

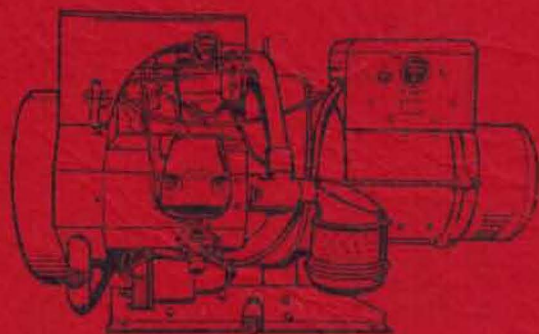
INSTRUCTION MANUAL

FOR

ONAN DIESEL ELECTRIC GENERATING PLANTS

Series

DRN



Onan

DIVISION OF STUDEBAKER-PACKARD CORPORATION
MINNEAPOLIS 14, MINNESOTA

939-1

Price \$1.00

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We mean it.....

.....and this certificate with the Onan electric plant you purchased proves we mean it! When this plant left our factory in Minneapolis it took with it our sincere assurance that it will produce exactly as stated on its nameplate.

The name of ONAN is synonymous with satisfactory performance, certified performance.



If you need help with your old Onan, visit the "Smart Guys" at The Stak. They have many years of experience and they are happy to help.

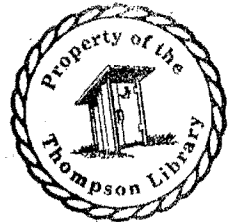
<http://www.smokstak.com/forum/forumdisplay.php?f=1>

GENERAL INFORMATION

This instruction book contains information for the proper installation, operation, and maintenance of your equipment. We suggest that this book be kept handy so that it can be referred to when necessary.

This equipment is the result of proven engineering design, highest quality materials, and expert workmanship. Thorough inspection and testing assures you that this equipment will perform as expected.

If you wish to contact your dealer or the factory regarding this equipment, be sure to supply the complete **MODEL** and **SPEC. NO.**, and the full serial number of the equipment as shown on the nameplate. This information is necessary to identify the equipment among the many basic and special optional types manufactured.



MANUFACTURER'S WARRANTY

The Manufacturer warrants each product of its manufacture to be free from defects in material and factory workmanship if properly installed, serviced and operated under normal conditions according to the Manufacturer's instructions.

Manufacturer's obligation under this warranty is limited to correcting without charge at its factory any part or parts thereof which shall be returned to its factory or one of its Authorized Service Stations, transportation charges prepaid, within ninety (90) days after being put into service by the original user, and which upon examination shall disclose to the Manufacturer's satisfaction to have been originally defective. Correction of such defects by repair to, or supplying of replacements for defective parts, shall constitute fulfillment of all obligations to original user.

This warranty shall not apply to any of the Manufacturer's products which must be replaced because of normal wear, which have been subject to misuse, negligence or accident or which shall have been repaired or altered outside of the Manufacturer's factory unless authorized by the Manufacturer.

Manufacturer shall not be liable for loss, damage or expense directly or indirectly from the use of its product or from any other cause. The Manufacturer makes no warranty whatsoever with respect to component parts which are warranted separately by their respective manufacturers.

The above warranty supersedes and is in lieu of all other warranties, expressed or implied, and no person, agent or dealer is authorized to give any warranties on behalf of the Manufacturer nor to assume for the Manufacturer any other liability in connection with any of its products unless made in writing and signed by an officer of the Manufacturer.

IMPORTANT

RETURN WARRANTY CARD ATTACHED TO UNIT

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PLANT RUNNING HOURS COMPARED TO AUTOMOBILE RUNNING MILES

The engine of your generating plant makes as many revolutions in one hour, as the average automobile engine does when the car travels a distance of 41 miles.

100 running hours time on a generating plant engine is equivalent in total RPM's to approximately 4100 running miles on an automobile.

However, do not conclude that the wear on the generating plant engine and the wear on the automobile engine would be the same. The generating plant engine is built much more ruggedly, (having larger main bearings, bigger oil capacity and has a heavier crankshaft proportionately per horsepower) than most automobile engines. Given the proper care and periodic servicing the generating plant engine will continue to give many more hours of efficient service than an automobile engine will after having been run the equivalent number of running miles.

