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**Technical Data****System Type**

12 volt negative earth

**Battery (Type N70)**

Voltage	12V
Capacity	70 ampere/hour
Specific Gravity (fully charged)	1.260 at 20°C

**Starter Motor (Type S114 - 381)**

Direction of Rotation (viewed from pinion side)	Clockwise
Rated Time	30 seconds
Speed (off-load)	6000 rev/min
Current (off-load)	60A max.
Current (on-load)	540A max.
Terminal voltage (off-load)	12V
Terminal voltage (on-load)	5V
Torque (on-load)	15.69 Nm (1.6 kgf/m, 11.57 lbf ft)

**Bulbs**

Function	Rating
Cab light	18W
Working lights	55W
Indicators	3W
Power on	3W
Glow plug	3W
Working lights on/off	1.2W

**Circuit Protection**

The electrical circuits are protected by fuses located in a fuse box in the cab (to the right of the seat).

*Fuse	Circuit	Rating
1	Fuel shut-off solenoid	5A
2	Horn	15A
3	Alternator feed, Instruments	15A
4	Boom light, Cab working lights	5A
5	Wiper, Heater	5A
6	Cab Light	5A

**Note:** The optional flashing beacon is protected by a 10A in-line fuse.

**Battery**

**Negative Earth Electrical System**

- 1 Always connect the negative terminal of the battery to **EARTH**.
- 2 When connecting the battery, connect the earth lead **LAST**.
- 3 When disconnecting the battery, disconnect the earth lead **FIRST**.

**\*Inspection**

Check the level of the electrolyte (low maintenance). Make sure that the terminals are tight and clean. Coat them with petroleum jelly to prevent corrosion. Ensure the battery vent tube is correctly fitted.

**Testing the Specific Gravity**

The specific gravity of the electrolyte gives an indication of the state of charge of the battery. Readings should be taken using a hydrometer, when the electrolyte temperature is 15°C (60°F). If the battery has recently been charged, wait approximately one hour to dissipate the 'surface charge' before testing.

Readings should be as the table and should not vary between cells by more than 0.04. A greater variation indicates an internal fault on that particular cell.

If the electrolyte temperature is other than 15°C (60°F) a 'correction factor' must be applied to the reading obtained. Add 0.0007 per 1°C higher than 15°C, and subtract the same if the temperature is lower.

Specific Gravity (20°C)	Quantity of Electricity Discharged (%)	Residual Capacity (%)
1.260	0	100 (fully charged)
1.210	25	75
1.150	50	50
1.110	75	25
1.060	100	0 (fully discharged)

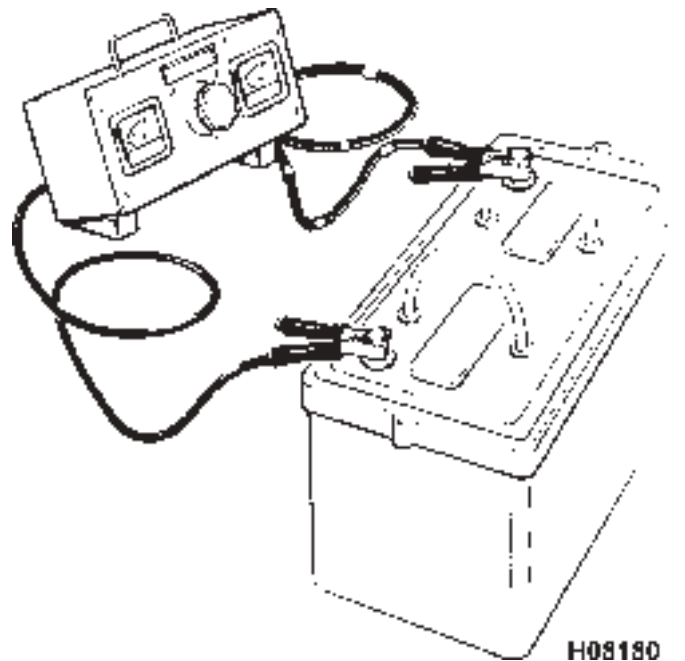
**High Rate Discharge Test**

This test is to determine the electrical condition of the battery and to give an indication of the remaining useful 'life'

Before testing, ensure that the battery is at least 75% charged.

- 1 Disconnect both terminals of the battery.
- 2 Adjust the discharge tester to 3 x amp/hour rating of the battery.
- 3 Connect the tester to the battery terminals, observing the polarity.
- 4 Note the voltmeter reading. The battery should be capable of maintaining at least 9 volts for 10 seconds. A rapidly falling voltage indicates a fault in one or more of the battery cells.

**Note:** Do not leave the discharge tester connected to the battery for longer than is necessary to complete the test.



## Alternator

### Removal and Replacement

#### Removal

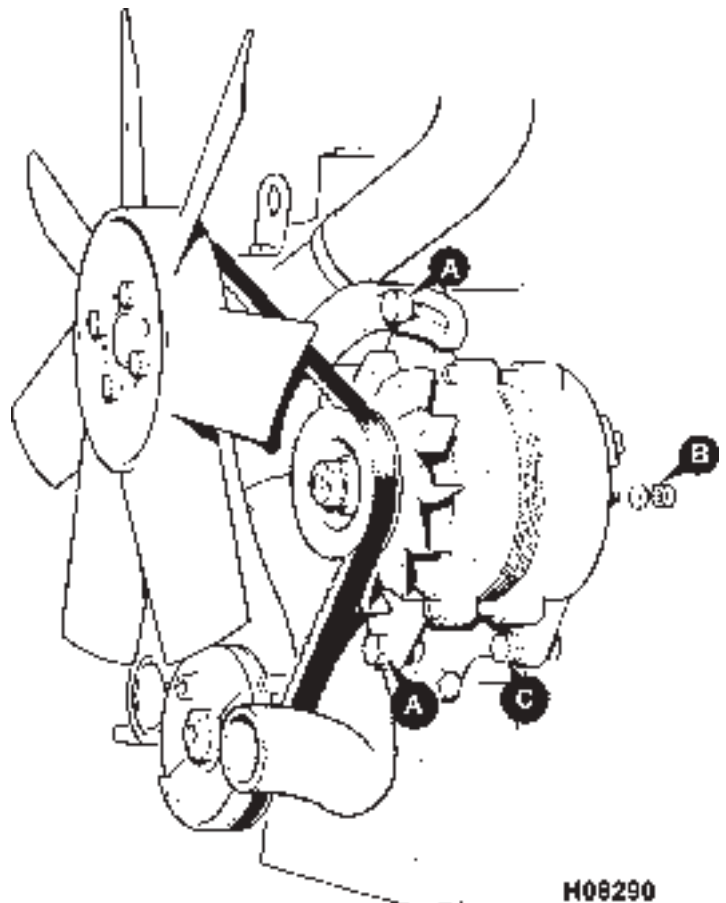
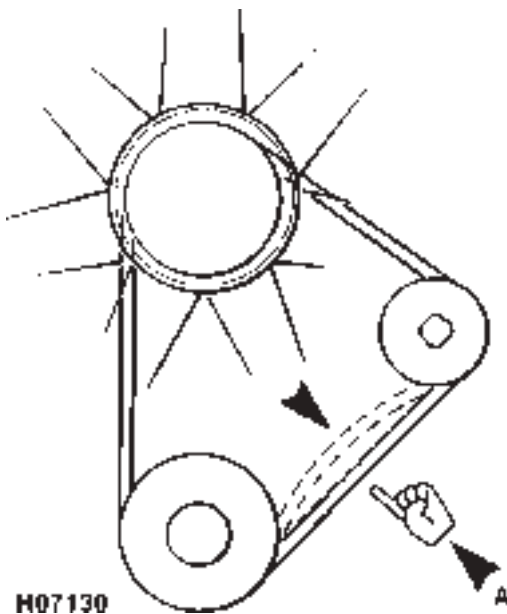
- 1 Raise the engine cover.
- 2 Remove the interior access panel.
- 3 Disconnect the battery.
- 4 Loosen the alternator mounting bolts **A** and **C**. Remove the fan belt from the alternator drive pulley.
- 5 Remove nuts and washers **B** and disconnect the electrical wires.
- 6 Support the alternator and remove the mounting bolts.
- 7 Remove the alternator.

#### Replacement

- 1 Put the alternator in place and install the mounting bolts. Do not tighten the bolts.
- 2 Put the fan belt on to the pulley.
- 3 Adjust the position of the alternator, so that when the belt is depressed at the mid-point between the crankshaft and alternator pulleys, the deflection is 5 mm (0.2 in.). Tighten the mounting bolts. Ensure that bolt **C** is tightened last.

**Note:** Failure to maintain correct fan belt adjustment can result in damage to timing case cover.

- 4 Correctly locate the electrical wire connections and install washers and nuts **B** and tighten.
- 5 Fit the interior access panel.
- 6 Lower the engine cover.



