MOTORCRAFT

American Motors (6 Cylinder)
Ford Motor Co. (All Models)

DESCRIPTION

The starting system includes a 4-pole, 4-brush starting motor with a positive engagement drive, a starter-ignition switch, neutral-start switch (some auto. trans. models), starter solenoid (starter relay), and heavy circuit wiring.

American Motors uses a starter with a 4½" diameter frame, while Ford Motor Company uses starters with both 4" and 4½" diameter frames. Starter motors have a movable pole shoe and appropriate linkage to engage the drive mechanism. Inside the drive assembly, an overrunning clutch prevents starter motor from being driven by the ring gear.

OPERATION

Turning the ignition switch to the "START" position activates the solenoid. The solenoid then connects the battery to the starter.

When the starter is not in use, one of the 4 field coils is connected directly to ground through a set of contacts. When the starter is first connected to the battery, a large current flows through the grounded field coil, activating the movable pole shoe.

The pole shoe, attached to the starter drive plunger lever, forces the drive assembly into the flywheel ring gear. When the movable pole shoe is fully seated, it opens the field coil grounding contacts and the starter operates normally. A holding coil is used to maintain the movable shoe in the fully-seated position while the starter is turning the engine.

TESTING

NOTE – *Before performing tests, clean and connect battery cables. Be sure battery is fully charged. Remove coil high tension wire from distributor and ground it. Place transmission in neutral or park and apply parking brake. When making voltmeter connections, be sure to connect leads to battery posts or threaded terminals and not just to cable ends. See Fig. 2 for Voltage Drop Test connections.*

STARTER CRANKING CIRCUIT TESTS

NOTE – *The tests that follow and the specifications offered are for the American Motors and Ford Motor Company starters with 4½" frames, rated at 150-210 amps. Test results may vary slightly for Ford Motor Company's starter with a 4" frame, rated at 150-250 amps. In voltage drop tests below, readings for Ford Motor Company's 4" frame starter should be: Test No. 1 – 0.5 volt; Test No. 2 – 0.3 volt; Test No. 3 – 0.1 volt; and Test No. 4 – 0.3 volt. Be sure starter motor has attained maximum RPM before taking amperage readings.*

Starter Motor Full Load Current Test – 1) Connect starter motor tester. Crank engine and observe voltmeter. Turn ignition switch "OFF". Turn load control until voltmeter reading shows the same voltage as when cranking. Observe ammeter reading. *See Fig. 1.*

