TROUBLE SHOOTING

AND

MAINTENANCE SECTION

NAME **PAGE**

EMERSON
2-71 GENERATORS

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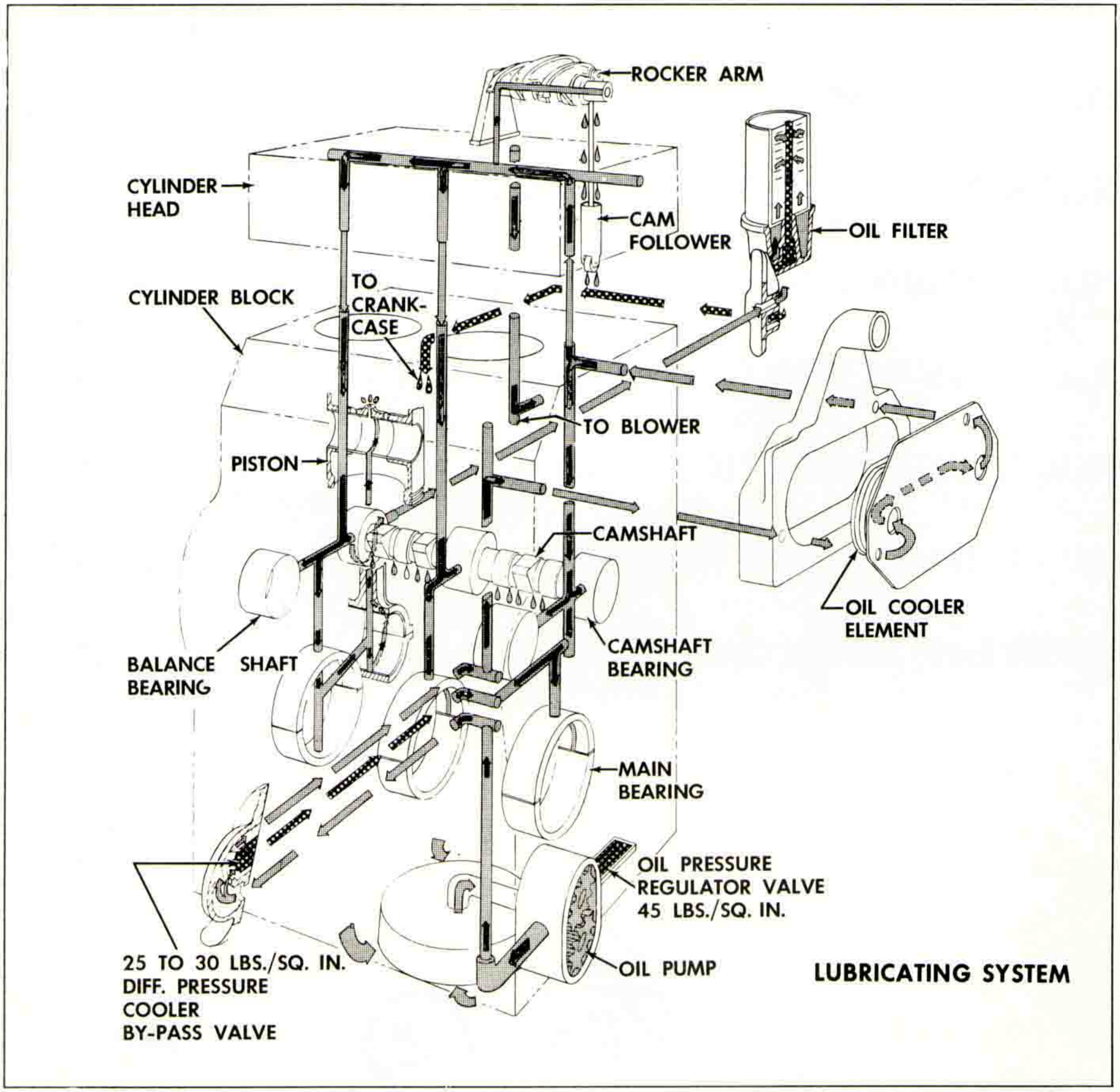
SCHEMATIC DIAGRAM OF LUBRICATING OIL SYSTEM



ENGINE EQUIPMENT

GOVERNORS

Three types of governors are available for use on the two cylinder Series 71 engine. These governors are:

1. Constant Speed Mechanical Governor.

2. Variable Speed Mechanical Governor.

3. Hydraulic Governor.

Engines, subjected to varying load conditions that require automatic fuel compensation to maintain constant engine speed in a range somewhat higher or lower than the rated full load speed, are equipped with a constant speed mechanical governor.

Reefer Engines are normally furnished with constant speed mechanical governors. The mechanical engine governors are identified by a name plate attached to the governor housing. The letters S.W.-C.S. stamped on the name plate denote a single weight constant speed governor.

Governor difficulties are usually indicated by speed variations of the engine. However, speed fluctuations are not necessarily caused by the governor and, therefore, when improper speed variations become evident, the unit should be checked for excessive load, misfiring, or bind in the linkage between the governor and injector control tube. If none of these conditions is contributing to the faulty governor operation, contact a GM Diesel Sales and Service Outlet for service.

Lubrication--Blower rear bearings, as well as governor weights and carrier assembly, are provided with gravity feed lubrication from the cylinder head. Oil flows from the push-rod well into a vertical drilled passage in the cylinder block and through a crosswise hole to the blower housing. Openings in the housing provide an oil passage to top of blower rear end plate, from which the oil flows over blower shaft rear bearings, is splashed on governor weights and carrier shaft bearings, then drains to the crankcase through openings in blower rear end plate and cylinder block.

AUTOMATIC SHUT-DOWN SYSTEM

Engine protective systems, which are optional equipment on two cylinder Series 71 engines, are designed to give continuous automatic engine protection and prevent serious damage to the engine in the event an abnormal engine condition develops. The protective systems that automatically stop the engine when an abnormal condition occurs are called shut-down systems.

The type of automatic shut-down system used on the 2-71 Reefer Engine is:

1. Automatic electrical shut-down system.

The automatic shut-down system consists of: A lubricating oil pressure switch introduced into the engine oil gallery, that closes whenever the oil pressure drops below a predetermined value; a water temperature switch, introduced into the water manifold, which closes whenever the engine coolant temperature exceeds a safe operating value; an electrical solenoid, linked to a lever on the flap valve shaft in the blower air inlet housing, which will close the valve and cut off the air to the blower whenever the solenoid coil is energized by a closed electrical circuit, and the necessary wires to complete the electrical circuit from the generator through the various instruments named above.

The lubricating oil pressure switch is closed when the engine is not running, but opens after starting and remains open while the engine is running. This switch will close only in case of lowered oil pressure or as the engine is stopped by the operator.

The water temperature switch always remains open except in case of excessively high water temperature, then it closes and actuates the solenoid and shuts the air valve.

Thus, while the engine is running, a failure resulting in either low oil pressure or high water temperature will complete the electrical circuit, actuate the shut-down solenoid, and stop the engine.

ENGINE TUNE-UP PROCEDURES

Approximately 100 hours after the initial start, or after an engine overhaul, and thereafter at 1,000 hour intervals, check the various engine adjustments and make the necessary corrections.

Three types of governors are used. Since each governor has different characteristics, the tune-up procedure varies accordingly. The three types are:

1. Constant speed mechanical.
2. Variable speed mechanical.
3. Hydraulic.

Reefer engines are normally furnished with constant speed mechanical governors. The mechanical engine governors are identified by a name plate attached to the governor housing. The letters S.W. C.S. stamped on the name plate denote a single weight constant speed governor.

Normally, when performing a tune-up on an engine in service, it is only necessary to check the various adjustments for a possible change in the settings. However, if the cylinder head, governor, or injectors have been replaced or overhauled, then certain preliminary adjustments are required before the engine is started.

The preliminary adjustments consist of the first four items in the tune-up sequence. The procedures are the same except that the valve clearance is greater for a cold engine.

To tune-up an engine completely, all of the adjustments are made by following the applicable tune-up sequence given below, after the engine has reached the normal operating temperature. Since the adjustments are normally made while the engine is stopped, it may be necessary to run the engine between adjustments to maintain normal operating temperature.

Tune-Up Sequence for Mechanical Governor

1. Adjust the exhaust valve clearance.
2. Time the fuel injectors.
3. Adjust the governor gap.
4. Position the injector rack control levers.
5. Adjust the high speed.
6. Adjust the low speed.

EXHAUST VALVE CLEARANCE ADJUSTMENT

The correct exhaust valve clearance at normal engine operating temperature is important for smooth, efficient operation of the engine.

Insufficient valve clearance can result in loss of compression, misfiring cylinders, and eventually, burned valve seats and valve seat inserts. Excessive valve clearance will result in noisy operation, especially in the low speed range.

Whenever the cylinder head is overhauled, the exhaust valves are reconditioned or replaced, or the valve operating mechanism is replaced or disturbed in any way, the valve clearance must first be adjusted to the cold setting to allow for normal expansion of the engine parts during the engine warm-up period. This will ensure a valve setting which is close enough to the specified clearance to prevent damage to the valves when the engine is started.

All of the exhaust valves may be adjusted, in firing order sequence, during one full revolution of the crankshaft. Refer to the general specifications at the front of the manual for the engine firing order.

Exhaust Valve Clearance Adjustment— (Cold Engine)

1. Place the governor speed control lever in the no-fuel position.
2. Rotate the crankshaft until the injector follower is fully depressed on the cylinder to be adjusted.

   CAUTION: When using a wrench on the crankshaft bolt at the front of the engine, do not turn the engine in a left-hand direction of rotation as the bolt will be loosened.

3. Loosen the push rod lock nut.
4. Place a .013" feeler gage J 9708 between the valve stem and the rocker arm, see Fig. 7. Adjust the push rod to obtain a smooth pull on the feeler gage.
5. Remove the feeler gage. Hold the push rod with a 5/16" wrench and tighten the lock nut with a 1/2" wrench.
6. Recheck the clearance. At this time, if the adjustment is correct, the .011" gage will pass freely between the end of the valve stem and the rocker arm and the .013" gage will not pass through.
7. Check and adjust the remaining valves in the same manner as outlined above.

Exhaust Valve Clearance Adjustment— (Hot Engine)

Maintaining normal engine operating temperature is particularly important when making the final valve clearance adjustment. If the engine is allowed to cool off before setting any of the valves, the clearance when running at full load may become insufficient.

With the engine at normal operating temperature (180°-205°F.) recheck the exhaust valve clearance with gage J 9708. At this time, if the valve clearance is correct, a .008" gage will pass between the end of the valve stem and the rocker arm and the .010" gage will not pass through.

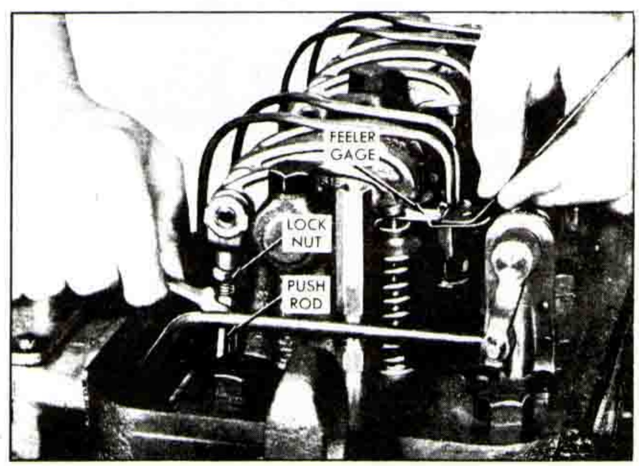


Fig. 7 - Adjusting Valve Clearance

TIMING FUEL INJECTOR

To properly time the injectors used in the 2-71 engines, the injector follower must be adjusted to a definite height in relation to the injector body.

Both injectors can be timed during one full revolution of the crankshaft.

Time Fuel Injector

1. Place the governor stop lever in the no-fuel position.

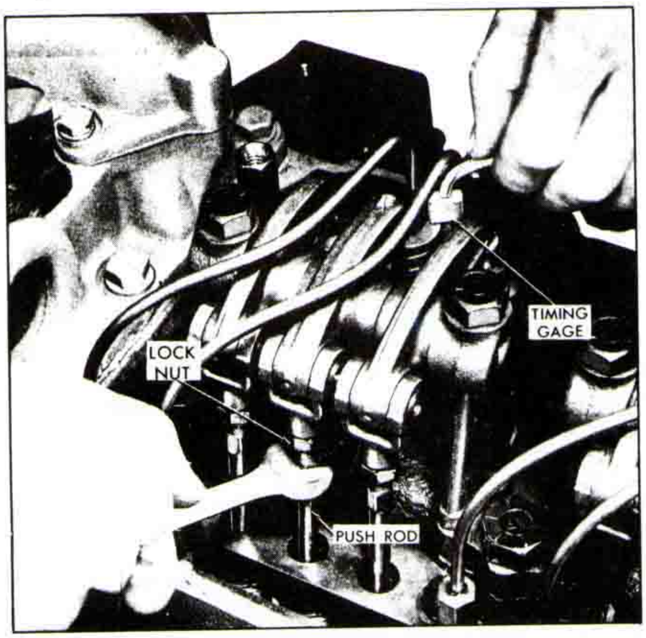


Fig. 8 - Timing Fuel Injector

2. Rotate the crankshaft until the exhaust valves are fully depressed on the particular cylinder to be timed.

3. Place the small end of the injector timing gage in the hole provided in the top of the injector body with the flat of the gage toward the injector follower, as shown in Fig. 8.

TIMING GAGE CHART FOR INJECTORS

Injector	Timing Gage Dimension	Tool No.
HV 6	1.484	J 1242
R-60	1.460	J1853

4. Loosen push rod lock nut.

5. Turn the push rod and adjust the injector rocker arm until the extended part of the gage will just pass over the top of the injector follower.

6. Hold the push rod and tighten the lock nut. Check the adjustment and if necessary, re-adjust the push rod.

7. Time the other injector as outlined above.

CONSTANT TWO SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

After adjusting the exhaust valves and timing the fuel injectors, adjust the constant speed mechanical governor and injector rack control levers.

Governor Gap Adjustment

With the engine at operating temperatures, the governor gap may be set as follows:

1. Remove the high speed spring cover.
2. With the engine operating and the speed control lever in the idle position, loosen the idle speed adjusting screw, Fig. 14, and turn the idle screw to obtain the recommended idle speed.
3. Stop the engine and remove the governor cover.
4. Check the gap between the low speed spring cap and high speed spring plunger with tool J 5407, as shown in Fig. 9.
5. If required, loosen the lock nut and turn the gap adjusting screw until a slight drag is felt on the gage.
6. Hold the adjusting screw and tighten the lock nut.
7. Recheck the gap and readjust if necessary.
8. Install the governor cover.

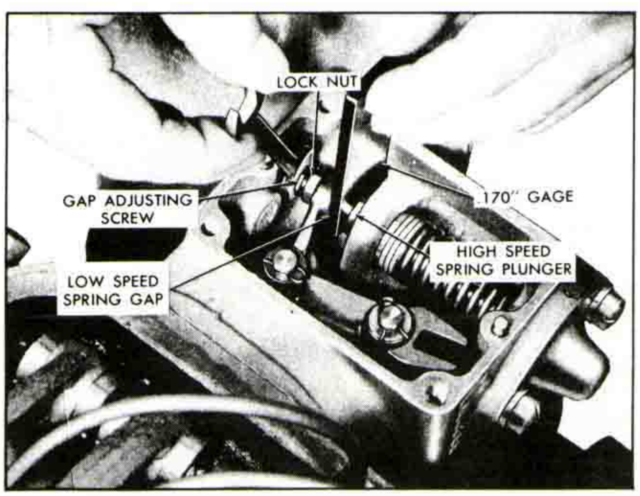


Fig. 9 - Adjusting Governor Gap

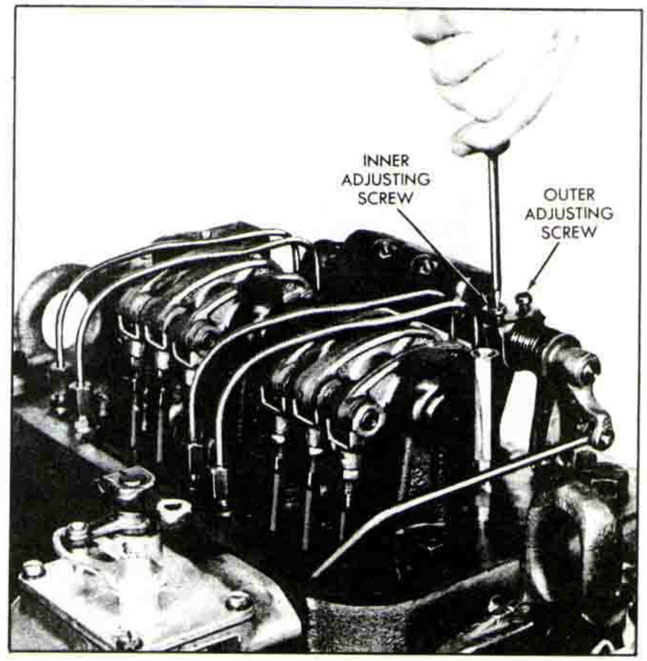


Fig. 10 - Positioning No. 2 Injector Rack Control Lever

Injector Rack Control Lever Positioning

Properly positioned injector rack control levers with the engine at full load will result in the following:

Speed control lever in the maximum speed position.

Governor gap closed.

High speed spring plunger on its seat in the governor control housing.

Injector fuel control racks in the full fuel position.

The cylinders are numbered starting at the front of the engine. Position the No. 2 injector rack control lever first to establish a guide for adjusting the No. 1 injector.

1. Disconnect any linkage attached to the governor speed control lever.
2. Move the speed control lever to the run position.
3. Remove the valve rocker cover.
4. Loosen all the inner and outer rack control lever adjusting screws. Be sure all the injector rack control levers are free on the injector control tube.

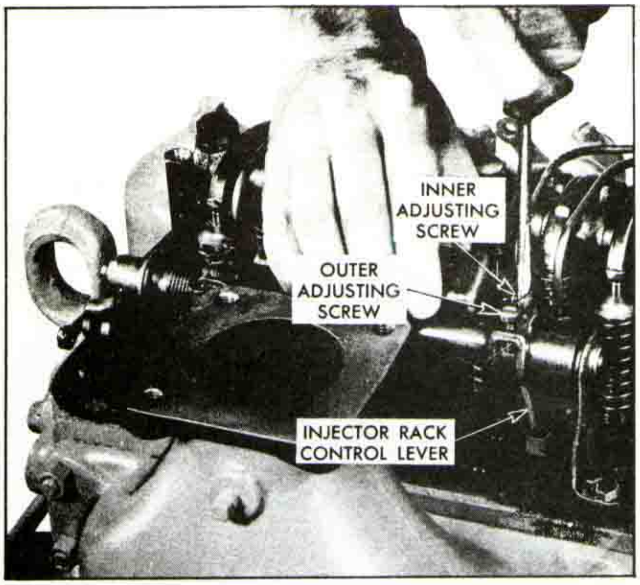


Fig. 11 - Positioning No. 1 Injector Rack Control Lever

5. Turn the inner adjusting screw of the No. 2 injector rack control lever down until a step up in effort is noted. This will place the No. 2 injector rack in the full fuel position. Turn down the outer adjusting screw until it bottoms lightly on the injector control tube. Then, alternately tighten both the inner and outer adjusting screws until tight (Fig. 10).

   NOTE: This places the governor linkage and control tube assembly in the position they will attain while the engine is running at full load. To be sure the injector control lever is properly positioned, the following check should be performed.

6. Hold the speed control lever in the run position and press down on the injector rack with a screw driver or finger tip, causing the rack to rotate. The setting is sufficiently tight if the injector rack returns to its original setting. The setting is too loose if the rack does not return to its original position. To correct this condition, back off the outer adjusting screw slightly, and tighten the inner adjusting screw slightly.

7. To adjust the other fuel injector, manually hold the No. 2 injector in the full fuel position. Then turn down the inner adjusting screw of the No. 1 injector until the injector rack of the No. 1 injector has moved into the full fuel position and the inner adjusting screw is bottomed on the injector control tube. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws until tight. See Fig. 11.

8. Recheck the No. 2 injector rack to be sure that it has remained snug on the ball end of the injector rack control lever while the No. 1 injector rack control lever was positioned. If the rack of the No. 2 injector has become loose, back off slightly on the inner adjusting screw on the No. 1 injector rack control lever. Tighten the outer adjusting screw.

   When the settings are correct, the racks of both injectors must be snug on the ball end of their respective rack control levers.

HIGH SPEED ADJUSTMENT (1200 R.P.M.)

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned, the high speed may be set by installing or removing shims. Installing shims will increase the speed, while removing shims will reduce the speed. Shims are available in .010'' and .078''.

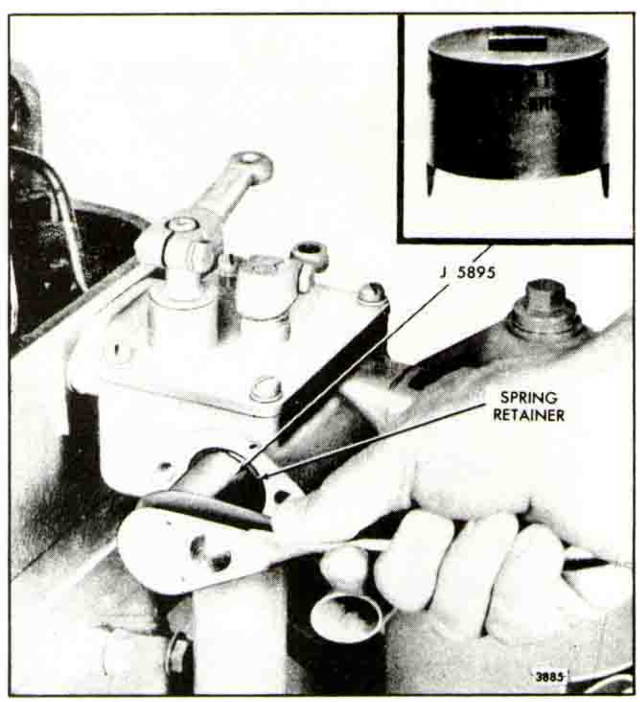


Fig. 12 - Removing or Installing High Speed Spring Retaining Nut

The adjustment, if necessary, is as follows:

1. Refer to Fig. 14 and loosen the lock nut on the low speed adjusting screw.

2. Remove the high speed retainer with tool J 5895 as shown in Fig. 12. Withdraw the retainer and high speed spring plunger as an assembly.

3. While holding the plunger firmly, as shown in Fig. 13, remove the idle speed adjusting screw from the high speed spring plunger.

