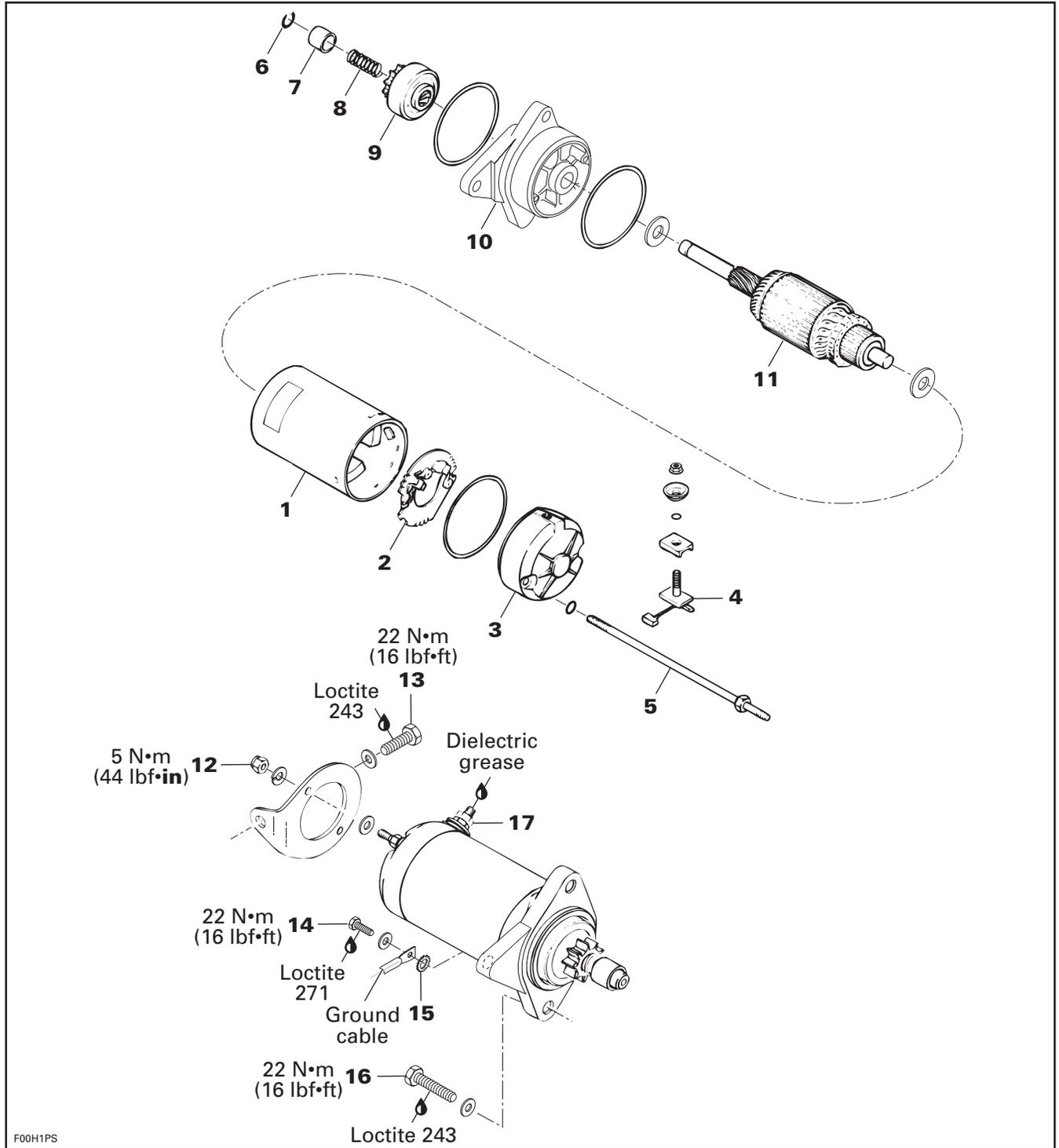


STARTING SYSTEM

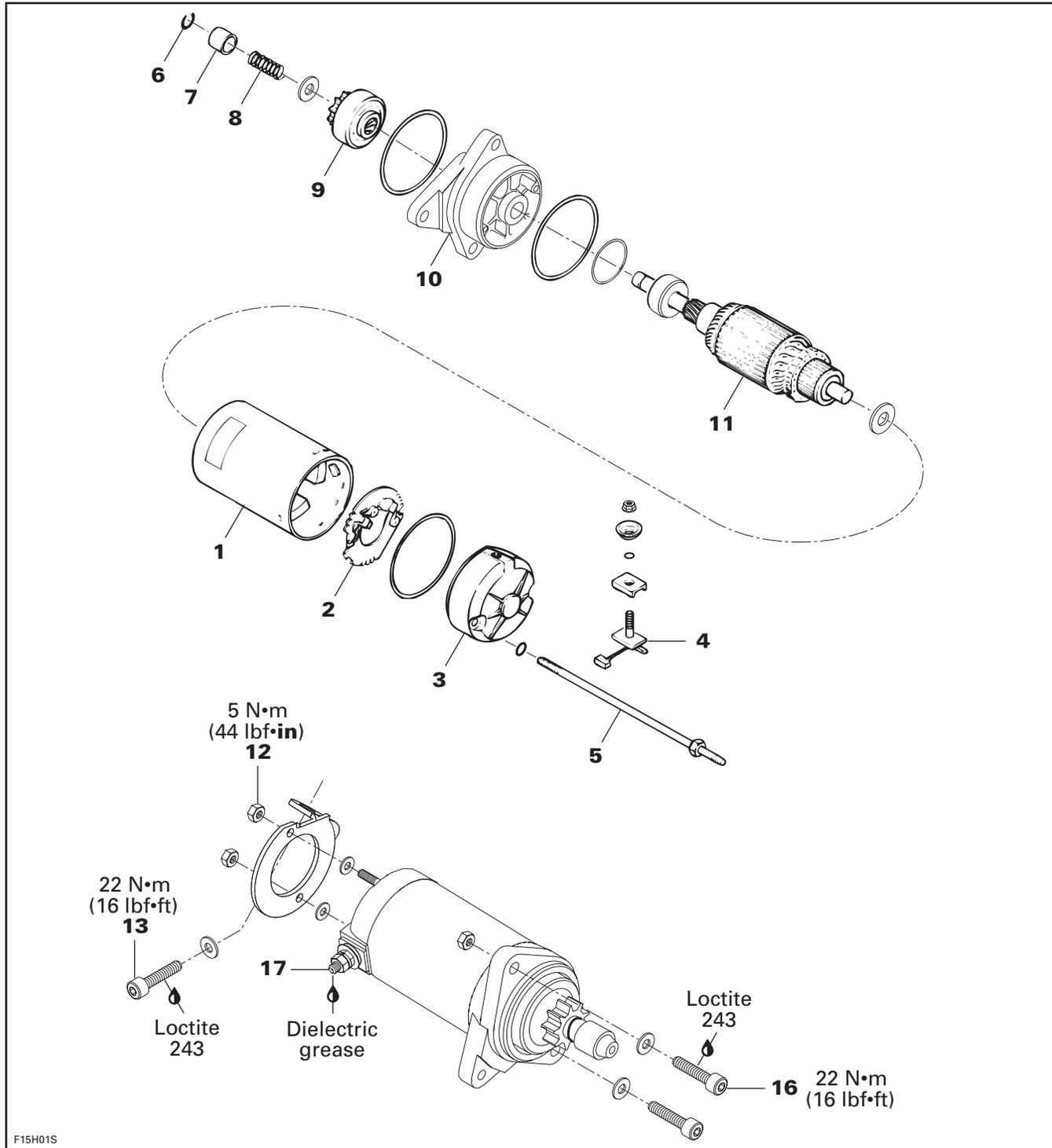
717 Engines



Section 12 ELECTRICAL SYSTEM

Subsection 03 (STARTING SYSTEM)

