

Rio Engine Electrical System

IGNITION SYSTEM	EE - 2
CHARGING SYSTEM	EE - 8
STARTING SYSTEM	EE -22

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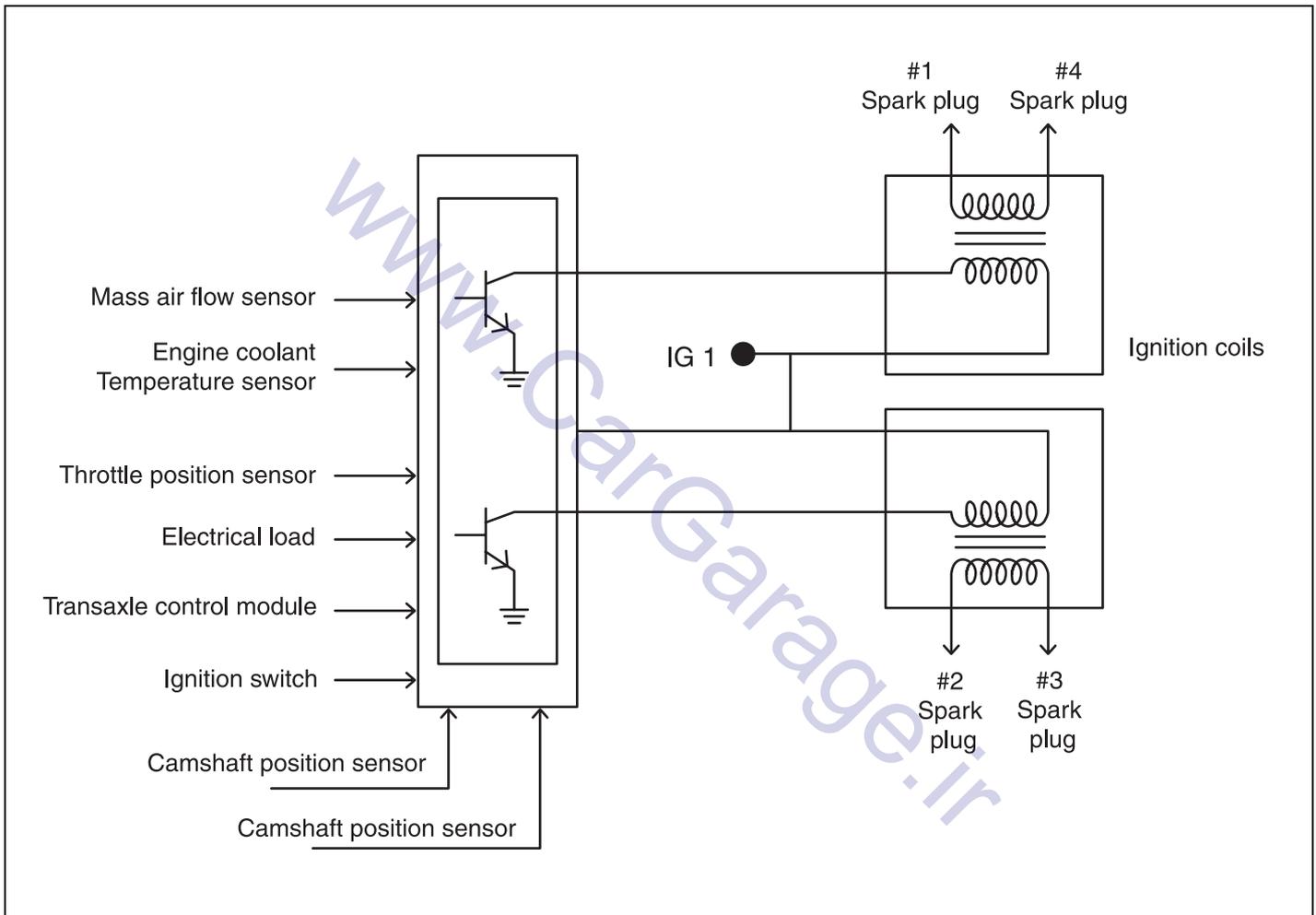
IGNITION SYSTEM

GENERAL DESCRIPTION E10A8AB7

This vehicle incorporates DLI(Distributorless ignition) system in order to increase the range of ignition timing and distributor voltage and to decrease electric wave noise. The components of this system are:

- Ignition Coil
- Camshaft Position Sensor
- ECM
- Spark Plug Wires and Spark Plugs

IGNITION SYSTEM OPERATION



BB2B050A

In a conventional ignition system, the ignition coil produces a high voltage current and the distributor then relays this current, at the required time, to each spark plug. In the distributorless ignition system, two sensors, the camshaft position sensor and the crankshaft position sensor, tell the Engine Control Module (ECM) which cylinder is ready to fire. The ECM then sends an ignition signal to an electronic ignition coil. This ignition coil then produces and sends a high voltage current to the proper spark plug. Distributorless ignition is a "wasted-spark" system in which two spark plugs fire simultaneously. One cylinder fires at TDC on the compression stroke, while the other fires at TDC of the exhaust stroke.

The cylinders are grouped together by firing order. For example, firing order is 1-3-4-2. Cylinders 1 and 4 are in the same position, while cylinders 2 and 3 are 180° behind. Plugs 1 and 4 fire together, as do the plugs in cylinders 2 and 3.

This means that an ignition spark is fired in one cylinder while at the same time a "waste" spark is fired in the companion cylinder.

Because of dual plug firing, if an inductive tachometer is connected to a plug wire, it will indicate an engine RPM that is twice the actual speed (i.e., 1,600 RPM, instead of 800 RPM).

IGNITION SYSTEM

ELECTRONIC SPARK ADVANCE SYSTEM

Ignition Timing is determined and set within the ECM based on signals from various sensors and switches. Optimum performance is gained with this system. The ECM varies ignition timing according to engine speed, intake air amount, coolant temperature and other conditions.

NOTE

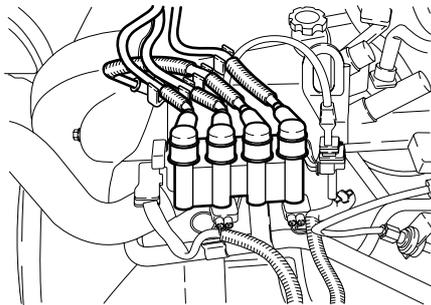
- Timing specification at idle is: $8\pm 5^\circ$ BTDC ($6\pm 5^\circ$ for Europe)
- Timing is not adjustable

IGNITION SYSTEM COMPONENTS

The mechanical, rotating high-voltage distributor mechanism has been replaced by static electronically controlled components. These components are described below.

IGNITION COILS

Two ignition coils are used in this system. The engine locates them directly above the #2 and #4 spark plugs. The coil resistance is identical for these two coils, and there is no maintenance required for them. If determined to be faulty, they must be replaced.



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SPARK PLUG CABLE

The spark plug cable connect the two ignition coils to the spark plugs. Their function is basically the same as on the previous system. Because of their shorter length, the DLI spark plug cable enhance the ignition systems delivered voltage. In addition, they reduce the wave interference from one high tension wire to another.

SPARK PLUGS

The spark plugs provide the air gap necessary to produce an arc from the electrical energy coming in from the ignition coil. This arc then ignites the fuel/air mixture in the cylinder, producing power.

IGNITION TIMING

Ignition timing can be thrown off for two reasons: A problem with a sensor, which will be detected by ECM or a misalignment of camshaft to crankshaft. This last problem indicates a problem with timing belt, which is covered in Group EM, Engine. There is no need to adjust engine timing after replacement of a coil.

CHECK PROCEDURE

1. Warm engine and let idle.
2. Turn all other electrical systems OFF.
3. Connect timing light to high-tension lead number one.
4. Check that ignition timing mark on crankshaft pulley aligns with timing mark on engine block.

SPARK PLUG AND IGNITION COIL E8BE978F

Item		A3E	A5D
Engine idle speed		750 ± 50 rpm	
Ignition coil	Type	Double-ended	
	Primary coil resistance	0.45~0.55 Ω at 68°F (20°C)	
	Secondary coil resistance	10.9~13.3 kΩ at 68°F (20°C)	
High-tension lead		4.48~6.72 kΩ per 3.28 feet (1m)	
Spark plug gap		0.039~0.043 in (1.0~1.1 mm)	
Spark plug type		BPR5ES-11	BKR6ES-11

LB2D310C

TROUBLE SHOOTING E9795726

Problem	Possible Cause	Action
Engine light "ON"	Engine control module detects fault in system	Check engine control module. Repair as required
Engine runs rough	Spark plug failure High-tension lead arcing to ground Ignition coil(s) faulty CMP sensor faulty CKP sensor faulty	Check, clean or replace plugs Replace high-tension leads Check/replace ignition coil(s) Check/replace sensor Check/replace sensor
Engine fails to start, starter turning	Fuse failure Low battery current Ignition coil(s) failure CMP sensor failure CKP sensor failure	Check/replace IGN fuse Check charging system Check/replace coil(s) Check/replace sensor Check/replace sensor

TIGHTENING TORQUES E8615D7A

Item	Torque
Ignition coil bolt	11.5~16.6 lb-ft (15.6~22.6 N·m, 1.6~2.3kg-m)
Spark plugs	18~22 lb-ft (25~30 N·m, 2.5~3.0 kg-m)

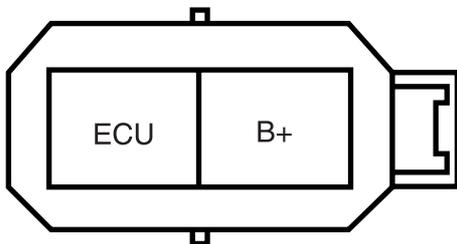
IGNITION SYSTEM**EE -5****IGNITION COIL****REMOVAL** EC4C9BF1

1. Disconnect battery cable.
2. Disconnect high-tension leads.
3. Disconnect ignition coil connectors.
4. Remove four ignition coil mounting bolts.
5. Remove ignition coils.