**Alternator (cont'd)**

**Dismantling and Assembly**

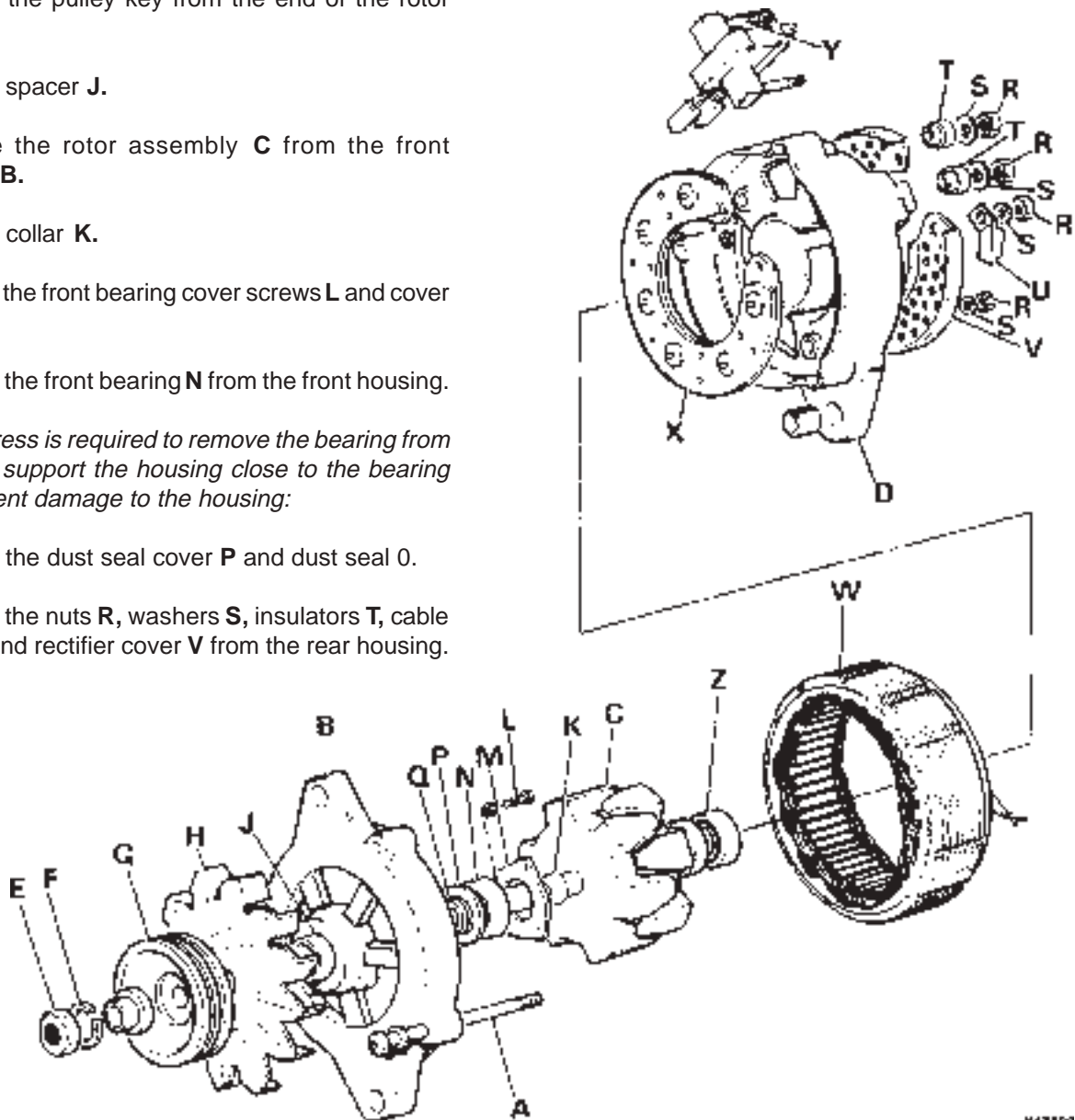
**Dismantling**

- 1 Scribe an alignment mark across the end housing and the stator frame.
- 2 Remove the housing through bolts **A**.
- 3 Separate the front housing **B** and rotor assembly **C** from the rear housing **D**.
- 4 Remove the nut **E** and the lockwasher **F** from the end of the rotor shaft.
- 5 Remove the pulley **G** and the fan **H**.
- 6 Remove the pulley key from the end of the rotor shaft.
- 7 Remove spacer **J**.
- 8 Remove the rotor assembly **C** from the front housing **B**.
- 9 Remove collar **K**.
- 10 Remove the front bearing cover screws **L** and cover **M**.
- 11 Remove the front bearing **N** from the front housing.

**NOTE:** *If a press is required to remove the bearing from the housing, support the housing close to the bearing boss to prevent damage to the housing:*

- 12 Remove the dust seal cover **P** and dust seal **Q**.
- 13 Remove the nuts **R**, washers **S**, insulators **T**, cable clips **U** and rectifier cover **V** from the rear housing.

- 14 Remove the stator assembly **W** with rectifier plate **X** from the rear housing **D**.
- 15 Using a pre-heated soldering iron, unsolder the stator wire from the rectifier terminals. Grip each rectifier terminal with needle nose pliers and separate the wire from the terminal as soon as the solder melts. When the wire is separated from each rectifier terminal, touch the terminal with a damp cloth.
- 16 Remove the brush holder assembly **Y** from the rectifier plate **X**.
- 17 Using a suitable puller, remove the rear bearing **Z** from the rotor shaft.



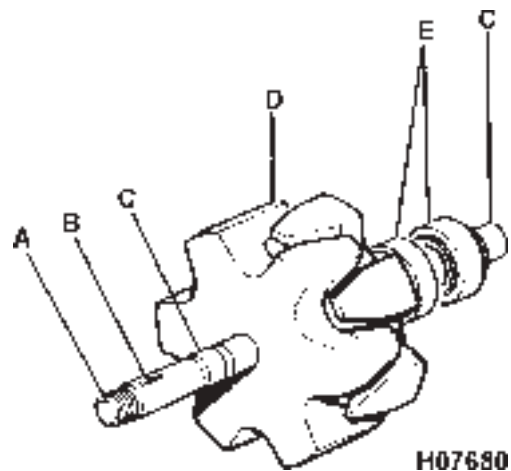
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## Alternator (cont'd)

### Inspection/Testing

#### Rotor Assembly

- 1 Inspect the rotor assembly for the following:
  - a Stripped or damaged threads **A**.
  - b Damaged or enlarged key slot **B**.
  - c Damaged or scored bearing journals **C** (indicates bearing spinning on shaft).
  - d Scuff marks on pole fingers **D** (indicates a bent shaft).
  - e Dirty or damaged slip rings **E**. If the slip rings are dirty or lightly scored, use silicon carbide paper No 400 (not emery cloth) to clean them. Finish with crocus cloth. Rotate the rotors in a lathe or drill press to prevent flat spots.
- 2 Using an ohmmeter, touch one of the ohmmeter leads to each of the slip rings **E** (winding continuity test).
- 3 Observe the ohmmeter reading. If the ohmmeter indicates approximately  $4.2\Omega$  the rotor winding resistance is satisfactory. If the ohmmeter indicates low zero resistance, the rotor winding is short circuited renew the rotor assembly. If the ohmmeter indicates high resistance, the rotor winding is open circuited - renew the rotor assembly.
- 4 Using the ohmmeter, touch one ohmmeter lead to a slip ring **E** and the other ohmmeter lead to the pole fingers **D** (insulation resistance test).
- 5 Observe the ohmmeter reading. If a high resistance is indicated, the insulation resistance is satisfactory. If a low resistance is indicated, the winding is grounding to the rotor - renew the rotor assembly.

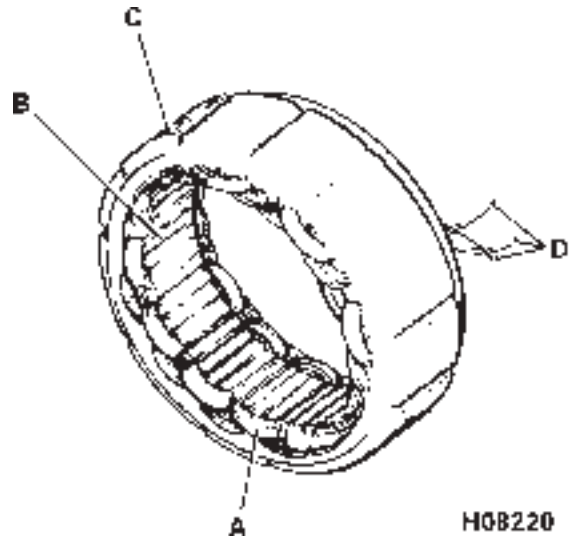


## Alternator (cont'd)

### Inspection/Testing

#### Stator Assembly

- 1 Inspect the stator for the following:
  - a Burnt or discoloured winding **A** (indicates electrical overload)
  - b Scuff marks on inside of the stator pole faces **B** (indicates bent shaft).
  - c Damage to the stator frame **C**/pole faces **B**.
  - d Missing, damaged or burnt winding insulator.
- e Using an ohmmeter, touch one ohmmeter lead to one of the stator leads **D**, and the other ohmmeter lead to each of the other stator leads in turn (stator winding continuity test).
- 3 Observe the ohmmeter reading. If a low resistance is indicated, stator winding continuity is satisfactory. If a high resistance is indicated, the stator winding is open circuited - replace the stator.
- 4 Using the ohmmeter, touch on ohmmeter lead to one of the stator leads **D** and the other ohmmeter lead to the stator frame **C** (stator insulation resistance test).
- 5 Observe the ohmmeter reading. If a high resistance is indicated, the stator insulation resistance is satisfactory. If a low resistance is indicated, the stator winding is grounding to the stator frame - replace the stator assembly.



**ALTERNATOR (cont'd)****Inspection/Testing****Rectifier Assembly**

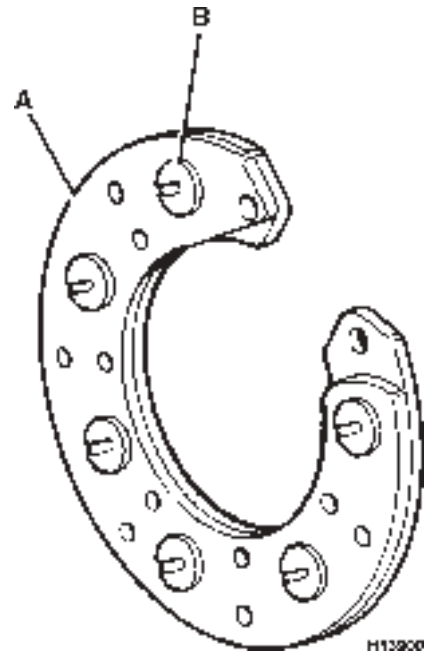
- 1 Inspect the rectifier assembly for any obvious damage.
- 2 Using a ohmmeter, touch one ohmmeter lead to the rectifier frame **A** and the other ohmmeter lead to each of the diodes **B** (6 off) terminals in turn.
- 3 Observe the ohmmeter readings.
- 4 Change over the ohmmeter leads and repeat step 2.
- 5 Observe the ohmmeter readings.

**NOTE:** A serviceable diode shown continuity in one direction and high resistance in the other direction.

- 6 If each diode gives a high and low resistance, the rectifier is satisfactory.
- 7 If one or more diodes shows a high resistance in both directions - replace the rectifier assembly.
- 8 If one or more diodes shows a low resistance in both directions - replace the rectifier assembly.

**Brush Holder and Brushes**

- 1 Inspect the brush holder assembly for the following:
  - a Damaged, corroded or stretched brush springs.
  - b Chipped or broken bushes.
  - c Dirt or contamination.
  - d Broken mounting holes, cracks or other damage.
- 2 Measure the length of the brushes. If less than 0.217in (5.5mm) replace them.
- 3 If the bushes are to remain in use, clean them with a soft cloth.





### Alternator (cont'd)

#### inspection/Testing

##### Bearings

- 1 Rotate the bearings, on the shaft or between the fingers to determine their condition. Replace the bearing if the movement is not smooth and regular.
- 2 Examine the seal **A** for grease leakage.
- 3 Examine the inner race **B** for signs of spinning on the shaft.
- 4 Examine the outer race **C** for signs of spinning in the housing.
- 5 Inspect the bearing for signs of oil leakage past the bearing to the front housing seal.

