Electrical System
Model 444
Service Manual 9-50271

J I Case
A Tenneco Company

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NOTE

This Service Manual Section covers only those components which are peculiar to the Solid State Electrical System used on Model 444 tractors prior to serial number 9646800. Components common on all tractors such as batteries and spark plugs are covered in Service Manual Sections, Form Numbers 9-99761 and 9-99771.

INTRODUCTION

The purpose of this Service Manual section is to familiarize the field with the electrical system used on the Model 444 Tractor prior to serial number 9646800. This procedure contains some very important information pertaining to safeguarding and testing the ignition and electrical components used in the breakerless-alternator ignition system of these 14 H.P. engines.

This system uses solid state devices which eliminate the need for mechanically operated breaker points. With breakerless ignition, timing is permanently set for the lifetime of the engine. With the exception of the spark plug, the entire system is virtually service-free. The system provides an instantaneous, high energy spark which not only prolongs the service life of the spark plug but makes spark gap and the condition of the plug less critical. However, the components of this system can be rendered useless through careless, improper service procedures or application.

PRECAUTIONS AND SAFETY

1. Emergency Stopping
   In an emergency where a breakerless ignition equipped engine cannot be stopped by the conventional method, stop the engine by lowering the choke lever to full choke and open the throttle. When this is done, the engine should flood and stop within a few revolutions.
   DO NOT stop breakerless ignition engines by pulling the high tension lead off the spark plug. This creates an ultra high energy "corona" effect which can permanently damage the windings in the ignition coil. The ignition coil must be replaced if damaged in this manner.

2. Battery polarity must be correct. Negative ground systems are used with Kohler engines. Do not reverse battery connections.

3. Prevent alternator leads (AC) from touching or shorting. This could permanently damage the stator.

4. Disconnect leads at Rectifier-Regulator before electric welding is done on equipment in common ground with the engine.

5. Disconnect battery cable or Rectifier-Regulator battery lead when quick charging or when tractor is standing unused for extended time periods.

