SHOP TIPS

Autolite Ford

VOL. 8, NO. 7 MARCH, 1970

STARTING SYSTEMS

Diagnosis and Repair

SEE CENTER INSERT FOR TIMELY PROMOTIONS!

STARTER TROUBLE

Technical parts and service information published by the Autolite-Ford Parts Division and distributed by Ford and Lincoln-Mercury dealers to assist servicemen in Service Stations, Independent Garages and Fleets.

IN THIS ISSUE

Be sure and file this and future bulletins for ready reference. If you have any suggestions for additional information that you would like to see included in this publication, please write to: Autolite-Ford Parts Division of Ford Motor Company, Merchandising Services Dept., P.O. Box 3000, Livonia, Michigan 48151.

The descriptions and specifications contained in this book were in effect at the time the publication was approved for printing. The Ford Motor Company, whose policy is one of continuous improvement, reserves the right to discontinue models at any time, or to change specifications or design without notice and without incurring obligation.

Autolite Ford

VOL. 70 MSD 30 LITHO IN U.S.A.

"NO START" PROBLEMS

Every day countless motorists get into their cars, turn the key in the ignition and hear something go "CLUNK" or "WHIRR" under the hood and suddenly realize the engine isn't turning over. They have starter troubles.

To the motorist a faulty starter is a very serious problem. There is practically nothing he can do to make a temporary repair and if his car can't be started with a push, he will have to have it towed to the garage. So, if a man arrives at the shop in the front seat of a tow truck with his car in tow, take pity and assure the man you have what it takes to get him back on the road in a hurry.

Finding The Trouble . . .

To find some starter troubles you have to play it by ear—listen to what's happening. You can get down to the real problem a lot quicker if you know what the "CLUNK" and "WHIRRING" or "HUMMING" sounds mean.

Use the steps outlined in the chart on the next page to help you find the trouble:

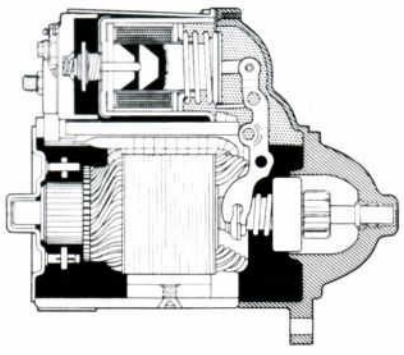


Figure 1—Autolite Solenoid Actuated Starting Motor

STARTER WILL NOT CRANK ENGINE—ROAD MAP

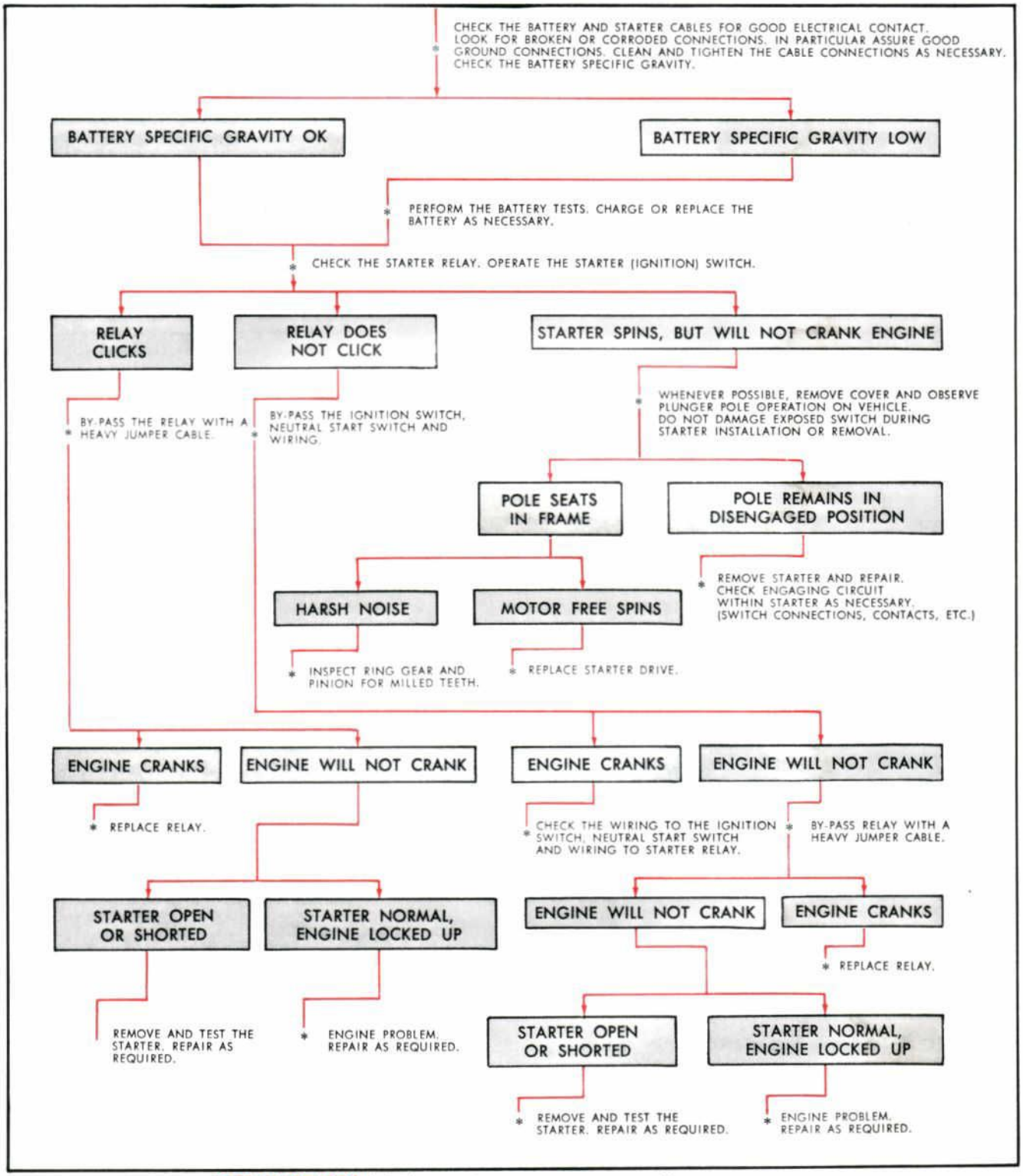


Figure 2

REMEMBER! Ask the customer as many questions as you can about the problem—the answers may help you solve it quicker.

STARTER TROUBLE

STARTING SYSTEMS . . . How They Work

The starting system has five parts to it.

- BATTERY
- STARTER RELAY
- STARTER
- IGNITION SWITCH
- NEUTRAL SWITCH

The battery supplies the electricity needed to run the starter motor.

The starter relay works like an ON and OFF switch and starts and stops the flow of electricity from the battery to the starter motor.

The starter is really an electric motor built to turn with a lot of force for a short amount of time.

The ignition switch is the control center for starting the car. When it is OFF, the car cannot be started because the ignition circuit is open and electricity is stopped, at the switch, from flowing through the system.

When the ignition switch is turned ON, it lets the electricity flow through the switch to complete the circuit. When the switch is turned past the ON position to the START position, it closes a separate circuit which makes the starter relay click ON and lets electricity from the battery reach the starter motor.