##### Fan

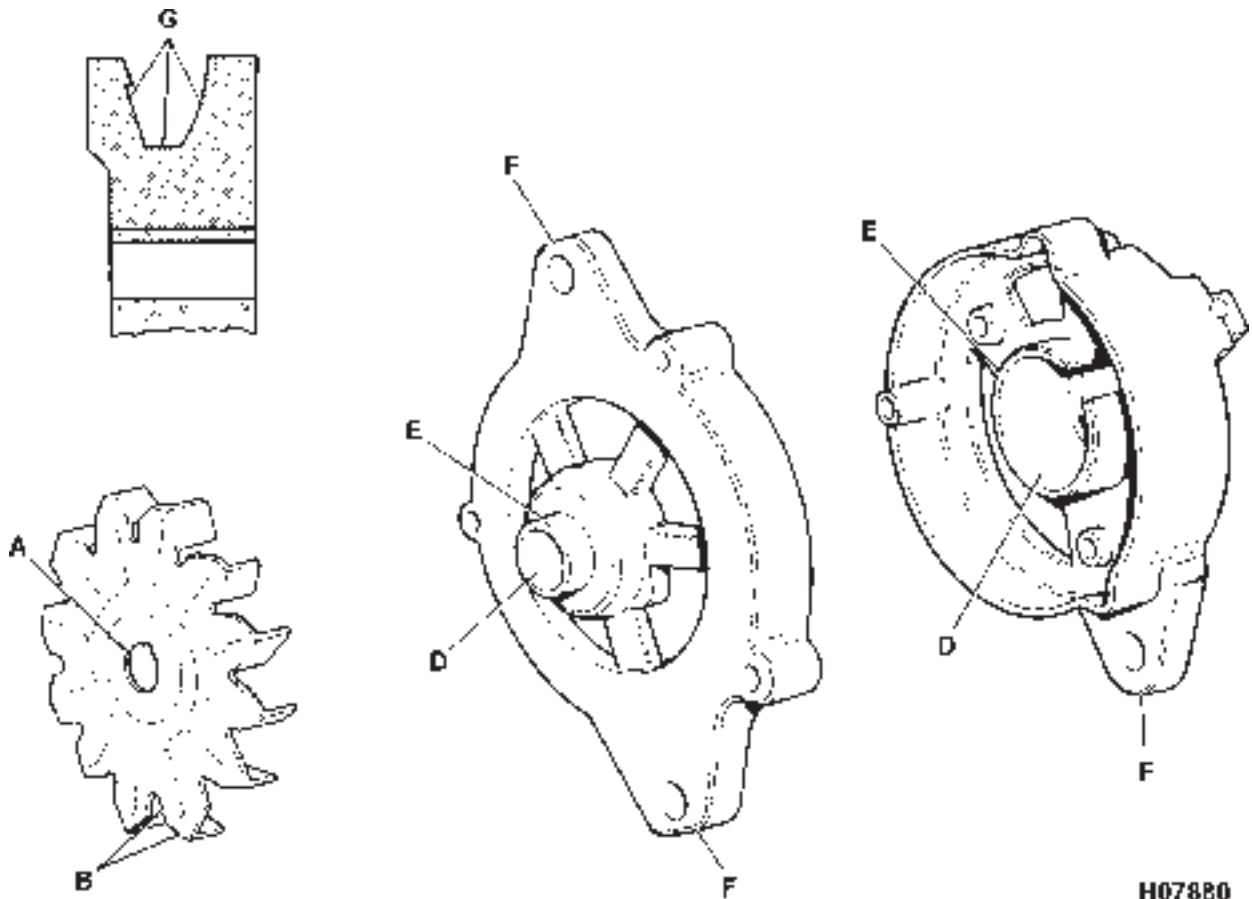
- 1 Inspect the fan for cracks or damage around the mounting hole **A**.
- 2 Inspect the fan blades **B** for damage and distortion.

##### Drive Pulley

- 1 Inspect the pulley for the following:
  - a** Worn, bent or cracked pulley groove. If the groove is polished at positions **A**, it indicates a worn groove.
  - b** Wear or damage to the pulley key slot, which could prevent a tight fit on the shaft.

##### Front and Rear Housings

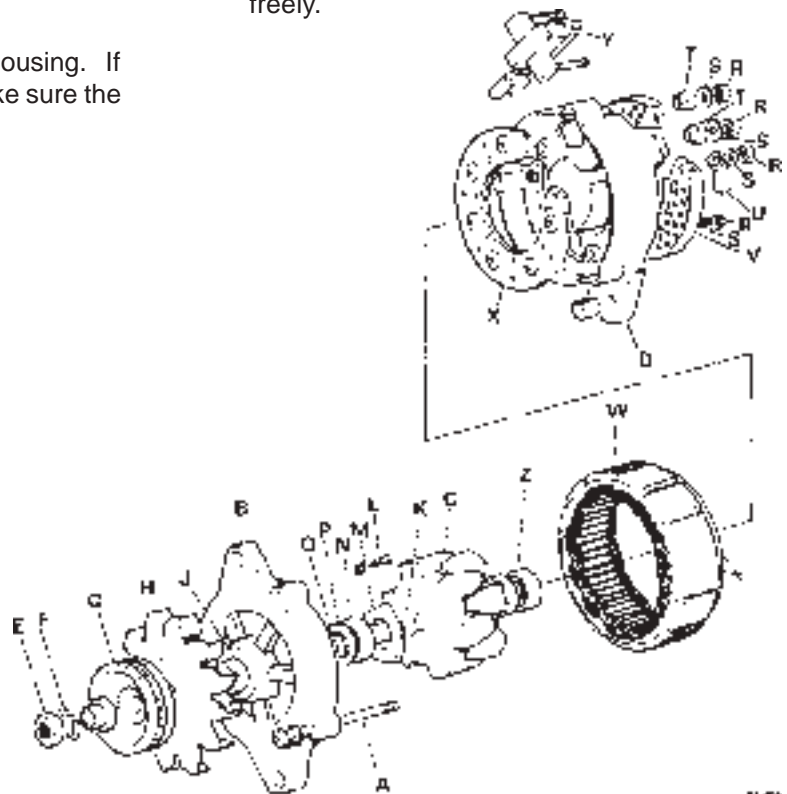
- 1 Inspect the housings for the following:
  - a** Scoring in the bearing bosses **A**, which indicates that the bearing is spinning in the housing.
  - b** Cracked or damaged bearing mounting bosses **B**.
  - c** Cracked or damaged mounting bosses **C**.
  - d** Generally, for cracks and damage.



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**Alternator (cont'd)****Assembly**

- 1 Using a suitable press and sleeve, install the rear bearing **Z** in the rear housing **D**. Make sure that the sleeve only touches the inner race.
- 2 Install the brush holder assembly **V** on the rectifier plate **X**.
- 3 Connect the rectifier plate assembly **X** to the stator **W** as follows:
  - a Clean the ends of the stator wire and the diode terminals.
  - b Hold the diode terminals with needle nose pliers (to protect the diodes from heat damage during soldering).
  - c Using a pre-heated soldering iron, solder the stator wires to the diode terminals. Use a resin cored solder.
  - d After soldering, cool the connection quickly with a damp cloth.
- 4 Install the stator **W** and rectifier plate assembly **X** in the rear housing **D**. Make sure the scribe marks on the housing and stator frame are aligned.
- 5 Install the rectifier cover **V**, the insulators **T**, washers **S** and nuts **R** in the positions from which they were removed on the rear housing.
- 6 Install the dust seal **Q** and dust seal cover **P** in the front housing **B**.
- 7 Install the front bearing **N** in the front housing. If necessary, use a press and sleeve. Make sure the sleeve only touches the inner race,
- 8 Fit the front bearing cover **M** with the washers and screws **L**.
- 9 Fit the collar **K** to the shaft of the rotor assembly **C**.
- 10 Install the rotor assembly **C** in the front housing **B**.
- 11 Fit the spacer **J** on the rotor shaft.
- 12 Fit the pulley key in the slot in the rotor shaft.
- 13 Install the fan **H** and pulley **G** on the rotor shaft, located correctly on the key.
- 14 Fit the lockwasher **F** and nut **E** and tighten the nut **E**.
- 15 On the rear housing assembly, push the brushes into the brush holder assembly and insert a pin punch through the back of the alternator to hold the bushes back.
- 16 Align the scribe marks on the housings and stator frame, and fit the front housing **B** and rotor **C** to the rear housing assembly.
- 17 Fit the through bolts **A** and tighten them evenly.
- 18 Spin the fan and make sure that the rotor rotates freely.



VOLTAGE REGULATOR OPERATION

Key on - Engine off (see fig. 1)

Indicator Lamp Circuit

When the starter switch is turned to the ON position, battery current will flow from the switch through the indicator lamp to the L terminal of the regulator. In the regulator, the current flows through the closed points P5 and P6 to the regulator E terminal. From the E terminal the current flows to earth at the alternator. When the current reaches earth, the circuit is complete and the charge indicator lamp will illuminate.

Field Circuit

When the starter switch is turned to the ON position, battery current will flow from the switch to the IG terminal of the regulator. In the regulator, the current flows through the closed points P1 and P2 to the regulator F terminal. From this terminal the current flows to the alternator F terminal which is the battery side of the rotor field coil. It is the current flowing from the F terminal through the rotor coil to earth which provides the initial magnetic field needed by the alternator before it can begin producing its own current.

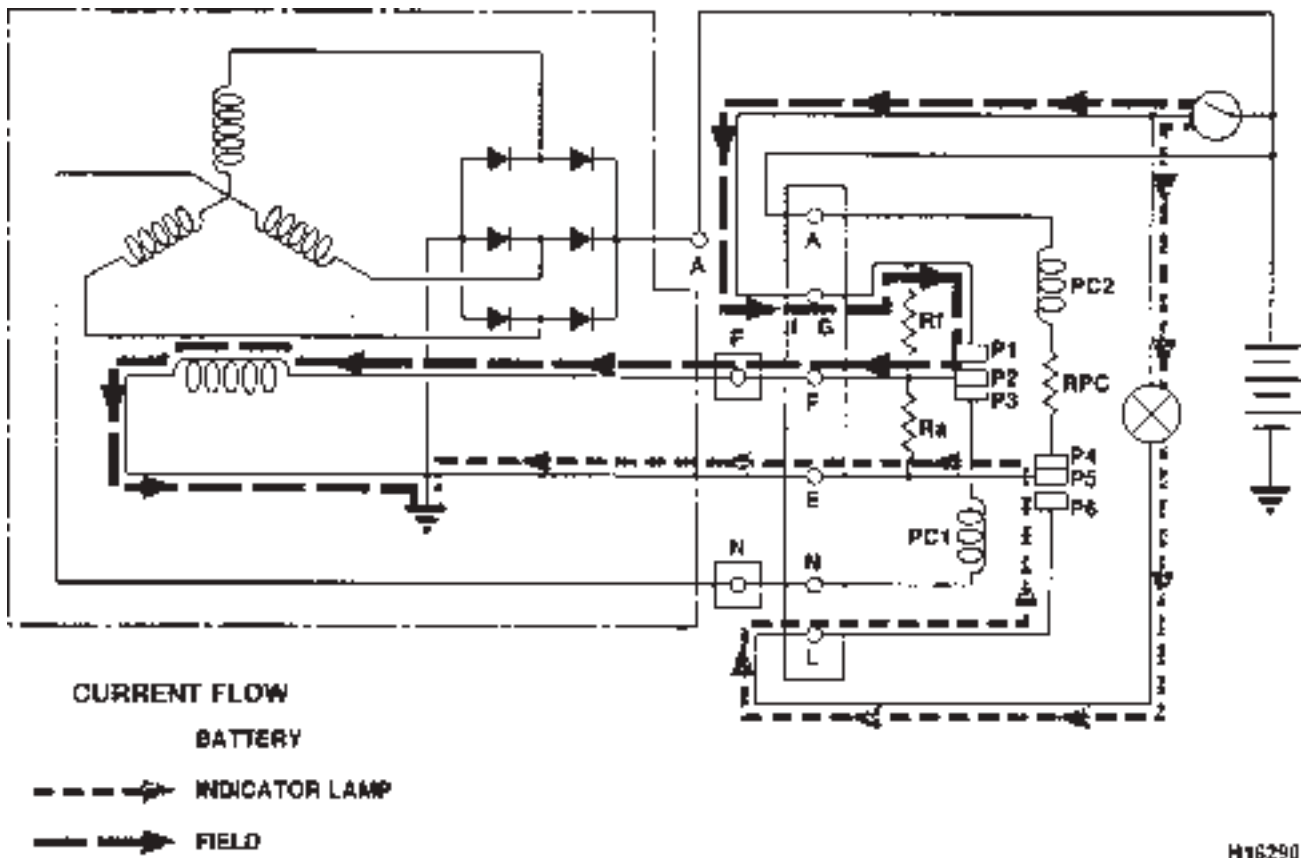


Figure 1  
Alternator - Regulator Circuit  
Key ON - Engine Off

VOLTAGE REGULATOR OPERATION (continued)

Engine on - Low speed (see fig. 2)

Indicator Lamp Circuit

A phase tap is connected to the stator winding in such a manner that when the alternator begins charging approximately 5 volts will be generated at the N terminal of the alternator. The current resulting from this voltage is applied to the N terminal of the regulator. In the regulator the current flows through coil PC1 to earth through terminal E. The current flow through PC2 will create a magnetic field strong enough to attract point P5 away from point P6 to point P4. The connection of P5 and P4 will accomplish two things:

- 1 With points P5 and P6 separated, the lamp circuit is open and the charge indicator light will go out.
- 2 The closing of points P5 and P4 will provide an earth circuit for coil PC2.