VOLTAGE CHECK E1AE1364

1. Disconnect negative battery cable.
2. Disconnect ignition coil connector.
3. Turn ignition switch to "ON"
4. Measure voltage between terminal ECU and B+ at ignition coil connector.

Voltage: approximately 12 Volts



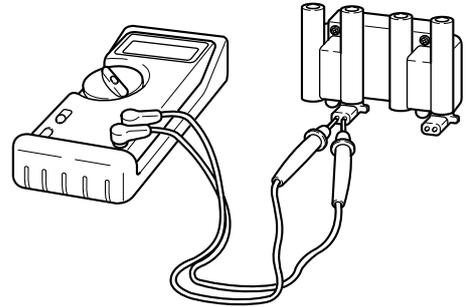
BB2B080A

5. If no voltage, check main fuse, ignition switch and wire harness.

RESISTANCE CHECK

1. Using an ohmmeter, check resistance of primary coil. Connect one lead of ohmmeter to positive (+) terminal and other lead to each negative (-) terminal. If not within specification, replace coil. Remember that unit has two coil assemblies, so both must be checked.

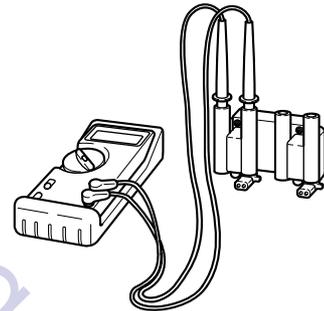
Primary coil resistance:
0.45~0.55 Ω @ 68°F (20°C)



BB2B080B

2. Using an ohmmeter, check resistance of the secondary coil. If not within specification, replace coil. Remember that you must check resistance of both top and bottom secondary coil. If one is out of specification replace the whole unit.

Secondary coil resistance:
10.9~13.3 k Ω @ 68°F (20°C)



BB2B080C

INSTALLATION EB0DE251

1. Position two coils above No.2 and No.4 spark plugs, and firmly push down to connect.
2. Insert and tighten four ignition coil mounting bolts.

Tightening torque:
11.5~16.6 lb-ft (15.6~22.6 N·m, 1.6~2.3 kg-m)

3. Reconnect ignition coil connectors.
4. Reattach high tension leads. Leads are marked for correct connection.
5. Reconnect battery cable.

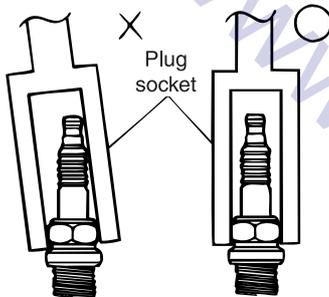
SPARK PLUG

REMOVAL E919982B

CAUTION

Do not attempt any maintenance on spark plugs if engine is hot.

1. Disconnect negative battery terminal.
2. Carefully remove high-tension leads.
3. Use compressed air to blow any dirt or debris from around spark plug hole.
4. Check that spark plug fits squarely in spark plug socket and remove spark plug.



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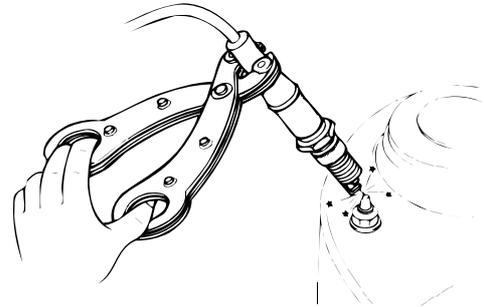
INSPECTION EBEAF673

1. Reconnect negative battery cable.
2. Connect spark plug to high-tension lead.
3. Hold spark plug with insulated pliers 0.2 to 0.39 inch (5~10 mm) from a ground.

WARNING

Do not touch vehicle body during following instructions.

4. While holding spark plug, have a second person crank engine. Verify that a strong blue spark jumps from spark plug to ground.

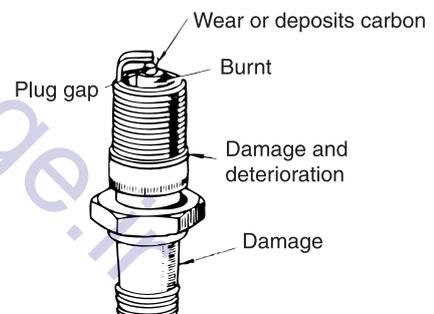


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5. If there is no spark or the spark is weak, check for, and implement correction:
 - Carbon deposits. Clean out or replace plug.
 - Oil fouling. Correct oil problem, replace plug.
 - Worn or burnt electrode. If present, replace plug.
 - Broken or burned ceramic insulator. If present replace plug.
 - Damaged spark plug ring. If so, replace ring.
 - Improper spark plug gap. Regap if possible, otherwise replace plug.

A3E Gap : 0.039-0.043 in (1.0-1.1 mm)

A5D Gap : 0.039-0.043 in (1.0-1.1 mm)



BB2B120B

INSTALLATION ED7DEBC2

1. Install spark plug into cylinder head.

Tightening torque:

18~22 lb-ft (25~30 N·m, 2.5~3.0 kg-m)

2. Reconnect high-tension leads.
3. Reconnect negative battery cable.

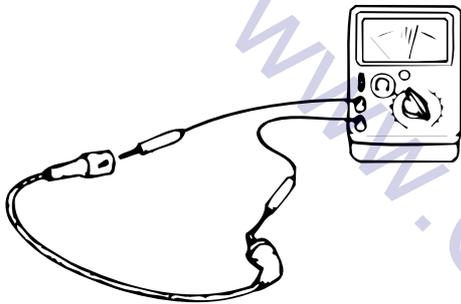
IGNITION SYSTEM

SPARK PLUG CABLE

INSPECTION EBA2D68C

1. Disconnect from coil and spark plugs.
2. Check for breaks in insulation.
3. Check inside high-tension lead connectors for corrosion or carbon deposits.
4. Connect high-tension lead to an ohmmeter and check resistance.

Resistance : 4.48~6.72K Ω per 3.28 ft (1m)



BB2B140A

5. Replace if defective.

CHARGING SYSTEM

ON-VEHICLE SERVICE E1DF8DD7

GENERATOR INSPECTION

Before testing the generator, perform the following checks:

1. Inspect the battery condition.
2. Inspect condition of battery cable and terminals, battery posts, connections at engine block, starter solenoid and relay.
3. Inspect all fuses in both the engine compartment fuse/relay box and the passenger compartment fuse box.
4. Inspect the generator mounting bolts for tightness.
5. Inspect the generator drive belt condition and tension.
6. Inspect connections at generator field, battery output and ground terminals. Check ground connection at engine.

CHARGING SYSTEM RESISTANCE CHECK

This tests will indicate the amount of voltage drop across the generator output wire, from the generator output (B+) terminal to the battery positive post. They will also show the amount of voltage drop from the ground (-) terminal on the generator to the negative battery post. Refer to the Rio Electrical Troubleshooting Manual for connector and terminal information.

1. Engage the parking brake, make sure the transaxle is in PARK (A/T) or NEUTRAL (M/T) and start the engine.
2. Set blower control to the maximum position.
3. Turn on headlights and set in high-beam position and turn the vehicle interior lamps on.
4. Bring the engine speed up to 2400 RPM and hold.
5. Touch the DVOM(Digital Voltage and Ohm Meter) negative lead directly to the positive battery post.

6. Touch the DVOM positive lead to the B+ output terminal stud on the generator (not the terminal mounting nut). The output voltage should be no higher than 0.6V. If the voltage is higher than 0.6V, touch the DVOM positive lead to the terminal mounting stud nut and then to the wiring connector. If the voltage is now below 0.6V, look for dirty, loose or poor connection.
7. Touch the DVOM negative lead directly to the negative battery post.
8. Touch the DVOM positive lead to the ground terminal stud on the generator case (not the terminal mounting nut). The voltage should be no higher than 0.3V. If the voltage is higher than 0.3V touch the DVOM positive lead to the terminal mounting stud nut and then to the wiring connector. If the voltage is now below 0.3V, look for dirty, loose or poor connection.

NOTE

A voltage drop test can be performed at each (-) connection in this circuit to locate the excessive resistance. This test can also be performed between the generator case and the engine. If test voltage is higher than 0.3V, check for corrosion at the generator mounting points or loose generator mounting.

CURRENT OUTPUT TEST

This test will determine if the charging system can deliver its minimum test current (amperage) output. A volt/amp tester equipped with both a battery load control and an inductive type pickup clamp (ammeter probe) will be used for this test. Refer to the operating instructions supplied with the tester.

1. Engage the parking brake, make sure the transaxle is in PARK (A/T) or NEUTRAL (M/T) and start the engine.
2. Bring the engine speed up to 2500 RPM and hold.

CAUTION

This load test must be performed within 15 seconds to prevent damage to test equipment.

3. Slowly adjust the rheostat control (load) on the tester to obtain the highest amperage reading. Do not allow the voltage to drop below 12V.

NOTE

On certain brands of test equipment, this load will be applied automatically. Refer to the operating instructions supplied with the test equipment.

CHARGING SYSTEM**EE -9**

4. The ammeter reading must meet the minimum amps specifications listed on the specifications chart.
5. Turn the load control knob on the tester to the OFF position but continue to hold the engine speed at 2500 RPM. If all circuitry is okay, the amperage should drop below 15 to 20 amps. This may take several minutes with all electrical accessories OFF. If amperage does not drop, refer to the Electrical Troubleshooting Manual and check circuitry.
6. Remove the volt/amp tester. If the minimum amperage requirements could not be met, test the generator. If the generator tests okay, check the charging system circuitry (refer to the Electrical Troubleshooting Manual).

