SECTION 1E

ENGINE ELECTRICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

TABLE OF CONTENTS

DESCRIPTION AND OPERATION

BATTERY

The sealed battery is standard on all cars. There are no vent plugs in the cover. The battery is completely sealed, except for two small vent holes in the sides.

These vent holes allow the small amount of gas produced in the battery to escape. The battery has the

following advantages over conventional batteries:

- No water addition for the life of the battery.
- Overcharge protection. If too much voltage is applied to the battery, it will not accept as much current as a conventional battery. In a conventional battery, the excess voltage will still try to charge the battery, leading to gassing, which causes liquid loss.
- Not as liable to self-discharge as a conventional battery. This is particularly important when a battery is left standing for long periods of time.
- More power available in a lighter, smaller case.

The battery has three major functions in the electrical system. First, the battery provides a source of energy for cranking the engine. Second, the battery acts as a voltage stabilizer for the electrical system. Finally, the battery can, for a limited time, provide energy when the electrical demand exceeds the output of the generator.

RATINGS

A battery has two ratings: (1) a reserve capacity rating designated at 27 °C (80 °F), which is the time a fully charged battery will provide 25 amperes of current flow at or above 10.5 volts; (2) a cold cranking amp rating determined under testing at -18 °C (0 °F), which indicates the cranking load capacity.

Reserve Capacity

The reserve capacity (RC) is the maximum length of time it is possible to travel at night with the minimum electrical load and no generator output. Expressed in minutes, the RC rating is the time required for a fully charged battery, at a temperature of 27 °C (80 °F) and being discharged at a current of 25 amperes, to reach a terminal voltage of 10.5 volts.

Cold Cranking Amperage

The cold cranking amperage test is expressed at a battery temperature of -18 °C (0 °F). The current rating is the minimum amperage, which must be maintained by the battery for 30 seconds at the specified temperature, while meeting a minimum voltage requirement of 7.2 volts. This rating is a measure of cold cranking capacity.

The battery is not designed to last indefinitely. However, with proper care, the battery will provide many years of service. If the battery tests well, but fails to perform satisfactorily in service for no apparent reason, the following factors may point to the cause of the trouble:

- Vehicle accessories are left on overnight.
- Slow average driving speeds are used for short periods.
- The vehicle's electrical load is more than the generator output, particularly with the addition of aftermarket equipment.
- Defects in the charging system, such as electrical shorts, a slipping generator belt, a faulty generator, or a faulty voltage regulator.
- Battery abuse, including failure to keep the battery cable terminals clean and tight or a loose battery hold-down clamp.
- Mechanical problems in the electrical system, such as shorted or pinched wires.

CHARGING TIME REQUIRED

The time required to charge a battery will vary depending upon the following factors:

- **Size of Battery** — A Completely discharged large heavy-duty battery required more than twice the re-charging time as a completely discharged small passenger car battery.
- **Temperature** — A longer time will be needed to charge any battery at —18 °C (0 °F) than at 27 °C (80 °F). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first. The battery will accept a higher current rate as the battery warms.
- **Charger Capacity** — A charger which can supply only 5 amperes will require a much longer charging period than a charger that can supply 30 amperes or more.
- **State-of-Charge** — A completely discharged battery requires more than twice as much charge as a one-half charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

CHARGING A COMPLETELY DISCHARGED BATTERY (OFF THE VEHICLE)

Unless this procedure is properly followed, a perfectly good battery may be needlessly replaced. The following procedure should be used to recharge a completely discharged battery:

1. Measure the voltage at the battery terminals with an accurate voltmeter. If the reading is below 10 volts, the charge current will be very low, and it could take some time before the battery accepts the current in excess of a few milliamperes. Refer to “Charging Time Required” in this section, which focuses on the factors affecting both the charging time required. Such low current may not be detectable on ammeters available in the field.
2. Set the battery charger on the high setting.

Important: Some chargers feature polarity protection circuitry, which prevents charger unless the charger leads are correctly connected to the battery terminals. A completely discharged battery may not have enough voltage to activate this circuitry, even though the leads are connected properly, making it appear that the battery will not accept charging current. Therefore, follow the specific charger manufacturer’s instruction for by passing or overriding the circuitry so that the charger will turn on and charge a low-voltage battery.

3. Continue to charge the battery until the charge current is measurable. Battery chargers vary in the amount of voltage and current provided. The time required for the battery to accept a measurable charger current at various voltages may be as follows:

Voltage	Hours
16.0 or more	Up to 4 hours
14.0 - 15.9	Up to 8 hours
13.9 or less	Up to 16 hours

- If the charge current is not measurable at the end of the above charging times, the battery should be replaced.
- If the charge current is measurable during the charging time, the battery is good, and charging should be completed in the normal manner.

Important: It is important to remember that a completely discharged battery must be recharged for a sufficient number of ampere hours (AH) to restore the battery to a usable state.

- If the charge current is still not measurable after using the charging time calculated by the above method, the battery should be replaced.

JUMP STARTING PROCEDURE

1. Position the vehicle with the charged battery so that the jumper cables will reach from the charged battery to the battery that requires charging.
2. Turn off the ignition, all the lights, and all the electrical loads in both vehicles.
3. Leave the hazard flasher on if jump starting where there may be other traffic and any other lights needed for the work area.
4. Apply the parking brake firmly in both vehicles.

   Notice: In order to avoid damaging the vehicle make sure the cables are not on or near pulleys, fans, or other parts that will move when the engine starts.

5. Shift an automatic transmission to PARK.

Caution: In order to avoid injury, do not use cables that have loose or missing insulation.

6. Clamp one end of the first jumper cable to the positive terminal on the booster battery. Make sure it does not touch any other metal parts.
7. Clamp the other end of the same cable to the positive terminal on the discharged battery. Never connect the other end to the negative terminal of the discharged battery.

Caution: Do not attach the cable directly to the negative terminal of the discharged battery. Doing so could cause sparks and possible battery explosion.

8. Clamp one end of the second cable to the negative terminal of the booster battery.
9. Make the final connection to a solid engine ground, such as the engine lift bracket at least 450 millimeters (18 inches) from the discharged battery.
10. Start the engine of the vehicle with the good battery. Run the engine at a moderate speed for several minutes.
11. Then start the engine of the vehicle with the discharged battery.
12. Remove the jumper cables by reversing the above sequence exactly, removing the negative cable from the vehicle with the discharged battery first. While removing each clamp, take care that it does not touch any other metal while the other end remains attached.

GENERATOR

Generators are equipped with internal regulators. Unlike three-wire generators, the generator may be used with only two connections: battery positive and an “D+” terminal to the charge indicator lamp.

As with other charging systems, the charge indicator lamp lights when the ignition switch is turned to RUN, and goes out when the engine is running. If the charge idicator is on with the engine running, a charging system defect is indicated. This indicator light will glow at full brilliance for several kinds of defects as well as when the system voltage is too high or too low.

The regulator voltage setting varies with temperature and limits the system voltage by controlling rotor field current. Achieve correct average field current for proper system voltage control by varying the on-off time. At high speeds, the on-time may be 10 percent and the off-time 90 percent. At low speeds, with high electrical loads, the on-time may be 90 percent and the off-time 10 percent.

CHARGING SYSTEM

Generators use a new type of regulator that incorporates a diode trio. A Delta stator, a rectifier bridge, and a rotor with slip rings and brushes are electrically similar to earlier generators. A conventional pulley and fan are used. There is no test hole.

STARTER

Wound field starter motors have pole pieces, arranged around the armature, which are energized by wound field coils.

Enclosed shift lever cranking motors have the shift lever mechanism and the solenoid plunger enclosed in the drive housing, protecting them from exposure to dirt, icy conditions, and splashes. In the basic circuit, solenoid windings are energized when the switch is closed. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear. The solenoid main contacts close. Cranking then takes place.

When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage.

To prevent excessive overrun, the switch should be released immediately after the engine starts.

STARTING SYSTEM

The engine electrical system includes the battery, the ignition, the starter, the generator, and all the related wiring.

Diagnostic tables will aid in troubleshooting system faults. When a fault is traced to a particular component, refer to that component section of the service manual.

The starting system circuit consists of the battery, the starter motor, the ignition switch, and all the related electrical wiring. All of these components are connected electrically.

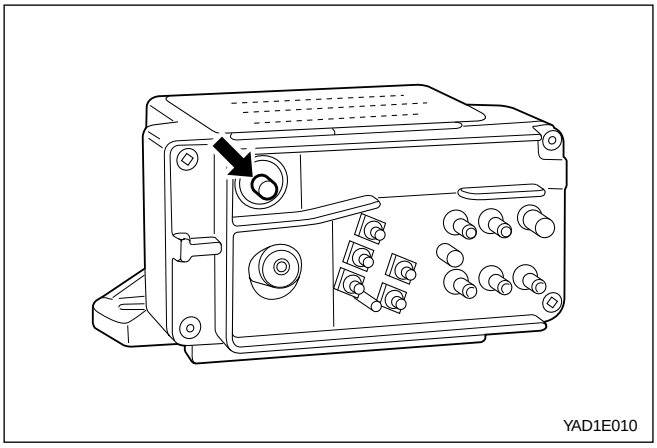
DIAGNOSTIC INFORMATION AND PROCEDURE

IGNITION SYSTEM

Condition	Probable Cause	Correction
No Crank	• Low battery voltage.	• Charging the battery or Replace the battery.
	• Battery cable is loose, corroded, or damaged.	• Repair or Replace the battery cable.
	• Faulty starter motor or starter motor circuit is open.	• Repair or Replace the starter motor/starter motor circuit.
	• Faulty ignition switch.	• Replace the ignition switch.
	• Ground short.	• Repair the ground short.
Crank OK, But Too Slow	• Low battery voltage.	• Charging the battery or Replace the battery.
	• Battery. • Battery cables are loose, corroded, or damaged.	• Repair or Replace the battery cable.
	• Faulty starter motor.	• Repair or Replace the starter motor.
Starter Motor Does Not Stop	• Faulty starter motor.	• Repair or Replace the starter motor.
	• Faulty ignition switch.	• Replace the ignition switch.
Starter Motor Running, But Not Cranking	• Broken the clutch pinion gear or faulty starter motor.	• Replace the starter motor.
	• Broken the flywheel ring gear.	• Replace the flywheel.
	• Connected circuit is open.	• Repair the open circuit.
Battery Discharge	• Loosen the generator drive belt.	• Adjust the belt tension or Replace the belt.
	• The circuit is open or a short.	• Repair the open or a short circuit.
	• Battery run down.	• Replace the battery.
	• Open ground circuit.	• Repair the open ground circuit.
Charging Indicator Lamp Does Not Work When the Ignition Switch ON (Engine Does Not Work)	• Charging indicator lamp is blown or fuse is blown.	• Repair or Replace the charging indicator lamp/fuse.
	• Faulty ignition switch.	• Replace the ignition switch.
	• Generator ground circuit is open or a short.	• Repair the circuit.
Charging Indicator Lamp Does Not Put Out Lights After Starting the Engine	• Battery cable is corroded or damaged.	• Repair or Replace the battery cable.
	• Loosen the generator drive belt.	• Adjust the belt tension or Replace the belt.
	• Faulty wiring harness.	• Repair the wiring harness.
Battery Over Charging	• Generator Voltage Regulator Faulty	• Replace Generator
	• Voltage detecfing wiring faulty	• Repair Wiring

IGNITION SYSTEM (Cont'd)

Condition	Probable Cause	Correction
Hard Engine Starting	• Ignition coil faulty	• Replace ignition coil
	• Distributor (including optical sensor) faulty	• Replace distribator (or sensor)
	• Spark plug malfuntion	• Replace spark plug or adjust clearance
	• Ignition timing faulty (spark plug light is normal)	• Resetting valve timing
Unstable Engine Idling	• Spark plug malfunction	• Replace spark plug or adjust clearance
	• Ignition coil faulty	• Replace ignition coil
	• Ignition timing faulty	• Resetting valve timing
Enging Acceralation Malfunction	• Ignition timing faulty	• Resetting valve timing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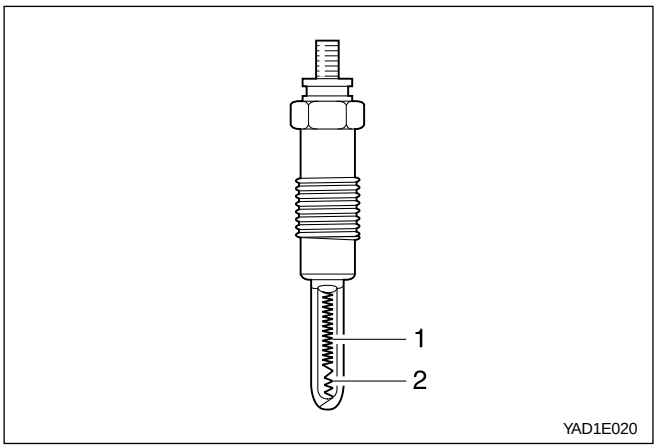

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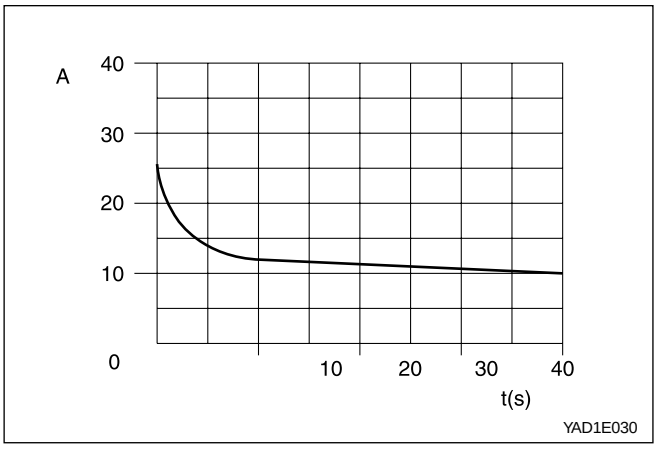

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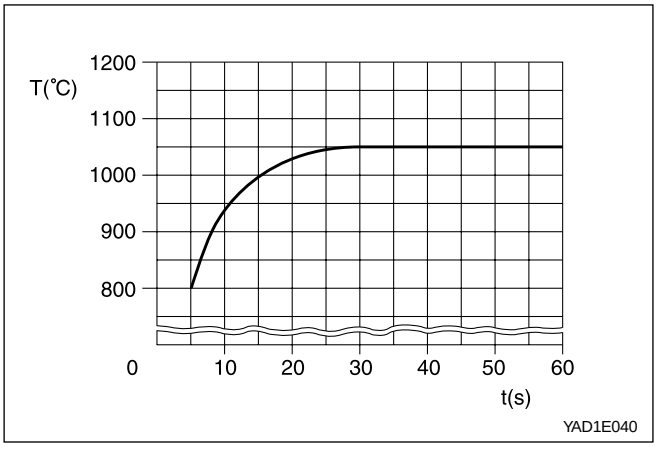

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PREHEATING SYSTEM (DIESEL ENGINE)

General information

The preheating system consists of control relay, coolant temperature sensor and glow plugs.

