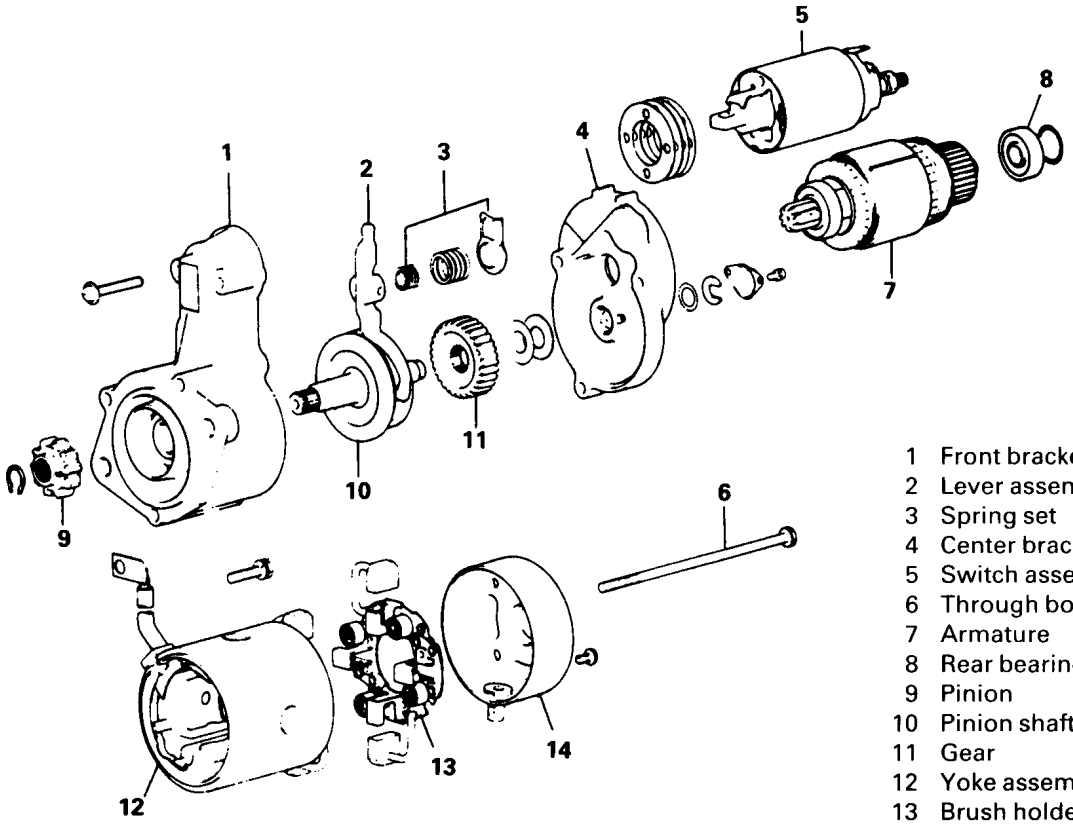
ENGINE ELECTRICAL

CONTENTS

1. SPECIFICATIONS

Description	Specifications	Remarks
Starting motor		
Type	Electromagnetic push-in, reduction drive type	
Part No.	M2T56185	
Output	2 kW	
Turning direction (as viewed from pinion side)	Clockwise	
Number of pinion teeth	12	
No load characteristics		
Terminal voltage	11V	
Current	130A max.	
Speed	4 000 rpm	
Alternator		
Type	AC type with vacuum pump	
Part No.	A5T15784	
Output	12V – 45A	
Regulator type	IC regulator	
No-load regulated voltage	14.4 ± 0.3V (at 20°C)	
Output characteristics		
When cold (20°C)	18A (13.5V, 1 300 rpm)	
	42A (13.5V, 2 500 rpm)	
When hot	14A (13.5V, 1 300 rpm)	
	36A (13.5V, 2 500 rpm)	
	44A (13.5V, 5 000 rpm)	
Capacitor capacity	0.5 μF	
Vacuum pump		
Type	Vane type	
Discharge/rev.	30 cc	
Attainable vacuum	600 mmHg min. (at 3 000 rpm)	
Glow plug		
Type	Sheathed type	
Voltage – Resistance	12.0V – 0.25 Ω	
Energization control	Electronic control	
Control elements (see "Chassis".)	Glow control unit	
	Glow plug relay	

2. STARTING MOTOR



1 Front bracket assembly
2 Lever assembly
3 Spring set
4 Center bracket assembly
5 Switch assembly
6 Through bolt
7 Armature
8 Rear bearing
9 Pinion
10 Pinion shaft assembly
11 Gear
12 Yoke assembly
13 Brush holder assembly
14 Rear bracket

DEL002

2.1 INSPECTION AND ADJUSTMENT

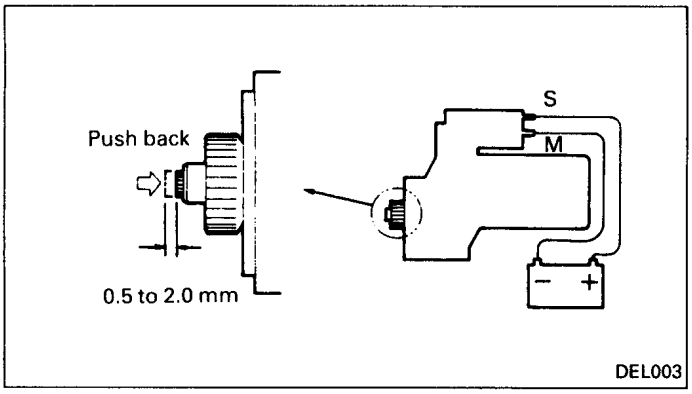
If defective, adjust or disassemble and correct.

Pinion Gap

1. Connect the positive side + of the battery (12V) to the S terminal of the starting motor and the negative side – to the M terminal to cause the pinion to pop out.

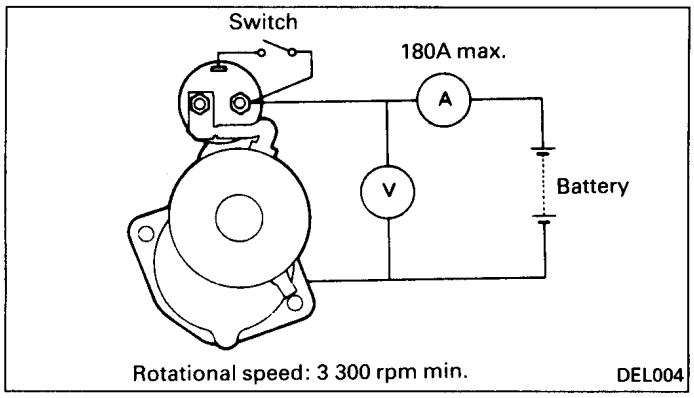
Caution:

- **Do not energize over 10 seconds.**



2. Lightly push down the popped out pinion with finger to measure the back stroke (shift).
3. If the measured value is not within the range of 0.5 to 2.0 mm, adjust it by increasing the number of switch packings.
   Increasing the number of packings decreases the pinion gap.

No-load Test

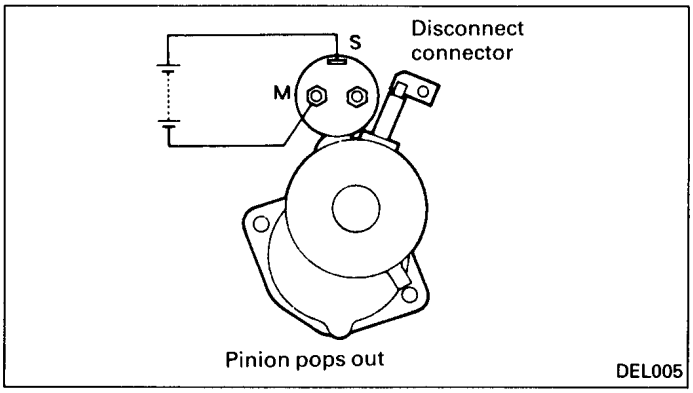


1. Connect an ammeter, a voltmeter and a battery.
2. It is normal if the pinion pops out and the starting motor turns smoothly upon turning on the switch. If the current or motor speed is not within the specified limits, disassemble and check the starting motor and correct as necessary.

Caution:

- **Use as thick wire as possible for wiring and tighten sufficiently the terminals.**
- **When checking rotational noises, note that the noise level is higher than the direct drive motor.**
- **When detecting rotations at the tip of the pinion, take sufficient care as the pinion will pop out.**

Magnetic Switch



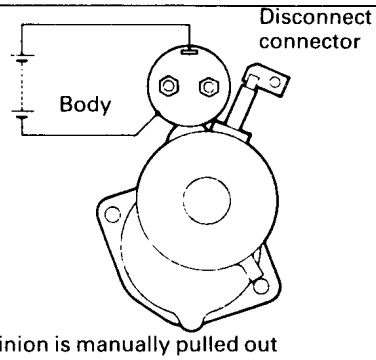
Check the following and replace the magnetic switch assembly if defective.

