DENSO

ELECTRICAL EQUIPMENT

Brushless Alternator

Service Manual

FOREWORD

This manual, which describes the construction, operation, and maintenance procedure for the brushless alternators listed below, has been prepared to assist in servicing these products in a correct, efficient, and safe manner.

Type	Part Number	Nominal Output
Type A	101211-8100	12V-90A
	101211-8110	12V-105A
	101211-8120	12V-130A
	101211-8130	24V-50A
	101211-8140	24V-65A
Type B	101211-8040	12V-90A
	101211-8050	12V-105A
	101211-8060	12V-130A
Type C	101211-8070	12V-90A
	101211-8080	12V-105A
	101211-8090	12V-130A

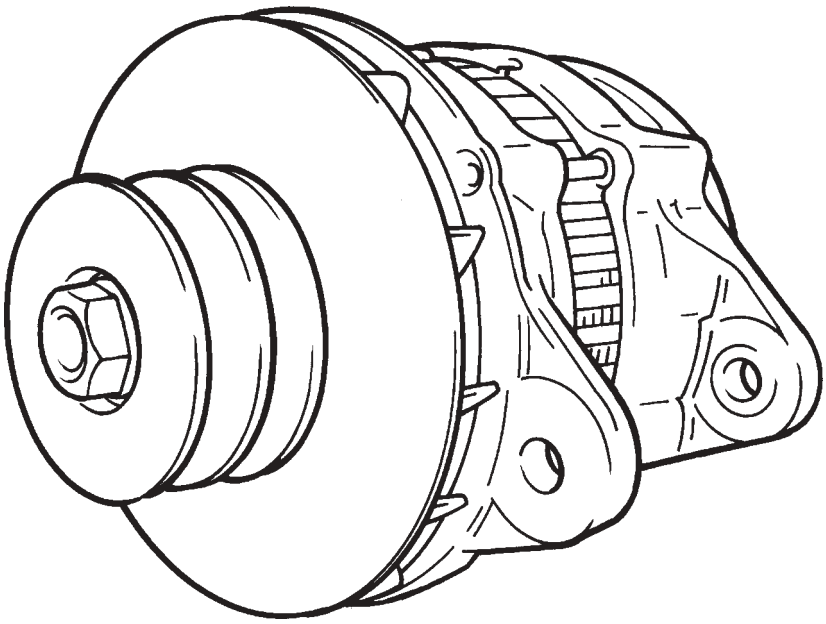
TABLE OF CONTENTS

1. OVERVIEW

This alternator has been developed specifically for construction equipment and/or trucks, which demand a high level of durability. In order to decrease maintenance, the brushes and slip rings, which wear in time, have been eliminated from the brushless alternator.

To generate electricity, this alternator adopts a system in which the alternator's internal residual magnetism is used for initial activation. Once the alternator starts operating, the electrical power that the alternator itself generates is supplied to the exciting coil, which is used for self-excitation.

This alternator is equipped with an internal regulator (voltage regulator). The voltage regulator monitors the voltage that is generated during operation of the alternator, and regulates the current that is supplied to the exciting coil, thus maintaining the constant output voltage.



Doesn’t come with a pulley

Fig. 1-1 External View

2. CONSTRUCTION

The interior of the alternator is self cooled by a rotating fan. The alternator consists of the following parts: a stator, rotor, exciting coil, regulator, rectifier, frames, etc.

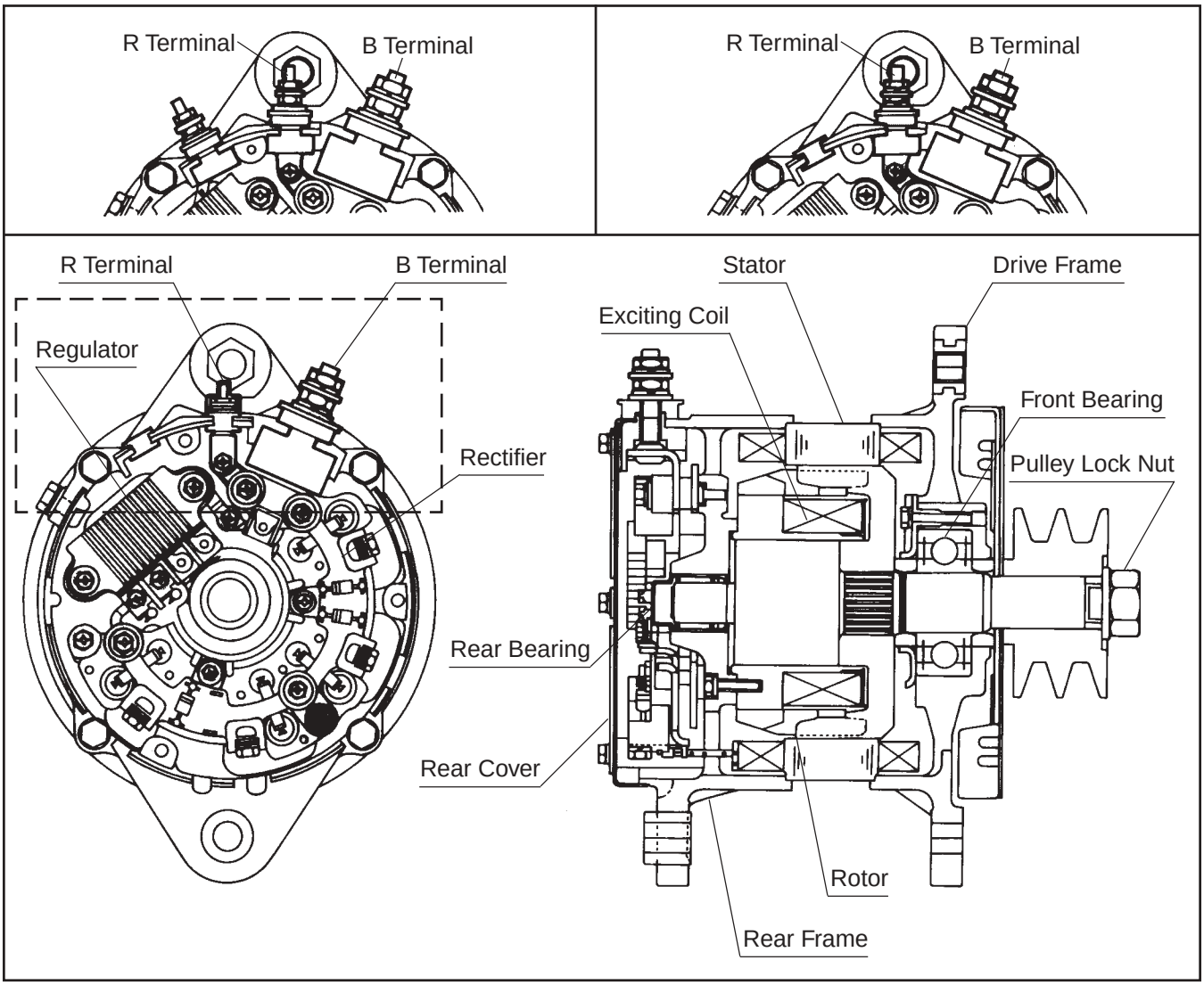


Fig. 2-1 Internal View

(1) Stator

The stator consists of an insulating sheet which is inserted into the slotted portion of a laminated steel core. The core contains a coil providing a three-phase stator (Y type winding) connection.

The stator coil receives magnetism from the exciting coil (the rotor) which generates an alternating current (a three-phase alternating current).

(2) Exciting Coil

The exciting coil consists of a coil that is wound over a donut shaped insulated core. An electric current flows through the coil to produce a magnetic field.

(3) Rotor

The rotor houses a non-magnetic ring (made of stainless steel) in between two claw shaped cores which face each other. The claw shaped cores are welded together and then press-fitted over a shaft. The rotor rotates in the space between the exciting coil and the stator in order to transfer the magnetic field that is generated in the exciting coil to the stator in the form of magnetic flux.

(4) Frame

The frame is a component of the alternator that encloses the stator and rotor. The frame consists of a drive frame and a rear frame. The drive frame contains a ball bearing, while the rear frame contains a roller bearing. Both bearings support the rotor for proper rotation. In addition, the frame houses the rectifier assy, regulator, etc.

(5) Regulator

The function of the regulator is to regulate the voltage that is generated by the alternator and to keep the voltage constant. The regulator is constructed of an aluminum fin case, plastic terminal board, transistors and diodes. The case is sealed to prevent the semi-conductor elements from coming into contact with air.