1. Preheating time - control relay.

   Control relay functions as followings :

   - Switching of preheating current.
   - Indication of preheating finish.
   - Control of preheating sequence.
   - Indication of fault.

2. Coolant temperature sensor.

   Coolant temperature sensor senses coolant's temperature and signals it to the preheating relay continuously.

3. Glow plug

   The glow plug parts are housing with M12 ´ 1.25 thread and heating pin in housing. It is connected in a parallel circuit with the specified voltage of 11.5 V.

   The heating element has a heating coil and a control coil and they are connected in series.

4. Current and temperature of glow plug

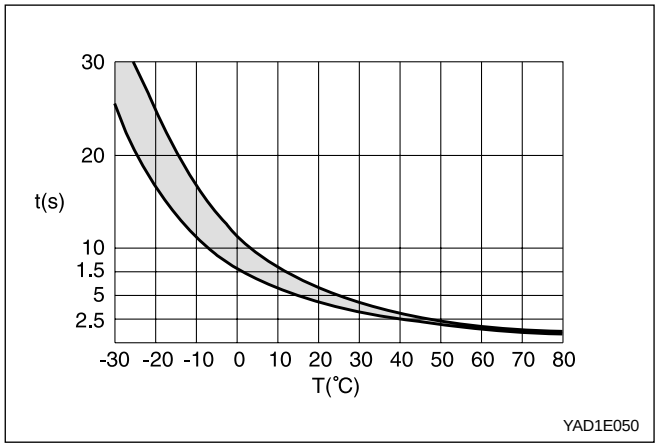
   - Current of glow plug

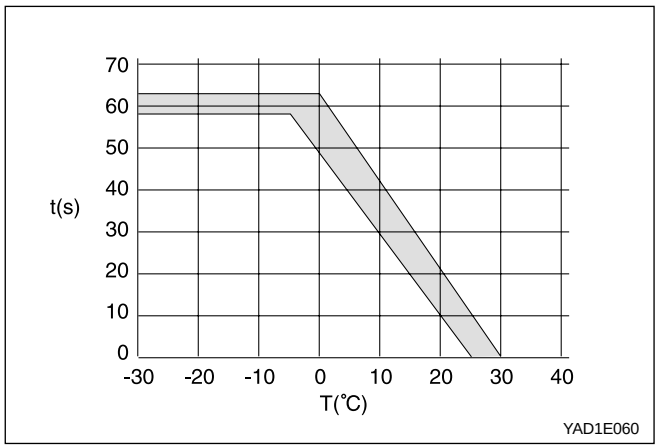
     While the preheating system operates, current of about 30 A flows in each glow plug and temperature of heating coil rises very fast.

     Due to the rise of temperature, the resistance of control coil increases therefore the current is controlled to about 8 - 15A and that protects the glow plug from overheating.

   - Temperature of glow plug

     The temperature of the glow plug reaches up to 900 °C (1,652 °F) after about 9 seconds and up to 1,050 °C (1,922 °F) after 30 seconds.





Preheating System Operation

1. Preheating before start.

   Preheating time is different by coolant temperature and it is on until the glow indicator light goes off.

2. Preheating after start.

   Preheating continues for max. 60 seconds to rise in characteristic of warming-up on engine after starting too.

3. Monitoring on glow plug.

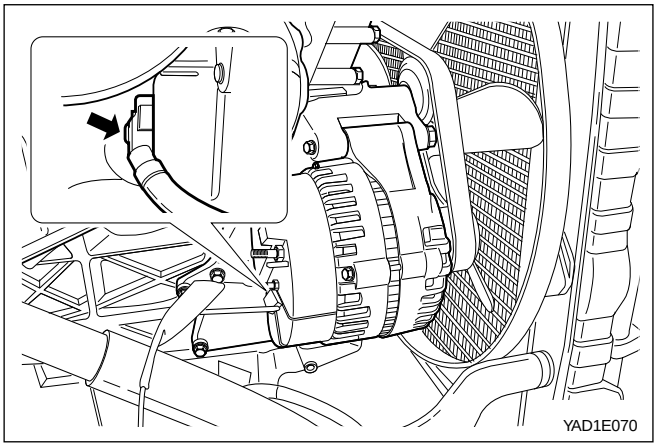
   Glow plugs are monitored by low current by the micro processor in control relay respectively while running the engine.

   If glow indicator comes on after starting for about one minute, it indicates one or several plugs are faulty.

	Problem	Possible Cause
1	Glow indicator does not come on in preheating time and comes on after starting the engine.	One or several glow are faulty
2	Glow indicator does not come on while preheating and after starting engine.	Faulty glow indicator Faulty circuit of glow indicator Faulty control relay
3	Glow indicator does not come on and engine's starting is difficult or does not start at all.	Circuits short in one or several glow plugs Faulty preheating circuits Faulty control relay
4	Glow indicator comes on after starting for about one minute.	One or several glow plugs are faulty
5	Glow indicator comes on constantly.	Faulty circuit of glow indicator Faulty control relay
6	Preheating time until glow indicator goes off is too short/long.	Faulty coolant temperature sensor Faulty control relay Short/Open circuit in wire.

REPAIR INSTRUCTIONS

ON-VEHICLE SERVICE



GENERATOR (GASOLINE ENGINE)

Preceding Work : Removal of the polly V-belt

Removal & Installation Procedure

1. Disconnect the negative battery terminal.
2. Unscrew the nut and disconnect the terminal (1).

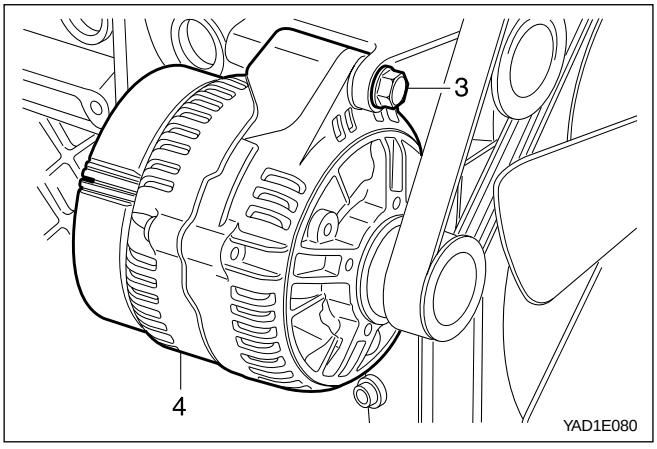
Installation Notice

Tightening Torque	14 - 18 N•m (10 - 13 lb-ft)

3. Unscrew the nut and disconnect the terminal (2).

Installation Notice

Tightening Torque	4 - 5 N•m (35 - 44 lb-in)

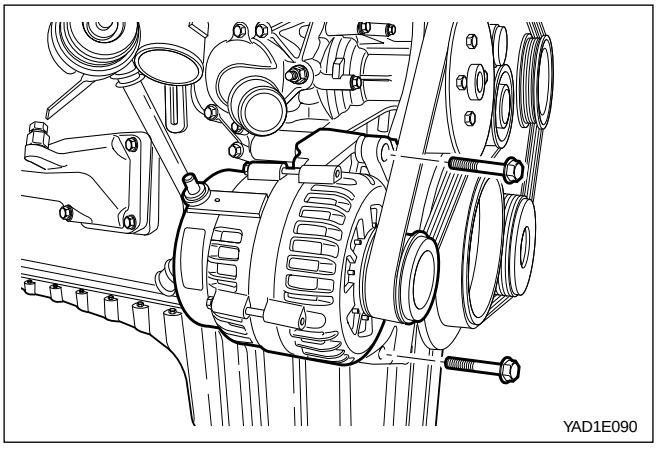


4. Unscrew the combination bolt (3).

Installation Notice

Tightening Torque	42 - 50 N•m (31 - 37 lb-ft)

5. Remove the generator.
6. Installation should follow the removal procedure in the reverse order.



GENERATOR (DIESEL ENGINE)

Preceding Work: Removal of the polly V-belt

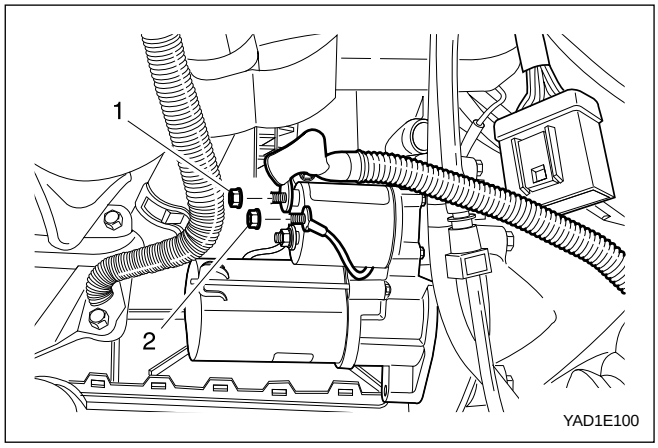
Removal & Installation Procedure

1. Disconnect the negative battery terminal.
2. Disconnect the plug connection.
3. Unscrew the bolts and take out the generator.

Installation Notice

Tightening Torque	42 - 50 N•m (31 - 37 lb-ft)

4. Installation should follow the removal procedure in the reverse order.



STARTER

Removal & Installation Procedure

1. Disconnect the negative battery terminal.
2. Unscrew the nut and disconnect the battery cable(1).

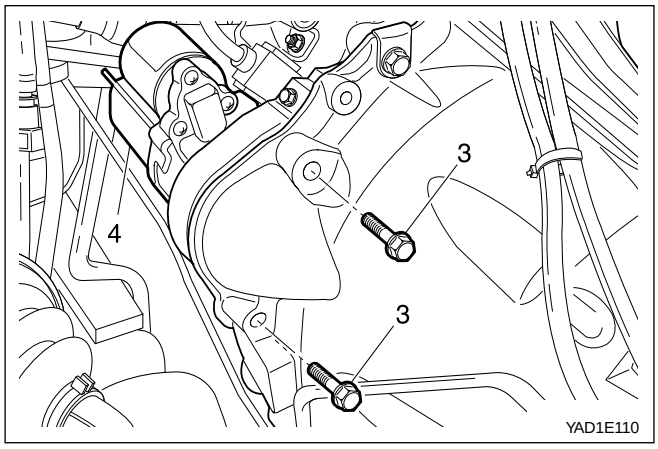
Installation Notice

Tightening Torque	12 - 15 N•m (9 - 11 lb-ft)

3. Unscrew the nut and disconnect the engine electric wire (2).

Installation Notice

Tightening Torque	6 - 7 N•m (53 - 62 lb-in)

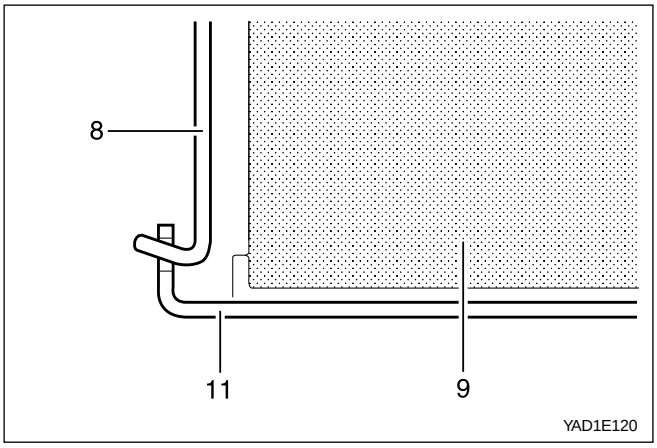


4. Unscrew the mounting bolts (3) of starter.

Installation Notice

Tightening Torque	35 - 48 N•m (26 - 35 lb-ft)

5. Remove the starter.
6. Installation should follow the removal procedure in the reverse order.

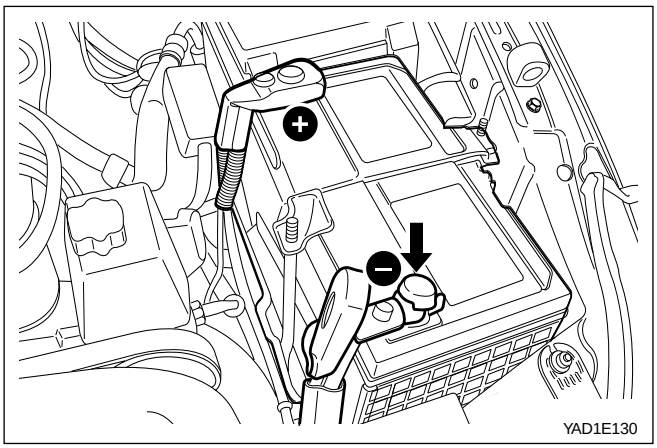


BATTERY

Removal & Installation Procedure

Notice:

- Disconnect the negative battery cable first.
- Insert the clamp bolt (8) into the battery tray hole (11) from inside when installing.