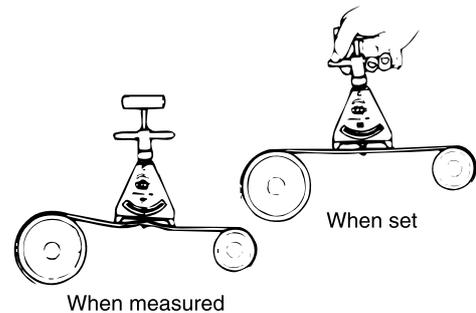
DRIVE BELT EF6FA1B3**INSPECTION**

1. Check drive belt and pulley for wear, cracks, and fraying. Replace if necessary.
2. Measure drive belt tension with a tension gauge.

TENSION

Drive belt	lb (N)	
	New	Used
Generator	85.8~103.4 (383~461)	68.2~85.8 (304~383)
A/C and P/S	110~132 (491~589)	95~110 (422~491)

BB2D001B



BB2B360A

3. Measure deflection by applying moderate pressure (22 lb [98 N]) midway between pulleys. Adjust if necessary.

DEFLECTION

Drive belt	in (mm)	
	New	Used
Generator	0.31~0.35 (8~9)	0.35~0.39 (9~10)
A/C and P/S	0.31~0.35 (8~9)	0.35~0.39 (9~10)

BB2D001C

EE -10

ENGINE ELECTRICAL SYSTEM

SPECIFICATION EB0BEE84

BATTERY

Item	Engine	A3E/A5D
Voltage	V	12
Type		48-23 FL
Capacity (20-hour rate)	A-h	60
Cold cranking performance (at -18°C)	Current	500 A (Max)
	30 sec. Voltage	7.2 V (Min)

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GENERATOR

Item	Engine	A3E/A5D
Type		A/C
Output	V-A	12-80
Regulator type		Transistorized (built-in IC regulator)
Regulator voltage	V	14.1-14.7

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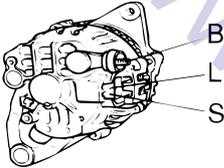
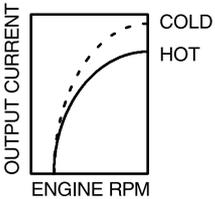
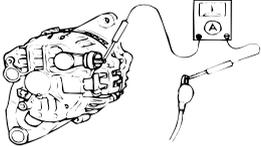
CHARGING SYSTEM

EE -11

SYMPTOM-RELATED DIAGNOSTIC

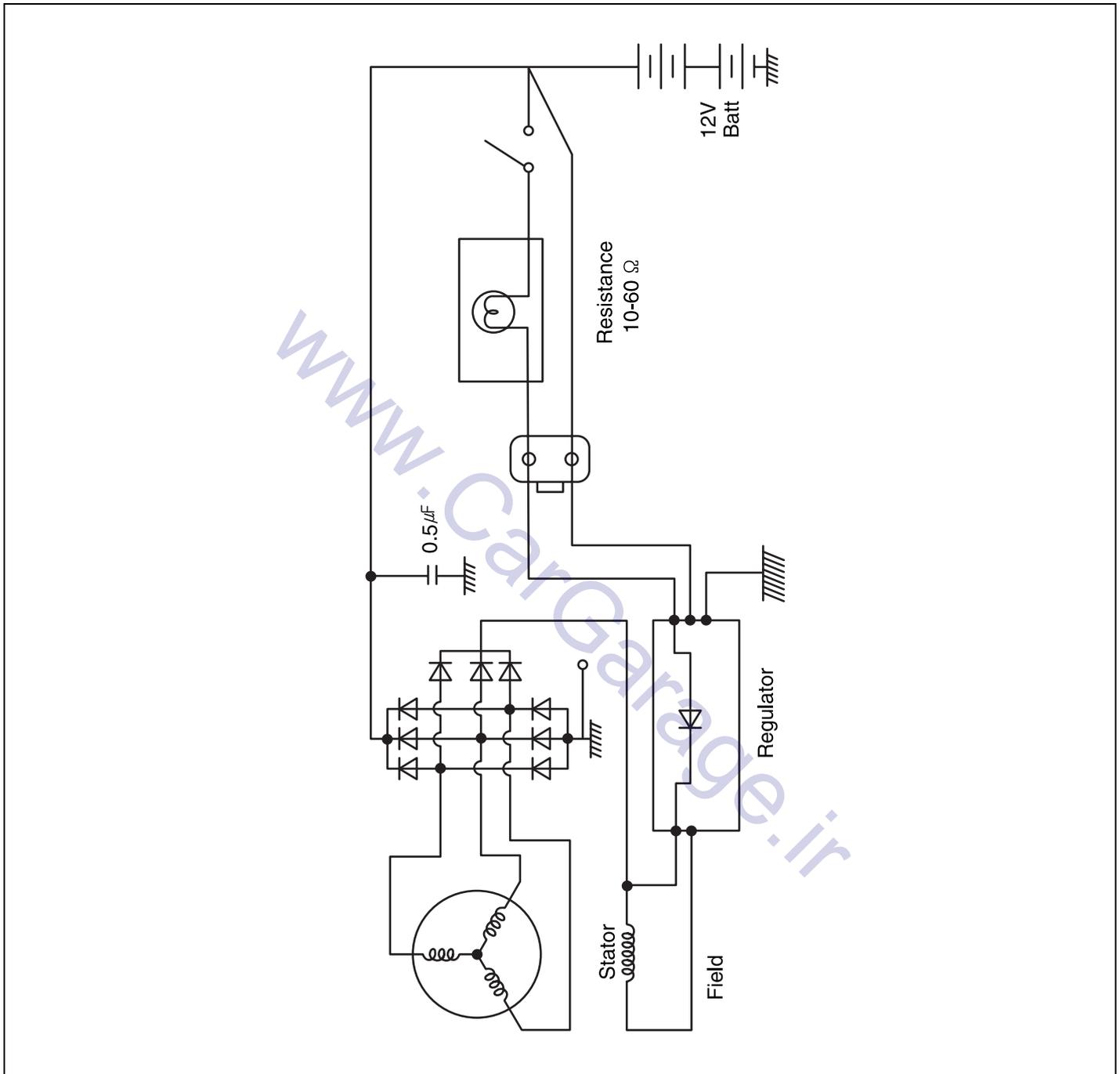
PROCEDURE EA7FEBD3

GENERATOR

Step	Inspection	Action													
1	Check battery voltage. Specification: Above 12.4V	Yes	Go to next step.												
		No	Check battery.												
2	Start engine and check if generator warning light goes out.	Yes	Go to step 4.												
		No	Go to next step.												
3	Check if voltage at generator terminals are correct <table border="1" data-bbox="225 678 751 860"> <thead> <tr> <th>Terminal</th> <th>Ign: On (V)</th> <th>Idle (V)</th> </tr> </thead> <tbody> <tr> <td>B</td> <td>Approx. 12</td> <td>14.1~14.7</td> </tr> <tr> <td>L</td> <td>Approx. 1</td> <td>14.1~14.7</td> </tr> <tr> <td>S</td> <td>Approx. 12</td> <td>14.1~14.7</td> </tr> </tbody> </table>  <p style="text-align: center;">BB2B300A</p>	Terminal	Ign: On (V)	Idle (V)	B	Approx. 12	14.1~14.7	L	Approx. 1	14.1~14.7	S	Approx. 12	14.1~14.7	Yes	Check wiring harness between battery and terminal B.
		Terminal	Ign: On (V)	Idle (V)											
B	Approx. 12	14.1~14.7													
L	Approx. 1	14.1~14.7													
S	Approx. 12	14.1~14.7													
No	<ul style="list-style-type: none"> • Check wiring harness. • Replace generator. 														
4	1. Connect an ammeter (80A minimum) between terminal B and terminal B harness connector. 2. Start engine. 3. Turn all electrical loads ON and depress brake pedal. 4. Check if output current is 65A or more at 2,500-3,000 rpm. CAUTION Do not ground terminal B.   <p style="text-align: center;">BB2B300B</p>	Yes	Charging system normal.												
		No	Go to next step.												
5	Check drive belt tension OK?	Yes	Replace generator.												
		No	Adjust drive belt tension.												

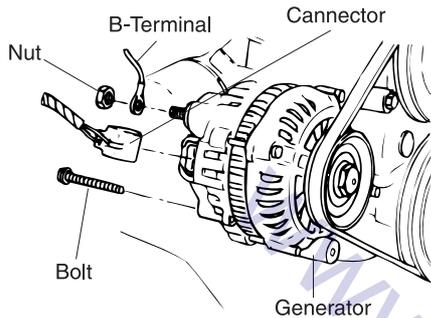
GENERATOR

CIRCUIT DIAGRAM E35AE805



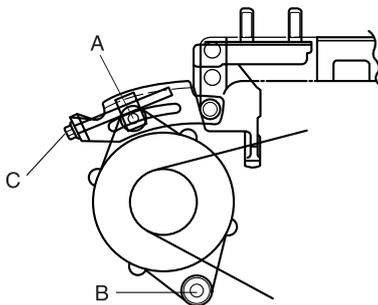
CHARGING SYSTEM**EE -13****REMOVAL** E6CC50FD

1. Remove negative battery cable.
2. Open B terminal cover cap.
3. Remove B terminal nut.
4. Remove B terminal lead.
5. Disconnect generator connector.