1. Disconnect the M terminal connector.
2. Attraction test
   It is normal if the pinion pops out when a battery is connected across the magnetic switch terminals S and M.

Caution:

- **Do not energize more than 10 seconds.**

3. Holding Test



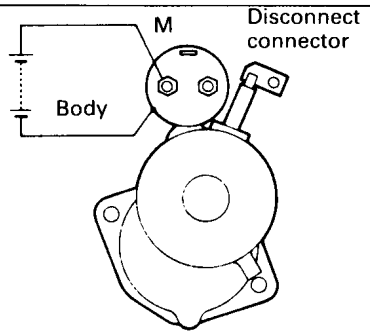
When pinion is manually pulled out and released, it does not return. DEL006

With a battery connected between the magnetic switch S terminal and the body, manually pull out the pinion as far as it goes. It is normal if the pinion does not return when it is released.

Caution:

- **Do not energize more than 10 seconds.**

4. Return Test



Manually pull out pinion and release. The pinion returns immediately. DEL007

With a battery connected between the magnetic switch M terminal and the body, manually pull out the pinion as far as it goes. It is normal if the pinion returns to initial position upon releasing.

Caution:

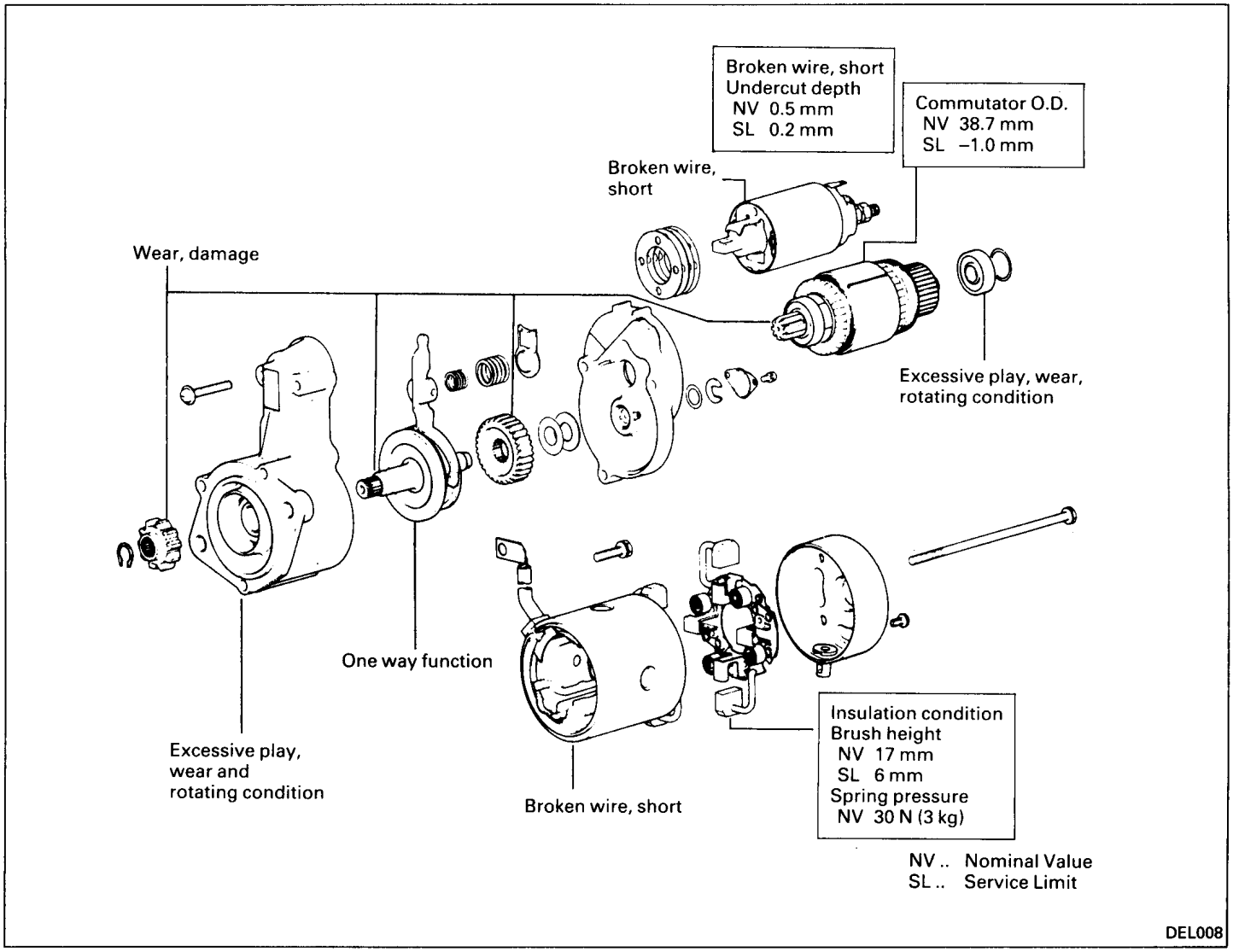
- **Do not energize more than 10 seconds.**

2.2 DISASSEMBLY

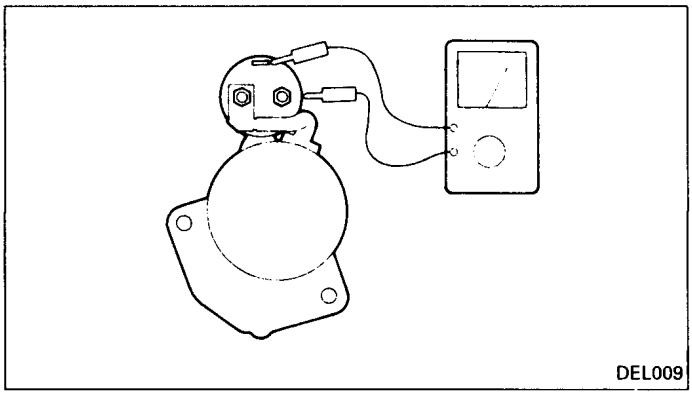
1. Loosen the M terminal nut and disconnect the connector.
2. Remove the two screws securing the magnetic switch and remove the magnetic switch assembly.
3. Remove the two through bolts and remove the two screws securing the brush holder. Then, remove the rear bracket.
4. While lifting two brushes, remove the yoke and brush holder assembly. Then, remove the armature.
5. Remove the cover and remove the snap ring and the washer.
6. Pull out the bolts and remove the center bracket. Several washers for adjusting the pinion shaft end play will come off simultaneously.
7. Remove the reduction gear, lever and lever spring from the front bracket.
8. Remove the snap ring securing the pinion and pull out the pinion and pinion shaft.
9. Using a bearing puller, etc, remove the ball bearings from both ends of the armature. The bearing press-fitted in the front bracket is not replaceable. Therefore, replace the front bracket assembly.

2.3 INSPECTION

Check the following.

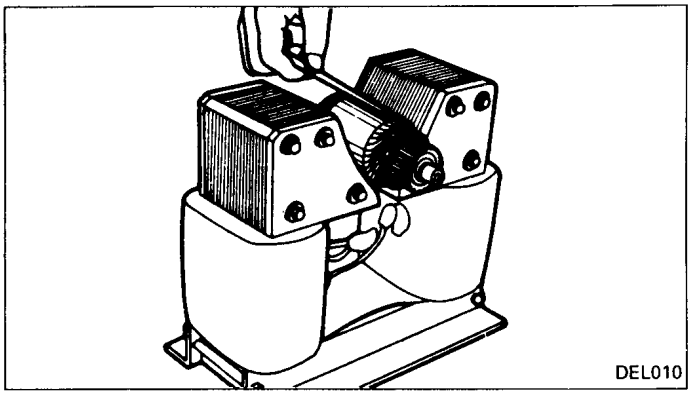


Checking Magnetic Switch



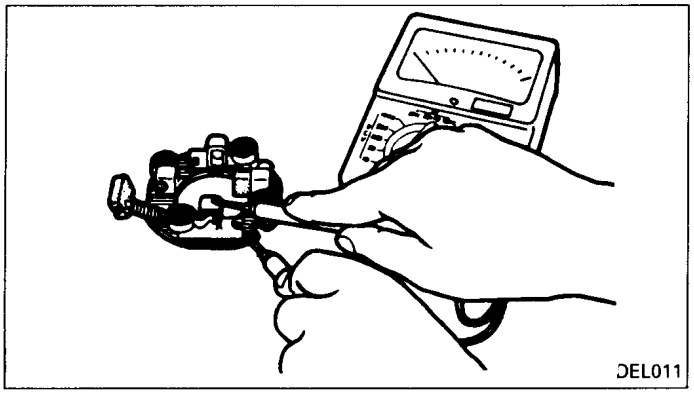
1. There must be continuity between the S and M terminals and between the S terminal and the body. If the resistance is zero (i.e. short circuited), replace the switch.