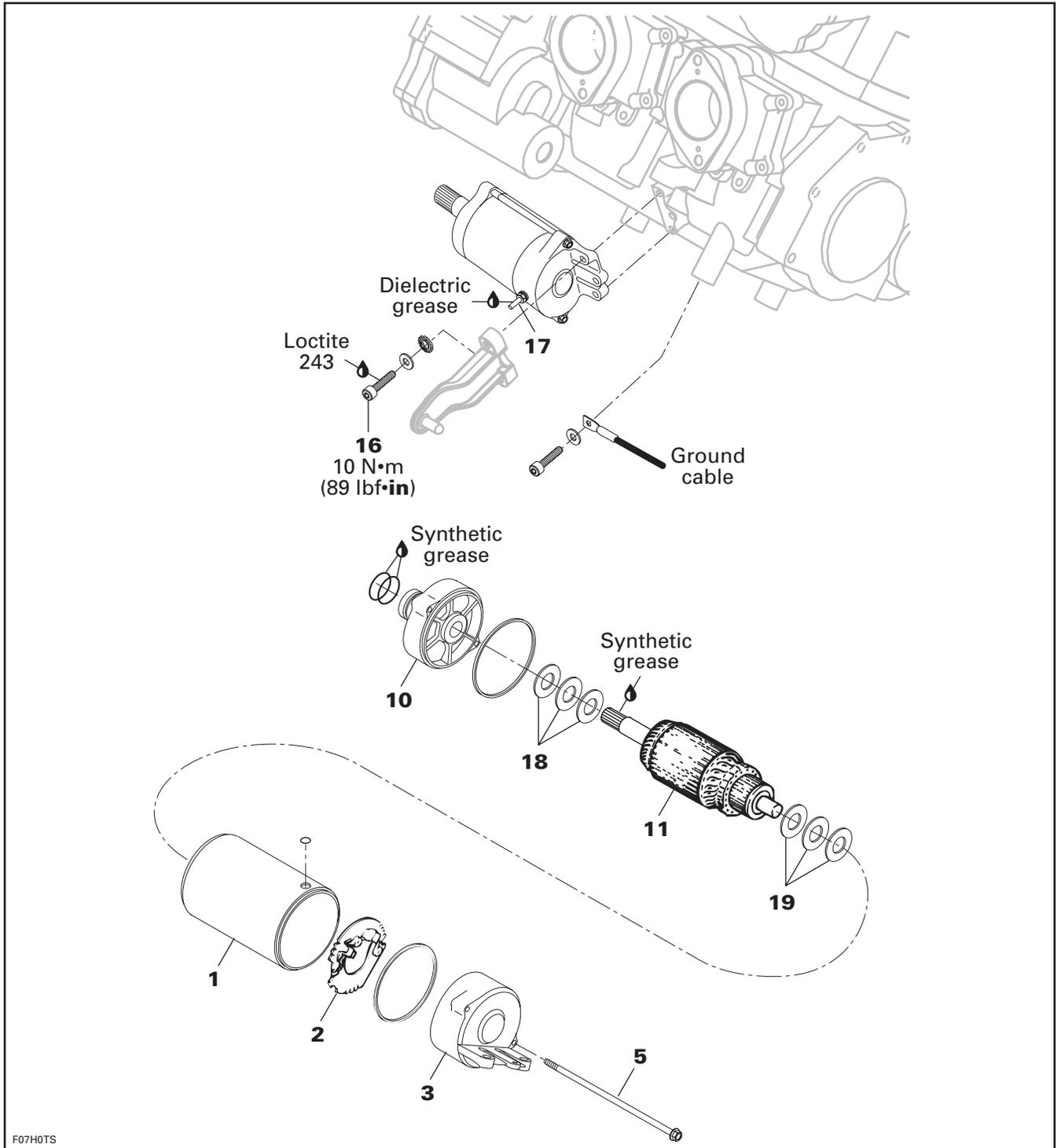
787 RFI Engines



F15H01S

Section 12 ELECTRICAL SYSTEM
Subsection 03 (STARTING SYSTEM)

947 DI Engines



F07H0TS

Section 12 ELECTRICAL SYSTEM

Subsection 03 (STARTING SYSTEM)

GENERAL

Causes of troubles are not necessarily related to starter but may be due to a burnt fuse, faulty battery, start/stop switch, safety lanyard switch, MPEM (or ECM on **4-TEC engines**), solenoid, electrical cables or connections.

Check these components before removing starter. Consult also the starting system troubleshooting table on next page for a general view of possible problems.

WARNING

Short circuiting electric starter is always a danger, therefore disconnect the battery ground cable before carrying out any kind of maintenance on starting system. Do not place tools on battery.

Fuse

Make sure the following fuse(s) is in good condition.

717 and 787 RFI Engines

5 A fuse on the MPEM.

Fuse on the power supply cut-off relay.

947 DI Engines

25 A BAT and 15 A INJ fuses on the MPEM.

Fuse on the power supply cut-off relay.

4-TEC Engines

10 A (# 9 on wiring diagram) fuse on the MPEM and the 30 A main fuse (starting system) besides the MPEM.

The solenoid may be the cause of a burnt fuse. If the solenoid checks good, one of the accessory may be defective.

Battery

To check battery condition, refer to CHARGING SYSTEM.

MPEM (or ECM on 4-TEC engines)

If 2 short beeps are not heard when installing the safety lanyard, refer to DIGITALLY ENCODED SECURITY SYSTEM or ENGINE MANAGEMENT.

Engine Start/Stop Switch and Safety Lanyard Switch

Refer to IGNITION SYSTEM or ENGINE MANAGEMENT or INSTRUMENTS AND ACCESSORIES.

Solenoid

NOTE: Solenoid is located in the electrical box or above MPEM on **787 RFI engines** and besides MPEM on **4-TEC engines**.

Inspect connections and clean as necessary.

Static Test: Continuity

With a multimeter, check primary winding resistance.

It should be approximately 5 ohms.

There should be no continuity between the positive posts of the solenoid.

Dynamic Test

Depress start/stop button and measure the voltage on the solenoid positive posts with a multimeter.