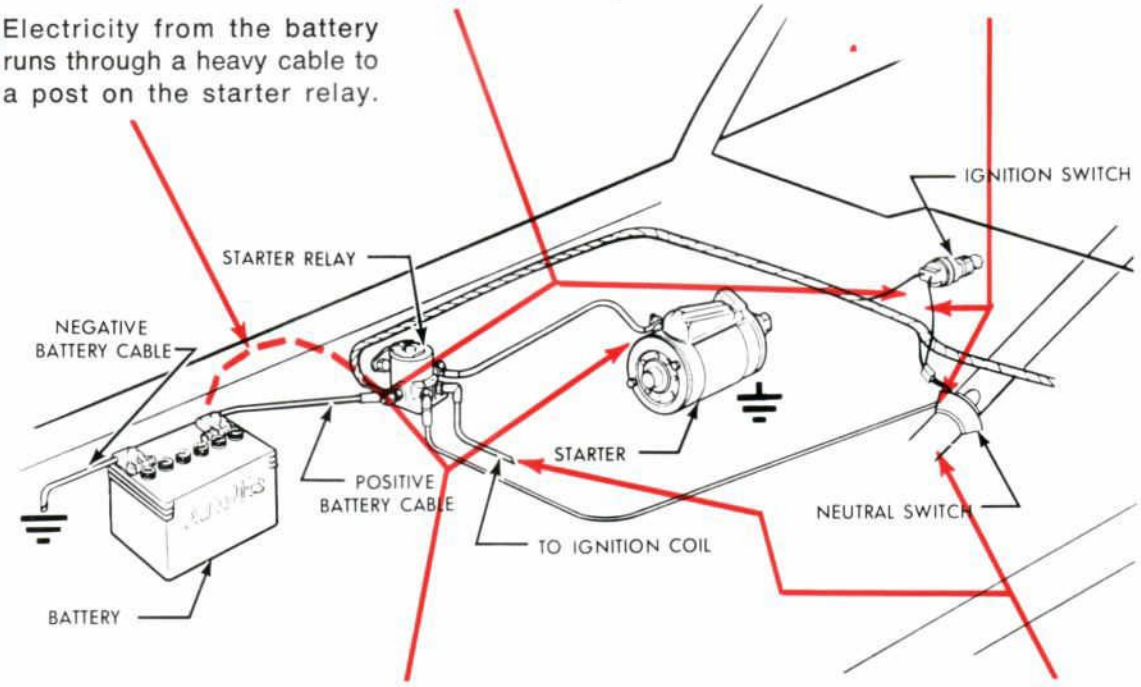
The NEUTRAL switch is really a safety device. It prevents the car from being started while the car is in gear.

When the ignition switch is turned to the START position, this is what happens:

A. Electricity from the battery runs through a heavy cable to a post on the starter relay.

B. A smaller wire runs from the same post to the ignition switch.

C. When the ignition switch is turned to START position the electricity travels through the switch to the NEUTRAL switch.



D. When it reaches the starter relay the electricity energizes a small electro-magnet which in turn closes a switch. When the switch is closed it lets the electricity from the battery continue to flow to the starter motor.

E. If the NEUTRAL switch is open the electricity will stop there. If the switch is closed the electricity will continue through the switch and back to the starter relay.

Figure 3—Starting System

STARTING MOTORS

Beginning in 1968, Thunderbirds equipped with the new 429 CID engine, Lincoln Continentals equipped with the 460 CID engine, and all Lincoln Continental Mark III models use a new Autolite solenoid actuated starter (figure 1, page 2).

Operation

When the ignition switch is turned to START, the starter relay supplies voltage to the solenoid. Two separate windings–a "pull-in" coil and a "hold-in" coil–energize the solenoid. This draws the plunger into the coil windings, moving the shift fork to slide the drive pinion into mesh with the flywheel ring gear. As the plunger nears the end of its travel, it presses against a spring loaded pin attached to a contact plate. The contact plate completes the circuit to the starting motor . . . only after the pinion gear is engaged. The plunger also closes a set of contacts that bypass the pull-in coil, to energize the hold-in coil. When the ignition switch is released, the spring loaded pin pushes the plunger out of the solenoid coils and breaks the circuit to the starting motor.

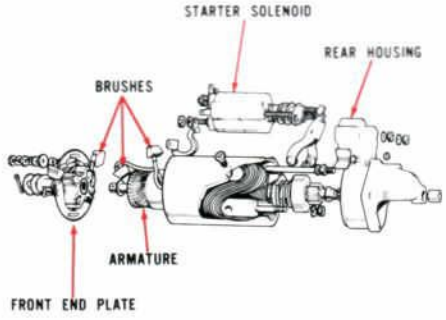


Figure 4–Cortina Starter

Cortina models also use solenoid type starter (figure 4).

All other 1968 Ford-built cars and most other late model vehicles use the Autolite starter shown in figure 5. Like the other Autolite starter, it is a four-brush, four-pole, four-field, series wound unit. Operation is similar, except for the method of engagement.

Operation

Instead of using a separate solenoid atop the starter to activate the engagement mechanism, this unit uses one of its four field coils as a "pull-in" coil. It's located directly below a movable pole, and also contains a fine winding that serves as a "hold-in" coil (figure 6).

Turning the ignition switch to the START position causes current to flow through the "pull-in" coil to the ground contacts. This creates a strong magnetic field around the "pull-in" coil. The magnetic field pulls the movable pole, which is part of the shift lever, downward to its seat. This movement, in turn, causes the lever fork to slide the drive pinion gear into engagement with the engine flywheel ring gear.

When seated, the movable pole functions as a normal field pole and the "pull-in" coil functions as a normal field coil. An extension of the movable pole lever opens the ground contacts. With the contacts held open, equal current flows through all the field coils and the armature begins to rotate. In order to maintain drive engagement during cranking, the "hold-in" coil assists in keeping the movable pole seated to the frame and the contacts open.

Releasing the ignition key opens the circuit in the starter relay. This releases the starter drive actuating lever and the movable pole, which disengages the drive pinion from the ring gear.

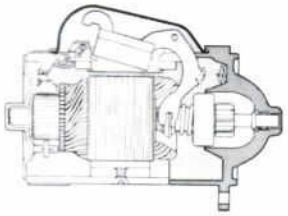


Figure 5–Autolite Starting Motor

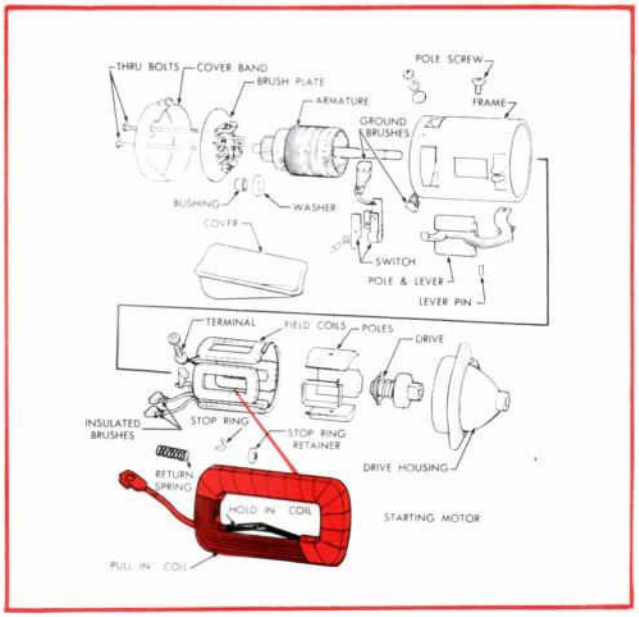


Figure 6–Exploded View of Typical Starter

STARTER SPECIFICATIONS

Type	Current Draw Under Normal Load (Amps)	Normal Engine Cranking Speed RPM	Minimum Stall Torque @ 5V Ft. Lbs.	Maximum Load Amperes	No-Load Amperes	Mfg. Length (inches)	Brushes Wear Limit (inches)	Brush Spring Tension (oz)
Ford Positive Engagement 4.5 inch Diameter	150-200	250-290	15.5	670	70	0.5	0.25	40
4.0 inch Diameter	150-200	250-290	9.0	460	70	0.5	0.25	40

Maximum starting circuit voltage drop (battery + terminal to starter terminal @ normal engine temperature)—0.5 volt.
Maximum Commutator runout is 0.005 inch.

STARTER TROUBLE

CAUTION: Be certain the transmission selector lever is in the "P" or "N" position (automatic transmission) or NEUTRAL position (manual transmission) and the hand brake is "set" prior to performing any starting system tests that require engine cranking.

TESTS

A *thorough* visual inspection of the starting system components should be made prior to any component replacement or test procedures.