4. Separate the low speed adjusting screw, spring retainer, and high speed spring from the high speed spring plunger.

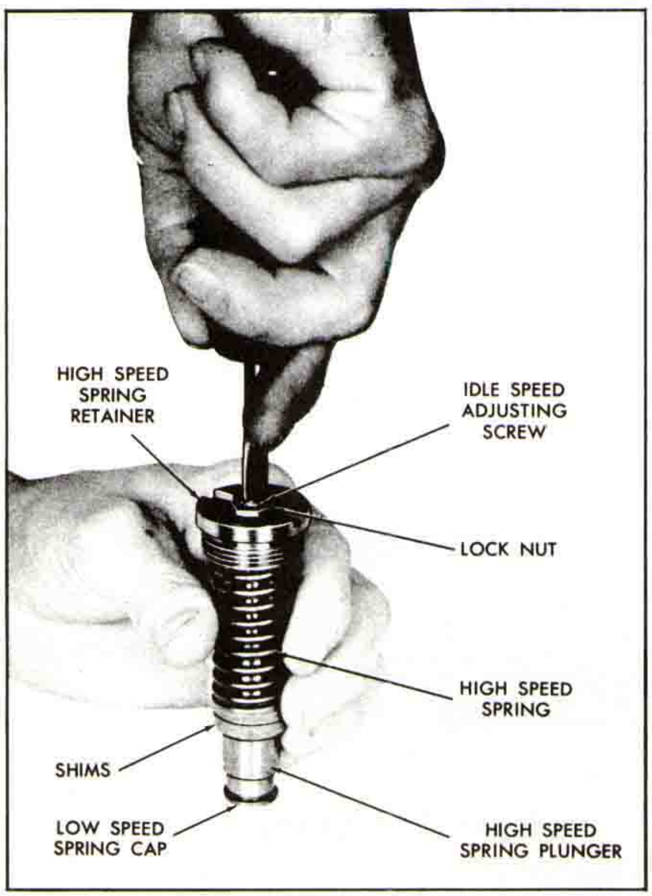


Fig. 13 - Adjusting High Speed

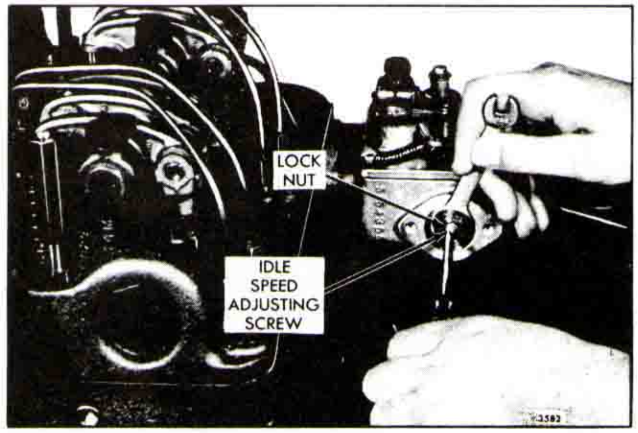


Fig. 14 - Adjusting Engine Low Speed

5. Install or remove governor shims as required.

6. Place the high speed spring over the plunger and against the governor shims. With the spring retainer resting on the high speed spring, insert the low speed adjusting screw through the retainer and into the highspeed spring plunger.

7. Compress the high speed spring and thread the low speed adjusting screw into the high speed spring plunger.

8. Insert the spring and plunger assembly into the governor and tighten the retainer.

9. Using a hand tachometer, recheck the high speed. If required, repeat steps 2 through 8.

LOW SPEED ADJUSTMENT (800 R.P.M.)

With the high speed properly adjusted, the low speed may be adjusted as follows:

1. Place the speed control lever in the low position.

2. With the engine operating, loosen the lock nut (Fig. 14). Turn the low speed adjusting screw until the engine runs at the recommended speed. Hold the screw and tighten the lock nut.

TWO SPEED SOLENOID LINKAGE ADJUSTMENT

1. Remove two speed solenoid cover.

2. Loosen lock screw and swing control arm over against its 800 RPM Stop, and hold it against stop while adjusting linkage. Slide plunger over so plunger-to-solenoid gap is .050, and tighten the lock screw.

3. Swing control arm over against its 1200 RPM Stop, and make certain protruding linkage end does not hit sheet metal enclosure. If enclosure is limiting control arm travel, remove arm from its shaft and reposition it on shaft so it will travel freely to both stops, and repeat step 2.

4. After performing steps 1, 2, and 3, start engine and check to see that the Governor lever is going all the way against the 1200 RPM Stop, then energize the solenoid. Make certain that governor lever is against its 800 RPM Stop, and that solenoid plunger is bottomed in the solenoid.

CAUTION

If solenoid plunger does not completely bottom, damage to solenoid will result.

ENGINE SHUT-DOWN LINKAGE ADJUSTMENT

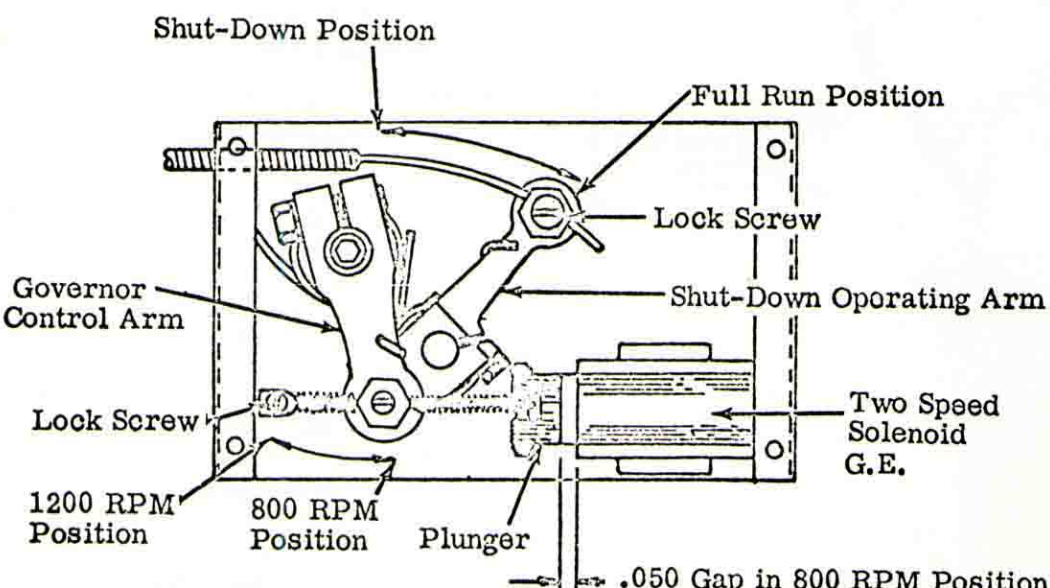
1. Remove two speed solenoid cover.

2. Loosen shut-down linkage lock screw.

3. Push shut-down handle on engine control panel all the way in.

4. Swing the shut-down operating arm over against its Stop in the full run position and hold it against Stop while tightening lock screw.

5. When the shut-down handle is pushed all the way in, make certain that the operating arm is against its stop in the full run position.



NOTE: Plunger should bottom when energized

CAUTION: Failure to bottom will damage solenoid coil.

Fig. 15 - Governor Linkage Adjustment

TROUBLE SHOOTING

Abnormal conditions which may interfere with the satisfactory performance of a GM Diesel engine, together with the methods of determining the cause of such conditions are covered in the trouble Shooting Charts.

The ability of the engine to start and operate properly depends primarily on:

1. The presence of an adequate supply of air compressed to a sufficiently high compression pressure.

2. The injection of the correct amount of fuel at the right time.

Lack of power, uneven running, excessive vibration, stalling at idle speed, and hard starting may be caused by low compression, faulty fuel injection, or lack of sufficient air.

Locating a Misfiring Cylinder

1. Start and run engine at approximately one-half throttle until it reaches normal operating temperature.

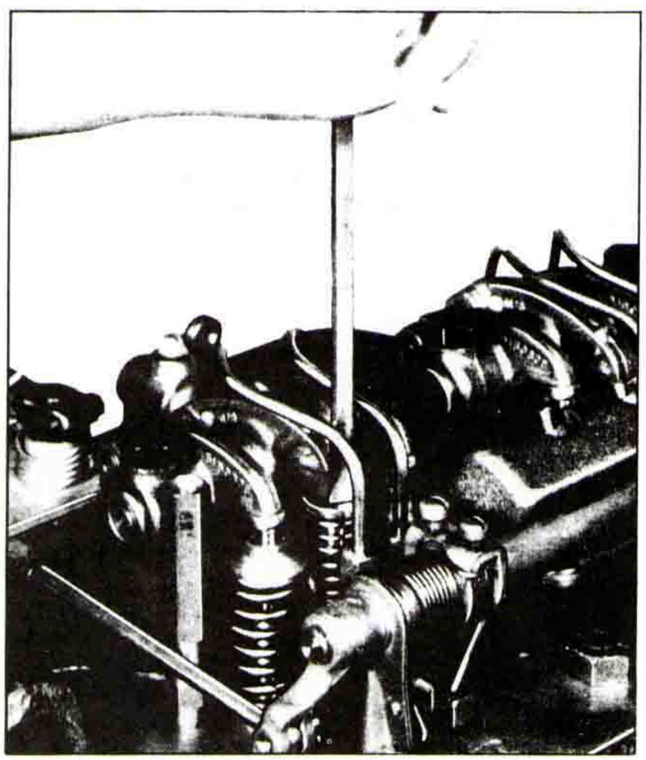


Fig. 16 - Locating a Misfiring Cylinder

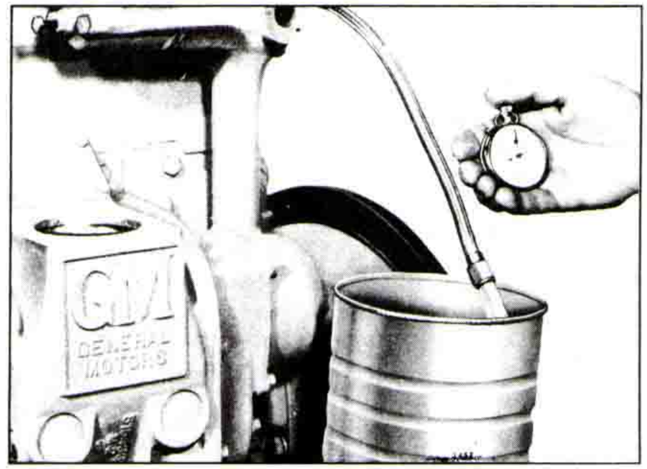


Fig. 17 - Measuring Return Fuel Flow

2. Then with engine operating at idle speed, check valve clearance. The clearance should be .009" with engine at operating temperature.

3. Hold the No. 2 injector follower down as illustrated in Fig. 16, thus preventing operation of the injector.

   If the cylinder has been misfiring, there will be no noticeable difference in the sound and operation of the engine. If the cylinder has been firing properly, there will be a noticeable difference in the sound and operation when the injector follower is held down.

4. If No. 2 cylinder is firing properly, repeat the procedure outlined in item 3 at the other cylinder.

5. If the injector operating mechanism of an improperly firing cylinder is functioning satisfactory, remove faulty injector and install a new or reconditioned injector as previously outlined.

6. If the installation of a new or reconditioned injector does not eliminate the misfiring, the compression pressure of the cylinder in question should be checked.

Check Fuel Flow

1. Disconnect the fuel return line at some point between the cylinder head and fuel tank.

2. Place open end of return line in a receptacle as shown in Fig. 17

3. Start and operate engine at 1,200 rpm and measure the amount of fuel returned in a one minute period.

   A minimum of one-half gallon of fuel should flow from the return line per minute.

   If the fuel return fails to meet the amount specified, the strainer, filter, or fuel pump should be serviced.

4. Also, while the open end of fuel return line is immersed, check for air bubbles rising to the surface of the fuel. Presence of air bubbles in the fuel return indicates there is a leak on the suction side of the fuel pump. In such a case, check fuel lines and connections.

Checking Compression Pressure

1. Remove valve rocker cover.
2. Start on No. 1 cylinder and remove fuel lines from both injector and fuel connectors.
3. Remove the injector from No. 1 cylinder and install the pressure gage adaptor in its place, in the same manner as installing an injector.
4. Close both fuel openings in cylinder head fuel connectors with shipping caps.
5. Start engine, run at approximately 800 rpm and take readings on the gage.

   Do not take compression pressure by cranking engine with the starter.

6. Perform this same operation on each cylinder in turn. The compression pressure in any one cylinder should not be less than 400 lbs./sq. in. (at 800 rpm) and in addition the variation in compression pressures between cylinders of an engine MUST NOT EXCEED 25 p.s.i. at approximately 800 engine rpm. For example:

If the compression pressure readings of an engine were:

Cylinder	Gage Reading
1	525 p.s.i.
2	490 p.s.i.

It would indicate that No. 2 cylinder was out of line with the other cylinder of the engine. Therefore, this cylinder should be inspected and the cause of the low compression pressure corrected.

Note that No. 1 cylinder in the example is above the low limit for satisfactory operation of the engine. Nevertheless, the No. 2 cylinder compression pressure indicates that something out of the ordinary has taken place and a localized pressure leak has developed. Therefore, the cause should be determined and corrective measures taken.

Crankcase Pressure

The crankcase pressure indicates the amount of air passing between the oil control rings and the liner into the crankcase, most of which is clean air from the air box. A slight pressure in the crankcase is desirable to prevent the entrance of dust. A loss of engine lubricating oil through the governor breather tube, crankcase ventilator, or dipstick hole in the cylinder block is indicative of excessive crankcase pressure. The maximum crankcase pressure is shown in the following chart.

CRANKCASE PRESSURE (MAX.) (in inches of water)			
	Speed		
Engine	1200		
2-71	0.5		

The causes of high crankcase pressure may be traced to excessive blow-by due to worn piston rings, a hole or crack in a piston crown, loose piston pin retainers, worn blower oil seals, defective blower, cylinder head or end plate gaskets, or excessive exhaust back pressure. Also, the breather tube or crankcase ventilator should be checked for obstructions.

The crankcase pressure may be checked by means of a manometer. The manometer should be connected to the oil level dipstick opening in the cylinder block. Check the readings obtained at various engine speeds with the specifications in the chart.

Delco-Remy

Enclosed Shift Lever Type (Heavy Duty)
CRANKING MOTORS

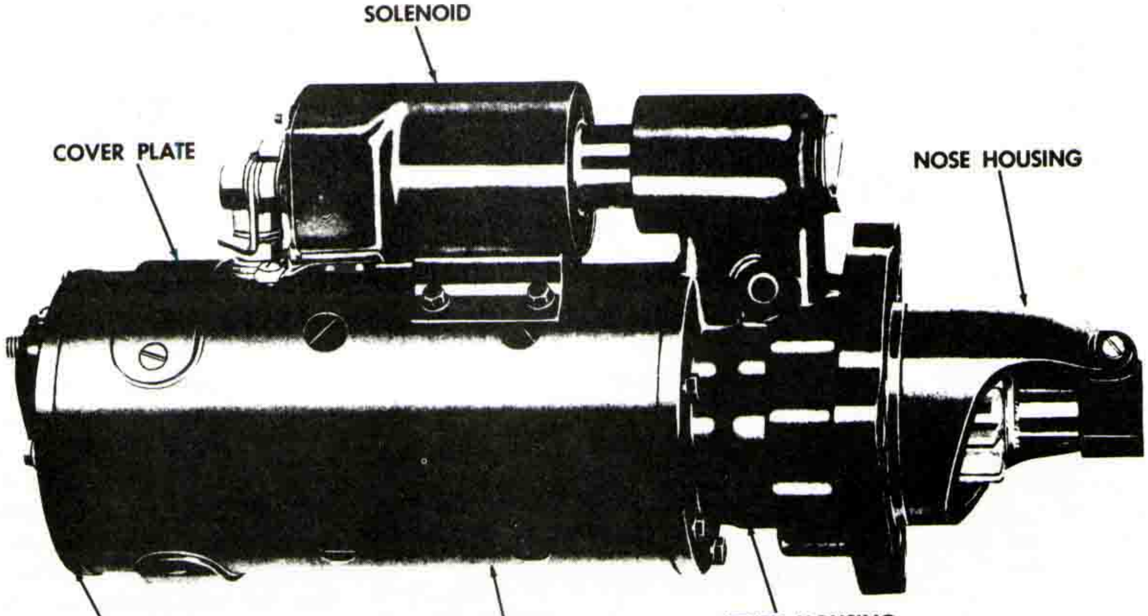


Figure 1—Typical enclosed shift lever type heavy duty cranking motor.

The heavy duty cranking motors covered in this bulletin have a shift lever and solenoid plunger that are totally enclosed to protect them from exposure to dirt, icing conditions and splash. The nose housing can be rotated to obtain a number of different solenoid positions with respect to the mounting flange, which is a feature that makes these motors universally adaptable to a wide variety of different mounting applications.

Positive lubrication is provided to the bronze bushings by an oil saturated wick that projects through the bushings and contacts the armature shaft. Oil can be added to each wick by removing a pipe plug which is accessible on the outside of the motor. Roller bearings in the lever housing on some models contain a supply of lubricant which will last between engine overhaul periods.

Available as an optional feature are oil reservoirs for the bronze bearings which makes available a larger oil supply thereby extending the time required between lubrication periods. Another optional feature is "O" rings which can be added to resist entry of dirt and moisture into the entire motor assembly. When the oil reservoirs and "O" rings are included, the motor is classified as "long life," and will provide long periods of attention-free operation.

Many models feature a seal between the shaft and lever housing and all models have a rubber boot or linkage seal over the solenoid plunger. The seal and the boot, when used together, prevent entry of oil into the motor main frame and solenoid case, allowing the motor to be used on wet clutch applications.

Four kinds of clutches, a heavy duty sprag, a Positork drive, an intermediate duty type and a splined drive, may be used with enclosed heavy duty type cranking motors. The intermediate clutch may be either the sprag type or the four-roll type. All four types are moved into mesh with the ring gear by the action of the solenoid. The pinion remains engaged until starting is assured and the solenoid circuit is interrupted. In case of a butt engagement with the heavy duty sprag clutch or Positork drive, the motor will not be energized to prevent damage to the pinion and gear teeth. The spline drive is normally used on gas turbine applications, and can be engaged into the turbine spline gear before the turbine gear has coasted to a stop.

MAINTENANCE

Under normal operating conditions, no maintenance will be required between engine overhaul periods. At time of engine overhaul, motors without oil reservoirs and "O" rings and "long life" motors incorporating oil reservoirs and "O" rings should be disassembled, inspected, cleaned, and tested as described in succeeding paragraphs.

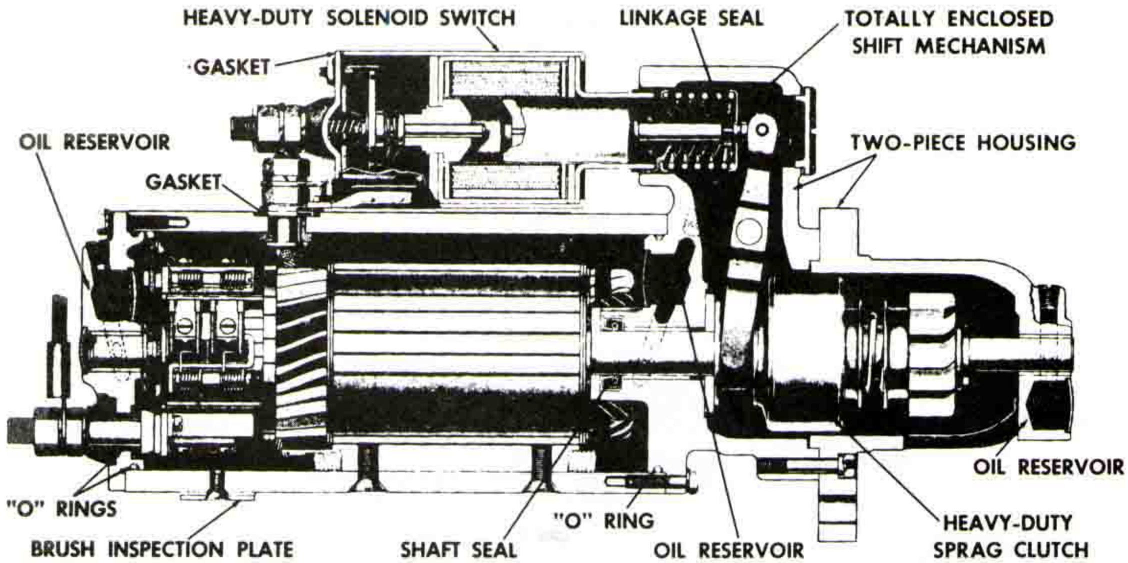


Figure 2—Cross-sectional view of motor with heavy duty sprag clutch.

ADJUSTABLE NOSE HOUSING

Two methods are employed to attach the nose housing to the lever housing. As shown in the cross-sectional views of Figure 2 and Figure 3 one method, employed when the heavy duty clutch and spline drive are used, attaches the nose housing to the lever housing by means of six bolts located around the outside of the housing. To relocate the housing, it is only necessary to remove the bolts, rotate the housing to the desired position, and reinstall the bolts. The bolts should be torqued to 13-17 lb. ft. during reassembly. In this type of assembly, the lever housing and the commutator end frame are attached to the field frame independently by bolts entering threaded holes in the field frame.

In the second method, where the intermediate duty clutch is used, the lever housing and commutator end frame are held to the field frame by thru-bolts extending from the commutator end frame to threaded holes in the lever housing. The nose housing is held to the lever housing by internal attaching bolts extending from the lever housing to threaded holes in the nose housing (Fig. 4). With this arrangement, it is necessary to partially disassemble the motor to provide access to the attaching bolts when relocating the nose housing.

To accomplish this, remove the electrical connector and the screws attaching the solenoid assembly to the field frame and then remove the thru-bolts from the commutator end frame. Separate the field frame from the remaining assembly, and pull the armature away from the lever housing until the pinion stop rests against the clutch pinion. This will clear the nose housing attaching bolts so they can be removed with a box or open end wrench, permitting relocation of the nose housing. During reassembly, torque the nose housing attaching bolts to 11-15 lb. ft.