BB2B370A

6. Loosen pivot bolt B and tensioner mounting bolt A. Do not remove.



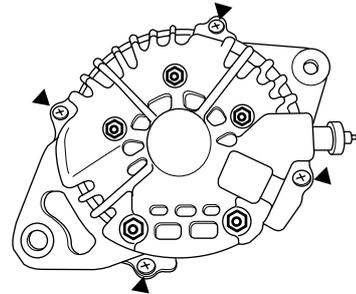
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7. Relieve tension on drive belt by rotating adjustment bolt C.
8. Remove drive belt from generator pulley.
9. Remove tensioner mounting bolt and belt tensioner.
10. Remove generator pivot bolt.
11. Loosen bolt at base of adjusting bracket and rotate the bracket up.
12. Lift generator from engine compartment.

DISASSEMBLY E71CE956**NOTE**

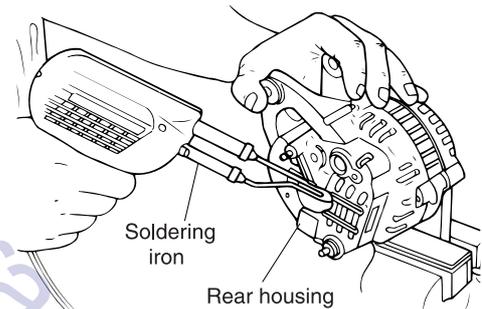
Insert protective material in the jaws of the vise.

1. Remove four cap screws from rear housing.



BB2B390A

2. Use a 200-watt soldering iron to heat the rear of bearing box to allow the bearing to be removed from rear housing.

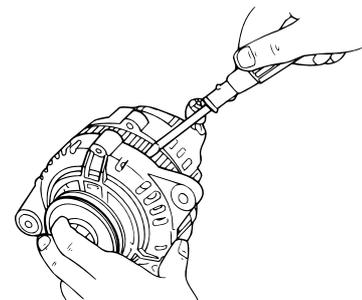


BB2B390B

NOTE

If bearing box is not heated, bearing cannot be pulled out of rear housing. The rear bearing and rear housing fit together very tightly.

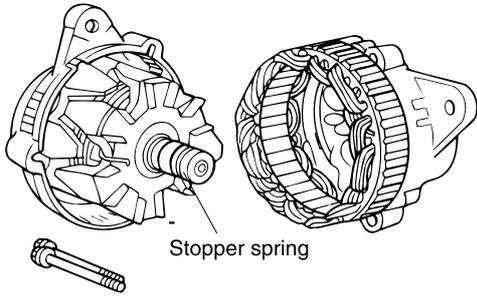
3. Use a flat-blade screwdriver to separate front housing from stator.



BB2B390C

NOTE

Insert protective material in the jaws of the vise.

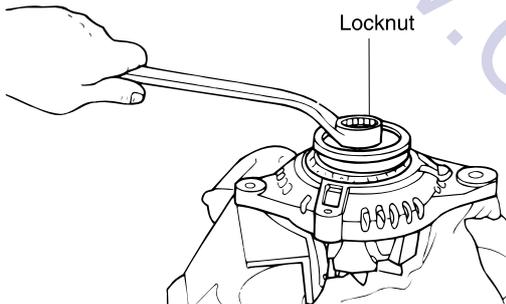


BB2B390D

NOTE

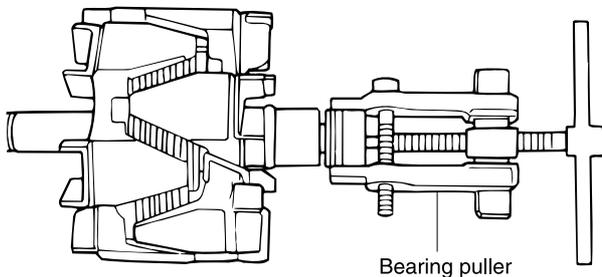
Insert protective material in the jaws of the vise.

- Place rotor in a vise and loosen locknut, then disassemble pulley, rotor, and front housing.



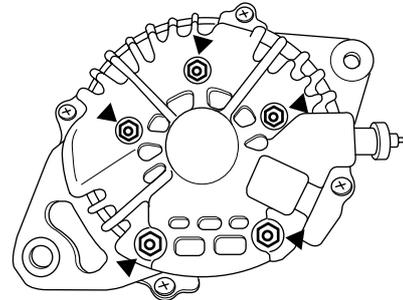
BB2B390E

- If necessary, remove front bearing using a socket and a hand press or vise.
- Remove rear bearing with a bearing puller.



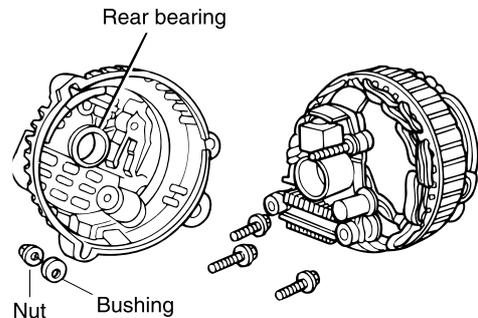
BB2B390F

- Remove B terminal nut and insulating bushing.
- Remove five screws holding the rectifier and brush holder.



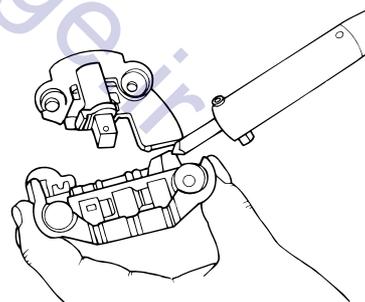
BB2B390G

- Separate rear bracket and stator.



BB2B390H

- Use a soldering iron to remove solder from rectifier and stator leads, and then remove IC regulator.



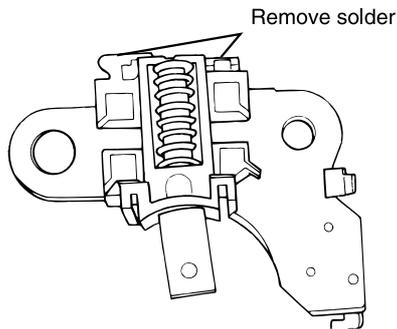
BB2B390I

NOTE

Disconnect quickly. If soldering iron is used for more than 5 seconds, rectifier may be damaged by heat.

CHARGING SYSTEM

11. Replace brushes. Remove solder from pigtail, and then remove brush.



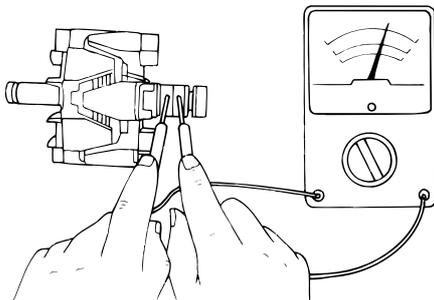
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INSPECTION E7AB7FCD

ROTOR

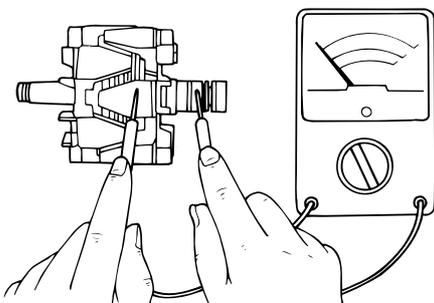
1. Measure resistance between slip rings with an ohmmeter. If it is not within standard resistance, replace rotor.

Standard resistance: $3.5\sim 4.5\Omega$



BB2B400A

2. Check for continuity between slip ring and core with a circuit tester. Replace rotor if there is continuity.

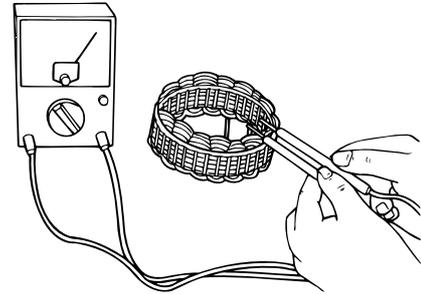


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3. If slip ring surface is rough, smooth with a lathe or fine sandpaper.

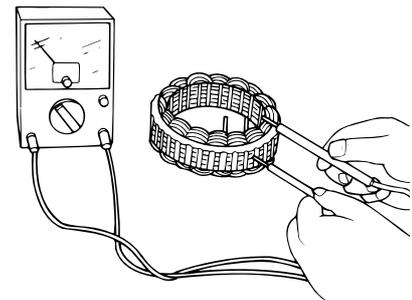
STATOR

1. Check for continuity between stator coil leads with a circuit tester.



BB2B410A

2. Replace stator if there is no continuity.
3. Check for continuity between stator coil leads and core with a circuit tester.



BB2B410B

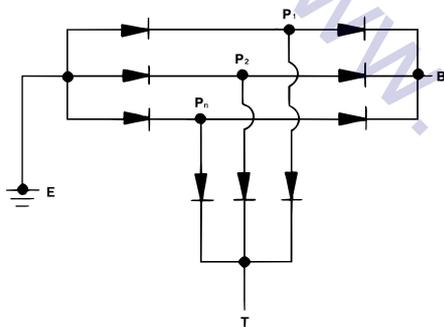
4. Replace stator if there is continuity.

RECTIFIER

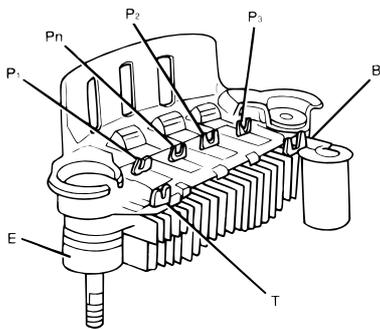
1. Check for continuity between each diode with an ohm-meter.

