (2) as shown in Figure 5E-27J. Two 1/4-20 x 1-3/4 in. long Part No. 2797B attaching screws are inserted through the puller flange slots and thread into two tapped holes in the commutator end cover.

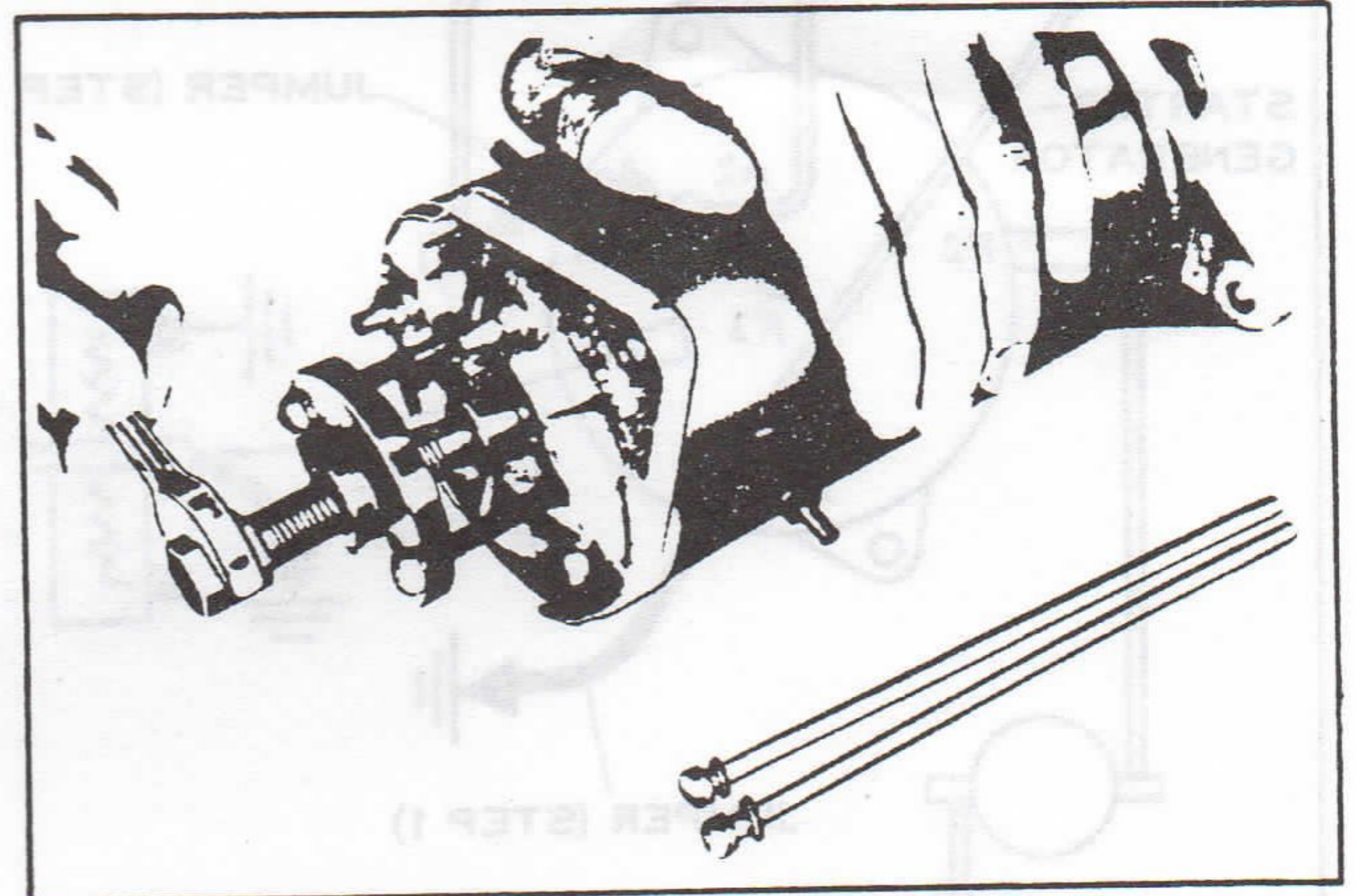


Figure 5E-27J. Removing SIBA Starter-Generator Commutator End Cover

Bosch:

Remove brush cover band (2) held by clamping screw (1). Remove brush lead terminal screws and lock-washers (3). Retract brush springs (4) with wire hook and remove 4 brushes (5) from holders.

Hitachi

Remove rubber brush cover (2) and terminal screws (3). Lift up on brush spring (4) with wire hook and pull out brush (5).

Bosch, Siba and Hitachi

Brushes must be replaced when worn down to half or less their original length. Siba and Hitachi Brushes - replace if 1/4 in. less in total length. Bosch Brushes - replace if 1/2 in. less in total length. If brushes are still serviceable, check tightness of pigtail leads in brush material and test for continuity by using a test lamp circuit. Discard chipped brushes. Remove all carbon from brush holders so brushes move freely. Brushes are furnished in sets and should be replaced in sets only. Brush terminals and brush holders are insulated from frame and should be checked with a test lamp circuit for possible grounding.

Test lamp should not glow when touching one lead to frame and the other lead to brush terminal or to brush holder.

NOTE

If starter-generator does not require further disassembly, proceed to "Reassembling Starter-Generator".

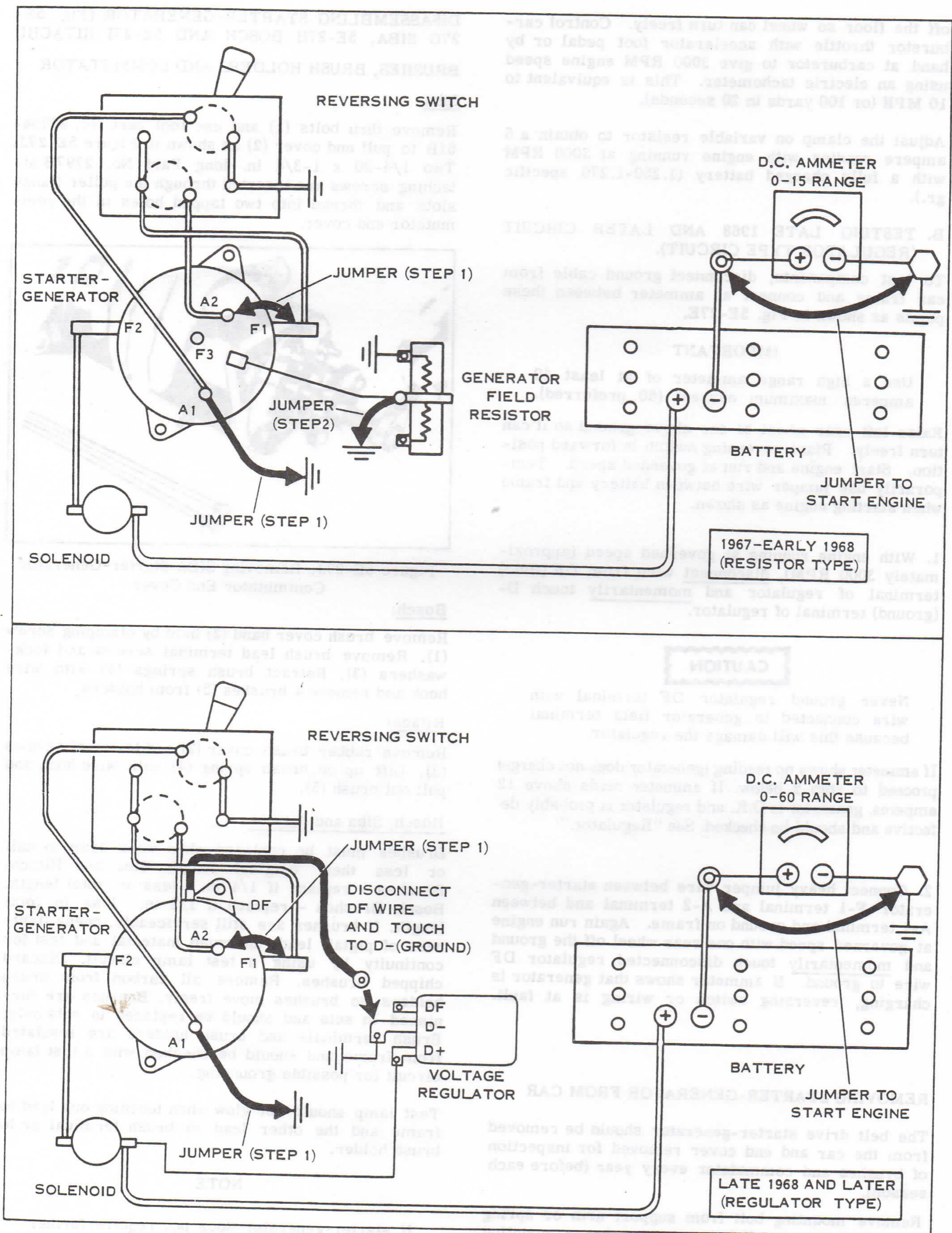
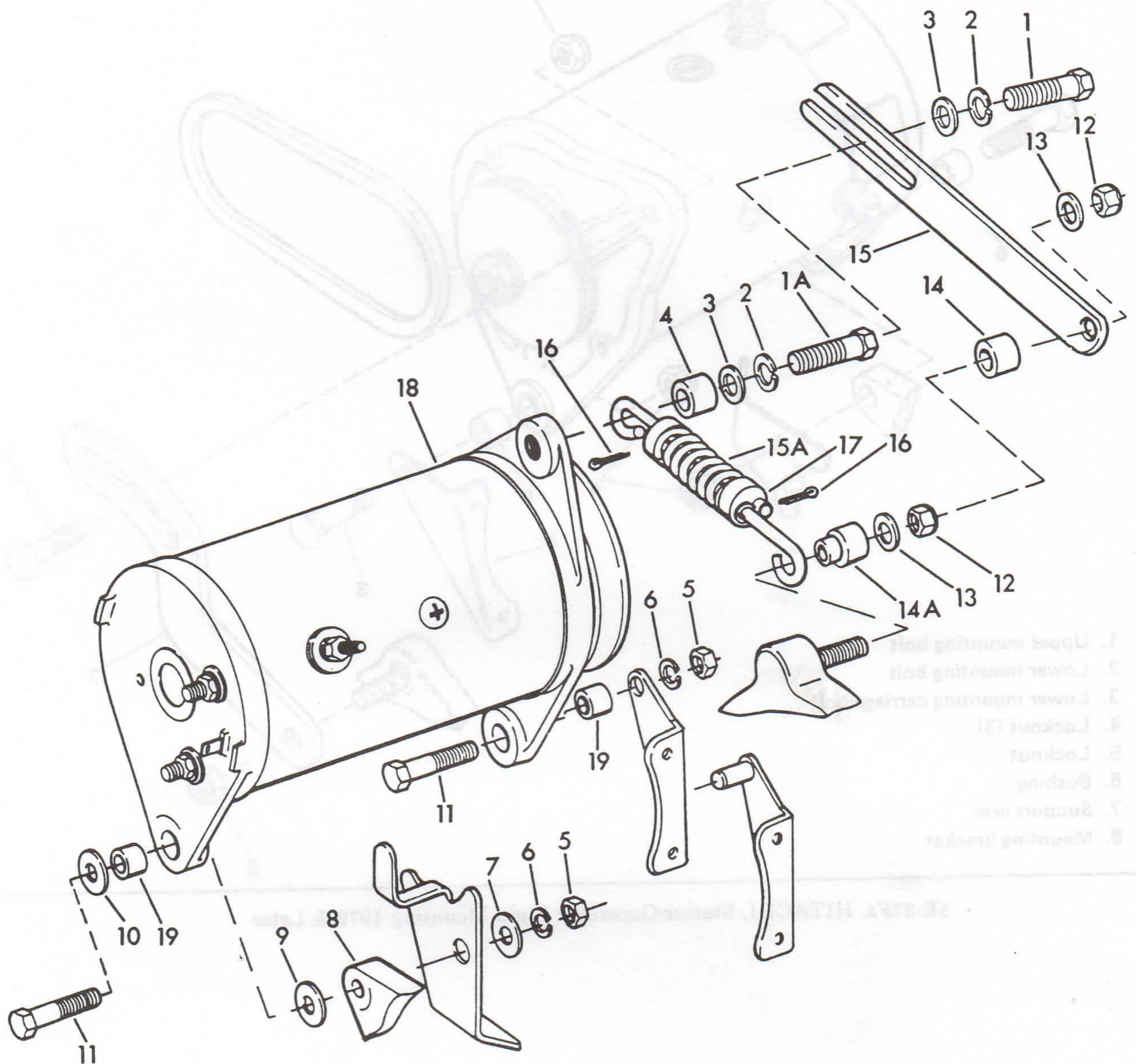