Inspect the starter and battery cables for clean and tight connections at the battery, starter relay, starting motor, and battery ground. Inspect the starting system cables and wiring for a possible grounded or open condition.

Battery Tests

The battery must be fully charged before performing starter system tests. Use a temperature corrected hydrometer to check the state of charge. Figure 7 shows specific gravity readings for percents of discharge.

SPECIFIC GRAVITY	STATE OF CHARGE
1.260-1.280	100% CHARGED
1.230-1.250	75% CHARGED
1.200-1.220	50% CHARGED
1.170-1.190	25% CHARGED
1.140-1.160	VERY WEAK
1.110-1.130	DISCHARGED

Figure 7—Specific Gravities for Percents of Discharge

In addition to the specific gravity test, a capacity test may be necessary if there is any doubt about the battery's ability to deliver current. A specific gravity test by itself will not do because it only measures the strength of the electrolyte. Only a capacity test actually measures the battery's ability to deliver current by putting a load on it.

Capacity Test—Connect the appropriate leads of a Battery-Starter tester with a fixed load or carbon pile resistor and a voltmeter to the battery posts (figure 8). Be sure the voltmeter clips are connected DIRECTLY to the battery posts, and not to the battery tester clips.

Turn the control knob of the carbon pile resistor, if so equipped, until the ammeter reads three times the ampere-hour rating of the battery. (A 45 ampere-hour battery should be tested at 135 ampere load.) Hold for 15 seconds (NO LONGER) and note the voltage. If the voltmeter reads 9.6 volts or more for a 12-volt battery (4.8 volts for a 6-volt battery), the battery has sufficient output capacity, and should be considered okay. However, if the specific gravity is below 1.230 it should be recharged. If the voltage is less than 9.6 (4.8 for a 6-volt battery), recharge and retest the battery. If the specific gravity reading between any two cells differs more than 50 points (.050), the battery will probably have to be replaced.

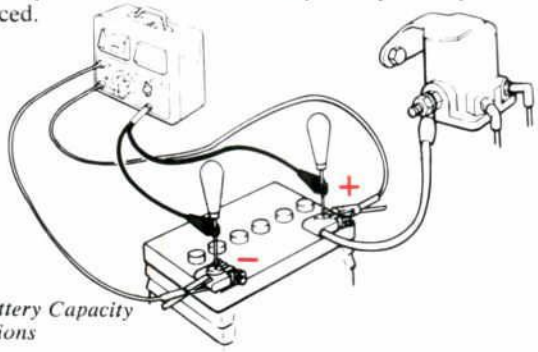


Figure 8—Battery Capacity Test Connections

Circuit Resistance Tests

Before making any circuit resistance tests, disconnect and ground the high tension lead from the ignition coil to prevent the engine from starting.

Battery-to-Starter—Connect the positive lead of a voltmeter to the positive battery *post* (figure 9). Connect the voltmeter negative lead to the starting motor terminal. Crank the engine. A voltmeter reading in excess of 0.5 volts indicates excessive resistance.

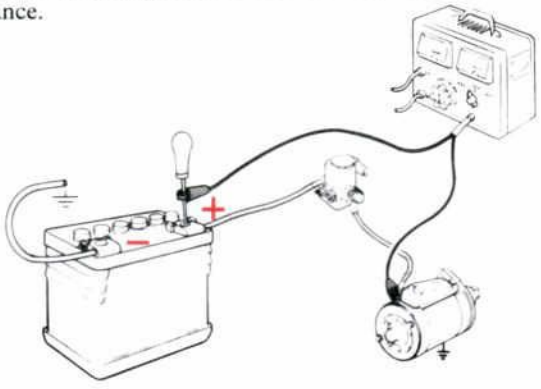


Figure 9—Battery-to-Starter Circuit Resistance Test

Battery Side of Relay to Battery—Connect the positive lead of a voltmeter to the positive battery *post* (figure 10). Connect the negative voltmeter lead to the battery terminal of the relay. Crank the engine. A voltmeter reading in excess of 0.1 volts indicates excessive resistance.

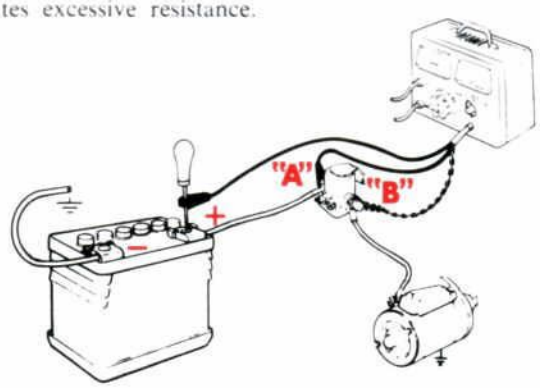


Figure 10—Circuit Resistance Test—Battery Side of Relay to Battery

Starter Side of Relay to Battery—Connect the positive lead of a voltmeter to the positive battery *post*. Connect the voltmeter negative lead to the starter terminal of the relay. Crank the engine. A voltmeter reading in excess of 0.3 volts indicates excessive resistance.

Ground Circuit—Connect the negative lead of a voltmeter to the negative battery *post*. Connect the voltmeter positive lead to the starter frame. Crank the engine. A voltmeter reading in excess of 0.1 volts indicates excessive resistance.

If the voltmeter readings are higher than those specified in any of the preceding tests, look for loose and/or corroded connections and defective components in the part of the circuit under test.

Current Draw Test

Set the rheostat (carbon pile) at maximum resistance—fully counterclockwise position. Connect the positive lead of an ammeter to the positive battery cable clamp (figure 11). Connect the negative lead of the ammeter to the negative battery cable clamp. Connect the positive voltmeter lead to the battery positive *post* and the negative lead to the negative *post*. Crank the engine and carefully observe the voltmeter reading.

Stop cranking the engine and reduce the resistance of the carbon pile rheostat (turn load control clockwise) until the voltmeter indicates the exact same reading as that obtained while the starting motor cranked the engine.

The ammeter will indicate the current draw of the starter. If the current draw does not meet specifications, remove the starter for repairs.

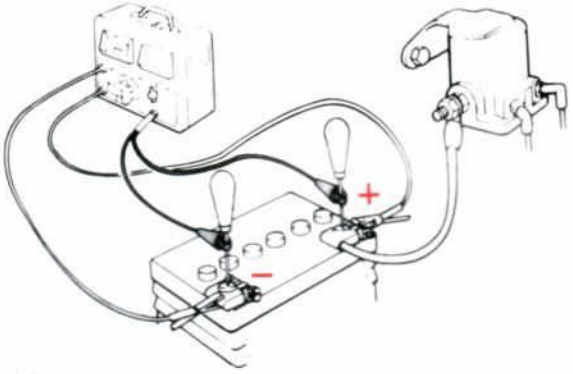


Figure 11—Starter Load Current Draw Test

Starter and Starter Drive Tests

Operate the ignition switch and listen for starter noise. If the starter rotates or makes a distinct clunk, but will not crank the engine, the drive is defective. Whenever possible, remove the plunger cover and observe the plunger pole operation on the vehicle. *Do not damage the exposed switch during starter installation or removal.*

Temporarily connect a heavy jumper wire from the battery positive terminal to the starter terminal of the starter relay (figure 12, connection #1). If the starter will not crank the engine, the starter is defective. Repair or replace the starter.

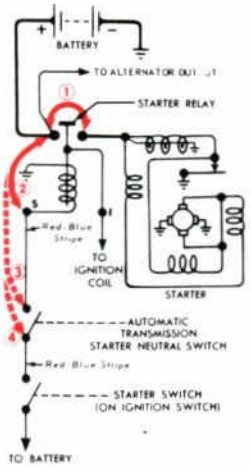


Figure 12—Starting Control Circuit Tests

Drive Pinion and Ring Gear Wear—When a starter is repaired or replaced, the entire ring gear should be thoroughly inspected for tooth damage. Damaged ring gear teeth can cause a repeat starter malfunction. The repeat failure will not necessarily occur immediately following the starter repair or replacement. The degree of the ring gear tooth damage will determine the time interval before a recurrence of the starter malfunction.