Negative (Black)	Negative (Black)	Negative (Black)
E	Pn, P1, P2, P3	O
B	Pn, P1, P2, P3	X
T	Pn, P1, P2, P3	X
Pn, P1, P2, P3	E	X
	B	O
Pn, P2, P3	T	O
	T	X

BB2D001D



BB2B420A

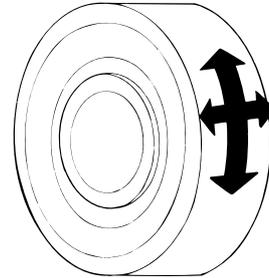


BB2B420B

2. Replace if necessary.

BEARING.

1. Check for abnormal noise, looseness, insufficient lubrication, etc.



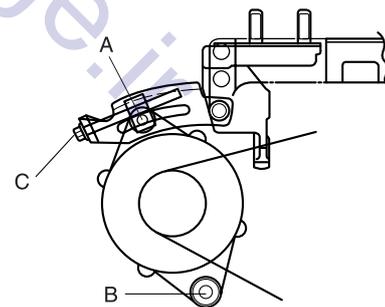
BB2B430A

2. Replace bearing(s) if there is any abnormality.

REPLACEMENT

E56D9D67

1. Position generator on engine.
2. Install pivot bolt(leave loose).
3. Rotate bracket into position on top of generator.
4. Place belt tensioner into position on adjustment bracket.
5. Install tensioner mounting bolt (leave loose)
6. Place drive belt on generator pulley.
7. Adjust belt tension by rotating adjustment bolt C.



BB2B370B

Allowable deflection:

New belt: 0.22-0.28 in (5.5-7.0 mm)

Old belt: 0.24-0.28 in (6.0-7.0 mm)

CHARGING SYSTEM**EE -17**

8. Tighten tensioner bolt.

Tighten tensioner bolt to
14-19 lb-ft (19-26 N·m, 1.9~2.6 Kg-m)

9. Tighten pivot bolt and bracket bolt.

Tighten pivot and bracket bolt to
28-38 lb-ft (38-51 N·m, 3.8~5.3 Kg-m)

10. Connect generator L and S terminal connectors.

11. Connect B terminal lead.

12. Install and tighten B terminal nut.

13. Close B terminal nut cover.

14. Install air intake inlet pipe and tighten end clamp.

15. Connect top hose to air intake inlet pipe.

16. Install front air intake inlet pipe bolts.

17. Connect negative battery cable.

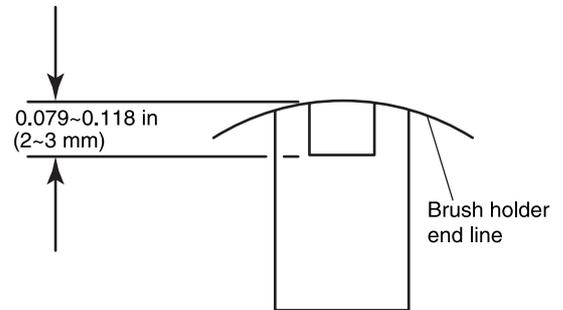
CAUTION

- **Be sure battery connections are not reversed. This will damage rectifier.**
- **Do not use highvoltage testers, such as a megger. They will damage the rectifier.**
- **Remember that battery voltage is always applied to alternator B terminal.**
- **Do not ground L terminal while engine is running.**
- **Do not start engine while L and S terminals are disconnected from generator.**

REASSEMBLY

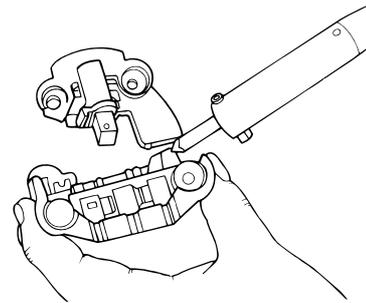
EBADEF1

1. Assemble brush, and solder pigtail so that wear limit line of brush projects 0.079~0.118 in (2~3 mm) out of brush holder.



BB2B440A

2. Assemble regulator, and solder with rectifier and stator leads.



BB2B440B

NOTE

Disconnect quickly. If solderings iron is used for more than 5 seconds, rectifier may be damaged by heat.

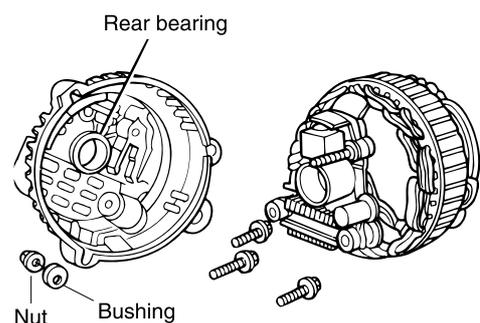
3. Assemble rear bracket and stator.

4. Tighten screws holding rectifier and brush holder.

Tightening torque:

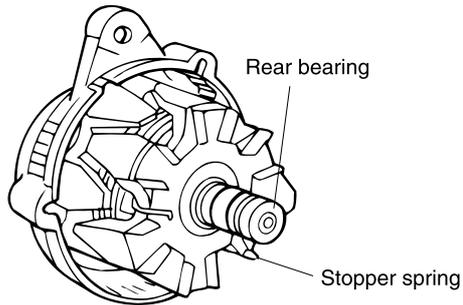
1.5~4.0 lb-ft (2.0~5.4 N·m, 0.2~0.55 kg-m)

5. Tighten B terminal nut and insulating bushing.



BB2B390H

6. Assemble rear bearing and stopper spring.

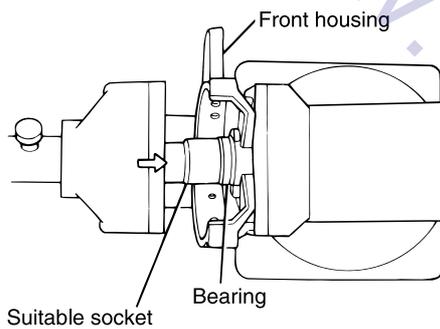


BB2B440C

NOTE

Make sure groove on bearing rim is facing slip ring side.

7. Assemble front bearing. Using a socket which exactly fits outer race of bearing, carefully push in front bearing. Use a hand press or a vise.



BB2B440D

NOTE

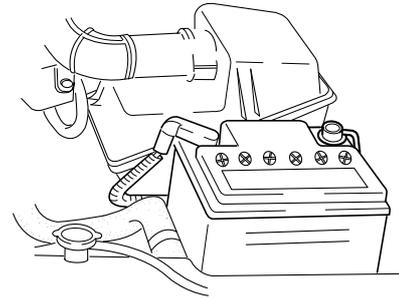
Insert protective material in the jaws of the vise.

BATTERY

INSPECTION ECC4C8F3BATTERY RECHARGING E083048E

SLOW CHARGING

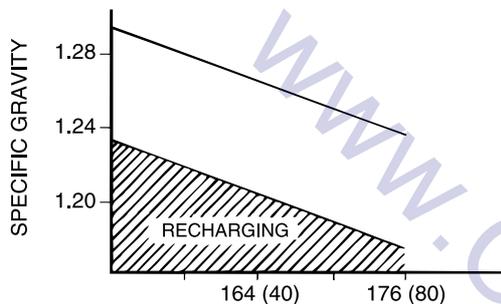
1. It is not necessary to remove vent caps to perform a slow charge.



BB2B340A

Battery	Slow charge (A)	Quick charge (A)
48-23 FL	Under 5	Maximum 20

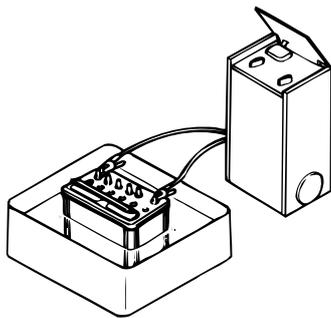
BB2D001A



BB2B350A

QUICK CHARGING

1. Remove battery from vehicle and remove vent caps to perform a quick charge.



BB2B350B

⊗ WARNING

- Before performing maintenance or recharging battery, turn off all accessories and stop engine.
- Negative cable must be removed first and installed last.
- Set battery in water when quick charging to prevent overheating battery.

Any of the following conditions can result in abnormal battery discharging:

1. Corroded or loose battery posts and terminal clamps.
2. A loose or worn generator drive belt.
3. Electrical loads that exceed the output of the charging system. This can be due to equipment installed after manufacture or repeated short trip use.
4. Slow driving speeds (heavy traffic conditions) or prolonged idling with high-amperage draw system in use.
5. A faulty circuit or component causing excessive ignition-off draw or "parasitic" draw.
6. A faulty or incorrect charging system component.
7. A faulty or incorrect battery. Before testing, visually inspect the battery for any damage (a cracked case or cover, loose posts, etc.) that would cause the battery to be faulty.

⊗ WARNING

- IF A BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS OR LOW ELECTROLYTE LEVEL, DO NOT TEST, ASSIST-BOOST OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY OR DEATH COULD OCCUR.
- EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY OR DEATH COULD OCCUR.

⊗ WARNING

- **THE BATTERY CONTAINS SULFURIC ACID WHICH IS POISONOUS AND CAUSTIC. AVOID CONTACT WITH THE SKIN, EYES OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CONTACT A PHYSICIAN IMMEDIATELY. KEEP OUT OF THE REACH OF CHILDREN.**
- **IF THE BATTERY IS EQUIPPED WITH REMOVABLE CELL CAPS, BE CERTAIN THAT EACH OF THE CELL CAPS IS IN PLACE AND TIGHT BEFORE THE BATTERY IS RETURNED TO SERVICE. PERSONAL INJURY AND/OR VEHICLE DAMAGE COULD OCCUR.**

ELECTROLYTE LEVEL

1. Check whether or not the electrolyte level lies between "UPPERLEVEL" line and "LOWER LEVEL" line.
2. If low, add distilled water to "UPPER LEVEL" line. Do not overfill.