1. Disconnect the negative battery cable and then disconnect the positive battery cable.

   Installation Notice

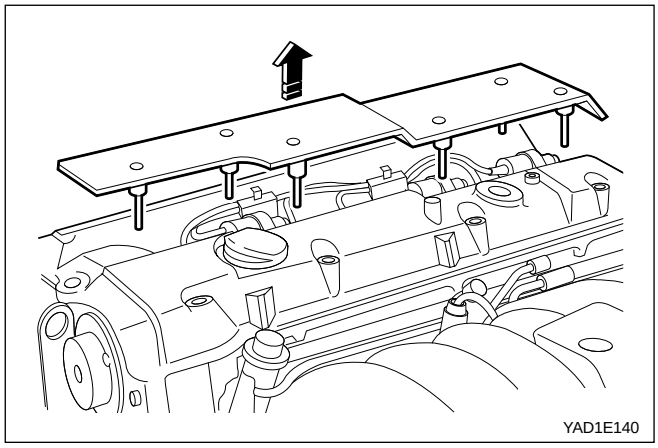
Tightening Torque	12 - 18 N•m (9 - 13 lb-ft)

2. Remove the nut from the battery clamp bolt that fasten the battery holddown bracket.

   Installation Notice

Tightening Torque	15 N•m (11 lb-ft)

3. Remove the battery.
4. Installation should follow the removal procedure in the reverse order.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SPARK PLUG AND IGNITION COIL (GASOLINE ENGINE)

Preceding Work : Removal of intake air duct

Tools Required

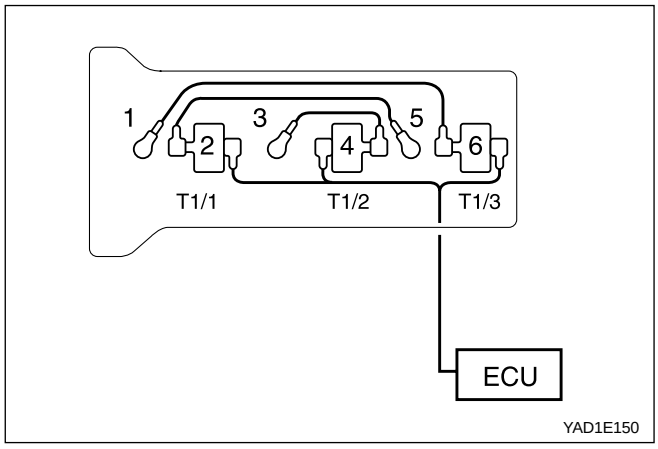
120 589 02 09 00 Spark Plug Wrench

Replacement Procedure

1. Disconnect the negative battery cable.
2. Remove the ignition cable cover bolts and remove the ignition cable cover.

Installation Notice

Tightening Torque	9 - 11 N•m (80 - 97 lb-in)



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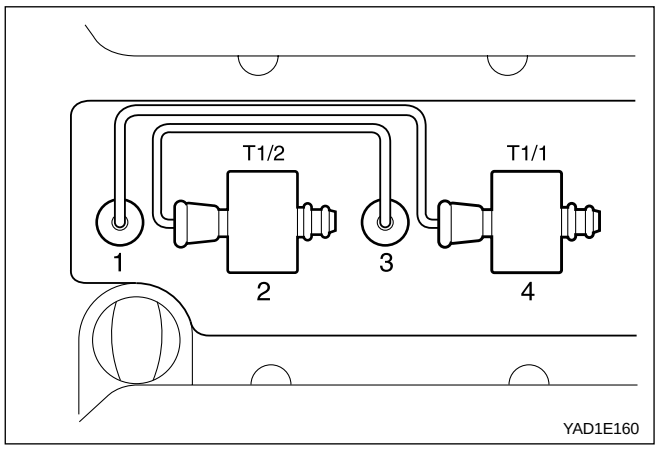

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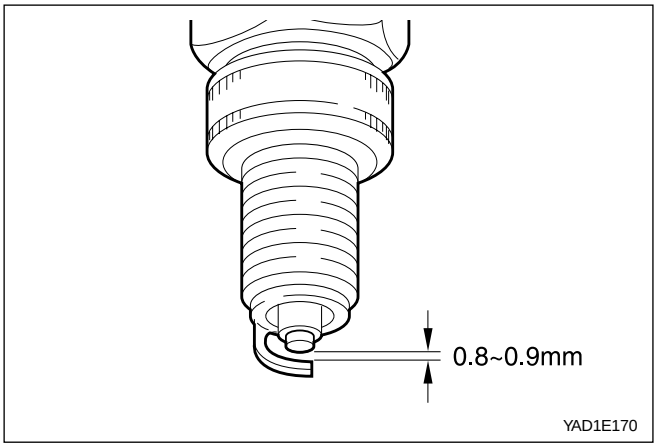
3. Separate the ignition cable from the ignition coil and the spark plug.
4. Remove the two bolts (M6 X 25) from each ignition coil and remove the ignition coil.

Installation Notice

Tightening Torque	9 - 11 N•m (80 - 97 lb-in)

- Make sure that the ignition cables are correctly routed.
- Exactly install the ignition cable guide pin into the vehicle to be grounded.
- The ignition cables are located on the cylinder head cover. Each ignition coil provides the high voltage to two spark plugs simultaneously.
  - M162 ENGINE
    T 1/1 : Cylinder 2 and 5
    T 1/2 : Cylinder 3 and 4
    T 1/3 : Cylinder 1 and 6
  - M161 ENGINE
    T 1/1 : Cylinder 1 and 4
    T 1/2 : Cylinder 2 and 3

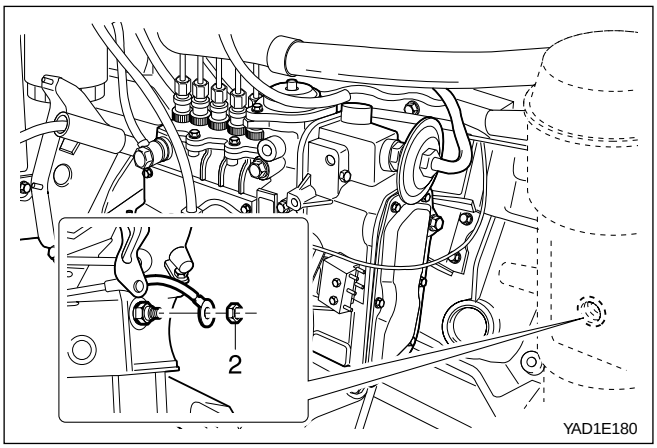


5. Remove the spark plug using the spark plug wrench 120 589 02 09 00.

Installation Notice

Tightening Torque	25 - 30 N•m (15 - 22 lb-ft)
Clearance	0.8 + 0.1 mm

6. Installation should follow the removal procedure in the reverse order.



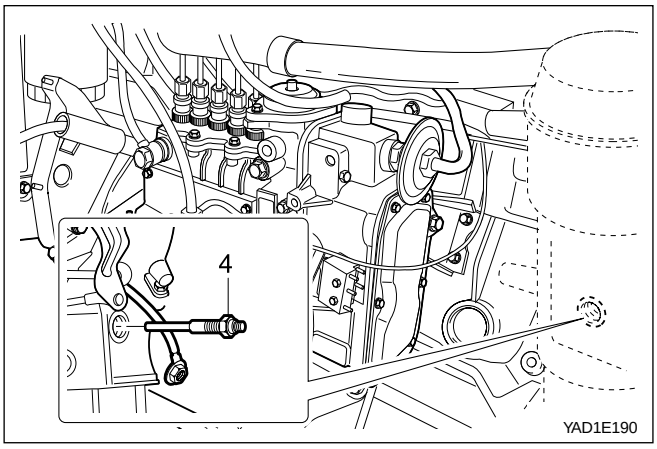
GLOW PLUG (DIESEL ENGINE)

Removal & Installation Procedure

1. Disconnect the negative battery cable.
2. Remove the nut (2).

Installation Notice

Tightening Torque	4 N•m (35 lb-in)



3. Remove the glow plug (4).

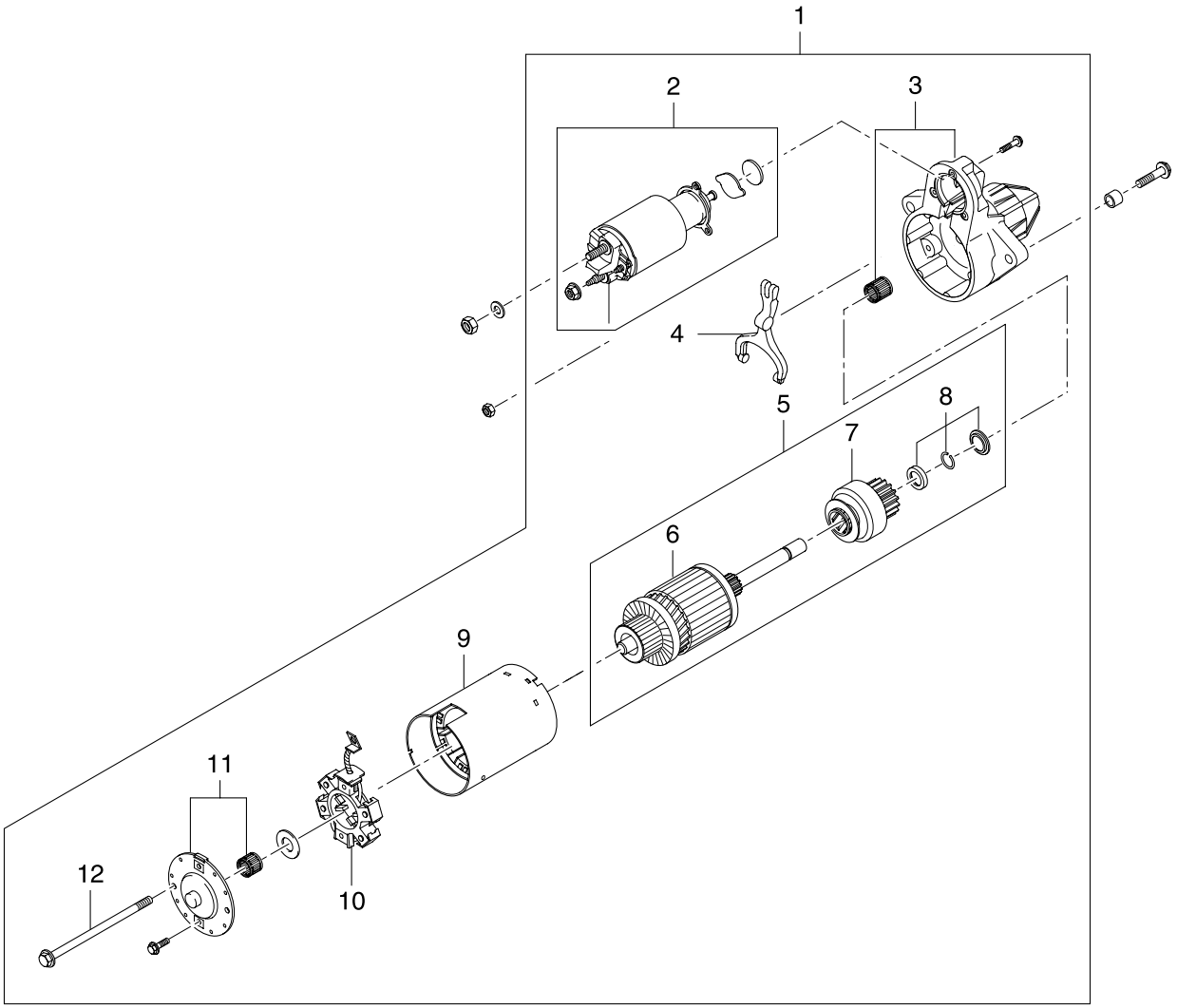
Installation Notice

Tightening Torque	20 N•m (15 lb-ft)

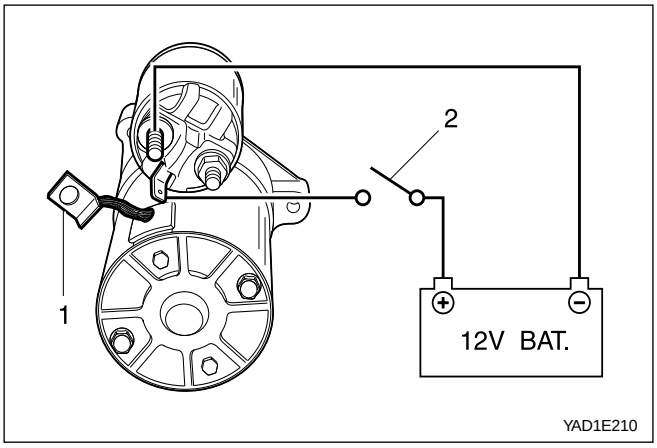
4. Installation should follow the removal procedure in the reverse order.