Compare the running time of your generating plant engine with the number of miles traveled by an automobile. The oil in an auto is checked every one or two hundred miles (3 to 5 hrs. running time) and changed every 1000 to 1500 miles (28 to 42 hrs.) whereas in a generating plant or stationary power engine, the oil should be checked every 6 to 8 running hours (250 to 350 miles) and changed every 50 to 100 operating hours (2000 to 4000 miles) depending on operating conditions.

About every 5,000 to 10,000 miles (120 to 250 hours), services have to be performed on an auto, such as checking ignition points, replacing spark plugs, condensers, etc. Similarly on your generating plant engine, these same services have to be performed periodically except the change period is reckoned in hours. 10,000 miles on an auto is equivalent to about 250 running hours on your plant engine.

To arrive at an approximate figure of comparative generating plant running hours as against automobile engine running miles, multiply the total number of running hours by 41 to find the equivalent of running miles on an automobile.

Your generating plant engine can "take it" and will give many hours of efficient performance provided it is serviced regularly.

Below is a chart showing the comparison between a generating plant engine running hours and an automobile running miles.

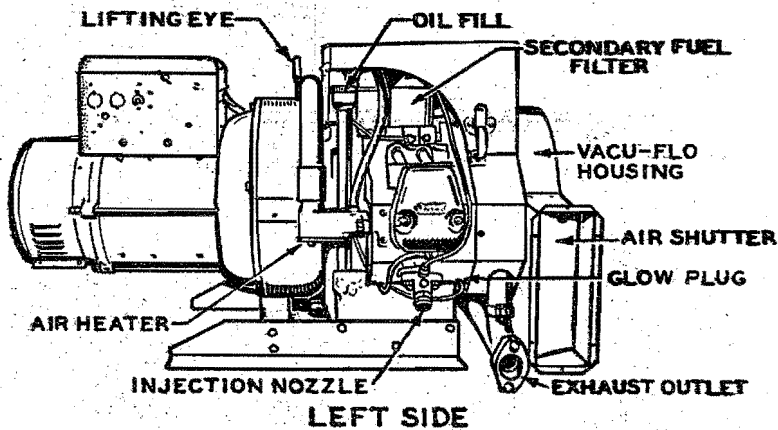
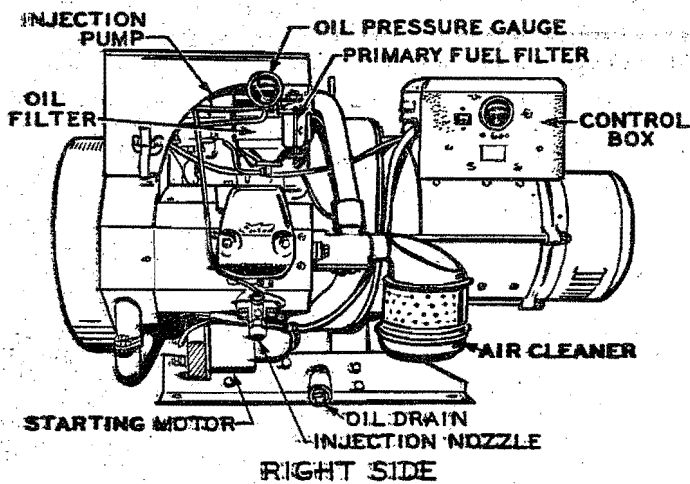
GENERATING PLANT RUNNING HOURS		AUTOMOBILE RUNNING MILES		GENERATING PLANT RUNNING HOURS		AUTOMOBILE RUNNING MILES	
	1 Hr.		41 Miles		30 Hrs.		1,230 Miles
DAILY	4 Hrs.		164 "	MONTHLY	120 "		4,920 "
AVERAGE	6 "		246 "	AVERAGE	180 "		7,380 "
	8 "		328 "		240 "		9,840 "
	7 "		287 "		365 "		14,965 "
WEEKLY	28 "		1,148 "	YEARLY	1,460 "		59,860 "
AVERAGE	42 "		1,722 "	AVERAGE	2,190 "		89,790 "
	56 "		2,296 "		2,920 "		119,720 "

NOTE: Electric generating plants do not operate economically when used to power electric refrigerators and will add from 4 to 8 operating hours per day in addition to the regular lighting load.