HYDROMETER (SPECIFIC-GRAVITY) TEST

The hydrometer tests battery state-of-charge by measuring the specific gravity of the electrolyte. This test cannot be performed on maintenance-free batteries with non-removable cell caps. Specific gravity is a comparison of the density of the electrolyte to the density of pure water. Pure water has a specific gravity of 1.000, and sulfuric (battery) acid makes up approximately 35% of the electrolyte by weight, or 24% of its volume. In a fully charged battery the electrolyte will have a temperature-corrected specific gravity of 1.260 to 1.290. However, a specific gravity of 1.235 or above is satisfactory for battery load testing and/or return to service.

1. Measure specific gravity with a hydrometer. Refer to the instructions supplied with the hydrometer for recommendations on the correct use of the hydrometer.

BATTERY OPEN-CIRCUIT VOLTAGE TEST

A battery open-circuit voltage (no load) test will show the state of charge of a battery. This test can be used in place of the hydrometer test. Before proceeding with this test, make sure the battery is completely charged.

1. Before measuring the open-circuit voltage, the surface charge must be removed from the battery. Turn on the headlights for fifteen seconds, then allow up to five minutes for the battery voltage to stabilize.
2. Disconnect and isolate both battery cables, negative cable first.

3. Using a DVOM(Digital Voltage and Ohm Meter) connected to the battery post, measure the open-circuit voltage. Refer to the Open-Circuit Voltage table. This voltage will indicate the battery state-of-charge, but will not reveal its cranking capacity. If the open-circuit voltage reading is 12.4V or greater, perform the load test.

BATTERY LOAD TEST

1. Disconnect and isolate both battery cables, negative cable first. Make sure the battery top and posts are clean.
2. Connect a suitable VAT Tester to the battery posts. Check the open-circuit (no load) of the battery. Open-circuit voltage must be 12.4V or greater.
3. Apply a 300 Amp load to the battery for fifteen seconds to remove the surface charge from the battery, then allow the battery to stabilize for five minutes.
4. Apply a load equal to 50% of the CCA rating of the battery. After approximately fifteen seconds, check the loaded voltage reading, then remove the load.
5. The voltage drop will vary with the battery temperature at the time of the load test.

Battery voltage with load

Approximate battery temp	Minimum voltage (V)
80F (27°C)	9.7
70F (21°C)	9.6
60F (15°C)	9.5
50F (10°C)	9.4
40F (4°C)	9.3
30F (-1°C)	9.1
20F (-7°C)	8.9
10F (-12°C)	8.7

BB2B340B

BATTERY IGNITION OFF DRAW TEST

The battery draw test refers to power being drained from the battery with the ignition switch in the OFF position. A normal electrical system will draw from five to twenty-five milliamps (0.005 to 0.025 ampere) with the ignition OFF and all non-ignition controlled circuits working properly. The 0.025 ampere is needed to enable the memory functions of the vehicle to function.

1. Verify that all electrical accessories are OFF. Turn off all lamps, remove the ignition key and close all doors.
2. Disconnect the negative battery cable.
3. Set a DVOM(Digital Voltage and Ohm Meter) to its highest amperage scale and connect the DVOM between the disconnected negative battery cable and the negative battery post.

CHARGING SYSTEM**EE -21**

4. If the amperage reading is higher than 0.025 ampere, remove each fuse until the amperage reading becomes within specifications, this will isolate each circuit and identify the source of the draw. If the amperage reading remains high after disconnecting each fuse, unplug the connector from the generator. If the amperage reading becomes within specifications, check the charging system.
5. After appropriate repairs have been made, retest the system.
10. Turn the ignition switch to START and observe the DVOM. If the reading is above 0.2V, clean and tighten the battery cable connection on the engine block and repeat the test. If the reading is still above 0.2V, correct the faulty negative battery cable.
11. Connect the DVOM positive lead to the starter housing. Connect the DVOM negative lead to the negative battery terminal post.
12. Turn the ignition switch to START and observe the DVOM. If the reading is above 0.2V, correct the poor starter to engine block ground contact.

VOLTAGE DROP TEST

The voltage drop test will determine if there is excessive resistance in the battery terminal connections or the battery cables. When performing these tests, remember that the voltage drop is giving an indication of the resistance between the two points at which the DVOM probes are attached. For example, when testing the resistance of the battery positive cable, connect one of the DVOM leads to the positive battery cable clamp and the other cable connector at the starter solenoid. If you probe the positive battery terminal post and the cable connector at the starter solenoid, you are actually reading the combined voltage drop in the positive battery cable clamp-to-terminal post connection and the positive battery cable.

1. Connect the positive lead of the DVOM to the negative battery terminal post.
2. Connect the negative lead of the DVOM to the negative battery terminal cable clamp.
3. Turn the ignition switch to the start meter and observe the DVOM. If voltage is detected, correct the poor contact between the cable clamp and the terminal post.
4. Connect the positive lead of the DVOM to the positive battery terminal post.
5. Connect the negative lead of the DVOM to the positive battery terminal cable clamp.
6. Turn the ignition switch to START and observe the DVOM. If voltage is detected, correct the poor contact between the cable clamp and the terminal post.
7. Connect the voltmeter to measure between the positive battery terminal post and the starter solenoid battery terminal stud.
8. Turn the ignition switch to START and observe the reading on the DVOM. If the reading is above 0.2V, clean and tighten the battery cable connection at the solenoid and repeat the test. If the reading is still above 0.2V, replace the faulty positive battery cable.
9. Connect the DVOM to measure between the negative battery terminal post and a good clean ground on the engine block.

STARTING SYSTEM

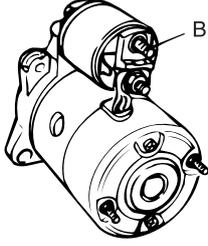
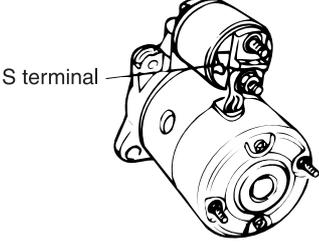
STARTER EBDAC8A5

Item	Engine/Trans		A3E/A5D
	Starter	Type	
Output		V-KW	12-0.85

LB2D190A

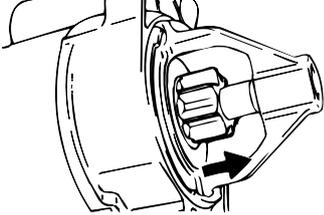
SYMPTOM-RELATED DIAGNOSTIC

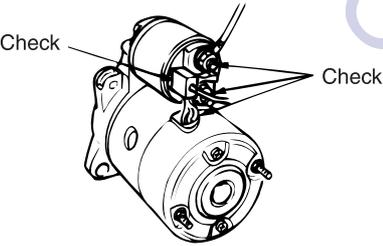
PROCEDURE EDC3B3AB

1	Will not crank-starter motor does not operate		
Step	Inspection		Action
1	Check if engine cranks with fully charged battery.	Yes	Check charging system.
		No	Go to next step.
2	Check if battery voltage is supplied at B terminal.  <small>BB2B180A</small>	Yes	Go to next step.
		No	Check wiring harness.
3	Check if battery voltage is supplied at S terminal with clutch pedal depressed (M/T), car in park (A/T), and ignition switch in START position.  <small>BB2B180B</small>	Yes	Replace starter unit.
		No	<ul style="list-style-type: none"> • Check transmission range switch (A/T) (Refer to Section AT.) • Check ignition switch. • Check wiring harness.

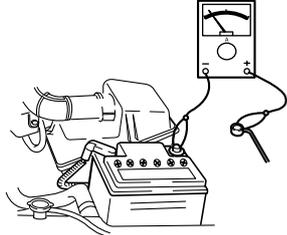
STARTING SYSTEM

EE -23

2		Will not crank-starter motor spins	
Step	Inspection	Action	
1	Check if drive pinion is pulled out while cranking. (Click heard when pulled out.) 	Yes	Remove starter and check flywheel ring gear teeth and starter drive pinion teeth.
		No	Replace starter unit.
BB2B180C			

3		Crank slowly	
Step	Inspection	Action	
1	Check if engine cranks normally when fully charged.	Yes	Check charging system.
		No	Go to next step.
2	Check starter cable connection for looseness and corrosion. 	Yes	Repair or replace connection.
		No	Check for seized motor armature. Repair or replace as necessary.
BB2B180D			