Remove the starter and examine the drive pinion for milled, chipped, cracked and/or bent teeth. Examine the entire ring gear for broken or milled teeth and wear pattern. The wear pattern must penetrate to a depth greater than ½ the tooth depth. Normal wear shown in figure 13.

A wear pattern of less than ½ the tooth depth, or a rounding and galling condition of the ring gear teeth indicates insufficient engagement into the ring gear. Replace all ring gears that show broken or milled teeth, or evidence of inadequate engagement.

Six cylinder engines will show a concentrated wear pattern on three equally spaced areas of the ring gear teeth. Eight cylinder engines will show a concentrated wear pattern on four equally spaced areas of the ring gear teeth. These wear patterns are normal, and result from the engine stopping in definite positions because of engine compression and friction.

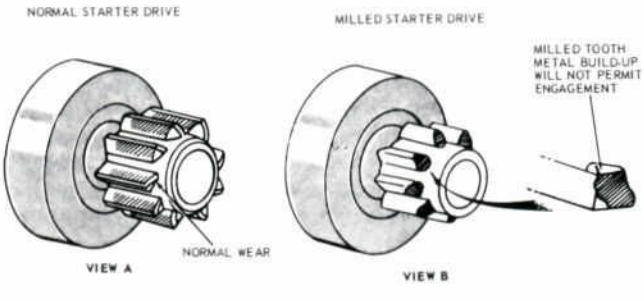
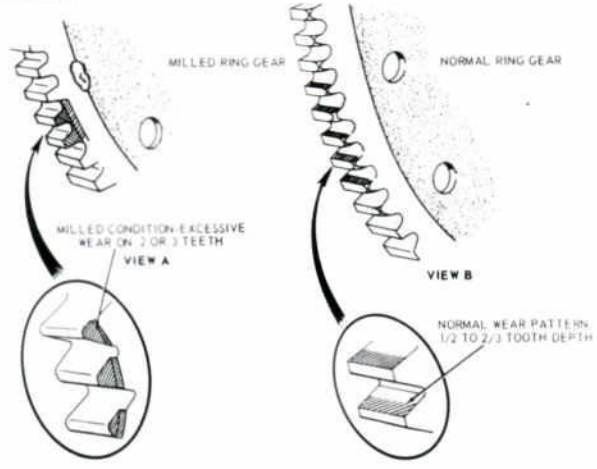


Figure 13—Starter Drive Pinion and Flywheel Tooth Damage



STARTER TROUBLE Diagnosis And Testing Continued

Starters should be installed only according to the following sequence:

1. Insert the starter into pilot hole, making sure that the starter housing pilot completely enters the pilot hole for a full 360°. Also, be sure that the starter housing face is square and tight to the engine rear cover plate (figure 14).
2. Hold the starter in position and install the top bolt. Tighten bolt enough to hold the starter in the pilot hole.
3. Install and tighten lower bolt. Then tighten top bolt. On three-ear mount starters, tighten the middle bolt last.

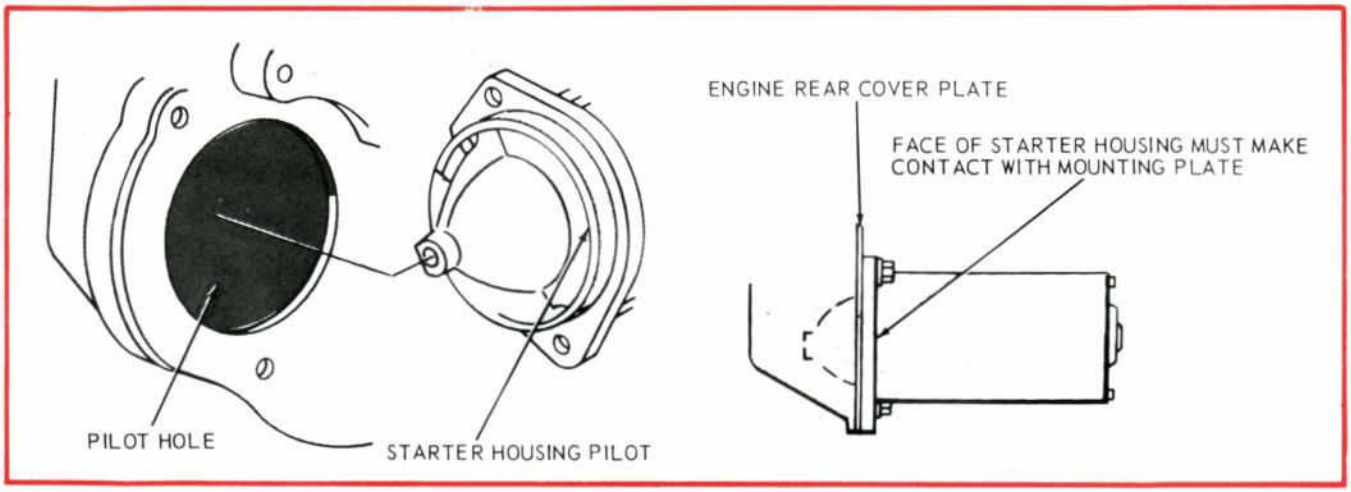


Figure 14—Starter Installation

Starter Relay Tests

Connect a heavy jumper cable from the battery terminal of the relay to the starter terminal of the relay (figure 12, connection #2). If the engine does not crank, the starter relay probably is at fault.

If the starter relay is suspected of intermittently sticking and causing the starter drive to remain engaged, attempt to repeat the condition by re-starting the engine. If the engaged drive condition can be accomplished, allow the engine to run at idle with the starter engaged and lightly tap the starter relay with a screwdriver handle. Disengagement of the drive would indicate a defective relay. If the drive remains engaged, replace the starter relay.

CAUTION: Do not accelerate the engine or let it run for an extended period of time with the starter engaged.

Starter Control Circuit Tests

On vehicles equipped with an automatic transmission, connect a jumper from the battery terminal of the relay to relay side of the neutral start switch (figure 12, connection #3). If the engine does not crank, the wiring between the neutral start switch and the relay is at fault. If the engine cranks, connect a jumper from the battery terminal of the relay to the starter (ignition) switch side of the neutral start switch (figure 12, connection #4). If the engines does not crank, the neutral start switch is out of adjustment or defective. If the engine cranks, check for voltage at the battery terminal of the starter (ignition) switch. If no voltage exists, the ignition switch is at fault. If voltage exists, substitute a known good switch, or bypass the ignition switch. If the engine still will not crank, the trouble is in the wiring or connections between the ignition switch and the starter neutral switch.

Neutral Start Switch Tests

(Except Mechanical Lock-out Type)

On vehicles equipped with an automatic transmission, apply the brakes and attempt to start the engine while moving the transmission selector lever through all ranges. This may determine if the problem is caused by a maladjusted or defective neutral start switch.

Place the selector lever in "N" or "P" and set the brakes. Remove the neutral start switch connector block and connect a jumper between the two red-blue stripe wires. If the engine will not crank, the neutral start switch is defective. Replace the switch.

In cases of starter drive and/or ring gear damage on automatic transmission equipped vehicles, check the neutral start switch adjustment. If this switch is out of adjustment, or faulty, the rolling movement of the engine from initial starting torque reaction can cause the switch to open and close, thereby making and breaking the control circuit. This permits the drive to disengage and re-engage while the engine is being cranked (causing a chatter or machine-gun type sound) and eventually will result in destruction of the starter, starter drive and/or ring gear.

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STARTER MOTOR Overhaul Procedures

REPAIR OR REPLACE?

A faulty component just about always presents the automotive technician with the problem: repair or replace it? Parts *do* wear out, and when they do, replace them. But replacing parts that can be repaired can result in an unnecessary cost to your customers—a practice that builds neither confidence nor goodwill. You can avoid this pitfall by taking a little time to inspect each part before deciding how to correct the problem.