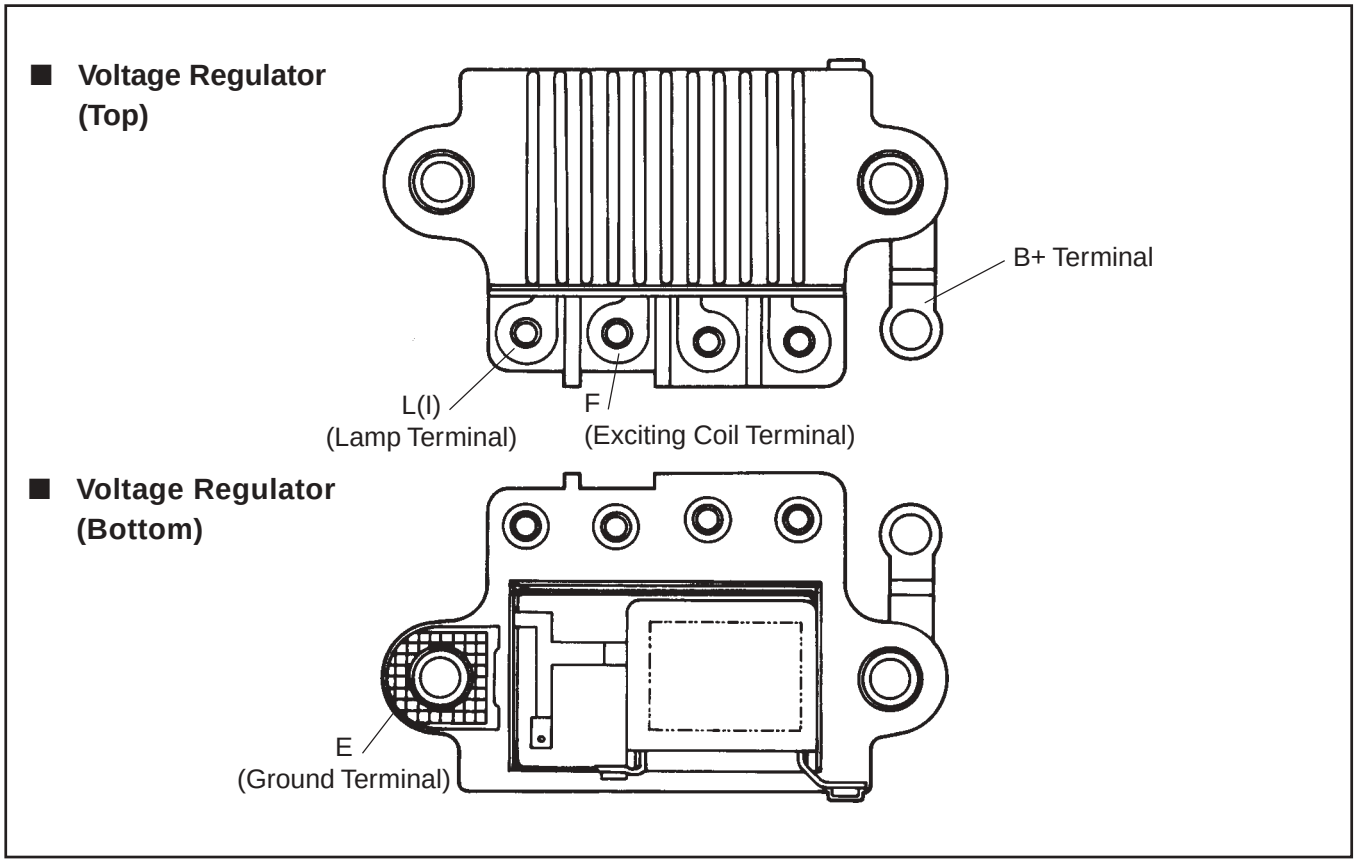


Fig. 2-2 Regulator

3. OPERATION

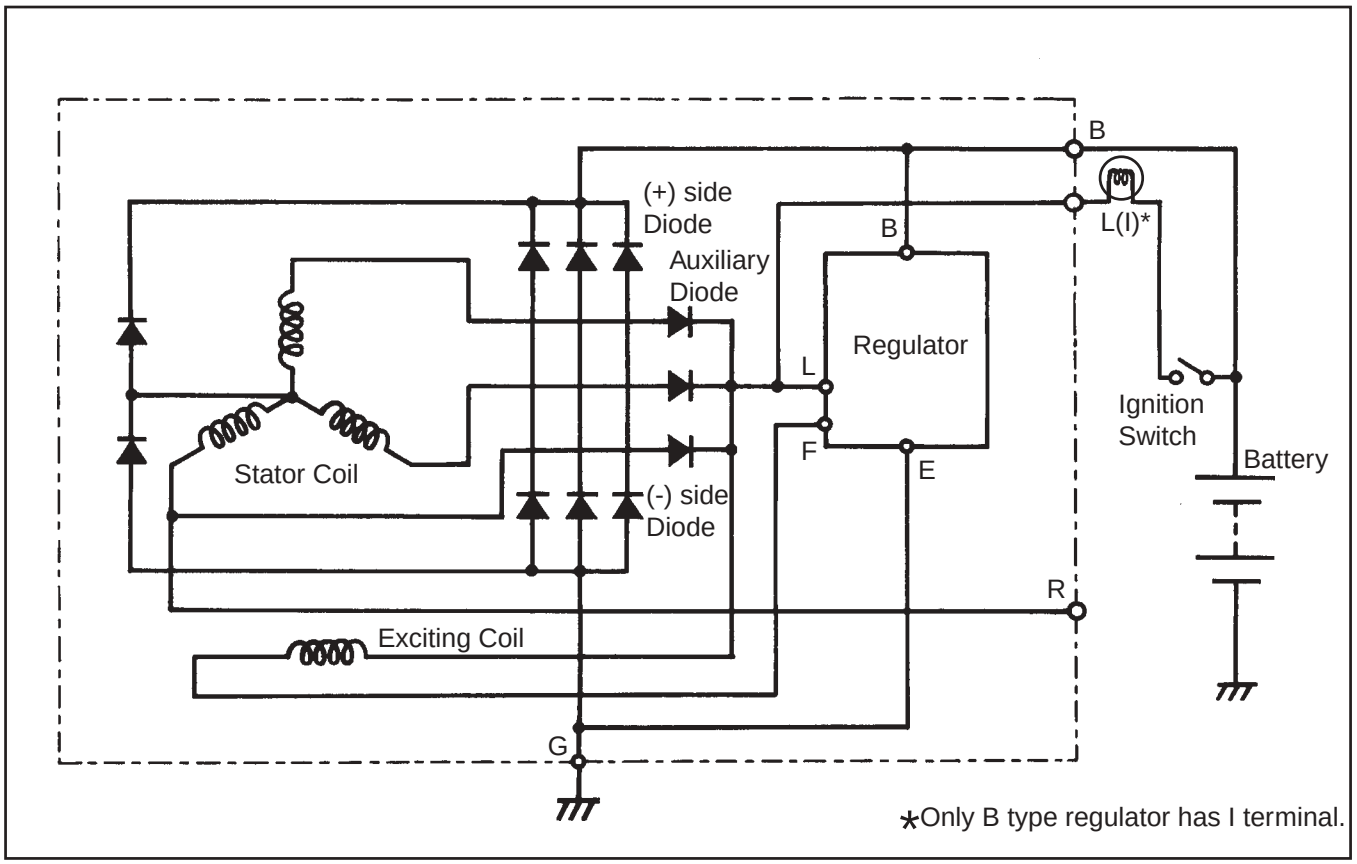


Fig. 3-1 Circuit Diagram

3-1. SELF-EXCITING AND CHARGING

(1) When the engine is started, the alternator's rotor rotates, and the residual magnetic field generates voltage in the stator coil.

(2) As generated voltage increases with the increase in the engine rpm, the electric current flows from the auxiliary diode to the exciting coil. Thus, a strong magnetic field is created by the exciting coil, causing the voltage that is generated in the stator coil to increase suddenly to the battery voltage.

NOTE

The excitation by residual magnetism changes over to that of self-generated excitation. This is called self-excited starting, and the alternator rpm at this time is called “turn on speed”.

(3) Simultaneously with self-excited starting, the charging current flows from the alternator's B terminal to the battery, and starts the charging of the battery.

3-2. REGULATING THE OUTPUT VOLTAGE

(1) As the charging of the battery advances and the battery terminal voltage reaches the regulator's regulating voltage, the regulator shuts off the current that flows to the exciting coil.

(2) When the current that flows to the exciting coil is shut off, the magnetic field that is generated in the exciting coil weakens, causing the voltage that is generated in the stator coil to decrease (which reduces the alternator's output voltage).

(3) When the voltage that is generated in the stator coil becomes lower than the regulator's regulated voltage, the regulator allows the current to flow to the exciting coil. As a result, the magnetic field that is generated in the exciting coil strengthens, causing the voltage in the stator coil to increase.

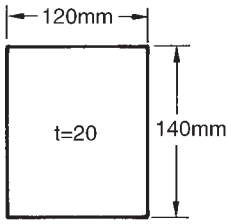
(4) The operations described in steps 1 to 3 above are repeated continuously at high speeds, thus controlling (regulating) the alternator's output voltage to a constant level.

4. SERVICE AND REPAIR

4-1. SPECIAL TOOLS (JIG)

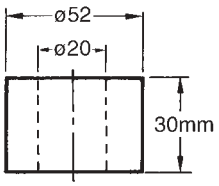
REFERENCE DIMENSION OF EACH JIG

JIG A

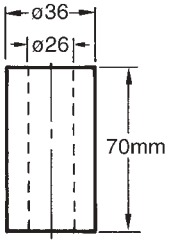


JIG B

for support

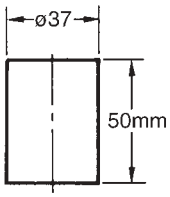


for press



JIG C

for press



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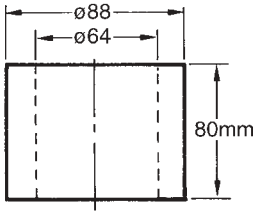
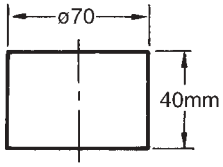
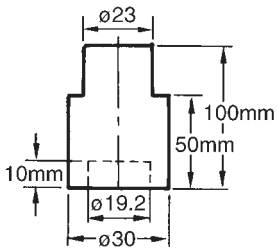