6. Always unhook the battery ground cable first, and hook it up last.

7. Never cause sparks to occur or smoke near batteries that are charging or have been recently charged.

8. Never wear rings or metal watch bands that may ground a live circuit.

9. Think out your circuit before you make or break a connection. A wrong connection can be painful and expensive.

COMPONENTS

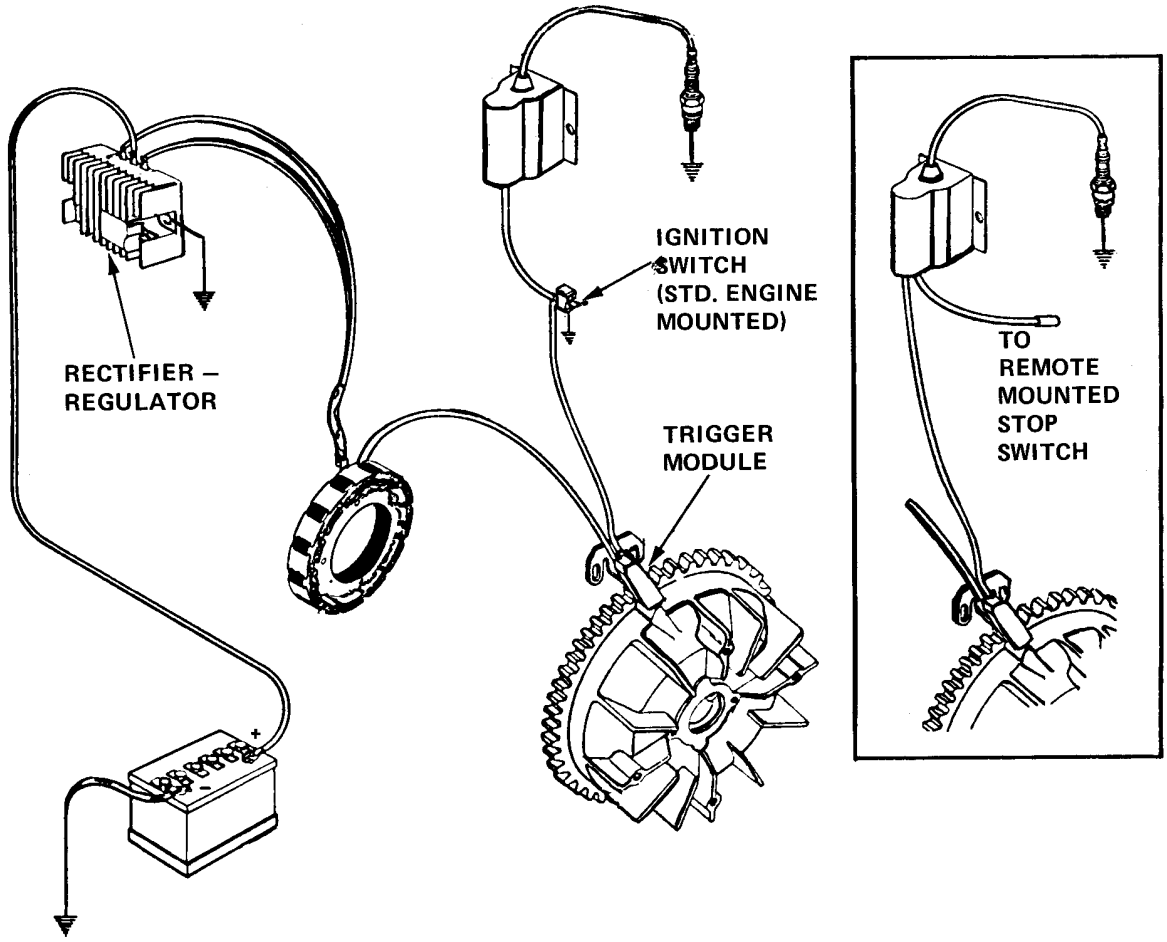

Figure 1. Breakerless - Alternator Ignition System

As shown in Figure 1, the breakerless ignition system includes four major components which are: ignition winding (on alternator stator), trigger module, ignition coil assembly and special flywheel with trigger projection. The system also includes the conventional spark plug and lead, plus an ignition switch. The ignition winding is separate from the other AC windings on the alternator stator--the other windings are used for battery charging and other purposes.

The trigger module includes three diodes, a resistor, a sensing coil and magnet, plus an electronic switch called an SCR. The trigger module has two clip-on type terminals. The terminal marked A must be connected to the alternator while the I terminal is connected to the ignition coil--improper hook-up will cause damage to the solid state devices. See Figure 2.

The ignition coil assembly includes the capacitor and a pulse transformer arrangement similar to the conventional high tension coil with primary and secondary windings. The flywheel has a special projection for triggering the ignition. Operation of the system is briefly described in the following.

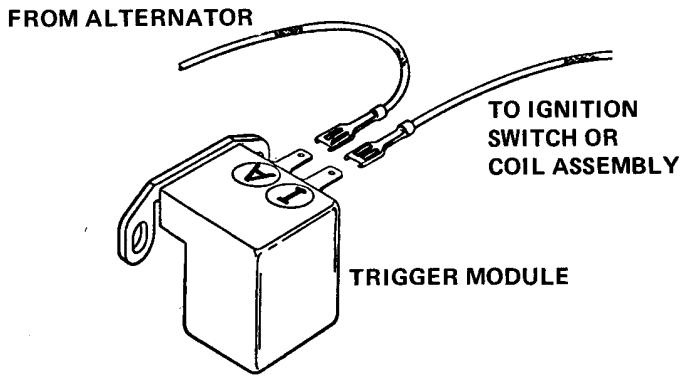

Figure 2. Wiring Connection Detail on Trigger Module

OPERATION

Refer to the wiring diagram (Figure 3) for location of components described. Only 1/2 of the energy produced in the ignition winding is used for charging the capacitor. When the alternating current flows in one direction, it takes the shortest path (least resistance) through diode 1 and returns to the windings. When the current reverses direction, it travels through diode 2 (being blocked by diode 1) and flows into the capacitor. The capacitor thus builds up charge and cannot discharge since diode 2 blocks the return of the current. The only circuit available for discharge is through the SCR, but at this point, it is turned off. To turn the SCR on, a small current must be applied to the gate terminal of the SCR.