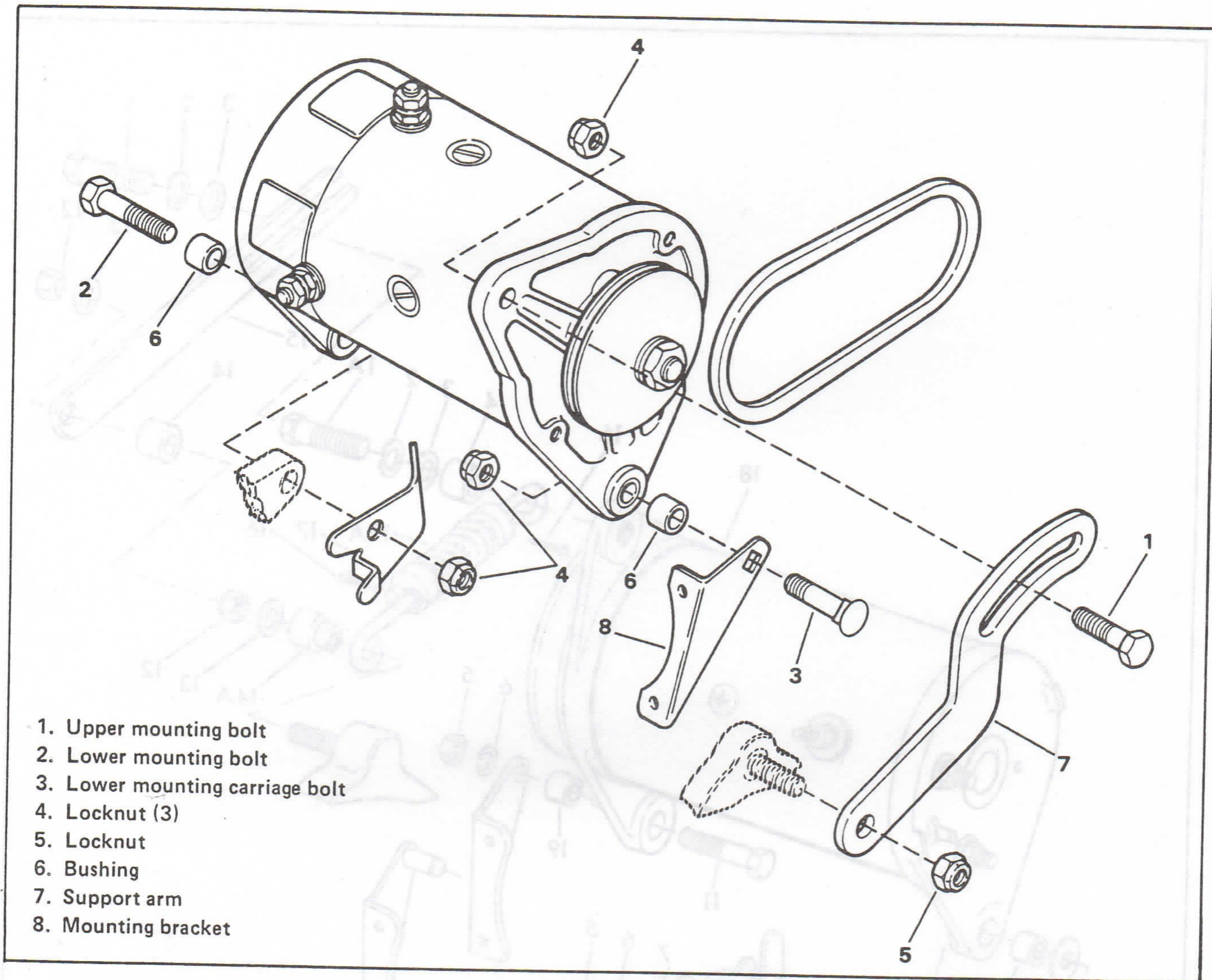
Figure 5E-27E. Starter-Generator Test Circuit



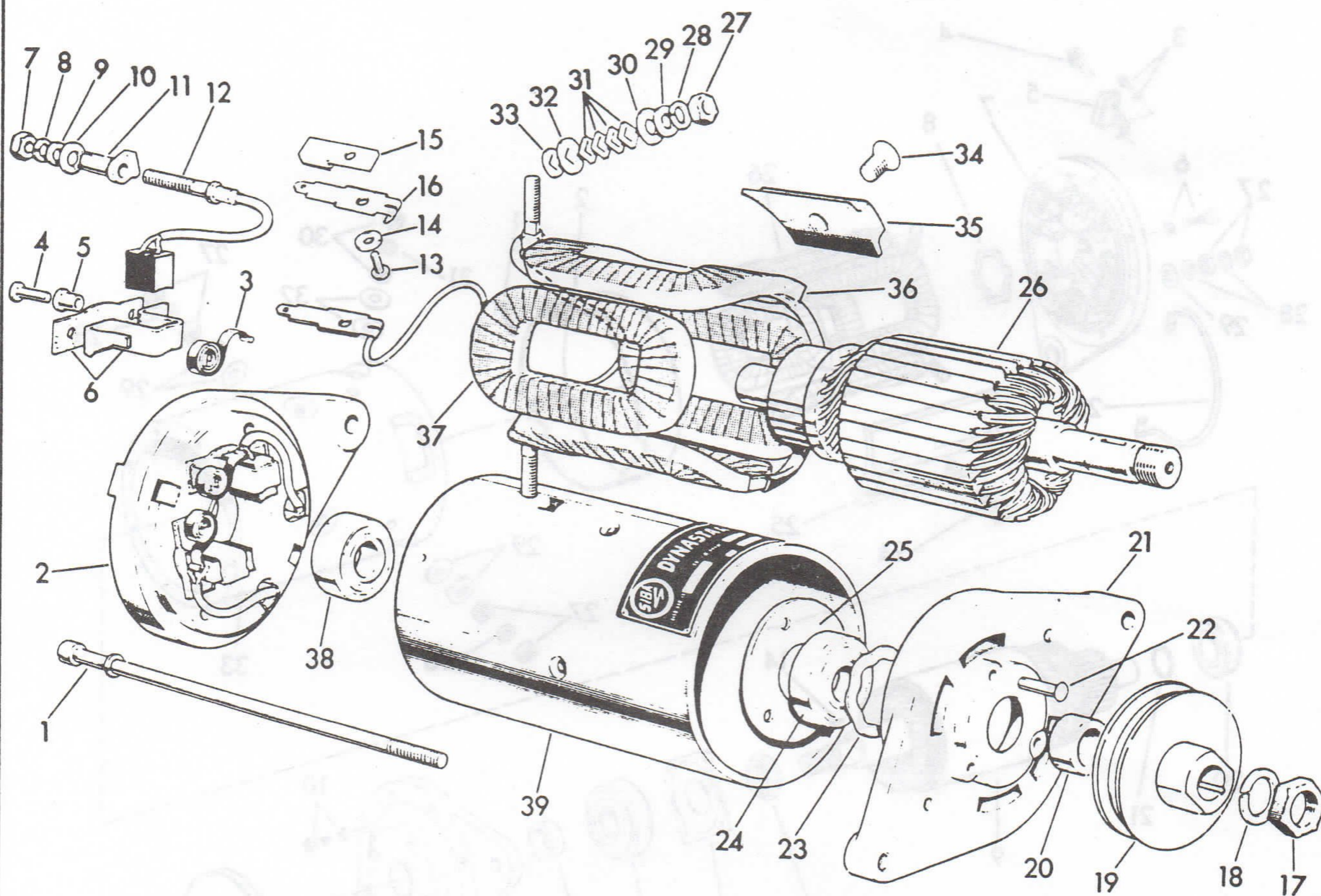
1. Upper Mounting Bolt (1967-68)
- 1A. Upper Mounting Bolt (1969 and Later)
2. Lockwasher (1967-68)
3. Washer
4. Spacer
5. Nut
6. Lockwasher
7. Washer (1969 and Later)
8. Bracket
9. Washer (1969 and Later)
10. Washer (1969 and Later)

11. Lower Mounting Bolt (2, 1967-68) (1, 1969 and Later)
12. Nut
13. Washer
14. Spacer (1967-68)
- 14A. Spacer (1969 and Later)
15. Support Arm (1967-68)
- 15A. Spring Tensioner (1969 to Late 1978)
16. Cotter Pin (2)
17. Bushing (2)
18. Starter-Generator
19. Bushing (2) (1 or 2 Steel 1967-68) (2 Bronze 1969 and Later)

Figure 5E-27F. (1967-1978) Starter-Generator Mounting/Arm Type and Spring Type Belt Tensioners