If there is no voltage and battery is in good condition, replace the solenoid.

Electrical Cables or Connections

Check all connections, cables and wires. Tighten any loose cables. Replace any chafed wires.

STARTING SYSTEM TROUBLESHOOTING

| SYMPTOM | CAUSE | REMEDY |
|--|---|---|
| STARTER DOES NOT TURN. | Burnt fuse (see text above). | Check wiring condition and replace fuse. |
| | Poor contact of battery terminal(s). | Clean and tighten terminal(s). |
| | Poor battery ground cable connection. | Clean and tighten. |
| | Weak battery. | Recharge or replace battery. |
| | Poor contact of start/stop switch, safety lanyard switch or solenoid. | Check connectors and clean contacts. Check and replace defective parts. |
| | Open circuit: start/stop switch or solenoid. | Check and replace. |
| | Safety lanyard or MPEM (or ECM on 4-TEC engines). | Refer to DIGITALLY ENCODED SECURITY SYSTEM or ENGINE MANAGEMENT. |
| STARTER ENGAGES; BUT DOES NOT CRANK THE ENGINE. | Poor battery cable connections. | Clean battery cable connections. |
| | Poor contact of brush. | Straighten commutator and brush. |
| | Burnt commutator. | Turn commutator on a lathe. |
| | Worn commutator segments. | Undercut mica. |
| | Shorted armature. | Repair or replace armature. |
| | Weak brush spring tension. | Replace brush holder or spring. |
| | Weak magnet. | Replace yoke assembly. |
| | Worn bushings. | Replace clutch. |
| | Weak battery. | Recharge or replace battery. |
| STARTER TURNS, BUT OVERRUNNING CLUTCH PINION DOES NOT MESH WITH RING GEAR. | Worn clutch pinion gear. | Replace clutch. |
| | Defective clutch. | Replace clutch. |
| | Poor movement of clutch on splines. | Clean and correct. |
| | Worn clutch bushing. | Replace clutch. |
| | Worn ring gear. | Replace ring gear. |
| STARTER MOTOR KEEPS RUNNING. | Shorted solenoid winding. | Replace solenoid. |
| | Melted solenoid contacts. | Replace solenoid. |
| | Sticking or defective starter clutch. | Lubricate or replace. |
| | Presence of salt water in the electrical box (if so equipped) which gives continuity. | Verify electrical box watertightness. |

Section 12 ELECTRICAL SYSTEM

Subsection 03 (STARTING SYSTEM)

STARTER REMOVAL

Disconnect BLACK cable ground connection from battery.

⚠ WARNING

Always disconnect ground cable first and re-connect last.

Disconnect RED cable connection from battery.

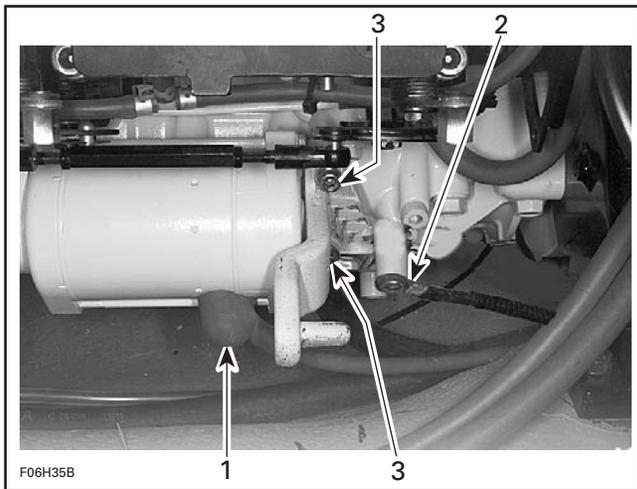
717 and 787 RFI Engines

Remove the following parts:

- cables from starter
- screw no. 13 of starter rear support
- starter mount screws no. 16.

947 DI Engines

Disconnect starter cables and loosen Allen screws no. 16 retaining starter bracket to engine.



1. Positive starter cable
2. Negative starter cable
3. Allen screw

Remove bracket and starter.

NOTE: To remove the starter drive assembly, magneto flywheel has to be removed. Refer to MAGNETO SYSTEM and BOTTOM END.

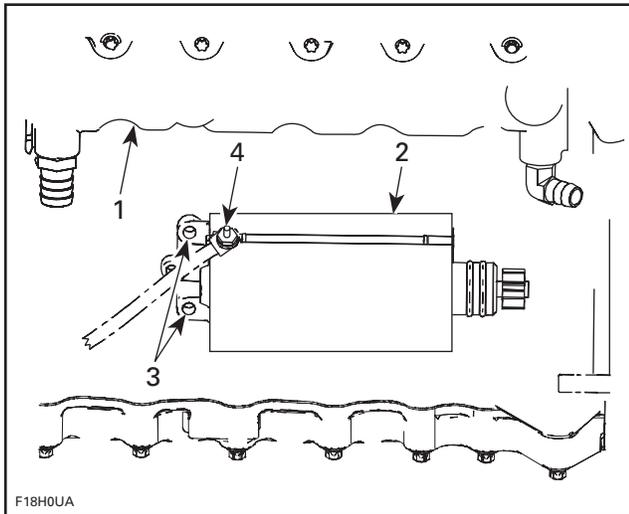
To check and replace the starter end bearing, refer to BOTTOM END section.

4-TEC Engines

NOTE: To facilitate starter removal on RXP models, remove engine cover. Refer to BODY section.

Remove retaining screws from starter.

Pull starter out. Lift starter enough to reach starter cable then disconnect from starter.

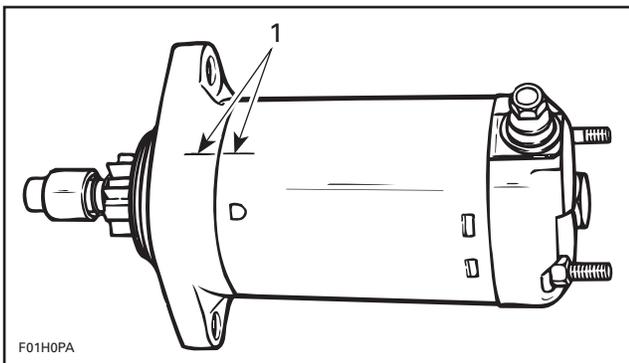


1. Exhaust manifold
2. Starter
3. Retaining screws
4. Nut

STARTER DISASSEMBLY

717 and 787 RFI Engines

Before disassembling, trace index marks on yoke no. 1 and clutch housing no. 10 to ease further assembly.



TYPICAL

1. Trace indexing marks

Remove starter support nuts no. 12 then through bolts no. 5. Separate end frame no. 3 from yoke assembly no. 1. Withdraw yoke assembly from armature no. 11.