UNIT REPAIR

STARTER



1 Starter Motor Assembly
2 Starter Solenoid Assembly
3 Starter Housing
4 Shift Lever
5 Armature Set
6 Armature
7 Pinion Gear Assembly
8 Ring Set
9 Field Frame Assembly
10 Brush Holder Assembly
11 Contact End Frame Assembly
12 Starter Through – Bolts



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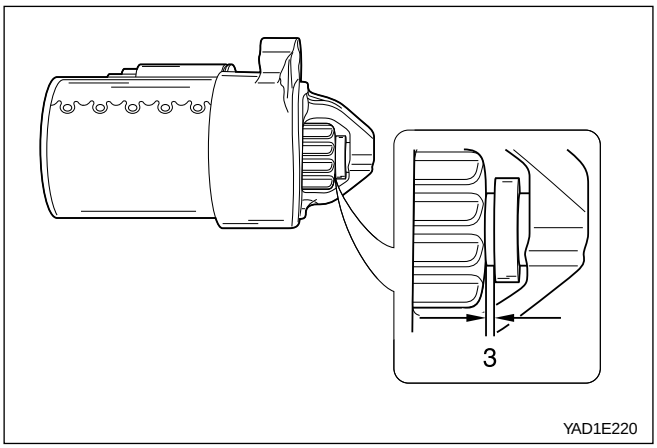
Inspection/Measurement (Before the Overhaul)

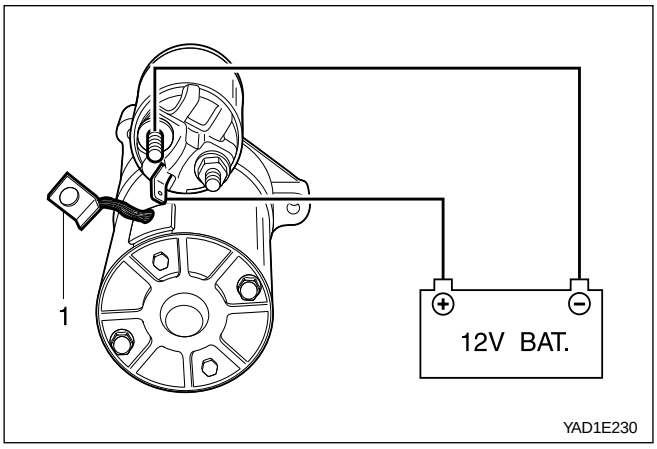
1. Remove the starter. Refer to “Starter” in this section.
2. Pinion clearance inspection.
   - Disconnect the starter motor terminal M (1).
   - Connect the 12-volt battery lead to the starter motor terminals M and S.

   Notice: Complete the testing in a minimum amount of time to prevent overheating and damaging the solenoid. (in 10 seconds)



YAD1E220

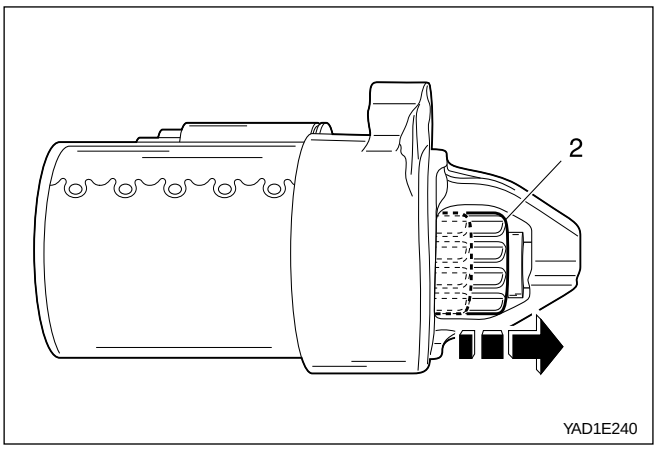
   - Switch on to move the pinion gear (2).
   - Now check the clearance between the pinion and the stopper with the filler gauge (3).
   - If the clearance does not fall within the limits, check for improper installation and replace all wom parts.



YAD1E230

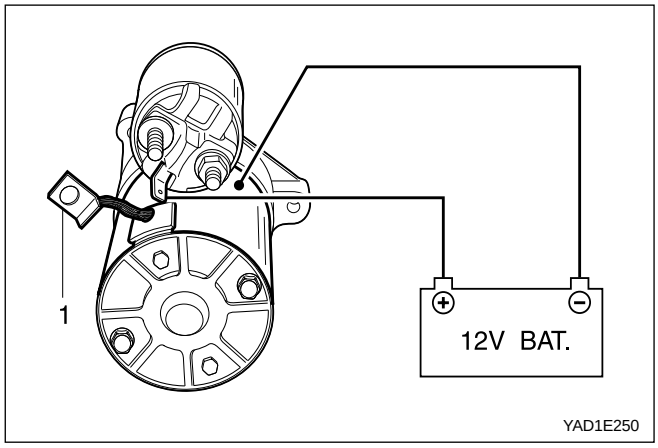
3. Magnetic switch pull-in test.
   - Disconnect the starter motor terminal M (1).
   - Connect the 12-volt battery lead to the starter motor terminals M and S.

   Notice: Complete the testing in a minimum amount of time to prevent overheating and damaging the solenoid. (in 10 seconds)



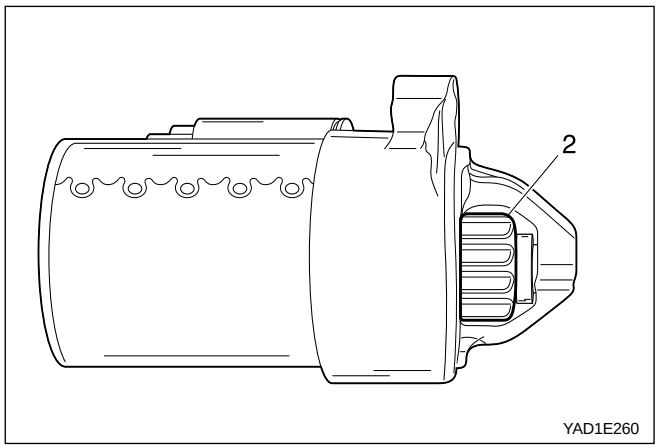
YAD1E240

   - Inspect the pinion gear’s moving to the outside (2).
   - If the pinion gear does not move outside, replace the magnetic switch.

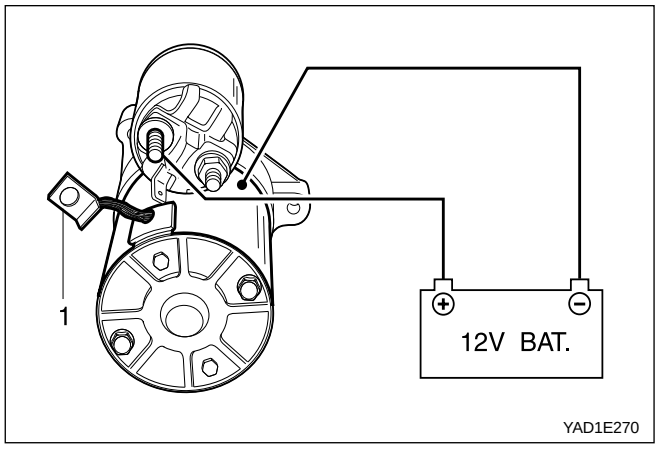


4. Solenoid hold-in test.
   - Disconnect the starter motor terminal M (1).
   - Connect the 12-volt battery lead to the starter motor terminal S and body.

   Notice : Complete the testing in a minimum amount of time to prevent overheating and damaging the solenoid.

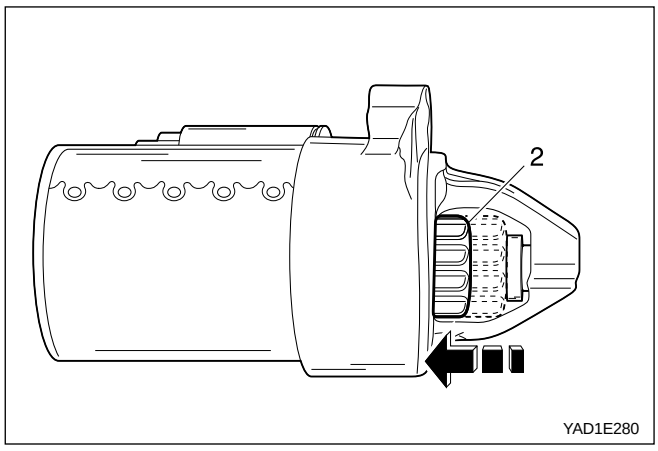


- Check the pinion gear's moving to the outside (2).
- If the pinion gear move to the inside, the circuit is open. Replace the magnetic switch.

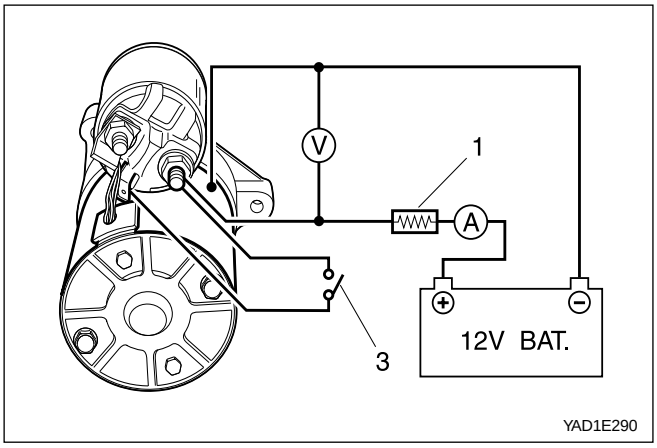


5. Solenoid return test.
   - Disconnect the starter motor terminal M (1).
   - Connect the 12-volt battery lead to the starter motor terminal S and body.

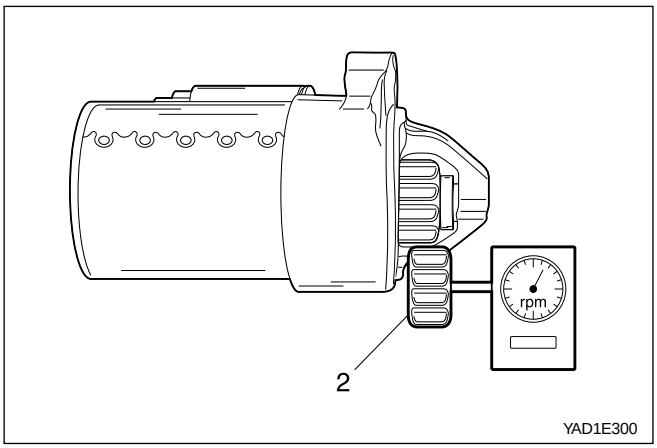
   Notice: Complete the testing in a minimum amount of time to prevent overheating and damaging the solenoid.



- Check the returning speed of pinion gear (2). If the returning speed is fast, the operation is normal.
- Replace the solenoid if the operation is abnormal.



5. No-road test.
   - Connect the 12-volt battery lead to the starter circuit.
   - Connect the current and the voltage (1).
   - Install the starter motor rpm gage (2).
   - Start the starter motor with the switch on (3).
   - Measure the speed of pinion gear and the current.
   - If the measurement satisfy the limit, the starter motor is normal.

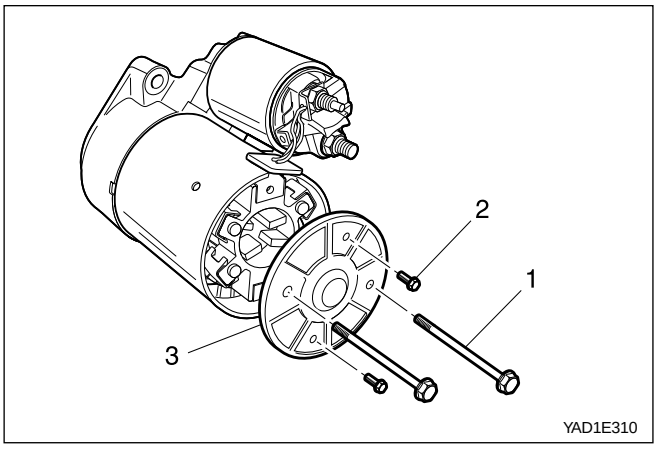


Desciption	Limit
The speed of pinion gear	Minimum : 2,000 rpm
Condition : Voltage/ Current	Maximum : 9V / 150A

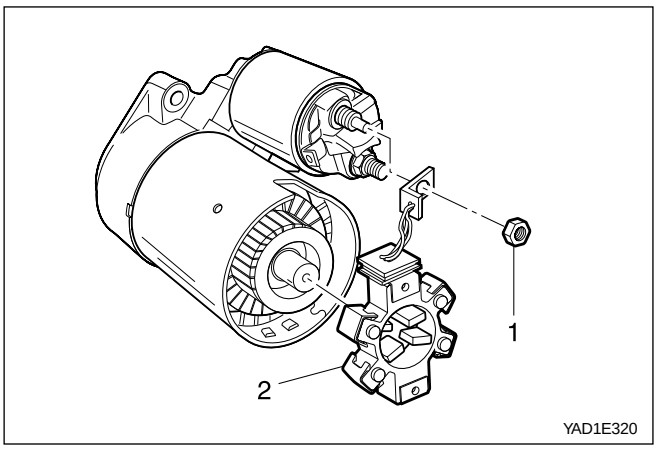
- Replace the starter motor if necessary.

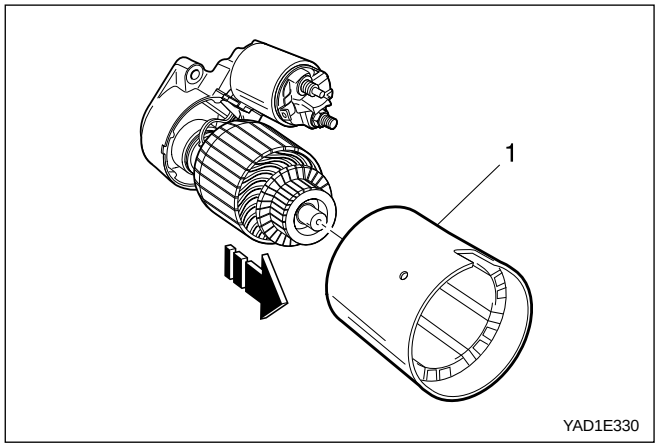
Disassembly Procedure

1. Remove the starter contact end frame.
   - Remove the through-bolts (1).
   - Remove the contact end frame bolts (2).
   - Remove the frame with the spacer (3).