For instance, the following list illustrates three types of starting motor problems and the most common causes. Most starters can be repaired with Autolite starting motor components available from your Autolite parts source.

NO CRANK	SLOW CRANK	NOISY
1. Open field to terminal connection.	1. Loose pole (armature rub).	1. Loose pole (armature rub).
2. Loose pole (armature rub).	2. Foreign material between armature and pole (pole rub).	2. Foreign material between armature and pole.
3. Foreign material between armature and pole.	3. Worn bearings (pole rub).	3. Damaged or worn starter drive.
4. Grounded or open armature.	4. Open field coil.	4. Damaged or worn ring gear.
5. Damaged or worn starter drive.	5. Grounded field coil.	5. Worn bearings (pole rub).
6. Shift mechanism worn or inoperative.	6. Shorted field coil.	6. Cracked/broken drive housing.
7. High mica on armature.	7. Grounded insulated brush holder and/or brush heads.	7. Cocked or misaligned on engine.
8. Glazed commutator.	8. Grounded armature	
9. No point air gap.	9. Open armature.	
10. Grounded field circuit.	10. Broken or weak brush springs.	
11. Cracked/broken drive housing.	11. Glazed commutator.	
	12. Cracked/broken drive housing.	

DISASSEMBLY AND INSPECTION

1. Check for clearance of cover band and plunger cover at starter field terminal. Check for clearance between plunger cover and movable pole and lever assembly. Check drive pinion for chipped or broken teeth and drive clutch drag condition. A drive with little drag, no drag, or rough drag action is a probable slipping drive.
2. Remove cover band and plunger cover. Actuate plunger lever manually to check freedom of action. Examine switch connections to field and ground; switch contact gap while lever is seated on frame.
3. Examine brush leads for grounding to frame, brush holder or brush springs. Examine brush leads for rubbing against commutator. Using a small wire hook, remove brushes from holders.
4. Remove through bolts, examining each one for evidence of grounding to field coil connecting straps (burn spots on bolt).
5. Remove drive and housing, examine for physical damage such as cracks or fractures, excessive bearing wear or any bearing movement.
6. Remove brush end plate and check brush holders for tightness, insulators for cracks. Burn marks around brush holder rivets indicate a grounded brush holder.
7. Remove lever pin and lever. Check pin for pits or blackened condition which would indicate a lack of lubrication on the hinge and pin.
8. Remove armature and check for evidence of pole rub on the laminations, burned or pitted commutator resulting from short brushes or a burned spot which would indicate an open armature winding.
9. Remove drive assembly and check condition of shaft splines, drive flange and general condition.
10. Examine general condition of frame assembly, brushes, brush leads, field coils and connecting straps for physical evidence of overheating, grounds, or shorts.
11. If the problem or defect has not been located by this point clean the components and conduct individual component testing as detailed below.

Cleaning

Use a brush or compressed air to clean the frame and field coils, armature and drive assembly. Clean the other components in solvent and wipe dry.

NOTE: DO NOT CLEAN DRIVE IN SOLVENT

STARTER MOTOR

Drive Housing

Carefully inspect the drive housing (figure 1) for broken or cracked areas and for a damaged or corroded mounting surface. Inspect the drive housing bushing for excessive wear or scoring. Replace the drive housing assembly if damaged or if the bushing is worn. Do not attempt to replace the drive housing bushing. On starters equipped with needle bearings in the drive housing, check the bearing for flat or missing needles. Replace the caged needle bearing assembly if worn or damaged.

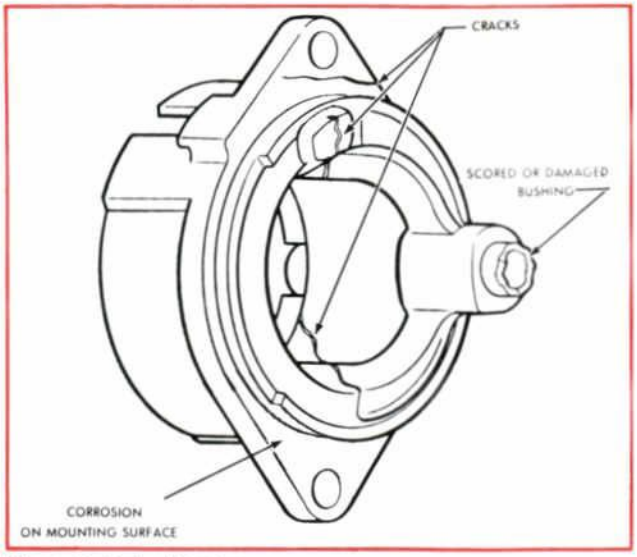

Figure 1—Drive Housing

TESTING

Brush Plate

Check the brush holders for broken springs and both insulated brush holders for shorts to ground.

1. Connect a jumper cable from the battery positive post to the brush end plate (figure 2).
2. Connect the negative lead of a voltmeter to the negative battery post.
3. Connect the positive lead of the voltmeter to the insulated brush holder.

If the voltmeter indicates any voltage the brush holder is grounded. Replace the brush plate assembly.

4. Check the brush end plate bushing for excessive wear.
5. Check the brush plate assembly for broken or cracked brush holder insulators.

Replace the brush plate assembly in case of broken or cracked brush holder insulators. Replace the brush plate bushing if excessively worn.

Armature

Examine the commutator for burned spots which usually indicate an open circuit. Such spots are caused by arcing each time a commutator segment that is connected to an open circuit winding passes beneath a brush. Carefully examine the armature for evidence of pole shoe rub. If the armature is scored or galled as shown in figure 3, it is usually the result of a loose pole shoe, worn bushing in the drive end housing or brush plate, or a cracked drive end housing.

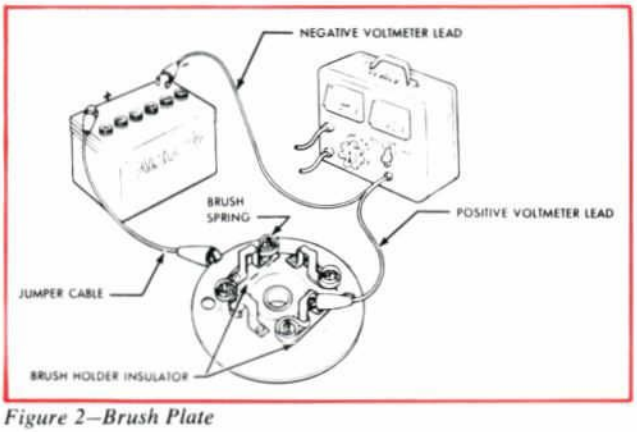

Figure 2—Brush Plate

If visual inspection of the armature indicates it is suitable for use, make an armature ground test (figure 4).

1. Connect a jumper wire from a 12-volt battery positive post to the drive end of the armature shaft.
2. Connect the voltmeter negative lead to the battery negative post and touch the voltmeter positive lead to the commutator.

If the voltmeter indicates any voltage, the armature windings are grounded and the armature must be replaced.

Check the armature for a short circuit by placing it in a growler. Hold a thin steel blade (hacksaw blade) parallel to the core and just above it while slowly rotating the armature in the growler (figure 5). A shorted armature will cause the blade to vibrate and be attracted to the core.