JIG D

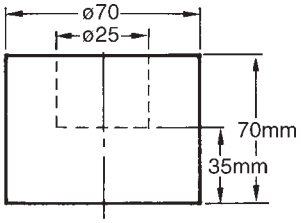


JIG E

for press



for support



4-2. DISASSEMBLED VIEW

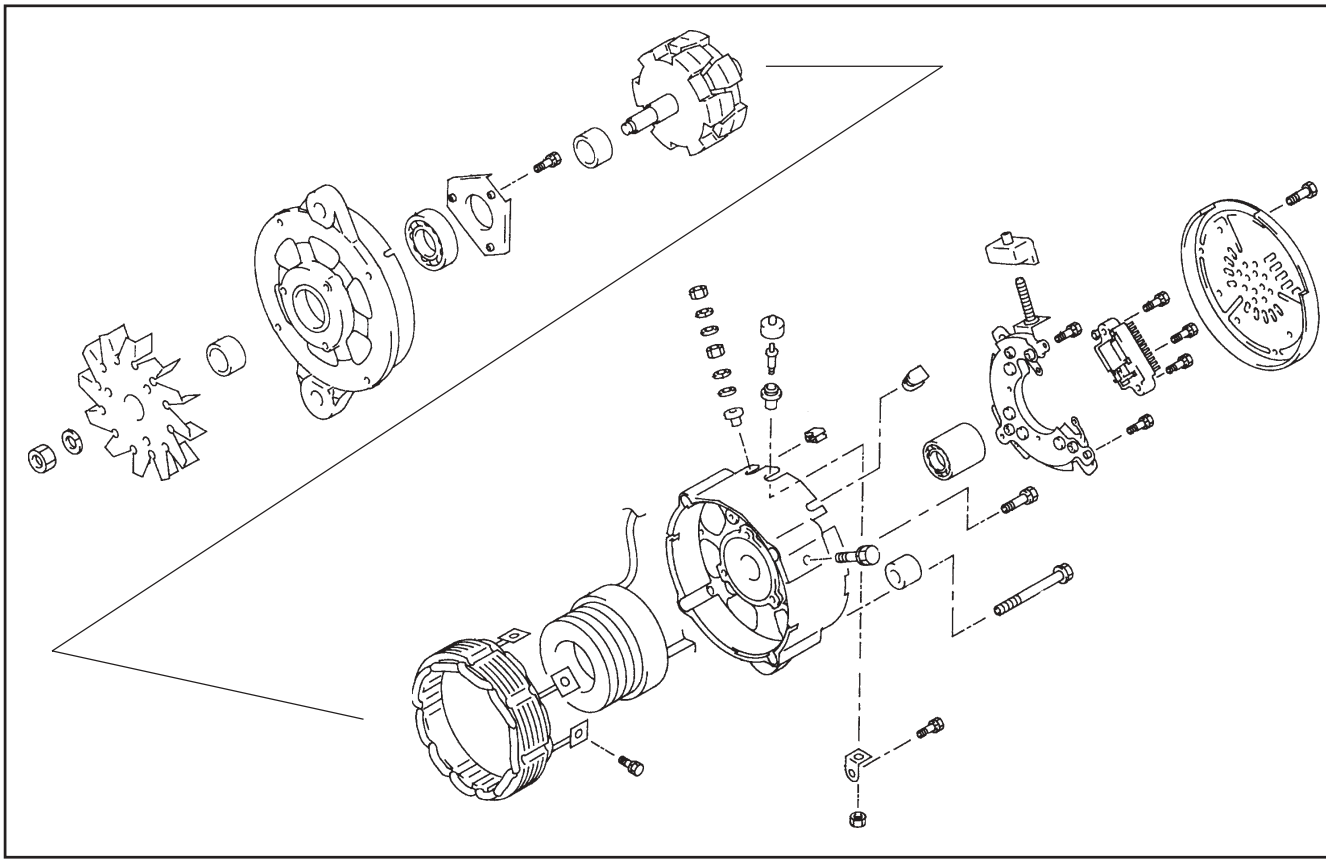


Fig. 4-1 Disassembled View

4-3. DISASSEMBLY

(1) Removing the rear cover

Remove 3 screws from the rear cover.

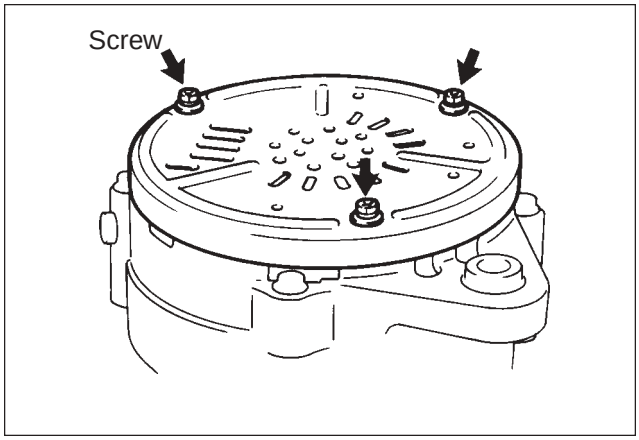


Fig. 4-2 Removing the rear cover

(2) Separating the front and rear portions

a. Remove 4 screws and separate the stator outlet terminal and the rectifier assembly.

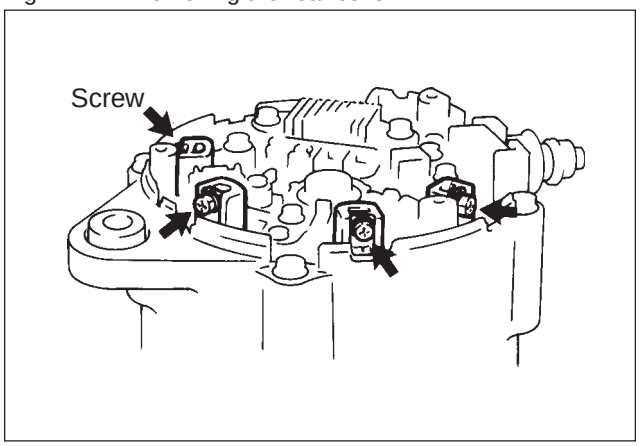


Fig. 4-3 Separating the front and rear portions (1)

b. Remove 4 through bolts.

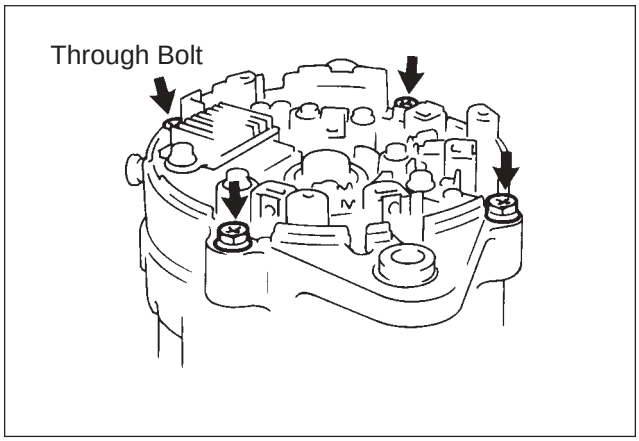


Fig. 4-4 Separating the front and rear portions (2)

c. While keeping the stator and the rear frame together, lift away from the drive frame.

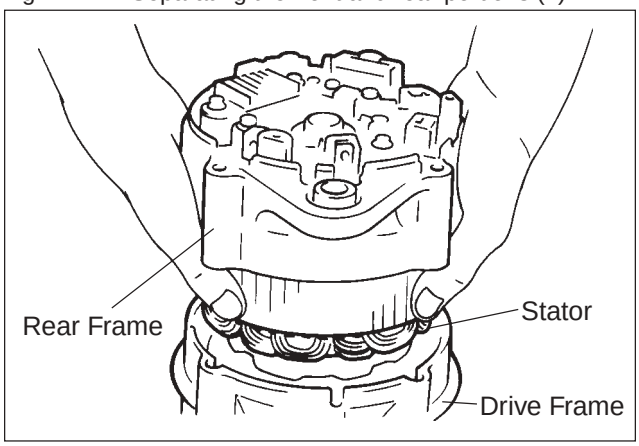


Fig. 4-5 Separating the front and rear portions (3)

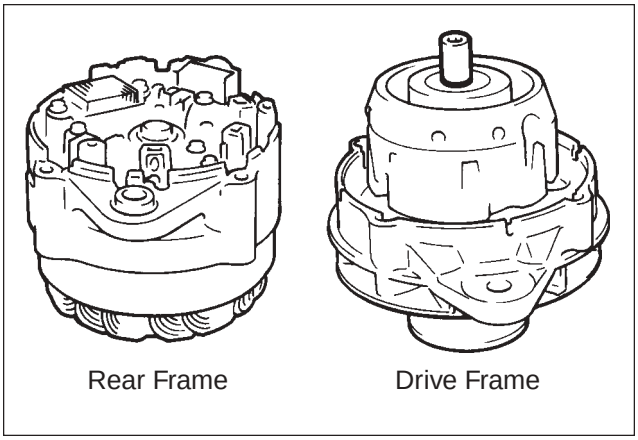


Fig. 4-6 Separating the front and rear portions (4)

d. Drive and rear frames separated.

(3) Removing the pulley, fan and collar

a. Remove the pulley lock nut using an impact wrench.

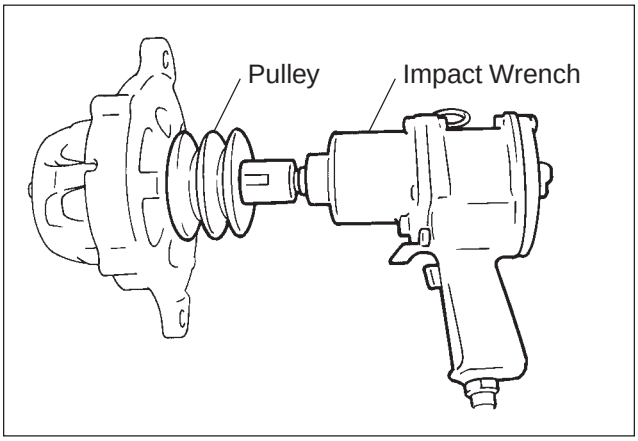


Fig. 4-7 Removing the pulley (1)

b. Remove the pulley from the shaft.

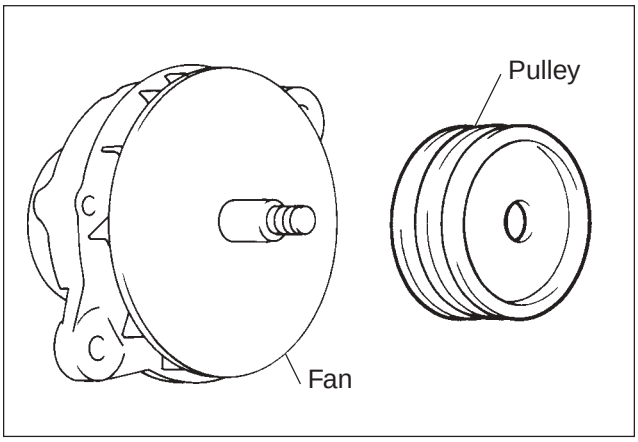


Fig. 4-8 Removing the pulley (2)

c. Remove the fan and collar.