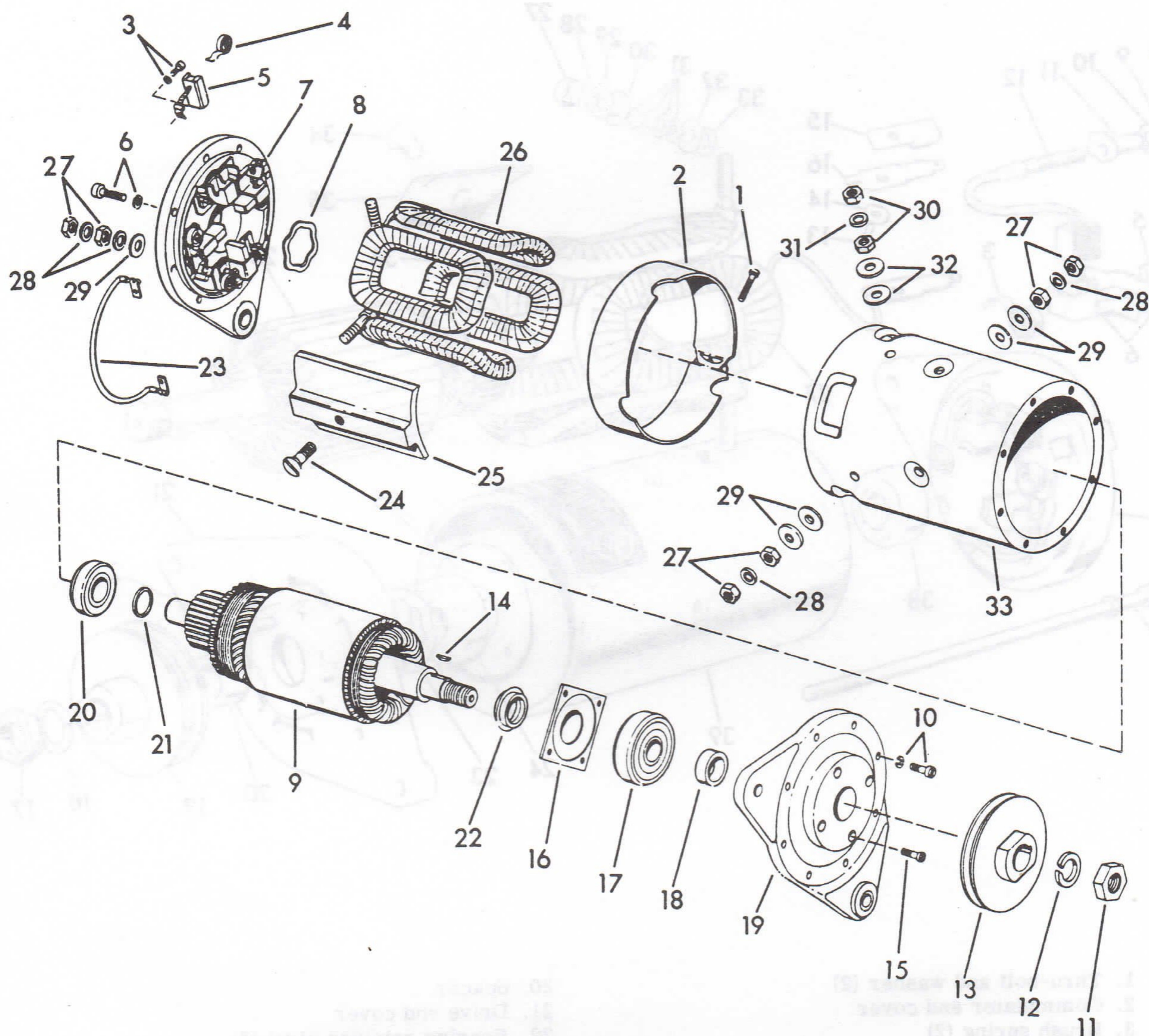
5E-27Fa. HITACHI, Starter-Generator Rigid Mounting 1979 & Later



1. Thru-bolt and washer (2)
2. Commutator end cover
3. Brush spring (2)
4. Brush holder rivet (2)
5. Rivet insulator (2)
6. Brush holder and insulation (2)
7. Brush terminal nut (2)
8. Brush terminal nut lockwasher (2)
9. Brush terminal nut washer (2)
10. Brush terminal insulating washer (2)
11. Brush terminal insulator (2)
12. Brush terminal
13. Spade (F1) terminal rivet
14. Spade (F1) terminal insulator washer
15. Spade (F1) terminal insulator
16. Spade terminal
17. Pulley nut
18. Pulley nut lockwasher
19. Pulley

20. Spacer
21. Drive end cover
22. Bearing retainer rivet (3)
23. Spring washer
24. Ball bearing
25. Retainer plate
26. Armature
27. Field terminal stud nut
28. Field terminal stud lockwasher (2)
29. Field terminal stud washer (2)
30. Field terminal stud insulating washer (2)
31. Field terminal stud insulator (8)
32. Field terminal stud insulating washer (2)
33. Field terminal stud washer (2)
34. Pole shoe screw (4)
35. Pole shoe (4)
36. Series field coil set
37. Shunt field coil set
38. Ball bearing
39. Frame

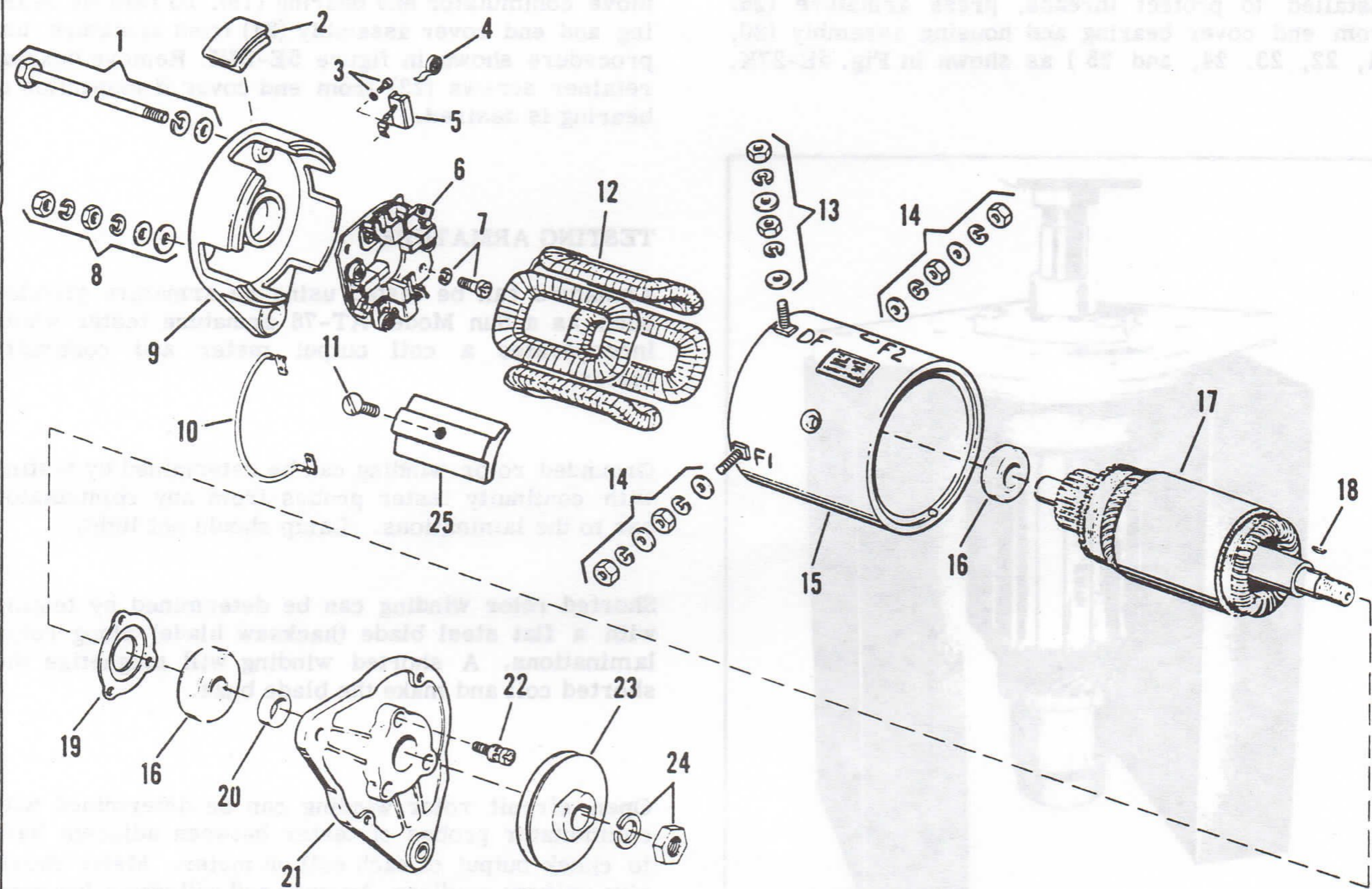
Figure 5E-27G. SIBA Starter-Generator - Exploded View



1. Screw
2. Brush cover band
3. Terminal screw & lockwasher (4)
4. Brush spring (4)
5. Brush (4)
6. Commutator end cover screw & lockwasher (8)
7. Commutator end cover assembly
8. Commutator end cover bearing spring washer
9. Armature
10. Pulley end cover screws & lockwashers (8)
11. Shaft nut
12. Lockwasher
13. Pulley
14. Key
15. Retainer screw (4)
16. Retainer

17. Bearing
18. Spacer
19. Pulley end cover
20. Bearing
21. Bearing spacer
22. Bearing shield
23. Brush interconnecting wire (2)
24. Pole shoe screw (4)
25. Pole shoe (4)
26. Field coil (No. 1, 2, 3 & 4)
27. Terminal nut (8)
28. Terminal washer (8)
29. Terminal insulator washer (8)
30. DF terminal nut (2)
31. DF terminal washer (2)
32. DF terminal insulator washer (2)
33. Frame

Figure 5E-27H. BOSCH Starter-Generator - Exploded View



1. Thru-bolt and washer (2)
2. Brush cover (4)
3. Terminal screw and lockwasher (4)
4. Brush spring (4)
5. Brush (4)
6. Brush holder
7. Brush holder screw and lockwasher (3)
8. Terminal nut, washer and lockwasher (2)
9. Commutator end cover
10. Brush connecting wire (2)
11. Pole shoe screw (4)
12. Field coil assembly
13. DF terminal nut, washer and lockwasher

14. F1-F2 terminal nut, washer and lockwasher (2)
15. Frame
16. Bearing (2)
17. Armature
18. Key
19. Bearing holder
20. Spacer
21. Drive end cover
22. Bearing retainer screw (3)
23. Pulley
24. Nut and lockwasher
25. Pole shoe (4)

Figure 5E-27I. HITACHI Starter-Generator - Exploded View

ARMATURE

Siba:

To separate armature from end cover, remove drive pulley nut (17) and lockwasher (18). Support end cover with suitable blocking and with nut partially installed to protect threads, press armature (26) from end cover bearing and housing assembly (20, 21, 22, 23, 24, and 25) as shown in Fig. 5E-27K.