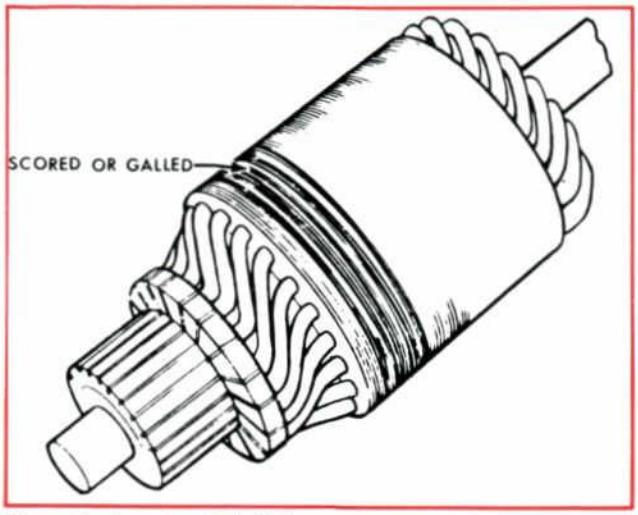

Figure 3—Armature Pole Rub

Overhaul Procedures Continued

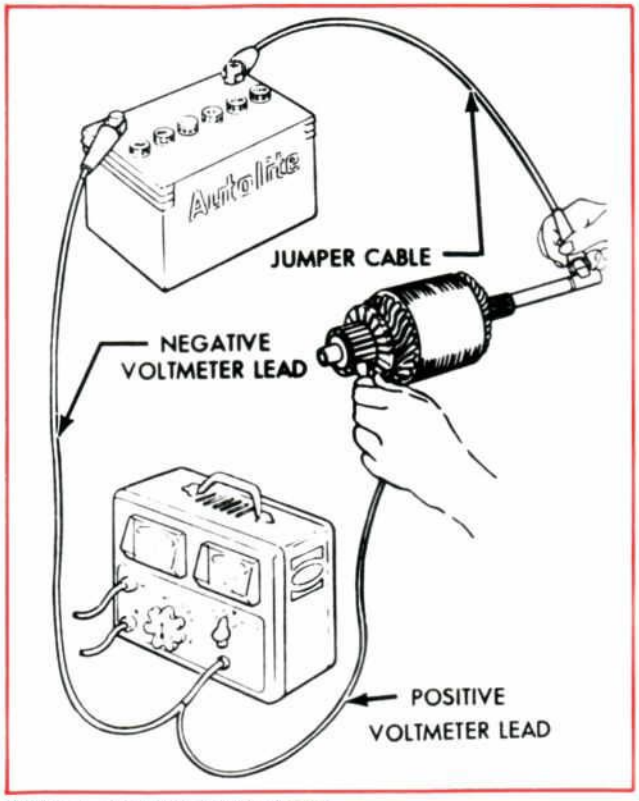

Figure 4—Armature Ground Test

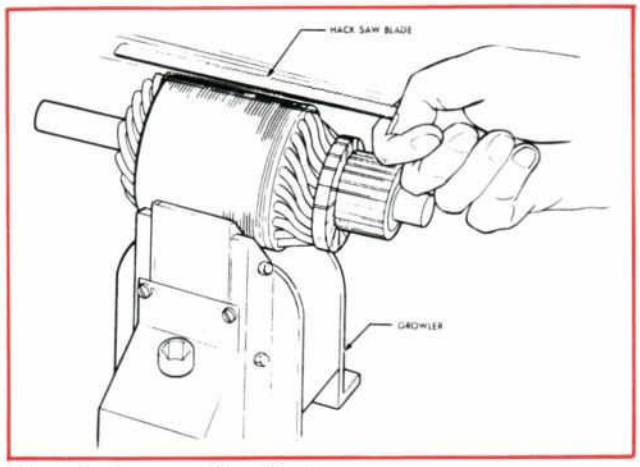

Figure 5—Armature Short Test

Field Coil—Open Circuit Test

1. Inspect all coil-to-coil connections, coil to switch connection and the coil to terminal connection for clean and tight solder joints or welds. Solder all loose connections using rosin core solder and a 300-watt iron.

2. Insulate the field coil and frame assembly from the workbench.

3. Using the type of instrument illustrated, turn the voltmeter range selector switch to the 4.0 volt position and turn the load control knob fully counterclockwise.

4. Connect a heavy jumper wire from the negative battery post to the two insulated brushes (figure 6).

5. Connect the negative lead of the voltmeter to the two insulated brushes and the positive lead of the voltmeter to the starter terminal.

6. Connect the negative lead of the ammeter to the starter terminal and the positive lead of the ammeter to the battery positive post. Be certain that all of the brush leads and tester leads are insulated from the starter frame.

7. Decrease the resistance by turning the load control knob clockwise until the voltmeter reads 0.5 volts. The ammeter should read 100 amps.

If the ammeter reading is 50 amps at 0.5 volts, one of the field coils or connections is open. Any deviation from the above readings resulting in higher ampere readings indicates a shorted or grounded field coil or connection. A lower ampere reading indicates a poor solder connection resulting in high resistance.

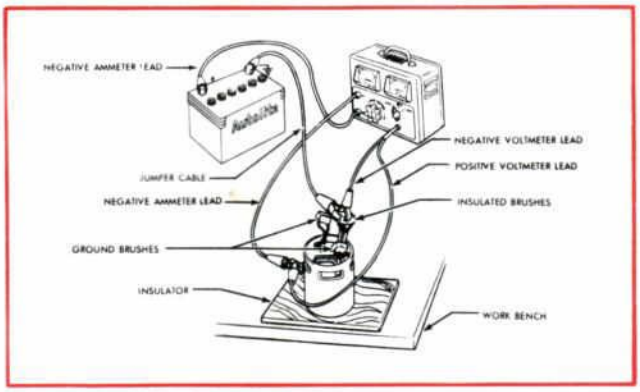

Figure 6—Field Coil Open Circuit Test

Field Coil—Grounded Circuit Test

To detect grounded field coils or connections proceed as follows:

1. Insert an insulator (business card or its equivalent) between the switch contacts (figure 7).

2. Disconnect the holding coil ground lead. Hold the field brushes and the holding coil ground lead away from starter frame.

3. Connect a jumper wire from the positive battery post to the starter frame.

4. Connect the positive voltmeter lead to the starter terminal and the negative voltmeter lead to the negative battery post.

If the voltmeter indicates any voltage, the field windings are grounded.