When the projection on the flywheel is rotated adjacent to the sensing coil, it interrupts the magnetic field of the permanent magnet located inside this coil. The small current induced in the coil is applied to the gate which switches the SCR on to complete the circuit from the charged side of the capacitor through the high tension coil to the negative side of the capacitor. This instantaneous discharge of energy induces a very high density magnetic field around the primary winding which cuts the secondary winding and thus creates sufficient energy to fire the spark plug. Unlike the conventional system, there is no build up time nor does the sudden collapse of the magnetic field create the spark.

When the capacitor discharges completely and current through the SCR drops to 0 value, the SCR again switches off ready for the next ignition cycle. Diode 3 functions to block reverse current from reaching and damaging the gate of the SCR. The resistor prevents transient voltage from entering the gate circuit which could turn the SCR on at the wrong moment.

AIR GAP

The air gap between trigger assembly and projection on the flywheel is set at .010". Although the actual gap setting is not critical to operation at normal speeds, adjusting the gap to .010" may promote faster starting under certain conditions. To check the gap, rotate the flywheel until projection is adjacent to the trigger assembly. To adjust, loosen capscrews on trigger bracket and move trigger closer to projection until .010" gap is measured on feeler gauge. Do not set closer than .010, and make sure flat surfaces on trigger and projection are parallel to each other. Retighten capscrews after gap is readjusted.