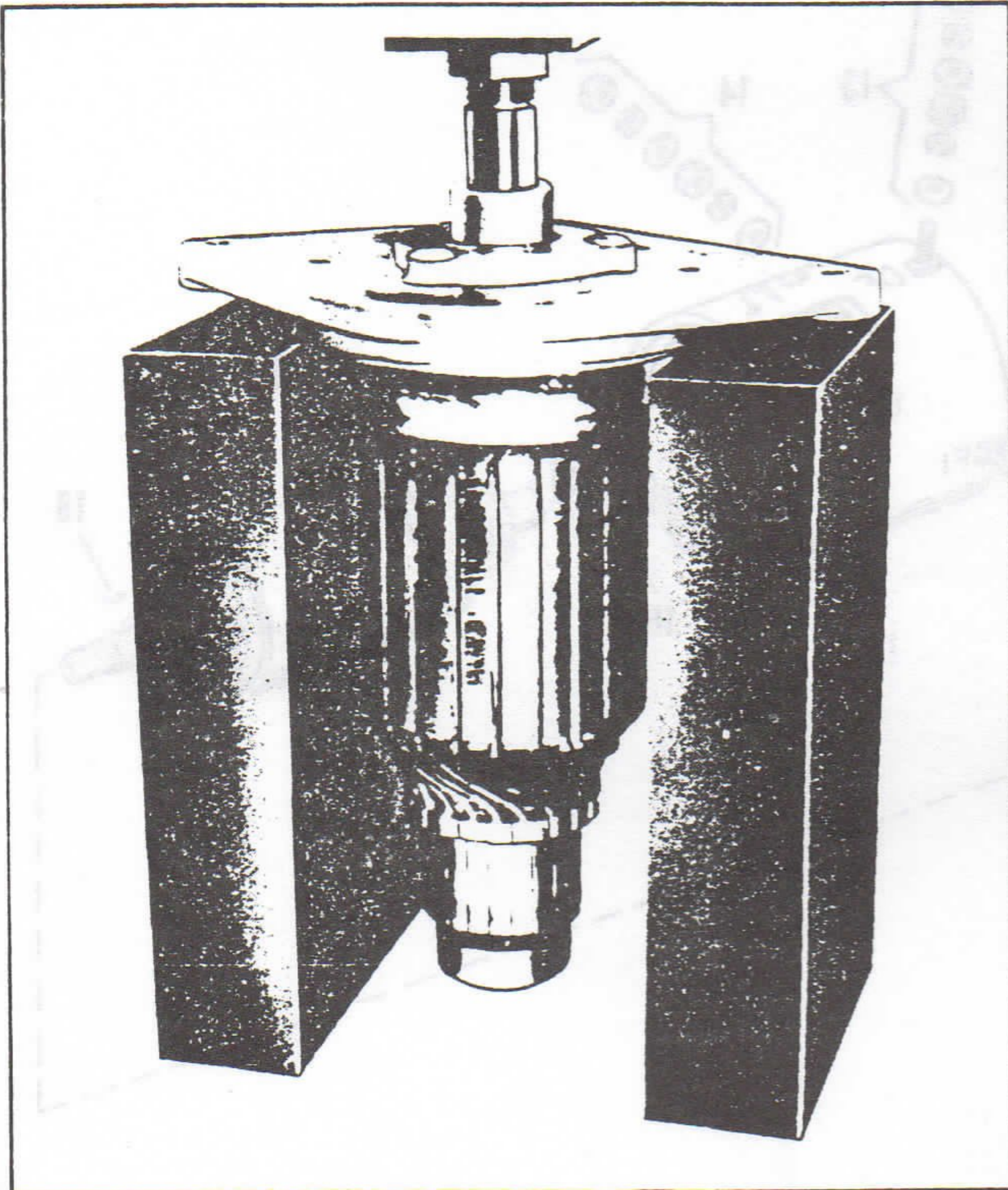


Figure 5E-27K. Pressing Armature from Drive End Cover (SIBA)

Bosch:

Remove 8 commutator end cover screws and lockwashers (6). Remove commutator end cover (7) with attached parts. Remove commutator end bearing, spring washer (8) from housing. Remove 8 pulley cover screws (10) to free armature (9), and pulley end assembly from housing (23).

Disassemble armature from end cover as follows: Holding pulley (13) with wrench on hub flats, remove nut (11) and lockwasher (12). Remove pulley (13) with claw puller. Remove key (14) from keyway. Remove pulley end cover (19) from shaft with claw puller or arbor press. Remove 4 retainer screws (15) to free retainer (16), bearing (17) and spacer (18). Remove bearing (20), bearing spacer (21) and bearing shield (22) from armature shaft.

Hitachi

Remove the two thru-bolts (1) and separate rear cover assembly, frame and field coil assembly and armature assembly. Remove pulley nut and screw (24), pulley (23) and key (18). Use claw puller to remove pulley if necessary. Use bearing puller to remove commutator end bearing (16). To remove bearing and end cover assembly (21) from armature, use procedure shown in figure 5E-27K. Remove bearing retainer screws (22) from end cover if inspection of bearing is desired.

TESTING ARMATURE

Armature can be tested using an armature growler such as a Sun Model AT-76 armature tester which incorporates a coil output meter and continuity tester.

Grounded rotor winding can be determined by testing with continuity tester probes from any commutator bar to the laminations. Lamp should not light.

Shorted rotor winding can be determined by testing with a flat steel blade (hacksaw blade) along rotor laminations. A shorted winding will magnetize the shorted coil and make the blade buzz.

Open circuit rotor winding can be determined with commutator probes of tester between adjacent bars to check output of each coil on meter. Meter should give uniform readings. An open coil will give a low reading and usually be indicated by a burned spot at two adjacent bars.

NOTE

Under operating conditions "flying shorts or opens" may occur due to centrifugal force, and these defects would not show up in the armature tests mentioned above.

If armature is found to be shorted or grounded, make sure commutator is free from carbon and copper dust deposits. If commutator is only slightly carboned, polish with No. 00 sandpaper (do not use emery cloth). A badly worn commutator should be cut down in a lathe as described in following paragraphs.

After cleaning thoroughly between segments and at ends of commutator and blowing dry with compressed air, repeat test. 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.

A starter-generator that has been in extended service may fail to crank the engine or deliver enough current to keep the battery in a charged condition although its field coils 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 (4/0) sandpaper until true and smooth.

NOTE:

Minimum diameter for Bosch and Hitachi commutators is 1.535 in. (39 mm).

Mount armature in lathe on its bearing seats not on shaft centers. Never sand a commutator with emery cloth. Particles will embed 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 5E-27L.

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

Check bearings for roughness and wear and replace if necessary. To replace pulley end bearing on Siba unit, grind or drill rivet heads (22) and use new rivets to secure assembly in end cover (21) with spring washer (23) and plate (25).

FIELD COILS

Pole shoes and field coils are secured with screws. Do not remove unless electrical test indicates it is necessary.

Check shunt field coils with an ohmmeter as follows: Connect an ohmmeter between terminal F3 (DF terminal) and F1 terminal. Resistance should read as follows: Siba Unit - 4 to 5 ohms for 2 coils in series or 2 to 2.5 ohms per coil. Bosch Unit - 4.5 to 5.5 for 2 coils in series or 2.2 to 2.7 per coil. Hitachi Unit - 4.5 to 5.5 for 2 coils in series or 2.2 to 2.7 per coil. Check series field for open with ohmmeter or test lamp connected between F2 terminal and F1 terminal. Check series field for ground to frame with ohmmeter or test lamp connected between F2 terminal and ground on starter-generator frame.

Note: Terminal studs are insulated from frame with insulator bushings.

Replace defective field coils in sets only. Bore Siba pole shoe inside diameter to 2.825 in. I.D. on a lathe, if necessary.

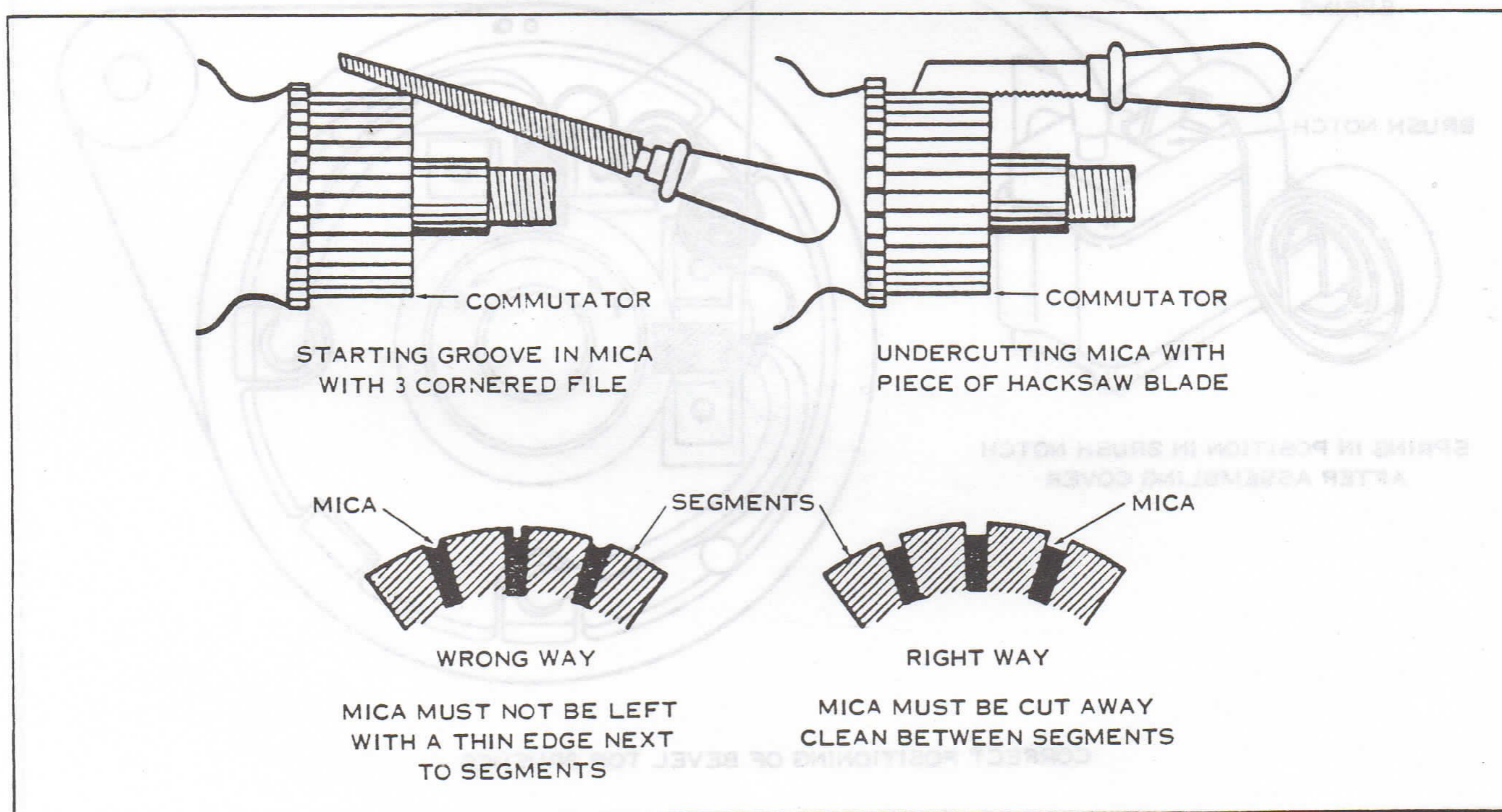


Figure 5E-27L. Recessing Mica Separators

REASSEMBLING STARTER-GENERATOR (Fig. 5E-27F SIBA, 5E-27H BOSCH AND 5E-27I HITACHI)

Siba:

Reassemble starter-generator in reverse order of disassembly. Carefully note positioning of insulating washer (10) against end cover (2) when reassembling terminal insulator (11) on terminal stud (12). Do not overtighten terminals. Use care when assembling commutator end cover to prevent damage to spade

terminal and insulator. Also retract brushes in holders and hold in place by putting brush spring end against side of brush instead of on top. Then proceed to assemble cover until almost in place against frame and use a hooked wire to lift brush springs to correct position on top of brushes as shown in Fig. 5E-27M.