Checking Armature



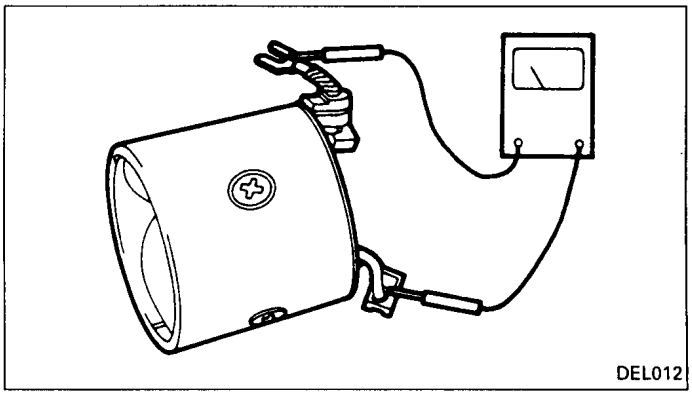
1. Using a growler, check the armature coil. Replace if short-circuited. Also check continuity between the commutator and the shaft and replace if there is continuity.
2. Measure the commutator O.D. and undercut depth. Correct or replace if the limits are exceeded. If the commutator outer surface is rough, use fine emery paper to correct it.

Checking Brush Holder



1. Check the brush and replace if worn to the wear limit line (service limit).
2. Check the brush spring tension and replace the brush holder assembly if the spring is defective.
3. Check for continuity between the positive + side brush holder and the brush holder base and replace the holder assembly if there is continuity. Also check for loose brush holder caulking.

Checking Field Coil



1. There must be no continuity between one end (brush) of the coil and the yoke.
2. There must be continuity between both ends (brush) of the coil.
3. The pole piece and the coil shall not be loose.

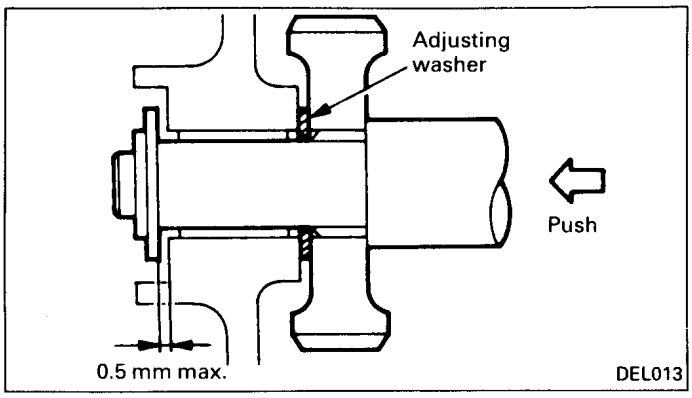
2.4 ASSEMBLY AND ADJUSTMENT

Assemble in reverse order of the disassembly, paying attention to the following.

Adjusting Pinion Shaft End Play

Adjust the end play to 0.5 mm or less by placing adjusting washer(s) between the center bracket and the reduction gear.

1. Assemble the pinion shaft, reduction gear, washer and snap ring to the center bracket.



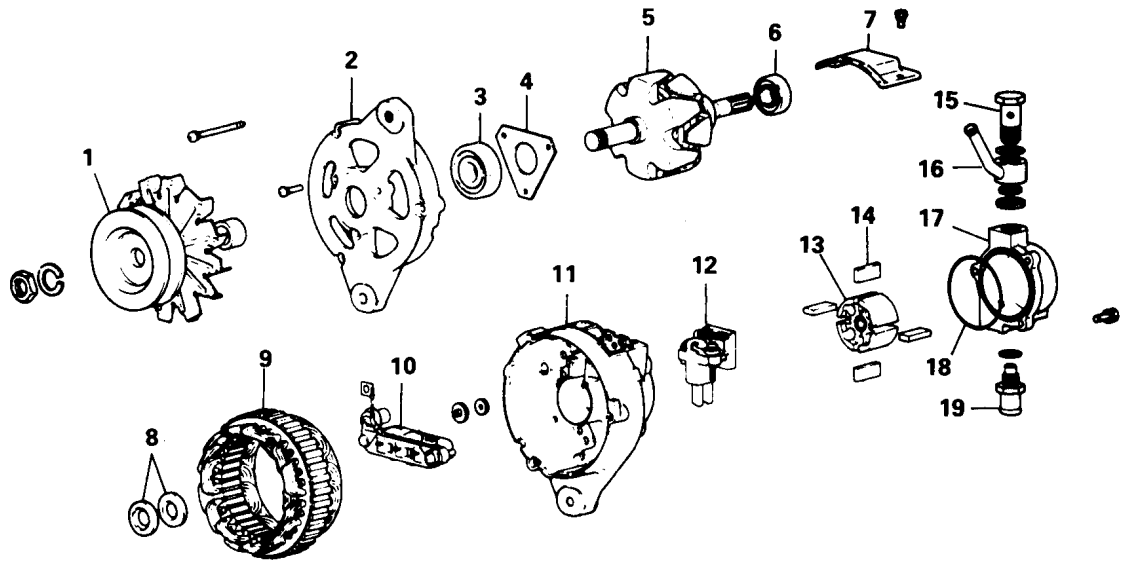
2. Slide the pinion shaft axially to measure the end play. If it exceeds 0.5 mm increase the number of adjusting washers to reduce the end play to 0.5 mm or less.

Lubrication

When the starting motor has been overhauled, apply grease to the following sliding parts, gears and bearings.

- Armature shaft gear and reduction gear
- Bearing
- Pinion shaft washer and snap ring
- Bearing sleeve
- Pinion
- Lever sliding part

3. ALTERNATOR



1	Pulley	6	Rear bearing	11	Rear bracket	16	Nipple
2	Front bracket	7	Cover	12	IC regulator	17	Housing
3	Front bearing	8	Oil seal	13	Rotor	18	O-ring
4	Bearing retainer	9	Stator	14	Vane	19	Joint
5	Rotor	10	Rectifier	15	Check valve		

DEL014

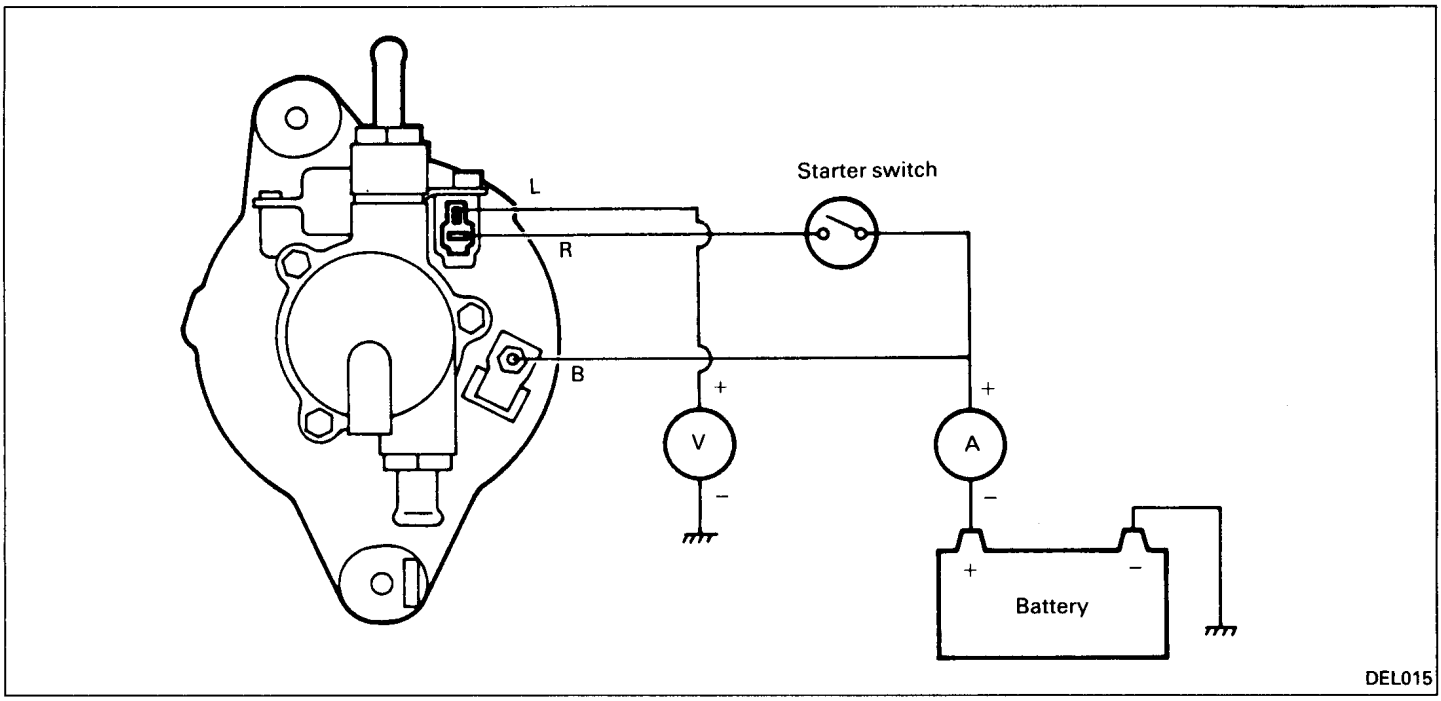
3.1 INSPECTION ON VEHICLE

Precautions on Handling

Pay attention to the following as mishandling could result in the failure or breakdown of the alternator.