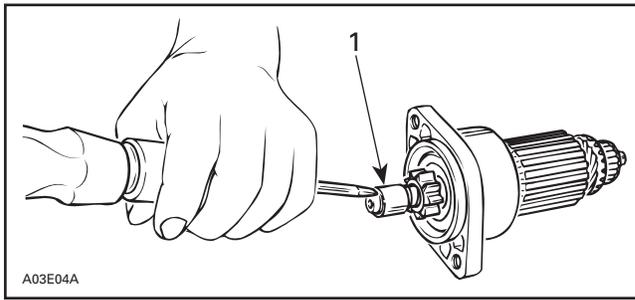
Brush holder no. 2 can be removed from end frame no. 3 by unscrewing nut retaining terminal.

Section 12 ELECTRICAL SYSTEM

Subsection 03 (STARTING SYSTEM)

Check that the radial play between the armature shaft and end frame is not greater than 0.20 mm (.008 in). Replace end frame if so.

Tap the pinion stop collar **no. 7** using a screwdriver. Remove circlip **no. 6**. Disassemble pinion stop collar **no. 7** and spring **no. 8**.



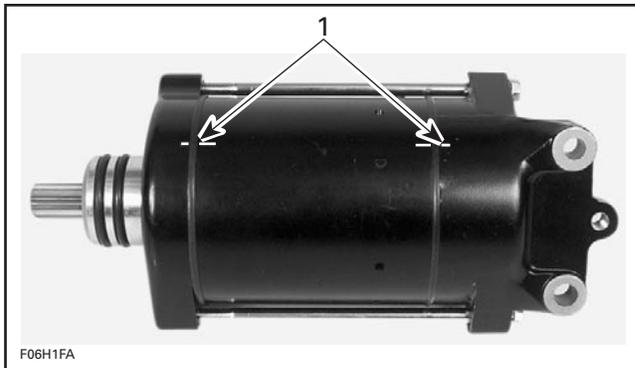
1. Pinion stop collar

Turn clutch assembly **no. 9** clockwise to remove it from armature assembly **no. 11**.

Pull housing from armature.

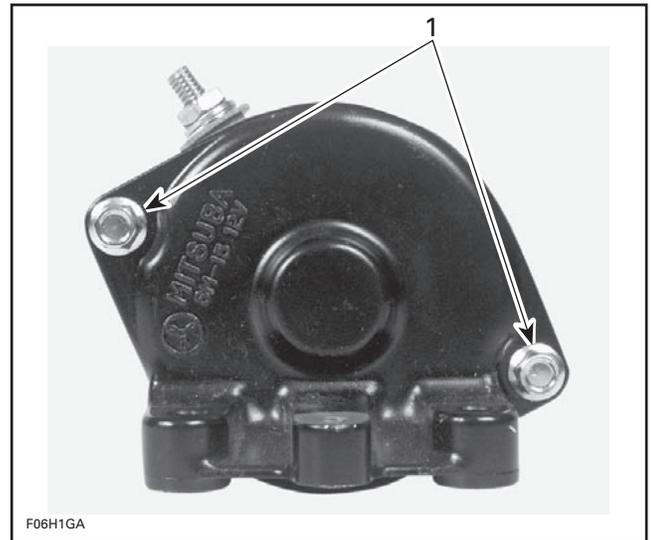
947 DI Engines

Locate index marks on yoke **no. 1** and end covers **no. 3** and **no. 10**.



1. Index marks

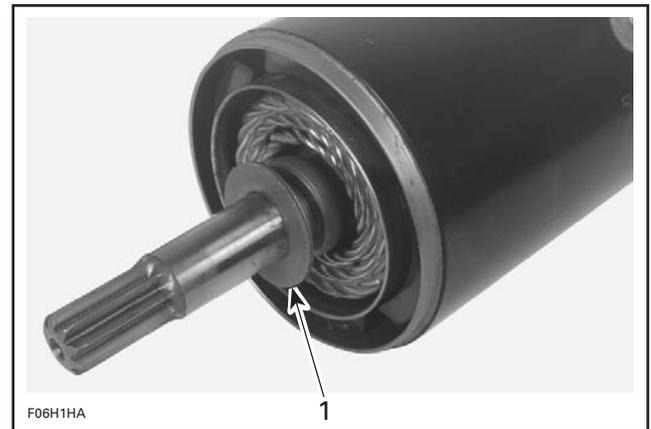
Loosen through bolts **no. 5**.



1. Through bolts

Remove end cover **no. 3** and gasket on armature shaft side.

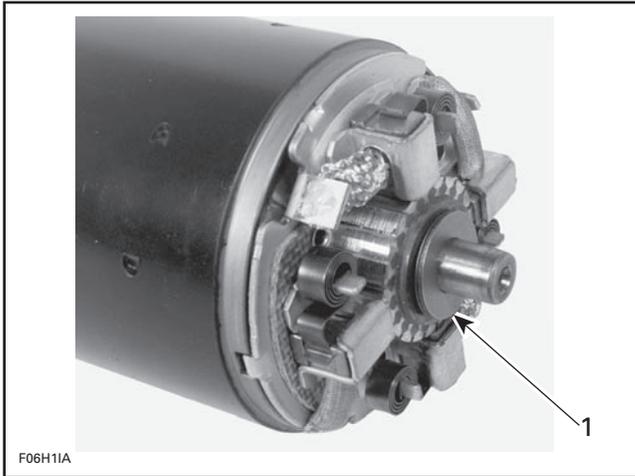
Remove thrust washers **no. 19** from armature shaft.



1. Thrust washers

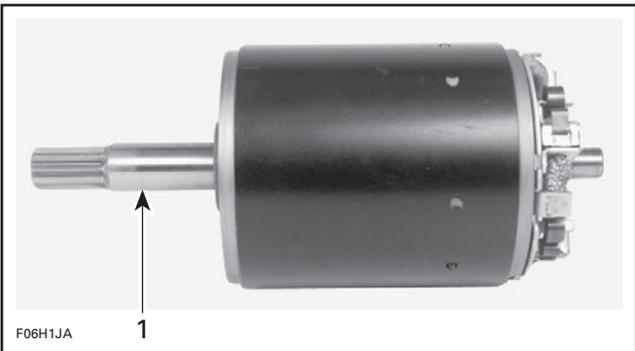
Remove the other end cover **no. 10** and gasket.
Remove the three washers **no. 18** from armature shaft.

Section 12 ELECTRICAL SYSTEM
Subsection 03 (STARTING SYSTEM)



1. Washers

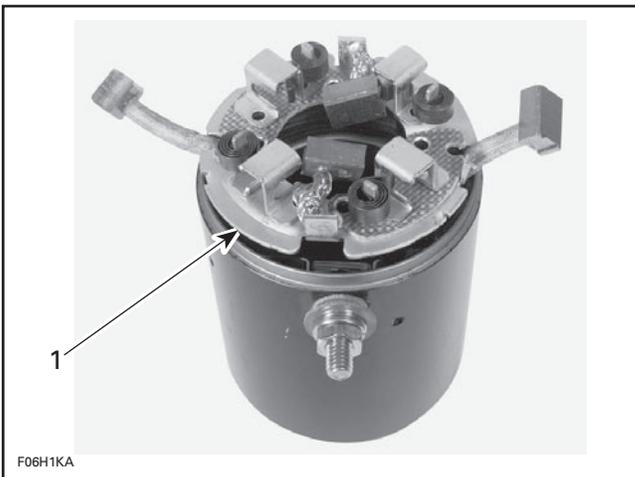
Remove armature no. 11.