INTRODUCTORY

The ONAN DRN Series diesel powered electric generating plants to which this manual applies are complete electric generating plants. Each plant includes an engine, generator, and necessary accessories. Each plant is thoroughly tested before leaving the factory to assure that all parts are in good condition and that each plant will produce its rated output.

The manual contains instructions on installing, operating, servicing, adjusting, and repairing your plant. Read all instructions carefully. Correct installation, operation, and servicing are important in assuring long life operation. Disregarding these instructions may lead to unnecessary trouble and expense.



**TWO-CYLINDER OPPOSED DIESEL
ELECTRIC GENERATING PLANT**

INTRODUCTORY (Continued)

Standard models of the alternating current plants are covered in this manual. Where standard model differences in connecting, installing and servicing occur, they will be treated separately.

This instruction manual is supplied with all generating plants of the DRN series. Instructions apply specifically to the standard alternating current models. Some special installation or operating conditions may require the operator of this plant to modify these instructions. If the plant has optional equipment, a corresponding specification number appears in its model designation. Some details do not apply to special models. However, by following as closely as possible the recommendations as given in this book, the operator should have no difficulty in making a good installation and in properly operating the generating plant. If the special difference is electrical, refer to the special wiring diagram for that plant rather than the wiring diagrams shown in the rear of this manual.

DETAILS

The engine is a 4 cycle; opposed two cylinder; 3-1/2 inch bore; 3-1/2 inch stroke; air cooled (Vacu-Flo type); full diesel engine.

The main and connecting rod bearings are pressure lubricated. Speed is governor controlled. The fuel system has a primary fuel filter, a transfer pump, a cartridge type secondary fuel filter and a distributing type injection pump. The circulated air is discharged through a single duct. To aid starting, induction air heaters and glow plugs are used.

The generator is of the four pole type, self-excited, saturated field, inherently regulated, revolving armature type, direct connected to the engine. Generator output rating ranges from 5 to 6 KW at unity power factor, depending on the voltage and speed characteristics of the model in question.

The mounted control box contains the necessary operating controls and instruments. Remote control switches and automatic controls for starting and stopping may be connected.

Plants of the alternating current type must be operated whenever alternating current is used. A small auxiliary load may be taken from the starting battery for short periods of time while the plant is idle.

The main difference between the 50 cycle plant and the 60 cycle plant is in the current frequency. Most electrical appliances can be used on either frequency but it is advisable to check appliances for use with 50 cycle plants before purchasing to assure that they are adaptable to the frequency of the current.

SPECIAL ACCESSORIES

The following accessories are available.

55 GALLON UNDERGROUND FUEL TANK AND FITTINGS. - Under-writers approved tanks of heavy-gauge steel, complete with fill and vent pipes and other necessary fittings. Specify Part Number 415K3.

FUEL LINES AND FITTINGS. - 25 feet of 5/16" copper tubing complete with fittings. Specify Kit Number 415K7 (2 kits required).

PRIMING KIT. - Designed for cold weather starting. Easily installed. Simple to operate. Incorporates using a special ethyl-ether starting fluid in capsule form by atomizing the fluid into the engine induction system.

OIL LEVEL REGULATOR. - This regulator is gravity operated and float controlled. It serves to maintain the lubricating oil level in the crankcase at proper level during periods of unattended operation.

KEEP FUEL

Clean!

DIRTY FUEL IS ONE OF THE
MAJOR CAUSES OF PLANT
FAILURE.

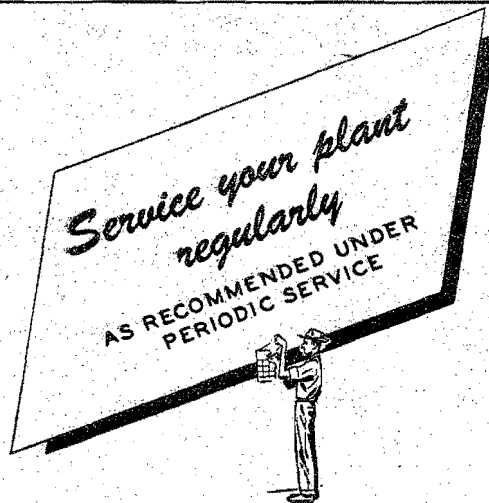
REMEMBER-EVEN A TINY PARTICLE
OF DIRT IN THE INJECTION SYSTEM
MAY STOP YOUR PLANT!