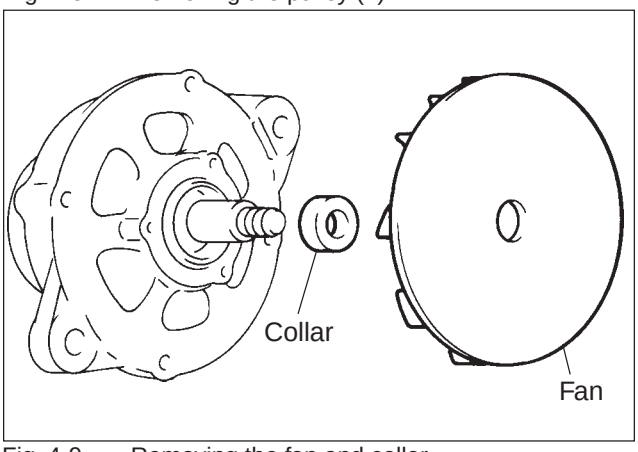


Fig. 4-9 Removing the fan and collar

(4) Removing the rotor

Using JIG A, and a hydraulic or manual press, remove the rotor from the drive frame.

NOTE
Do not drop the rotor.

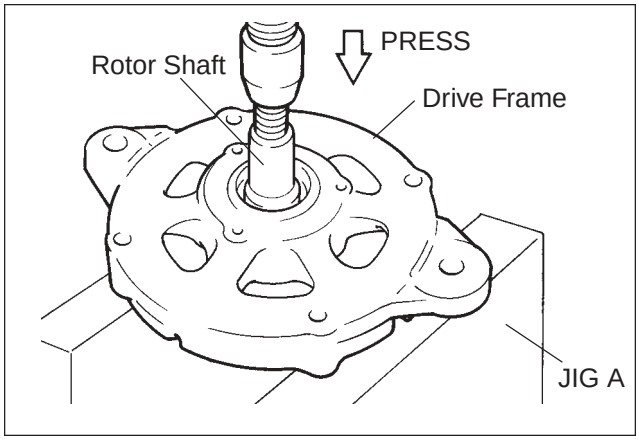


Fig. 4-10 Removing the rotor

(5) Removing the front bearing

a. Remove 3 screws to remove the bearing cover.

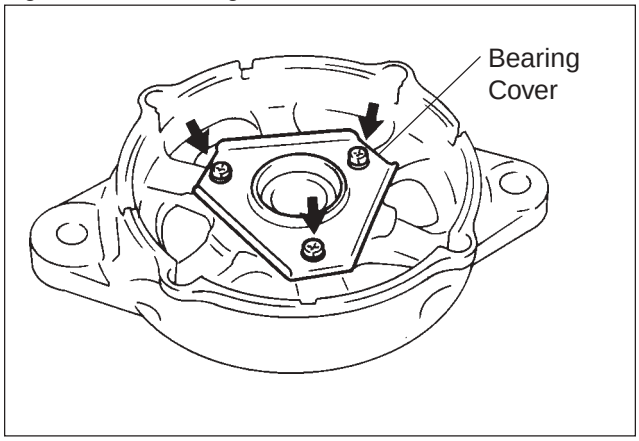


Fig. 4-11 Removing the front bearing (1)

b. Using JIG C and a hydraulic or manual press, remove the front bearing from the drive frame.

NOTE
Do not drop the front bearing.

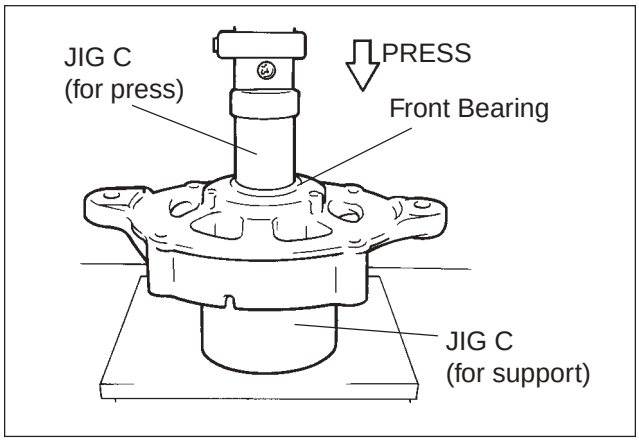


Fig. 4-12 Removing the front bearing (2)

(6) Separating the rear frame and stator

Remove the rear frame from the stator.

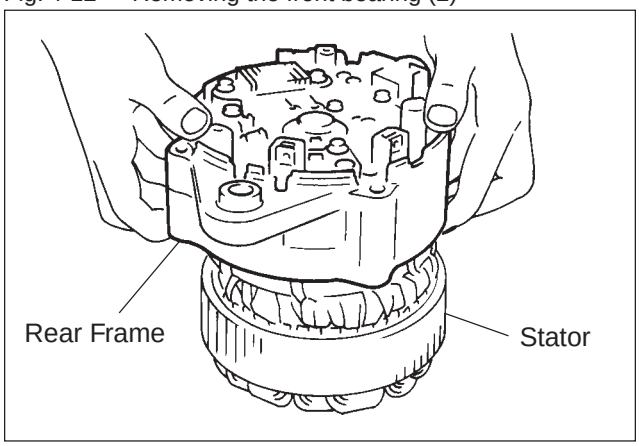


Fig. 4-13 Separating the rear frame and stator

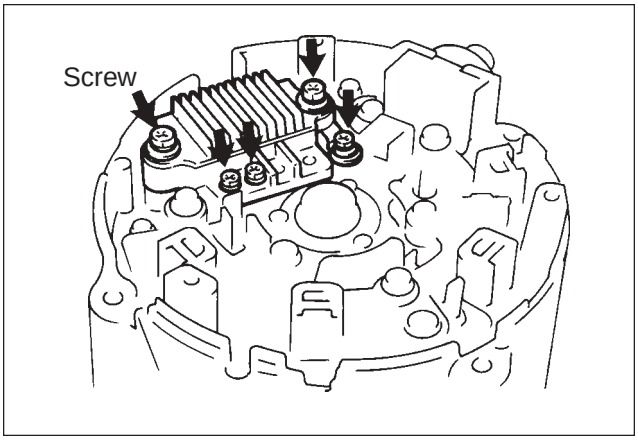


Fig. 4-14 Removing the regulator (1)

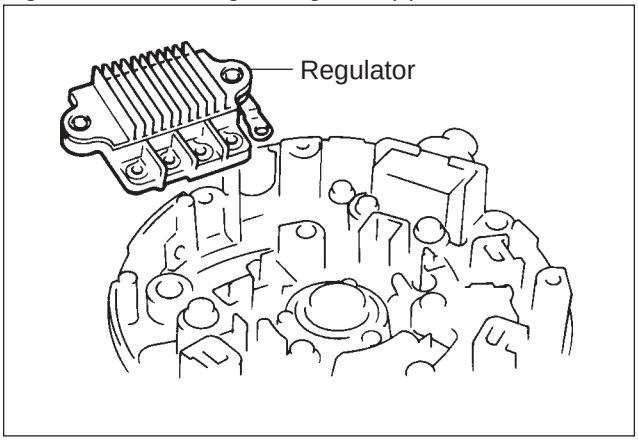


Fig. 4-15 Removing the regulator (2)

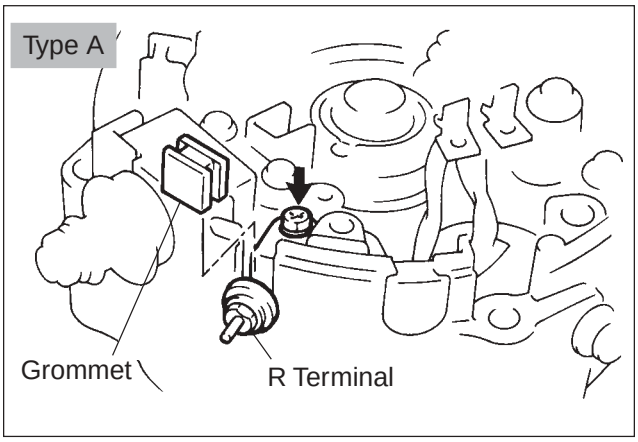


Fig. 4-16 Removing the R terminal (1)

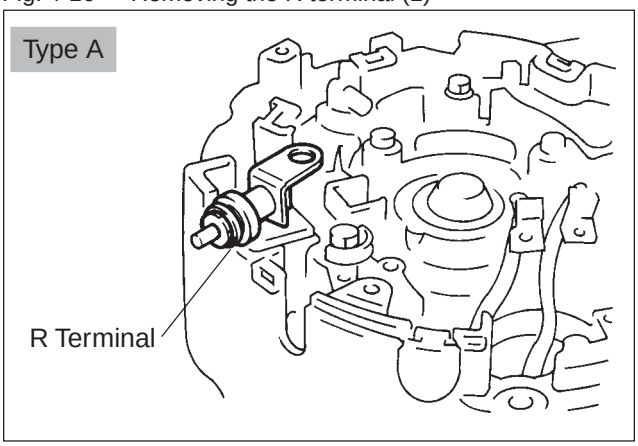


Fig. 4-17 Removing the R terminal (2)

(7) Removing the regulator

a. Remove 3 screws to separate the rectifier, the exciting coil outlet terminal, and the regulator.

b. Remove 2 screws to remove the regulator.

c. Remove regulator.

(8) Removing the R terminal

Type A Alternator

a. Remove the grommet.

b. Remove the screw to remove the R terminal.

c. Remove R terminal.

Type B, Type C Alternator

a. Loosen the R terminal nut.

b. Remove the screw to remove the R terminal.

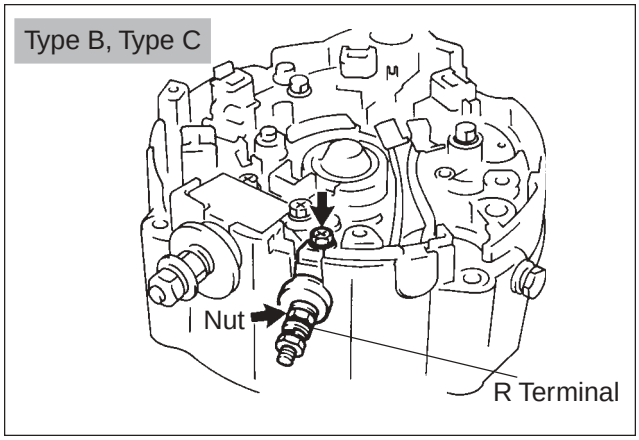


Fig. 4-18 Removing the R terminal (3)

c. Remove R terminal.