1. Pull armature shaft

Release brush wires of yoke from brush holder no. 2.

Remove brush holder no. 2.



1. Remove brush holder

To remove brushes from yoke no. 1, loosen nut and remove washers.



1. Loosen nut and remove washers

Remove brushes.

To remove bearing and seal in end cover, release tabs of retainer.

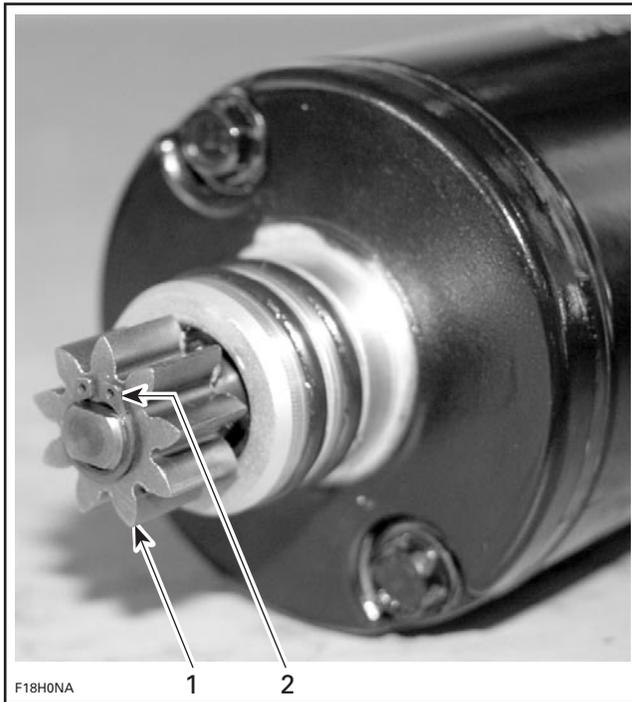


1. Retainer

4-TEC Engines

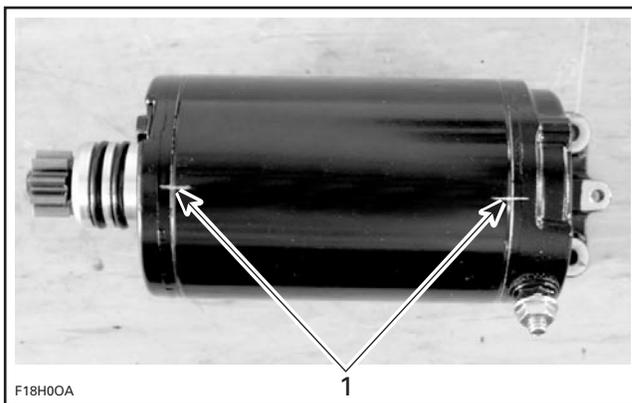
Remove bendix retaining circlip no. 4 and starter bendix no. 5.

Section 12 ELECTRICAL SYSTEM
Subsection 03 (STARTING SYSTEM)



F18H0NA
 1. Retaining circlip
 2. Starter bendix

Locate index marks on yoke and end covers.



F18H00A
 1. Index marks

Loosen through bolts.

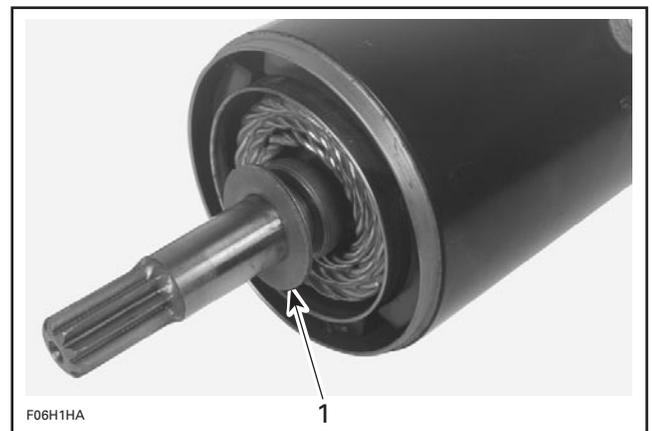


F18H0PA

1. Through bolts

Remove end cover.

Remove thrust washer from armature shaft.



F06H1HA

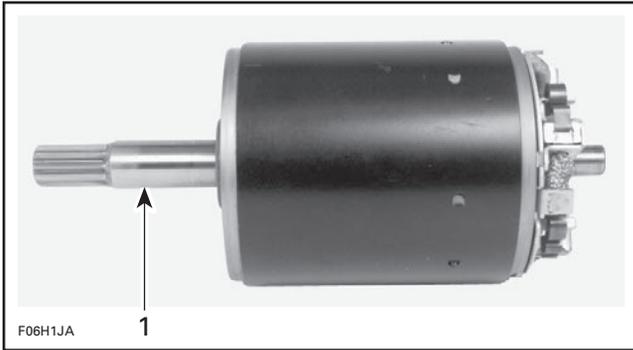
TYPICAL
 1. Thrust washers

Remove the other end cover with brushes and brush holder assembly.

Remove armature.

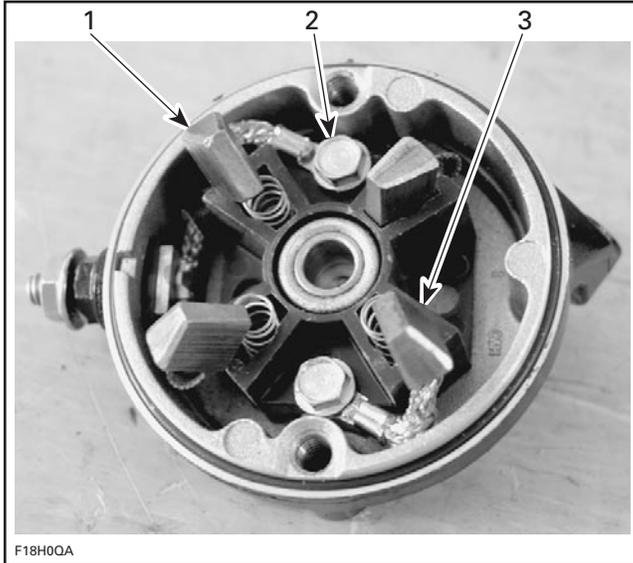
Section 12 ELECTRICAL SYSTEM

Subsection 03 (STARTING SYSTEM)



TYPICAL
1. Pull armature shaft

Remove brushes from brush holder by loosening retaining screws.



1. Brushes
2. Retaining screw
3. Brush holder

Remove springs.

CLEANING

All Engines

CAUTION: Yoke ass'y and drive unit assembly must not be immersed in cleaning solvent.

Discard all O-rings.