Field Circuit

As the alternator speed increases the voltage generated will approach 14 volts. This voltage is applied to the A terminal of the regulator. In the regulator the current flow resulting from the voltage will flow through coil PC2 and points P4 and P5 to earth at terminal E. The magnetic field generated in coil PC2, will become strong enough to attract point P2 away from point P1. With points P1 and P2 open, field current will flow through resistance R1. The resistor reduces current flow to the alternator field which reduces the voltage generated by the alternator. During low speed operation and when electrical loads are high, point P2 will vibrate against P1 to maintain the alternator voltage at 13.8 to 14.8 volts.

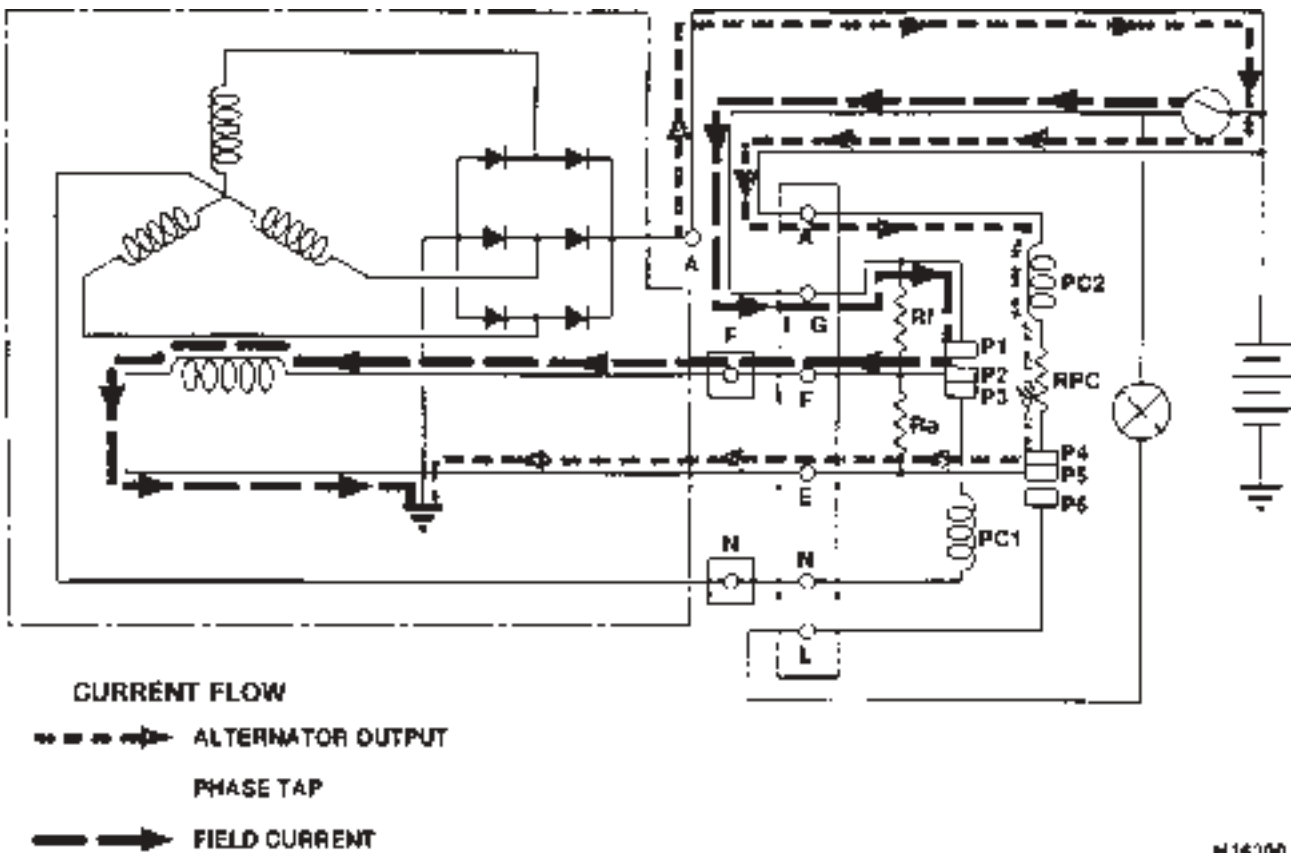


Figure 2  
Alternator - Regulator Circuit  
Key ON - Low Speed

VOLTAGE REGULATOR OPERATION (continued)

Engine on - High speed (see fig. 3)

As engine speed increases the higher rotor speed will cause the alternator output voltage to rise even though the current flow to the field has been reduced by resistor R1. The increased voltage level raises the amount of current flowing through coil PC2 which generates a stronger magnetic field around the coil. The coil now has enough force to pull point P2 into contact with point P3.

The closing of points P2 and P3 earths the field circuit at the regulator. Without field current the alternator stops charging which causes the voltage level to drop. The reduced voltage allows spring pressure to open points P2 and P3 - restoring field current. During high speed operation, point P2 will vibrate against point P3 to maintain the alternator voltage at 13.8to 14.8 volts

CHARGING SYSTEM - PRELIMINARY CHECK AND ELECTRICAL TEST

Service Precautions

To avoid damage to the components of the charging system, observe the following precautions.

- Never connect or disconnect any of the charging system circuit connections when the engine is running.
- Never short any of the charging components to earth.
- Always disconnect the battery earth cable when installing or removing the alternator.
- Always disconnect the battery earth cable when charging the battery in the machine using a battery charger
- Always observe the correct polarity when installing the, battery or using a slave battery to start the engine.

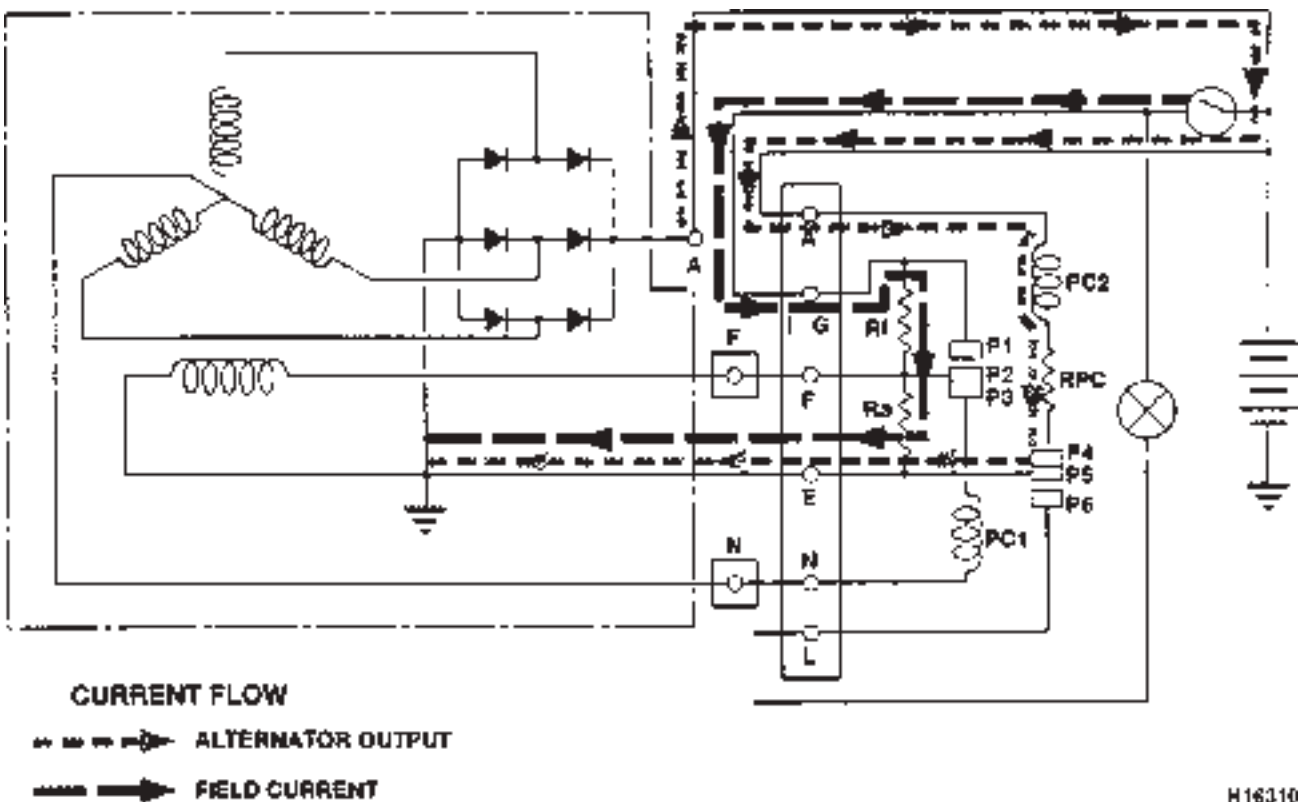


Figure 3  
Alternator - Regulator Circuit  
Engine On - High Speed

**PRELIMINARY CHECKS**

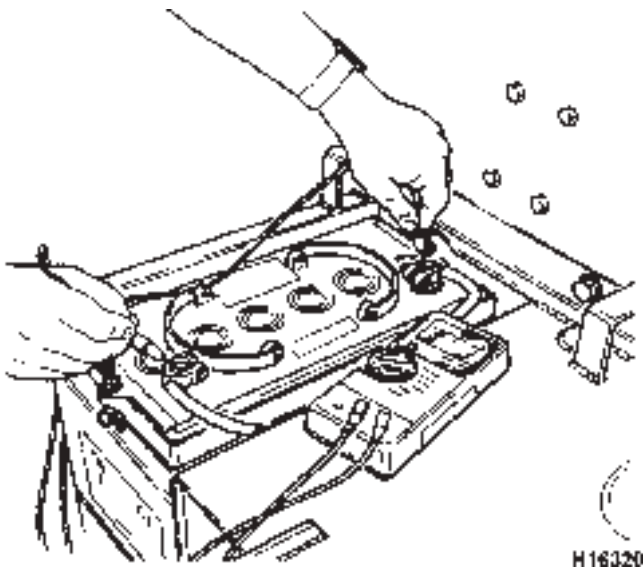
Prior to electrical testing, thoroughly inspect the charging and electrical system leads and connections.

**ALTERNATOR VOLTAGE OUTPUT TEST (see fig. 4)****Indicator Lamp On - Engine Running**

- 1 Turn on the headlights for 1 minute.
- 2 Connect a load tester and voltmeter to the battery. Make sure the load control knob is in the OFF position before making the connection.

**NOTE:** Connect the red leads to the battery positive post and the black leads to the battery negative post. Make sure the voltmeter leads contact the battery posts - not the load tester leads.

- 3 Read and record the voltage indicated on the voltmeter.
- 4 Start the engine and adjust the speeds to 1400-1800 rpm.
- 5 Using the load tester, apply a 30 amp load to the battery.
- 6 Read and record the voltage indicated on voltmeter.