STARTER MOTOR

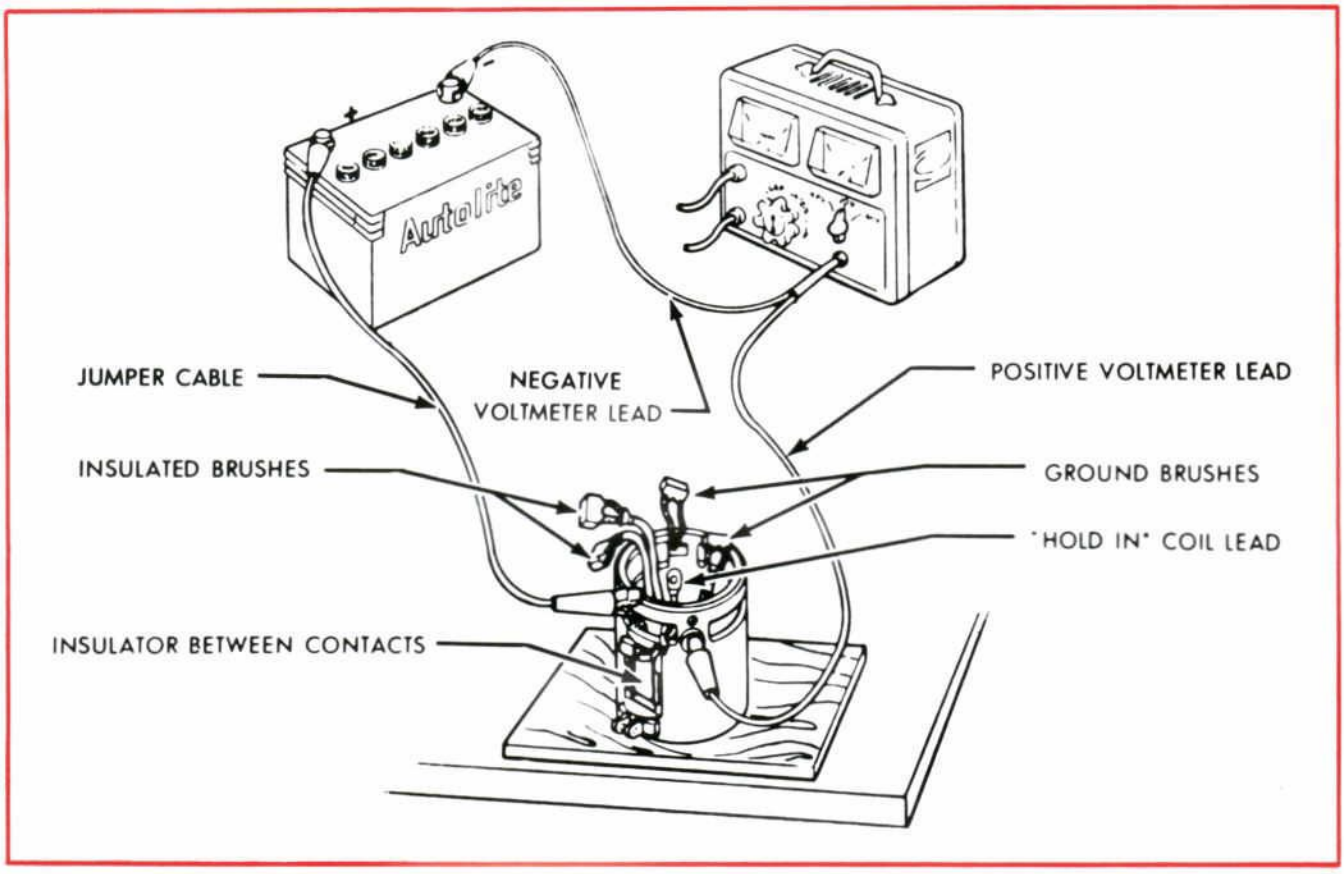

Figure 7—Field Coil Grounded Circuit Test

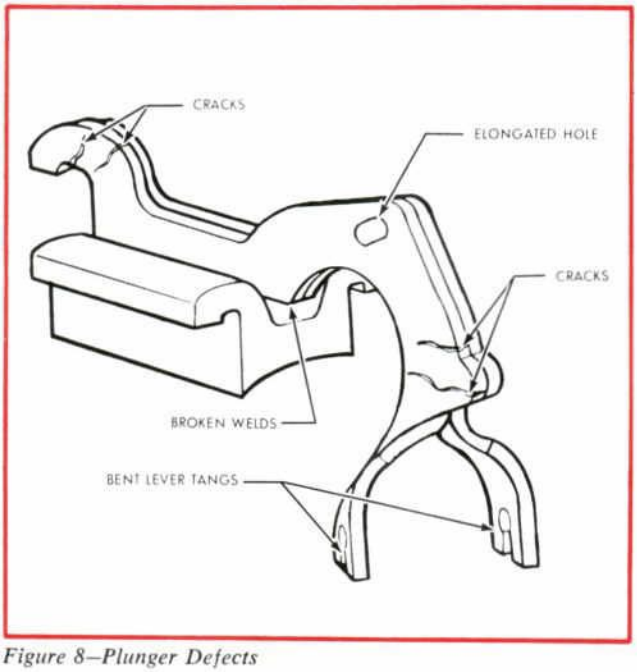

Figure 8—Plunger Defects

Terminal Stud

Check the terminal stud for crossed or stripped threads. Replace the terminal if it is broken, bent or if the threads are damaged.

Plunger

Thoroughly check the plunger lever assembly for the conditions shown in figure 8. Replace any lever assembly which exhibits any of the above conditions.

Brushes

Replace the starter brushes when they are worn down to ¼ inch. Check for broken or cracked brushes and burnt or broken brush leads. When brush replacement is necessary, always install a complete set of brushes. Instructions for starter brush replacement are contained in the starter brush kit.

Switch Contacts

Be certain the switch contacts are properly aligned, have sufficient spring tension, and are clean. The contacts can be cleaned with a fine grade of sandpaper. Instructions for switch contact replacement are contained in the switch repair kit.

Overhaul Procedures Continued

Re-assembly

1. Install the starter terminal, insulator, washers, and retaining nut in the frame. Be sure to position the slot in the screw perpendicular to the frame end surface.
2. Position the coils and pole pieces, with the coil leads in the terminal screw slot, and then install the retaining screws (figure 9). As the pole shoe screws are tightened, strike the frame several sharp blows with a soft-faced hammer to seat and align the pole shoes, then tighten the screws securely.
3. Install the "hold-in" coil and retainer and bend the tabs to retain the coils to the frame.
4. Solder the field coil leads to the starter terminal using rosin core solder and a 300-watt iron. Solder the field coil lead to the stationary switch contact.
5. Check for continuity and grounds in the assembled coils.
6. Position the new insulated field brush leads on the field coil terminal. Install the clip provided with the brushes to hold the brush lead to the terminal. Solder the lead, clip, and terminal together, using rosin core solder and a 300-watt iron.
7. Position the "hold-in" coil ground terminal over the nearest ground screw hole.
8. Position the ground brushes to the starter frame and install the retaining screws.
9. Apply a thin coating of Lubriplate 777 (or equivalent) along the armature shaft splines. Install the starter motor drive gear assembly to the armature shaft and install a new stop ring. Install a new stop ring retainer.
10. Position the fiber thrust washer on the commutator end of the armature shaft and position the armature in the starter frame.
11. Lubricate brush end plate bearing with Lubriplate 777; position the starter brush end plate to the frame with the end plate boss in the frame slot.
12. Position the starter drive lever assembly to the frame and starter drive assembly, be certain the lever is correctly positioned over the starter drive flange, and install the pivot pin. Place a dab of Lubriplate 777 on the pivot pin.
13. Position the starter drive lever return spring and the drive end housing to the frame and install and tighten the through bolts to specifications (55-75 inch pounds). DO NOT PINCH THE BRUSH LEAD BETWEEN THE BRUSH PLATE AND THE FRAME. Be sure that the stop ring retainer is seated properly in the drive housing.
14. Install the brushes in the brush holders.

    BE SURE TO CENTER THE BRUSH SPRINGS ON THE BRUSHES AND POSITION THE BRUSH LEADS TO INSURE AGAINST GROUNDS AND SHORTS.
15. Check for switch contact alignment and clearance. Contact air gap—with lever fully seated—should be .020" to .100".
16. Position the plunger cover and gasket on the starter and install the brush cover band. Tighten the band retaining screw.

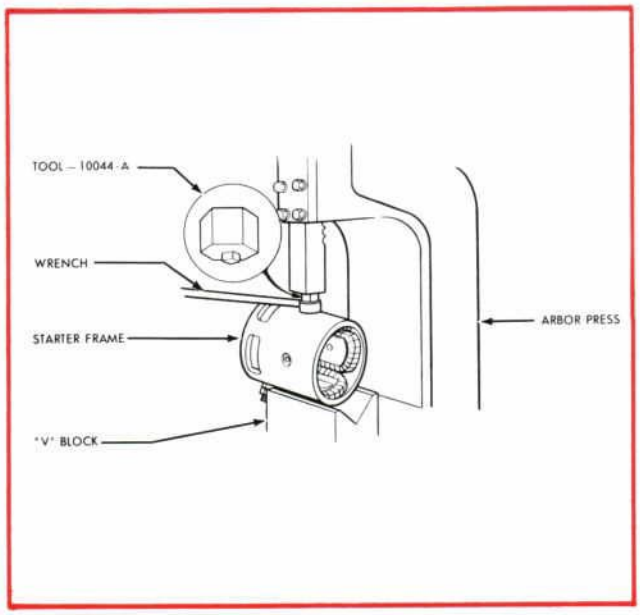

Figure 9—Field Coil Replacement

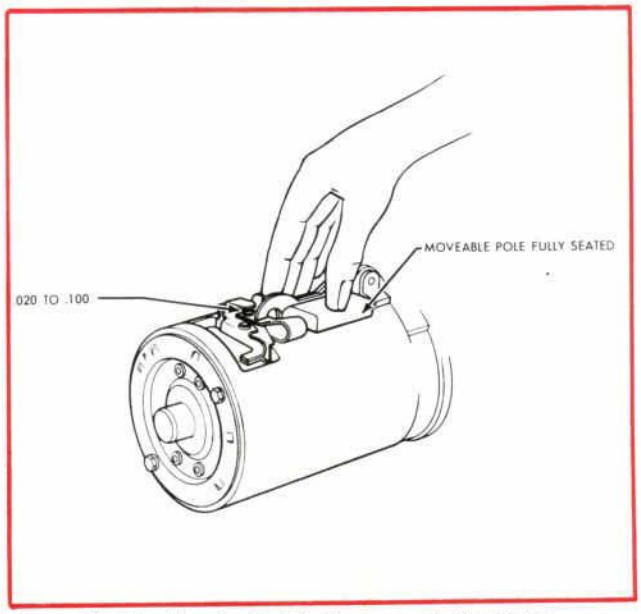

Figure 10—Checking for Switch Contact and Alignment

ENGINE OVERHEATING

All cars and trucks equipped with Air Conditioning and Automatic Transmissions may overheat while running at idle for 15 minutes or longer with the air conditioning operating if the transmission is in DRIVE. Engine overheating may be reduced if the automatic transmission selector is placed in PARK.