End covers have registering pins to locate them in correct position on starter-generator frame. Tighten pulley nut to 50 ft. lbs. torque.

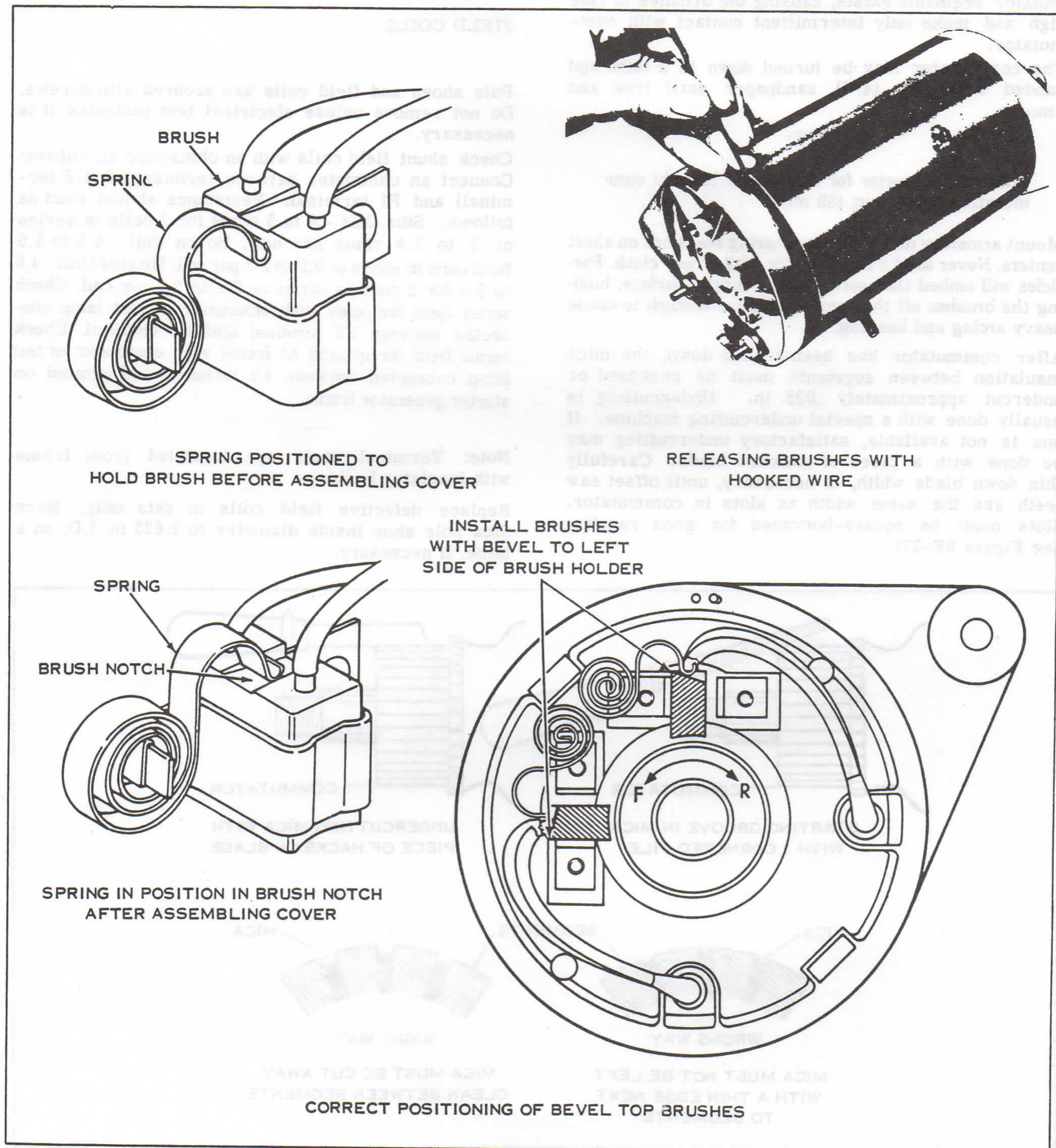


Figure 5E-27M. SIBA Commutator End Cover Assembly

VOLTAGE REGULATOR (1963-66 D, 1963-68 DC)

GENERAL

The generator output is controlled by the voltage control unit protecting the battery from overcharge and other components from too high voltage. Basic regulator operation is described in Section 5A.

In addition to the conventional voltage control coil connected in series with the generator field, a current coil is wound integral with the voltage coil with full current from the generator passing through this coil. This serves to reinforce the magnetic strength as the output of the generator increases, attracting the armature of the regulating unit, opening the contacts in the field circuit to reduce generator output. Thus, with a high current flow, the voltage will drop slightly. This characteristic is adapted to the prevailing conditions so that when all power consumers are connected with the battery discharged, the maximum output of the generator will not be exceeded. This also adapts the charging current to the existing level of the battery charge state by charging a low battery with a high current, but charging a fully charged battery with a low current.

SERVICE INFORMATION

The voltage control unit is located in the control box along with the starter relay and cutout relay. The regulator unit and cutout relay unit require no internal attention and are not adjustable. If tests indicate that either unit is defective, the entire control box must be replaced.

GENERATOR TEST

To determine if the voltage regulator and cutout relay or the generator is faulty, make the test specified for the generator. See "Checking Generator Circuit." If the trouble is isolated to the voltage regulator or cutout relay unit, make the following tests to determine if these units are functioning correctly.

TESTING VOLTAGE REGULATOR UNIT

Battery must be in good condition and fully charged (1.270 Hydrometer reading in each cell). Engine must be warmed up so that regulator is at normal operating temperature.

1. Remove the black wire at the control box terminal marked 61/D+. Using a 0-15A. D.C. Ammeter, connect the negative lead to 61/D+ terminal and the positive lead to the black wire removed from the terminal. See Fig. 5I-3. Start the engine and run in neutral at 2000 rpm. If ammeter shows more than 1/2 amp., cutout relay is functioning correctly and voltage unit is operating.

2. If ammeter does not show a charge on above test, proceed directly to Step 3. If ammeter does show a charge, check the voltage values running the engine at 3500 rpm. (Use electric tachometer for 2-cycle engine, and connect a 0-15 V. D.C. voltmeter from 51/30 terminal of control box to ground.) See Fig. 5I-3.

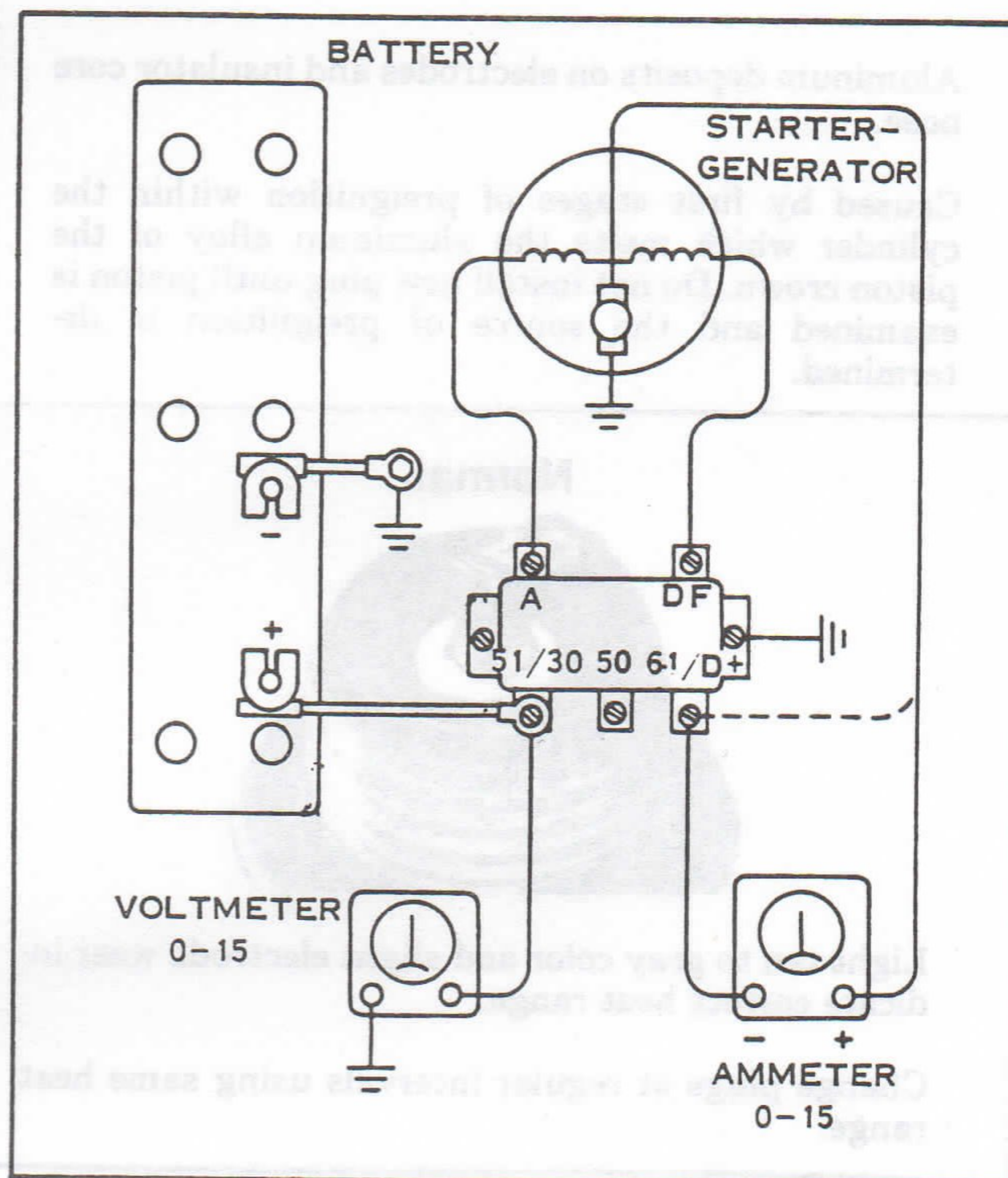


Figure 5I-3. Voltage Regulator Test

Voltage must be not less than 14 V. at 7-1/2 amp. at 3500 rpm. Note: Use load bank in parallel with battery if necessary, to obtain 7-1/2 amp. value.

Voltage must be 15 to 16 V. at 2 amperes or less at 3500 rpm.

Note: Battery must be fully charged to obtain this low charge rate.

If voltage values do not correspond to above specifications, control box should be replaced.