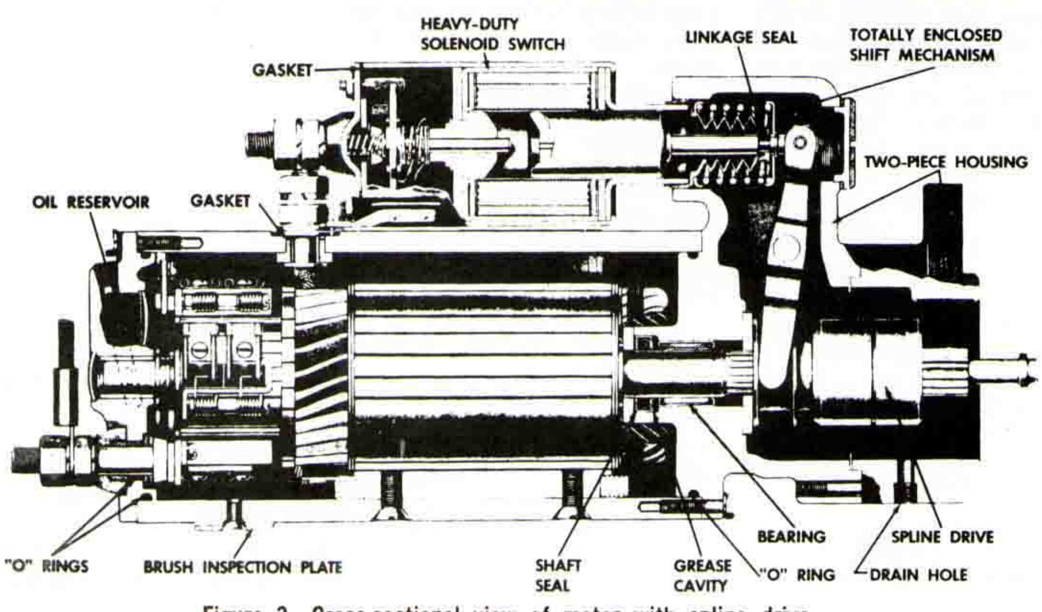


Figure 3—Cross-sectional view of motor with spline drive.

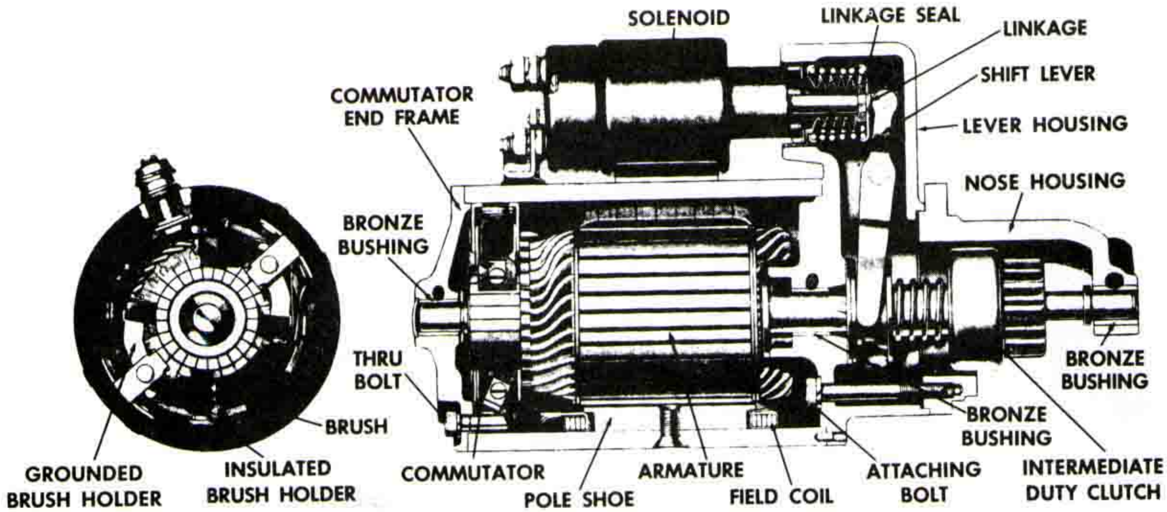


Figure 4—Cross-sectional view of motor with intermediate duty clutch.

OPERATION

In the basic circuit shown in Figure 5, the solenoid windings are energized when the switch is closed. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close, and cranking takes place. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun and damage to the drive and armature windings, the switch must be opened immediately when the engine starts.

TROUBLESHOOTING THE CRANKING CIRCUIT

Before removing any unit in a cranking circuit for repair, the following checks should be made:

Battery: To determine the condition of the battery, follow the testing procedure outlined in Service Bulletin 7D-100 or 7D-100E. Insure that the battery is fully charged.

Wiring: Inspect the wiring for damage. Inspect all connections to the cranking motor, solenoid, magnetic switch, ignition switch or any other control switch, and battery, including all ground connections. Clean and tighten all connections as required.

Magnetic Switch, Solenoid and Control Switches: Inspect all switches to determine their condition. Connect a jumper lead around any switch suspected of being defective. If the system functions properly using this method, repair or replace the bypassed switch.

Motor: If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined below.

CRANKING MOTOR TESTS

Regardless of the construction, never operate the cranking motor more than 30 seconds at a time without pausing to allow it to cool at least two minutes. On some applications, 30 seconds may be excessive. Overheating, caused by excessive cranking will seriously damage the cranking motor.

With the cranking motor removed from

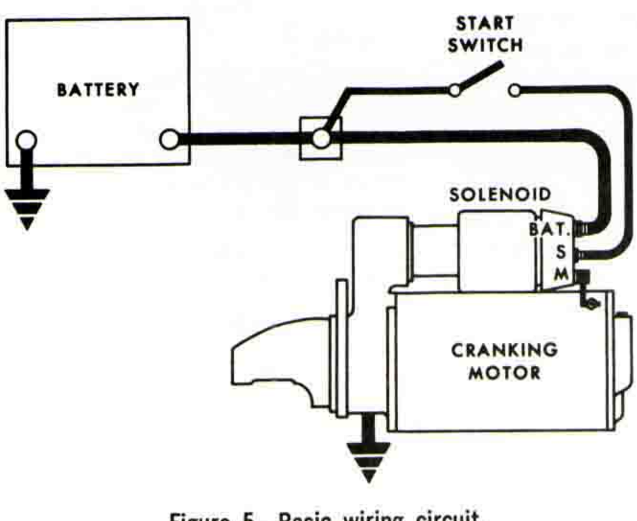


Figure 5—Basic wiring circuit.

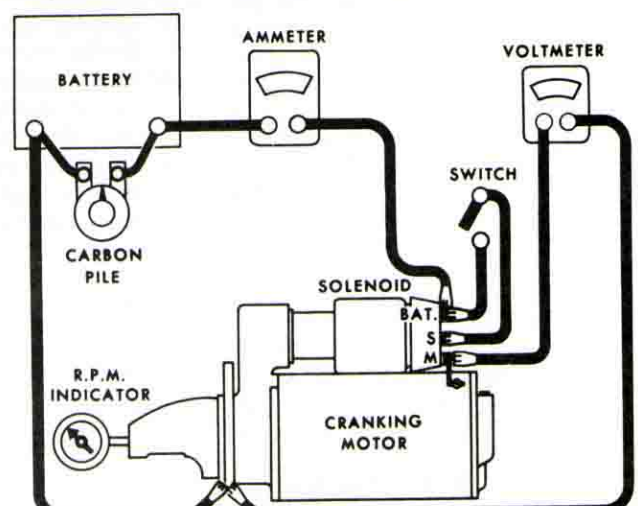


Figure 6—No-load test circuit.

Enclosed Shift Lever Type (Heavy Duty) CRANKING MOTORS

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Figure 7—Removing retainer from snap ring.

the engine, the armature should be checked for freedom of rotation by prying the pinion with a screwdriver. Tight bearings, a bent armature shaft, or a loose pole shoe screw will cause the armature to not turn freely. If the armature does not turn freely the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

No-Load Test (Fig. 6)

Connect a voltmeter from the motor terminal to the motor frame, and use an r.p.m. indicator to measure armature speed. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position from the solenoid battery terminal to the solenoid switch terminal. Close the switch and compare the r.p.m., current, and voltage reading with the specifications in Service Bulletins 1M-186 or 1M-187. It is not necessary to obtain the exact voltage specified in these bulletins, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the r.p.m. will be proportionately higher, with the current remaining essentially unchanged. However, if the exact voltage is desired, a carbon pile connected across the battery can be used to reduce the voltage to the specified value. If more than one 12-volt battery is used, connect the carbon pile to only one of the 12-volt batteries. If the specified current draw does not include the solenoid, deduct from the ammeter reading the specified current draw of the solenoid hold-in winding. Make disconnections only with the switch open. Interpret the test results as follows:

Interpreting Results of Tests

1. Rated current draw and no-load speed indicates normal condition of the cranking motor.
2. Low free speed and high current draw indicate:
   a. Too much friction—tight, dirty, or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.
   b. Shorted armature. This can be further checked on a growler after disassembly.
   c. Grounded armature or fields. Check further after disassembly.
3. Failure to operate with high current draw indicates:
   a. A direct ground in the terminal or fields.
   b. "Frozen" bearings (this should have been determined by turning the armature by hand).
4. Failure to operate with no current draw indicates:
   a. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.
   b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.
   c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.
5. Low no-load speed and low current draw indicate:
   a. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under Number 4.
6. High free speed and high current draw indicate shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

DISASSEMBLY

Normally the cranking motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the cranking motor.

Intermediate Duty Clutch Motor

1. Note the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.
2. Disconnect field coil connector from solenoid motor terminal, and remove solenoid mounting screws.
3. Remove thru-bolts.
4. Remove commutator end frame from field frame and field frame from lever housing.
5. Remove nose housing attaching bolts and separate nose housing from lever housing.
6. Slide a standard half-inch pipe coupling or other metal cylinder of suitable size (an old pinion of suitable size can be used if available) onto shaft so end of coupling or cylinder butts against edge of retainer. Tap end of coupling with hammer, driving retainer towards armature and off snap ring (Fig. 7).
7. Remove snap ring from groove in shaft using pliers or other suitable tool. If snap ring is too badly distorted during removal it may be necessary to use a new one when reassembling clutch.
8. Remove the armature and clutch from the lever housing.
9. Separate the solenoid from the lever housing.

Heavy Duty Clutch, Positork Drive, and Spline Drive Motors

1. Note the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.

2. Disconnect field coil connector from solenoid motor terminal, and lead from solenoid ground terminal.
3. On motors which have brush inspection plates, remove the plates and then remove the brush lead screws. This will disconnect the field leads from the brush holders.
4. Remove the attaching bolts and separate the commutator end frame from the field frame.
5. Separate the nose housing and field frame from lever housing by removing attaching bolts.
6. Remove armature and clutch assembly from lever housing.
7. Separate solenoid from lever housing by pulling apart.

CLEANING

The drive, armature and fields should not be cleaned in any degreasing tank, or with grease dissolving solvents, since these would dissolve the lubricant in the drive and damage the insulation in the armature and field coils. All parts except the drive should be cleaned with mineral spirits and a brush. The drive can be wiped with a clean cloth.

If the commutator is dirty it may be cleaned with No. 00 sandpaper. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR.

BRUSHES AND HOLDERS

Inspect the brushes for wear. If they are worn excessively when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator to give proper performance. Check by hand to insure that the brush springs are giving firm contact between the brushes and commutator. If the springs are distorted or discolored, they should be replaced.

ARMATURE SERVICING

If the armature commutator is worn, dirty, out of round, or has high insulation, the armature should be put in a

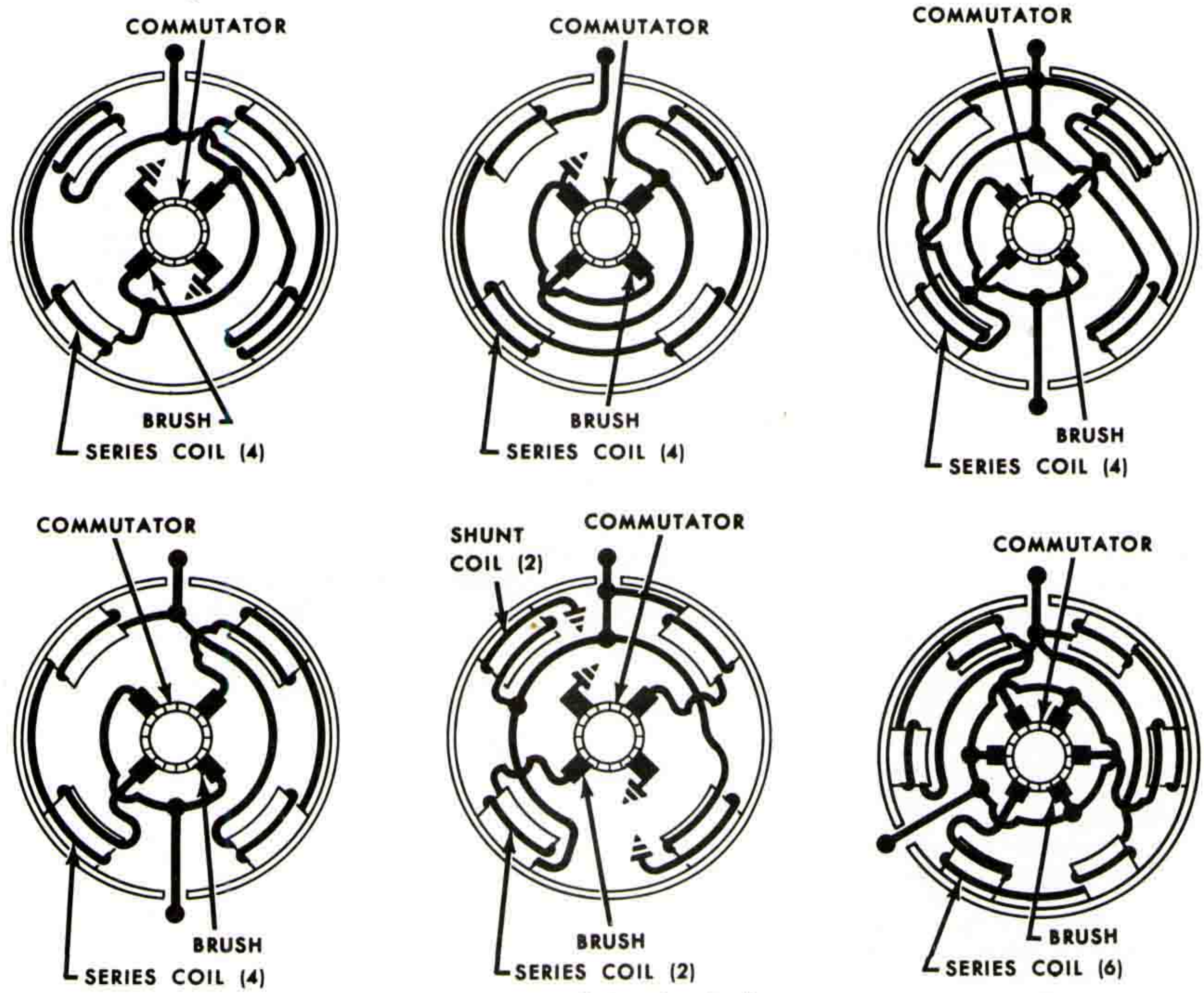

Figure 8—Typical motor circuits.

Enclosed Shift Lever Type (Heavy Duty) CRANKING MOTORS

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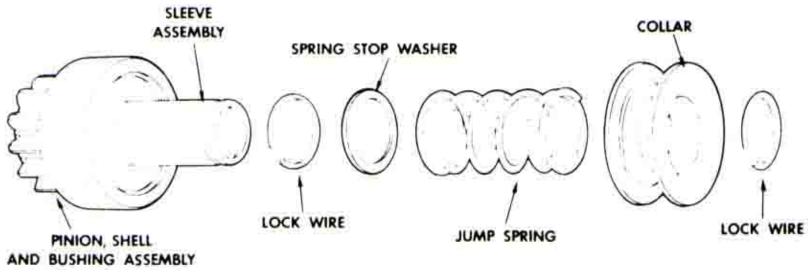

Figure 9—Disassembled view of early type intermediate duty sprag clutch drive assembly.

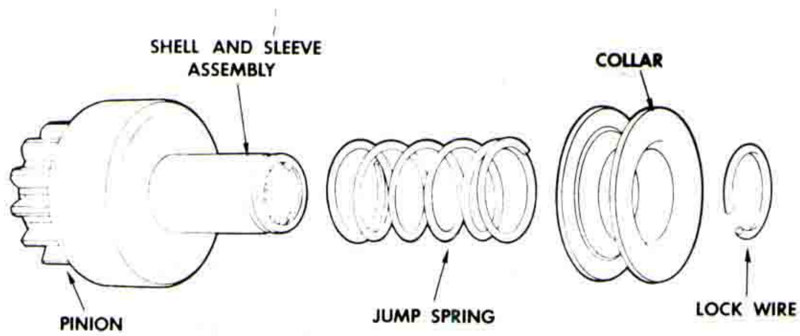

Figure 10—Disassembled view of late type intermediate duty sprag clutch drive assembly.

lathe so the commutator can be turned down. The insulation should then be undercut 1/32 of an inch wide and 1/32 of an inch deep, and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure. NOTE: The undercut operation must be omitted on cranking motors having Test Specifications 3501 and 3564 as listed in Delco-Remy Service Bulletins 1M-186 and 1M-187. **Do not** undercut commutators on motors having these two specifications.

The armature should be checked for opens, short circuits and grounds as follows:

1. Opens—Opens are usually caused by excessively long cranking periods. The most likely place for an open to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be effected by resoldering or welding the leads in the riser bars (using rosin flux), and turning down the commutator in a lathe to remove the burned material. The insulation should then be undercut except as noted above.

2. Short Circuits—Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.

3. Grounds—Grounds in the armature can be detected by the use of a 110-volt test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the cranking motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

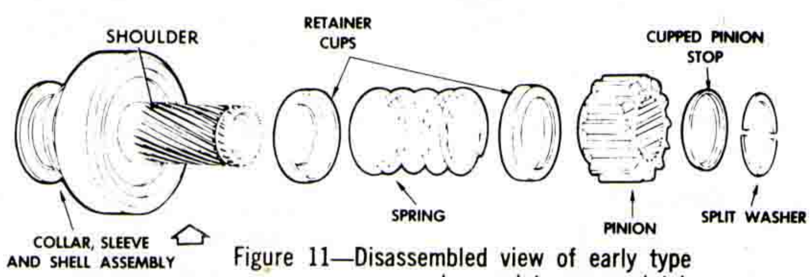

Figure 11—Disassembled view of early type heavy duty sprag clutch drive assembly.

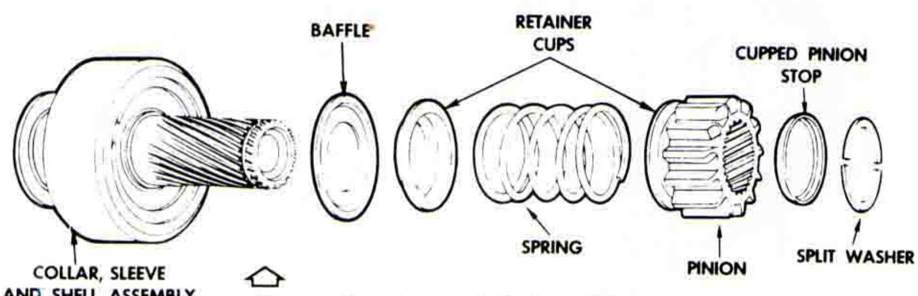

Figure 12—Disassembled view of late type heavy duty sprag clutch drive assembly.

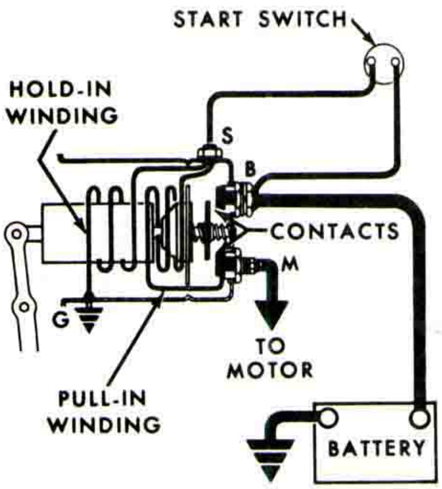

Figure 13—Basic solenoid circuit.

FIELD COIL CHECKS

The various types of circuits used are shown in the wiring diagrams of Figure 8. The field coils can be checked for grounds and opens by using a test lamp.

Grounds—If the motor has one or more coils normally connected to ground, the ground connections must be disconnected during this check. Connect one lead of the 110-volt test lamp to the field frame and the other lead to the field connector. If the lamp lights, at least one field coil is grounded which must be repaired or replaced. This check cannot be made if the ground connection cannot be disconnected.

Opens—Connect test lamp leads to ends of field coils. If lamp does not light, the field coils are open.

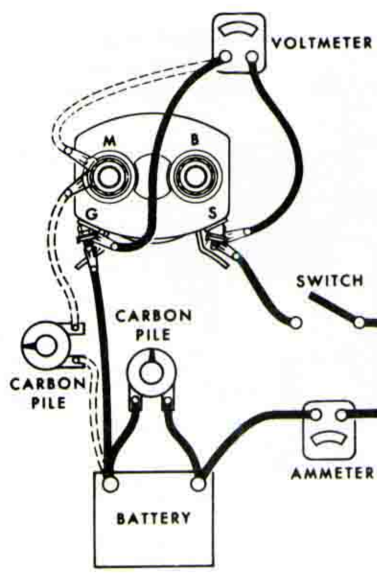

Figure 14—Checking solenoid hold-in and pull-in windings. (Note: Terminal locations may vary.)

FIELD COIL REMOVAL

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

CLUTCH ASSEMBLY

Disassembly procedures for the various types of clutches are outlined below.

A. Intermediate Duty Sprag Clutch

An early type clutch and late type clutch are shown in Figures 9 and 10.

1. Remove the lock wire, collar, and jump spring from the sleeve assembly.
2. Remove the spring stop washer and second lock wire from the early type clutch (Fig. 9).
3. Remove the retainer ring and large washers. Do not remove the sleeve assembly or sprags from the shell assembly.
4. Lubricate the sprags and saturate the felt washer with No. 5W20 oil. Heavier oil must not be used.
5. Assembly is the reverse of disassembly.

B. Heavy Duty Sprag Clutch

An early type and a late type heavy duty sprag clutch are shown in Figures 11 and 12.

1. Remove the cupped pinion stop and split washer. In removing the cupped pinion stop, it will probably be damaged. A new one will be required at time of reassembly.
2. Remove the pinion, spring, and retainer cups.
3. Remove the retainer ring and washers. Do not remove the collar,

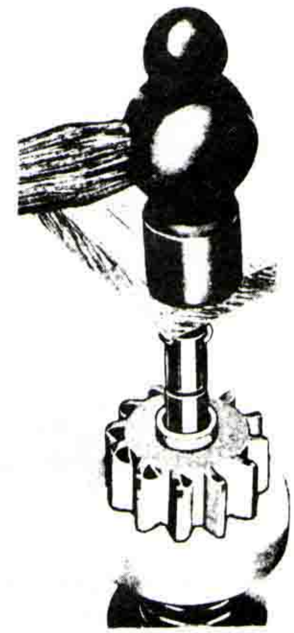

Figure 15—Forcing snap ring over shaft.