**Figure 4**  
**Voltage Output Test**

**TEST RESULTS**

- Voltmeter reading increases but remains below 15.5 volts = Perform output current test
- Voltmeter reading remains the same or decreases = Perform max. field output test
- Voltmeter reading increases above 15.5 volts = Replace regulator and check battery

**ALTERNATOR CURRENT OUTPUT TEST (see fig. 5)****Indicator Lamp On - Engine Running**

**NOTE:** This test is a continuation of the output voltage test.

- 1 Disconnect the voltmeter and load tester leads from the battery negative terminal.
- 2 Disconnect the cable from the battery negative post. Observe all safety precautions as outlined in the Battery Chapter.
- 3 Disconnect the output terminal at the alternator.
- 4 Connect an ammeter in series with the alternator output terminal and the wiring terminal. Connect the ammeter negative lead to the output terminal and the positive lead to the output terminal.
- 5 Connect the cable, load tester and voltmeter to the battery negative post.

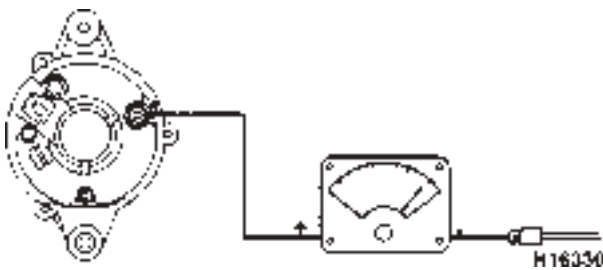
- 6 Start the engine and adjust the engine speed to 1000 rpm.
- 7 Using the load tester, load the charging system enough to produce a 3-4 amp reading on the ammeter. Maintain this load for 2-3 minutes to stabilise alternator and regulator temperature.
- 8 Increase the engine speed to 1400-1800 rpm.
- 9 Using the load tester apply a 30 amp load to the charging system and observe the reading on the ammeter connected to the alternator.

**MAXIMUM FIELD OUTPUT TEST (see fig. 6)**

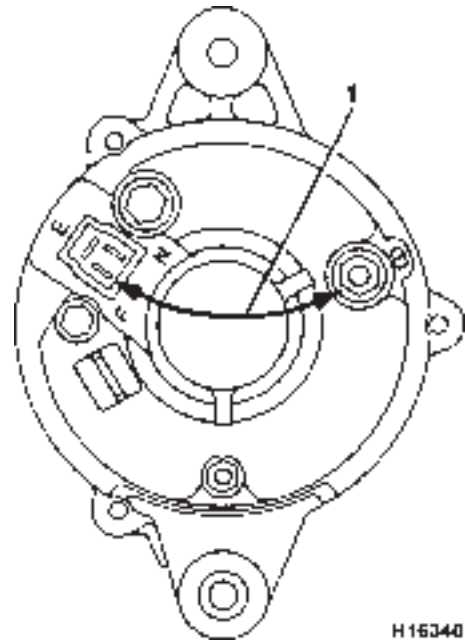
**Indicator Lamp On - Engine Running**

**NOTE:** This test should be performed only as a continuation of the output voltage or output current tests.

- 1 Perform all the steps outlined under the output voltage or output current tests, except, before starting the engine connect a jumper wire from the output terminal to the field terminal.



**Figure 5**  
**Current Output Test**



**Figure 6**  
**Maximum Field Output Test**

**TEST RESULTS**

- Voltmeter reading increases but remains below 15.5 volts and the ammeter reads a minimum of 18 amps = Charging system is operating properly check for an earthed lamp circuit
- Voltmeter reading remains the same or decreases and the ammeter reads a minimum of 18 amps = Perform max. field output test

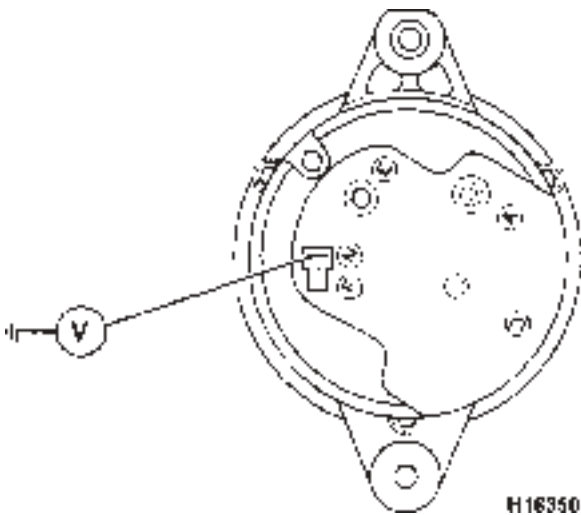
**TEST RESULTS**

- Voltmeter or ammeter reading increases = Perform N circuit tests
- Voltmeter or ammeter reading remains the same or decreases = Disassemble alternator and test components

**ALTERNATOR - N TERMINAL TEST (see fig. 7)**

**Indicator Lamp On - Engine Running**

- 1 Connect the voltmeter red lead to the N terminal of the alternator.
- 2 Connect the voltmeter black lead to a good earth.
- 3 Start the engine and adjust the engine speed to 1400-1800 rpm.
- 4 Observe the voltmeter reading.



**Figure 7**  
**Alternator N Terminal Test**

**REGULATOR - N TERMINAL VOLTAGE TEST (see fig. 8)**

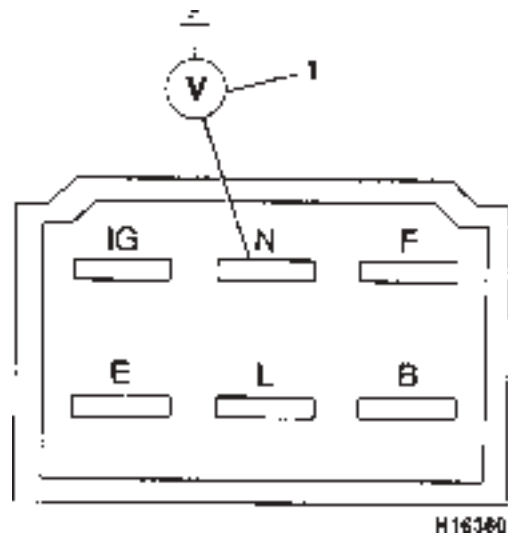
**Indicator Lamp On - Engine Running**

**NOTE:** This test is a continuation of the N terminal voltage check made at the alternator.

- 2 Connect the voltmeter red lead to the voltage regulator N terminal.

**NOTE:** Do not disconnect the regulator connector for this test.

- 2 Connect the voltmeter black lead to a good earth.
- 3 Start the engine and adjust the engine speed to 1400 - 1800 rpm.
- 4 Observe the voltmeter reading.



**Figure 8**  
**Regulator N Terminal Voltage Test**

**TEST RESULTS**

- Voltmeter reads 4.0 - 5.8 volts = Check N terminal voltage at regulator
- Voltmeter reads less than: 4.0 = Disassemble alternator and bench test components

**1 Voltmeter**

- Low Resistance Reading = Good
- High Resistance Reading = Replace Switch
- Voltmeter reads: 4.0 - 5.8 volts = Check N circuit continuity in regulator

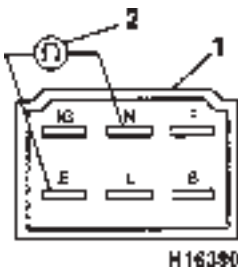


**CONTINUITY TESTS**

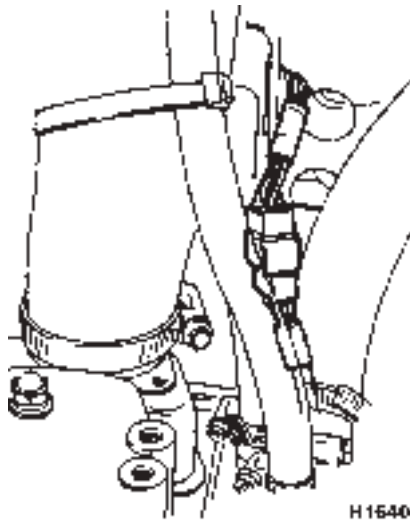
**N CIRCUIT IN REGULATOR (see fig. 9)**

**Indicator Lamp On - Engine Running**

- 1 Disconnect the regulator from the wiring harness.
- 2 Connect one ohmmeter lead to the N terminal.
- 3 Connect the remaining ohmmeter lead to the E terminal and observe the ohmmeter.



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**Figure 9**  
**Regulator N Circuit Continuity Test**

1 Regulator Wiring Connector 2 Ohmmeter

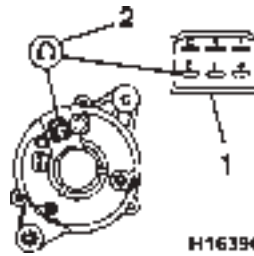
**TEST RESULTS**

- High Resistance Reading = Repair open or
- Low Resistance Reading = Proceed to F circuit continuity test

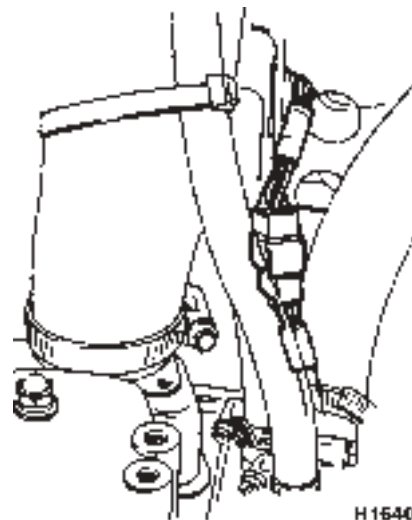
**ALTERNATOR TO REGULATOR E CIRCUIT (see fig. 10)**

**Indicator Lamp On - Engine Running**

- 1 Disconnect the regulator from the wiring harness.
- 2 Connect one ohmmeter lead to the wiring harness E terminal.
- 3 Connect the remaining ohmmeter lead to the alternator E terminal and observe the ohmmeter.



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**Figure 10**  
**Alternator to Regulator E Circuit Continuity Test**

1 Regulator Wiring Connector 2 Ohmmeter

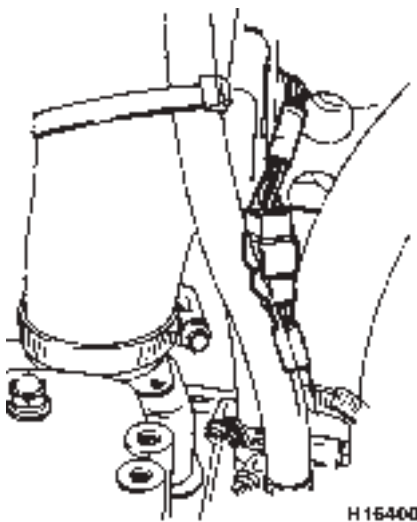
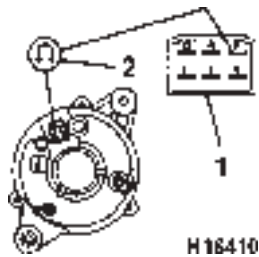
**TEST RESULTS**

- High Resistance Reading = Repair open or cause of high resistance in the E wire
- Low Resistance Reading = Proceed to F circuit continuity check - alternator to regulator

**ALTERNATOR TO REGULATOR F CIRCUIT CONTINUITY TEST (see fig. 11)**

**Indicator Lamp On - Engine Running**

- 1 Disconnect the regulator from the wiring harness.
- 2 Connect one ohmmeter lead to the wiring harness F terminal.
- 3 Connect the remaining ohmmeter lead to alternator F terminal and observe the ohmmeter reading.