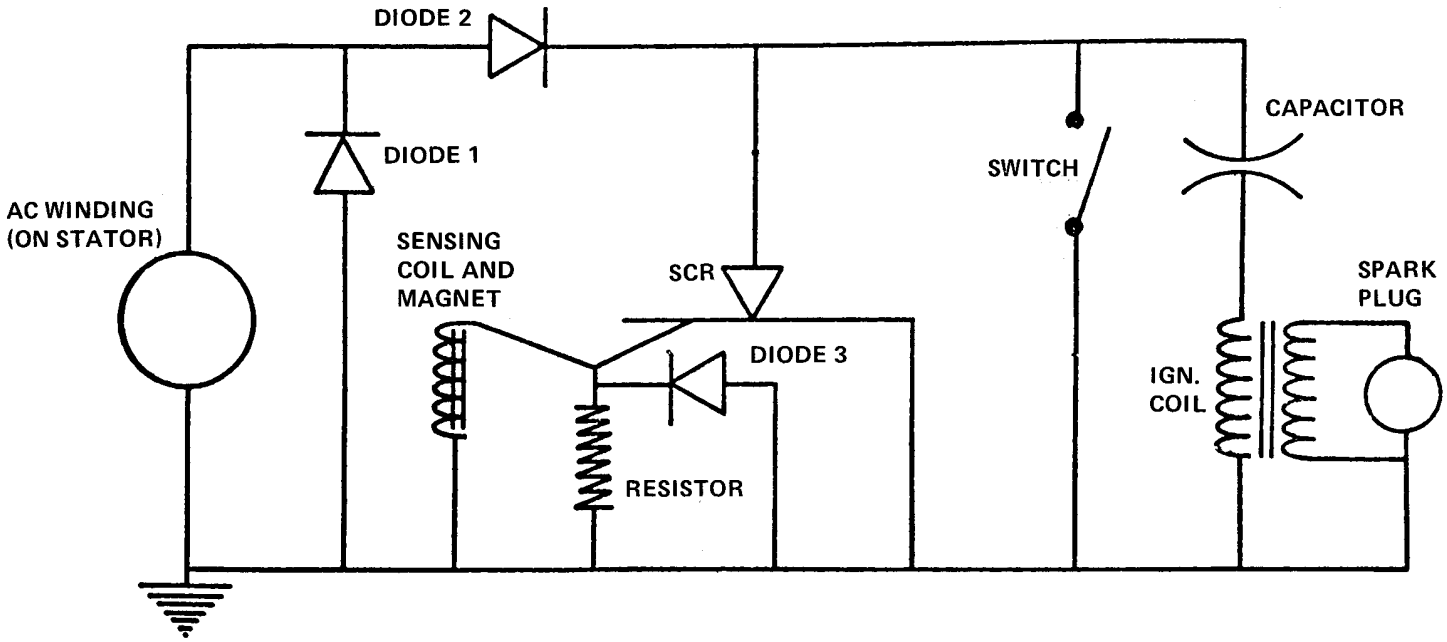

Figure 3. Wiring Diagram, Breakerless Ignition

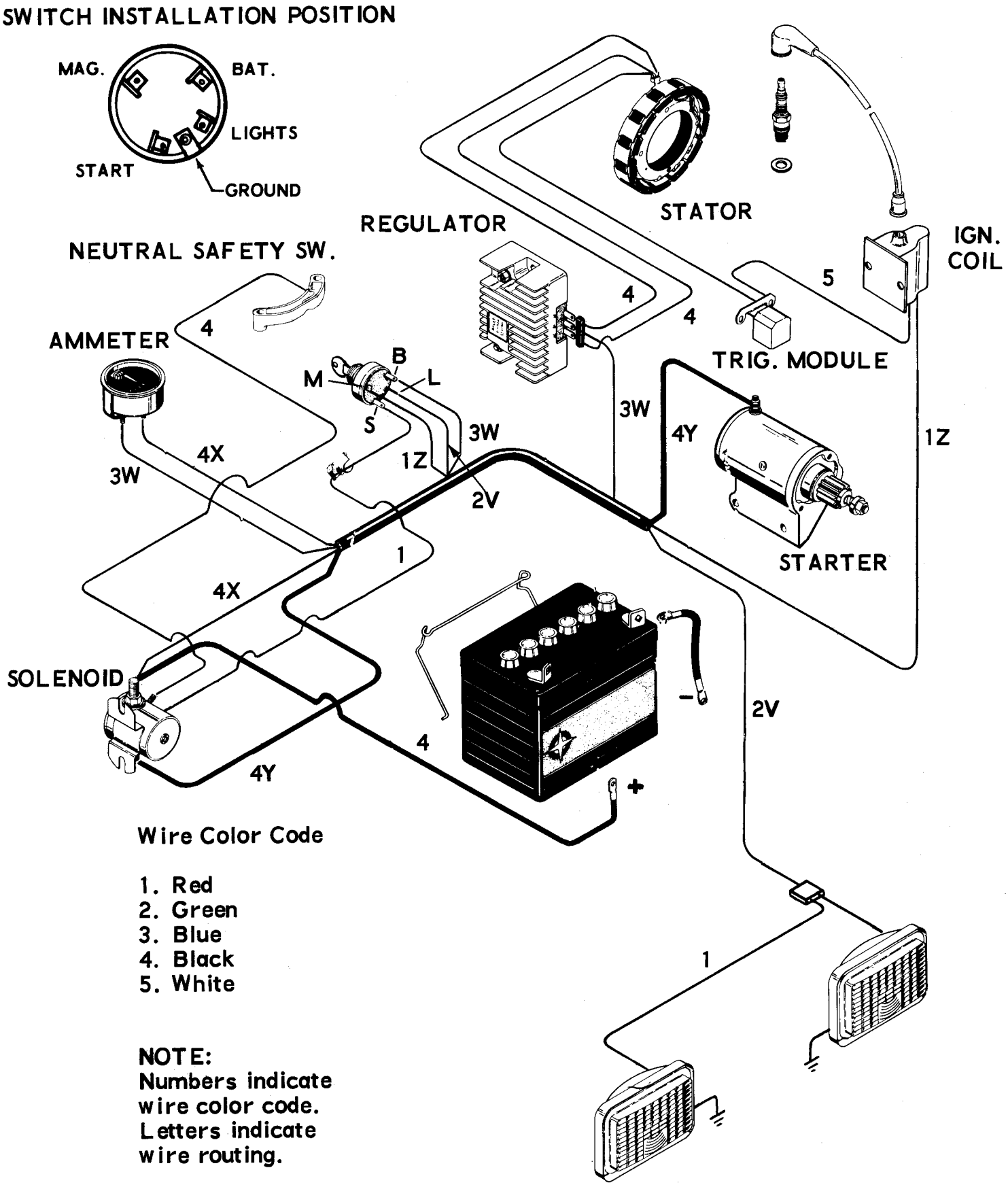

Figure 4. Wiring Diagram for Case Model 444 Compact Tractors

IGNITION SYSTEM

In case of ignition trouble, make the following tests in the sequence listed until the faulty part is located. Use an ohmmeter or flashlight type continuity tester to perform the ignition coil and trigger module tests.

IGNITION SWITCH TESTS

When the 14 H.P. Engine with solid state ignition cannot be stopped with the ignition switch, check the switch and wiring as follows:

1. Using a jumper (lead) wire, with one end contacting the ignition switch ground strap (see illustration) and opposite end contacting the engine block on a common ground, and the engine is stopped -- the ignition switch is not grounded to the tractor dash.

   Correction: Remove ignition switch and clean paint, etc. from ignition switch contact area on the dash. Install an internal shake-proof lockwasher between the ignition switch and the tractor dash to improve the contact between these two areas.

2. If the engine cannot be stopped as outlined under item one (1.), either the ignition switch or wiring 1Z, (Figure 4) from ignition coil to switch is defective. Check as follows to determine which item is defective. Attach jumper wire to engine block or to a common ground and to mag. position on the ignition switch.

   a. If the engine stops, the ignition switch is defective.

      Correction: Replace ignition switch.

   b. If the engine fails to stop, the wiring 1Z from ignition coil to ignition switch is defective.

      Correction: Determine that contact is being made at the connector where the ignition switch wire 1Z attaches to the coil wire. Determine that the wiring insulation has been removed and the wire ends are making contact at the connectors. A continuity light or ohmmeter may be used to determine if the wire ends are making contact.