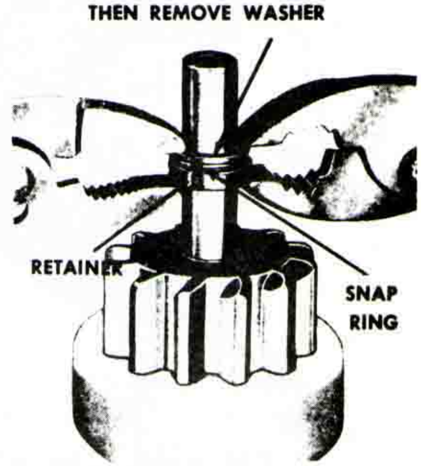

Figure 16—Forcing retainer over snap ring.

winding (Fig. 14). Use the carbon pile to decrease the battery voltage to the value specified in Service Bulletins 1S-180, 1S-186, or 1S-187, and compare the ammeter reading with specifications. A high reading indicates a shorted or grounded hold-in winding, and a low reading excessive resistance. To check the pull-in winding connect from the solenoid switch terminal (S) to the solenoid motor (M or MOT) terminal.

NOTE: If needed to reduce the voltage to the specified value, connect the carbon pile between the battery and the "M" terminal as shown in dashed red instead of across the battery as shown in solid red lines. If the carbon pile is not needed, connect a jumper directly from the battery to the "M" terminal as shown by the dashed red line.

CAUTION: To prevent overheating, do not leave the pull-in winding energized more than 15 seconds. The current draw will decrease as the winding temperature increases.

A magnetic switch can be checked in the same manner by connecting across its winding.

REASSEMBLY

The reassembly procedure for each type of motor is the reverse of disassembly.

On motors using a snap ring and retainer on the shaft as a pinion stop, the ring and retainer can be assembled in the manner shown in Figures 15 and 16. With the retainer placed over the shaft with the cupped surface facing the end of the shaft, force the ring over the shaft with a light hammer blow and then slide the ring down into the groove (Fig. 15). To force the retainer over the snap ring, place a suitable washer over the shaft and squeeze with pliers (Fig. 16). REMOVE THE WASHER.

To reassemble the end frame having eight brushes onto the field frame, pull the armature out of the field frame just far enough to permit the brushes to be placed over the commutator. Then push the commutator end frame and the armature back against the field frame.

On intermediate duty clutch motors, be sure to assemble all brushes to the brush arms so the long side of the brush is toward the commutator end frame. (The brush holes are offset.) Otherwise the brushes may contact the riser bars. See Figure 17.

LUBRICATION

All wicks and oil reservoirs should be saturated with SAE No. 10 oil, and the splines underneath the clutch should be lubricated with a light coat of SAE No. 10 oil. (Heavier oil may cause failure to mesh at low temperatures.) Lever housings having a bearing and seal should have the grease cavity between the bearing and seal filled with Delco-Remy Lubricant No. 1960954 (Fig. 3).

PINION CLEARANCE

There are no provisions for adjusting pinion clearance on motors using the intermediate duty clutch (Fig. 4). However, all four types should be checked after reassembly to make sure the clearance is within specifications.

To check pinion or drive clearance follow the steps listed below.

1. Disconnect the motor field coil connector from the solenoid motor terminal.
2. Connect a battery, of the same voltage as the solenoid, from the solenoid switch terminal to the solenoid frame or ground terminal (Fig. 18).
3. MOMENTARILY flash a jumper lead from the solenoid motor terminal to the solenoid frame or ground terminal. The drive will now shift into cranking position and remain so until the battery is disconnected.
4. Push the pinion or drive back towards the commutator end to eliminate slack movement.

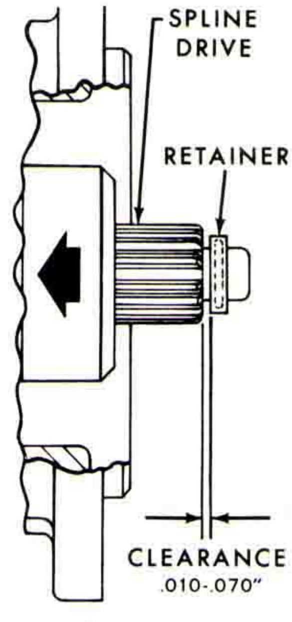

Figure 21—Checking pinion clearance on spline drive motor.

5. Measure the distance between drive and drive stop (Figs. 19, 20, and 21).
6. Adjust clearance by removing plug and turning shaft nut (Figs. 20 and 21 only). Although typical specifications are shown, always refer to the appropriate Delco-Remy Service Bulletin for specifications applying to specific models. The clearance for the Positork drive (Fig. 22) is the same as that shown in Figure 20.

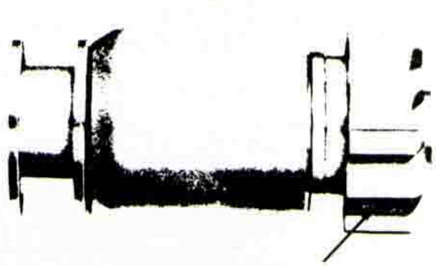

Figure 22—Positork drive.

MAINTENANCE

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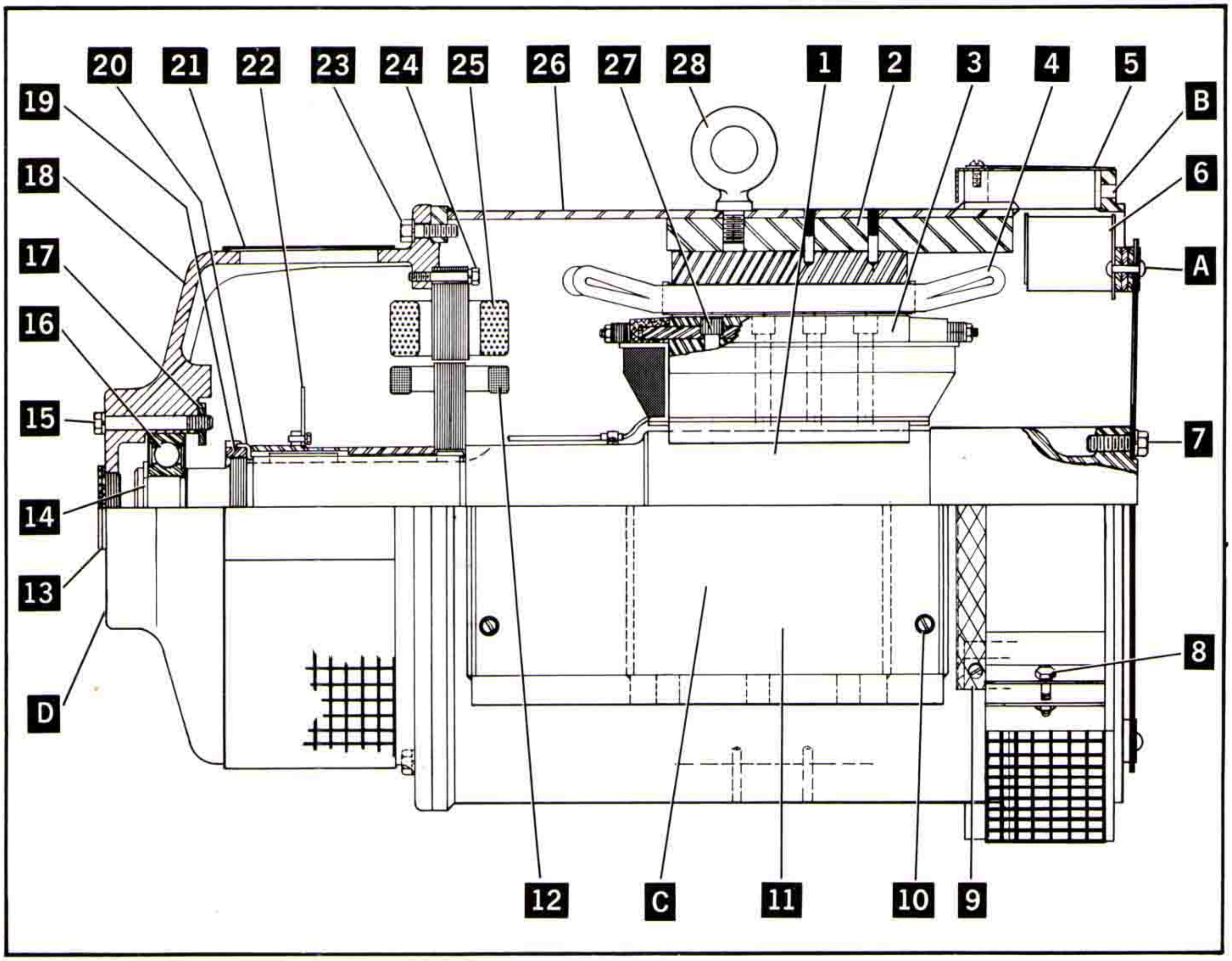


FIGURE 1. CUTAWAY VIEW OF TYPICAL
RAILROAD REFRIGERATION GENERATOR

1. Rotating Field Assembly (Rotor)
2. Stationary Armature (Stator)
3. Rotating Coil
4. Stator Coil
5. Fan Cover
6. Fan and Driving Disc Assembly
7. Bolt – Fan Mounting
8. Bolt – Cover Band Mounting
9. Guard
10. Screw – Cover Mounting
11. Cover and Compensator Assembly
12. Exciter Armature
13. Plug
14. Snap Ring – Bearing Retaining
15. Bolt – Bearing Plate Mounting
16. Ball Bearing
17. Bearing Plate
18. End Frame
19. Locknut – Rotating Rectifier Assembly Retaining
20. Lockwasher – Rotating Rectifier Assembly Retaining
21. Cover Band
22. Rotating Rectifier Assembly
23. Bolt – End Frame Mounting
24. Bolt – Exciter Field Mounting
25. Exciter Field Assembly
26. Main Frame
27. Bolt – Rotating Coil Mounting
28. Eye Bolt

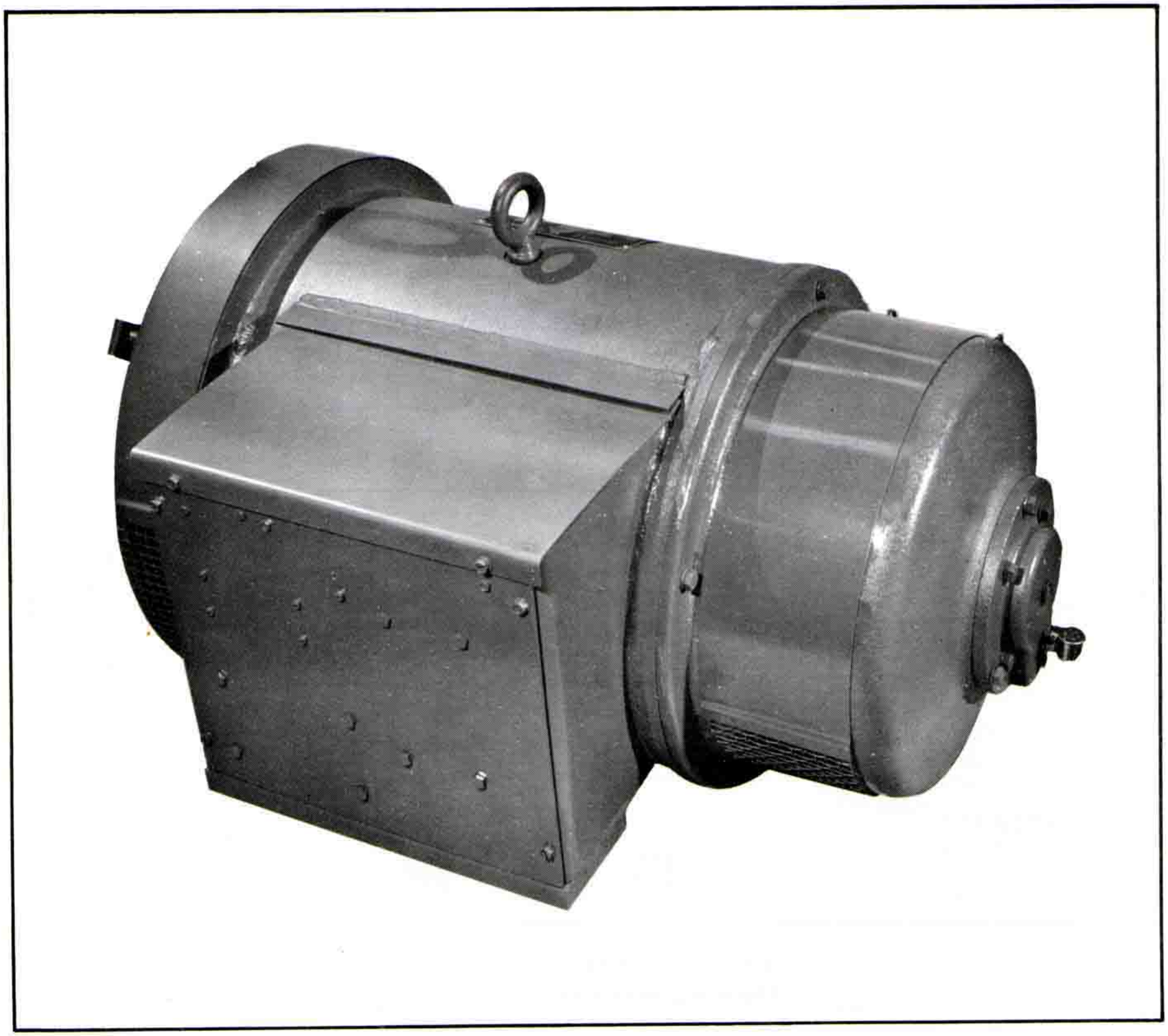


FIGURE 2. EXTERIOR VIEW OF TYPICAL RAILROAD REFRIGERATION GENERATOR

DESCRIPTION

(Numbers in parentheses refer to Figure 1)

General: The generator illustrated in Figure 1 and Figure 2 consists of three principal components: the alternator, the integral direct-connected exciter, and the built-in compensator. The alternator may be sub-divided into the rotating field (1), the stationary armature, or stator (2). The exciter consists of a rotating armature (12), a stationary exciter field assembly (25), a rotating rectifier assembly (22). This Delco design eliminates collector rings, commutator brushes, brush holders, and brush mounting parts.

The compensator, usually located in and on the foot of the generator (see Figure 1, location "C" and Figure 3) senses load changes, and automatically varies the exciter field to keep the generator output within specified limits.

The rotating rectifier bridge, exciter armature, and rotating field assembly are mounted adjacent to each other on the main shaft. The shaft is supported at the exciter end by a ball bearing (16), and at the drive end by the fan and driving disc assembly (6), which in turn is bolted (see Figure 1, location "A") to the driving engine flywheel. The generator is rigidly mounted (see Figure 1, location "B") to the engine flywheel housing.

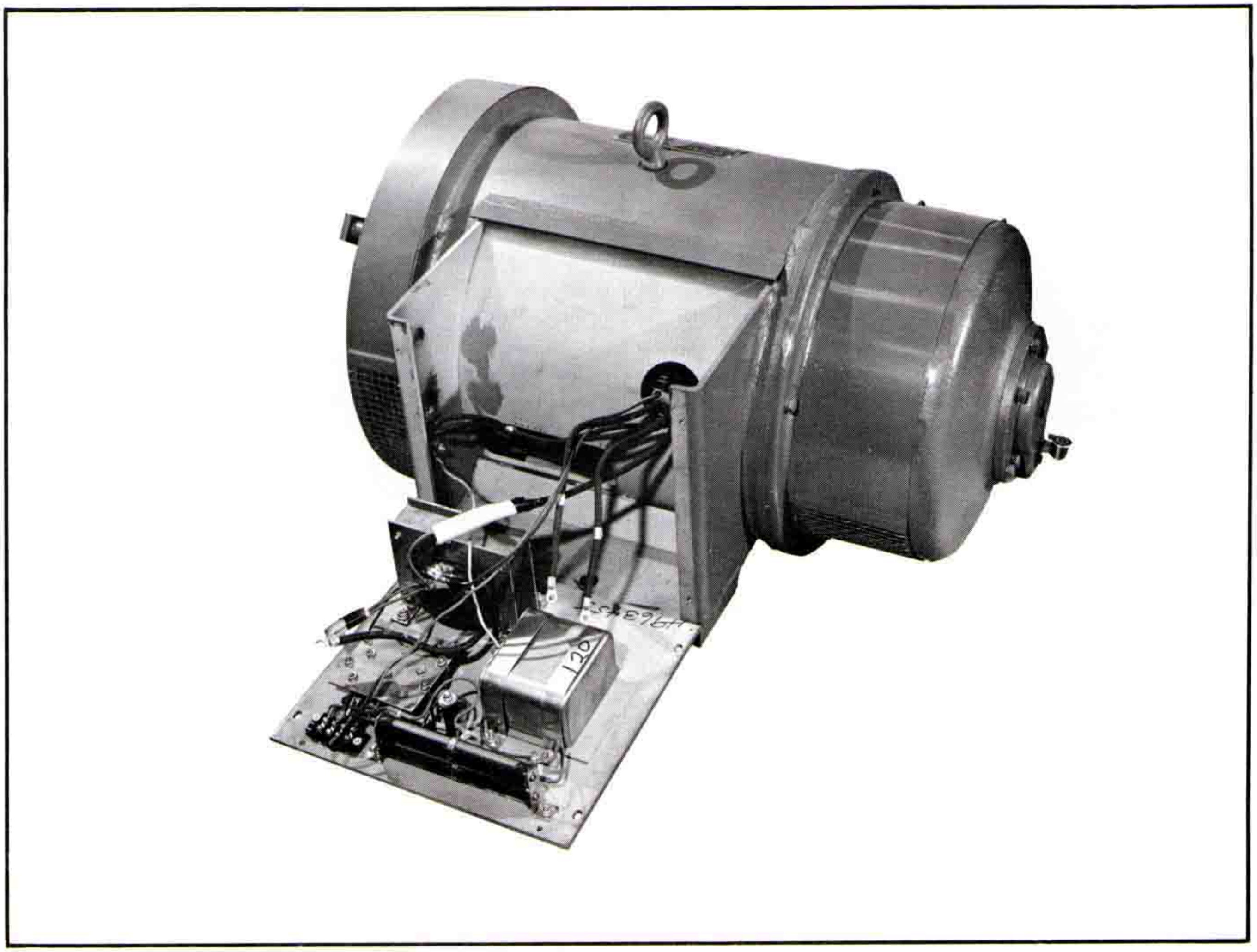


FIGURE 3. TYPICAL RAILROAD REFRIGERATION GENERATOR SHOWING COMPENSATOR LOCATION

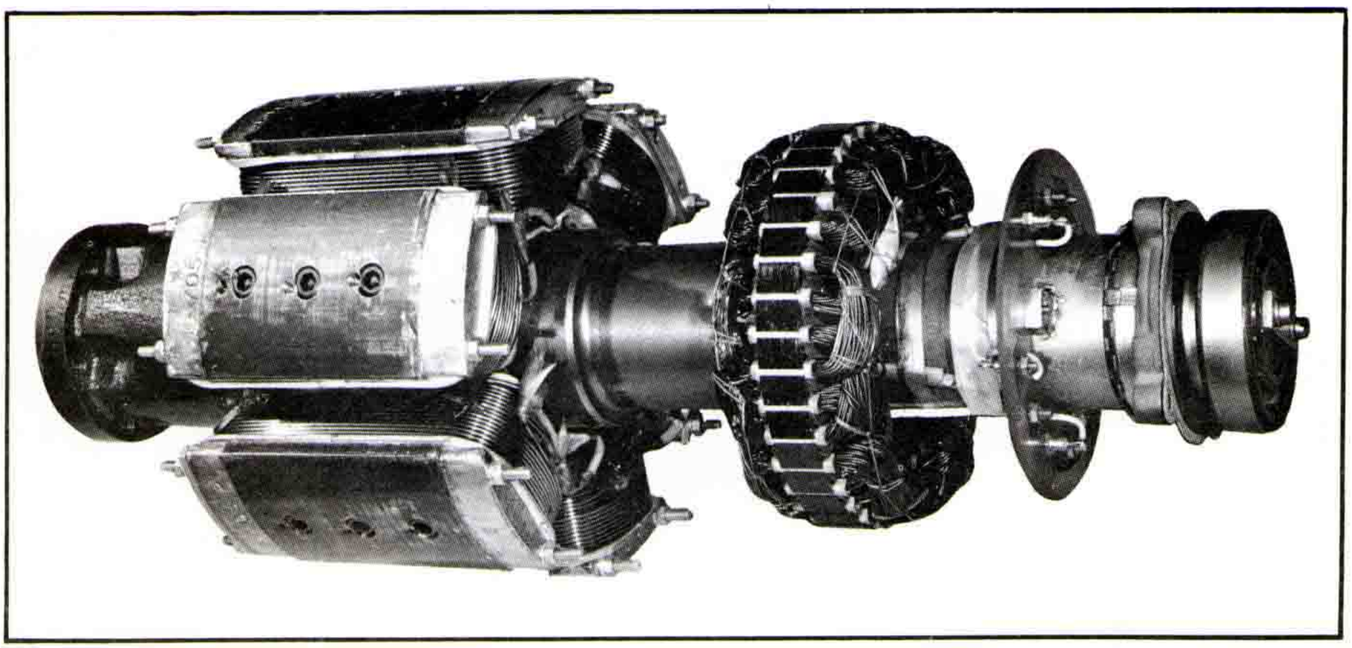


FIGURE 4. ROTATING FIELD ASSEMBLY, INCLUDING EXCITER ARMATURE, RECTIFIER PLATE ASSEMBLY AND BALL BEARING

On some specially designed refrigerator applications, the engine generator sets are designed for two speed operation. A higher speed, usually 1200 rpm, provides 60 cycle current, and is used when rapid "pull-down" is required. A lower speed, usually 800 rpm, provides 40 cycle current for maintaining preset car temperatures. Advantages of two speed operation are reduced engine wear, less noise, and considerable savings in fuel.

Rotating Field (Rotor) (See Figure 4): The rotating field (1) of the alternator consists of six individual coil and pole piece assemblies (3) bolted to the shaft. These coils are connected in series, and leads are brought out to the rectifier assembly (22). The rotating coils are energized by the rectified exciter output current.

Embedded in the face of the pole piece are copper or cast aluminum conductors forming the "Amortisseur" or damper windings which help to prevent "hunting" with sudden load applications.

Alternator Armature (Stator): The alternator armature (2) consists of coil groups embedded in the semi-enclosed slots of a laminated steel core. This stator and coil assembly is pressed into the main frame (26 and Figure 5) of the generator which is of fabricated steel construction. The complete assembly is usually identified as the frame, stator and coil assembly. Power leads are brought out into the large mounting foot of the frame.

Exciter Armature (See Figure 4): The exciter armature (12) is constructed of a conventional stackup of slotted steel laminations containing the coils, and keyed to the generator shaft. A slotted sleeve, welded to the exciter armature, separates it from the rotating rectifier assembly.