**Figure 11**  
**Alternator to Regulator F Circuit Continuity Test**

1 Regulator Wiring Connector      2 Ohmmeter

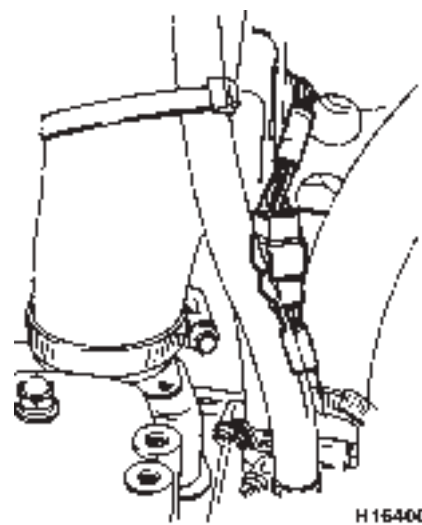
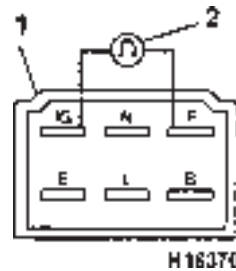
**TEST RESULTS**

- High Resistance Reading = Repair open or cause of high resistance in the F wire
- Low Resistance Reading = Proceed to F circuit continuity - in regulator

**REGULATOR TO F CIRCUIT CONTINUITY TEST (see fig. 12)**

**Indication Lamp On - Engine Running 1**

- 1 Disconnect the regulator from the wiring harness.
- 2 Connect one ohmmeter lead to regulator F terminal
- 3 Connect the remaining ohmmeter lead to the IG terminal and observe the ohmmeter reading.



**Figure 12**  
**Regulator F Circuit Continuity Test**

1 Regulator Wiring Connector      2 Ohmmeter

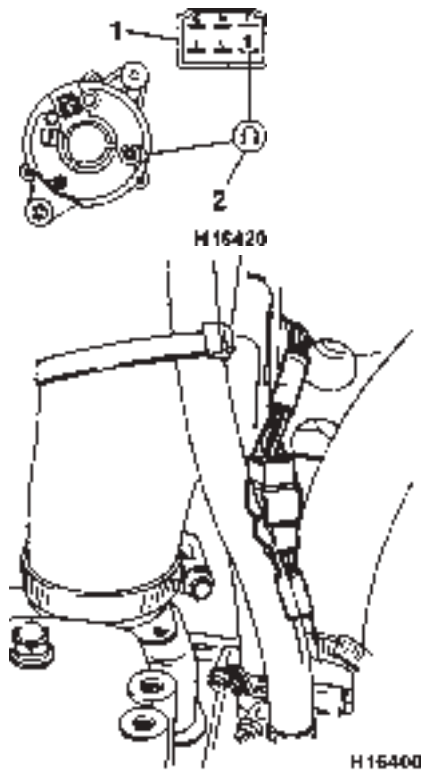
**TEST RESULTS**

- High Resistance Reading = Replace Regulator
- Low Resistance Reading = Proceed to B circuit continuity check - alternator to regulator

**ALTERNATOR TO REGULATOR B CIRCUIT CONTINUITY TEST (see fig. 13)**

**indication Lamp On - Engine Running**

- 1 Disconnect the cable from the battery negative post.
- 2 Turn the starter switch to the ON position.
- 3 Disconnect the regulator from the wiring harness.
- 4 Connect one ohmmeter lead to the wiring harness B terminal.
- 5 Connect the remaining ohmmeter lead to alternator B terminal and observe the ohmmeter reading.



**Figure 13**  
**Alternator to Regulator B Circuit Continuity Test**

1 Regulator Wiring Connector 2 Ohmmeter

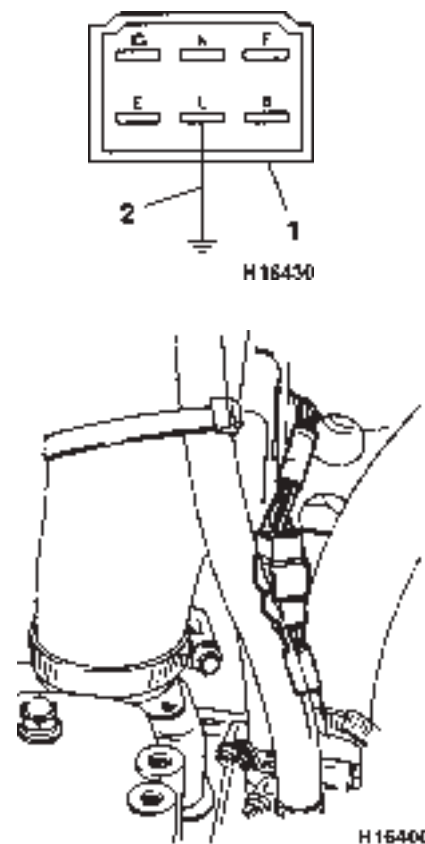
**TEST RESULTS**

- High Resistance Reading = Repair open or cause of high resistance in the B circuit
- Low Resistance Reading = Replace regulator

**FUSE TO REGULATOR L TERMINAL CIRCUIT CONTINUITY TEST (see fig. 14)**

**Starter Switch On - Indicator Lamp Off**

- 1 Disconnect the wiring harness at the regulator.
- 2 Connect a jumper from the wiring harness L terminal to ground.
- 3 Turn the starter switch to the ON position and observe the indicator lamp.



**Figure 14**  
**Fuse to Regulator L Terminal Circuit Continuity Test**

1 Regulator Wire Connector 2 Jumper Wire

**TEST RESULTS**

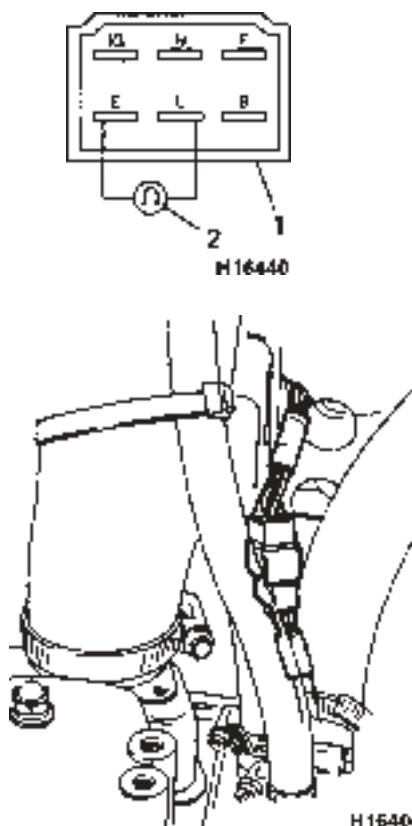
- Indicator lamp is ON = Check L circuit continuity in regulator
- Indicator lamp is OFF = Check fuse, bulb and wiring for an open circuit

### REGULATOR L CIRCUIT CONTINUITY TEST (see fig. 15)

#### Starter Switch On - Indicator Lamp Off

**NOTE:** This test is a continuation of the SWITCH ON - LAMP OFF TEST

- 1 Disconnect the regulator from the wiring harness.
- 2 Connect one ohmmeter lead to the L terminal.
- 3 Connect the remaining ohmmeter lead to E terminal and observe the ohmmeter reading.



**Figure 15**  
**Regulator L Circuit Continuity Test**

1 Regulator Wire Connector      2 Jumper Wire

#### TEST RESULTS

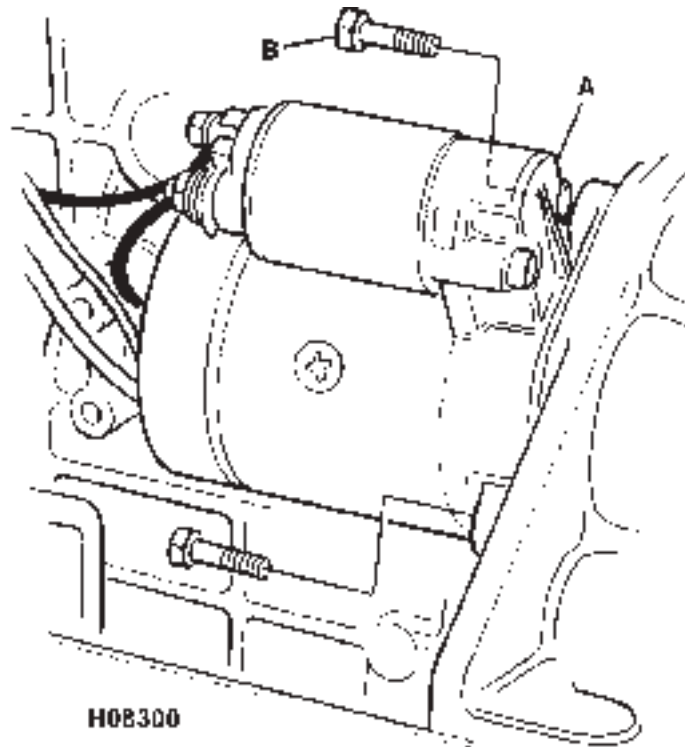
- High Resistance Reading = Replace regulator
- Low Resistance Reading = L circuit check is complete

**STARTER MOTOR****Removal and Replacement****Removal**

- 1 Raise the engine cover.
- 2 Remove the interior access panel.
- 3 Disconnect the battery.
- 4 Disconnect the starter electrical connections.
- 5 Support the starter motor **A**, loosen and remove the securing bolts **B**.
- 6 Disengage the pinion from the flywheel gear teeth and remove the starter motor.

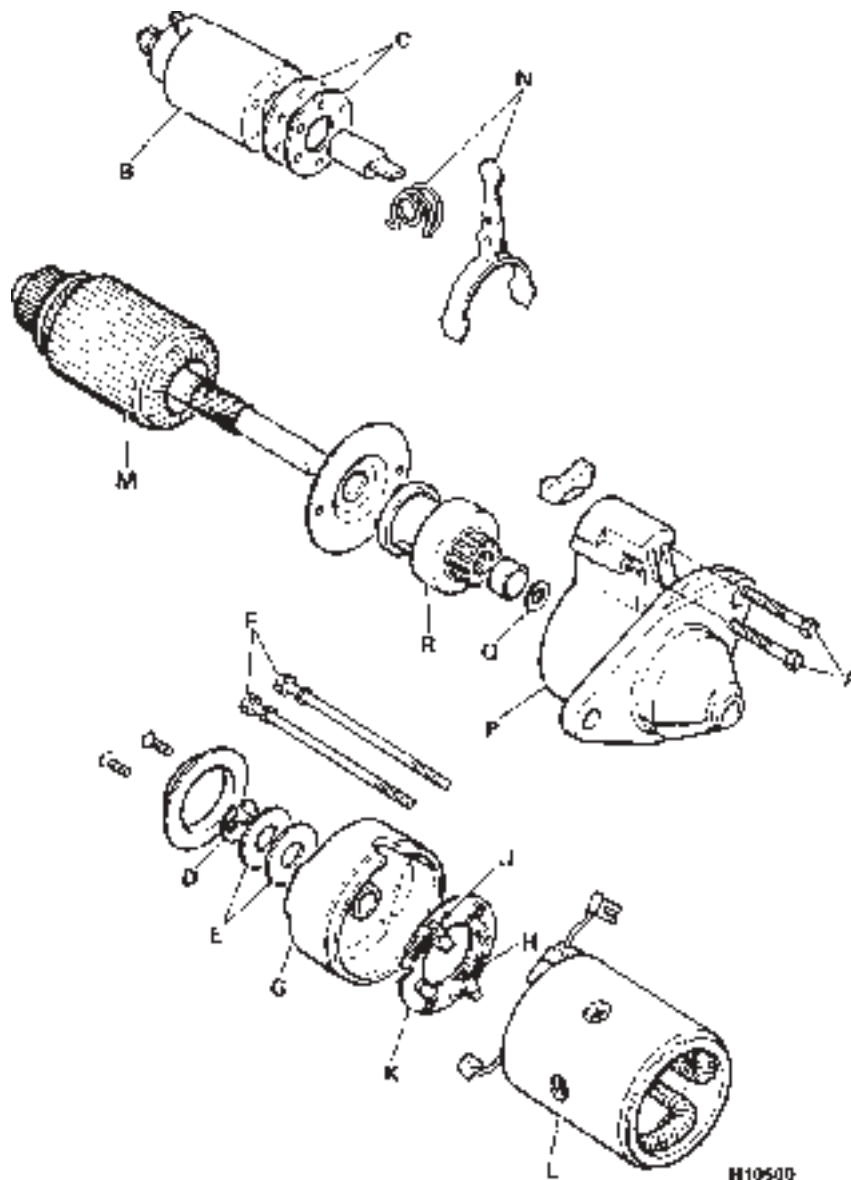
**Replacement**

- 1 Put the starter motor in position and align the pinion in the flywheel gear teeth.
- 2 Fit and tighten the securing bolts **S**
- 3 Connect the electrical connections.
- 4 Connect the battery terminals. Connect the earth terminal last.
- 5 Fit the interior access panel.
- 6 Close the engine cover.