1. Do not connect battery in reverse polarity.
2. Do not use megger or other high voltage tester.
3. Disconnect the battery cable when charging the battery.
4. Do not disconnect the lead from the B terminal of alternator while the engine is running.
5. Do not ground the B terminal of alternator as it is always applied with the battery voltage.
6. Do not short or ground the L terminal.
7. When using a steam cleaner, do not apply steam directly to the alternator.

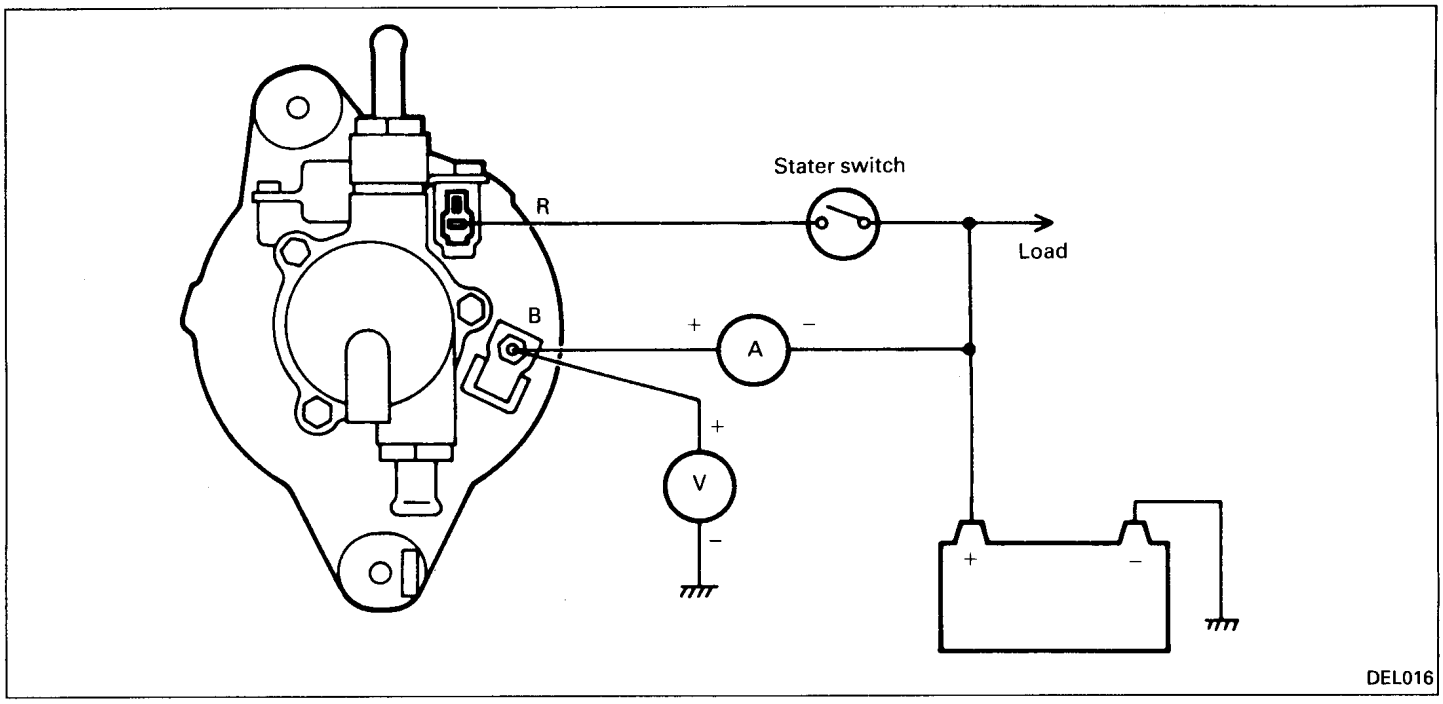
Checking Regulated Voltage



1. Disconnect the + terminal of battery and insert an ammeter.
2. Connect a voltmeter between the L terminal and the ground.
3. The voltmeter should read zero when the starter switch is turned off.
   The voltmeter should read voltage significantly lower than the battery voltage when the starter switch is turned on (the engine is not started).
4. With the ammeter terminals shorted, start the engine.
5. With the ammeter reading 5A max., the engine running at 2 000 to 3 000 rpm and the indicator lamp switches turned off, read the voltmeter (regulated voltage). Note that the regulated voltage changes with the alternator temperature, decreasing with increasing temperature.

Description	Nominal value
Regulated voltage (at 20°C)	14.4 ± 0.3V

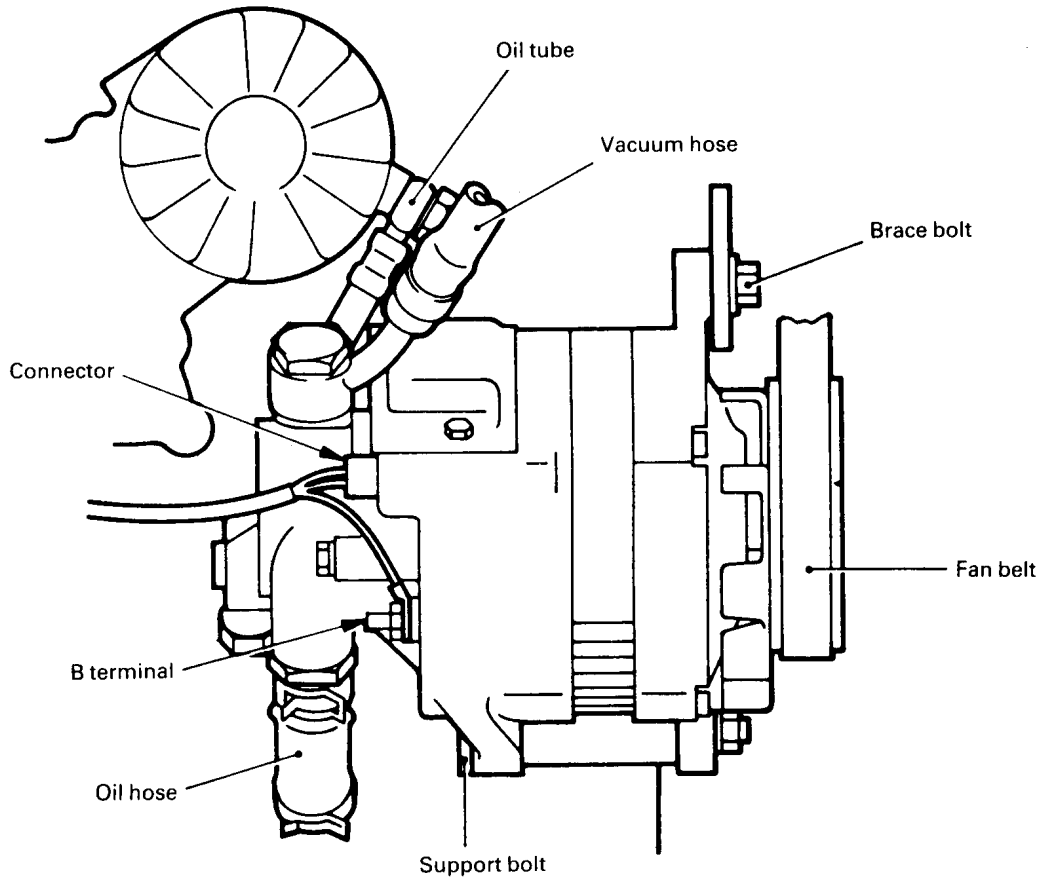
Checking Output



1. Disconnect the battery ground cable.
2. Disconnect the alternator B terminal and insert an ammeter. Connect a voltmeter between the B terminal and the ground.
3. Connect the battery ground cable.
4. Start the engine.
5. Connect all loads including indicator lamps, heater, etc.
6. Increase the engine speed and measure maximum output current obtained when the voltmeter indicates 13.5V and the alternator is at 2 500 rpm. The alternator is normal if the output current reading is over 70% of nominal output.