AVOID BATTERY FAILURE!

CONTINUOUS OPERATION AT HIGH CHARGE RATE WHEN THE BATTERY IS FULLY CHARGED, MAY SHORTEN THE BATTERY LIFE!

THE BATTERY INTERNAL RESISTANCE INCREASES AS THE BATTERY REACHES A FULLY CHARGED CONDITION, CAUSING A DESIRABLE TAPERING OFF CHARGE RATE. HOWEVER, THE BATTERY SPECIFIC GRAVITY MUST BE CHECKED FREQUENTLY DURING OPERATION AT HIGH CHARGE RATE.

THE PLANT MAY BE OPERATED AT LOW CHARGE RATE WITHOUT DAMAGING A FULLY CHARGED BATTERY.



GENERAL. - Proper installation of the diesel powered electric generating plant is essential for satisfactory performance.

The following instructions should be followed as closely as possible. If the instructions cannot be followed as given, use them as a guide and make the best installation that conditions permit.

LOCATION. - The location selected for the plant should be as near to the center of the electrical load as practicable. For example, if several buildings are to be serviced with electricity it is much better and costs less to run lines from a central point to each of the buildings than to run lines from one building to another. Not only will the voltage drop from the plant to load be less but smaller wire can be used to carry the same current without much voltage loss between the plant and the point of service.

The enclosure should be clean, dry, well ventilated, and if necessary, heated in cold weather.

VENTILATION AND COOLING. - There must be a constant supply of fresh air for cooling the plant. Cooling air travels from the rear of the plant, through the generator and over the engine cooling surfaces, and is blown out through a 3-5/8 x 10 inch outlet at the front end of the plant. The outlet usually faces horizontally left, but can be rotated in steps of 45 degrees to right or left limited only by the floor.

In a large room, or out doors, cooling will be no problem. However, if the plant is installed inside a small room or compartment, provide separate air inlet and outlet openings. Automatically operated louvers in the room are desirable. Consider the following factors.

To prevent recirculation of heated air, install a duct between the plant air discharge opening and the room or compartment outlet opening. The duct must be equal to or larger than the outlet area at the engine to duct the heated air outside of the compartment. Use a canvas section (flexible material) next to the engine housing to absorb vibrations. Factory tests under high temperature conditions indicate satisfactory cooling using 35 square inch area ducting up to 9 feet in length and with no more than 2 radius type 90 degree elbows. Do not use square type elbows. Increase the duct size for longer lengths or if additional turns are necessary, so that back pressure will be minimized. If a louver or screen is required at the duct outlet, increase the size of the duct at the outlet or install the screen diagonally to attain a net open area equal to or greater than the duct area.

Locate the compartment air inlet opening where most convenient. This air inlet opening should be large enough so that air pressure inside the compartment is equal to air pressure outside the compartment. The

exact size of the air inlet opening, as necessary for adequate cooling, is dependent upon several possible variable conditions peculiar to the installation in question. The simplest way to determine whether or not the room inlet is large enough, is to compare the engine circulated air temperature rise with that given in the following table. Hold a thermometer in the air stream near the cylinder head and again at the air outlet scroll. Subtract the air-in temperature from the air-out temperature to determine the temperature rise. If the air temperature rise does not exceed the desired higher temperature given in the table for the respective ambient and load condition, then the supply of cooling air reaching the plant is enough. No damage will result from a lower than expected temperature rise. If operation of the plant in a normally heated room tends to drop the room temperature due to the rapid discharge of air, it may be permissible to install an adjustable register in the outlet duct to permit recirculation of some of the air heated by the engine.

The temperature rise limit given in the table is a goal to strive for and reasonable deviations are permissible. For 50 cycle (1500 rpm) plants the temperature rise will be a nominal 10 per cent lower than given in the table. Lower ambient temperatures also lower the temperature rise. Speeds above 1800 rpm will increase the temperature rise given.

- Table of Desired Nominal Air Temperature Rises at Given Loads -

	<u>Rise with 75°F. Air-In</u>	<u>Rise with 110°F. Air-In</u>
Full Rated Load	43 to 50°F.	48 to 55°F.
3/4 Rated Load	37 to 43°F.	41 to 48°F.
1/2 Rated Load	32 to 37°F.	35 to 41°F.
Less than 1/2 Rated Load.	27 to 32°F.	30 to 35°F.