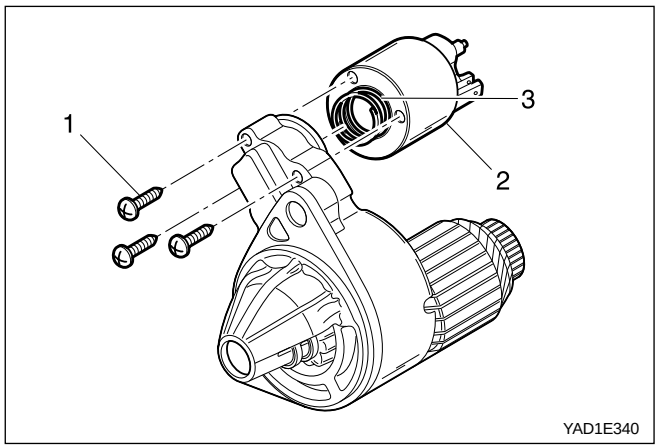


2. Remove the brush holder assembly.
   - Remove the starter motor terminal M nut (1).
   - Remove the brush holder assembly (2).

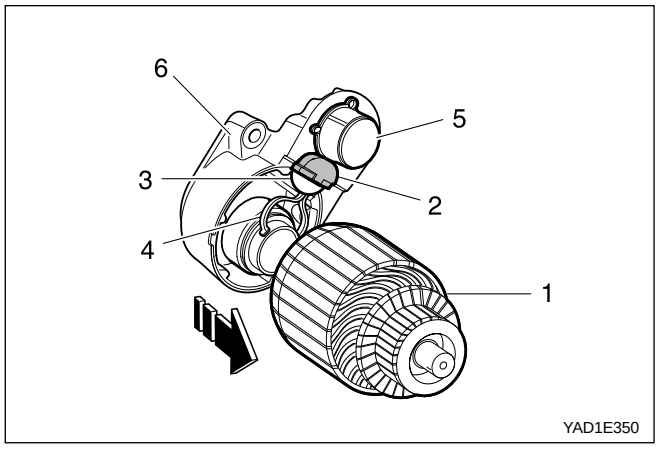




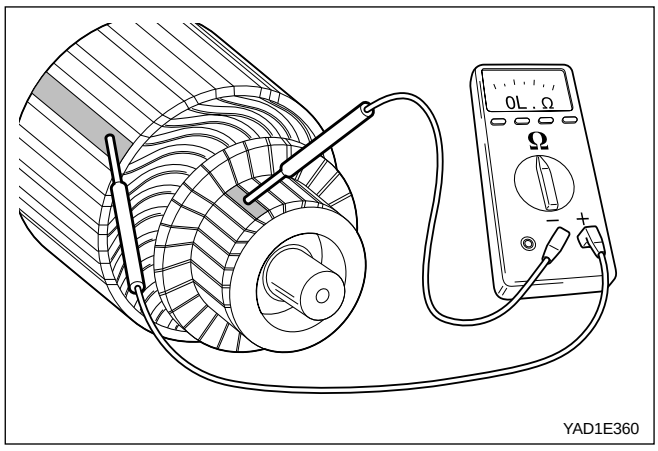
3. Remove the field frame assembly from the armature set (1).



4. Remove the solenoid assembly.
   - Remove the solenoid screws (1).
   - Remove the magnetic switch (2).
   - Remove the spring (3).

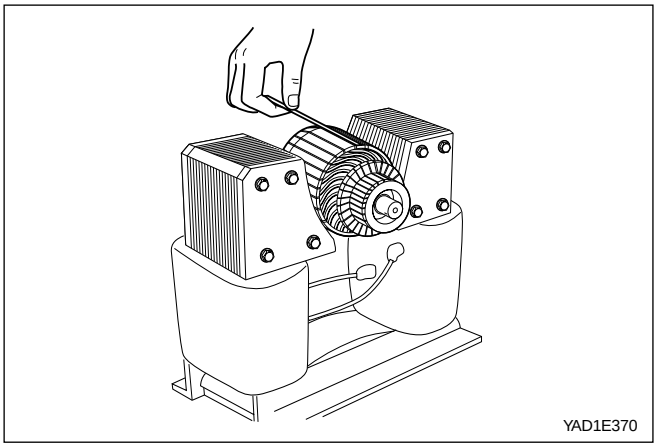


5. Remove the armature set and solenoid from the starter housing.
   - Remove the armature set (1).
   - Remove the rubber sealer (2).
   - Remove the shift lever plate (3).
   - Remove the shift lever (4).
   - Remove the solenoid (5).
   - Remove the gasket (6).

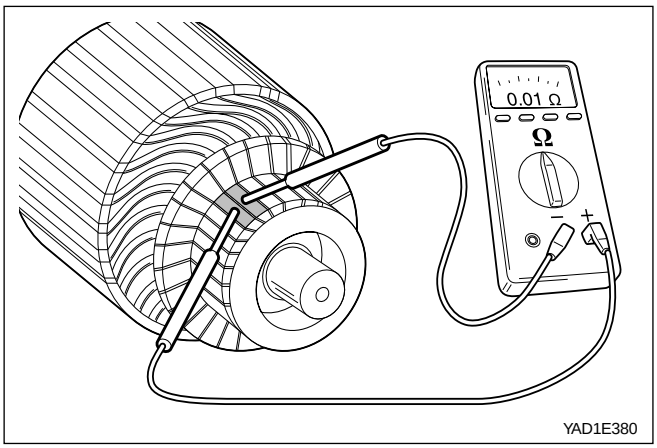


Inspection / Measurement (After the Overhaul)

1. Ground test for armature coil.
   - Inspect the insulation between commutator and armature coil using the voltmeter.
   - Replace the armature assembly if necessary.

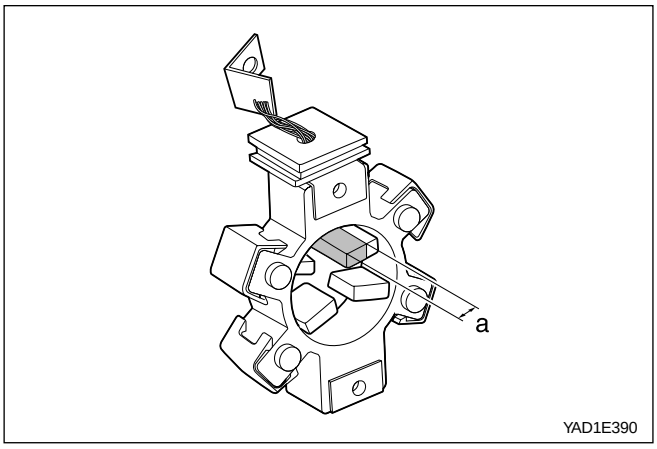

YAD1E370

2. Short circuit test for armature coil.
   - If test equipment is available, check the armature for short circuit by placing it on a growler, and holding back a saw blade over the armature core while the armature is rotated. If the saw blade vibrates, replace the armature.



YAD1E380

3. Open circuit test for armature coil.
   - Check the continuity between the commutator bars using multimeter.
   - Replace the armature assembly if necessary.

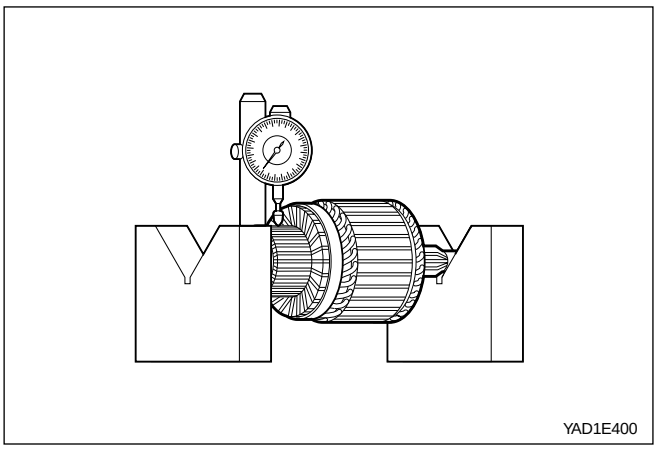


YAD1E390

4. Inspect the brushes wear.
   - Inspect the brushes, the pop-out springs and the brush holder for wear and damage, Replace the brushes, if necessary.

   a. Brushes wear limit.

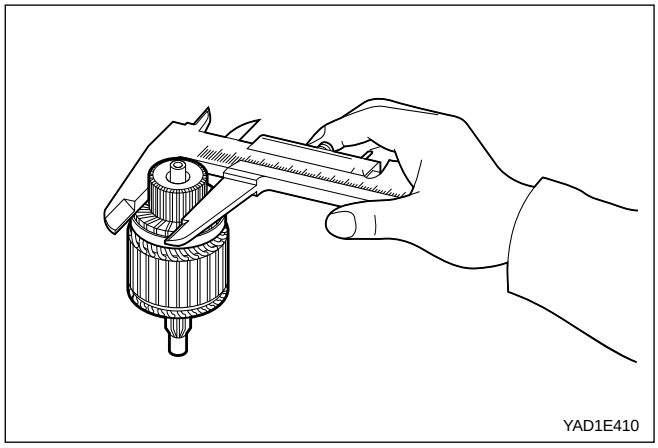
Desciption	Standard	Limit
Brushes wea	11.3 - 11.5 mm (0.445 - 0.453 in)	7.0 - 7.25 mm (0.275 - 0.285 in)


YAD1E400

Inspection the Commutator Bar

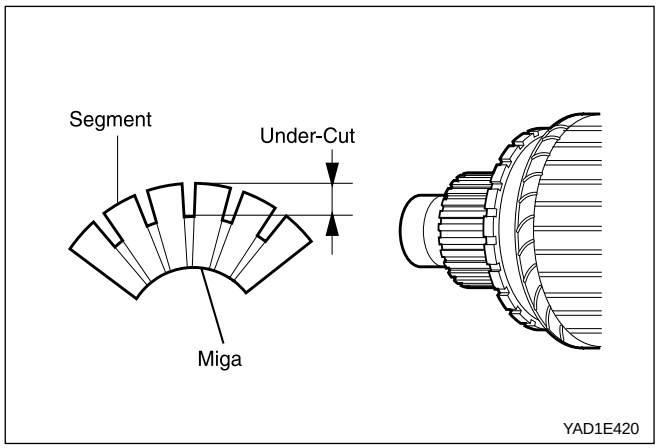
1. Inspect the wear length using the dial indicator after placing the armature coil on the two “V” block.

Application	Standard (mm)	Limit (mm)
Wear	0.05	0.1


YAD1E410

2. Measure the outside diameter of the commutator bar.

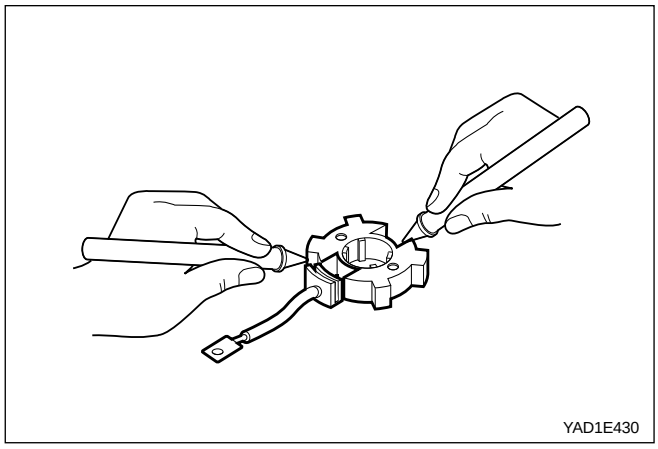
Application	Standard (mm)	Limit (mm)
O.D.	29.4	28.4



YAD1E420

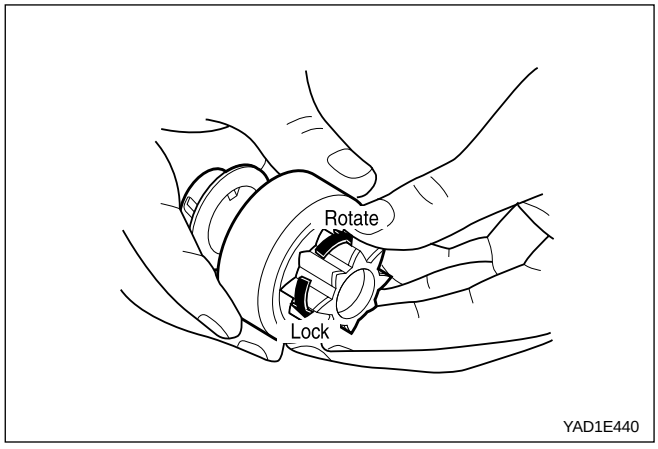
3. Check the under-cut depth between segments.

Application	Standard (mm)	Limit (mm)
Under-cut depth	0.5	0.2


YAD1E430

Brush Holder

Inspect the continuity between the brush holder plate and (+) brush holder. If the current does not send, it's normal.

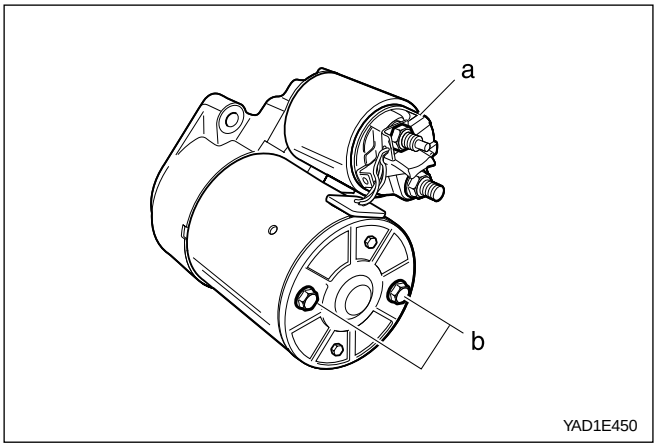


YAD1E440

Overrunning Clutch

1. Rotate the pinion grabbing the clutch housing. The driving pinion must rotate softly at one direction and must not rotate at opposite direction. If the driving pinion rotates at opposite direction, replace the overrunning clutch assembly.
2. Check the wear and damage of the pinion and replace the pinion as needed. If the pinion gets damaged, inspect the wear and damage of the ring gear.
3. Front and rear bracket bushing

   Check the wear and damage of the bushing and replace the front and rear bracket as needed.



Assembly Procedure

1. Installation should follow the removal procedure in the reverse order.

   For installing the lever to the starter housing, install it according to its proper direction.