Rotating Rectifier Assembly (See Figure 6): The rotating rectifier assembly (22) is mounted on a similar sleeve which is keyed to the shaft. When the retaining locknut (19) is tightened, the exciter armature and the rotating rectifier assembly are held tightly, and have a positive drive through the key on the shaft.

The rotating rectifier assembly (22) typically consists of six rectifiers to form a full wave bridge. The bridge rectifies the exciter output and delivers direct current to the rotating field. Two types of rectifiers are used. In one type, called a forward polarity rectifier, the stud or base is positive. The reverse polarity rectifier has a stud or base that is negative. The two types of rectifiers are not interchangeable since polarity must be observed to avoid permanent damage.

Exciter Field Assembly (See Figure 7): The exciter field assembly (25) consists of a lamination assembly having twelve field coils connected in series. This assembly is bolted to the end frame (18).

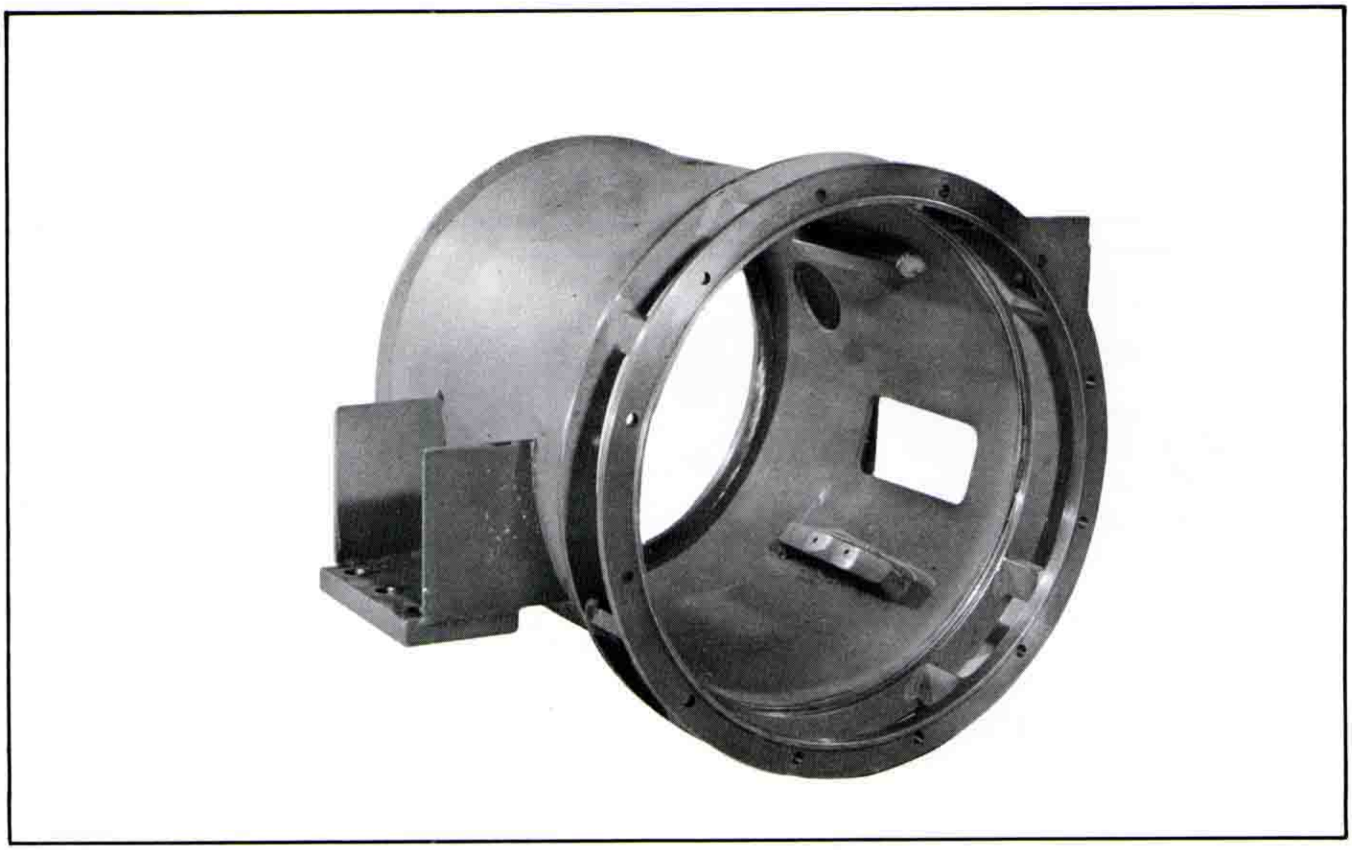


FIGURE 5. TYPICAL MAIN FRAME OF RAILROAD REFRIGERATION GENERATOR

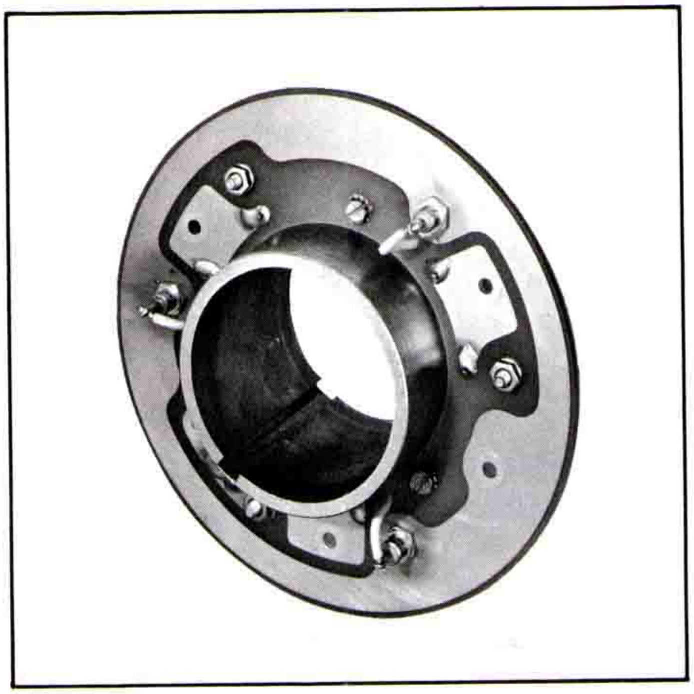


FIGURE 6. ROTATING RECTIFIER ASSEMBLY

FIGURE 7. EXCITER FIELD ASSEMBLY

End Frame: The end frame (18), in addition to furnishing support for the exciter field assembly (25), also incorporates the housing and oil or grease reservoir for the ball bearing (16).

Compensator: The compensator is a device which keeps the voltage output of a generator reasonably constant despite load changes by supplying excitation proportional to load current.

The Delco Railroad Refrigeration Generators have two types of compensators, single-speed and dual-speed. In a compensator circuit, the rectifier bridge is fed by the voltage sensing circuit and the current transformer secondary, with the outputs connected in series. See Figure 9 for the basic circuit and Figure 10 for a block diagram. In single speed designs, the capacitor is not used.

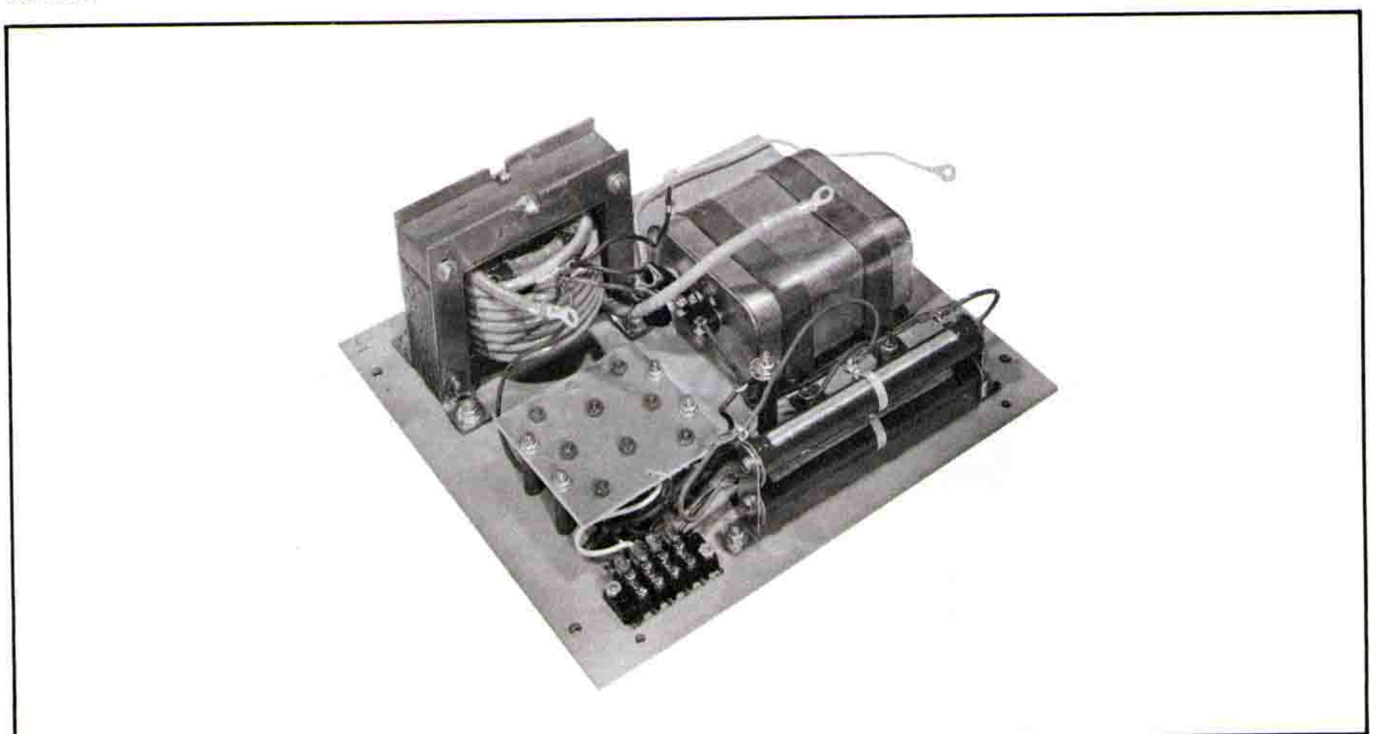


FIGURE 8. TYPICAL SERIES COMPENSATOR

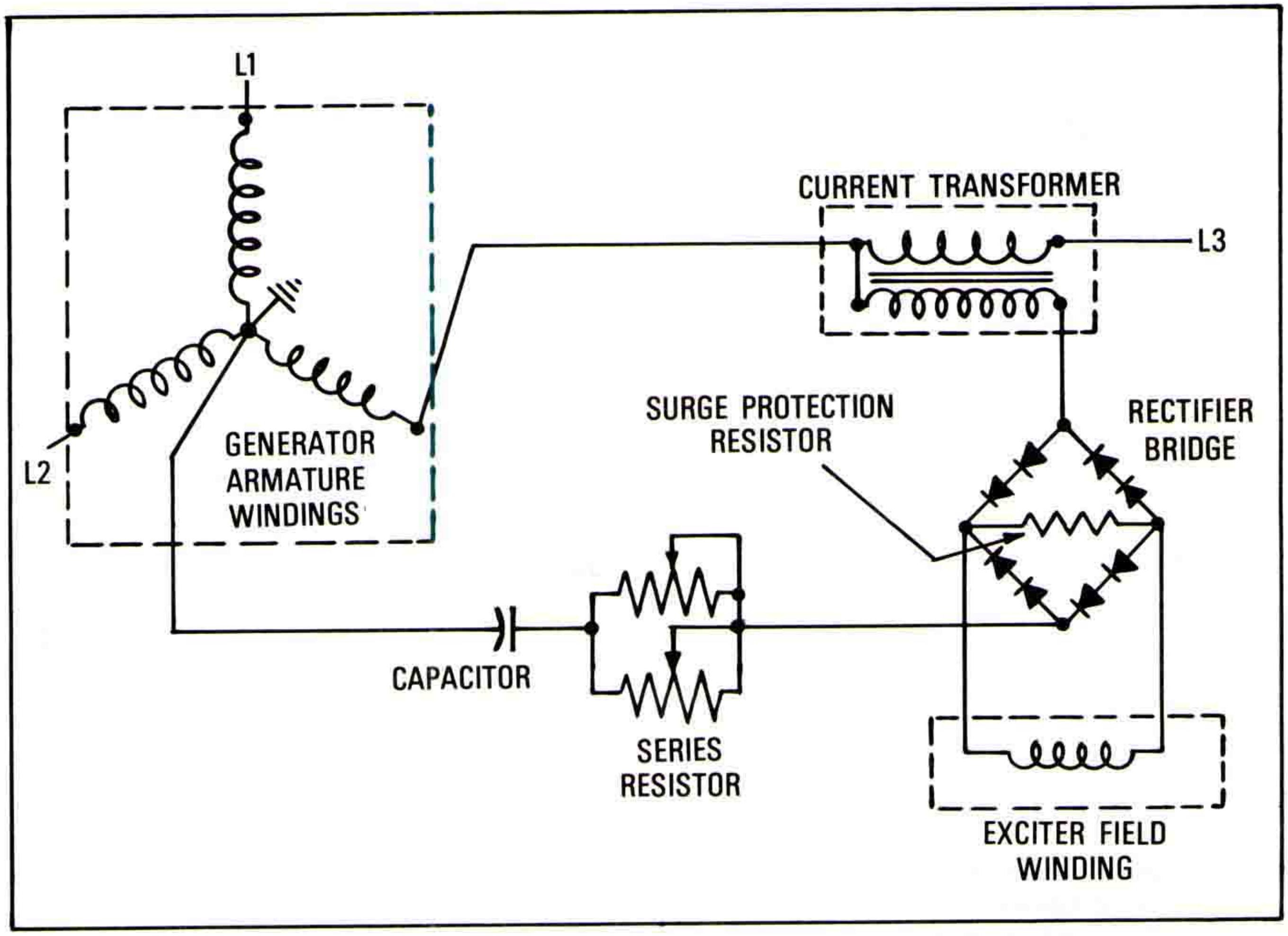


FIGURE 9. BASIC SERIES COMPENSATOR CIRCUIT

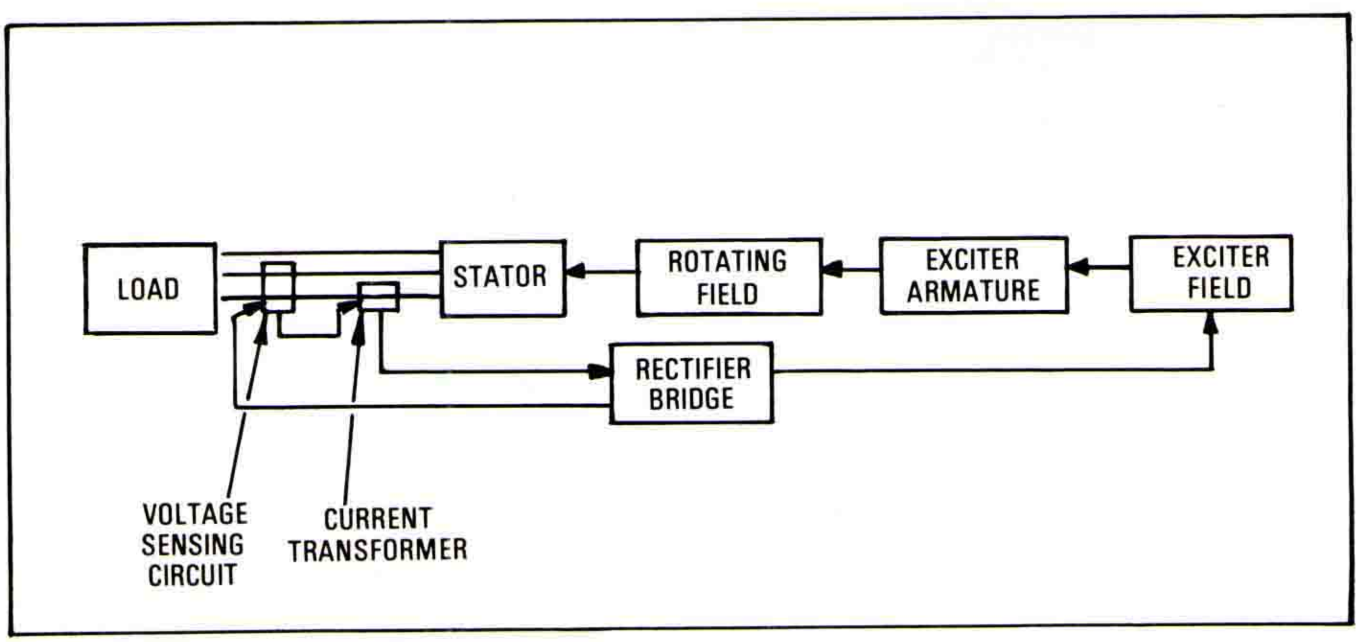


FIGURE 10. BLOCK DIAGRAM SHOWING SERIES COMPENSATOR CIRCUIT

STARTING AND RUNNING

Before Starting: The following procedure should be observed before starting the generator:

1. Make sure that circuit breaker or line switch is open, and any external power source is disconnected.
2. Be certain that the diesel engine cannot start during inspection, maintenance and testing except when authorized by repairman.
3. If interior of generator is dusty, blow out with dry air at low pressure (25 psi max).
4. If generator has oil-lubricated bearing, check oil level at gage (see Figure 1, location "D").

   WARNING: New generators with oil-lubricated bearings are shipped without oil. Be sure to add oil before running new generator.

Starting: After the above steps have been observed, the generator is ready to be started as follows:

1. Make sure all lines are clear of personnel, and that line switch or circuit breaker is open.
2. Start the driving engine and adjust speed as directed in the Engine Manual.
3. Close line switch or circuit breaker.
4. Recheck engine rpm.

   NOTE: Generator voltage is preset. If voltage is thought to be high or low, check engine rpm. If rpm is within limits, check line to line voltage with ac voltmeter.

Running: The following checks should be made after the unit is running:

1. Make sure generator is not loaded beyond nameplate rating.
2. If single phase loads are used, they must be equally divided among the three phases, and the current through any one terminal should not exceed the rated current of the machine. Single phase power at 57% of the three phase voltage is available by using L-O with L-1, L-2, or L-3.

MAINTENANCE

(Numbers in parentheses refer to Figure 1)

The Delco generator is so designed and constructed that it requires a minimum of maintenance. A few simple routine practices will greatly contribute to the useful life of the machine.

Safety Precautions:

1. Shut down system according to authorized instructions – such as the Engine Manual.
2. To protect personnel, take all necessary steps to be sure engine cannot be started unless authorized. For example, disconnect remote-starting circuits, starting battery, and mechanical starting equipment. Place red tags, or other warning markers on switches, leads, etc.
3. To protect personnel, take all necessary steps to be sure all lines are electrically "dead". For example, disconnect generator load, and external power lines feeding into system. Place red tags, or other markers on switches, leads, etc.

Cleaning: Keep the generator clean inside and out. A CLEAN MACHINE RUNS COOLER. Wipe all loose dirt from covers before removing. Blow out all loose dirt and dust from windings and rectifier assemblies occasionally with dry, low-pressure air (25 psi max). Remove greasy dirt with a dry cloth.

Lubrication: The generator requires lubrication at only point – the ball bearing (16). If the bearing is oil-lubricated, use same type of oil as is specified for engine crankcase. Maintain oil level to line of sight gage. DO NOT OVERFILL. After adding oil, recheck level after running several minutes. Check oil level every 300 hours; change oil every 6 months.

WARNING: Oil-lubricated generators are shipped without oil. Be sure to add oil before generator is run.

If bearing is grease lubricated, use Standard Oil of California SRI-2, its equivalent or successor.

To grease the generator, remove grease plug (13). Add grease until level is up to bottom of shaft.

As a general rule, a new generator with a grease-lubricated bearing will not need relubrication for 2 years after initial installation. After that, bearing should be lubricated annually. Unusually severe operating conditions require more frequent additions of grease. During an overhaul, the grease reservoir should be cleaned, and new grease added.

Adjustment for Series Compensator:

1. Be sure rpm is at nameplate rating. If necessary, adjust rpm to correct value according to instructions in engine manual.

   WARNING: Stop engine before and during adjustments described below.

2. If voltage is reasonably close at no load and full load, make small adjustments by moving both sliders on the two variable resistors the same distance.

3. If voltage is acceptable at no load and full load voltage is higher than desired, change to tap S2. These adjustments will change no load voltage, and will require readjustment as described in 2 above.

4. If full load voltage is lower than desired, change to tap ST1. These adjustments will change no load voltage, and will require readjustment as described in 2 above.

SERVICE

Minor Repair: Many repair or replacement operations can be performed without complete disassembly of the generator. For example, the end frame, ball bearing, rotating rectifier assembly, exciter armature, and the exciter field assembly, can be removed and inspected with generator in place.

See items marked with asterisk (*) in Major Repair Section for operations that can be performed without disassembly. Tests on components are in Trouble-Shooting Section.

In some designs, having seven bolts in the center section of the end frame, the bearing can be replaced without removing the end frame as shown in Fig. 11

1. Drain oil by unscrewing oil drain plug.

2. Remove seven bolts from center section of end frame.

3. Pull bearing housing straight out.

4. Remove the retaining screws, washers and plate.

5. Using a gear or bearing puller, withdraw bearing from shaft, and discard bearing.

6. To replace bearing, apply pressure to inner race until bearing presses bearing collar tightly against shoulder of shaft.

7. When reassembling unit remove end frame cover band in order to position bearing cap and gasket. Use new bearing cap gasket each time bearing housing is removed. To insure proper oil seal, be sure both gasket surfaces are clean.

8. Add oil to 3/16" from top of oiler.

Major Repair, Disassembly Required: Should the replacement of parts become necessary, the Delco generator may be serviced without special tools except for torque wrenches. However, REPAIRS SHOULD NOT BE ATTEMPTED BY ANYONE WHO IS NOT AN EXPERIENCED ELECTRICAL MECHANIC. The following procedures should be thoroughly studied before any repair operation is started. ALL SAFETY RULES MUST BE FOLLOWED.