MOUNTING THE PLANT. - Provide a permanent mounting base of timber, concrete or structural steel. The base

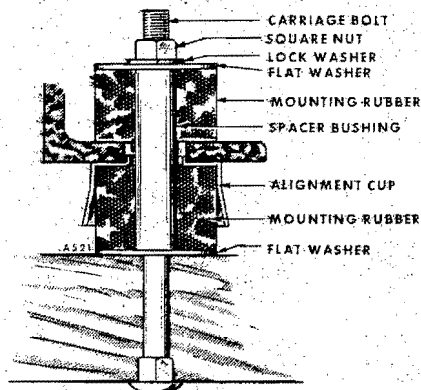


FIG. 1 - MOUNTING CUSHIONS

should be a nominal 12 inches or more high and located so that the plant will be accessible for operation and maintenance from all sides.

Use the four rubber mounting cushion assemblies to mount the plant on a permanent base. The short upper and long lower rubber cushions help isolate plant vibrations. The metal spacer bushing prevents compressing the cushions when the nut is securely tightened. The alignment cup installed between the plant and the lower cushion, centers the mount to prevent metal to metal contact.

Mounting hole centers in the plant base are 17 x 18-3/4 inches. Use four 3/8 inch diameter mounting bolts of the proper length so that 2-7/8 inches extend above the mounting surface to pass through the plant mounting cushions, as illustrated.

EXHAUST LINE. - Pipe all exhaust gases out of doors. Use flexible tubing next to the plant 1-1/4" iron pipe size outlet to absorb vibrations. Use 1-1/4" iron pipe for the first 10 feet increasing the pipe size one size for each additional 10 feet used. The exhaust line should always be shielded where it passes through a wall or near inflammable material. A thimble 12" larger than the exhaust line must be provided, extending 9" beyond wall or ceiling on each side. If there is danger of personnel contact with the exhaust line, shield or cover with a suitable insulating material. If the muffler is to be installed outside the enclosure, provide a suitable rain cap which does not restrict the flow of exhaust gases from the plant.

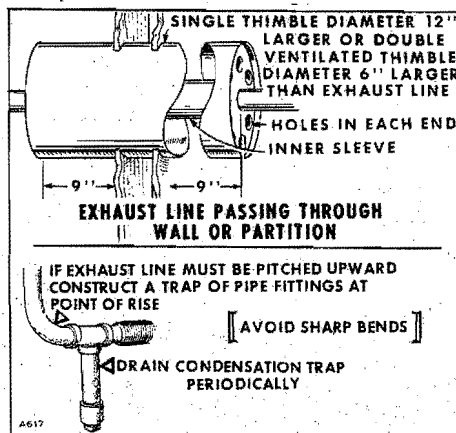


FIG. 3 - EXHAUST INSTALLATION

If the exhaust line must be pitched upward at any point construct a condensation trap of suitable pipe fittings and install it at the point the upward pitch begins.

FUEL TANK. - The fuel tank supplied with the plant should be installed so that the bottom of the tank is not more than 9 feet

below the transfer pump inlet. This distance also applies if a different tank is used. The tank must be within reach of the flexible fuel lines supplied unless additional line is installed.

If a larger fuel tank is to be used, be sure the fuel outlet is near the bottom of the tank and the opening for the return fuel line is in the top of the tank.

FUEL LINES. - Two flexible fuel lines are supplied with each unit, one for the suction line and the other for the return line.