NEW FRONT WHEEL BEARINGS

All 1970 Ford Motor Company car lines have a new type front wheel bearing. The new bearings have an increased inside diameter because of an increase in the diameter of the front spindle. The bearings also have an increased cup angle and a larger number of bearing rollers, however the diameter of the rollers is smaller.

Because of the new bearing design, they cannot be installed on spindles of previous models.

TACHOMETER MALFUNCTIONS AT HIGH ENGINE SPEED–Approx. 6,000 RPM (Boss 302 Mustang)

To prevent accidental over-revving, an electronic engine RPM limiter is used. This device interrupts the ignition primary circuit from which the tachometer is triggered. Whenever the limiter is functioning (approximately 6,000 RPM) the operation of the tachometer is affected and usually indicates a much lower RPM than actual. This condition is considered normal and no repair to the tachometer should be attempted.

PLASTIC INSERTS IN RADIATOR GRILLE MAY DISTORT UNDER PAINT DRYING TEMPERATURES (1970 F-100/350)

The radiator grille contains plastic inserts which may distort in temperatures over 210°F. These inserts must be removed for paint repairs or they will distort if they are subjected to heat during the paint drying operation.

HYDRAULIC BRAKE SYSTEM BLEEDING—ALTERNATE METHOD

(All "C" Series with Hydraulic Brakes—1957-70 Models)

When hydraulic brake system bleeding is required, such as after brake reline, cylinder overhaul, etc., this alternate method may be used in place of the method outlined in the truck shop manual.

1. Remove the bleed screw from the slave cylinder on the brake booster and install the adapter in the booster bleeder screw hole.
2. Connect your pressure bleeder to the adapter and pressurize the system.
3. When fluid starts to overflow the master cylinder reservoir, depress the brake pedal slightly to block compensating port. Keep the pedal in this position with a piece of wood between the pedal and the driver's seat.
4. Bleed the individual wheel cylinders in the following order: (a) Right Rear (b) Left Rear (c) Right Front (d) Left Front

   Use a drain tube and glass container so air bubbles can be seen.
5. After all wheel cylinders have been bled, shut off the bleeder and remove the block from the brake pedal.
6. Remove the adapter from the booster and install bleeder screw.
7. Refill the master cylinder with the specified fluid.

PARTS:

Part Number	Part Name	Source
73620	Adapter	Bendix Brake Distributor
73621	Adapter	Bendix Brake Distributor

ANTI-FREEZE PROTECTION REVISION

(1970 F-100-350, Bronco, Econoline and P-Series)

The anti-freeze protection level for U.S. built vehicles has been revised to —20°F. Vehicles built in Canada or built for shipment to Alaska are protected to —35°F. A tag is attached to the radiator of each vehicle to indicate the anti-freeze protection. A red tag is for protection to —20°F. and a tan tag is for —35°F.

COOLING SYSTEM PRESSURE SPECIFICATIONS

(Bronco, Econoline and all Trucks—1969-1970)

The cooling system pressure specifications shown on page 11-04-01 of the 1969 Truck Shop Manual and on page 24-01-11 of the 1970 Truck Shop Manual should be corrected as follows:

Cooling System Pressure—PSI	
F-100-350, P-Series, Bronco and Econoline	13 psi
500-9000 Series Trucks (except P-500-5000)	7 psi

SERVICE BRIEFS

NOISE AND/OR POOR FM RECEPTION WITH AM/FM STEREO RADIO

When diagnosing complaints of noisy or poor FM/FM stereo reception, be sure to consider the possibility of customer unfamiliarity with the unique characteristics of FM broadcast. These characteristics can often result in noises which may lead the customer to believe that the radio system is not operating correctly. Therefore, it is advisable to road-test the vehicle with the customer, if at all possible over the route where problems are encountered, before any repair work is attempted.

FLUTTER

Flutter can best be described as repeated pops and hissing bursts heard in the speaker, during an otherwise good broadcast. Usually this condition exists while traveling in the fringe area of the station. Flutter will become more severe within approximately 25 miles of the station. The signal loss will become greater as you drive farther from the station, until finally noise takes over and you can no longer receive the station. Flutter may also be noticed near the station because of the "line-of-sight" characteristic of FM radio waves. This condition can happen when a building or large structure is between you and the station you are trying to receive (figure 1).

Some FM signal "bends" around the building, but certain spots have almost no signal. Some of these signal losses are only a few inches wide and if your car is parked in one of these "dead spots" you will only hear noise from the speaker. As you move out of the shadow of the structure, the station will return to normal. Flutter will not occur on AM, because the radio waves are much longer than FM waves.

MULTIPATH CANCELLATION

Another effect caused by the "line-of-sight" characteristic is called cancellation. This condition exists when the radio waves are reflected from objects or structures (figure 2). The noises produced by cancellation are similar to flutter, with the addition of distortion in the program. A more familiar description of cancellation is its similarity to the multiple ghosts and picture jumping that occur on television when a low flying plane passes. The same condition exists in a car, except that a car is moving and the reflecting structure is stationary. The reflected signal cancels the normal signal, causing the antenna to pick up noise and distortion. Cancellation effects are most prominent in metropolitan areas, but can also become quite severe in hilly terrain and depressed roadways.

CAPTURE AND OVERLOADING

FM capture is an unusual condition that occurs when traveling in the vicinity of a broadcast tower. If you are listening to a weak FM station, when passing the broadcast tower a stronger station up or down the radio dial may capture the weak station. This switch to the stronger station occurs without changing the radio dial. As you pass the tower, the station may switch back and forth a few times before returning to the station that you were listening to originally. When several broadcast towers are present (common in metropolitan areas) several stations may **overload** the receiver resulting in considerable station changing, mixing and distortion. Fortunately this condition is localized and it will not harm your receiver. Some **overloading** may also be noticed on AM, but usually to a lesser degree.

FM STEREO SENSITIVITY

Because more data is carried in the FM stereo waves than in the monaural FM broadcasts, flutter, cancellation and capture are even more noticeable, especially in metropolitan areas, hilly terrain and depressed roadways.

Also, for the same reason, FM stereo broadcast range averages five miles less than for regular FM.

The 1970 AM/FM Stereo Operating Manual (included with every vehicle so equipped) should be helpful in explaining these unique characteristics to the customer. This manual also includes helpful suggestions on how to obtain the best possible radio reception.

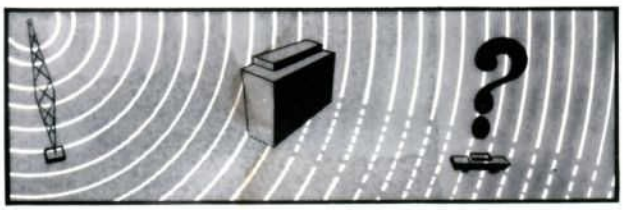

Figure 1—FM Flutter

Figure 2—FM Multipath Cancellation

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