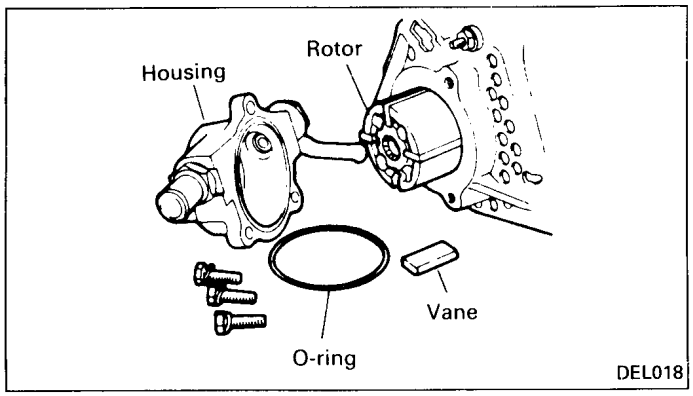
3.2 REMOVAL

1. Disconnect the battery ground cable.
2. Disconnect the lead from the B terminal on the rear of the alternator.
3. Disconnect the alternator connector.
4. Remove the oil tube, oil hose and vacuum hose.
5. Loosen the alternator brace bolts and support bolts and remove the fan belt with the alternator pressed against the engine.
6. Remove the alternator.

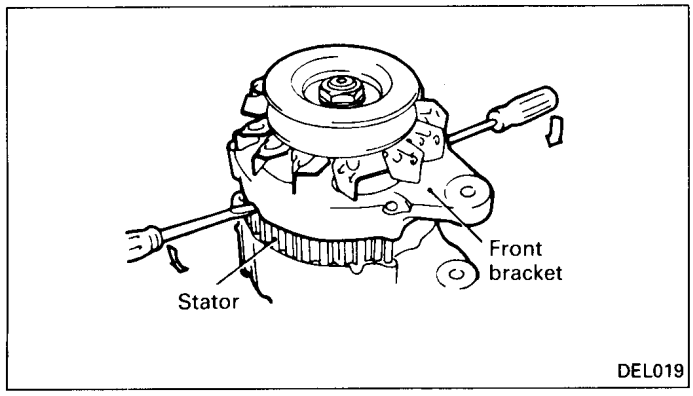


DEL017

3.3 DISASSEMBLING VACUUM PUMP



1. Remove the bolts securing the housing.
2. Remove the housing pulling it back straightly. Remove the vanes.
3. Remove the rotor.
4. Remove the rear bracket cover and remove the IC regulator assembly.

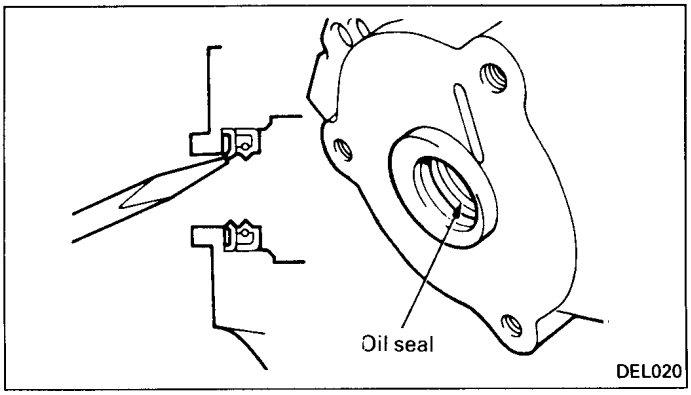


5. Remove the three through bolts securing the alternator and separate the front bracket from the stator, prying with a screwdriver for slotted screw heads inserted between the front bracket and the stator core. If they are not readily separated, tapping the front bracket with a plastic hammer while prying with a screwdriver will facilitate the separation.

Caution:

- **Do not insert the screwdriver too deep. The stator coil could be damaged.**

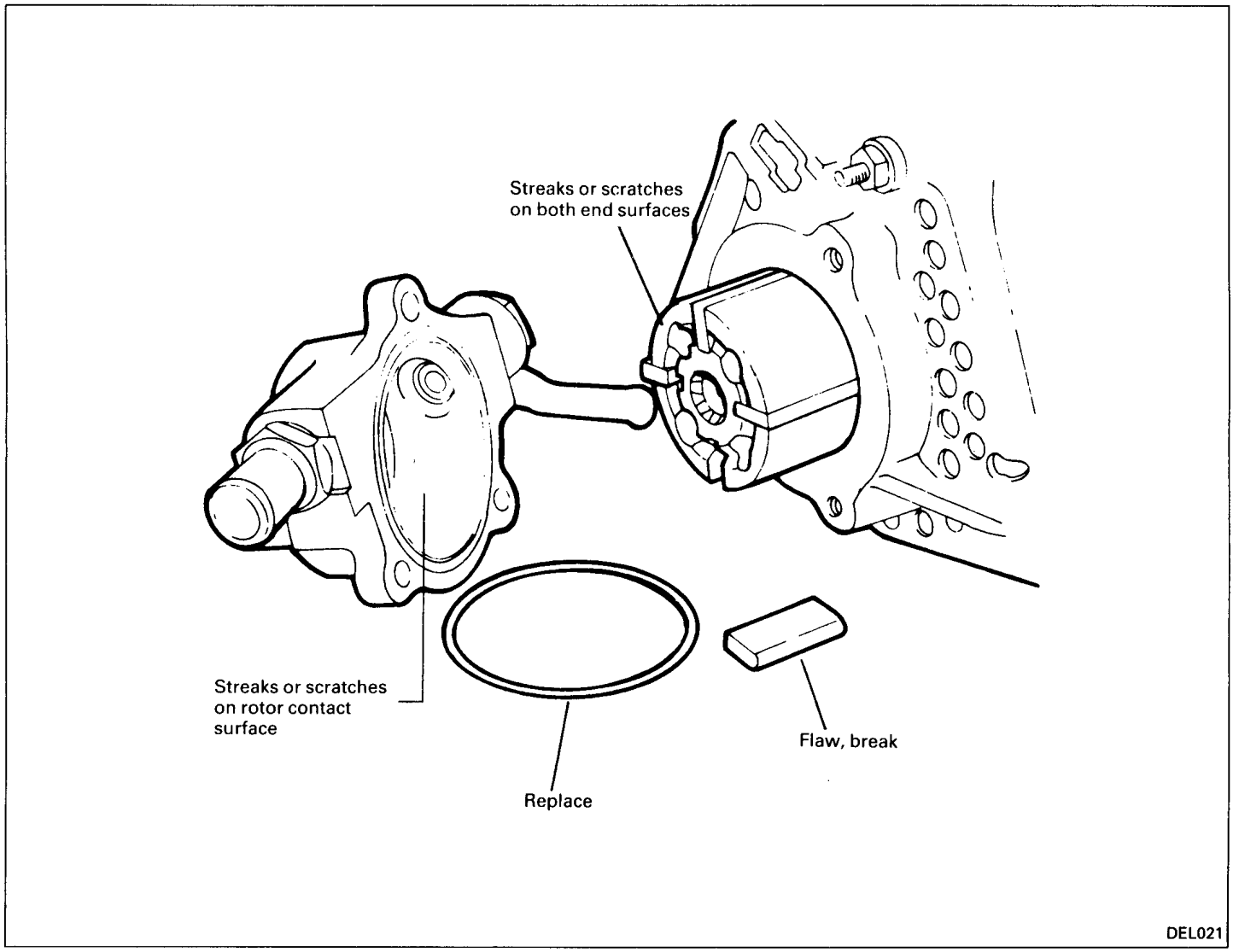
6. Remove the rotor together with the front bracket from the stator core.



7. Remove the oil seal, pushing out with a screwdriver.

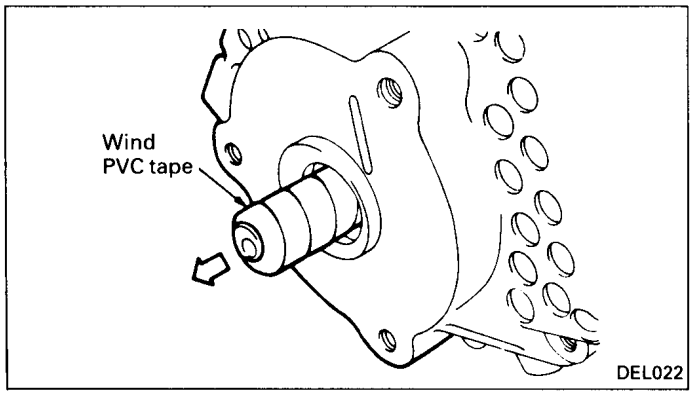
3.4 CHECKING VACUUM PUMP

Check and replace if defective.