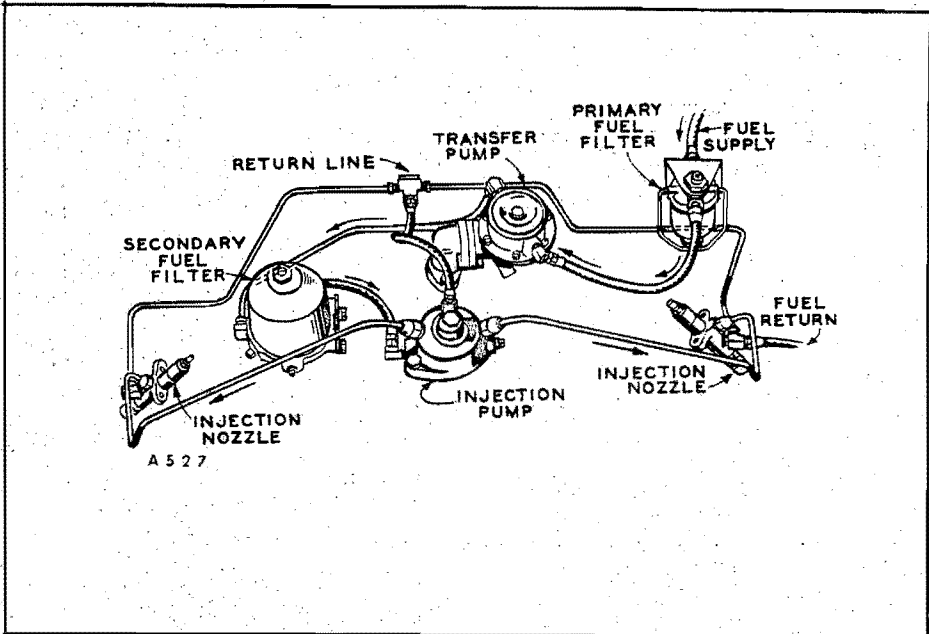


FIG. 4 - FUEL SYSTEM

Use as few as possible joints, valves, etc. in the suction line to limit possible entrance of air. Fuel-tight valves may not be air-tight. **DO NOT** use thread compound on fuel system connections because a loose particle may cause injection failure. Flush the suction line clean before connecting to the plant. If a fitting cannot be sufficiently tightened, install a new one.

Install the flexible fuel lines between the plant and the fuel tank. If longer lines are required, solid lines may be used from the tank to a point near the plant. The suction line runs from the fuel tank outlet to the fitting on the primary fuel filter. The return fuel line runs from the fitting on the number 2 cylinder nozzle to the top of the fuel tank.

CONNECTING THE STARTING BATTERIES (AC PLANTS). - A well charged 12 volt battery with a minimum of about 120 ampere hour rating is required for starting under favorable conditions. At temperature below 70°F. more battery amperes is recommended.

Provide for free circulation of air around the battery. Apply petroleum jelly on battery posts to reduce corrosion. Spread the cable terminal rather than hammer it onto the battery post! Cables must make full contact on battery posts to avoid voltage loss.

If two 6 volt batteries are to be connected in series to produce 12 volts, connect the battery jumper cable from the negative (-) post of one battery to the positive (+) post of the second battery.

As illustrated and as shown on the wiring diagram, connect the battery positive (+) to the terminal on the starter, then connect the battery negative (-) to GROUND on the plant.

CAUTION: Do not POSITIVE ground the battery or a dead short will burn up the charge circuit as the generator has negative polarity!!

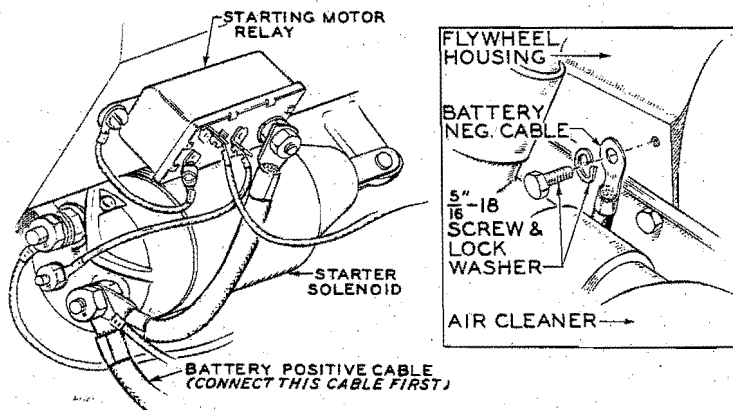


FIG. 5 - CONNECTING THE STARTING BATTERY

WIRING. - Use sufficiently large insulated wire to connect the load to the generator load terminals at the plant. The wire size will depend largely on the distance and permissible voltage drop between the plant and the load and the amount and kind of load. Consult a competent electrician. Check national and local codes before installing. Install a circuit breaker or a fused main switch in the load circuit near the plant. Where connections are made by joining two wires always be sure to tape, or otherwise insulate, each connection thoroughly.

Refer to the wiring diagram for electrical connections.