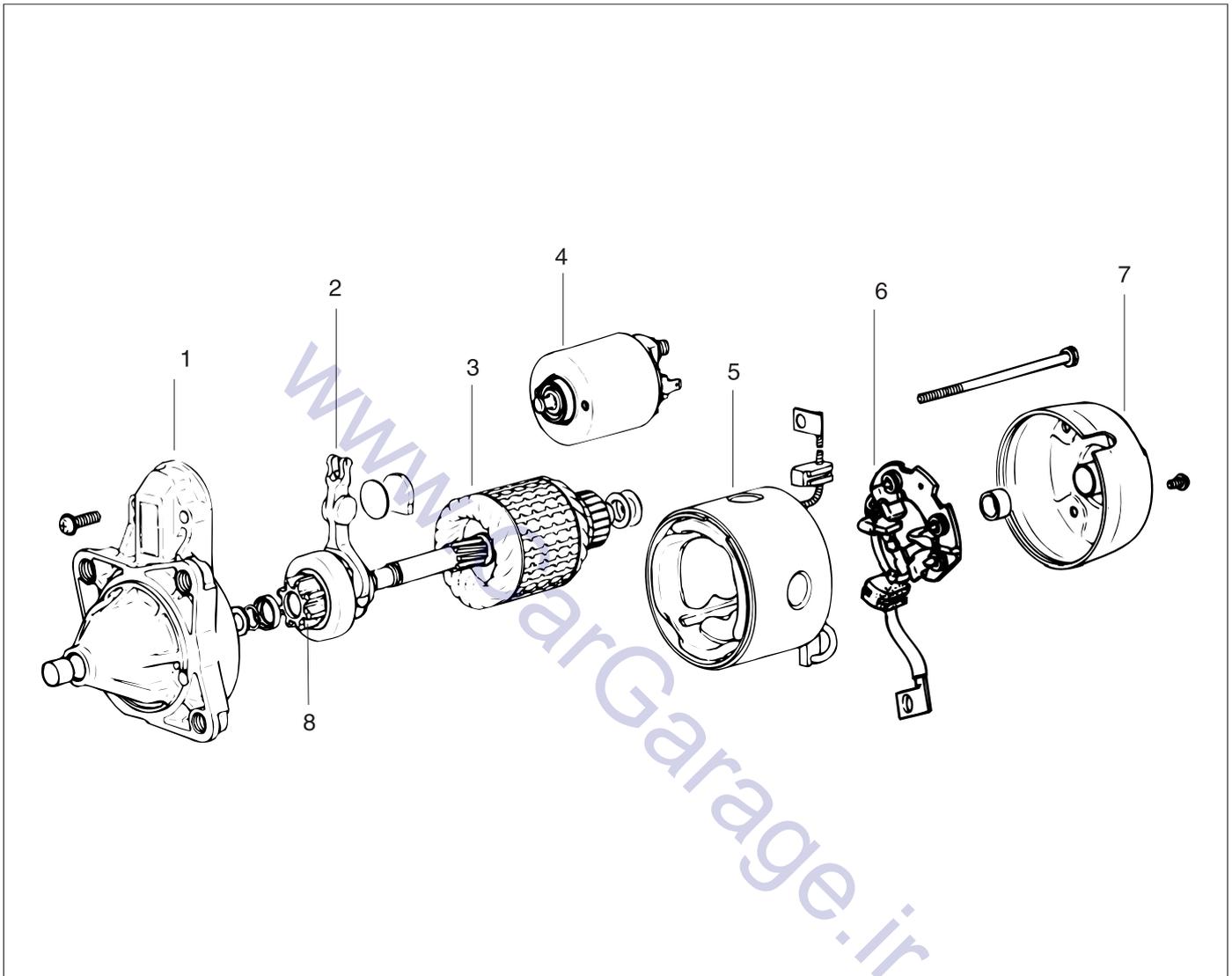
4		Generator warning lamp illuminates with engine running	
Step	Inspection	Action	
1	Check for correct battery voltage at idle. Specification: 14.1~14.7V	Yes	Check wiring harness between generator L terminal and generator warning lamp.
		No	Check charging system.

5		Discharged battery	
Step	Inspection	Action	
1	Check charging system.	Yes	Turn ignition switch ON and check dark current as shown.  BB2B180E Dark current: Below 20mA
		No	Repair or replace parts as necessary.

STARTING SYSTEM

STARTER

COMPONENT EADEEA27



- 1. Drive end housing
- 2. Lever
- 3. Armature
- 4. Solenoid

- 5. Field coil
- 6. Brush holder assembly
- 7. Rear cover
- 8. Drive pinion

COLD CRANKING TEST E1EC1EF6

1. Connect a DVOM(Digital Voltage and Ohm Meter) tester to the battery terminals. Refer to the operating instructions for the tester being used.
2. Make sure the parking brake is fully engaged. If the vehicle is equipped with an automatic transaxle, place the shift selector in the PARK position. If the vehicle is equipped with a manual transaxle, place the gearshift lever in the NEUTRAL position.
3. Make sure that all accessories are turned off.
4. Turn the ignition switch to START and observe the cranking voltage and current draw.
5. If the voltage reading is below 9.6 volts, remove the starter for bench testing. If the starter bench test is okay, refer to section EM for further diagnosis of the engine. If the starter bench test is not okay, replace the starter.
6. If the voltage reading is above 9.6V and the current (amperage) draw is below specifications, go to the BATTERY VOLTAGE DROP TEST.
7. If the voltage reading is 12.5V or more and the starter doesn't turn, go to the SOLENOID TEST.
8. If the voltage reading is 12.5V or more and the starter turns very slowly, go to the BATTERY VOLTAGE DROP TEST.

NOTE

A cold engine will increase the starter current (amperage) draw reading and reduce the battery voltage reading.

SOLENOID TEST EAF4F4D2

1. Remove the starter.
2. Check for continuity between the solenoid terminal and the field coil terminal. If there is continuity, go to next step. If there is no continuity, repair/replace the faulty components and retest.
3. Check for continuity between the solenoid terminal and the solenoid case. If there is continuity, check the Starter Relay, Park/Neutral Position Switch, Clutch Pedal Position Switch and Ignition Switch. Refer to the Rio Electrical Troubleshooting Manual. If there is no continuity, repair/replace the faulty components and retest.

INSPECTION E31C726C**SOLENOID**

1. Check for continuity between S and M terminals with ohmmeter. Replace solenoid if there is no continuity.



BB2B250A

2. Check for continuity between S terminal and solenoid body with ohmmeter. Replace solenoid if there is no continuity.



BB2B250B

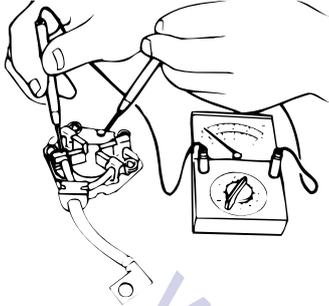
3. Check continuity between M and B terminal with ohmmeter. Replace solenoid if there is continuity.



BB2B250A

STARTING SYSTEM**EE -27****BRUSH AND BRUSH HOLDER**

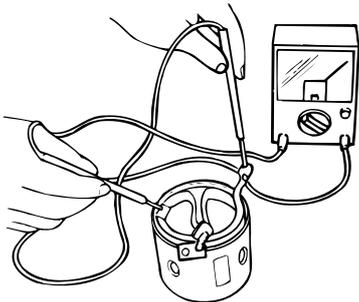
1. Check continuity between each insulated brush and plate with ohmmeter. Replace brush holder if there is continuity.
2. Replace spring if there is no continuity.



BB2B260A

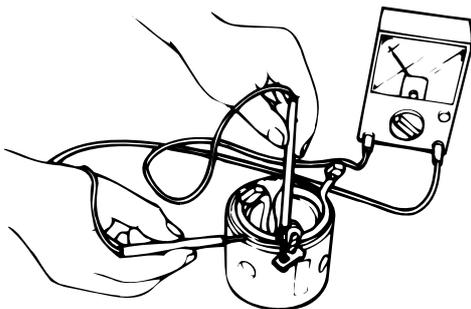
FIELD COIL

1. Check for continuity between M terminal wire and brushes with ohmmeter. Replace yoke assembly if there is no continuity.



BB2B270A

2. Check continuity between M terminal wire and yoke with ohmmeter. Replace yoke assembly if there is continuity.
3. Check if field coil is loose. Replace yoke assembly if necessary.



BB2B270B

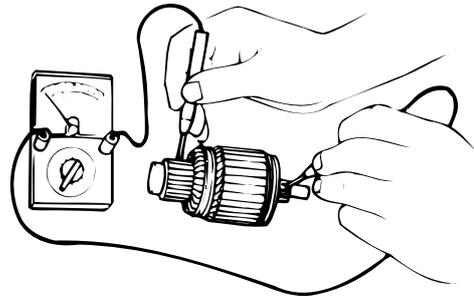
ARMATURE

1. Check continuity between commutator and core with ohmmeter. Replace armature if there is continuity.



BB2B280A

2. Check continuity between commutator and shaft with ohmmeter. Replace armature if there is continuity.



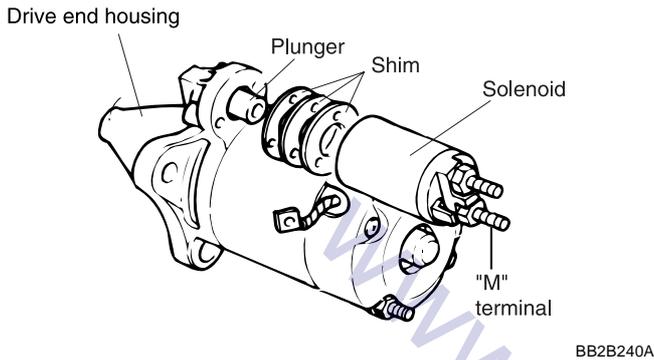
BB2B280B

DISASSEMBLY EC85E41D

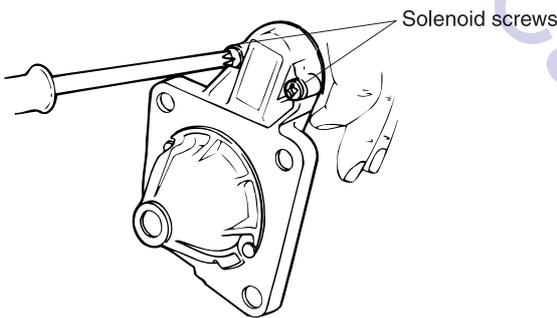
1. Remove nut from M terminal.
2. Remove field wire from M terminal.

NOTE

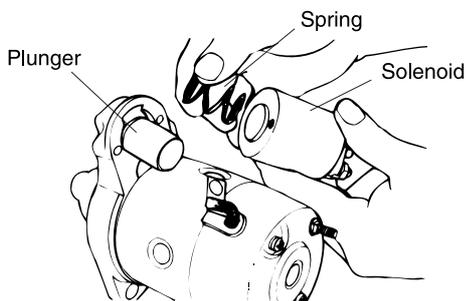
If pinion depth shims are found between solenoid and drive end housing, remove them and set aside.