**STARTER MOTOR (Cont'd)****Disassembly and Assembly****Disassembly**

- 1 Remove the screws **A**.
- 2 Remove the solenoid **B** and the washers **C**.
- 3 Remove the dust cover and take out the **E** ring **D** and thrust washer **E**, if fitted.
- 4 Remove the screws **F** and the rear cover **G**.
- 5 Remove the springs **H** and lift the brushes **J** from the brush assembly **K**.
- 6 Remove the brush assembly **K** and the yoke **L**.
- 7 Remove the armature **M** and the shift lever **N** from the front plate **P**.
- 8 Remove the snap ring **Q** and then remove the pinion **R**.



**STARTER MOTOR (cont'd)****Inspection****1 Armature**

- a** Short-circuit test of the coil.  
Use a growler tester for the test. Place the armature core in a growler tester and, applying an iron piece, turn the armature. Vibration of the iron piece indicates short-circuit. Renew the armature.
- b** Check the insulation between commutator and shaft. If continuity is indicated, it shows poor insulation. Renew the armature. Proper measurement with a circuit tester is impossible. Be sure to use a 500V megger for checking. If the test result is more than 1 MW, it is acceptable.
- c** inspection of the surface of commutator.  
The part of the commutator surface where the brush is in contact can be distinguished clearly. If the contact area is rough, grind with sand paper of No. 500 or 600. If the indication of a dial gauge exceeds 0.5 mm (0.002 in.), correct with a lathe.
- d** Insulation of the commutator.  
Measure the depth of the commutator segments and correct if the result is 0,2 mm (0.008 in.) or less.
- e** Shaft bend.  
Measure the bend of the shaft with a dial gauge. Holding the centre of the armature shaft ends, measure the run-out of the centre section. Turn the armature and read the value indicated by the dial gauge pointer. Real bend is 1/12 of the reading. Allowable bend limit: 0.08 mm (0.003 in.)

**2 Field Coil**

- a** Check the field coil for disconnection using a tester. Check the continuity between the two brushes which are in effect the terminals of the field coil. If no continuity is indicated on the tester, it shows disconnection. Renew the field coil.
- a** Check the continuity between the field coil and yoke with a tester. Continuity indicates insufficient insulation. Renew the coil.

**3 Movement of the brush**

- a** Check movement of the brush. When the brush does not move smoothly, check the brush holder for distortion and the sliding surface of the brush for damage. Correct and clean.
- b** Check the insulation between the brush holder (positive (+) side) and holder case (negative (-) side). If continuity is indicated, it shows insufficient insulation. Renew the brush holder assembly.
- c** Allowable wear limit of the brush is 12 mm (0.472 in.) [new length 16 mm (0.630 in)].
- d** Measure the tension of the brush springs.  
Standard tension is 1.6 kg to 2.0 kg (3.5 to 4.4 lb). Set the brush spring, pull up with a spring balance and measure the load when the brush is raised up. Renew faulty springs.  
Service limit: 1.4kg (3.0 lb)

**4 Magnetic switch**

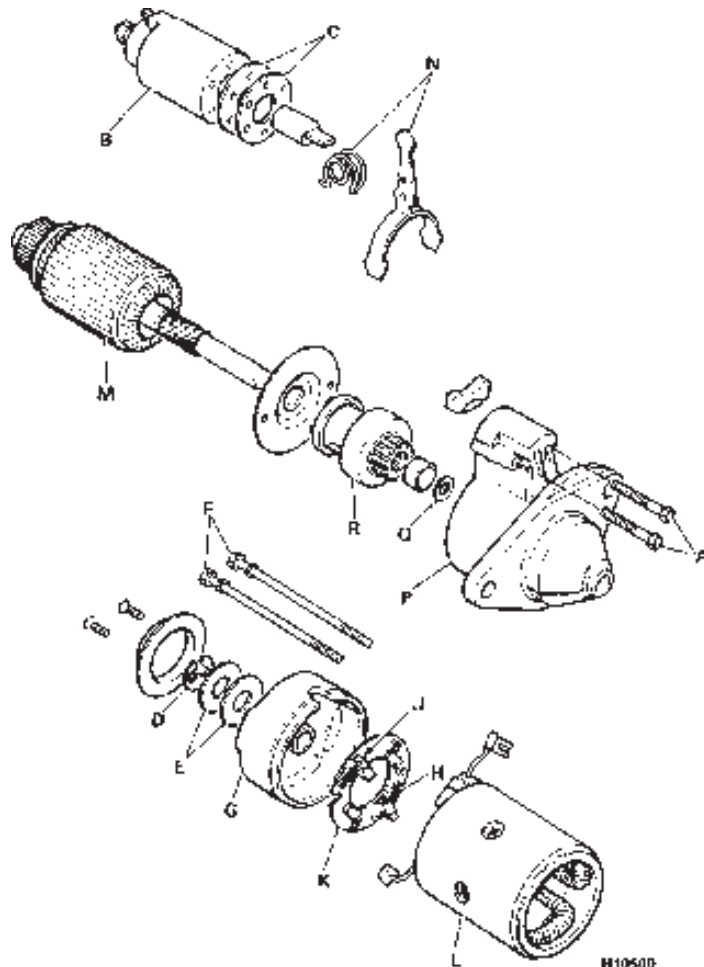
- a** Check the shunt coil for disconnection.  
Check the continuity between the magnetic switch S terminal and coil case (metal part). If continuity is not indicated, it shows disconnection. Renew the switch.

**STARTER MOTOR (cont'd)****Assembly**

- 1 Fit the pinion **R** and snap ring **O**.
  - 2 Insert the armature **M** into the front plate **P** and fit the shift lever **N**.
  - 3 Fit the yoke **L** and the brush assembly **K**.
  - 4 Insert the brushes **J** into the brush assembly and fit the springs **H**.
  - 5 Fit the rear cover **G** with the screws **F**. Tighten the screws **F**.
  - 6 Install the **E** ring **D** and thrust washer **E**, if fitted and fit the dust cover.
  - 7 Insert the washer **C** in the front plate and fit the solenoid **B**.
  - 8 Insert the screws **A** and tighten them.
  - 9 Check the thrust gap for the armature is 0.5 mm (.0197 in.) maximum.
- 10 Check the distance that the pinion is pushed by the solenoid as follows:
    - a Measure the distance between the pinion and the stop-ring (pinion clearance).
    - b Connect a 12V battery to the solenoid. The battery positive (+) should be connected to terminal **S** of the solenoid.
    - c Measure the pinion clearance again.
    - d Disconnect the battery.

The pinion clearance should be 0.2 to 1.5 mm (0.008 to 0.060 in.)

If the pinion clearance is incorrect, loosen the adjusting nut and adjust the adjusting screw. or shims where fitted.
  - 11 Check the operation of the solenoid and change adjusting plate if necessary.







**Component Key**

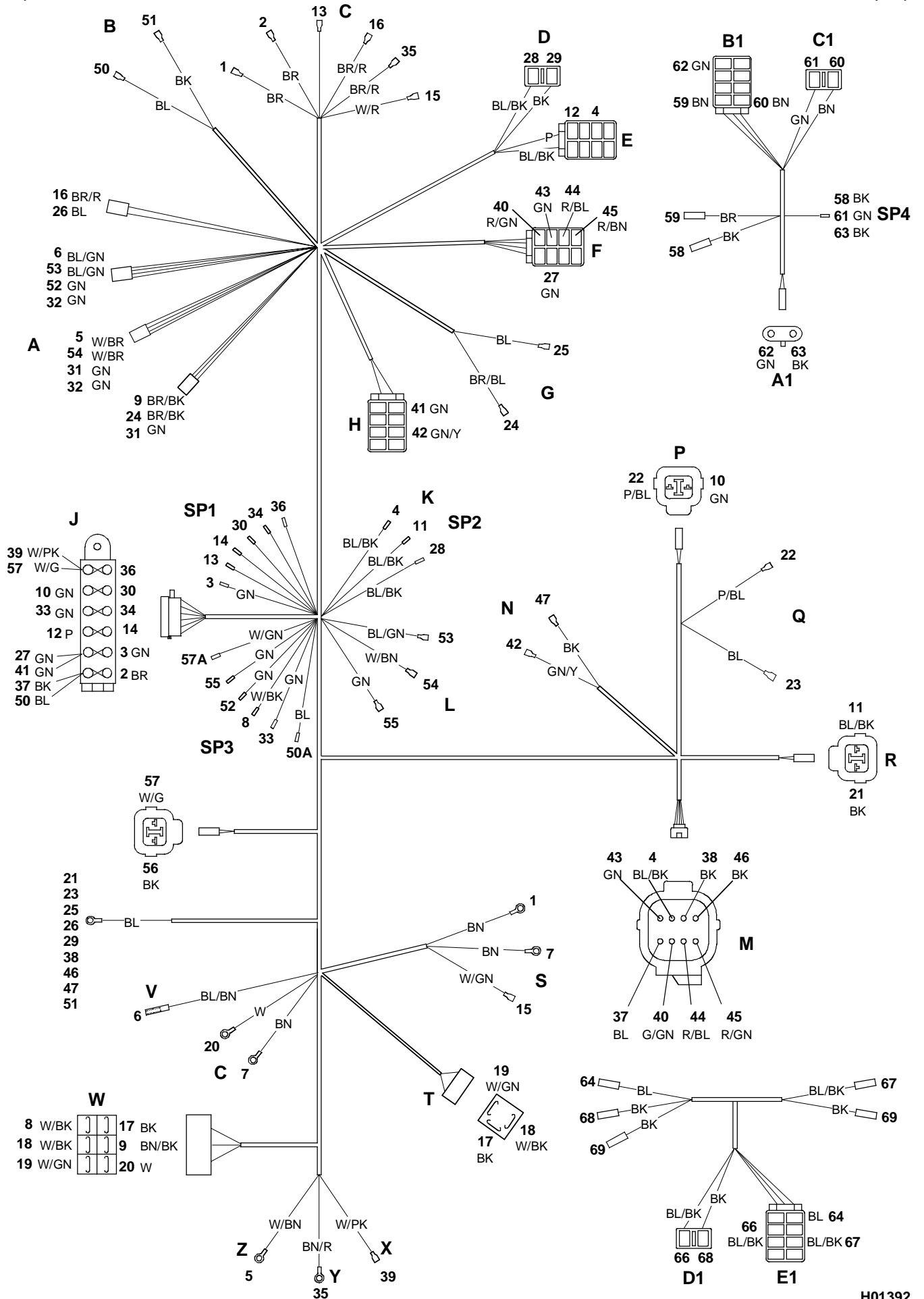
- 1 Battery
- 2 Alternator
- 3 Starter Motor
- 4 Starter Switch
- 5 Fuse Block
- 6 Warning Buzzer
- 7 Glow Plugs
- 8 Fuel Solenoid
- 9 Hourmeter
- 10 Engine Oil Pressure Switch
- 11 Engine Coolant Temperature Switch
- 12 Interior Light Switch
- 13 Windscreen Wiper motor
- 14 Wiper Motor Parking Switch
- 15 Heater Motor
- 16 Resistor
- 17 Heater Switch
- 18 Lamps Switch  
Cab Roof - Optional  
Boom
- 19 Servo Isolator Switch - Optional
- 20 Servo Supply Solenoid - Optional
- 21 Horn Switch
- 22 Horn
- 23 Beacon Light Switch - Optional
- 24 Beacon - Optional
- 25 Radio - Optional
- 26 Regulator