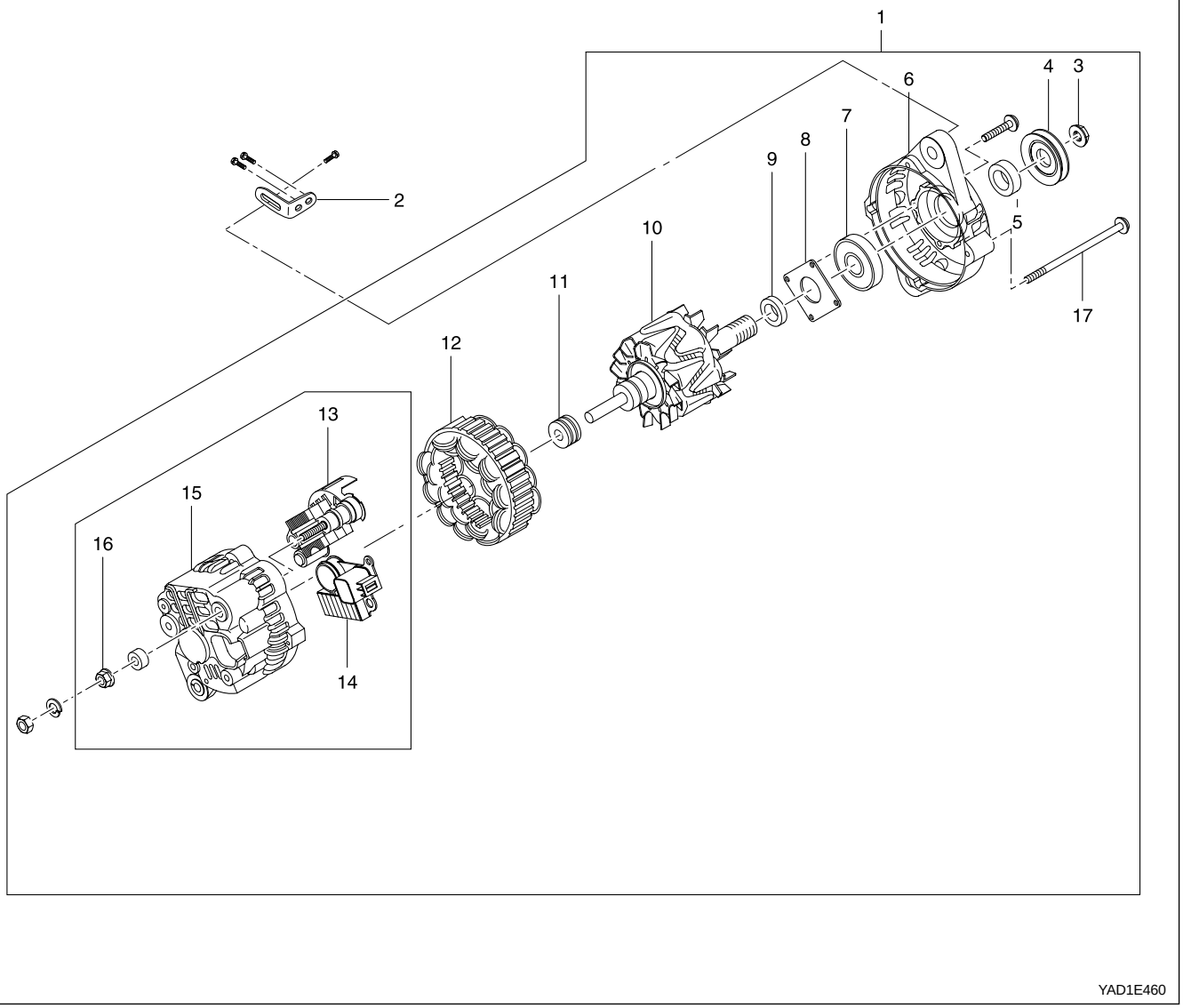
   (The lever should be installed to the hole of the starter housing at one direction.)

2. Tighten nuts/bolts as specified torque.

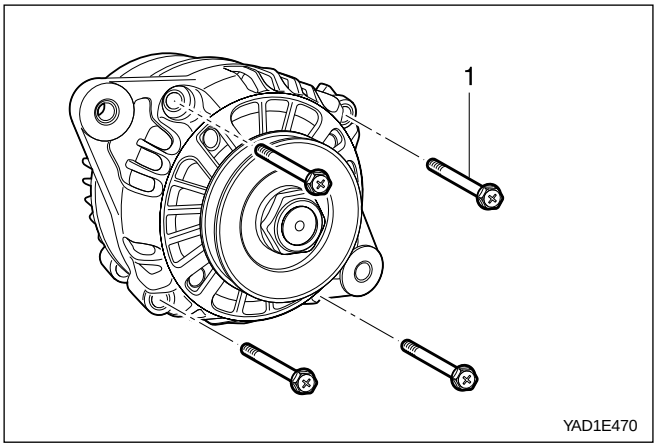
   a. Starter M terminal nut

   b. Starter pass-through bolt

GENERATOR (MANDO TYPE)

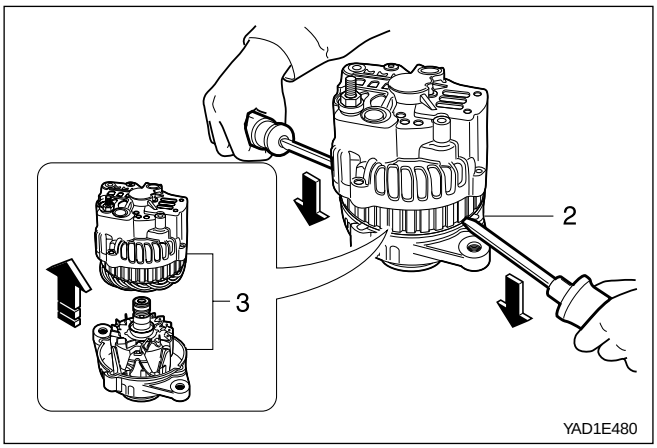


1 Generator Assembly
2 Generator Shackle
3 Generator Drive End Nut
4 Generator Pully
5 Generator Collar (Large)
6 Generator Front Bracket
7 Front Bearing
8 Bearing Spot Plate
9 Generator Collar (Small)
10 Generator Rotor Assembly
11 Rear Bearing
12 Generator Stator Assembly
13 Rectifier Assembly
14 Voltage Regulator / Brush Holder Assembly
15 Generator Rear Bracket
16 Battery Positive Terminal Nut
17 Through Bolt

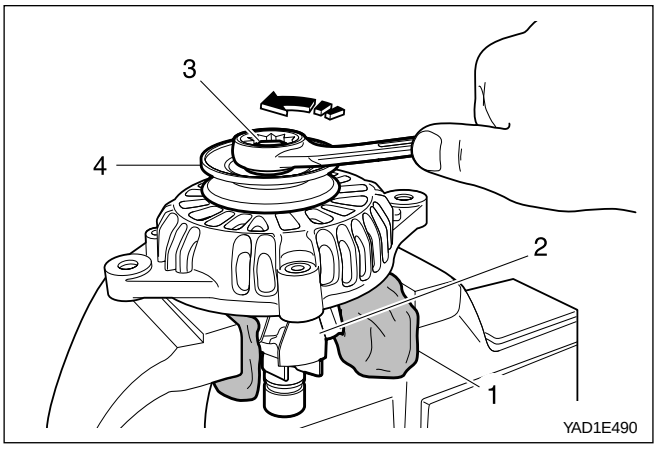


Disassembly Procedure

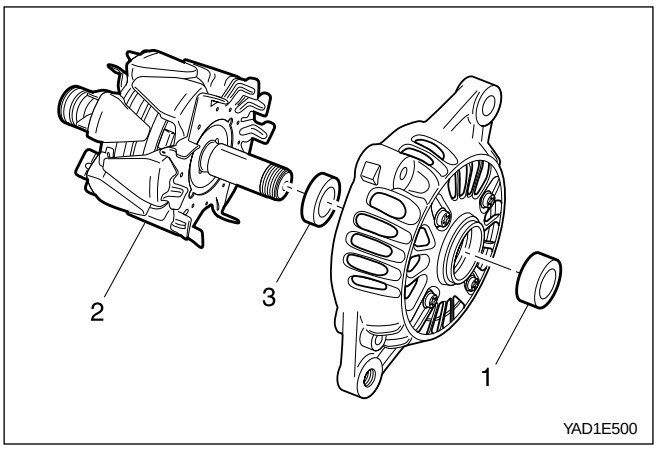
1. Remove the generator. Refer to “Generator” in this section.
2. Remove the front bracket and rear bracket.
   - Remove the through-bolts (1).



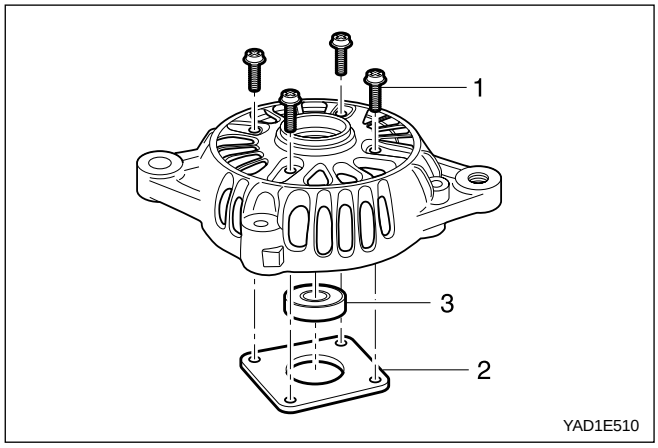
   - Pry front bracket downwards using a screwdriver (2).
   - Separate the front bracket and rear bracket (3).



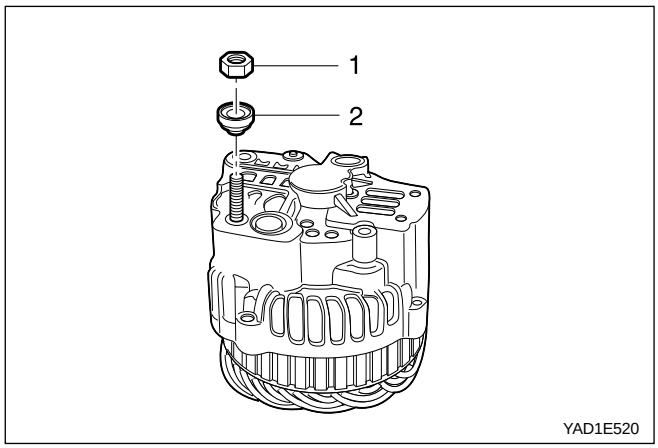
3. Remove the pulley and rotor assembly from the front bracket.
   - Cover the rotor with the cloth (1).
   - Place the pulley upwards and vice the rotor (2).
   - Remove the pulley nut (3).
   - Remove the pulley (4).



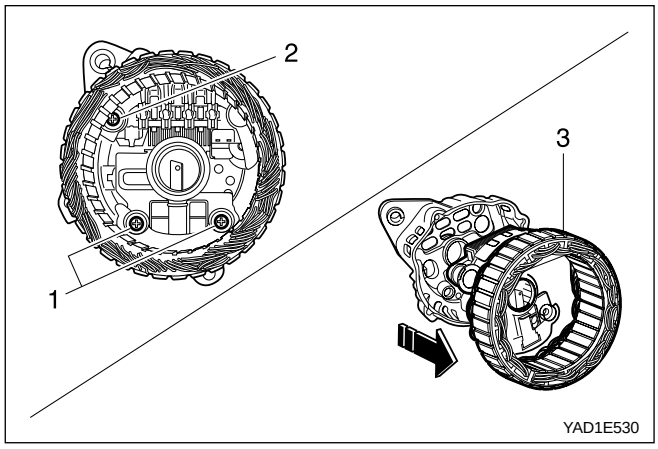
4. Remove the front bracket, rotor and collar.
   - Remove the collar (large) (1).
   - Remove the rotor from the front bracket (2).
   - Remove the collar (small) from the rotor shaft (3).



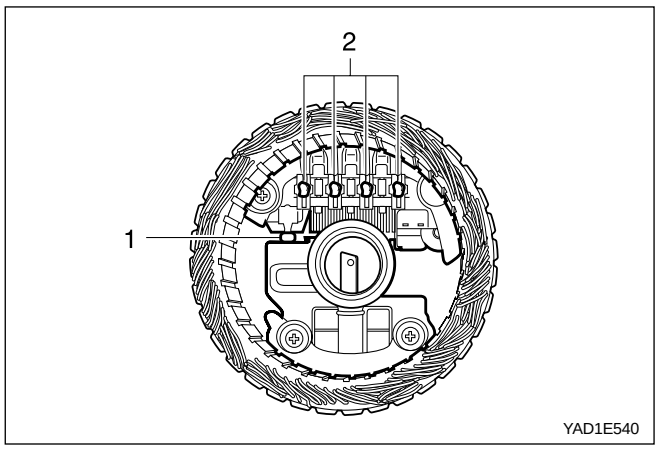
5. Remove the front bearing.
   - Remove the support plate screws (1).
   - Remove the plate (2).
   - Remove the front bearing using the press (3).



6. Remove the battery positive terminal nut from the rear bracket.
   - Remove the battery position terminal nut (1).
   - Remove the washer (2).

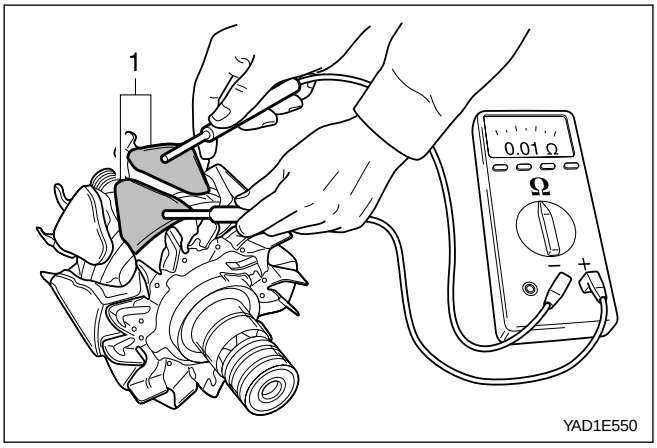


7. Remove the stator assembly from the rear bracket.
   - Remove the rectifier screw (1).
   - Remove the brush holder and regulator assembly screw (2).
   - Remove the stator assembly with the rectifier / brush holder / regulator (3).