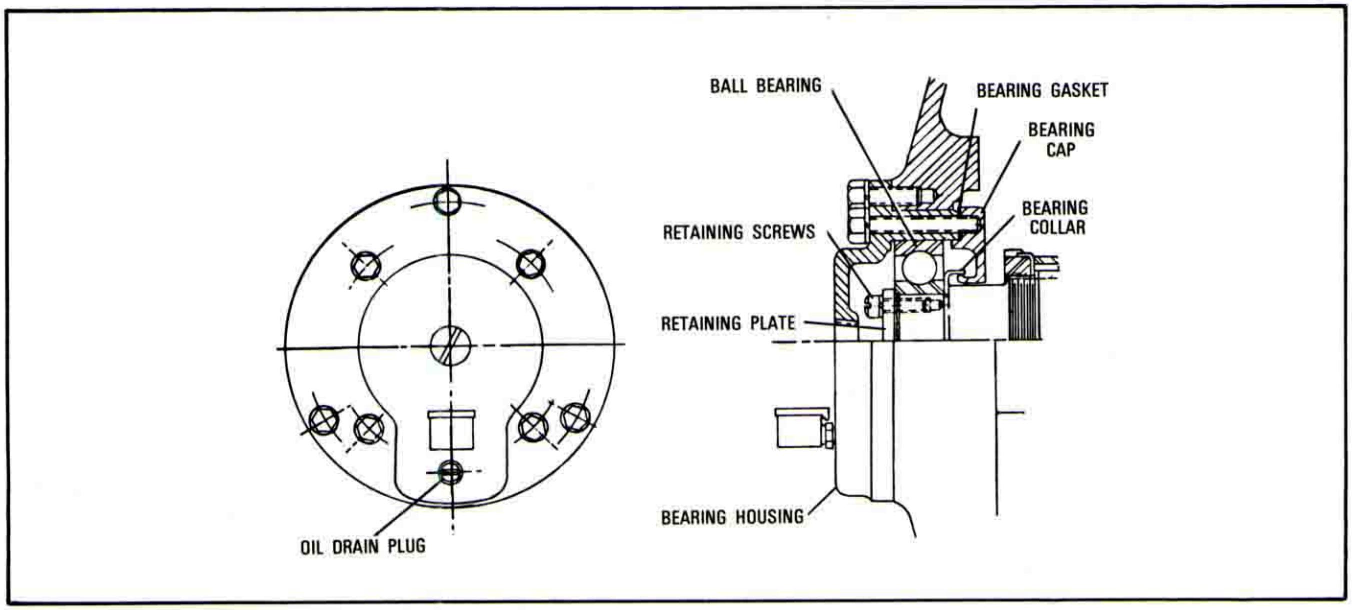


FIGURE 11. BEARING CARTRIDGE DESIGN

NOTE: Unless otherwise noted, reassembly is accomplished by reversing the disassembly procedure.

1. REMOVE GENERATOR FROM ENGINE: Using a chain hoist or equivalent tackle of adequate capacity, remove the generator from the engine as described below:

   a. Remove junction box cover plate (11) by removing attaching screws. Identify and remove all external leads.

   b. Remove generator foot-to-chassis mounting bolts.

   c. Attach chain hoist to eyebolt (28) of generator.

   CAUTION: Support rear end of engine before generator is detached.

   d. Remove fan cover mounting bolt (8), and lift off cover band (5).

   e. Remove the generator driving disc-to-engine flywheel mounting bolts. See location A, Figure 1.

   f. With chain hoist taut, remove the generator frame flange-to-engine flywheel housing mounting bolts. See location B, Figure 1.

   g. Using a pry at opposite sides of the generator, loosen the generator frame from engine flywheel housing.

   NOTE: Tenon on generator frame flange pilots inside engine flywheel housing; therefore, generator must be withdrawn in a straight line.

   h. When remounting generator to engine, align bolt holes of the generator driving disc with those of the engine flywheel before drawing up bolts on generator frame flange.

2. DISASSEMBLY OF GENERATOR: After removal from the engine, the generator should be disassembled in the order set forth below:

   a. Remove fan and driving disc assembly (6) by removing the mounting bolts (7).

   *b. If oil-lubricated, drain oil by removing drain plug.

   *c. Disconnect exciter leads at junction box and see that they are free to be withdrawn through frame.

   *d. Remove bearing cap or plate mounting bolts (15).

   *e. Remove end frame mounting bolts (23) and release end frame (18), by prying straight out.

   CAUTION: A chain hoist or some other method of support for the end frame is required to prevent damage to the exciter armature or rotating rectifier assembly by the exciter field assembly during this operation.

   *f. Detach exciter field assembly (25) by removing four mounting bolts and washers (24).

   *g. The ball bearing (16) should be removed as follows:

      (1) Remove the retaining screws and washers, or snap ring (14).

      (2) Using a gear or bearing puller, withdraw bearing from shaft, and discard bearing.

      (3) To replace bearing, apply pressure to inner race only.

   NOTE: If bearing is the sealed-shielded type be sure sealed side goes towards exciter to prevent grease from getting into exciter section.

   *h. Remove bearing collar, if used, and cap or plate (17).

   *i. Remove rotating rectifier assembly (22) and exciter armature (12), only if necessary, as follows:

      (1) Lift tang on lockwasher (20) and remove locknut (19).

      (2) Disconnect three leads from exciter armature and two leads from alternator field. Pull rotating rectifier assembly straight off shaft.

      (3) Remove exciter armature by pulling straight off of shaft.

   NOTE: When replacing the exciter armature, coat generator shaft with a light application of rust inhibiting grease.

   j. Remove rotating field and shaft assembly from stator as follows:

      (1) Obtain a 2 or 3 inch pipe about 6 feet in length.

      (2) Weld to one end, a flange with holes drilled to mate with those in the end of shaft. Use fan mounting bolts to secure in place. Attach hoist.

      (3) Support the bearing end of the shaft with a suitable leather or canvas sling attached to a hoist.

NOTE: Unless otherwise noted, reassembly is accomplished by reversing the disassembly procedure.

1. REMOVE GENERATOR FROM ENGINE: Using a chain hoist or equivalent tackle of adequate capacity, remove the generator from the engine as described below:

   a. Remove junction box cover plate (11) by removing attaching screws. Identify and remove all external leads.

   b. Remove generator foot-to-chassis mounting bolts.

   c. Attach chain hoist to eyebolt (28) of generator.

   CAUTION: Support rear end of engine before generator is detached.

   d. Remove fan cover mounting bolt (8), and lift off cover band (5).

   e. Remove the generator driving disc-to-engine flywheel mounting bolts. See location A, Figure 1.

   f. With chain hoist taut, remove the generator frame flange-to-engine flywheel housing mounting bolts. See location B, Figure 1.

   g. Using a pry at opposite sides of the generator, loosen the generator frame from engine flywheel housing.

   NOTE: Tenon on generator frame flange pilots inside engine flywheel housing; therefore, generator must be withdrawn in a straight line.

   h. When remounting generator to engine, align bolt holes of the generator driving disc with those of the engine flywheel before drawing up bolts on generator frame flange.

2. DISASSEMBLY OF GENERATOR: After removal from the engine, the generator should be disassembled in the order set forth below:

   a. Remove fan and driving disc assembly (6) by removing the mounting bolts (7).

   *b. If oil-lubricated, drain oil by removing drain plug.

   *c. Disconnect exciter leads at junction box and see that they are free to be withdrawn through frame.

   *d. Remove bearing cap or plate mounting bolts (15).

   *e. Remove end frame mounting bolts (23) and release end frame (18), by prying straight out.

CAUTION: A chain hoist or some other method of support for the end frame is required to prevent damage to the exciter armature or rotating rectifier assembly by the exciter field assembly during this operation.

   *f. Detach exciter field assembly (25) by removing four mounting bolts and washers (24).

   *g. The ball bearing (16) should be removed as follows:

      (1) Remove the retaining screws and washers, or snap ring (14).

      (2) Using a gear or bearing puller, withdraw bearing from shaft, and discard bearing.

      (3) To replace bearing, apply pressure to inner race only.

NOTE: If bearing is the sealed-shielded type be sure sealed side goes towards exciter to prevent grease from getting into exciter section.

   *h. Remove bearing collar, if used, and cap or plate (17).

   *i. Remove rotating rectifier assembly (22) and exciter armature (12), only if necessary, as follows:

      (1) Lift tang on lockwasher (20) and remove locknut (19).

      (2) Disconnect three leads from exciter armature and two leads from alternator field. Pull rotating rectifier assembly straight off shaft.

      (3) Remove exciter armature by pulling straight off of shaft.

NOTE: When replacing the exciter armature, coat generator shaft with a light application of rust inhibiting grease.

   j. Remove rotating field and shaft assembly from stator as follows:

      (1) Obtain a 2 or 3 inch pipe about 6 feet in length.

      (2) Weld to one end, a flange with holes drilled to mate with those in the end of shaft. Use fan mounting bolts to secure in place. Attach hoist.

      (3) Support the bearing end of the shaft with a suitable leather or canvas sling attached to a hoist.

(4) Hoist the pipe just enough to support the weight of the rotating field, and slide out of the stator, **using care not to damage the windings.**

(5) Use the same method to replace the rotating field.

k. To remove rotating field coils (3), clean the insulating varnish from the wrench sockets of the filed coil mounting bolts (27). Then, using a bar with a blunt or slightly rounded end, drive back staked laminations from bolt heads before attempting to remove bolts.

When remounting coils, pull bolts down tight (5/8 bolts to 250 ft-lbs, 7/16 bolts to 80 ft-lbs, 3/8 bolts to 35 ft-lbs). Stake or tack-weld bolt heads to laminations.

CAUTION: If new coils are installed, the rotating field and shaft assembly must be dynamically balanced before reassembling.

INITIAL TROUBLE-SHOOTING TESTS

1. Find out exact nature of trouble – low-voltage, high-voltage, etc., – before going to proper trouble-shooting chart. Follow steps 2, 3, and 4.

2. Follow safety rules.

   a. Shut down system according to authorized instructions – such as, the engine manual.

   b. To protect personnel, take all necessary steps to be sure engine can not be started unless authorized. For example, disconnect remote-starting circuits, starting battery, and mechanical starting equipment. Place red tags, or other warning markers on switches, leads, etc.

   c. To protect personnel, take all necessary steps to be sure all lines are electrically "dead". For example, disconnect generator load, and external power lines feeding into system. Place red tags, or other warning markers on switches, leads, etc.

   d. Be sure engine is not running during testing of components.

3. Check circuit against connection diagrams.

4. Visually inspect circuits and components of generator and compensator.

   a. Remove covers from fan intake end, and from feet.

   b. Look for broken wires or connections.

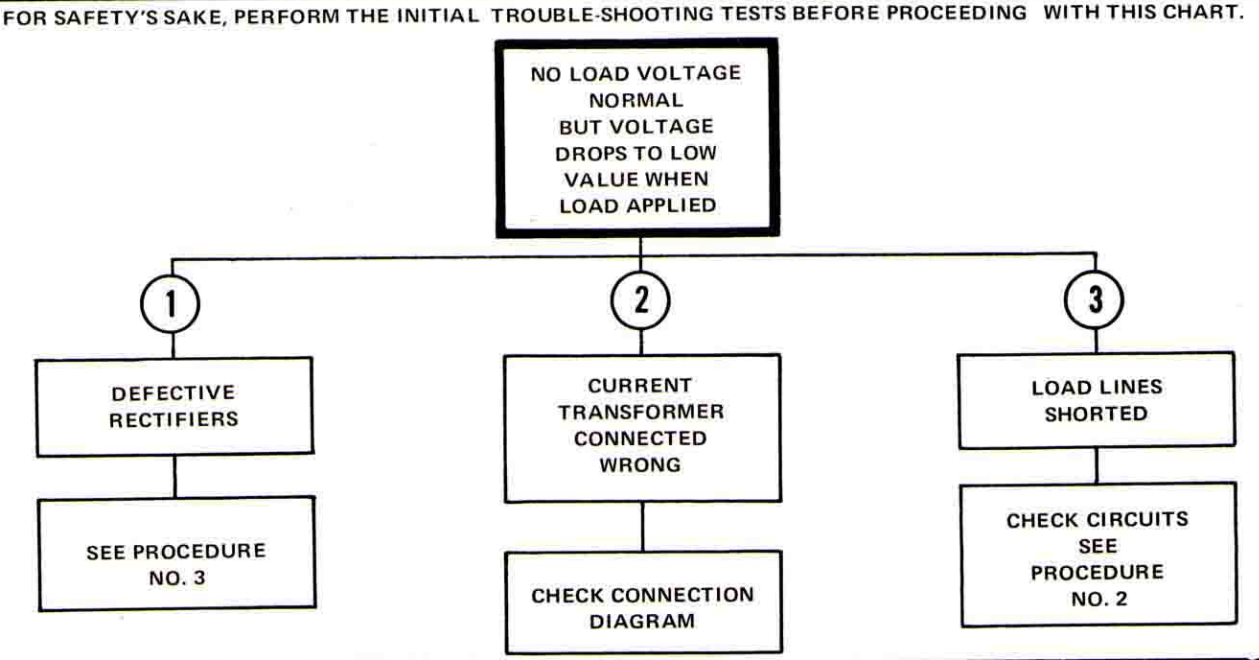
   c. With light pressure, gently move wires and lugs. Check for loose wires and connections.

   d. Look for burned spots on coils, and for bare wires which may be touching ground, or other bare parts.

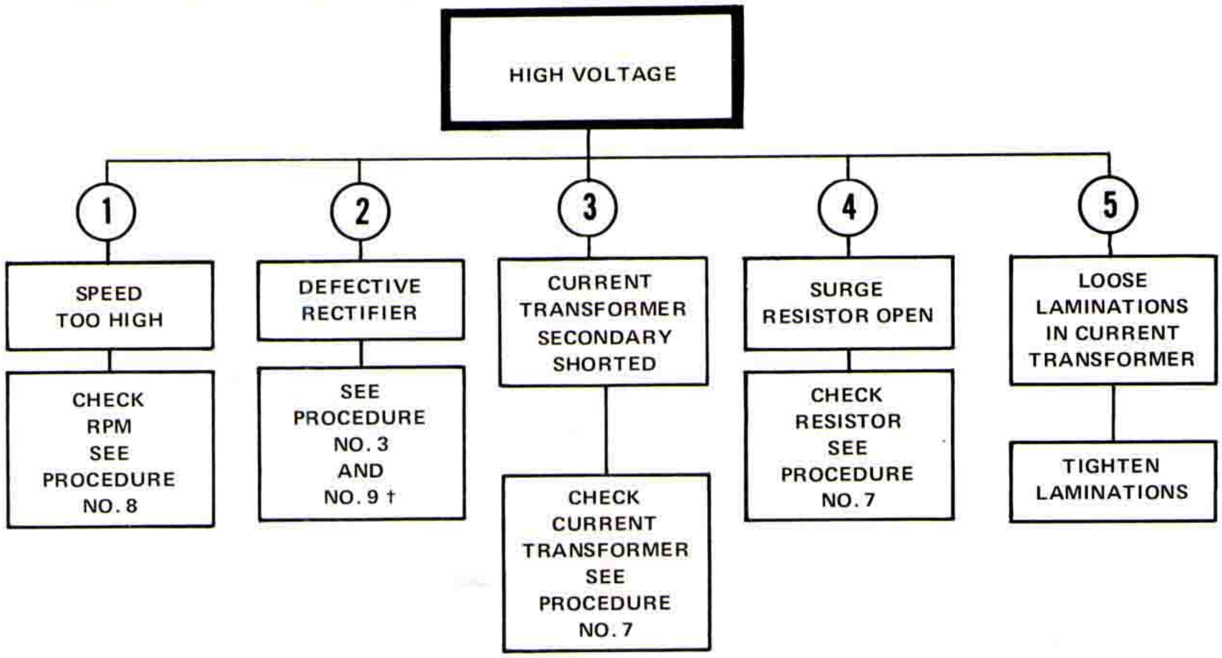
   e. Look for loose nuts and bolts, loose coils or laminations.

If trouble is not located, proceed to the 'trouble-shooting' charts on the following pages.

FOR SAFETY'S SAKE, PERFORM THE INITIAL TROUBLE-SHOOTING TESTS BEFORE PROCEEDING WITH THIS CHART.

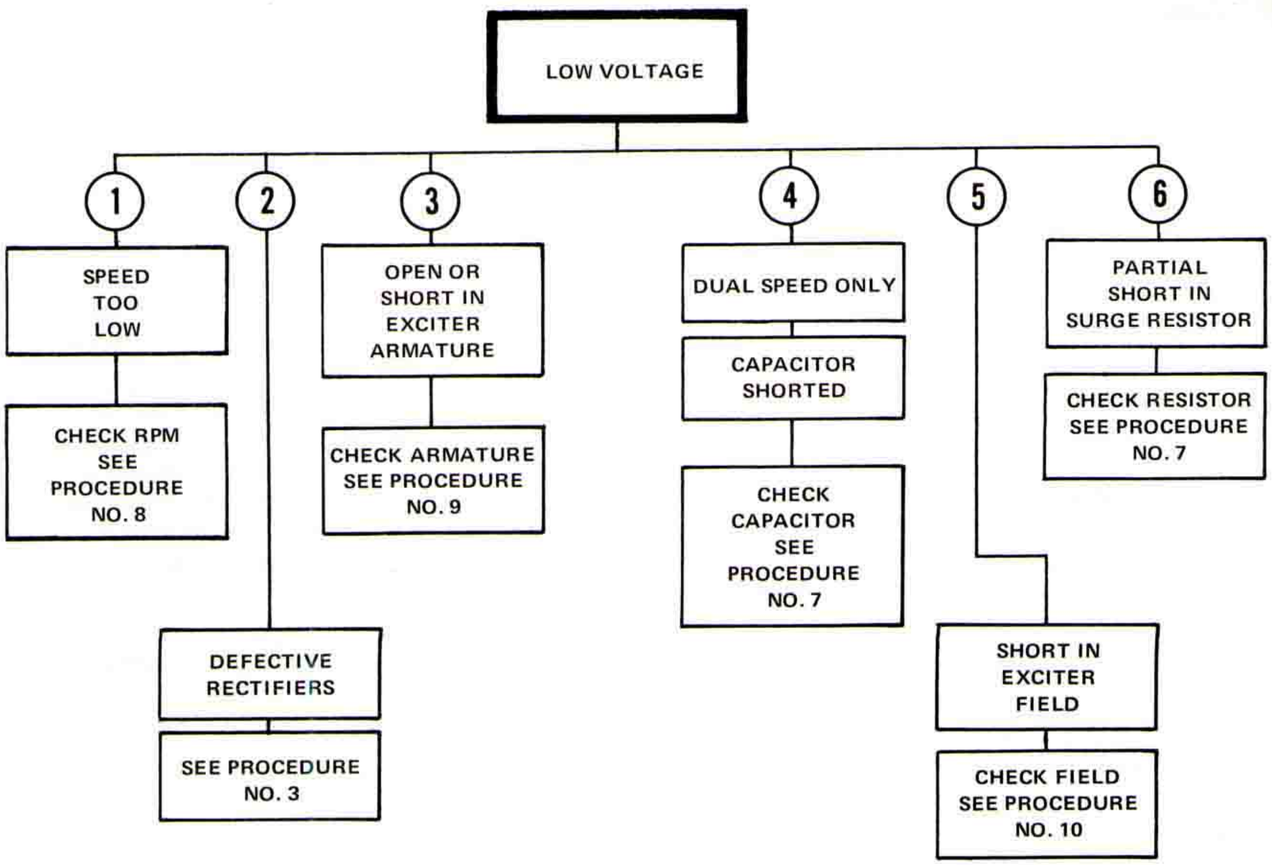


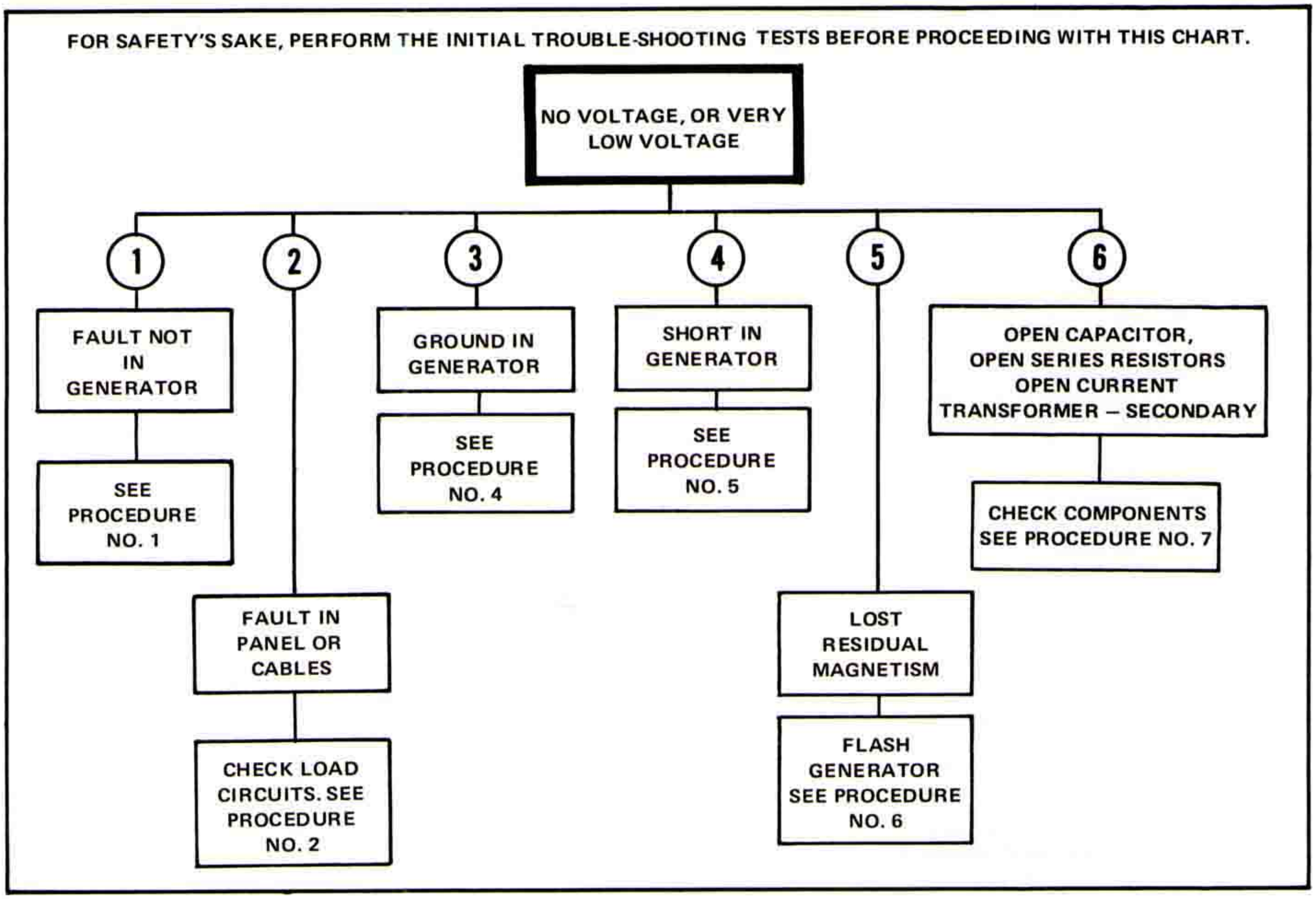
FOR SAFETY'S SAKE, PERFORM THE INITIAL TROUBLE-SHOOTING TESTS BEFORE PROCEEDING WITH THIS CHART.