3. If generator does not show a charge on ammeter in above tests, remove black wire from control box terminal marked DF and while running engine, touch it to the control box ground strap. (CAUTION: Do not ground black wire while connected to DF terminal

or serious damage to regulator points will result.) If the generator fails to charge when grounding the wire from the DF terminal, proceed directly to Step 4. If the ammeter shows a charge of 1/2 amp or more, the defect is in the voltage regulator unit of the control box or control box is not grounded. Check for secure ground strap connection from control box base to engine crankcase bolt. If ground is O.K., the control box is faulty and should be replaced.

5. Remove ammeter negative lead from the control box 61/D+ terminal. Attach black wire, previously

removed from the control box DF terminal in Step 3, to control box strap. Start engine and run at 2000 rpm. Touch negative ammeter lead to control box terminal 51/30. If ammeter shows a charge, the difficulty is in the cutout relay section of the control box and replacement of the control box assembly is necessary.

NOTE: It is not necessary to polarize the generator-regulator-battery circuit as this is done through the internal circuit of the starter-generator each time the starter circuit is operated.

The regulator requires no internal attention. It is indicated that the regulator is defective, it should be replaced.

If trouble is experienced with the electrical system, it is first necessary to determine if the generator is the regulator is faulty.

GENERATOR TESTS

To determine if the generator is functioning properly, make the tests specified for the Generator, Section 52.

CAUTION: Do not ground regulator "DF" terminal of regulator. Remove generator field wire from terminal and ground it when making output tests.

If generator tests indicate that the regulator is defective, it should be replaced.

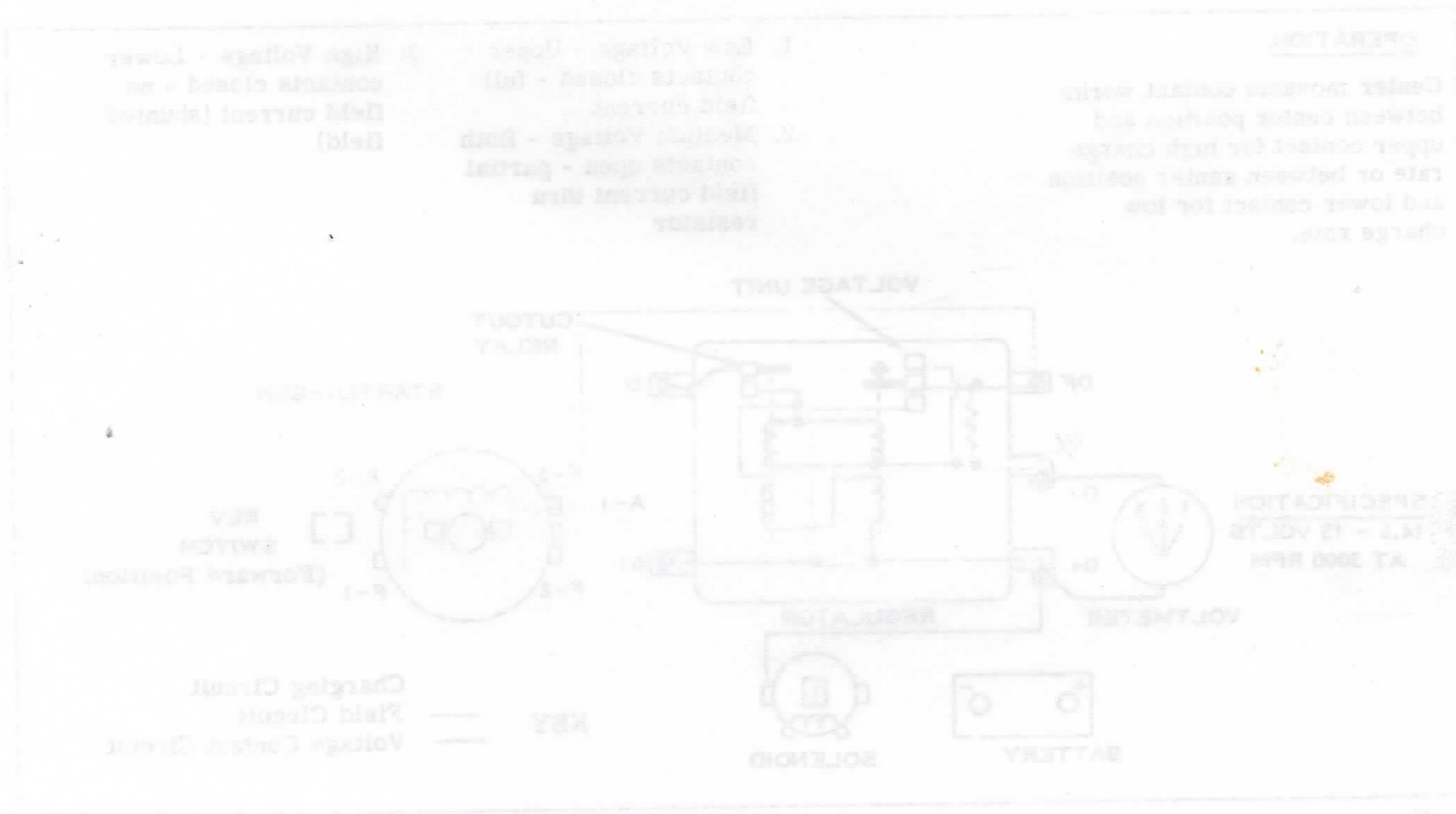


Figure 51-1. Voltage Regulator and Charging Circuit Gasoline

VOLTAGE REGULATOR

SERVICE INFORMATION

A voltage regulator is used to control the generator output. The function of the regulator in the circuit is shown in the schematic circuit diagram, Figure 5I-1. Note that cutout relay unit of the regulator is not used in the circuit.

The regulator requires no internal attention. If tests indicate that the regulator is defective, it should be replaced.

If trouble is experienced with the electrical system it is first necessary to determine if the generator or the regulator is faulty.

GENERATOR TESTS

To determine if the generator is functioning properly, make the tests specified for the Generator, Section 5E.

CAUTION: Do not ground regulator "DF" terminal of regulator! Remove generator field wire from terminal and ground it when making output tests.

If generator tests indicate that the regulator is defective, it should be replaced.

REGULATOR TESTS

Make the following electrical tests to determine if the regulator is functioning correctly. Battery must be in good condition and fully charged (1.270 Hydrometer reading in each cell). Engine must be warmed up so that regulator is at normal operating temperature. Make all tests with lights off.

Connect voltmeter positive lead to regulator terminal marked D+ and the voltmeter negative lead to regulator terminal marked "D-" (ground).

With the regulator cover in place and the regulator at operating temperature, run the engine at approximately 3000 RPM (governed speed) and read the voltmeter.

If voltmeter reads within specified voltages (Figure 5I-1), at approximately 75° air temperature surrounding the vehicle, it indicates that the voltage regulator is functioning properly.

If voltmeter reading is above upper limit, generator charging rate is too high and will over-charge the battery causing possible internal battery damage.

If voltmeter reading is under lower limit, charging rate is too low and may result in a discharged battery.

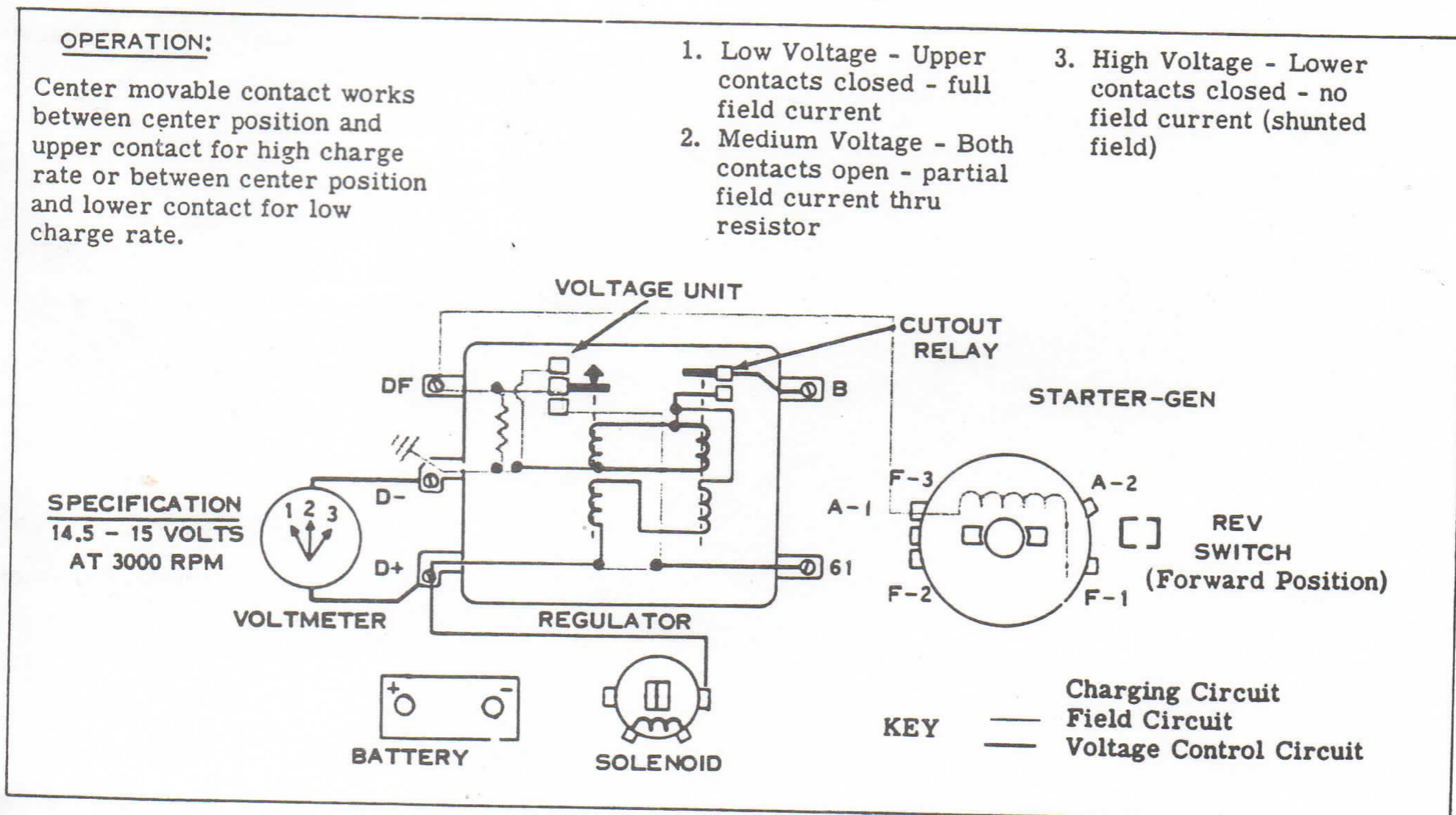


Figure 5I-1. Voltage Regulator and Charging Circuit Gasoline Car

ADJUSTING CHARGE RATE — HITACHI VOLTAGE REGULATOR

NOTE:

Adjustment must be made with golf car battery fully charged and voltage regulator at normal operating temperature, at least 70°F.