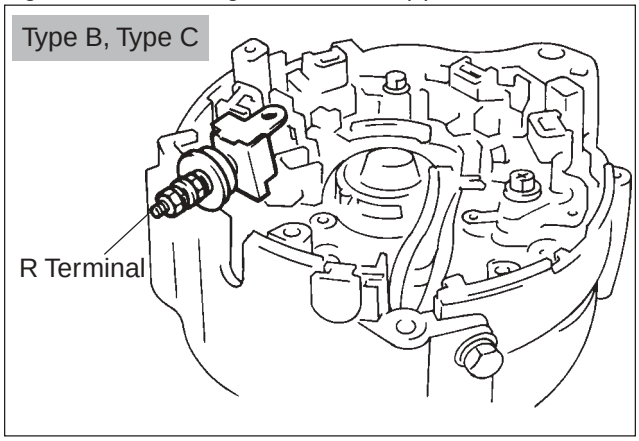


Fig. 4-19 Removing the R terminal (4)

(9) Removing the rectifier

a. Loosen the B terminal nut.

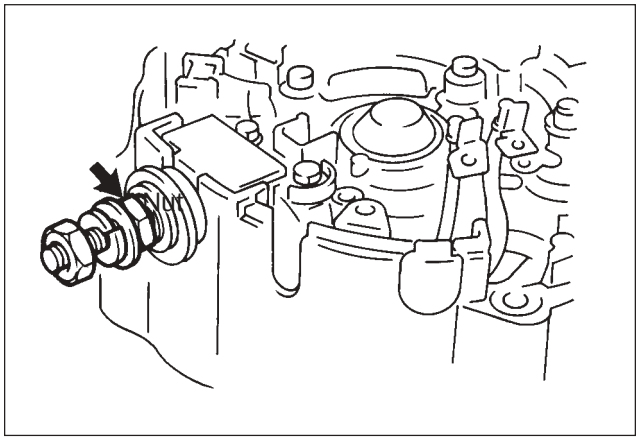


Fig. 4-20 Removing the rectifier (1)

b. Remove the screw from the rectifier's negative terminal.

c. Remove the 4 screws to remove the rectifier.

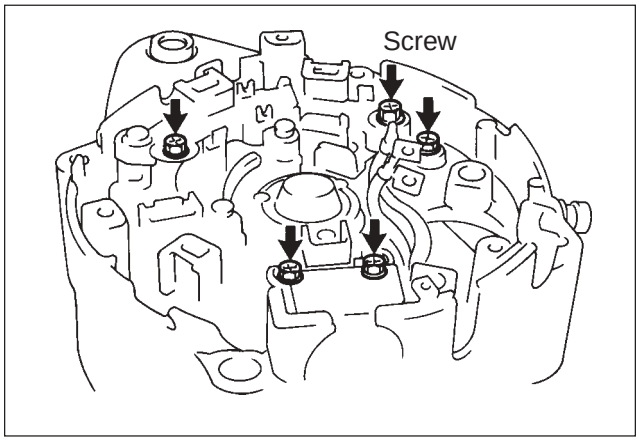


Fig. 4-21 Removing the rectifier (2)

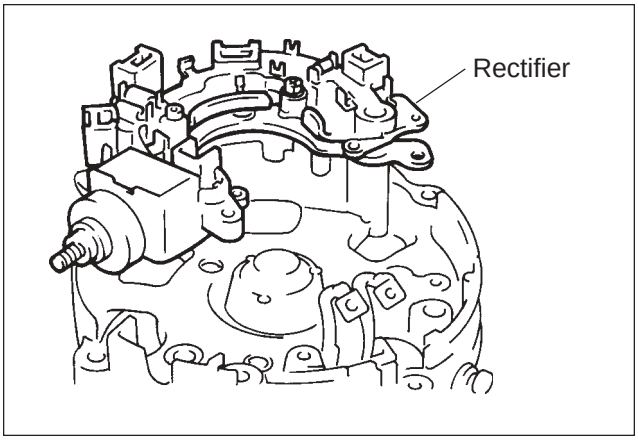


Fig. 4-22 Removing the rectifier (3)

d. Remove rectifier.

(10) Removing the I terminal (Type B Only)

a. Loosen the I terminal nut to remove the I terminal.

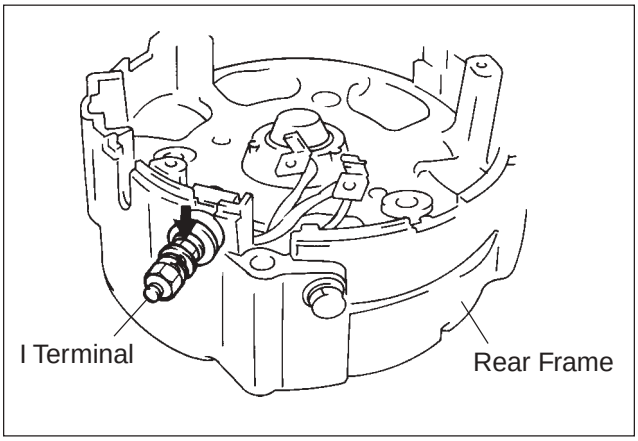


Fig. 4-23 Removing the I terminal (1)

b. Remove I terminal.

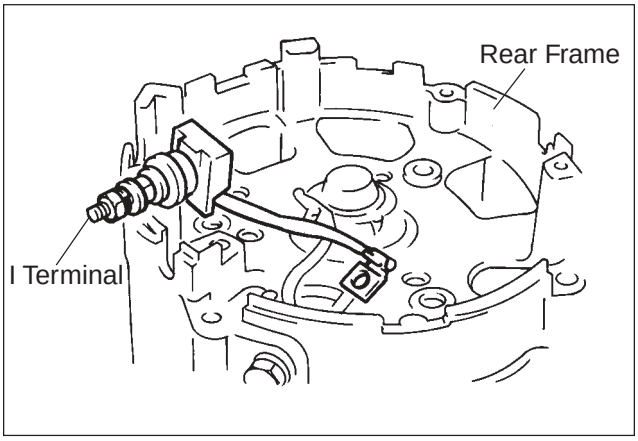


Fig. 4-24 Removing the I terminal (2)

(11) Removing the exciting coil

a. Remove 3 screws to remove the exciting coil from the rear frame.

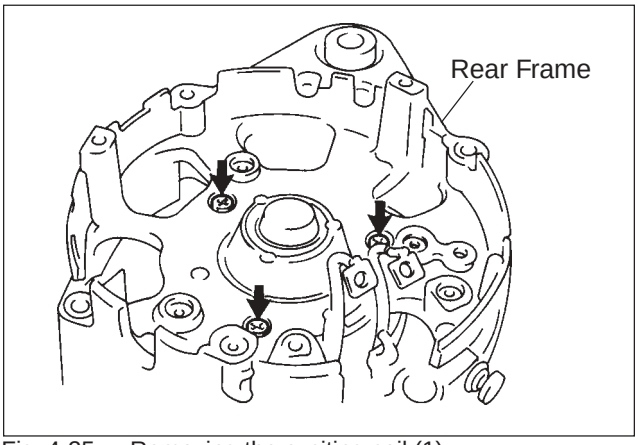


Fig. 4-25 Removing the exciting coil (1)

b. Remove exciting coil.

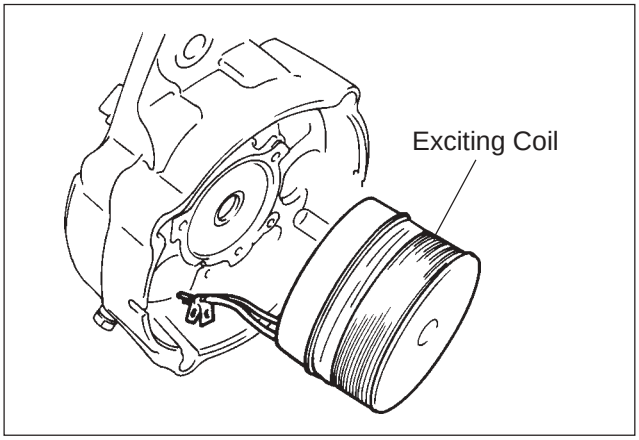


Fig. 4-26 Removing the exciting coil (2)

(12) Removing the rear bearing

Using JIG E and a hydraulic or manual press, remove the rear bearing from the rear frame.

NOTE
Do not reuse the rear bearing.