†EXCITER ARMATURE COULD ALSO BE OPEN AND CAUSE HIGH VOLTAGE.

FOR SAFETY'S SAKE, PERFORM THE INITIAL TROUBLE-SHOOTING TESTS BEFORE PROCEEDING WITH THIS CHART.





PROCEDURE NO. 1

1. Check ac output voltage.

   a. Pull main fuses.

   b. Start engine, bring up to speed.

   c. Check output voltage with nameplate rating. If voltage is normal, go to Procedure No. 2. If voltage is abnormal, check generator according to Procedure No. 3.

   d. Stop engine. Identify and check all fuses for opens.

PROCEDURE NO. 2

1. Disconnect car plug. Start engine and check voltage at part of plug still connected to generator. If normal voltage does not appear, shut down engine. Check cable still connected to generator for shorts, opens or grounds. If normal voltage appears, the cable connected to the generator is in working order, but the section of cable connected to the panel may be at fault. With engine shut down, check this section of cable for opens, grounds or shorts. Repair as required.

2. Check refrigeration controls and all components on the load side of the fuse blocks for shorts and grounds as follows:

   a. Remove all but main fuses.

   b. Starting with motor fuses, replace one fuse set. Start engine, and check line to line voltage in circuit under test.

      NOTE: Allow sufficient time for time delay circuits to engage.

      If the voltage is normal, then the tested circuit is presumably not grounded or shorted. If normal voltage does not appear, shut down engine. Locate and repair fault.

   c. Remove tested fuse set, and insert another fuse set. Start engine, and check voltage. Shut down engine and locate and repair faults as required.

   d. Repeat step c until all fused circuits are cleared of faults.

PROCEDURE NO. 3

Rectifier Trouble-Shooting: The precise evaluation of a rectifier requires laboratory type equipment that is seldom available for field testing. For service use, we suggest three possible tests requiring minimum equipment.

Method A. The most reliable of the three tests is a power test using 110 volts ac and putting the rectifier under load. This test requires a 110 volt ac source, a shorting switch, one 110 volt neon bulb with split electrodes (General Electric NE-34 or equivalent), and a two-pole line safety switch. See Figure 12 for the circuit. Connect rectifier in the test circuit and close two-pole switch. If the bulb lights, and one half of the neon bulb glows, the rectifier is good. If the bulb lights and both halves of neon bulb glow, the rectifier is bad.

As a confirming test, close the rectifier shorting switch. If the rectifier is good, the lamp will get noticeably brighter and the neon bulb will glow in both sections. If the rectifier is bad, the bulb will stay at the same intensity, and neon bulb will glow in both section regardless of position of shorting switch. This test cannot be performed with the rectifier in the circuit.

Method B. The second test uses a continuity tester made of a 3-6 volt dc source and a flashlight bulb. If the test prods of this type of tester are placed across a good rectifier, the light will visibly glow, (rectifier conducting direction) and when the test prods are reversed the light will be dark (rectifier blocking direction). If a rectifier is shorted, the lamp will glow in both positions of test prods. If a rectifier is open, the lamp will be dark in both positions of the test prods. This test cannot be performed with the rectifier in the circuit.

Method C. The third test is to use an ohmmeter across a rectifier or rectifier bridge. The resistance in one position of the test prods across the rectifiers must be very high, and very low in the opposite position if the rectifier is good. An open rectifier will read very high in both positions. A shorted rectifier will read very low in both positions. In many cases this is the best method, since it can be used with the rectifier in the circuit. However this test requires experience to obtain reliable data, since the results are sometimes misleading. If the ohmmeter gives doubtful indications, or if rectifiers which have passed the ohmmeter test do not seem to work properly, then the repairman must go to a more reliable test.

Use the most reliable testing method available. See Methods A, B, and C. Shut down engine.

1. Rotating rectifiers on shaft:

   a. Disconnect either alternator field lead from the rectifier plate. Be careful to avoid damage to rectifiers.

   b. Connect or touch one test prod to the outer ring on one side of the rectifier plate. Touch the other test prod to any terminal lug of a rectifier on the same side.

   NOTE: If Methods "B" or "C" are used, be sure to reverse test prods.

   c. If the test shows "good", then all the rectifiers on that side of the plate are good. If the test shows "bad" or "doubtful", then each rectifier must be disconnected and tested separately.

   d. Connect or touch test lead to outer ring on the other side of the plate and touch any terminal lug of a rectifier on the same side. Test as in step "c" above.

2. Compensator rectifiers in generator feet. Before testing compensator rectifiers it is necessary to isolate the rectifier bridge. Shut down engine.

   a. Disconnect one surge resistor lead at terminal block. Trace lead back to resistor to be certain correct lead has been selected.

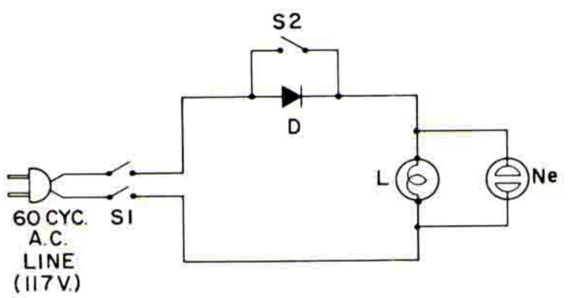
   b. Disconnect the following leads from the terminal strip.
   D4- (or D4, or red lead to bridge) from terminal.
   A4 (or white lead to bridge)from terminal.
   D2+ (or D2, or black lead to bridge) from terminal.
   A2 (or green lead to bridge)from terminal.

   c. Using the most reliable method available, (see Methods A, B, and C), check the following pairs of leads:

   See step "b" above for color codes.

   A2 and D2+ (or D2)
   D2+ (or D2) and A4
   A4 and D4- (or D4)
   D4- (D4) and A2

   d. If any of the four readings are "doubtful", or "bad", replace entire bridge assembly or remove the bridge and disconnect each rectifier from circuit. Check each rectifier by most reliable test method available.



SI - D.P.S.T. LINE SWITCH (NORMALLY OFF) PUSH AND HOLD TO KEEP CIRCUIT ENERGIZED.

S2 - S.P.S.T. (NORMALLY OPEN - PUSH AND HOLD FOR CONFIRMATION TEST) SWITCH.

L - LAMP FOR LOAD AND INDICATOR (SUGGEST 120 VOLT - 75 TO 100 W.)

Ne - NEON LAMP (SUGGEST G.E. Ne 34 OR EQUIV.)

D - DIODE (RECTIFIER) UNDERGOING TEST.

OPERATION :—

SI CLOSED AND S2 OPEN—LAMP BURNS WITH REDUCED BRILLIANCE AND NEON LAMP GLOWS ON ONE PLATE IF DIODE, D, IS GOOD.

CONFIRMING TEST—
SI AND S2 CLOSED—LAMP BURNS WITH FULL BRILLIANCE AND BOTH PLATES OF NEON LAMP GLOW.

FIGURE 12. POWER TESTER FOR SILICON RECTIFIERS

PROCEDURE NO. 4

1. Check connection diagrams for grounded neutral points, or grounded secondary of current transformer. Detach all grounded leads. Use ohmmeter to check for grounds. Locate and repair.

2. Check insulation resistance with a "Megger" or any insulation testing instrument employing a dc potential of 500 volts. Follow the procedure indicated below:

   NOTE: To prevent possible damage to the regulator and rotating rectifiers during this test, they should be isolated as follows:

   a. Place jumper across outer rings on each side of rectifier plate. Place additional jumper from either side to any one of three exciter armature leads at their termination on the rotating rectifier plate.

   b. Place jumper across four terminals on compensator terminal board.

   c. Detach, identify, and insulate lugs on all leads that are normally grounded. See connection diagrams.

   d. Short-circuit secondary of current transformer.

   e. Attach one "Megger", or equivalent, lead to frame, and the other to ac power lead, and measure the insulation resistance.

   f. Check the insulation resistance from the frame to the exciter field by removing both leads to the exciter field. One lead will be marked F+, F3 or F3+, or will be a black lead. The other lead will be marked F-, F4, or F4-, or will be a red lead. Make resistance measurement between either detached lead and frame. Trace lead to be sure correct lead has been selected.

   g. Check the insulation resistance from the shaft to either outer ring of the plate assembly.

   h. The minimum insulation resistance should be 1.3 megohms; if it is lower, the generator requires attention. If it is dirty, it should be cleaned, if it is wet it should be dried out, if it is grounded, the ground should be located and repaired.

   NOTE: The insulation resistance should be measured periodically and results recorded. Any sudden change in resistance requires immediate attention.

   i. Restore the circuit, and remove jumpers if insulation checks are in limits.

PROCEDURE NO. 5

1. Make sure Procedure No. 3 clears rectifier.

2. Disconnect black (+) and red (-) field leads going to exciter field.

3. Connect (+) lead of 12 volt battery to black (+) lead, and (-) lead of battery to red (-) lead. Insulate connections.

4. Start engine, and measure line-to-line voltages.

5. If line-to-line voltages are balanced — within 2-3 volts — the generator armature (stator) can be assumed to be free of shorts or opens. Record all three voltages.

6. See Generator Appendix for values of specific voltages on this test (Step 5), or confirm values with factory.

7. If dc voltage (see Procedure No. 13) on plates is normal, but ac output voltage is not normal, check rotating field (see Procedure No. 11) or stator (see Procedure No. 12.

8. This test — step 1-5 — may have restored lost residual. Restore circuit and check if generator is operational. If not, see Procedure 6.

PROCEDURE NO. 6

1. Insert a protective resistor — 25 watt, 12 ohm on 12 volt battery, or 25 watt, 24 ohm on 24 volt battery — in one battery lead.

2. Start engine. Touch (+) lead of battery to terminal on compensator terminal board having black leads. At the same time, touch (-) lead to terminal having red leads. Hold for (1) second. Watch ac voltage during flashing. If voltage builds up, and after removing battery leads, voltage collapses, go to Procedure No. 7.

PROCEDURE NO. 7

Disconnect component from circuit. Use ohmmeter to check for opens or shorts on current transformer and resistor. If correct value is not known, check identical part in a working system. To check capacitor, substitute new capacitor, or, with a volt-ohmmeter on X100 or X1000 resistance scale, place probes across capacitor. If needle goes over to zero ohms and remains, capacitor is shorted, if needle does not move, capacitor is probably open, or if needle swings to right and then slowly returns to left, capacitor is probably good. Another check may be made as follows: with engine running, observe ac voltmeter. Short capacitor with insulated screw driver. If voltage goes down, capacitor is good.

PROCEDURE NO. 8

Use a recently calibrated tachometer and check rpm or check frequency with reed-type frequency meter.

PROCEDURE NO. 9

Exciter Armature: An open or shorted armature may be detected by measuring the phase-to-phase resistance at the armature terminals. Each phase should be within limits. (See Resistance Limits Table in Generator Appendix.) Detach all three leads at the rectifier plate.

NOTE: An open armature may indicate an overload condition which should be investigated.

Check insulation resistance from winding to armature laminations. If a "ground" is indicated and is not located and repaired, the armature must be replaced.

CAUTION: The insulation test must be done with three phase-to-phase leads disconnected from rectifier plate, otherwise the rectifiers could be damaged.

PROCEDURE NO. 10

Exciter Field Coils: If a shorted or open-circuited field coil is suspected, check the resistance with a resistance bridge. (See Resistance Limits Table in Generator Appendix.) (Values may be too low to obtain accurate ohmmeter readings.)

Detach one lead, such as F+, and measure resistance between detached lead and its corresponding terminal, such as F-.

The resistance measured should include the total field plus the leads. Examine the insulation carefully. Tape and varnish any breaks.

PROCEDURE NO. 11

A short or open circuit in the rotating field coils may be detected by measuring the total resistance of the field. Detach both alternator field leads as they terminate on the rotating rectifier plate. (See Resistance Limits Table.) While leads are detached, check insulation resistance.

NOTE: If new field coil assemblies are installed, the rotating field and shaft assembly must be dynamically balanced before reassembling.

PROCEDURE NO. 12

1. Disconnect ac output lines from load.
2. Measure line-to-line resistance of output leads.
3. All three readings must be within limits, see Generator Appendix for values.

PROCEDURE NO. 13

1. Remove cover band from exciter end of generator.
2. Fasten copper-beryllium strips (preferred), or copper straps, to insulated test prods of the leads of a dc voltmeter (0-50 volts).
3. With solvent remove varnish from outer rings on each side of rotating rectifier plate.
4. Start engine, and, using extreme care, place test probes on outer rings of rotating rectifier plate. The side next to the exciter is positive.

   WARNING:

   a. Wear eye protection.

   b. Use extreme care to be sure probes do not touch each other, or other parts of rectifier plate.

   c. Angle probes away from direction of rotation.

5. Read voltage and compare with voltage given in Generator Appendix or confirm with factory.

   If voltage is abnormal, the exciter or rectifier plate assembly is defective.

   Recheck rectifiers following Procedure No. 3, the exciter armature following Procedure No. 9, the exciter field following Procedure No. 10. It is also possible that the rotating field is defective. See Procedure No. 11.

'E-TRONIC 200'

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR MODEL E-200 SCR TYPE AUTOMATIC BATTERY CHARGER

TECHNICAL CHARACTERISTICS

INPUT:	90-130, 140-230 Volt, 40/60 Hertz, 1 Phase
OUTPUT:	7.5 Ampere 12 Volt DC, Float Voltage 14.0 Volt, .1 Ampere Trickle
REGULATION:	Float Voltage to stay constant within 1%
PROTECTION:	Short Circuit, Open Circuit and Reverse Polarity
AMBIENT TEMPERATURE:	-40^{o}F to $+160^{o}$F
INPUT CONNECTION:	Two Spade Connectors on Terminal Board marked 1 & 2
OUTPUT CONNECTION:	Two Spade Connectors on Terminal Board marked 5 (+) and 6 (-)
CASE:	All Aluminum Case consisting of Bronze Anodized Base and Black Anodized Cover
VIBRATION AND SHOCK:	Designed to withstand Vibration and Shocks of 15G- Longitudinally, 10G- Transversely, and 5G- Vertically
DIMENSIONS:	4 5/8" High x 2 ¼" Wide x 6 ½" Deep
NET WEIGHT:	7 pounds
SHIPPING WEIGHT:	9 pounds
PILOT LIGHT:	Pilot Light Indicates Battery Fully Charged and when Connecting to Batteries Indicates Reverse Polarity
MODIFICATIONS AVAILABLE:	AC Switch, Ammeter, Voltmeter, AC Leads, Or DC Leads, Without Cabinet, Ambient Temperature Compensated

MODEL E-TRONIC 200 PRINCIPAL DIMENSIONS

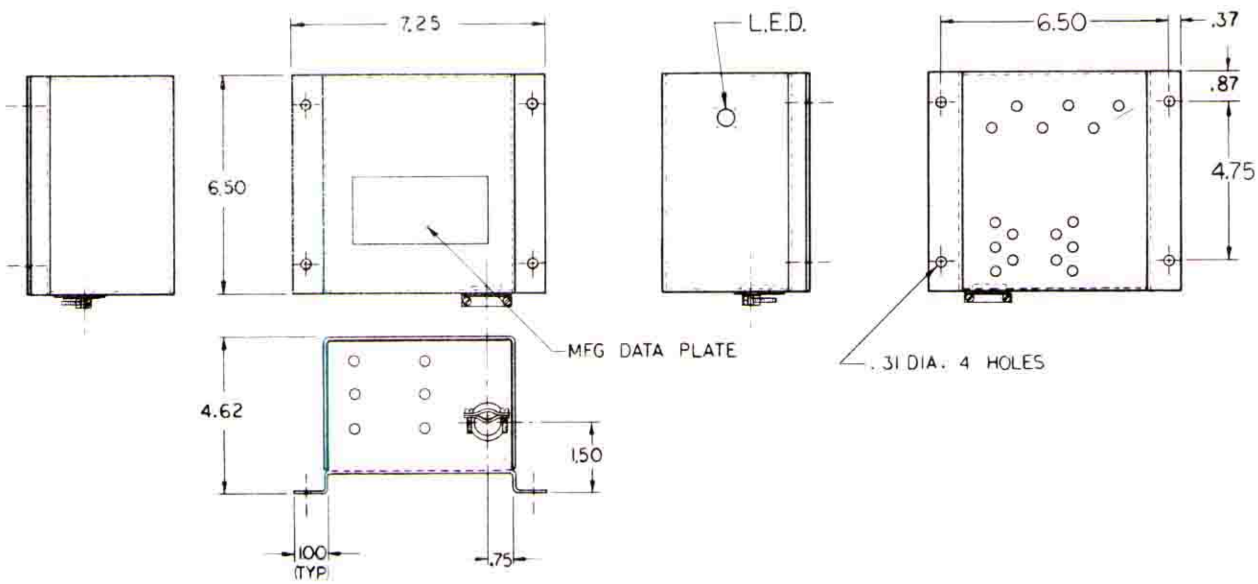
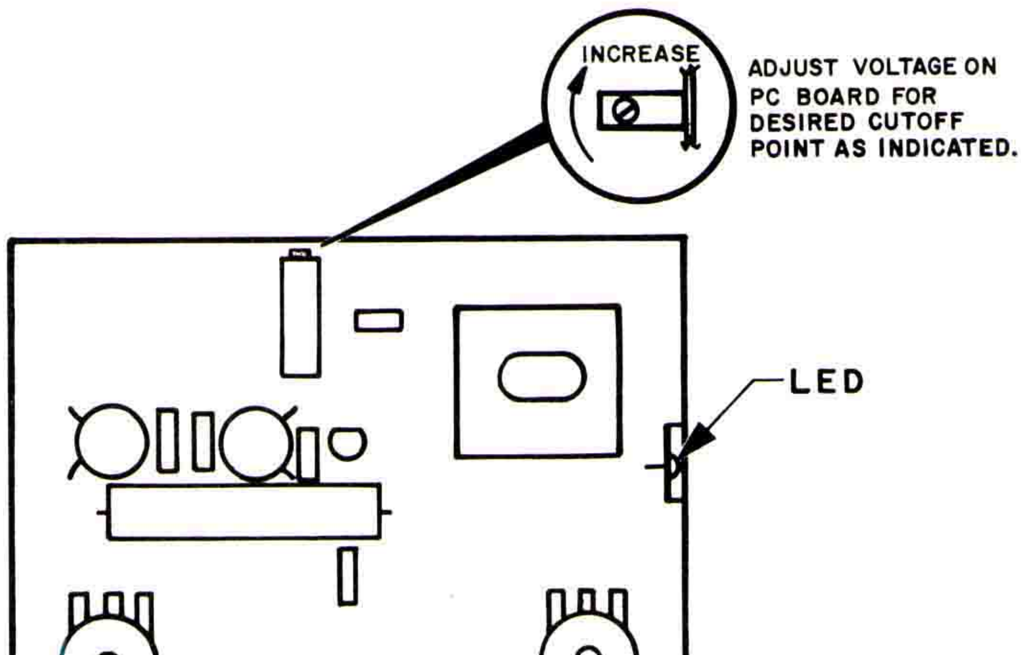


Figure 1



PRINTED CIRCUIT BOARD

Figure 2

DESCRIPTION

The E-Tronic 200 Charger is designed for continuous operation between 90-130/140-230 volt, 40 hertz, to 230 volt, 60 hertz, 1 phase AC. It is suited to operate from a one speed engine generator with a 230 volt, 60 hertz output; or a 2 speed engine generator with a 153 volt, 40 hertz; and a 230 volt, 60 hertz output. It will charge a discharged battery at 7.5 amperes with a 230 volt, 60 hertz input. With any input voltage, the float voltage across a fully charged battery is automatically maintained through the use of a solid state voltage compensator. The float voltage is factory set at 14.0 volts. It may be ordered or field adjusted to another value if desired.

THEORY OF OPERATION

The E-Tronic 200 Battery Charger is an S.C.R. type device utilizing the relaxation oscillator principle.

The circuit will not function unless the battery to be charged is connected with proper polarity. The battery voltage controls the charger and when the battery is fully charged, the charger will not supply current to the battery.

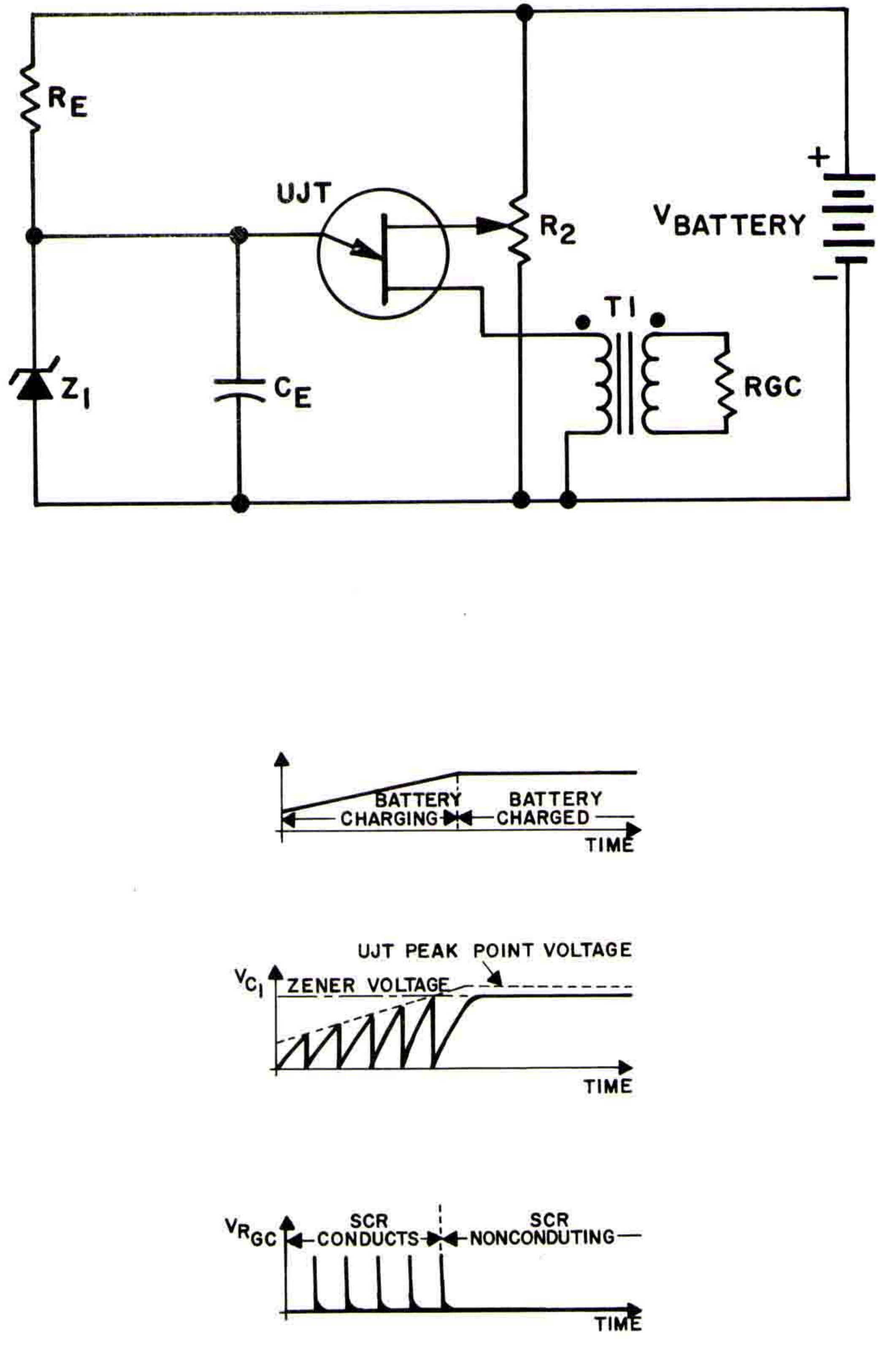
BASIC CIRCUIT OPERATION

The battery charging current is obtained through the S.C.R. when it is triggered into the conducting state by the U.J.T. (unijunction transistor) relaxation oscillator is only activated when the battery voltage is low.
The firing point of the U.J.T. (unijunction transistor) is a ratio of battery voltage and resistance as compared to the Z1 (Zener diode) voltage, setting R2 controls the point at which the charger tapers to trickle rate.