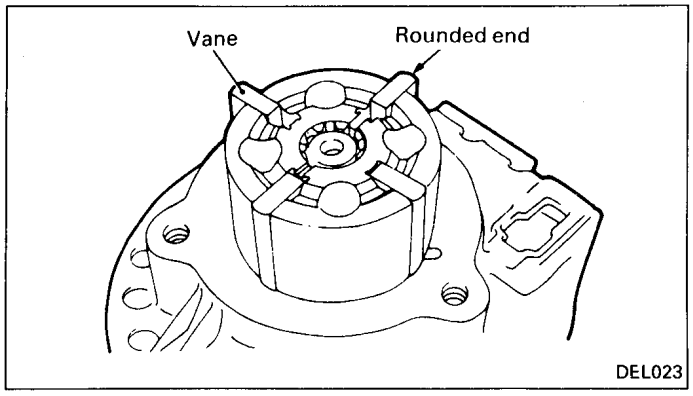


3.5 ASSEMBLING VACUUM PUMP

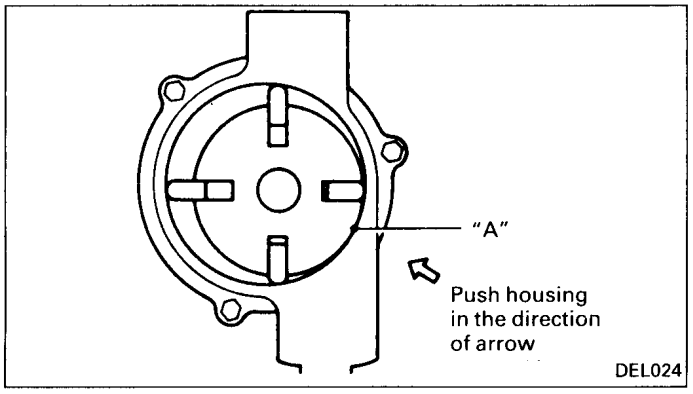
Assemble in reverse order of the disassembly, paying attention to the following.



1. When assembling the rotor to the alternator rear bracket, wind PVC tape or equivalent around the shaft splines to prevent damage of the oil seal and install the rotor slowly.
2. Make sure that the housing and the rotor are free from chips and other foreign material and apply engine oil to the sliding part before assembling.



3. Install the vanes with rounded end facing outward.
4. Apply grease to the O-ring and position it in the housing groove so that it will not be dislodged from the groove when the bolts are tightened.



5. When tightening the housing, push it lightly in the direction of arrow to minimize the clearance at point "A". Tighten the bolts evenly.
6. After assembly, be sure to conduct the performance test to check that the specified values are met.

Description		Nominal value
Attainable vacuum	Vacuum	600 mmHg min.
	rpm	3 000

3.6 DISASSEMBLING ALTERNATOR

1. Remove the vacuum pump.
2. Remove the rear bracket top cover and the voltage regulator assembly.
3. Remove the three through bolts. Then, remove the front bracket and the rotor, prying with a screwdriver (for slotted screw heads) inserted between the stator and the front bracket.

Caution:

- **Do not insert the screwdriver too deep. The stator coil could be damaged.**

4. Hold the rotor in a vice and remove the pulley nut. Then, pull out the pulley, fan and spacer.
5. Remove the rotor assembly from the front bracket.
6. Unsolder the stator coil leads and remove the stator assembly.

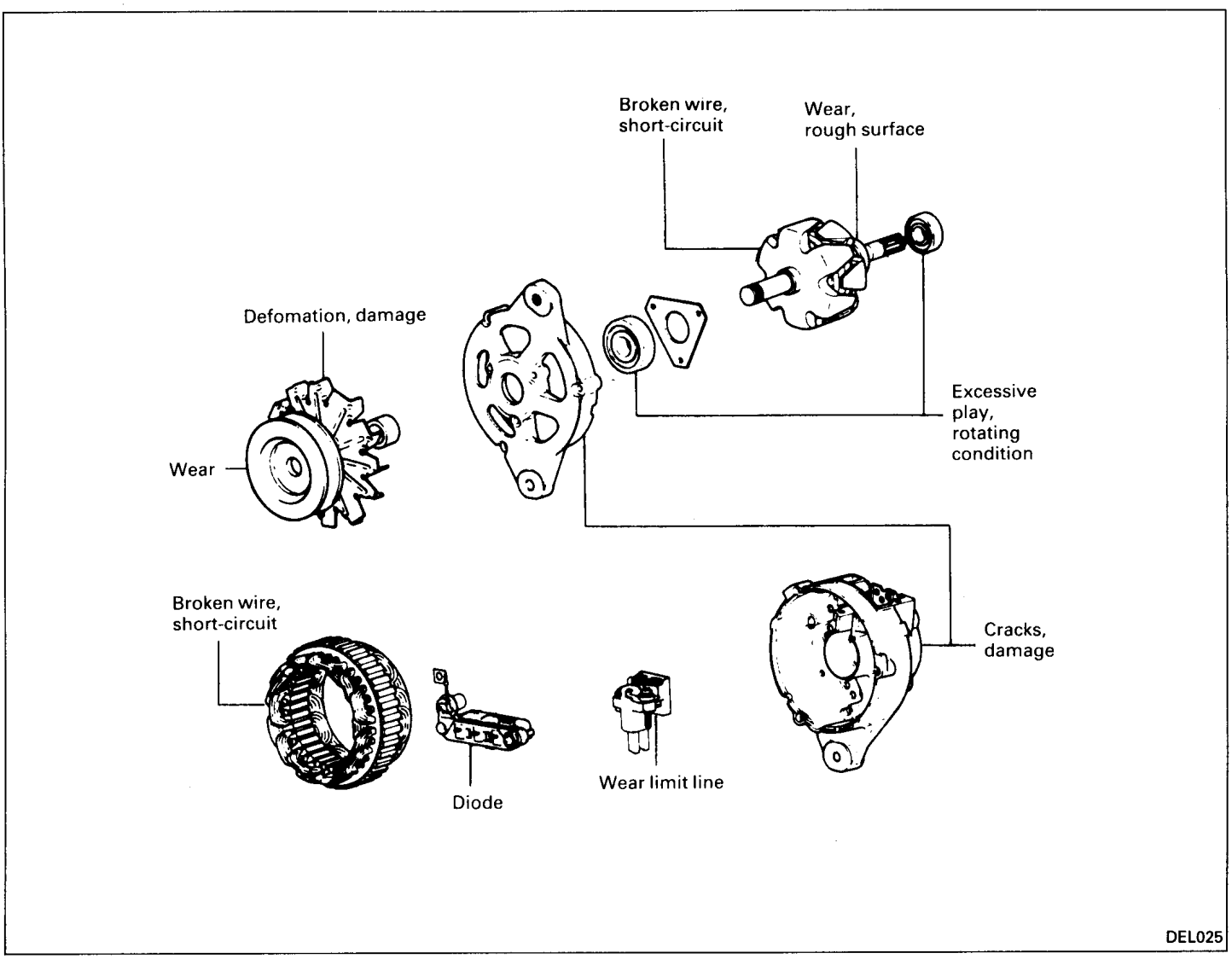
Caution:

- **Unsolder in as short a time as possible. Prolonged heating could result in damage to diode.**

7. Remove the capacitor from the B terminal.
8. Remove the screws securing the rectifier and remove the rectifier.

3.7 CHECKING ALTERNATOR

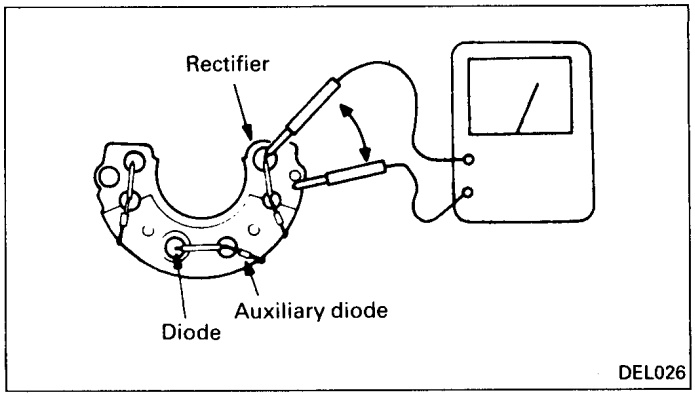
Check and replace if defective.



Checking Diodes

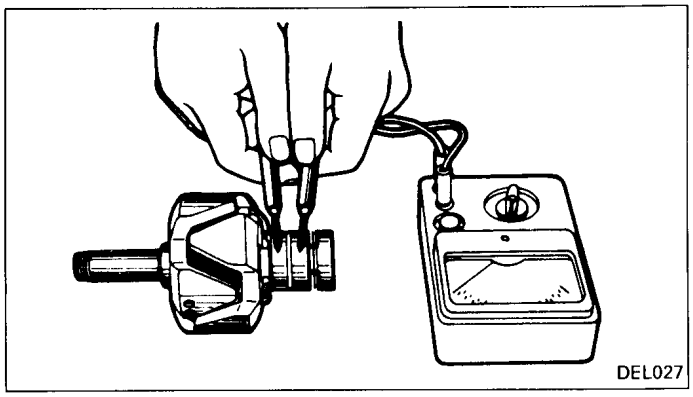
Check continuity of the diodes in te rectifier as follows.

1. Using a tester, check continuity between the lead of the diode and the diode case. It is normal if the resistance is large in one direction and small in the other direction.
2. The diode is defective if the same resistance is measured in both directions. In such a case, replace the rectifier assembly.