Clean brushes and holders with a clean cloth soaked in solvent. Brushes must be dried thoroughly with a clean cloth.

Blow brush holders clean using compressed air.

WARNING

Always wear safety glasses when using compressed air.

Remove dirt, oil or grease from commutator using a clean cloth soaked in suitable solvent. Dry well using a clean, dry cloth.

Clean engine ring gear teeth and drive unit (clutch).

NOTE: Bushings or bearings must not be cleaned with grease dissolving agents.

Immerse all metal components in cleaning solution. Dry using a clean, dry cloth.

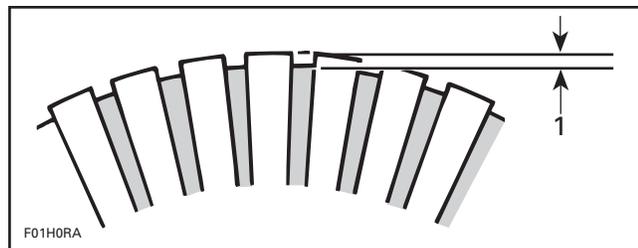
PARTS INSPECTION

Armature

NOTE: An ohmmeter may be used for the following testing procedures, except for the one concerning shorted windings in armature.

Check commutator for roughness, burnt or scored surface. If necessary, turn commutator on a lathe, enough to resurface only.

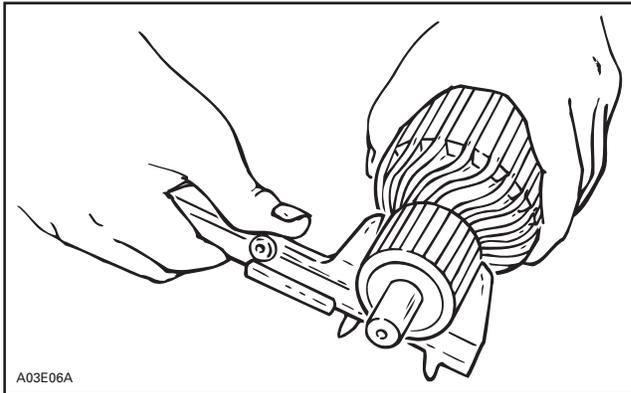
Check commutator for mica depth. If depth is less than 0.20 mm (.008 in), undercut mica. Be sure that no burrs are left and no copper dust remains between segments after undercutting operation is completed.



1. Commutator undercut 0.20 mm (.008 in)

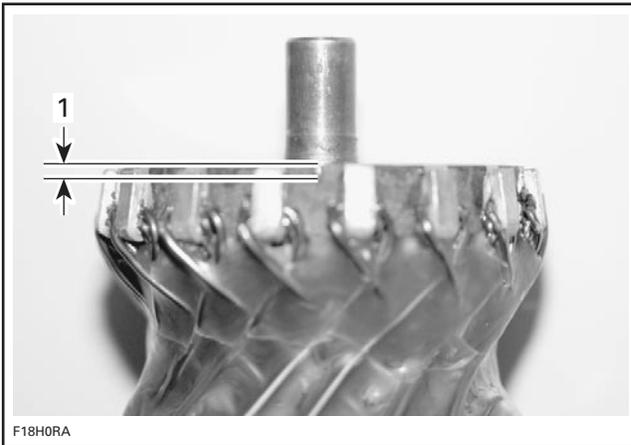
Check commutator out of round condition with V-shaped blocks and an indicator. If commutator out of round is more than 0.40 mm (.016 in), commutator should be turned on a lathe.

Check commutator outer diameter. If less than 27 mm (1.063 in), replace.



4-TEC Engines

Check commutator condition with an indicator. If out of specification, replace the starter.



1. Commutator undercut 0.20 mm (.008 in)

All Engines

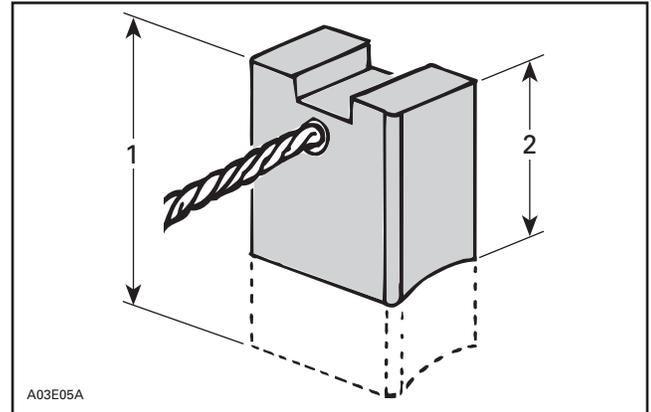
Brush Holder

Check brush holder for insulation using an ohmmeter. Place one test probe on insulated brush holder and the other test probe on brush holder plate. If continuity is found, brush holder has to be repaired or replaced.

Brush

Measure brush length. If less than 8.5 mm (.335 in), replace them.

NOTE: New brush length is 12 mm (.472 in).



1. New
2. Wear limit, 8.5 mm (.335 in)

Overrunning Clutch

2-Stroke Engines

Pinion of overrunning clutch should turn smoothly in clockwise direction, and should not slip in a counterclockwise direction. If defective, replace.

Check pinion teeth for wear and damage. If defective, replace.

NOTE: Always check engine ring gear teeth for wear and damage. If defective replace ring gear. Refer to MAGNETO.

STARTER ASSEMBLY

All Engines

Reverse the order of disassembly to reassemble starter. However, attention should be paid to the following operations.

717 and 787 RFI Engines

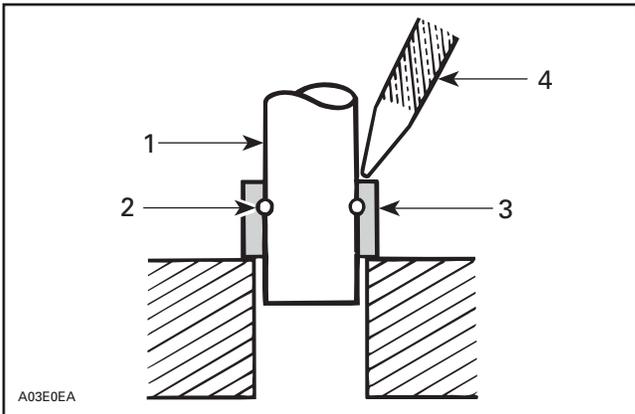
Prior to assembling, coat sliding surfaces on armature shaft splines, overrunning clutch and bushing (717 engines) with G.E. Versilube G 341 M or ES-SO Beacon 325 lubricant or equivalent.

After placing pinion stop collar no. 7 on armature shaft no. 11, fit circlip no. 6 into armature shaft, then make sure that it is properly secured.

Slide stop collar no. 7 over circlip no. 6 and secure in place by punching it at two or three places.