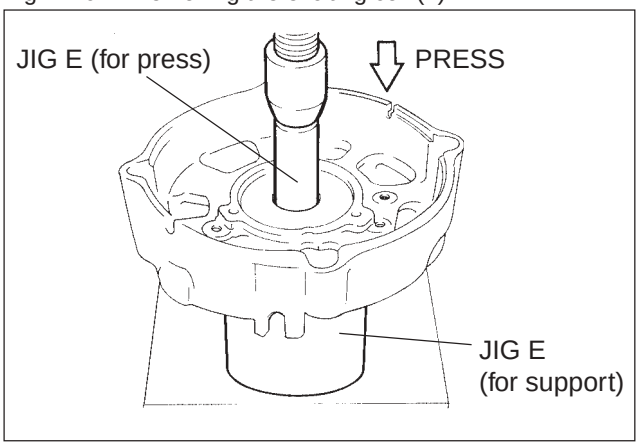


Fig. 4-27 Removing the rear bearing

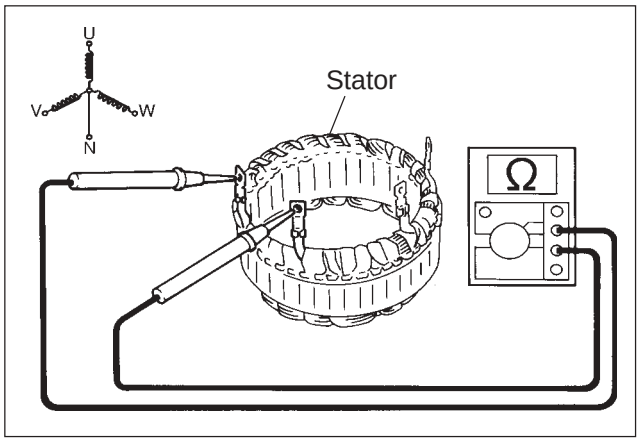


Fig. 4-28 Inspecting the stator (1)

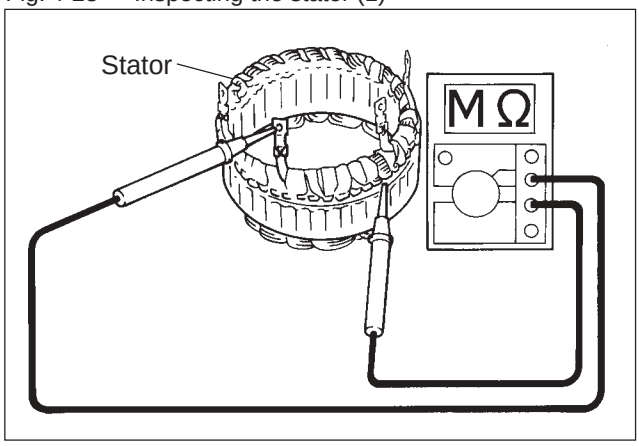


Fig. 4-29 Inspecting the stator (2)

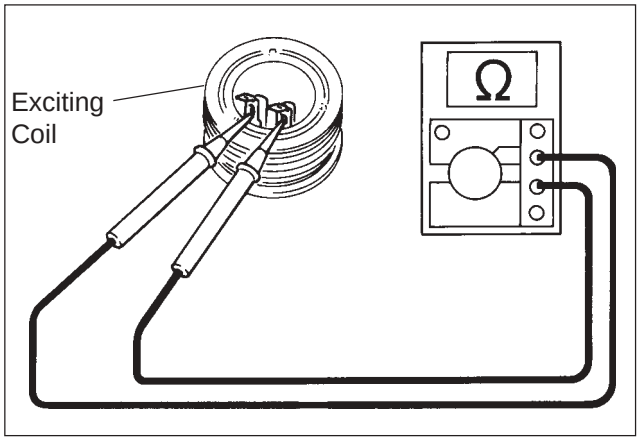


Fig. 4-30 Inspecting the exciting coil (1)

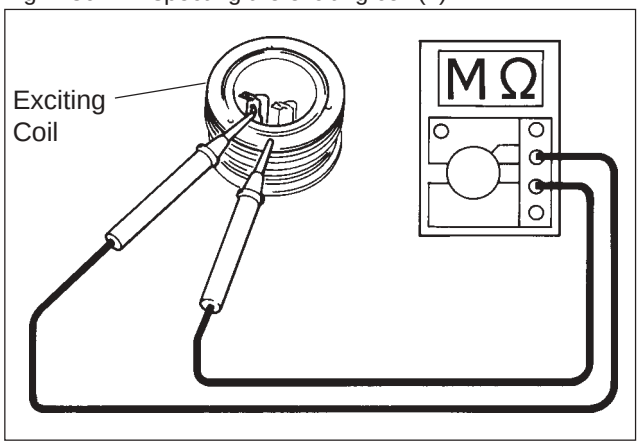


Fig. 4-31 Inspecting the exciting coil (2)

4-4. INSPECTION

(1) Inspecting the stator

a. Using an ohmmeter, measure the resistance between the coil outlet terminals (U-N, V-N, W-N).

Standard value: 0.01-0.10 Ω

b. Using an ohmmeter, measure the resistance between the coil outlet terminal and core.

Standard value: 1M Ω minimum

(2) Inspecting the exciting coil

a. Using an ohmmeter, measure the resistance between the coil outlet terminal.

Standard value: 2-3 Ω (12V system)
: 7-9 Ω (24V system)

b. Using an ohmmeter, measure the resistance between the coil outlet terminal and core.

Standard value: 1M Ω minimum

(3) Inspecting the rotor

a. Using a micrometer, measure the outer diameter of the portion that presses into the front bearing.

Standard value: 25.00-25.01mm
Limit: 24.99mm

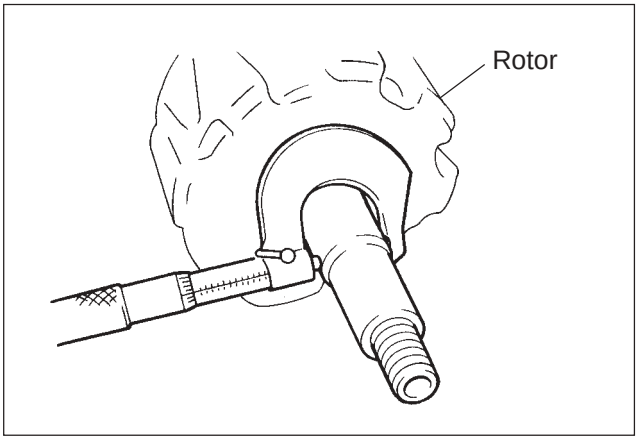


Fig. 4-32 Inspecting the rotor (1)

b. Using a micrometer, measure the outer diameter of the portion that presses into the rear bearing.

Standard value: 16.99-17.00mm
Limit: 16.98mm

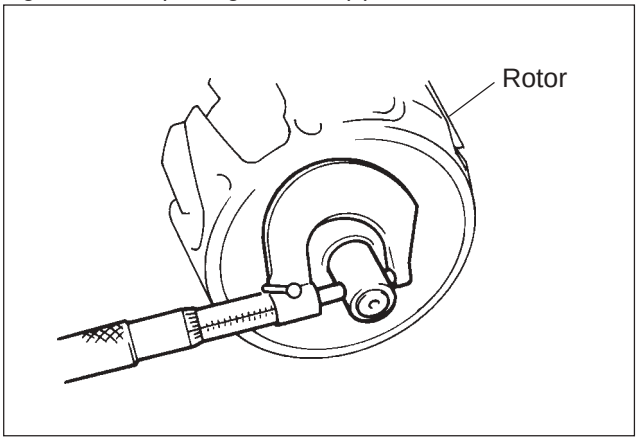


Fig. 4-33 Inspecting the rotor (2)

c. Using a micrometer, measure the outer diameter of the portion that joins with the pulley.

Standard value: 22.19-22.20mm
Limit: 22.18mm

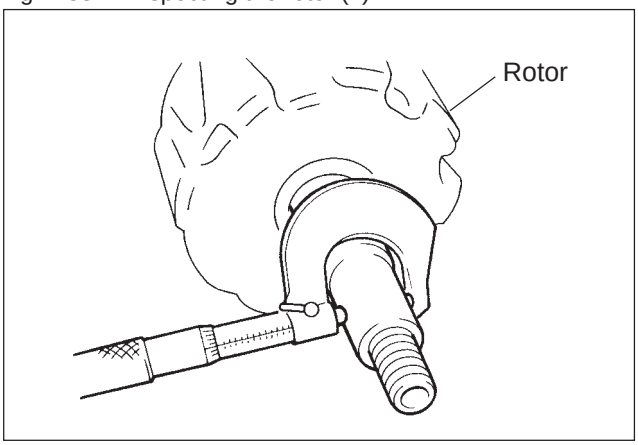


Fig. 4-34 Inspecting the rotor (3)

(4) Inspecting the rectifier

a. Using an ohmmeter, check for continuity between the “B” terminal and the heat sink.

Standard: When polarity is changed, there is continuity in one direction only.

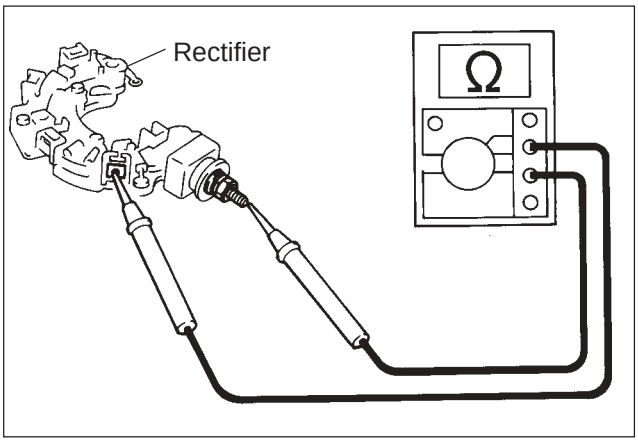


Fig. 4-35 Inspecting the rectifier (1)

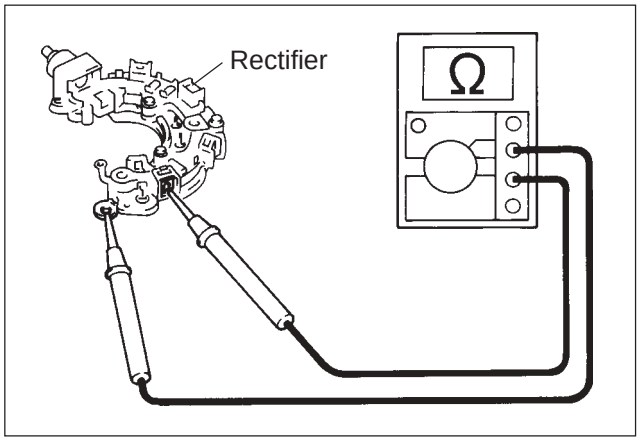


Fig. 4-36 Inspecting the rectifier (2)

b. Using an ohmmeter, check for continuity between the negative terminal and the heat sink.

Standard: When polarity is changed, there is continuity in one direction only.

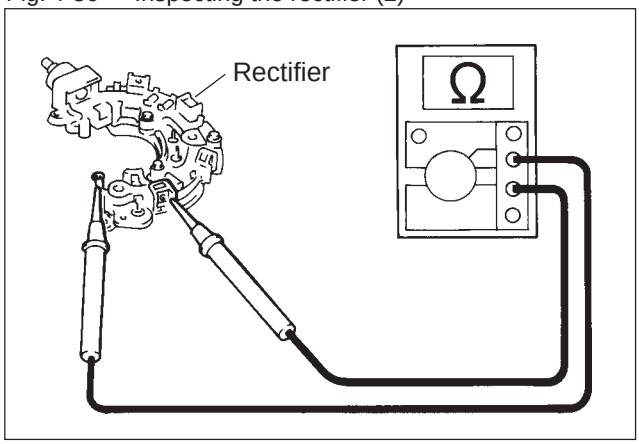


Fig. 4-37 Inspecting the rectifier (3)

c. Using an ohmmeter, check for continuity between the auxiliary diode terminal and the heat sink.