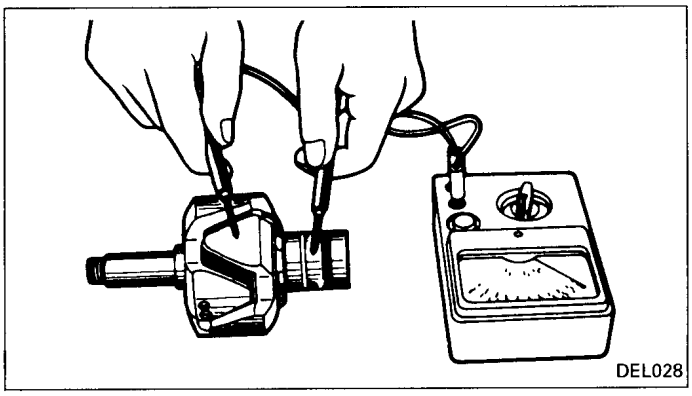


3. Conduct the same check on all diodes (9 in total).

Checking Field Coil

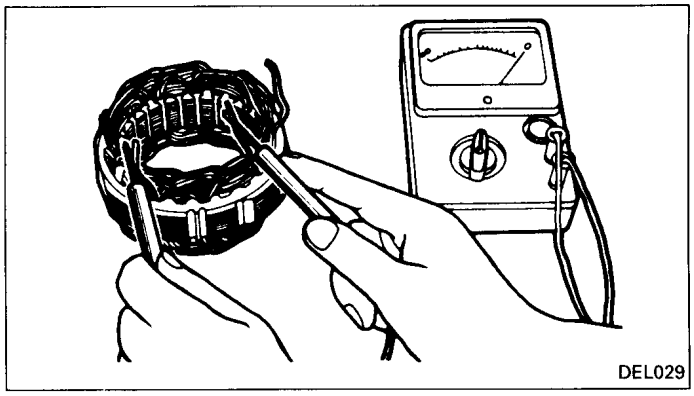


1. Check continuity between the slip rings. Absence of continuity means broken wire and requires replacement of the field coil.

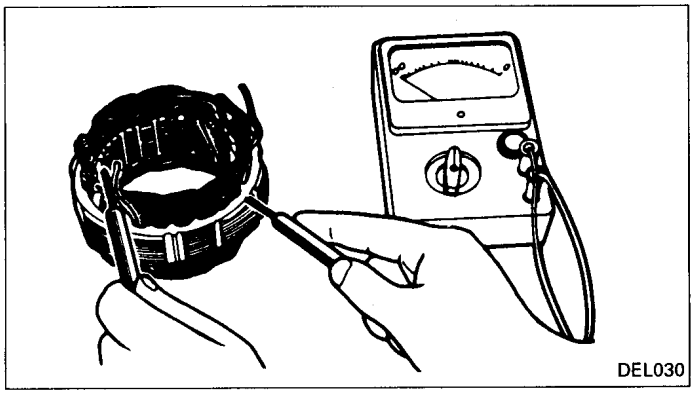


2. Check continuity between the slip ring and the shaft (or core). Presence of continuity means grounded field coil and requires its replacement.

Checking Stator Coil



1. Check continuity between stator coil leads. Absence of continuity means broken wire of the coil and requires replacement of the coil.



2. Check continuity between each lead of the stator coil and the stator core. Presence of continuity means grounded stator coil and requires replacement of the stator coil.

3.8 ASSEMBLING ALTERNATOR

Assemble the alternator in reverse order of the disassembly, paying attention to the following.

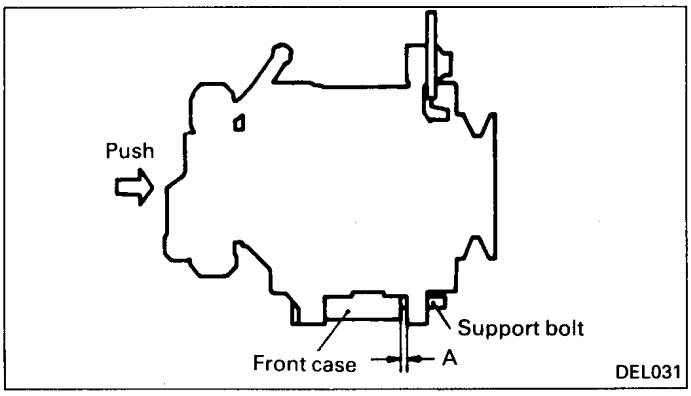
1. When soldering, take appropriate means to prevent transmission of heat from the soldering iron to the diode and complete soldering in as short a time as possible.
2. When inserting the rotor assembly in the rear bracket, take care not to damage the oil seal. (See "Assembling Vacuum Pump".)

3.9 INSTALLATION

Install the alternator in reverse order of the removal, paying attention to the following.

1. With the oil hose connected to the alternator, install the alternator, at the same time, installing the hose over the oil pan side nipple. Clamp the hose clip at the straight section of the nipple.
2. Install the oil tube, taking care to prevent it from contacting the cylinder block and with a redius of curvature large enough.

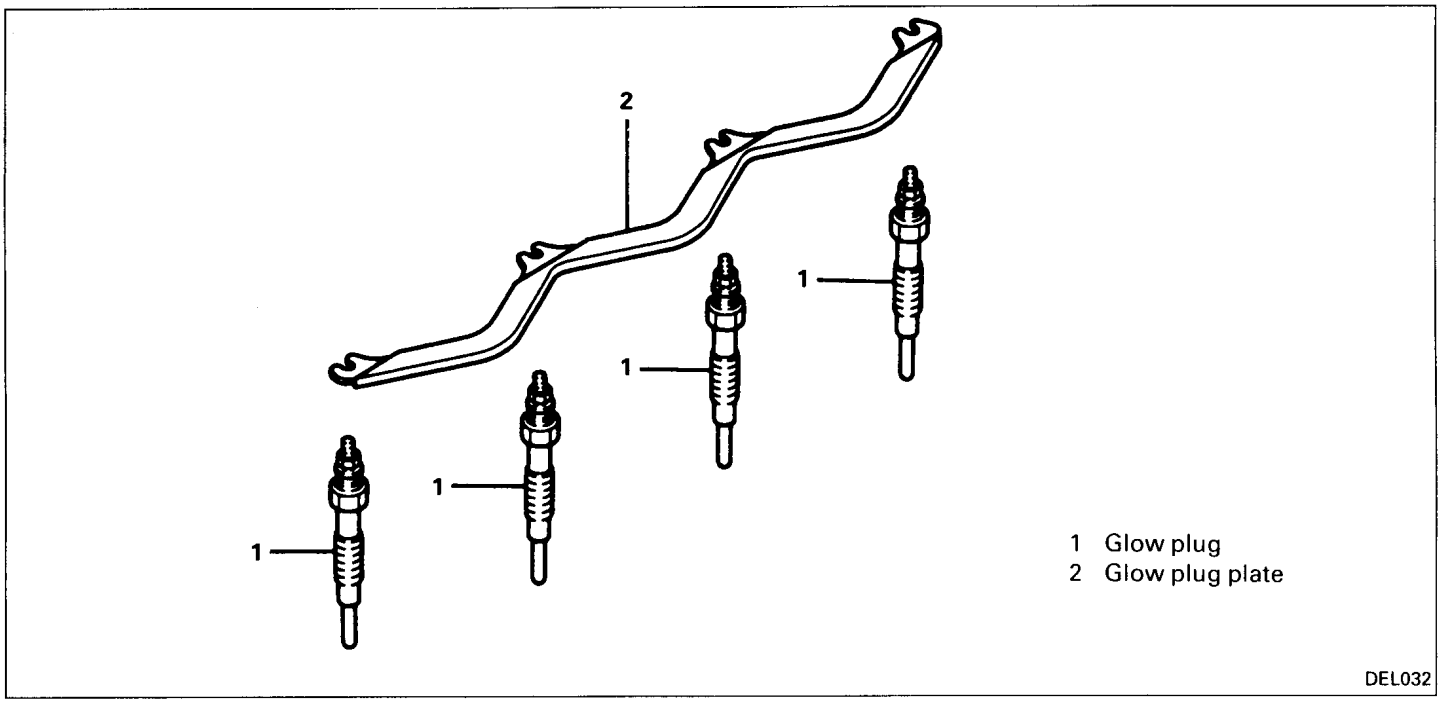
Adjusting Spacer



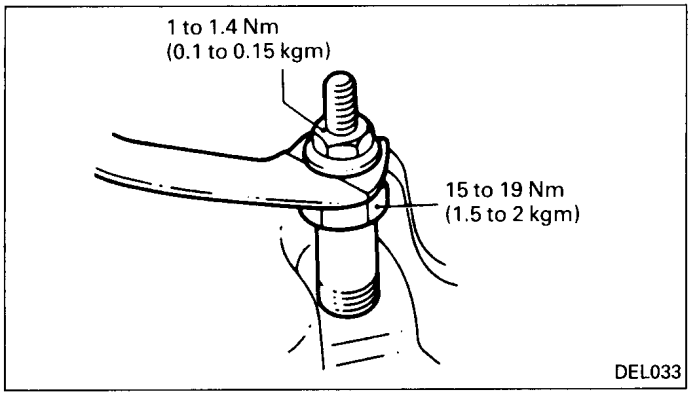
When installing the support bolt, insert spacers as follows.