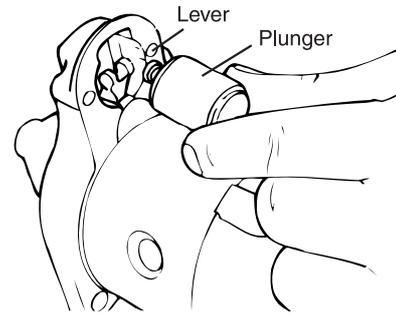
3. Remove solenoid screws and magnetic switch.



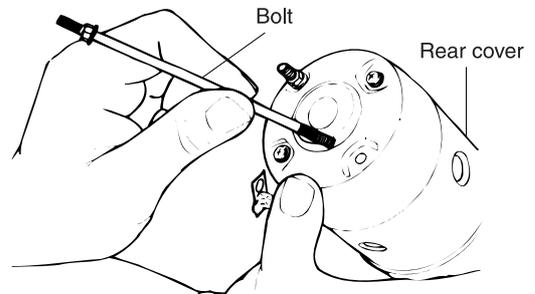
4. Remove solenoid plunger spring.



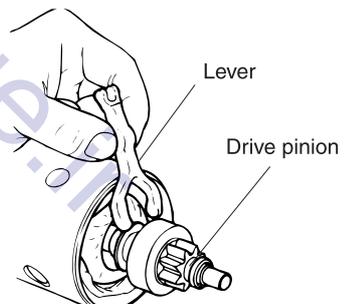
5. Disengage plunger from lever and remove plunger.



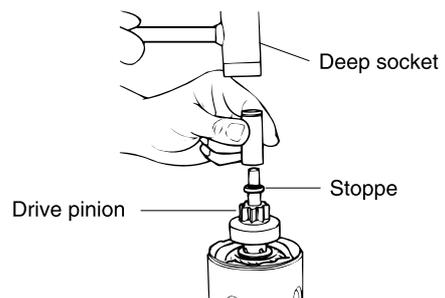
6. Remove bolts from rear cover. Separate motor assembly from drive end housing. Also separate motor assembly from planetary gear set, if present.



7. Remove lever from drive pinion.



8. Drive stopper from snap ring using a deep well socket or similar tool.



BB2B240D

BB2B240A

BB2B240B

BB2B240C

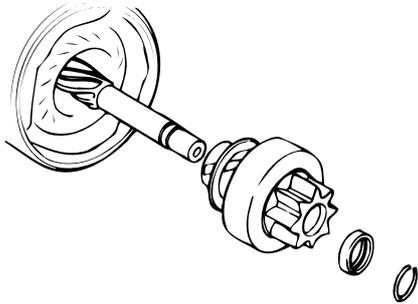
BB2B240E

BB2B240F

BB2B240G

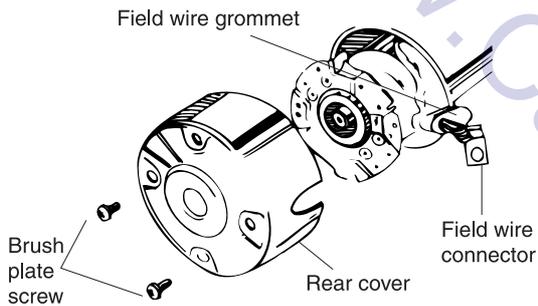
STARTING SYSTEM

- Remove snap ring from its groove in pinion shaft.
- Remove stopper and drive pinion from pinion shaft.



BB2B240H

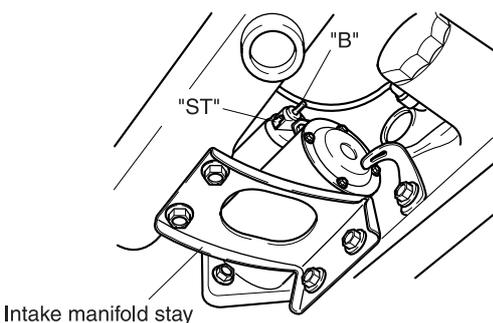
- Remove two brush plate screws and rear cover.
- Remove armature from field coil housing.
- Remove armature washers from the end of the armature.



BB2B240I

REMOVAL E9101F37

- Disconnect negative battery terminal.
- Remove four upper intake manifold support bracket bolts.
- Disconnect S terminal connector.
- Disconnect B terminal connector.
- Remove starter.

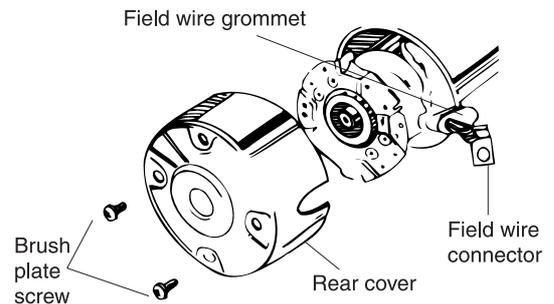


BB2B220A

REASSEMBLY EBFA8569

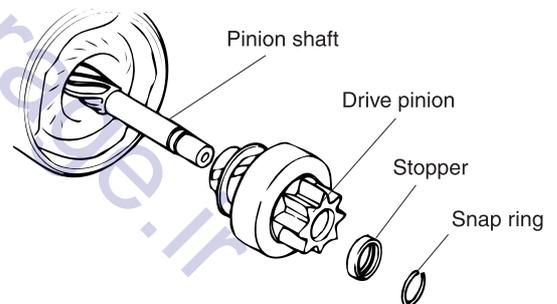
- Reassemble armature washers to the end of armature.
- Reassemble armature in field coil housing.
- Reassemble rear cover and tighten two brush plate screws.

Tightening torque:
1.7~3.2 lb-ft (2.4~4.4 N·m, 0.24~0.44 kg-m)



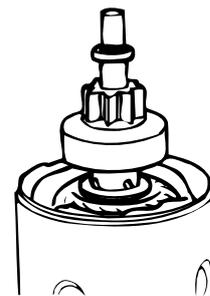
BB2B240I

- Reassemble drive pinion and stopper on pinion shaft.
- Place snap ring on its groove in pinion shaft.



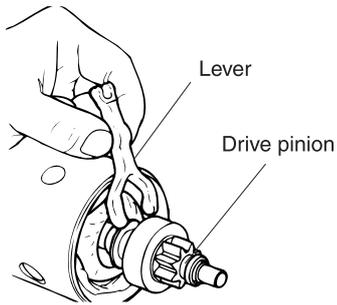
BB2B290A

- Reassemble stopper.



BB2B290B

7. Reassemble lever on drive pinion.



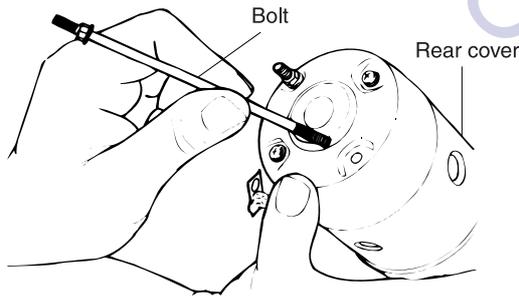
BB2B240F

8. If present, reassemble planetary gear set to motor assembly.

9. Reassemble motor assembly in drive end housing.

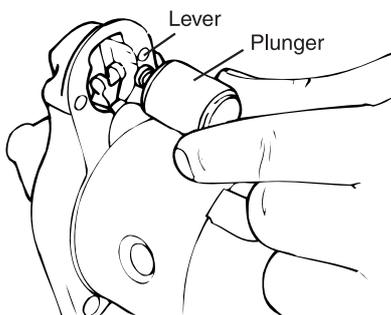
10. Place bolts in rear cover and tighten.

Tightening torque:
2.8~5.2 lb-ft (3.8~7.1 N·m, 0.39~0.72 kg·m)



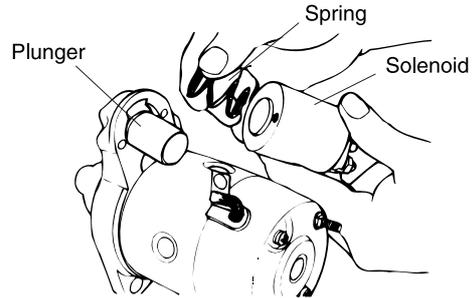
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11. Engage plunger in lever.



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12. Insert solenoid plunger spring.



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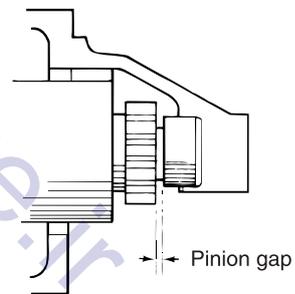
13. Reassemble magnetic switch and tighten solenoid screws.

Tightening torque:
3.0~5.6 lb-ft (4.1~7.6 N·m, 0.42~0.77 kg·m)

14. Apply battery power to the S terminal and ground starter motor body. Pinion will eject outward and then stop.

15. Measure clearance (pinion gap) between pinion and stopper.

Pinion gap: 0.079 in (2.0 mm)

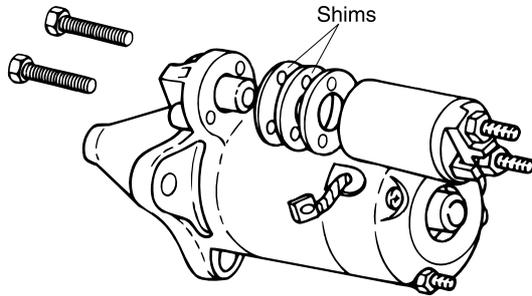


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NOTE

Be careful not to let electricity flow continuously for more than 10 seconds.

16. If pinion gap is not within specified range, adjust it by increasing or decreasing the number of washers used between solenoid and drive housing. The gap will become smaller if the number of washers is increased



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 **NOTE**

Do not use more washers than plates.

17. Connect field wire to M terminal.

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