Standard: When polarity is changed, there is continuity in one direction only.

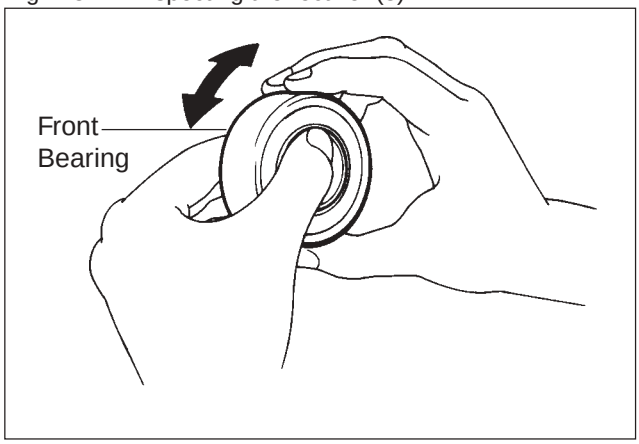


Fig. 4-38 Inspecting the front bearing

(5) Inspecting the front bearing

Verify that the bearing does not create any unusual noise or does not bind or have excessive play when rotated. Replace the bearing if any of the above exist.

4-5. ASSEMBLY OF MAIN COMPONENTS

(1) Assembling the front bearing

a. Using JIG D and a hydraulic or manual press, press the front bearing into the drive frame.

b. Using 3 screws, install the bearing cover.

Tightening torque: 2.9-4.9N·m (30-50kgf·cm)

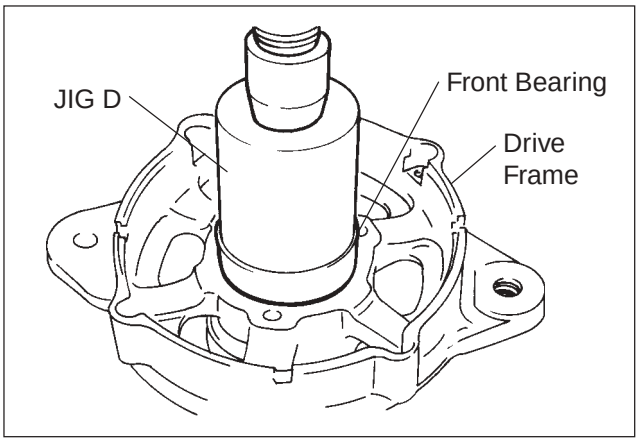


Fig. 4-39 Assembling the front bearing

(2) Assembling the rotor

a. Insert the collar onto the rotor shaft.

b. Using JIG B and a hydraulic or manual press, press the rotor into the bearing in the drive frame.

NOTE

1. Press the rotor while making sure that the rotor's shaft is perpendicular to the bearing.
2. During pressing, make sure not to damage the portion of the rotor that presses into the rear bearing.

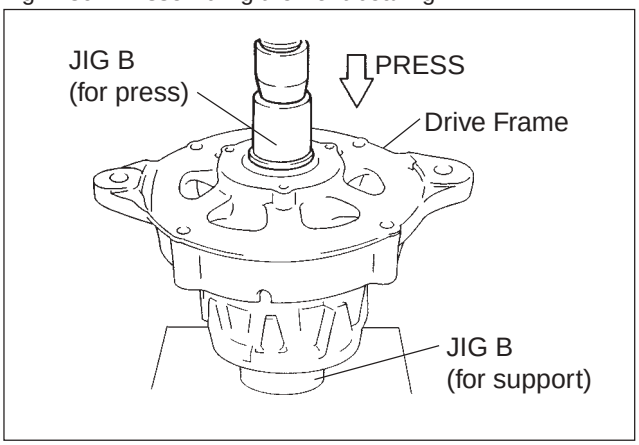


Fig. 4-40 Assembling the rotor

(3) Tightening the pulley

a. Insert the collar and fan onto the rotor shaft.

b. Secure the pulley with belt using a vise as shown in the figure, tighten the pulley lock nut with specified torque.

Tightening torque: 117.6-137.2N·m (1200 1400kgf·cm)

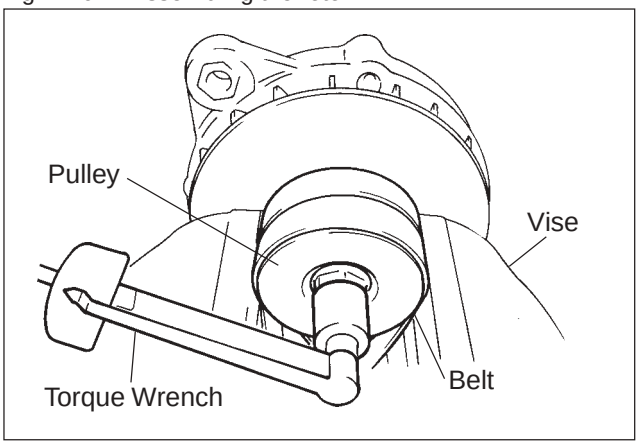


Fig. 4-41 Tightening the pulley

(4) Assembling the rear bearing

Using JIG E and a hydraulic or manual press, press a new rear bearing into the rear frame.

NOTE

Once a bearing is removed, do not reuse it.

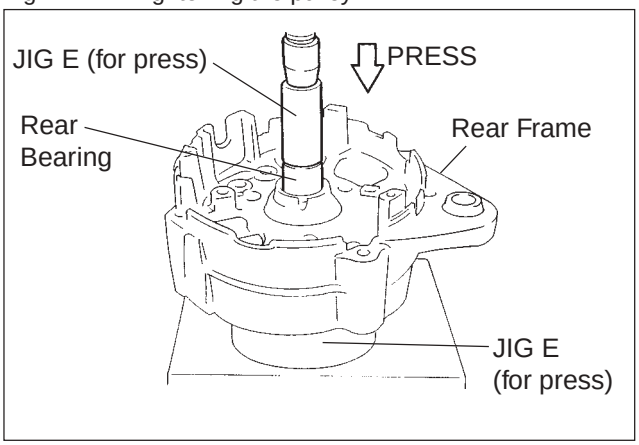


Fig. 4-42 Assembling the rear bearing

(5) Assembling the exciting coil

Using 3 screws, install the exciting coil on the rear frame.

Tightening torque: 2.9-4.9N·m (30-50kgf·cm)

(6) Assembling the I terminal (Type B only)

Install the I terminal on the rear frame and tighten the nut.

Tightening torque: 1.6-2.0N·m (16-20kgf·cm)

(7) Assembling the rectifier

a. Using 4 screws, install the rectifier.
   Tightening torque: 2.9-4.9N·m (30-50kgf·cm)
b. Using a screw, install the rectifier's (-) terminal.
   Tightening torque: 2.9-4.9N·m (30-50kgf·cm)
c. Tighten the B terminal nut.
   Tightening torque: 7.8-10.8N·m (80-110kgf·cm)

(8) Assembling the R terminal

Type A Alternator

a. Using a screw, install the R terminal.
   Tightening torque: 1.6-2.0N·m (16-20kgf·cm)
b. Install the grommet.

Type B, Type C Alternator

a. Using a screw, install the R terminal.
   Tightening torque: 1.6-2.0N·m (16-20kgf·cm)
b. Tighten the R terminal nut.
   Tightening torque: 1.6-2.0N·m (16-20kgf·cm)

(9) Assembling the regulator

a. Using 2 screws, install the regulator.
   Tightening torque: 2.9-4.9N·m (30-50kgf·cm)
b. Using 3 screws, install the rectifier and the exciting coil outlet terminal to the regulator.
   Tightening torque: 1.6-2.0N·m (16-20kgf·cm)

(10) Assembling the stator and the rear frame

Slowly insert the stator while maintaining it perpendicular to the rear frame.

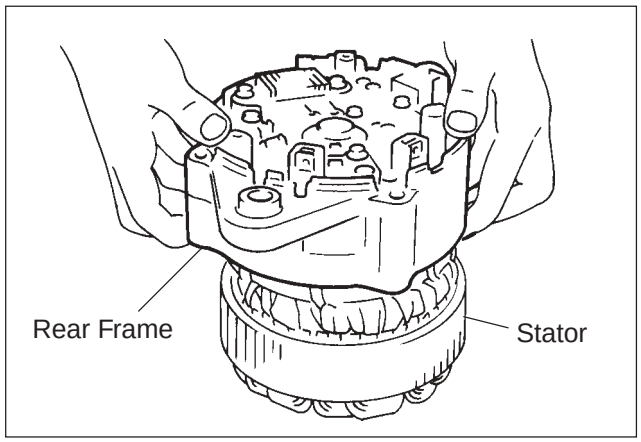


Fig. 4-43 Assembling the stator and the rear frame

(11) Assembling the drive and rear frame

a. Apply a thin coat of NSK EA5 grease on the rear bearing portion of the rotor shaft.
b. Slowly insert the rear frame while maintaining it perpendicular to the rotor shaft.

NOTE

To prevent damage to the rear bearing, do not apply excessive force during the insertion.

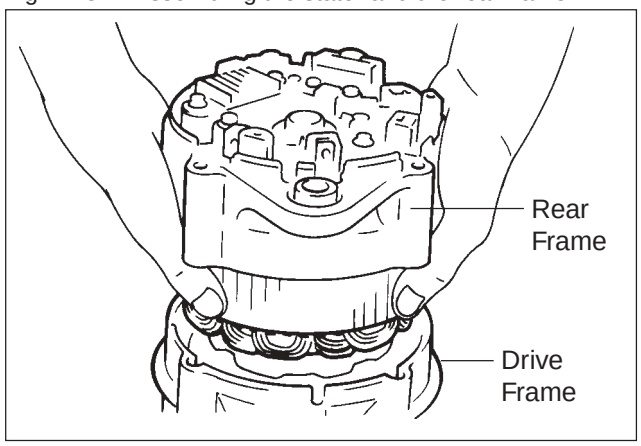


Fig. 4-44 Assembling the front and rear portions (1)

c. Install 4 through bolts.