Section 12 ELECTRICAL SYSTEM

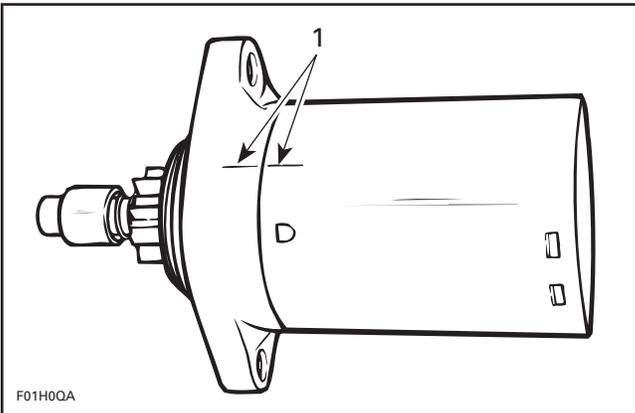
Subsection 03 (STARTING SYSTEM)



1. Armature shaft
2. Circlip
3. Pinion stop collar
4. Punch

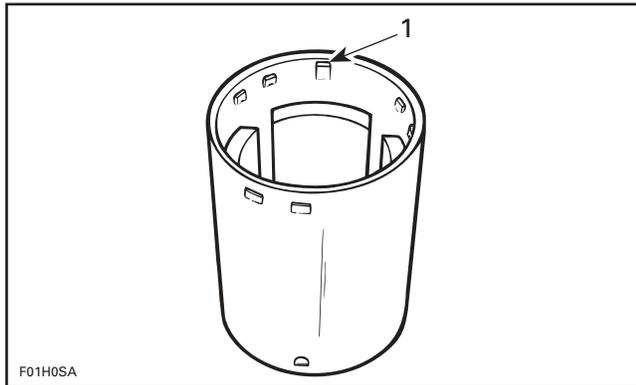
Yoke Assembly and Clutch Housing

Align previously traced indexing marks.

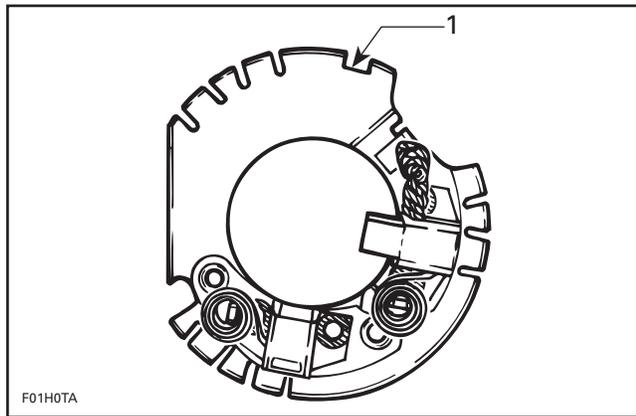


- TYPICAL**
1. Align marks

Open brushes **no. 4** and slide over commutator.
Align end frame locating notch with yoke locating protrusion and properly sit brush holder **no. 2** into yoke **no. 1**.



1. Locating protrusion is the higher one

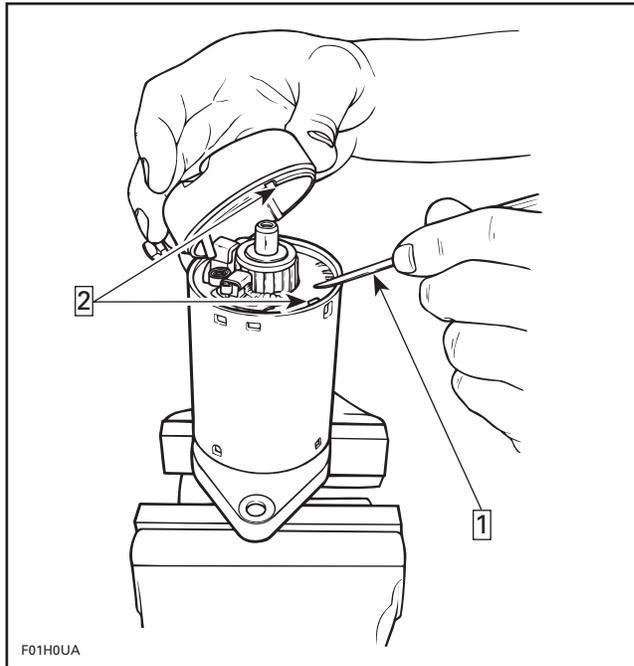


1. Brush holder locating notch

To ease end frame installation, retain brush holder with a small screwdriver while installing end frame.

Section 12 ELECTRICAL SYSTEM

Subsection 03 (STARTING SYSTEM)



Step 1: Retaining brush holder with a screwdriver
Step 2: Align here

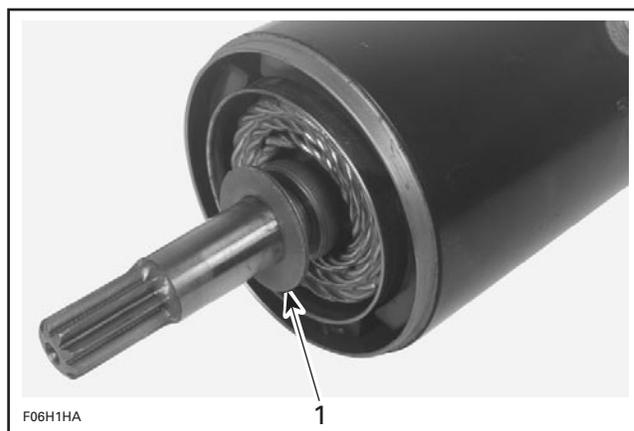
Align end frame notch with brush holder notch/yoke protrusion.

CAUTION: Make sure end frame fits perfectly on yoke.

947 DI Engines

Install new O-rings and gaskets.

Insert thrust washers no. 19 onto armature shaft.



1. Thrust washers

Install the three washers no. 8 onto armature shaft.

When installing end covers no. 3 and no. 10 to yoke, align index marks.

Apply Loctite 271 (red) on through bolts no. 5 and torque to 6 N•m (53 lbf•in).

STARTER INSTALLATION

Installation is essentially the reverse of removal procedure. However, pay particular attention to the following.

Make sure that starter and engine mating surfaces are free of debris. Serious trouble may arise if starter is not properly aligned.

717 and 787 RFI Engines

Screw

Apply service products as per the exploded view given at the beginning of the section, on threads and torque starter screws no. 13 and no. 16 to 22 N•m (16 lbf•ft).

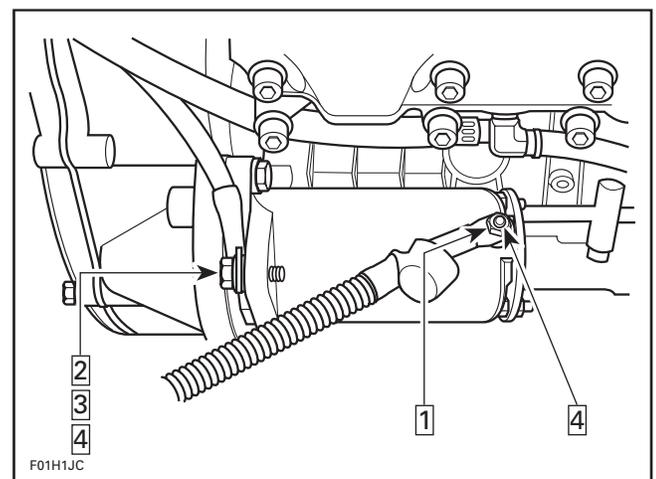
Nut

Connect the RED positive cable to the starter and torque nut no. 17 to 6 N•m (53 lbf•in). Apply dielectric grease on terminal and nut.