**Lamps**

- 27 Alternator Warning
- 28 Engine Oil Pressure Warning
- 29 Engine Coolant Temperature Warning
- 30 Glowplug Warning
- 31 Interior
- 32 Lamp Switch
- 33 Boom
- 34 Cab Roof - Optional
- 35 Cab Roof - Optional

**Fuses**

- F1 Fuel Solenoid
- F2 Servo Isolator Switch  
Servo Supply Solenoid  
Horn and Switch
- F3 Engine Oil Pressure Switch  
Engine Coolant Temperature Switch
- F4 Lamps Switch  
Cab Roof - Optional  
Boom
- F5 Windscreen Wiper Motor and Switch  
Heater Motor and Switch
- F6 Interior Light and Switch



**WIRE COLOUR KEY**

BR - BROWN  
 BK - BLACK  
 BL - BLUE  
 GN - GREEN  
 PK - PINK  
 LG - LIGHT GREEN  
 W - WHITE  
 P - PURPLE  
 Y - YELLOW

**QUICK REFERENCE KEY**

A AWARNING LIGHTS  
 \*A1 TWO-SPEED TRACKING SOLENOID  
 B AUX CONNECTORS  
 \*B1 TWO-SPEED TRACK SWITCH  
 C IGNITION SWITCH  
 \*C1 TWO-SPEED TRACK WARNING LIGHT  
 D BOOM LIGHT WARNING SYSTEM  
 \*D1 BEACON WARNING LIGHTS  
 E BOOM LIGHT SWITCH  
 \*E1 BEACON SWITCH  
 F WIPER MOTOR  
 G HOUR METER  
 H HEATER SWITCH  
 J FUSE BOX  
 K BOOM LIGHT SWITCH  
 L CONNECTION TO SUB HARNESS  
 M CAB CONNECTOR  
 N HEATER  
 P HORN BUTTON (on control lever to M727693 on instrument panel M722694 on)  
 Q HORN  
 R BOOM LIGHT  
 S STARTER  
 T ALTERNATOR  
 U ALTERNATOR B  
 V WATER TEMPERATURE SENDER  
 W REGULATOR  
 X ELECTRIC STOP SOLENOID  
 Y GLOW PLUG  
 Z ENGINE OIL PRESSURE  
 SP1 EXTERNAL SPLICE 1  
 SP2 EXTERNAL SPLICE 2  
 SP3 EXTERNAL SPLICE 3  
 \*SP4 EXTERNAL SPLICE 4

1 IGNITION SWITCH TO STARTER  
 2 IGNITION SWITCH TO FUSE BOX  
 3 FUSE BOX TO SP1  
 4 BOOM SWITCH TO CAB WORKING LIGHT  
 5 ENGINE OIL PRESSURE TO WARNING LIGHT  
 6 WATER TEMPERATURE SENDER TO WARNING LIGHT  
 7 ALTERNATOR 'B' TO STARTER  
 8 SP3 TO REGULATOR 'IG'  
 9 REGULATOR 'IND' TO WARNING LIGHT  
 10 FUSE BOX TO HORN BUTTON  
 11 BOOM LIGHT TO SWITCH  
 12 FUSE BOX TO BOOM LIGHT SWITCH  
 13 IGNITION SWITCH TO SP1  
 14 FUSE BOX TO SP1  
 15 IGNITION SWITCH TO STARTER  
 16 IGNITION SWITCH TO WARNING LIGHT  
 17 ALTERNATOR TO REGULATOR 'E'  
 18 ALTERNATOR TO REGULATOR 'N'  
 19 ALTERNATOR TO REGULATOR 'F'  
 20 ALTERNATOR B TO REGULATOR 'B'  
 21 EARTH TO BOOM LIGHT  
 22 HORN TO HORN BUTTON  
 23 EARTH TO HORN  
 24 HOUR METER TO WARNING LIGHT  
 25 EARTH TO HOUR METER  
 26 EARTH TO WARNING LIGHT  
 27 FUSE BOX TO WIPER SWITCH  
 28 BOOM LIGHT SWITCH TO LIGHT SWITCH WARNING LIGHT  
 29 EARTH TO BOOM LIGHT  
 30 FUSE BOX TO SP1  
 31 WARNING LIGHT LINK  
 32 WARNING LIGHT LINK  
 33 FUSE BOX TO SP3  
 34 FUSE BOX TO SP1  
 35 IGNITION SWITCH TO GLOW PLUGS  
 36 FUSE BOX TO SP1  
 37 FUSE BOX TO CAB LIGHT  
 38 EARTH TO CAB PLUG  
 39 FUSE BOX TO ELECTRIC STOP SOLENOID  
 40 SWITCH TO WIPER  
 41 FUSE TO HEATER SWITCH  
 42 SWITCH TO HEATER  
 43 SWITCH TO CAB PLUG  
 44 WIPER SWITCH TO CAB PLUG  
 45 WIPER SWITCH TO CAB PLUG  
 46 EARTH TO CAB PLUG  
 47 EARTH TO HEATER  
 50 FUSE TO AUX CONNECTION  
 \*50A SP3 TO AUX CONNECTION (TWO-SPEED TRACK ONLY)  
 51 EARTH TO AUX CONNECTION  
 52 SP3 TO WARNING LIGHTS  
 53 WATER TEMP LIGHT TO BUZZER  
 54 OIL PRESSURE LIGHT TO BUZZER  
 55 SP3 TO BUZZER  
 56 SERVO PLUG TO EARTH  
 57 PLUG TO FUSE BOX  
 \*57A PLUG TO SP3 (TWO SPEED TRACKING ONLY)  
 \*58 CONNECT TO 51 ON MAIN HARNESS  
 \*59 CONNECT TO 50 ON MAIN HARNESS  
 \*60 SWITCH TO WARNING LIGHT (TWO SPEED TRACKING ONLY)  
 \*61 WARNING LIGHT TO SPLICE (T.S.T. ONLY)  
 \*62 SWITCH TO SOLENOID (T.S.T. ONLY)  
 \*63 SOLENOID TO SPLICE (T.S.T. ONLY)  
 \*64 BEACON HARNESS TO SWITCH  
 \*65 BEACON SWITCH TO SOCKET  
 \*66 BEACON LIGHT TO SWITCH  
 \*67 BEACON SWITCH TO SOCKET  
 \*68 BEACON HARNESS TO LIGHT  
 \*69 BEACON SOCKET TO HARNESS

## Beacon

### Mounting

The rotating beacon relies on the force of a magnet to hold it in position on the machine. A cable and plug from the beacon fits into a socket located on a panel in the cab of the machine. The panel is wired to provide a beacon operating switch and warning light.

The intended beacon mounting position must be flat, clean and dry. When mounted, particularly ensure beacon positioning conforms to the following:

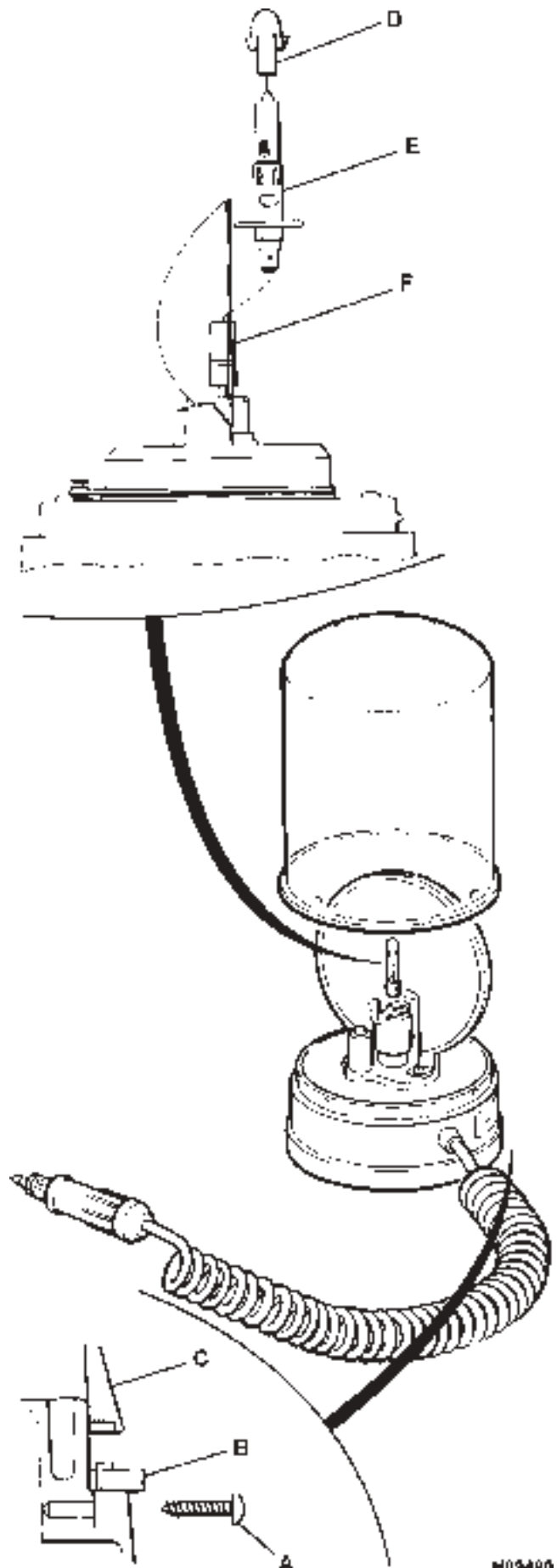
- Is in accordance with National and local legal requirements.
- The light is visible from any point at a reasonable distance from the machine.
- Beacon base parallel to the ground and on the machine longitudinal centre line.
- If radio equipment is fitted to the machine, there should be a minimum distance of 500 mm (20 in.) between the beacon and the radio antenna.

### CAUTION

**The beacon must be removed before the machine is towed or loaded onto a trailer for towing. The beacon must not be fitted if the machine is moved at speeds exceeding 80 kph (50 mph).**

### Bulb Change

- 1 Remove the lens latch locking screw **A**.
- 2 Push down the lens latch **B**. Turn lens **C** anti-clockwise to release and remove it.
- 3 Taking care not to touch the bulb glass, release the bulb retaining clip **D** and lift bulb **E** and attached clip from the connector **F**. Disconnect bulb **E**.
- 4 Remove the unserviceable bulb from clip **D**.
- 5 Fit a new bulb and assemble the beacon in reverse order of dismantling. Do not tighten the lens latch locking screw **A** to more than 0.65Nm (5.75 lbf in.).



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