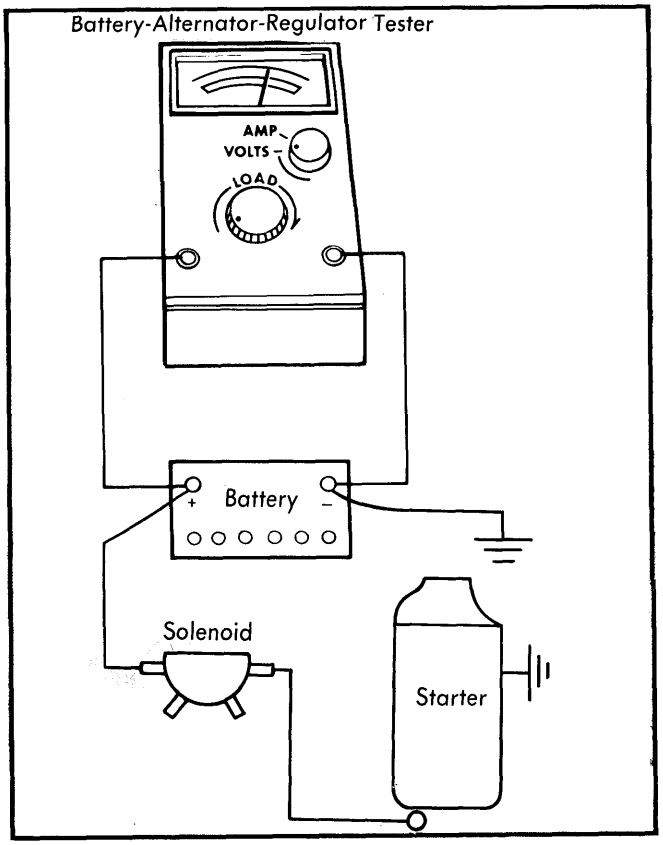

Fig. 1 Starter Full Load Test Connections

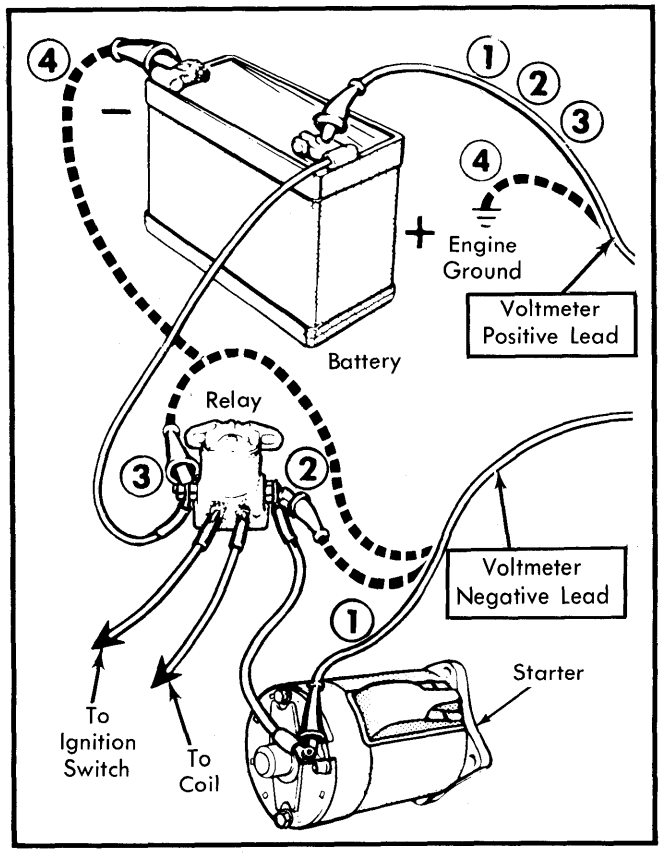

Fig. 2 Cranking Circuit (Voltage Drop) Test Connections

MOTORCRAFT (Cont.)

2) If ammeter reading is 150-180 amps., full load current test is satisfactory. If above 180 amps. and battery cables and solenoid repairs have been completed, repair starter motor. If above 180 amps. and no cable or solenoid testing or repair has occurred, proceed with the following voltage drop tests.

Battery-to-Starter Motor Voltage Drop (No. 1) Test – 1) Connect voltmeter positive lead to battery positive post and negative lead to starter motor terminal. Crank engine and note voltage. See *Fig. 2*.

2) If amperage in Full Load Current Test was 150-210 amps., voltage reading should be 0.5 volt. Voltage reading should be 0.7 volt if 215-295 amps.; 1.0 volt if 300-420 amps.; and 1.5 volts if 425-600 amps.

3) If voltage is at or below specification and problem exists, proceed to Starter Motor Ground Voltage Drop (No. 4) Test. If voltage is above specification, proceed to Battery-to-Solenoid Voltage Drop (No. 2) Test.

Battery-to-Solenoid Voltage Drop (No. 2) Test – 1) Connect voltmeter positive lead to battery positive post and negative lead to solenoid terminal (starter side). Crank engine and note voltmeter reading. See *Fig. 2*.

2) Voltmeter reading should be 0.3 volt if amperage reading in Full Load Current Test was 150-210 amps. Voltage reading should be 0.5 volt if 215-295 amps.; 0.6 volt if 300-420 amps.; and 0.9 volt if 425-600 amps.

3) If voltage is at or below specification and problem exists, proceed to Starter Motor Ground Voltage Drop (No. 4) Test. If voltage is above specification, proceed to Solenoid Voltage Drop (No. 3) Test.

Solenoid Voltage Drop (No. 3) Test – 1) Connect voltmeter positive lead to battery positive post and negative lead to solenoid terminal (battery side). Crank engine and note voltmeter reading. See *Fig. 2*.

2) Voltage should read 0.2 volt if amperage reading in Full Load Current Test was 150-210 amps. Voltage should be 0.3 volt if 215-295 amps.; 0.4 volt if 300-420 amps.; and 0.5 volt if 425-600 amps.

3) If voltage was at or below specification, repair solenoid. If above specification, repair battery-to-solenoid cable. In either event, proceed to Starter Motor Ground Voltage Drop (No. 4) Test.