Screw and Teeth Washer

Apply Loctite 271 (red) to screw.

Connect BLACK negative cable to starter using flat washer, teeth washer no. 15 and screw no. 14. Torque screw to 22 N•m (16 lbf•ft). Apply dielectric grease on terminal and screw.



717 ENGINES SHOWN

- STEP 1: Torque nut to 6 N•m (53 lbf•in)
- STEP 2: Apply Loctite 271 on screw
- STEP 3: Torque screw to 22 N•m (16 lbf•ft)
- STEP 4: Apply dielectric grease

Section 12 ELECTRICAL SYSTEM

Subsection 03 (STARTING SYSTEM)

⚠ WARNING

Always connect RED positive cable first then BLACK negative cable last. Whenever connecting the RED positive cable to the starter motor make sure the battery cables are disconnected to prevent electric shock.

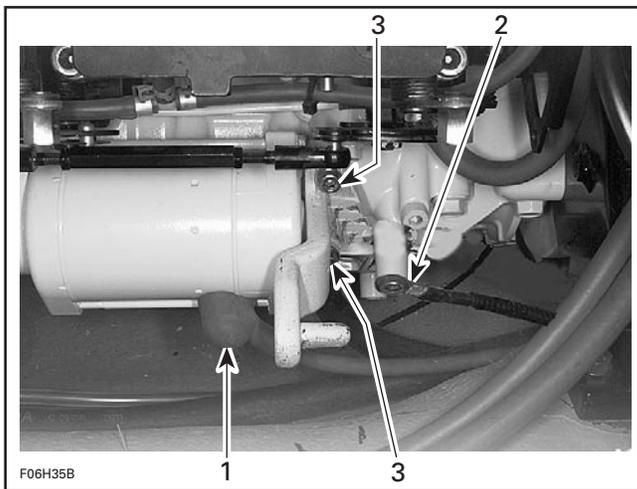
947 DI Engines

Screw

Apply Loctite 243 (blue) to Allen screws **no. 16** of starter bracket and torque to 10 N•m (89 lbf•in).

Nut

Connect the RED positive cable to the starter and torque nut **no. 17** to 6 N•m (53 lbf•in). Apply dielectric grease on terminal and nut.



947 DI ENGINES

1. Torque nut to 6 N•m (53 lbf•in), apply dielectric grease and install protection cover
2. Negative BLACK cable
3. 10 N•m (89 lbf•in)

⚠ WARNING

Always connect RED positive cable first then BLACK negative cable last. Whenever connecting the RED positive cable to the starter motor make sure the battery cables are disconnected to prevent electric shock.

4-TEC Engines

Apply grease Isoflex Topas NB52 (P/N 293 550 021) on O-rings of starter.

Install starter.

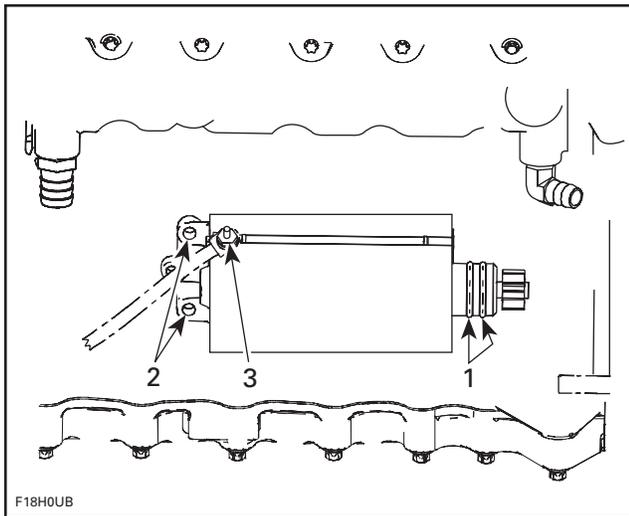
NOTE: If starter does not mesh properly, try to pull it out and slightly rotate the starter gear; then re-install starter. One could also temporarily remove both O-rings, properly mesh gears then remove starter to reinstall O-rings, being careful not to rotate gear to keep its position, to finally reinstall starter.

Apply Loctite 243 (blue) on retaining screws **no. 1** and torque to 10 N•m (89 lbf•in).

Nut

Connect the RED positive cable to the starter and torque nut to 7 N•m (62 lbf•in). Apply dielectric grease on terminal and nut.

Ensure to slide protector over nut to hide metallic parts.



1. Grease on O-rings.
2. Torque nut to 7 N•m (62 lbf•in) and apply dielectric grease and install protection cover
3. 10 N•m (89 lbf•in)

⚠ WARNING

Always connect RED positive cable first then BLACK negative cable last. Whenever connecting the RED positive cable to the starter motor make sure the battery cables are disconnected to prevent electric shock.

STARTER SPECIFICATION

717 and 787 RFI Engines

| | | |
|--|---------|--|
| Nominal output | | 0.6 kW |
| Voltage | | 12 V |
| Rated time | | 30 seconds |
| Rotation | | Counterclockwise (viewed from pinion side) |
| Weight | | Approx. 2 kg (4.4 lb) |
| Performance specification at 20°C (68°F) | No load | 11.5 V 20 A max. 5500 RPM |
| | Load | 8.5 V 170 A max. 2200 RPM |
| | Stall | 5 V 350 A max. 0 RPM |
| Battery | | 12 V, 19 Ah |

947 DI Engines

| | | |
|--|---------|--|
| Nominal output | | 8 kW |
| Voltage | | 12 V |
| Rated time | | 30 seconds |
| Rotation | | Counterclockwise (viewed from pinion side) |
| Weight | | 1.7 kg (3.7 lb) |
| Performance specification at 20°C (68°F) | No load | 10.9 V 45 A max. 8600 RPM |
| | Load | 9 V 120 A max. 5350 RPM |
| | Stall | 2.25 V 390 A max. 0 RPM |
| Battery | | 12 V, 19 Ah |

4-TEC Engines

| | | |
|--|---------|--|
| Nominal output | | 0.9 kW |
| Voltage | | 12 V |
| Rated time | | 30 seconds |
| Rotation | | Counterclockwise (viewed from pinion side) |
| Weight | | 2.5 kg (5.39 lb) |
| Performance specification at 20°C (68°F) | No load | 11.4 V 23 A max. 8600 RPM |
| | Load | 8.5 V 140 A max. 5200 RPM |
| | Stall | 3.75 V 330 A max. 0 RPM |
| Battery | | 12 V, 30 Ah |