The relaxation oscillator and the waveforms associated with the operation is shown in Figure 3 (The voltage increase will tend to change the pulse repetition rate, but this is not important, since the battery will tend to average the output).

* Ambient temperature compensation is accomplished by a Thermistor being added in series with R2 control which changes the cutoff point in relation to ambient temperature.

* Model E200TC Only



WAVEFORMS ASSOCIATED WITH BATTERY CHARGER OPERATION

Figure 3

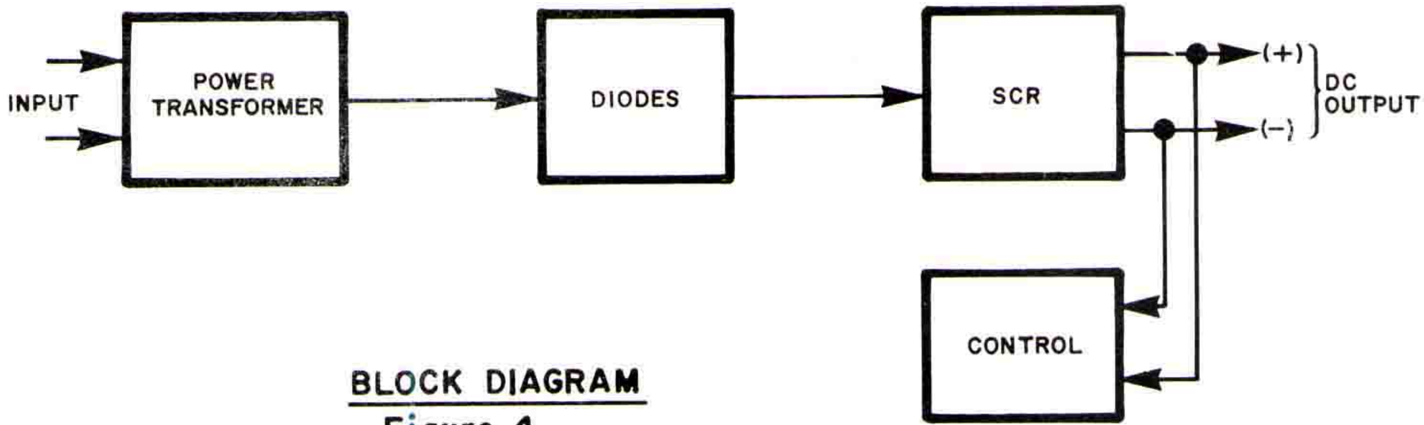
REPLACEABLE PARTS LIST

Qty.	Description	Mfg. Number	Sym.
1	Transformer	EC100-D-029-3	T1
1	Lens	EC7261-4	
1	Box	EC7261-2-1	
1	Cover	EC7261-2-2	
1	Printed Circuit Board Assembly	EC212-C-144	PC
1	Edge Connector	5012A20	EC
1	Squeeze Connector	3302	
1	Terminal Board	2065PB-302-6-SPA409-2 Jump 3-4	TB
1	Fuse	GBA-3	F
1	Fuse Holder	HPC	

NOTE: It is not recommended to make any repairs other than those accomplished by using parts listed above.

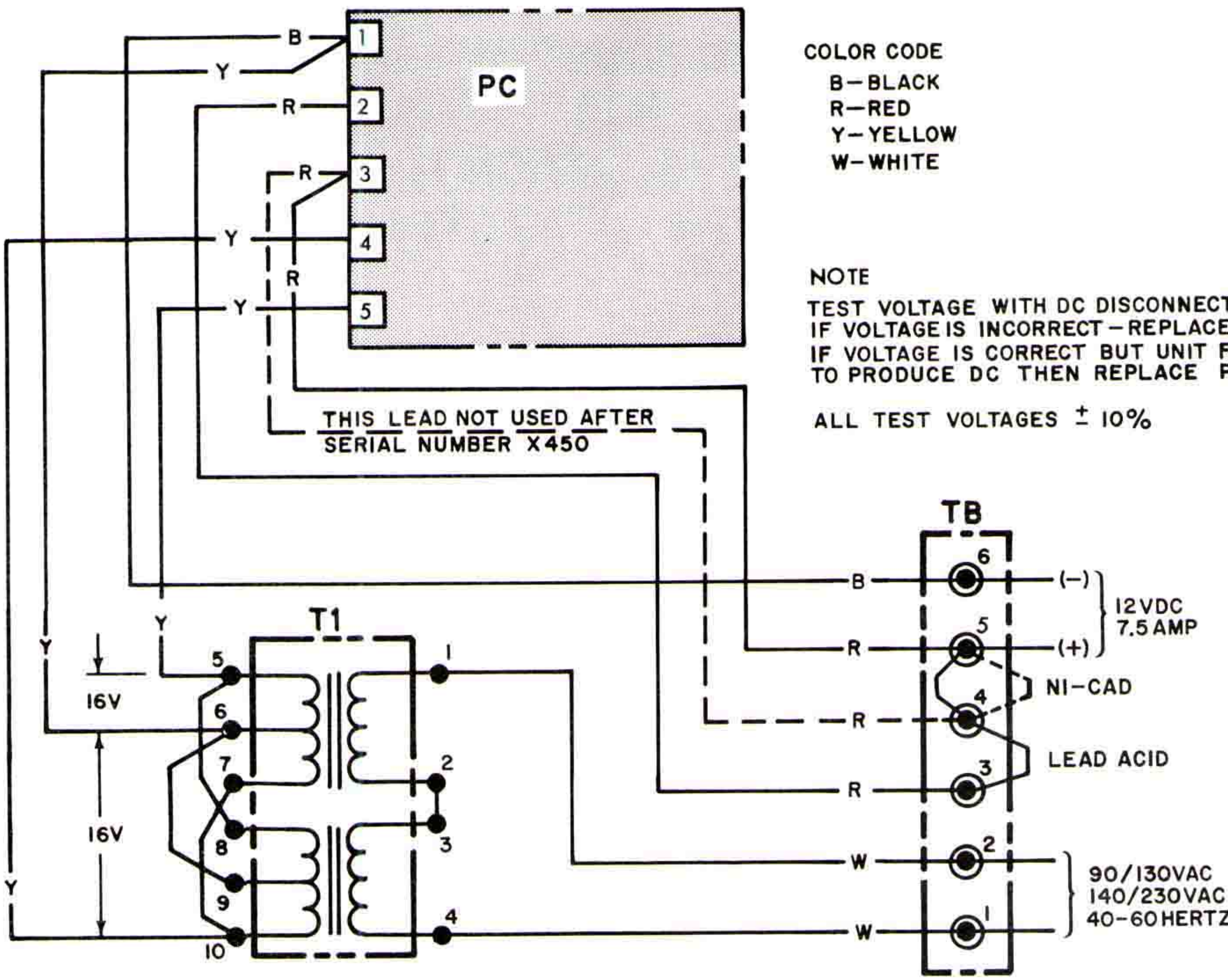
EMERSON
2-71 GENERATORS

Pocatello, Idaho 83201
1-800-387-4972



BLOCK DIAGRAM

Figure 4



COLOR CODE
B—BLACK
R—RED
Y—YELLOW
W—WHITE

NOTE

TEST VOLTAGE WITH DC DISCONNECTED. IF VOLTAGE IS INCORRECT—REPLACE T1. IF VOLTAGE IS CORRECT BUT UNIT FAILS TO PRODUCE DC THEN REPLACE PC.

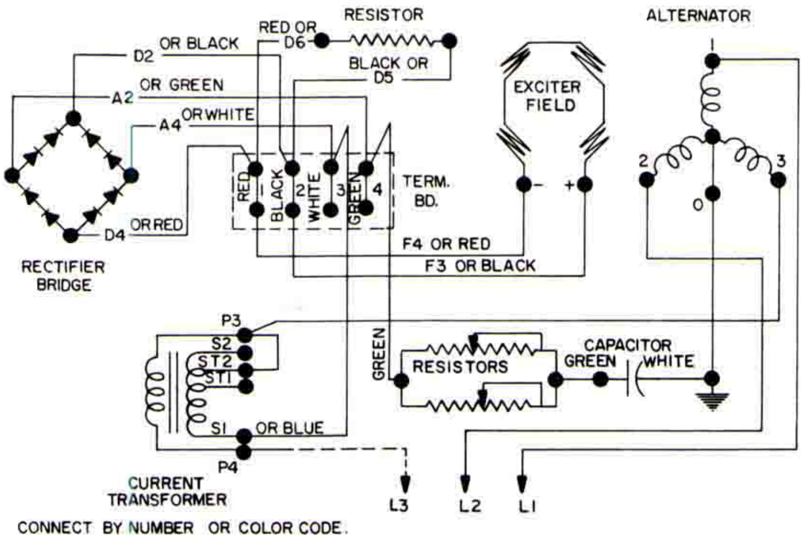
ALL TEST VOLTAGES ± 10%

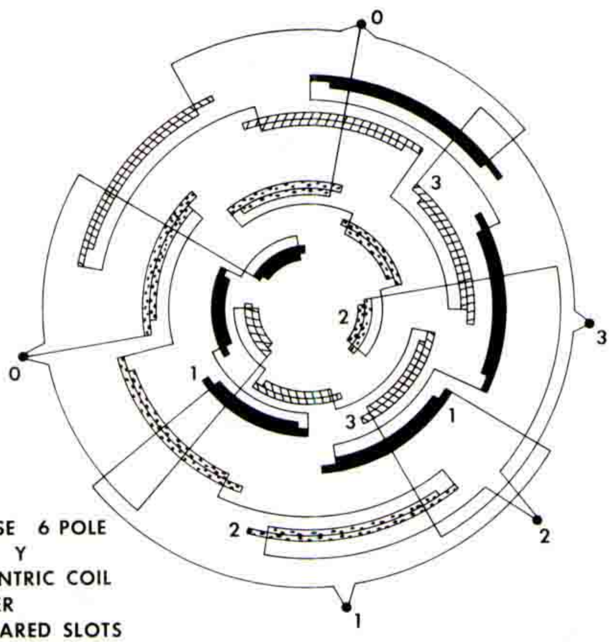
SCHEMATIC DIAGRAM

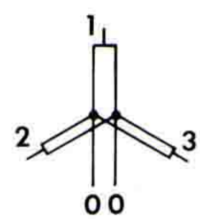
Figure 5

MODEL 3E-5396M3

20 KW, 230 Volts, 3 Phase, 60 Cycle, 1200 RPM
13.3 KW, 150 Volts, 3 Phase, 40 Cycle, 800 RPM





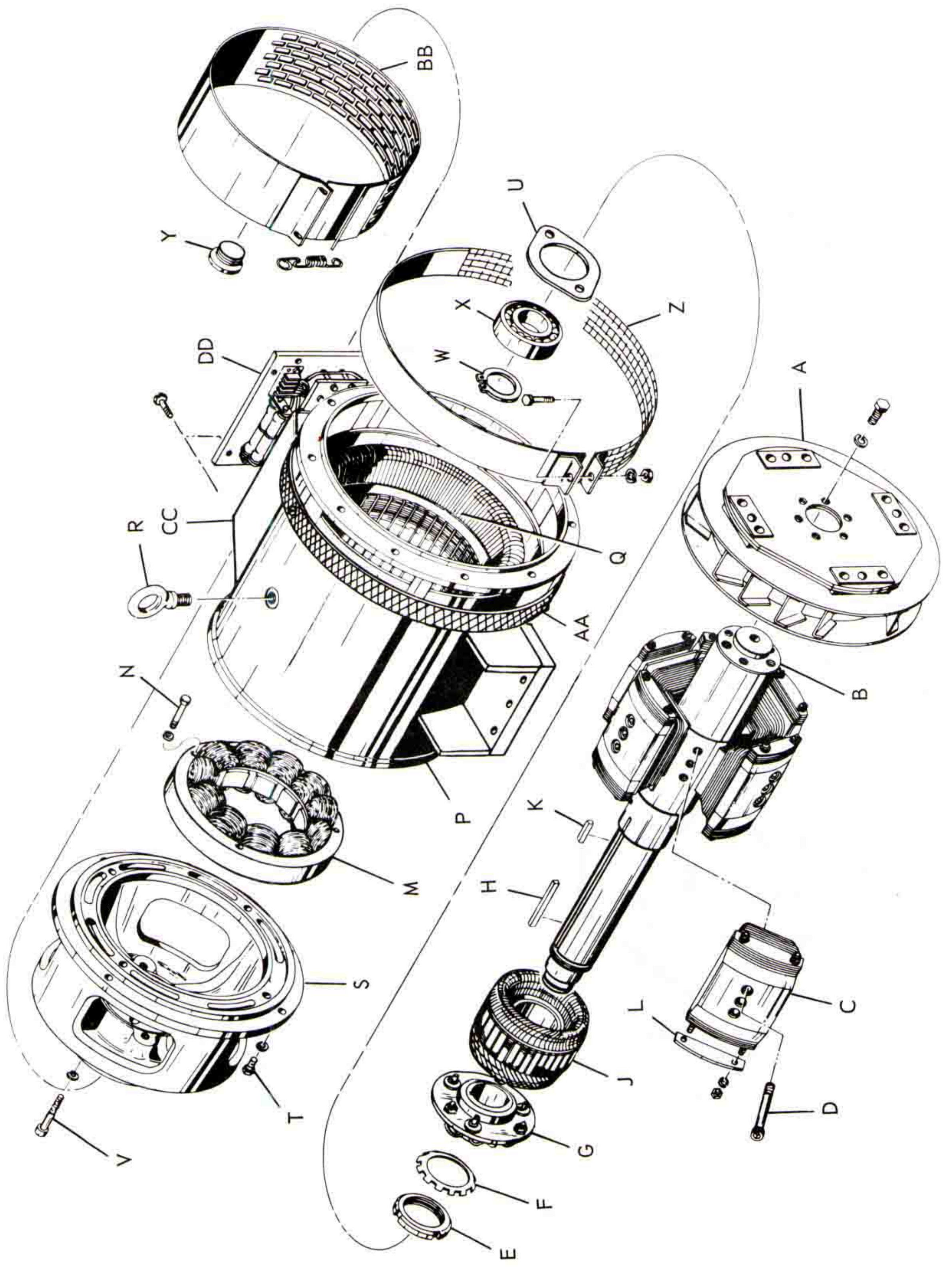


3 PHASE 6 POLE
2 PAR Y
CONCENTRIC COIL
6 LAYER
NO SHARED SLOTS
72 SLOTS
THROW OUTER COIL 1–12
THROW INNER COIL 2–11
MACHINE WOUND

RESISTANCE LIMITS
(Corrected for 25°C. or 77°F.)

Alternator Armature (Stator).....	.125	–	.139	Ohms
Alternator Field (Rotor)	1.45	–	1.55	Ohms
Exciter Armature.............	.36	–	.40	Ohms
Exciter Field	27.1	–	29.8	Ohms

Exploded View of Delco Generator



SERVICEABLE PARTS LIST

Item	Part No.	Description	No. Req.
1A	4951538	Fan and Driving Disc Assembly	1
2	9411385	Bolt - Fan Mounting	6
3	9411378	Lockwasher - Fan Mounting	6
4B	4967757	Rotating Field and Exciter Armature Assembly (Rotor)	1
5B	4967758	. Rotating Field and Shaft Assembly	1
6B	4967462	. . Shaft	1
7C	3196574	. . Rotating Coil Assembly	6
8D	4956744	. . Bolt - Coil Mounting (80 Ft. -Lb. Torque)	18
9*	3162227	. . Clip - Coil Lead Connector	5
10E	5390849	. Locknut - Exciter Retaining (350-400 Ft. -Lb. Torque)	1
11F	5379887	. Lockwasher - Exciter Retaining	1
12G	4961894	. Rectifier Mounting Assembly	1
13G	3179357	. . Rectifier - Forward Polarity	3
14G	3185796	. . Rectifier- Reverse Polarity	3
15G	3195233	. . Nut and Lockwasher Assembly - Rectifier Mounting	6
16G	5545806	. . Terminal Lug	5
17G	5536454	. . Screw and Lockwasher Assembly - Lug Connecting	5
18G	3190056	. . Nut and Lockwasher Assembly - Lug Connecting	5
19G	4957085	. . Plate - Rectifier Mounting	1
20G	5536454	. . Screw and Lockwasher Assembly - Plate Mounting	3
21G	4961893	. . Sleeve Assembly	1
22H	5545524	. Key - Rectifier Sleeve Locking	1
23J	4961895	. Armature Assembly - Exciter	1
24K	4961901	. Key - Armature Locking	1
25*	456184	. Clip - Field Lead Retaining	2
26*	9411395	. Screw - Clip Mounting	1
27*	453294	. Lockwasher - Clip Mounting	1
28*	1067379	. Sleeve - Clip Insulating	2
29*	5397610	. Clip - Field Lead Connector	2
30*	5534348	. Lead - Rotating Field to Rectifiers	2
31*	038092	. Sleeve - Lead Thru Armature Insulating	2
32L	†5545671	. Balance Weight - Steel	AR
33L	†3185618	. Balance Weight - Aluminum	AR
34*	5397124	. Thru Bolt - Balance Weight Mounting	12
35	9411381	. Nut - Balance Weight Mounting	24
36	453294	. Lockwasher - Balance Weight Mounting	24
37M	4968257	Exciter Field Assembly	1
38N	9417293	Bolt - Field Assembly Mounting	4
39*	453788	Lockwasher - Field Assembly Mounting	4
40P	4972337	Frame - Main	1
41Q	4961958	Stator and Coil Assembly (Alternator Armature)	1
42R	5344653	Eyebolt	1
43*	5391523	Pin - Stator Locking	4
44S	4967821	End Frame	1
45T	9411392	Bolt - End Frame Mounting	4
46	453788	Lockwasher - End Frame Mounting	4
47U	5392358	Plate - Bearing	1
48V	9422549	Bolt - Plate Mounting	2
49	453467	Lockwasher - Plate Mounting	2
50W	3185537	Ball Bearing	1
51X	274771	Ring - Bearing Retaining	1
52Y	4952899	Plug - End Frame Center	1
53Z	3195519	Cover Band - Fan	1
54	9417293	Bolt - Cover Band Mounting	1
55	9411382	Nut - Cover Band Mounting	1
56	453788	Lockwasher - Cover Band Mounting	1
57AA	3196323	Guard - Air Take-off	1
58	9419715	Screw - Guard Mounting	3
59*	3164878	Washer - Guard Mounting	3
60BB	3191204	Cover Band - End Frame	1
61	5545735	Spring - Cover Band	2
62CC	3188297	Cover	1
63*	3191231	Connection Diagram - System	1
64	9422090	Screw - Cover Mounting	2
65DD	4963455	Cover and Control Assembly	1
66*	3160549	. Terminal Block	1
67*	3160548	. Insulator - Terminal Block	1
68*	9420512	. Screw and Lockwasher Assembly - Block Mounting	2
69*	453434	. Nut - Block Mounting	2
70*	3190183	. Resistor Assembly	1
71*	3173701	. . Resistor - Adj. 100 Ohms, 100 Watts	2
72*	9418345	. Screw - Resistor Assembly Mounting	2
73*	3164878	. Washer - Resistor Assembly Mounting	2
74*	3160872	. Locknut - Resistor Assembly Mounting	2
75*	3191216	. Transformer Assembly - Current	1
76*	9413500	. Bolt - Transformer Mounting	4
77*	5550303	. Washer - Transformer Mounting	4
78*	5550325	. Locknut - Transformer Mounting	4
79*	3191213	. Rectifier Assembly	1
80*	3179357	. . Rectifier	8
81*	9414468	. Screw - Rectifier Assembly Mounting	4
82*	3160872	. Locknut - Rectifier Assembly Mounting	4
83*	5358953	. Washer - Rectifier Assembly Mounting	4

* — Denotes parts not illustrated.

† — 1/2" total maximum stackup. Place steel weights to outside of aluminum weights. If only aluminum weight is required, add one steel weight to outside and another steel weight 180° opposite.

Item	Part No.	Description	No. Req.
84*	3185805	. Spacer - Rectifier Assembly Mounting.	4
85*	3169554	. Capacitor Assembly	1
86*	3183268	. Bracket - Capacitor Mounting. .	2
87*	9413500	. Bolt - Bracket Mounting	4
88*	5550325	. Locknut - Bracket Mounting . . .	4
89*	5542216	. Insulator - Capacitor	1
90*	3167269	. Resistor - 250 Ohms	1
91*	9415610	. Screw - Resistor Mounting . . .	1
92*	3160872	. Locknut - Resistor Mounting . .	1
93*	046727	. Washer - Resistor Mounting . .	2
94*	5550445	. Washer - Resistor Centering . .	2
95*	5550447	. Washer - Resistor Insulating . .	2
96DD	3191232	. Cover - Control Mounting	1
97	9422090	Screw - Cover Mounting	4
98*	4965737	Leads Assembly - Exciter	1
99*	5397611	Clip - Lead Connector	2
100*	1067384	Sleeve - Clip Insulating	2
101*	120523	Clip - Lead Retaining	1
102*	9432196	Screw - Clip Mounting.	1
103*	453294	Lockwasher - Clip Mounting.	1
104*	3196559	Name Plate.	1
105*	145369	Drive Screw - Name Plate Mounting	4

* — Denotes parts not illustrated.