Starter Motor Ground Voltage Drop (No. 4) Test – 1) Connect NEGATIVE voltmeter lead to battery negative post and POSITIVE lead to starter or engine ground. Crank engine and note voltmeter reading. See *Fig. 2*.

2) Voltage should be 0.2 volt if amperage reading in Full Load Current Test was 150-210 amps. Voltage should be 0.3 volt if 215-295 amps.; 0.4 volt if 300-420 amps.; or 0.5 volt if 425-600 amps.

3) If voltage is at or below maximum specification and repairs to solenoid or cables has been performed, repeat Full Load Current Test. If voltage is at or below maximum specification and repairs to solenoid or cables was not required, repair starter motor. If voltage was still above maximum specification, repair engine-to-battery cable and repeat Full Load Current Test.

STARTER NO LOAD TEST

1) Connect battery, alternator, regulator and starter motor tester as shown in *Fig. 3*. Turn tester load control knob to the extreme counterclockwise (decrease) position. Turn tester to voltmeter position. Crank engine, determine exact starter motor RPM using a mechanical tachometer, and record voltage.

2) Disconnect battery cable from starter motor. Turn load control knob clockwise (toward increase) until voltage is exactly the same as it was with battery connected to starter. Switch tester from voltmeter position to ammeter position and record amps.

3) If amperage at no load speed is below specification, the starter motor has high electrical resistance and should be repaired or replaced. If amperage is higher than specification and starter motor RPM is less than minimum RPM specified, disassemble, clean, inspect and test starter motor.

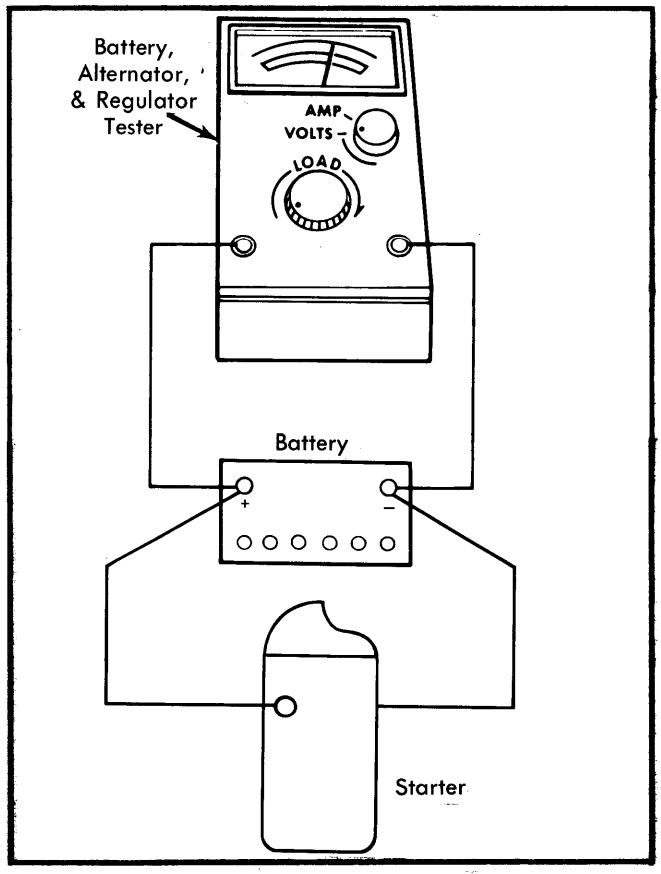

Fig. 3 Starter No-Load Test Connections

MOTORCRAFT (Cont.)

Starter No Load Test Specifications

Application	4" Frame	4 ½" Frame
Voltage	12 Volts	12 Volts
Amperage	80 amps.	67 amps.①
RPM Range	6700 Min. RPM	7380-9356 RPM

① – Specification is for American Motors. Ford Motor Company amperage is 85 amps.

OVERHAUL

DISASSEMBLY

1) Remove cover screw, cover, through bolts, starter drive end housing and starter drive plunger lever return spring. Remove starter gear plunger lever pivot pin and lever and slide armature out.

2) Remove stop ring retainer, thrust washer and stop ring from armature shaft. Remove starter drive gear assembly. Remove brush end plate and insulator assembly. Remove brushes from plastic brush holder and lift out holder. Note location of brush holder with respect to end terminal.