In case of ignition trouble, make the following tests in the sequence listed, until the faulty part is located. Use an ohmmeter with a 1000 to 100,000 OHM scale to perform the ignition coil test. Use a flashlight type tester for the trigger module tests.

Spark Plug Test:

Remove plug from head, leave high tension lead connected to the plug, ground plug on engine - then crank engine - if spark does not appear between electrodes, use new plug and repeat test. If spark is still not evident, proceed with the following test.

Ignition Coil Assembly Test:

A. Remove high tension lead from tower of coil. Insert one ohmmeter lead in coil tower and the other to the coil mounting bracket. A resistance of 11,000 to 13,000 OHM's should be indicated here.

B. Connect one ohmmeter lead to the coil mounting bracket and the other to the ignition switch wire. Total resistance should be indicated.

   Replace the ignition coil if wrong or widely varying results are obtained from either of these tests.

Trigger Module Tests:

A. Remove the trigger module from engine. Connect one flashlight tester lead to (A) alternator terminal on trigger module and the other to the (I) ignition terminal. The light should light in one direction only -- reverse the leads to check for this.

B. Connect one tester lead to trigger mounting bracket and the other to the A terminal of the module. Light should be indicated in one direction only - reverse the leads to check for this.

C. Connect the positive lead to the I terminal and the negative lead to the trigger mounting bracket. If a dim light appears, tester leads are reversed - change lead position. Lightly tap the trigger magnet with a metal object. The tester light should come on and stay on until one tester lead is unhooked. This indicates SCR switch in the module is operating properly. Repeat this test several times!