1. Run engine to stabilize regulator and raise temperature of regulator to at least 70°F.
2. Attach voltmeter across battery, or across D+ and D- terminals of voltage regulator.
3. Run engine at governed speed (3000 rpm) and check voltage reading. Correct reading is 14.5-15.5 volts.
4. To adjust voltage regulator remove cover, loosen locknut (1, Figure 5I-2) and turn adjusting screw (2, Figure 5I-2) in (clockwise) to increase voltage or out (counterclockwise) to decrease voltage.
5. When correct voltage reading is obtained, tighten locknut, recheck voltage reading and install voltage regulator cover gasket and cover.

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1. Locknut
2. Voltage adjusting screw

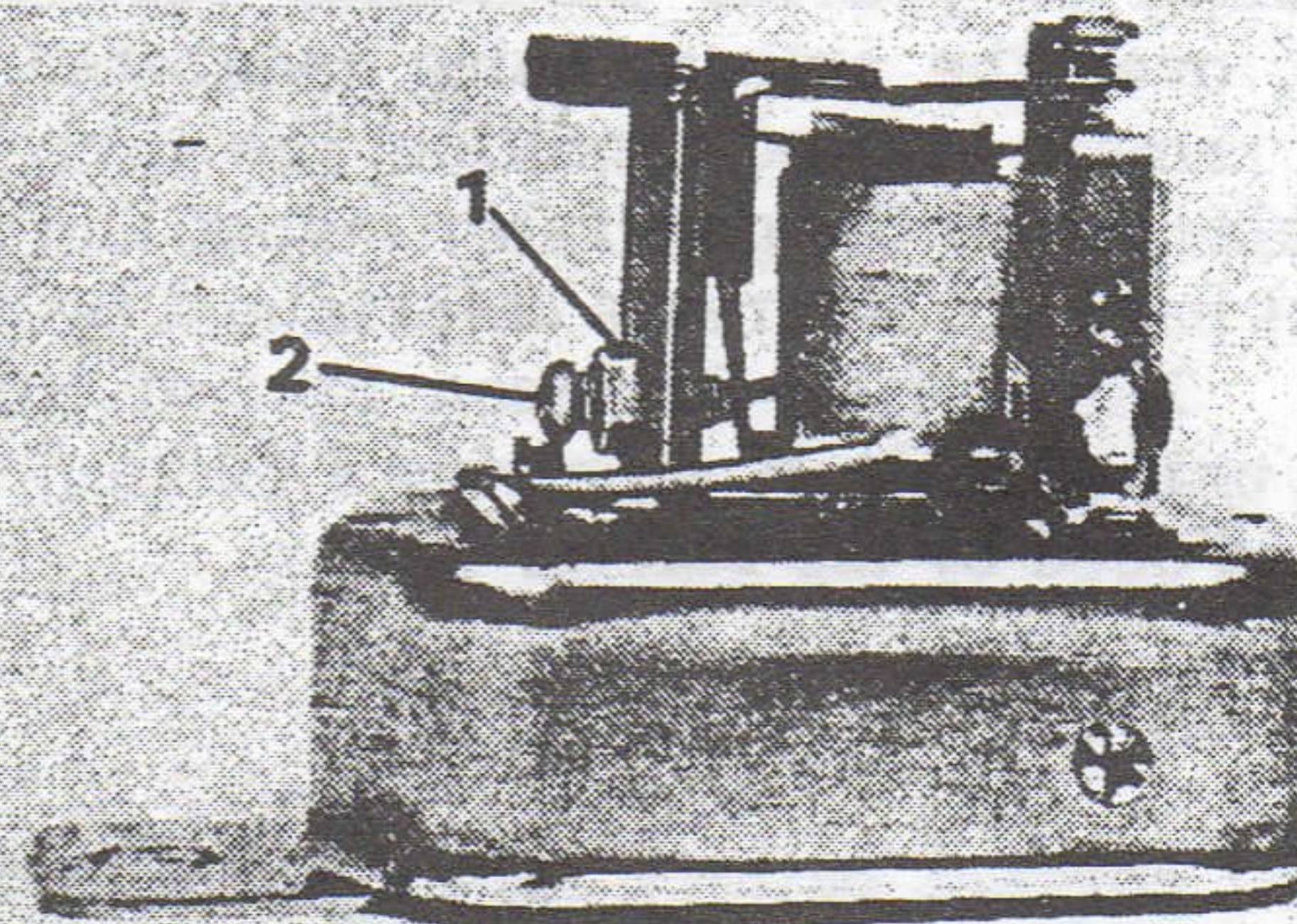
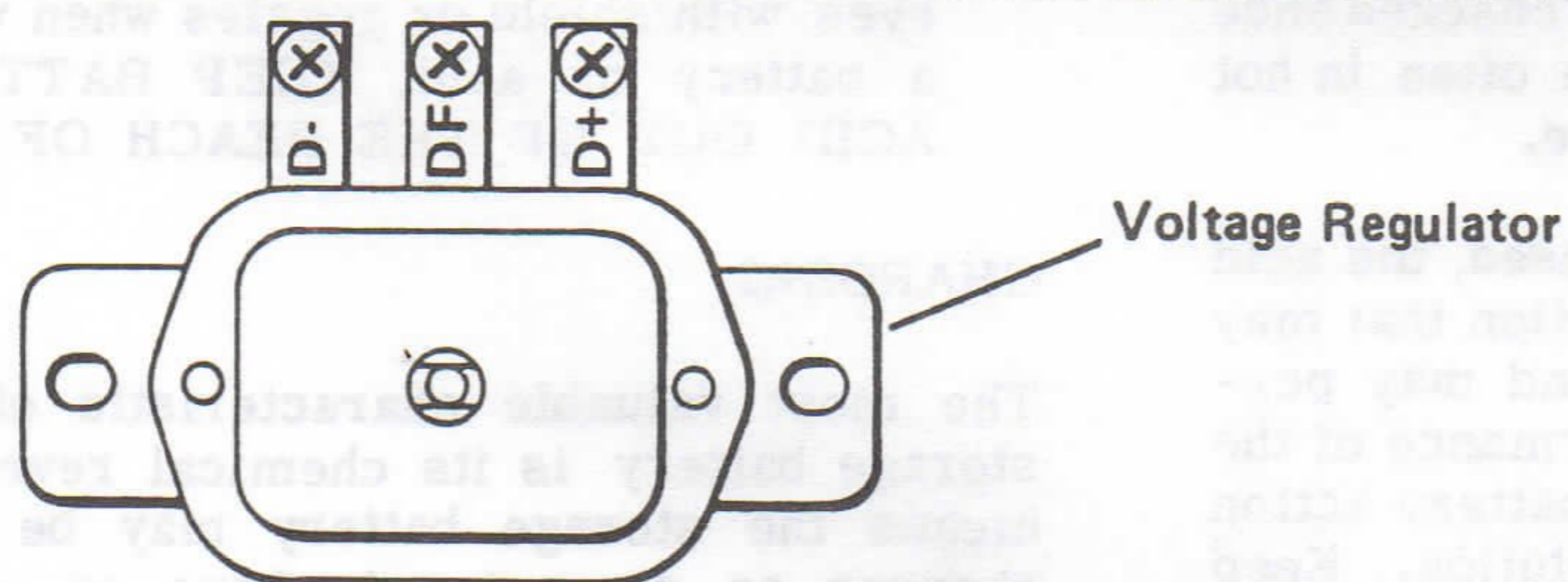


Figure 5I-2. Adjusting Hitachi Voltage Regulator



Wiring Diagram

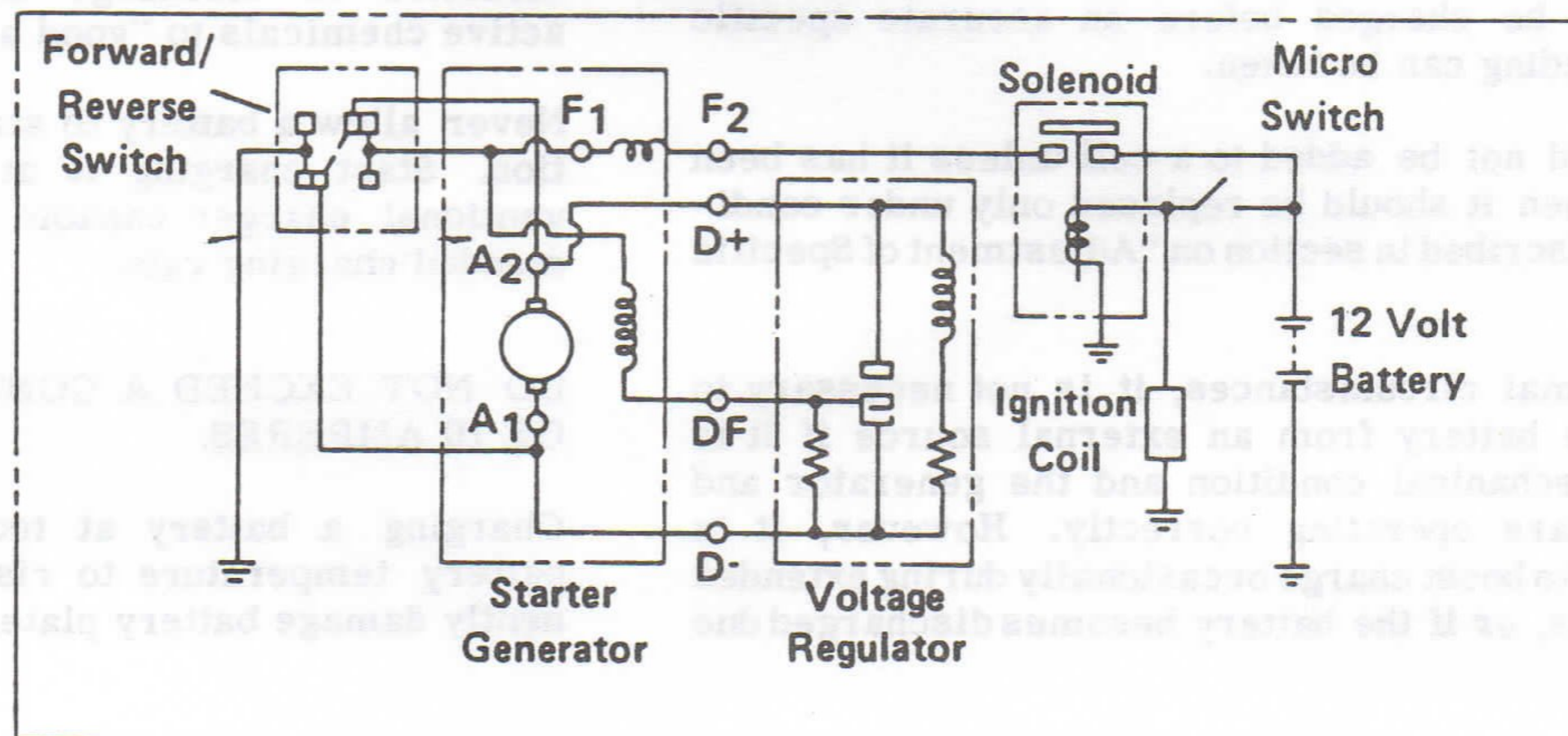


Figure 5I-3. HITACHI Regulator Charging Circuit

BATTERY

The battery serves as a power source for the starting motor, ignition and to operate accessories before the engine starts; 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 the generator output and must be serviced at periodic intervals determined by severity of usage. The Harley-Davidson 12-volt battery is a six cell unit capable of supplying a 60 ampere current demand used by the starter motor.