3) Remove screws retaining ground brushes to frame. Bend up the edges of the sleeve which is inserted in frame and remove sleeve and retainer. Detatch shunt field coil ground wire from copper tab riveted to frame.

4) Remove the three pole shoe retaining screws with tool 10044-A (or equivalent), and an arbor press. Cut the field coil connection at the switch post lead and remove pole shoes and coils from frame. Cut the positive brush leads from the field coils as close to the field connection point as possible.

CLEANING

Use a brush or compressed air to clean field coils, armature, brush end plate, drive end housing and starter drive. Wash other parts in suitable solvent.

PARTS REPLACEMENT & TESTING

Armature – **1)** Check armature for shorted coils with a growler. Hold steel blade parallel to and touching armature core. Slowly rotate armature one or more revolutions in growler jaws. If steel blade vibrates at any area of core, area is shorted and armature must be replaced.

2) Test for grounded coils with a test lamp or voltmeter and battery connected in a series. Touch one test probe to commutator and other test probe to core or armature shaft. If test lamp lights or voltmeter shows any reading, coils are grounded. Commutator should be clean and smooth. If commutator is burned or out-of-round more than .005", turn down in a lathe and clean with commutator paper.

Field Coil – **1)** Check for opens or grounded coils with a test lamp or voltmeter and battery connected in a series. Make sure insulated brush leads are clear of frame, block drive coil contacts (on frame) open by inserting insulator between contacts. Disconnect holding coil ground lead from frame.

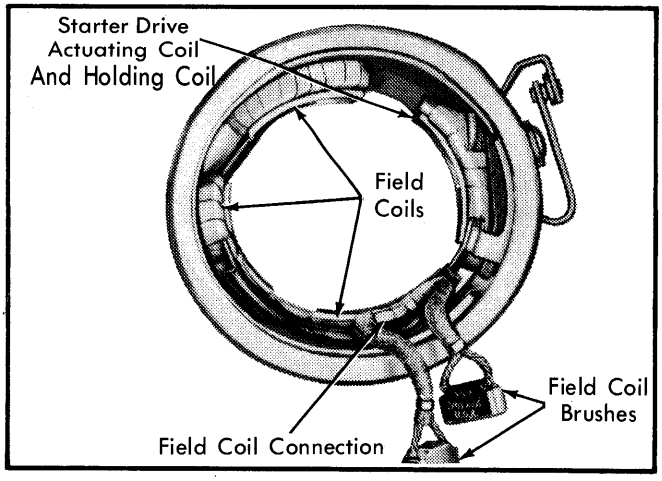

Fig. 4 Field Coil Assembly

2) Connect negative battery post to starter frame with jumper wire. Connect negative voltmeter lead to battery positive post, and positive lead to coil lead eyelet. If voltmeter shows a reading (or test lamp lights), coils are grounded.

3) Test for open coils by placing one test probe to field terminal and other probe to insulated brush lead. Lamp should light or voltmeter should show reading.

Brushes & Springs – Check brush holders for broken springs and insulated brush holders for shorts-to-ground. Tighten any loose rivets. Replace brushes if worn to ¼" length.

Brush Spring Tension

Application	Tension
4" Starter	80 ozs.
4½" Starter	80 ozs.

REASSEMBLY

1) Position coils and pole pieces (with coil leads in terminal screw slot), install retaining screws. As screws are tightened, strike frame several times with soft faced hammer to seat and align pole shoes, then stake screws.

2) Install plunger coil sleeve and retainer and bend tabs to retain coils to frame. Position grommet on end terminal and align into the notch in frame. Solder field coil to starter switch terminal post. Use a 300 watt iron and resin core solder.

3) Check for continuity and grounds in assembled coils. Position the ground brushes to starter frame and install retaining screws. Apply a thin coat of Lubriplate on armature shaft splines. Install starter motor drive gear assembly to armature shaft and install new stop ring, stop ring retainer and thrust washer.

4) Install armature in starter frame. Position the starter drive gear plunger lever to frame and starter drive assembly, and install pivot pin. Fill drive end housing bearing ¼ full with grease. Position drive end housing to frame making sure lever return spring engages tang on lever.

MOTORCRAFT (Cont.)