Replace the trigger module if wrong results are obtained from any of these tests.

AC Leads and Winding:

If ignition trouble persists after the system checks out in each of the foregoing tests, the AC leads or ignition windings are probably faulty. Replace the stator assembly in this event.

CHARGING SYSTEM TROUBLE ANALYSIS

1. Check to make sure that a good ground is provided between the rectifier-regulator unit and the equipment. This must be in common ground with the engine and battery.

2. Check for and correct poor connections or broken wires.

3. Test Procedure --
Condition: No charge to battery.

CONDITION: NO CHARGE TO BATTERY		POSSIBLE FAULT/REMEDY
TEST A:	Disconnect B+ cable at positive (+) terminal of battery. Connect DC Voltmeter between B+ cable and gound. With engine running at full speed (no load), check DC voltage. Voltage should be 14 volts.	
	A-1 If above 14 volts	A-1 Alternator system OK-ammeter may be giving false reading. Repair or replace ammeter.
	A-2 If less than 14 volts (but above 0 volts).	A-2 Check for defective rectifier-regulator (TEST C).
	A-3 If 0 volts	A-3 Check for defective stator or rectifier-regulator (TEST C).

CONDITION: NO CHARGE TO BATTERY		POSSIBLE FAULT/REMEDY
TEST B:	With B+ cable reconnected, check B+ (at terminal on rectifier-regulator) to ground with DC Voltmeter. If 13.8 volts or higher, place load (lights) on battery to reduce voltage below 13.6 volts:	
	B-1 If charge rate increases	B-1 Indicates alternator system OK, battery was fully charged.
	B-2 If charge rate does not increase.	B-2 Check for defective stator or rectifier - regulator (TEST C)
TEST C:	Unplug AC leads at rectifier-regulator, connect AC Voltmeter across AC leads, check voltage with engine running at full speed (no load). Voltage should be 20 volts.	
	C-1 If less than 20 volts.	C-1 Defective stator, replace with new assembly.
	C-2 If more than 20 volts.	C-2 Defective rectifier-regulator, replace with new unit.

CONDITION: BATTERY CONTINUOUSLY CHARGES AT HIGH RATE		POSSIBLE FAULT/REMEDY
TEST D:	Check B+ to ground with DC Voltmeter. Voltage should be 14.7 volts	
	D-1 If over 14.7 volts.	D-1 Rectifier-regulator not functioning properly. Replace with new unit.
	D-2 If under 14.7 volts	D-2 Alternator system OK. Battery unable to hold charge. Check specific gravity of battery. Replace if necessary.

STARTING SYSTEM

The low cranking effort required on ACR engines had led to introduction of the compact starting motors which are used with the new magneto alternator (ignition and battery charging) systems. These small starters, which are only about 3" in diameter, use Bendix type drives to engage and disengage from the engine. A high mount #KOA236396 version is used on the Model 444 Tractor prior to serial number 9646800.

STARTING MOTOR OPERATION

When the starting circuit is closed and the armature starts to rotate, the Bendix drive pinion moves laterally on a splined sleeve into mesh with the flywheel ring gear. When the pinion butts against a stop washer at the end of the armature shaft, the pinion rotates along with the armature to crank the engine. The armature and pinion remain in positive engagement until the engine fires and attains the speed where the flywheel begins overriding the armature. At this instant, the greater momentum of the flywheel throws the pinion out of mesh and back into the retracted or disengaged position. After the starting circuit is opened and as the armature coasts to a stop, a small spring holds the pinion in the retracted position.

Precaution: In the event of a "false start", that is, if the engine gets up sufficient speed to disengage the starter but fails to continue running, the engine must be allowed to come to a complete halt before a restart attempt is made. If the flywheel is still rotating when the starter is engaged, the pinion and ring gear will clash and possibly be damaged.