Tightening torque: 6.5-9.3N·m (66-95kgf·cm)

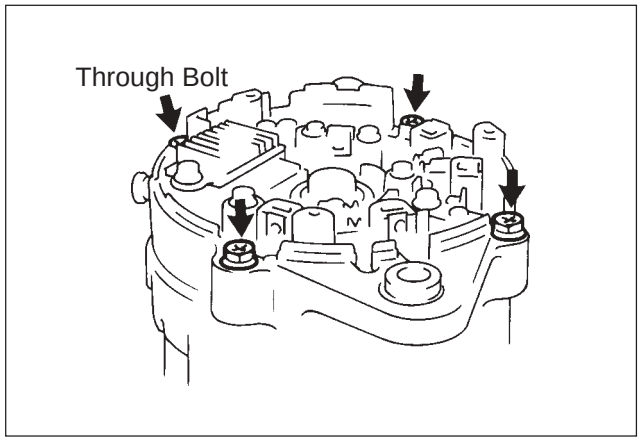


Fig. 4-45 Assembling the front and rear portions (2)

d. Using 4 screws, install the stator outlet terminal to the rectifier.

Tightening torque: 1.9-2.5N·m (19-25kgf·cm)

e. Using 3 screws, install the rear cover.

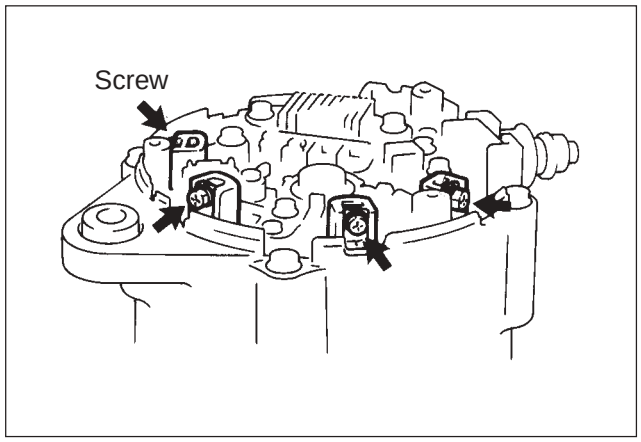


Fig. 4-46 Assembling the front and rear portions (3)

5. PERFORMANCE TEST

Using a bench tester, perform a performance test according to the procedure described below.

NOTE
During this inspection, make sure to use a fully charged battery.

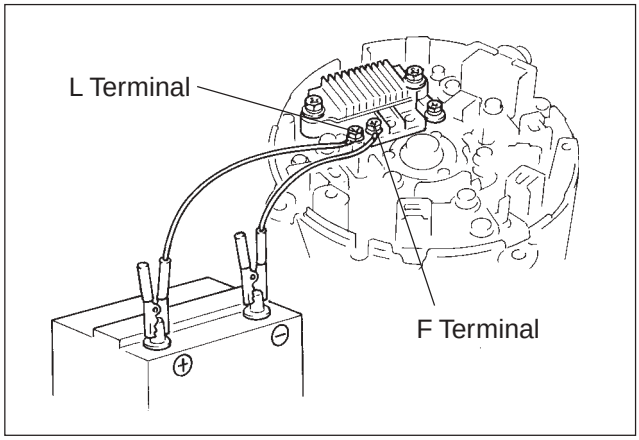


Fig. 5-1 Magnetizing

(1) Magnetizing

Momentarily connect an appropriate battery (12V or 24V) to the L terminal (plus) and F terminal (minus) of the regulator as shown in the figure.

12V type alternator: 12V battery
24V type alternator: 24V battery

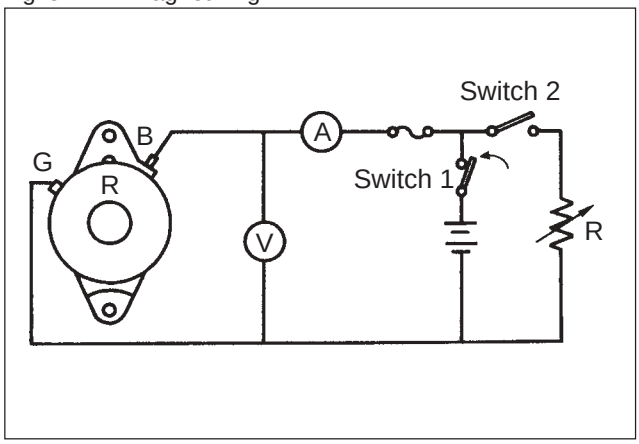


Fig. 5-2 Measuring the self-excited starting rpm

(2) Measuring the self-excited starting rpm

a. Turn Switch 1 ON.
b. Gradually increase the alternator rpm.
c. Measure the rpm (starting rpm) at which the charging current starts to flow. (It is normal if under 1500 rpm; however with the 12V-130A alternator only, under 2000 rpm.)

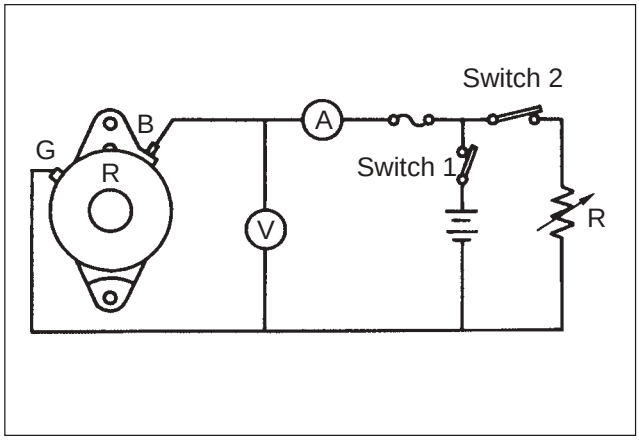


Fig. 5-3 Measuring the rated output

(3) Measuring the rated output

a. Turn Switch 1 and Switch 2 ON.
b. Maintain the alternator rpm at a constant 5000 rpm.
c. While observing a voltmeter, regulate the load (variable resistance: R) so that a 12V system outputs 13.5V and a 24V system outputs 27.0V.
d. At this time, measure the output current (it is normal if more than the rated output current is obtained).

(4) Verifying the regulator's regulated voltage

a. In the state in which the rated output was measured, turn Switch 2 OFF.

NOTE

At this time, reduce the current that flows to the load (variable resistance: R) to the minimum and turn Switch 2 OFF.

b. When the output current is less than 10A (the charging current to the battery is reduced), measure the voltage.

Standard
12V system: 14.0-14.4V or 13.7-14.3V
24V system: 27.0-29.0V

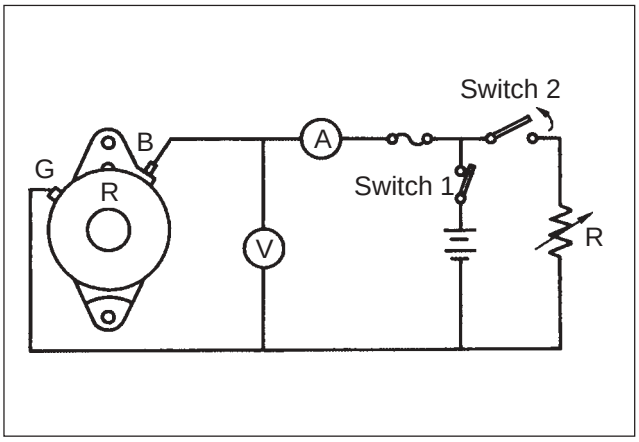


Fig. 5-4 Verifying the regulator's regulated voltage

6. PRECAUTIONS

(1) Precautions during operation

- Do not disconnect the battery while the alternator is rotating.
- Do not operate the alternator with the alternator's B terminal (output terminal) disconnected.
- Do not expose the alternator to water.

(2) Other precautions

- Make sure to disconnect the battery terminal before inspecting the alternator.
- Do not interchange the polarity of the battery cables when replacing the battery.
- Make sure to disconnect the cables and charge the battery separately when using a charger.
- Never use a Mega-Ohm tester on the alternator.
- Make sure to disconnect the wiring to the alternator when performing a megaohm test on the vehicle's wiring.

7. TROUBLESHOOTING

Symptom	Location of Malfunction	Possible Cause	Action
No charging	Alternator	Faulty regulator	Replace regulator
		Faulty stator coil (open or short circuit)	Replace stator
		Faulty exciting coil (open or short circuit)	Replace exciting coil
		Faulty rectifier (diode open or short circuit)	Replace rectifier
		Poor contact at connections	Repair or replace
	Wiring	Open circuit in wiring	Repair or replace
		Blown fuse or fusible link	Replace
Constantly undercharging (battery becomes discharged)	Alternator	Faulty stator coil (1 phase open or short circuit)	Replace stator
		Faulty rectifier (diode open or short circuit)	Replace rectifier
		Poor contact at connections	Repair or replace
	Electric load	Excessive current demand A large electric load is used	Increase alt output Reduce the electric load
	Belt	Insufficient tension	Tighten or replace
Constantly overcharging (battery electrolyte is depleted in a short time)	Alternator	Faulty regulator	Replace regulator
		Poor contact at voltage detection portion	Repair or replace
	Battery	Faulty battery	Replace battery
Abnormal noise	Alternator	Faulty stator coil (short)	Replace stator
		Faulty bearing(s)	Replace
	Belt	Improper belt tension	Repair

NOTES

DENSO SALES CALIFORNIA, INC.
Technical Services Department
Long Beach, California
DSCA P/N: LA990009-0332
Second Issue: May 1998

Kariya, Aichi, Japan
DNJP P/N: N5ZGS-01
First Issue: September 1997

DENSO

DNJP Publication No.: N5ZGS-01
DSCA Publication No.: LA990009-0332

Printed in USA©