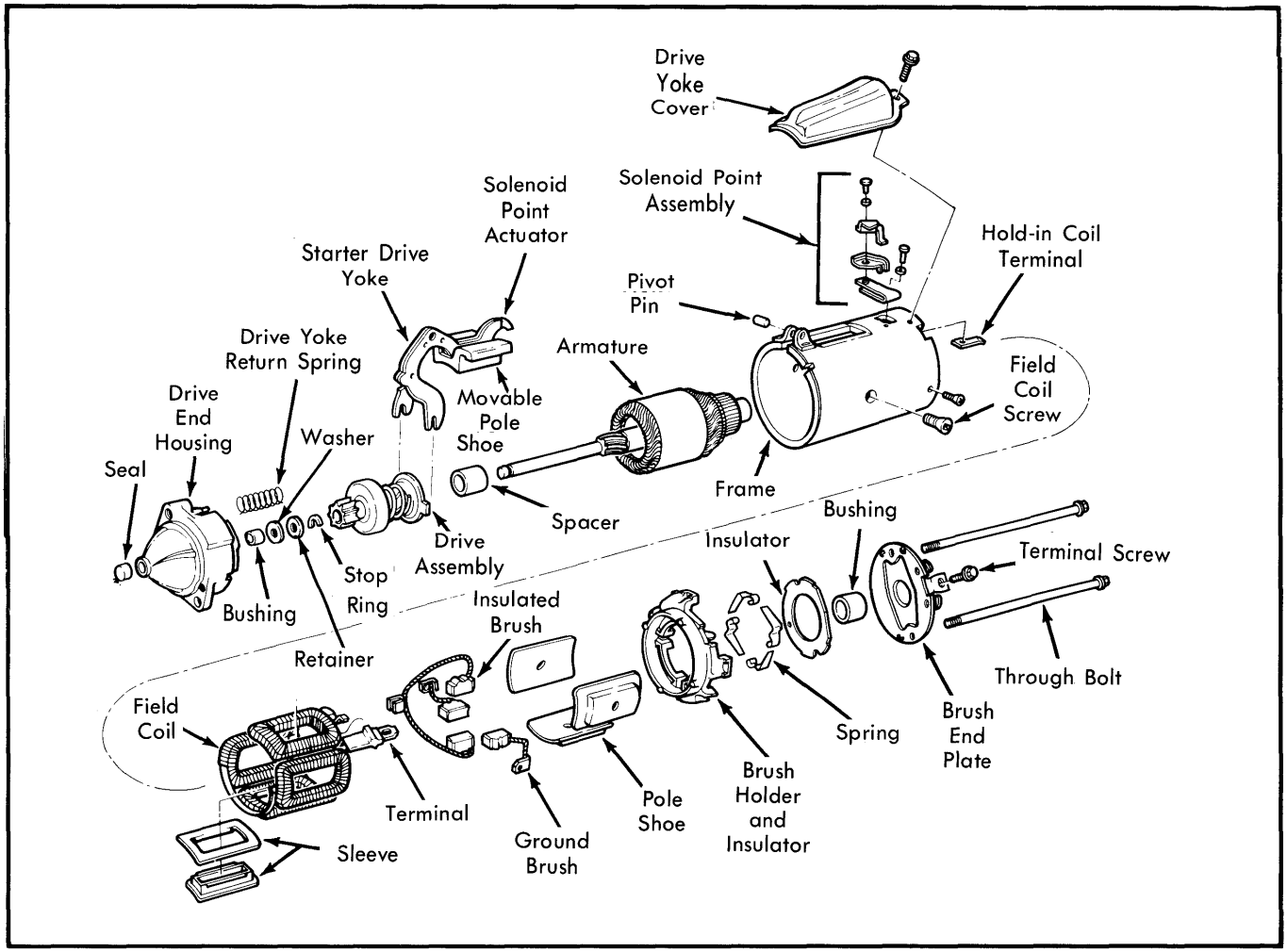

Fig. 5 Exploded View of Starter Motor Assembly

5) Install brush holder and insert brushes and brush springs. Positive brush leads should be positioned in their respective slots to prevent potential grounding. Install brush end plate. Ensure that end plate insulator is positioned properly on end plate.

6) Install through bolts to starter frame and tighten to 55-75 INCH lbs. Install starter drive plunger lever cover and tighten retaining screw. Check starter no-load current draw.