Also, as with all starting motors, the cranking time must be limited to prevent overheating of the starter. On these compact starters, the maximum time allowed for cranking is 60 seconds followed by a 30 second cooling period. The cranking limit is not unreasonable for if an engine fails to start after this length of time, ignition or carburetion troubles are indicated and these should be corrected before the engine is placed in operation.

Make sure the special mounting bolts, Part #KO234380 (3/8" x 1-13/32" Grade 8), (and lock washers) are used when installing starter. In addition to securing the starter to the machined surface on the crankcase, these special bolts provide proper alignment of the Bendix drive gear to the ring gear on the engine. Use of ordinary bolts will allow the starter to shift which could result in clashing and damage to the gears.

Service: These starters are pre-lubricated during assembly and further lubrication is not normally needed until the starter is partially dis-assembled for brush or commutator servicing. These services are not required at any specific hourly basis -- they should be performed only after starter performance indicates the need of such service.

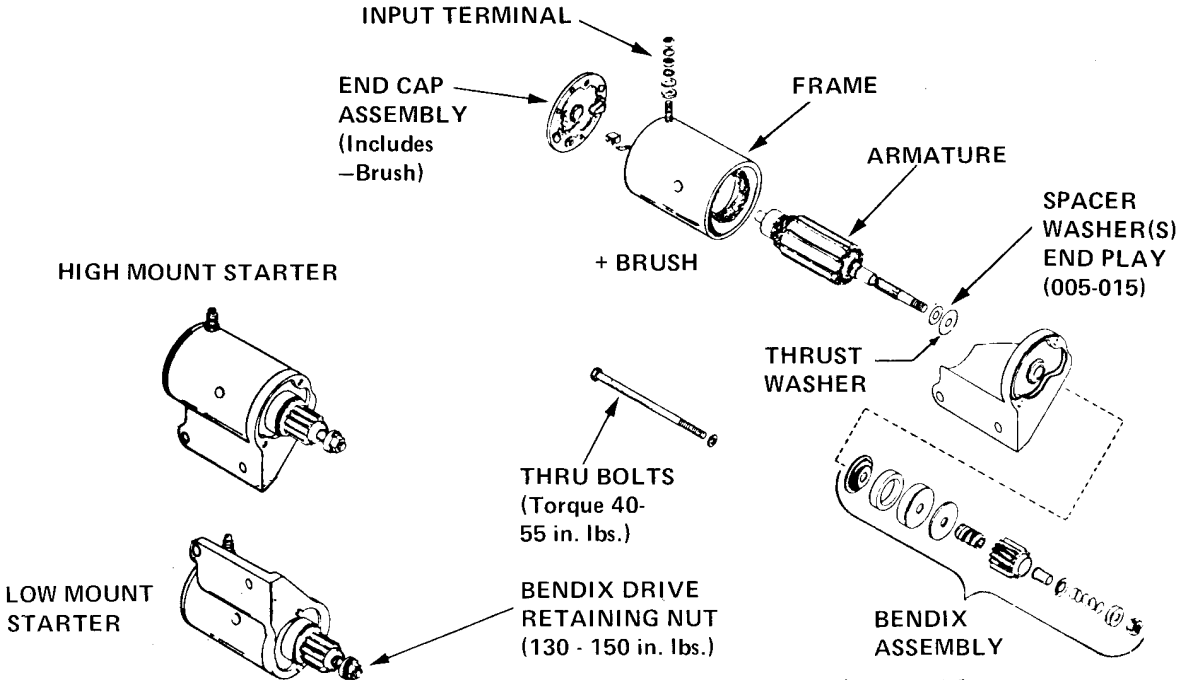

Figure 6. Starter Motor Assembly

STARTING TROUBLE ANALYSIS

Trouble Analysis: Problems that can occur during normal usage are listed on the accompanying chart. The sympton, possible cause and the suggested remedy are stated. If these steps do not solve the problem, the starting motor should be replaced.