BATTERY CARE

Prompt and correct battery care determines the life span and efficiency of the unit. Therefore, for the longest possible useful life, the following must be observed.

1. Keep battery solution (electrolyte) level up in cells.
2. Keep batteries charged.
3. Keep battery and connections clean.

These items are covered in detail in this section.

The battery solution should be maintained within the triangular section of filler opening. When not up to correct level, fill to triangle with distilled or approved water. 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 parts near the battery to be damaged. Solution level should be checked once a month in normal service and more often in hot weather when vehicle is in continuous use.

If a battery is operated with plates exposed, the acid will reach a dangerously high concentration that may char and disintegrate the separators and may permanently sulphate and impair the performance of the plates. Plates cannot take full part in battery action unless they are completely covered by solution. Keep solution up to specified height by adding approved water. When it is necessary to add water to batteries, they must be charged before an accurate specific gravity reading can be taken.

Acid should not be added to a cell unless it has been lost and then it should be replaced only under conditions as described in section on "Adjustment of Specific Gravity."

Under normal circumstances, it is not necessary to charge the battery from an external source if it is in good mechanical condition and the generator and regulator are operating correctly. However, it is necessary to boost charge occasionally during extended idle periods, or if the battery becomes discharged due

to a short circuit or other accidental means. See "CHARGING" and "STORAGE" in this section.

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 after wires have been attached to retard corroding.

WARNING

Batteries contain sulfuric 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.

Batteries produce explosive hydrogen gas at all times, especially when being charged. Keep cigarettes, open flame, and sparks away from the battery at all times. Ventilate area when charging battery. Always protect hands and eyes with shield or goggles when working near a battery or acid. **KEEP BATTERIES AND ACID OUT OF THE REACH OF CHILDREN!**

CHARGING

The most valuable characteristic of the lead-acid storage battery is its chemical reversibility. This means the storage battery may be connected to a charger or generator to have an electric current passed through it in the direction opposite to the direction of discharge and restore the battery's active chemicals to "good as new" state.

Never allow a battery to stand in a discharged condition. Start charging it at once using 12-volt conventional charger capable of delivering the recommended charging rate.

DO NOT EXCEED A CONTINUOUS CHARGE RATE OF 10 AMPERES.

Charging a battery at too high a rate will cause battery temperature to rise high enough to permanently damage battery plates.

CAUTION

If battery is overly filled, some of the solution will be forced out through the vent holes when battery is charging. This will not only weaken the solution, but also may damage parts near the battery. Keep battery clean and lightly coat terminals with petroleum jelly to prevent corrosion. Do not overtighten terminal connections. To prevent battery case damage caused by pressure build-up, be sure breather tube is properly routed and not kinked or obstructed.

WARNING

Battery should be charged in a well ventilated area with the filler caps removed. Be sure charger is properly connected and adjusted, observing positive (+) and negative (-) polarity to battery.

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.

HOW TO TEST

Discharged, or less than 1/2 charged batteries (1.210 gravity or 2.04 open circuit cell voltage) must be recharged in order to have charge sufficient for testing. Use hydrometer (A), cell tester (B), or load tester (C), 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 vary more than 50 points, replace battery.

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

5. Batteries with satisfactory specific gravity (1.220 or better) but very low or no open circuit voltage are probably not serviceable.

B. Use of Cell Tester: (Refer to chart below)

1. Remove surface charge.

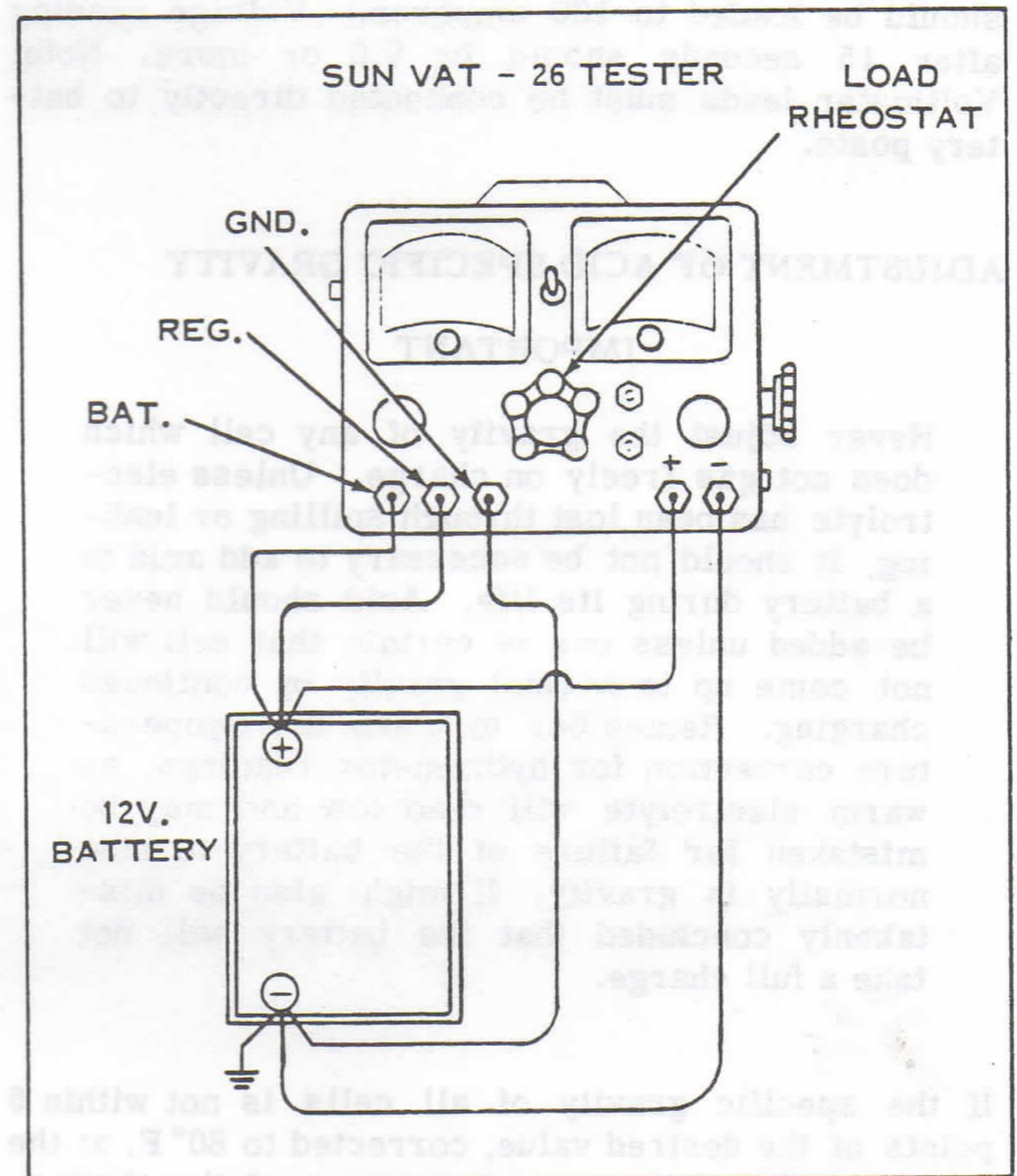


Figure 5J-7. Testing Battery Capacity

BATTERY CONDITION

State of Charge	Specific Gravity (A)	Freezing Point	Open Circuit Volts/Cell (B)
100%	1.250 - 1.270	-70°	2.10 - 2.12
75%	1.220 - 1.240	-39°F	2.07 - 2.09
50%	1.190 - 1.210	-16°F	2.04 - 2.06
25%	1.160 - 1.180	-2°F	2.01 - 2.03
Discharged	1.110 or below	+17°F	—

2. Follow manufacturer's instructions. Read open circuit voltage of each cell and record.

3. If any 2 cells vary more than .05 volts (25 percent or 5 scale divisions), replace battery.

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

C. Use of Load Tester or Shunt Type Prod Tester:

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

2. Fully charge the battery before testing. Load battery to 3 x amp hour rating using the sun VAT-26 Tester. (The Harley-Davidson 40 amp hr battery should be loaded to 120 amperes.) Voltage reading after 15 seconds should be 9.6 or more. Note: Voltmeter leads must be connected directly to battery posts.

ADJUSTMENT OF ACID SPECIFIC GRAVITY

IMPORTANT

Never adjust the gravity of any cell which does not gas freely on charge. Unless electrolyte has been lost through spilling or leaking, it should not be necessary to add acid to a battery during its life. Acid should never be added unless one is certain that cell will not come up to normal gravity by continued charging. Remember to make the temperature correction for hydrometer readings, as warm electrolyte will read low and may be mistaken for failure of the battery to rise normally in gravity. It might also be mistakenly concluded that the battery will not take a full charge.

If the specific gravity of all cells is not within 5 points of the desired value, corrected to 80°F. at the end of a full charge, remove some of the electrolyte with a hydrometer and add water to reduce gravity (if too high) or add 1.400 specific gravity acid to raise the gravity (if too low). Continue the

charge to give the electrolyte a chance to mix, then read the gravity after another hour to note the effect of additions. Continue this adjusting procedure until the gravity is brought to the desired value by charging for one hour after each adjustment.

STORAGE

When the car is being stored, the batteries should be kept in a fully charged condition with electrolyte level up to level in all cells. Store at temperatures between 20°F. to 50°F. Check state of charge every 8 to 10 weeks and charge as necessary to 1.250 to 1.270 specific gravity. New batteries in stock should be stored in same manner, however, when individual batteries are found to need charging, they must be connected to a conventional 12-volt battery charger and given a boosting charge.

If a battery is allowed to stand or is operated in a discharged condition for a long period of time, lead sulphate may develop on the plates, which is dense, hard and crystalline, and which cannot be electrochemically converted to normal active material again.

Lead sulphate formed on the plates during discharge is relatively insoluble as long as the specific gravity of electrolyte is kept above 1.125 specific gravity, but if allowed to drop below this value, the lead sulphate becomes increasingly soluble and may migrate into the pores of the separators and deposit as a white crystalline mass. Subsequent charging may convert these deposits into filamentous metallic lead which may "short" the positive and negative plates through the areas affected. These small shorts may cause a condition of low cell voltage when battery is charged. For this reason, battery cells must not be allowed to stand idle in a more than 75% discharged condition.

Batteries allowed to stand in a discharged condition (1.100 specific gravity) will freeze at 19° F. and ice may crack the container and damage the positive plates.

In general, it is advisable to keep batteries better than 3/4 charged when stored.

BATTERY CONDITION

State of Charge	Specific Gravity (at 80°F.)	Temperature Correction
100%	1.260 - 1.270	+1%
75%	1.230 - 1.240	+2%
50%	1.190 - 1.210	+3%
25%	1.150 - 1.180	+4%
Discharged	1.110 or below	+5%