1. Push in the support bolt to specified position (wihout nut).
2. With the alternator pushed forward, insert spacer(s) (0.2 mm thick) between the alternator front bracket and the front case to find the number of spacers required. (Use as many spacers as required to keep them in place after releasing them.)
3. Place required number of spacers at position A shown in illustration and assemble the alternator.
4. Adjust the belt tension.

4. GLOW PLUG



4.1 REMOVAL AND INSTALLATION

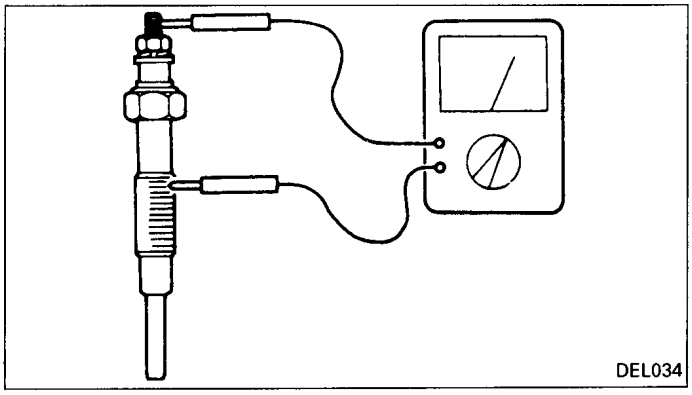


Tighten to the torque indicated in illustration.

Caution:

- **Tighten the glow plug plate correctly. Otherwise, poor continuity could result.**

4.2 INSPECTION



Check continuity between the terminal and the body as shown in illustration. Replace the glow plug if there is no large resistance or no continuity.

Caution:

- **When testing on vehicle, remove the glow plug plate and check each glow plug.**

5. TROUBLESHOOTING

5.1 STARTING SYSTEM

Problem	Probable cause	Remedy
1. Engine does not crank though starter motor spins	a. Defective starter motor components	a. Remove starter motor, inspect for broken or worn drive components.
	b. Defective flywheel ring gear	b. Inspect ring gear teeth. Replace flywheel if necessary.
2. Engine does not crank	a. Loosely connected or corroded battery cables	a. Clean and tighten cable connections.
	b. Undercharged battery	b. Check battery. Charge or replace.
	c. Burnt fusible link in main wire connected to ignition switch	c. Check fusible link – correct wiring problem.
	d. Loosely connected or broken cables	d. Tighten or replace cable.
	e. Starter motor malfunction	e. Repair or replace as required.
3. Engine cranks slowly	a. Loosely connected or corroded battery cables	a. Clean and tighten cable connections.
	b. Undercharged battery	b. Check battery. Charge or replace.
	c. Starter motor malfunction	c. Repair or replace as required.

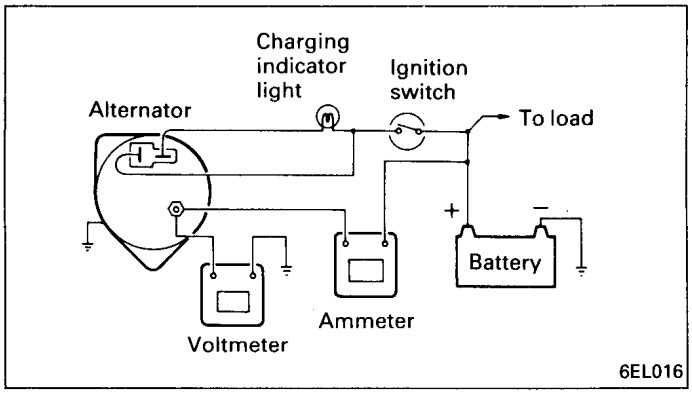
5.2 CHARGING SYSTEM

Problem	Probable cause	Remedy
1. Run-down battery	a. Loosely connected wiring	a. Tighten connections.
	b. Excessive load	b. Check accessory. Disconnect unnecessary accessories.
	c. Faulty battery	c. Check battery. Charge or replace.
	d. Faulty alternator (including voltage regulator)	d. Repair or replace as necessary.
2. Overcharge	a. Faulty voltage regulator	a. Replace regulator.
	b. Damaged battery	b. Check battery and replace as necessary.

5.3 GLOW CONTROL SYSTEM

Problem	Probable cause	Remedy
1. Hard starting at coolant temperature below 30°C	a. Loose connections or wrong wiring b. Faulty coolant temperature sensor c. Faulty glow plug d. Faulty glow plug relay e. Faulty glow control unit	a. Correct wiring and tighten connections. b. Inspect coolant temperature sensor, replace if necessary. c. Inspect glow plug resistance; replace if necessary. d. Inspect relay; replace if necessary. e. Perform engine starting test with new glow control unit connected. If necessary, replace control unit.
2. Engine stall after first explosion or rough idle at coolant temperature below 30°C	a. Loose connections or incorrect wirng harness b. Faulty glow plug c. Open dropping resistor d. Faulty glow plug relay (relay 2 for QGS or S-QGS) e. Faulty glow control unit	a. Correct wiring and tighten connections. b. Inspect glow plug resistance; replace if necessary. c. Inspect resistance and replace resistor if necessary. d. Inspect relay; replace if necessary. e. Perform engine starting test with new glow control unit connected. If necessary, replace control unit.
3. Red or green preheat indication lamp does not light (except for S-QGS)	a. Lamp opened b. Loose connections or broken wiring c. Faulty glow control unit	a. Replace red lamp. b. Replace wiring and tighten connections. c. Perform test with new glow control unit connected. If necessary, replace control unit.
4. Red or green preheat indication lamp does not go out (except for S-QGS)	a. Faulty coolant temperature sensor b. Wiring harness shorted c. Faulty glow control unit	a. Replace sensor. b. Repair or replace wiring harness. c. Replace unit if necessary.

5.4 ALTERNATOR OUTPUT CURRENT TEST



1. Place ignition switch to "OFF".
2. Disconnect battery positive cable.
3. Disconnect the cable from terminal "B" of alternator and connect an ammeter between terminal "B" and the cable.
4. Connect a voltmeter between terminal "B" of alternator and ground.
5. Set the engine tachometer.
6. Connect the battery cable to battery. The voltmeter should indicate the battery voltage.
7. Start the engine.
8. Turn on all electrical loads, accelerate the engine speed to the approx. 1 200 rpm and measure the output current.

Output current: Over 70% of nominal output

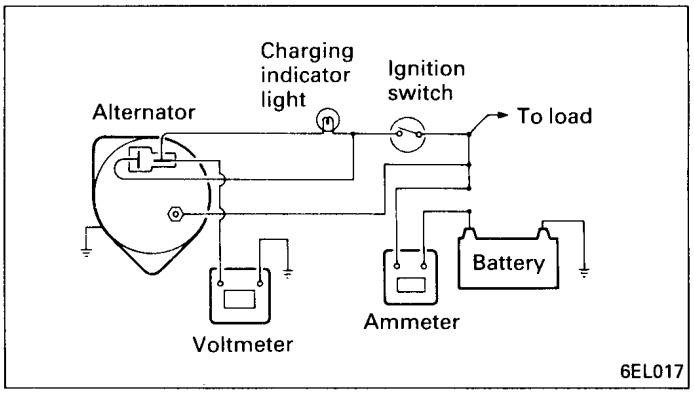
If output current is below 70% of nominal value, possible cause is poor brush contact (dirty slip ring), shorted field coil, defective diode, or defective voltage regulator.

NOTE:

1. After the engine has been started, the ammeter indication will drop as the battery reaches the fully charged condition.
Read the indication at its maximum value while increasing engine speed.

2. If the battery used for test is fully charged, current will not flow and alternator output current measurement is impossible. Measure the output current after the battery has been discharged by cranking engine or connecting additional electrical loads using parallel circuits.

5.5 ALTERNATOR OUTPUT VOLTAGE TEST



1. Turn ignition switch OFF.
2. Disconnect battery positive cable.
3. Connect a voltmeter between terminal "L" of alternator and negative terminal of battery.
4. Set engine tachometer.
5. Connect battery cable to battery.
6. Start engine.
7. Increase engine speed to 2 300 rpm and measure the regulated voltage.

Regulated voltage: 14.4 ± 0.3 V at 20°C

If voltmeter indication is less than battery voltage, alternator can be generating no current. Inspect alternator and voltage regulator to locate the cause.