TEST PROCEDURE - STARTER ON ENGINE

CONDITION	POSSIBLE FAULT AND CORRECTION
A. STARTING MOTOR FAILS TO ENERGIZE	A-1 Wiring; check for badly corroded or loose connections, also broken or frayed insulation. Clean and tighten connections, replace wires in poor condition. A-2 Starting Switch or Solenoid; bypass the switch or solenoid with jumper wire - if starter cranks normally, replace defective part. A-3 Battery; check specific gravity of battery - if low, recharge or replace battery as necessary.
B. STARTING MOTOR ENERGIZES BUT TURNS TOO SLOWLY	B-1 Battery; check condition of battery (See A-3). B-2 Brushes; remove end cap, check for unevenly worn or dirty brushes and commutator. Use a coarse cloth (not emery paper) to clean. Replace brushes if excessively or unevenly worn. See brush replacement procedure.

TEST PROCEDURE - STARTER REMOVED (BUT NOT DISASSEMBLED)

A. STARTER TURNS TOO SLOWLY	A-1 Armature Binding; remove starter from engine, turn armature shaft by hand - if it does not turn freely, the cause could be; too little end play, bushings not properly lubricated or badly worn.
B. STARTER SPINS WITHOUT ENGAGING	B-1 Drive Pinion Sticking; hold pinion, turn shaft in counter-clockwise direction -- pinion should move freely out on splined shaft. Note condition of spline, if dirty, clean but do not lubricate -- leave dry. Check for nicks or score marks and replace Bendix if necessary. B-2 Drive Pinion Gear Damaged; this of course will be obvious as soon as starter is removed from engine. If teeth are worn or broken, replace Bendix assembly. Also check ring gear teeth for damage.

SERVICE AND REPLACEMENT PROCEDURE

The end cap assembly must be removed to inspect and service the brushes and commutator. Remove the two thru bolts then carefully slip end cap off end of armature. Lift spring and remove positive brush from holder if complete removal of end cap is necessary.

Brush - Commutator Service: Use a coarse cloth to clean brushes and commutator. If commutator is grooved, it should be reconditioned -- in an armature lathe (turned down). If extremely dirty, use a commutator stone or fine sandpaper to polish -- do not use emery cloth.

Brush Replacement: Brushes should be replaced if unevenly worn or worn to less than 5/16" in length. Brush replacement can be made with a new end cap assembly or with a Brush Kit. The kit contains brushes, springs and attaching parts. The rivet holding the negative brush must be drilled out and the new brush riveted in its place. Make sure good mechanical and electrical contacts are made. Positive brush is affixed to field winding. Peel back insulating material, remove old brush. Solder or clip new brush to same spot, rewrap insulating material around new joint.

End Cap Installation: Before reassembling new or serviced end cap assembly, lightly coat bushing and end of the armature shaft with SAE #10 oil -- make sure there is no excess of oil to splatter from these parts. Insert positive brush in holder. Hold positive brush in holder. Hold positive brush spring away with a needle nose pliers, then carefully guide end cap into position -- release brush spring after brushes are started on commutator. Secure end cap to frame with two thru bolts. Tighten bolts to 40-55 inch lb. torque value.

Bendix Drive Assembly: To inspect and service the Bendix drive, remove starter from engine (remove two mounting bolts). If drive pinion or splined sleeve is damaged, replace Bendix drive assembly. If Bendix is in good condition, wipe clean but do not lubricate -- leave completely dry.

Ring Gear Replacement (Engine): If inspection of the ring gear reveals broken, excessively worn or otherwise damaged teeth, the ring gear must be replaced. The ring gear is press fitted into a recess on the outer perimeter of the flywheel. The flywheel must be removed from the engine for ring gear replacement.

Several methods may be used to remove the damaged ring gear. One method is to break the gear into sections with a cold chisel and/or a hack saw. Another way is to heat the ring gear with a torch, then drive the gear off the flywheel.

NOTE

The J I Case Company reserves the right to make improvements in design or changes in specifications at any time without incurring any obligations to install them on units previously sold.

JMRAO PRICE 40c PRINTED IN U.S.A.