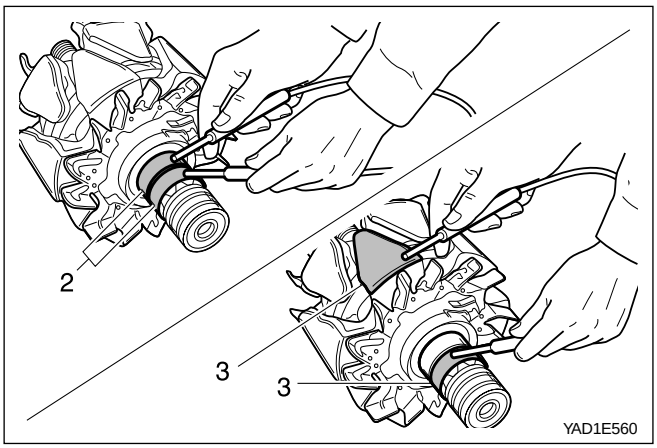
8. Remove the rectifier / brush holder / regulator from the stator.
   - Remove the rectifier / brush holder / regulator connections (1).
   - Remove the stator and rectifier connections (2).

   Notice: If the stator connections are welded, melt the lead. Avoid overheating as it can damage the diodes.



Inspection / Measurement

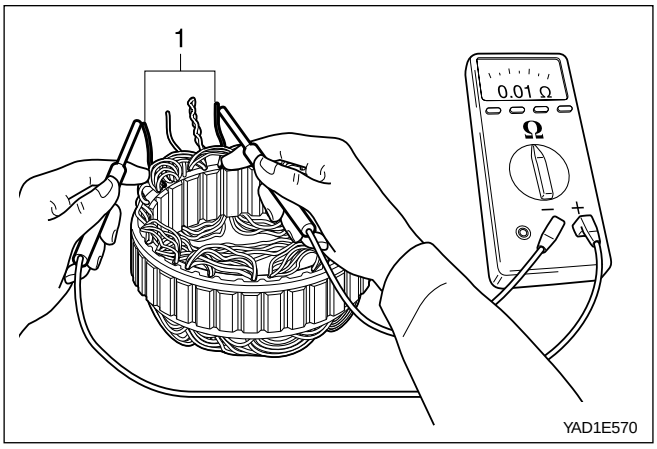
1. Inspect the rotor assembly.
   - Test the rotor for an open circuit by using the ohmmeter (1). Replace the rotor if necessary.



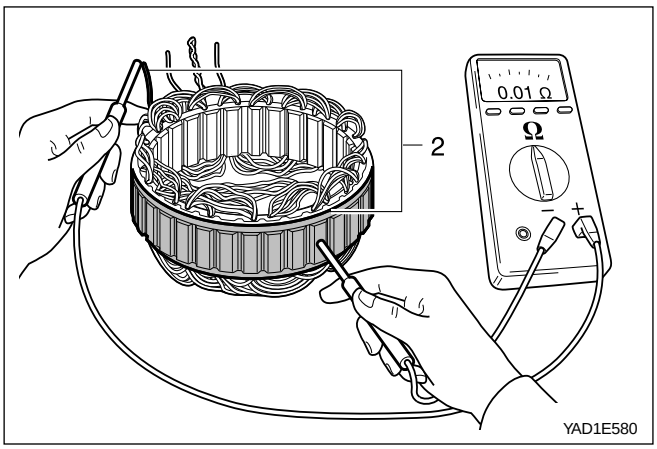
   - Test the rotor for open or short circuit (2).

Desciption	Limit
The measured resistance	2.9 Ω

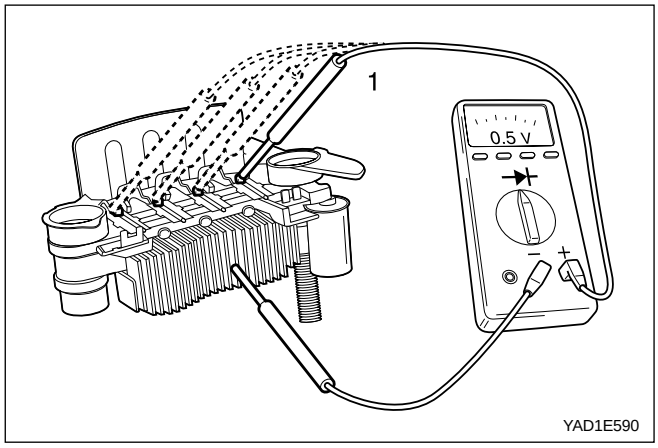
   - Replace the rotor if necessary.
   - Test the rotor for open or ground circuit by using the ohmmeter (3). Replace the rotor if necessary.



2. Inspect the stator.
   - Test the stator for an open circuit by using the ohmmeter (1). Replace the stator if necessary.

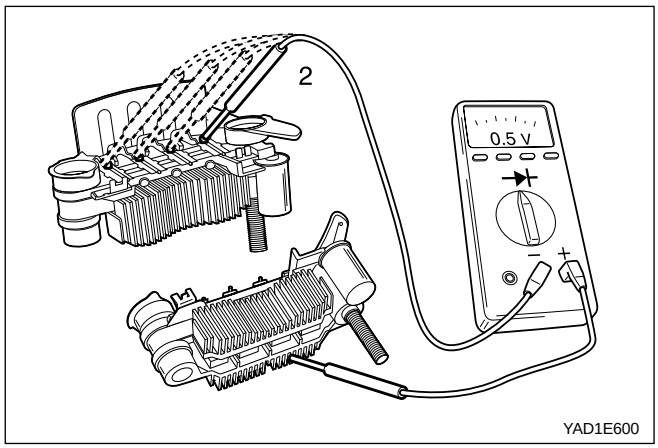


   - Test the stator for open or ground circuit by using the ohmmeter (2). Replace the starter if necessary.



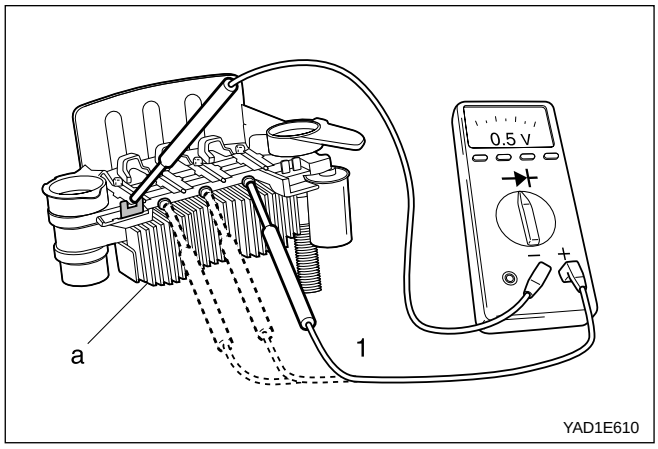
3. Inspect the rectifier.
   - Positive rectifier test :

     Inspect the open circuit for stator coil lead terminals using the ohmmeter (1). Replace the rectifier if necessary.

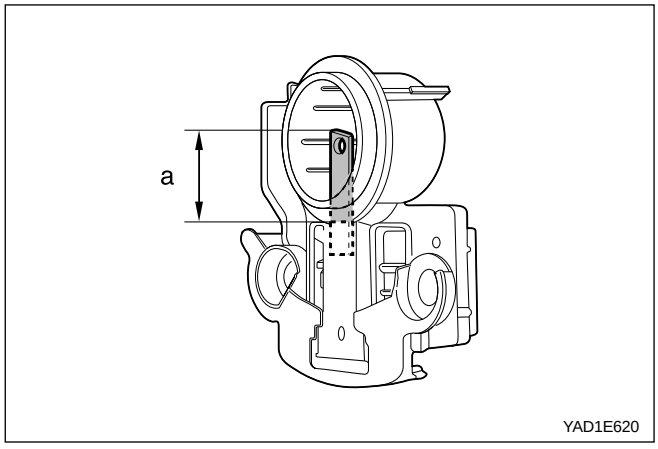


   - Negative rectifier test:

     Inspect the open circuit for stator coil lead terminals using the ohmmeter (2). Replace the rectifier if necessary.

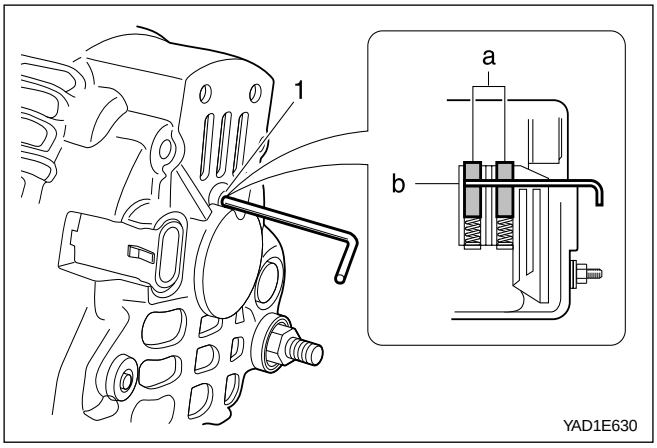


4. Inspect trio diodes.
   - Inspect the open circuit for trio diodes using the ohmmeter (1).
   - Replace the heat sink if necessary (a).



5. Inspect the brush wear.
   - If the brush wear exceeds the specified valve (a), replace the brush.

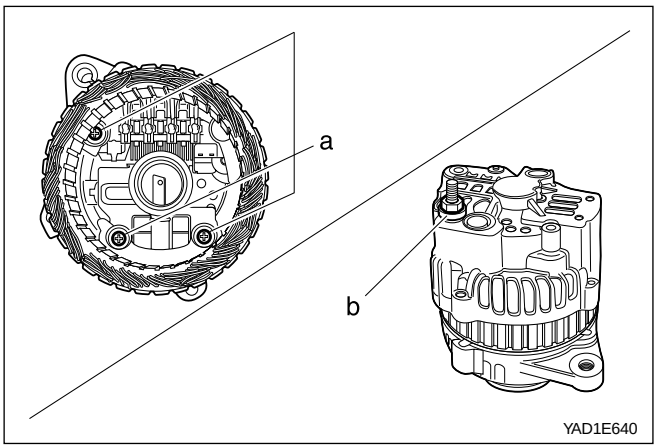
Application	Standard	Limit
Brushes wear	18.5 (0.73)	13.5 (0.53)



Assembly Procedure

1. Install in the reverse order of removal.
   - Assemble the stator assembly into the rear bracket and rotor assembly.

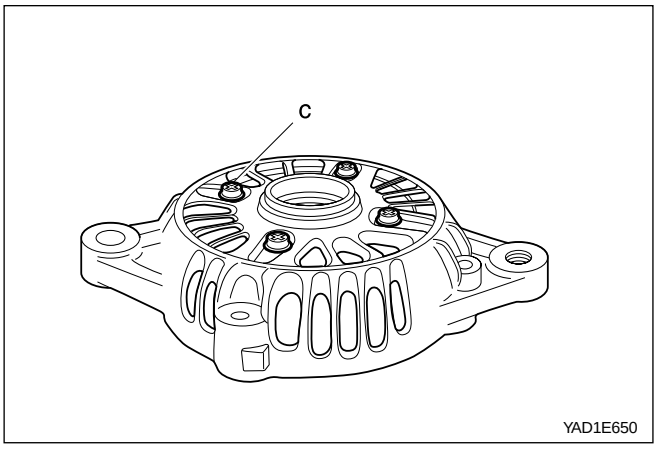
   a. Brushes.
   b. Hole.



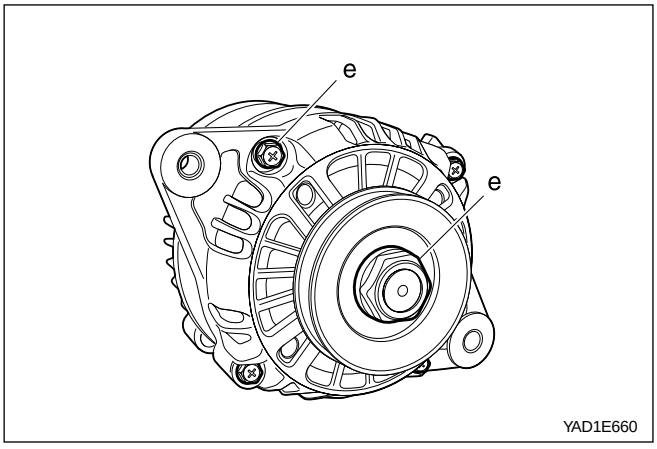
2. Install the bolts / nuts / screws.

   Tighten

   - Tighten the brush holder / regulator / rectifier screws to 9 - 12 N•m (80 - 106 Ib-in) (a).
   - Tighten the battery positive terminal nut to 4 - 7 N•m (35 - 62 Ib-in) (b).



   - Tighten the front bearing spot plate screws to 6 - 8N•m (53 - 71 Ib-in) (c).



   - Tighten the generator pulley nut to 80 - 110 N•m (59 - 81 Ib-ft) (d).
   - Tighten the through-bolts to 4 - 6 N•m (35 - 53 Ib-in)

SPECIFICATIONS

GENERAL SPECIFICATIONS

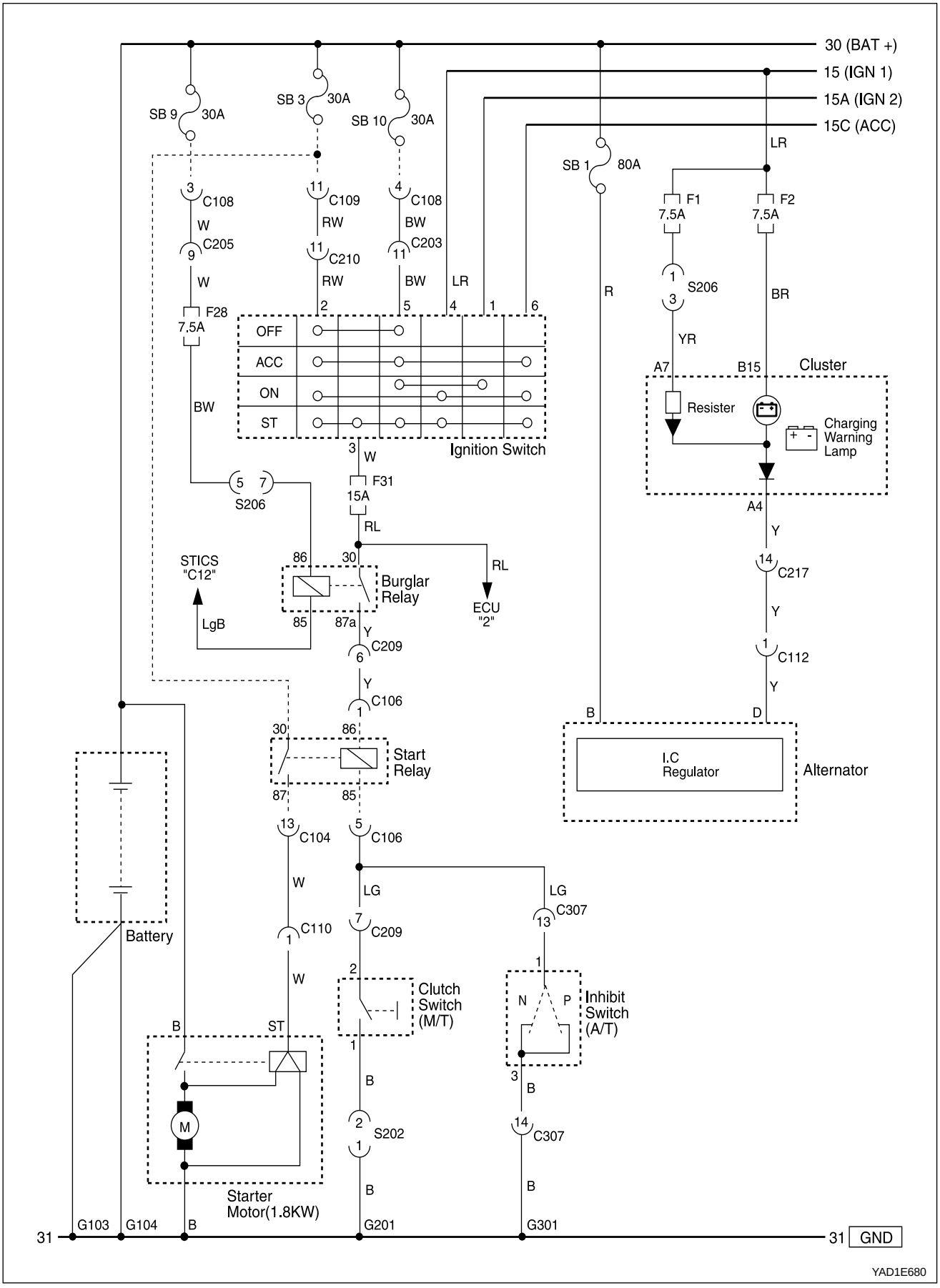
Application			Unit	Gasoline Engine	Diesel Engine
Starter	Type		-	PG170S	WP220
	Output Power		Kw	1.8	2.2
	No Load Test @ 12 volts		A	98	160
	Drive Pinion Speed at No Load		rpm	2,600	4500
	Drive Pinion Speed at Load		rpm/A	1,087/380	1700/430
	Brush Length		mm	16.1	18
	Armature Diameter		mm	54.1	55
	Armature Run-out		mm	0.08	0.1
	Segment Groove Depth		mm	19.6	21.7
Generator	Type		-	SG135	CS128D
	Output Voltage / Current		V/A	14/115	14/90
	Regulator Type		-	HYBRID	←
	Regulating Voltage		V	14.7	14.6
	Brush	Length	mm	18.5	12.5
		Quantity	-	2	2
		Abrasion Limit	mm	13.5	7
Battery	Type		-	MF	MF
	Capacity		AH	75	90
	Reserve Capacity		RC	130	160
Ignition Coil	Type		-	DIS	-
	Primary Coil Resistance		Ω	0.3 - 0.9	-
	Secondary Coil Resistance		KΩ	6 - 8.5	-
Spark Plug	Type		-	WR8DC	-
	Clearance		-	0.8 - 0.9	-
High Tension Cable	Resistance		KΩ/m	1.9	-
Glow Plug	Type		-	-	
	Used Voltage		-	-	11.5
	Circuit Connection		-	-	Parallel
	Preheating Time		sec	-	60 - 90

FASTENER TIGHTENING SPECIFICATIONS

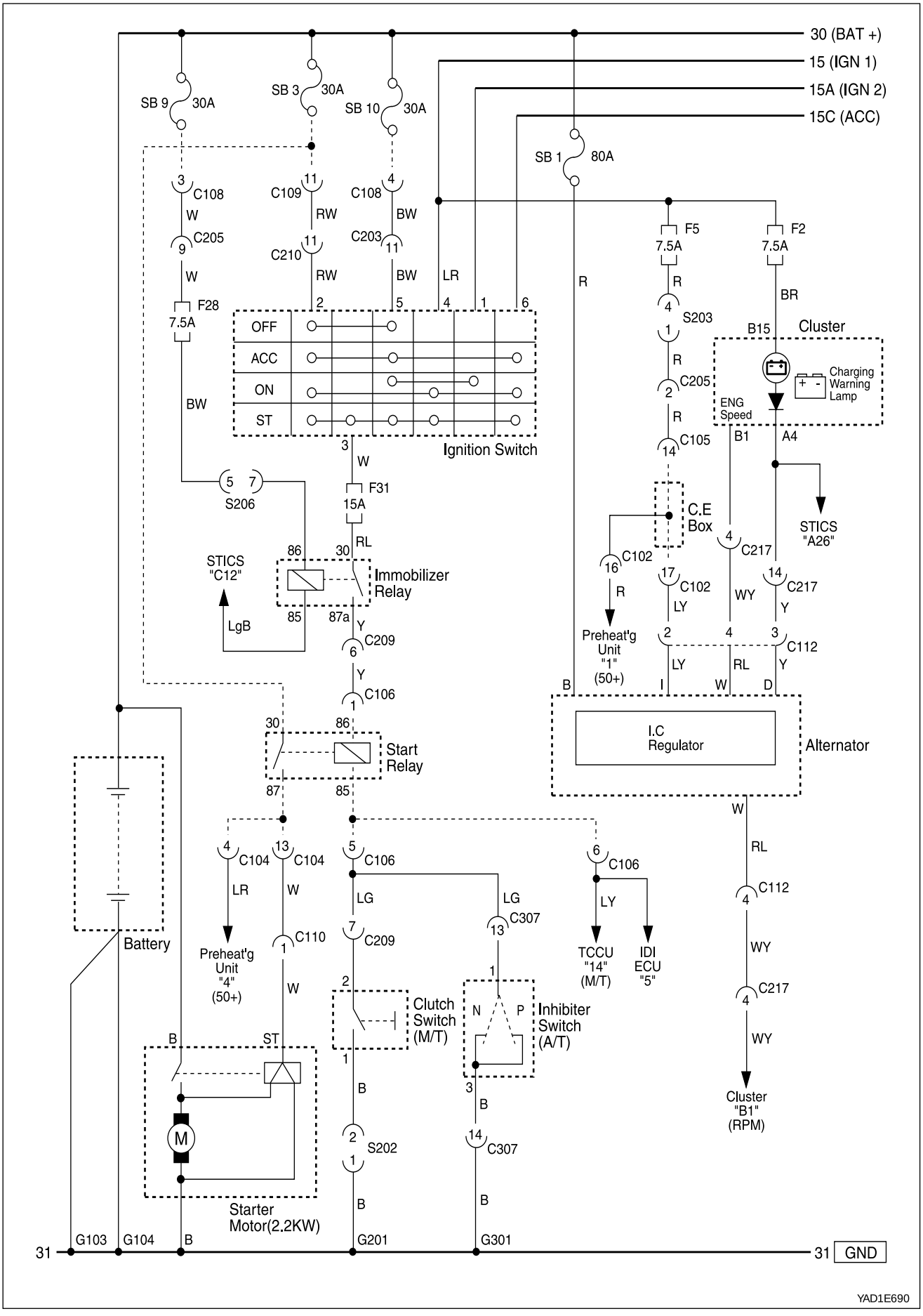
Application	N•m	Lb-Ft	Lb-In
Batter Cable Nut	12 - 18	9 - 13	-
Battery Cable Nut on Starter	12 - 15	9 - 11	-
Batter Mounting Bracket Nut	12 - 18	9 - 13	-
Engine Electric Wire Nut on Starter	6 - 7	-	53 - 62
Generator Combination Bolt	42 - 50	31 - 37	-
Generator Terminal B+ Nut	14 - 18	10 - 13	-
Generator Terminal D+ Nut	4 - 5	-	35 - 44
Glow Plug	20	15	-
Glow Plug Nut	4	-	35
Ignition Cable Cover Bolt	9 - 11	-	80 - 97
Ignition Coil Bolt	9 - 11	-	80 - 97
Spark Plug	25 - 30	15 - 22	-
Starter Mounting Bolt	35 - 48	26 - 35	-

SCHEMATIC AND ROUTING DIAGRAMS

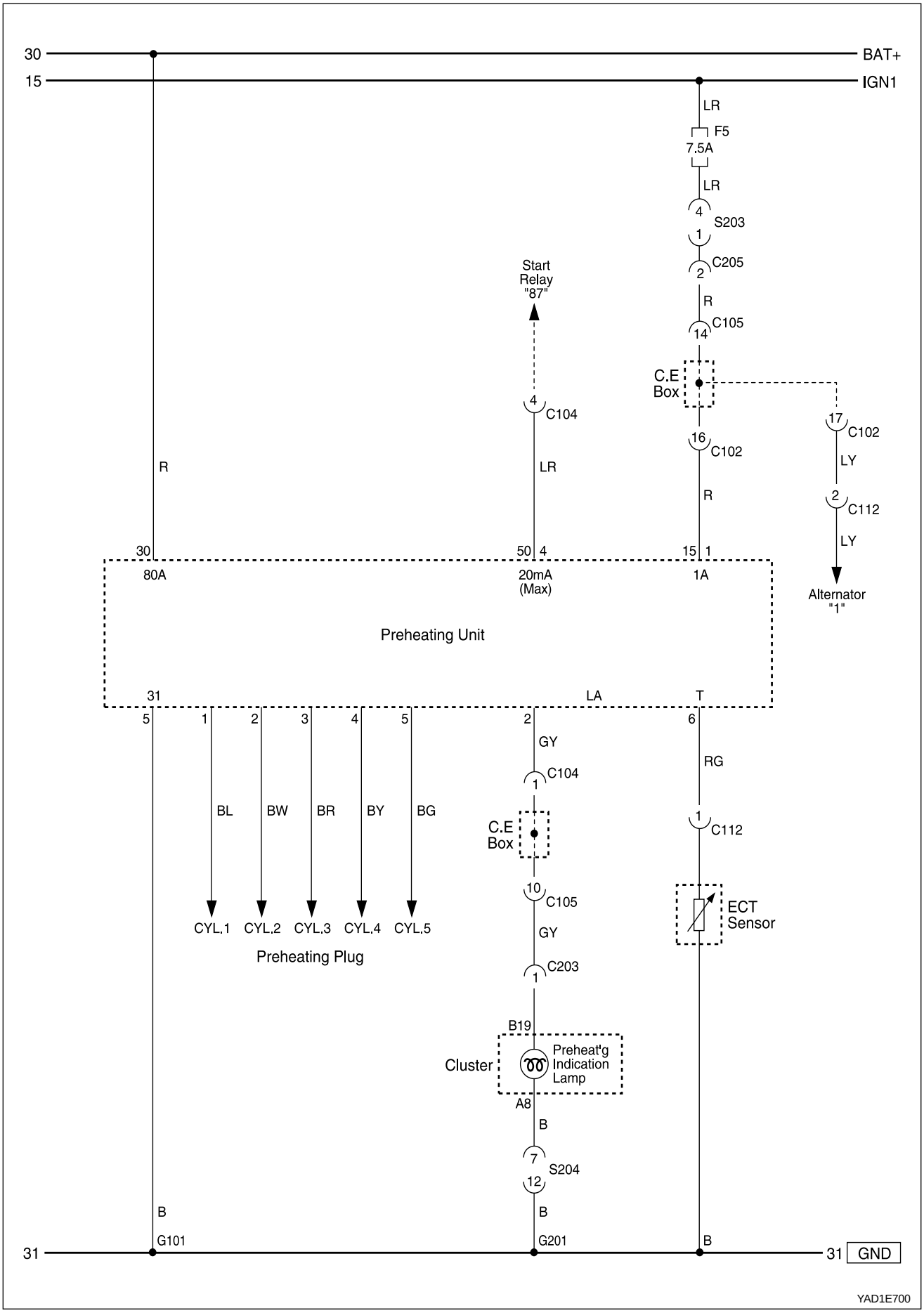
STARTING AND CHARGING SYSTEM (GASOLINE ENGINE)



STARTING AND CHARGING SYSTEM (DIESEL ENGINE)

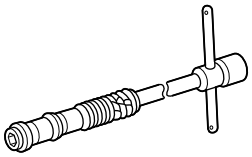


PREHEATING SYSTEM (DESEL ENGINE)



SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS TABLE

 YAD1E670	**120 589 02 09 00** **Spark Plug Wrench**