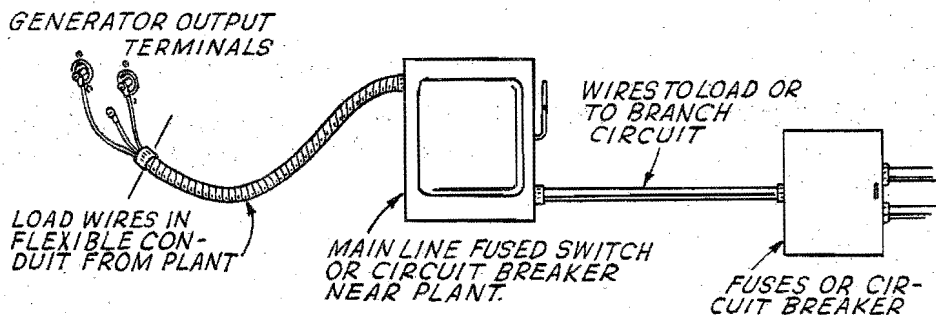


FIG. 6 - TYPICAL WIRING

CONNECTING THE LOAD (AC PLANTS). - Load wires should enter the knock-out hole in the cover for the AC output terminals at the rear of the control box. Each "hot" (un-grounded) generator output lead is connected to a feed thru condenser. The opposite end of this suppression condenser extends through the rear of the control box and is the terminal to which a "hot" (black) load wire must be connected. Connect the neutral load wire (white) to the grounded output terminal (the generator grounded lead is connected to the other end of this stud or screw). Installation of terminals on the load wires will facilitate good connections. The output terminals are marked "M1", "M2", etc., to agree with the same markings on the generator leads and on the wiring diagram.

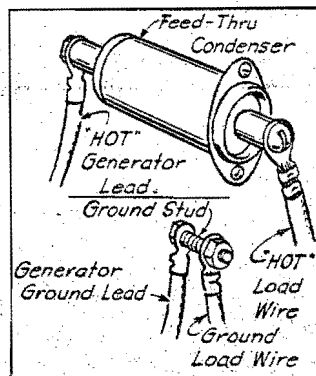


FIG. 7 - LOAD TERMINALS

Select the following instructions for load distribution which agrees with the electrical characteristics of the plant in question.

Wherever practicable, balance the load between the separate circuits of the same type current.

A. 1 PHASE, 2 WIRE PLANT. - "M2" terminal is grounded. The full plant rating as appears on the name-plate is available on circuit M1, M2.

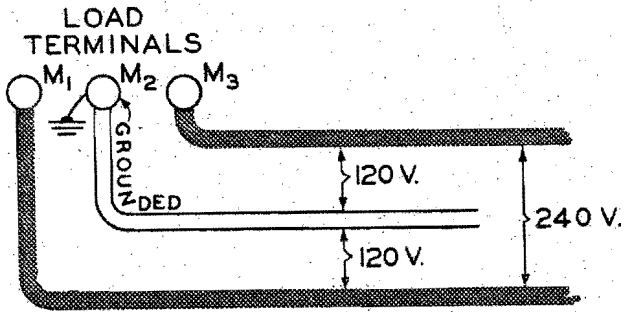


FIG. 8 - 1 PHASE, 3 WIRE LOAD CONNECTIONS

B. 1 PHASE, 3 WIRE PLANT. - "M2" terminal is grounded. Both 120 volt current and 240 volt current are obtainable.

Two 120 volt circuits are available. One circuit across "M1" and "M2", the other across "M2" and "M3". The load on each circuit should not be more than 1/2 the rated capacity of the plant.

One 240 volt circuit is available. This circuit is across "M1" and "M3". Terminal "M2" (ground) is not used with the 240 volt circuit. If only 240 volt current is used, the full rated capacity of the plant is available.

Both 120 volt current and 240 volt current may be used at the same time. However, the total load on all circuits should not exceed the plant capacity. (For example: A total of 3000 watts is available on each 120 volt circuit of a 6000 watt, single phase, three wire plant. If 1000 watts of current is used from each 120 volt circuit, only 4000 watts of 240 volt current can be used at the same time. If 3000 watts of 240 volt current is used, only 1500 watts of 120 volt current is available on each 120 volt circuit.) To determine the current available on each 120 volt circuit when the 240 volt load is known, subtract the 240 volt load from the plant rated capacity and divide the remainder by two.

C. 3 PHASE, 3 WIRE PLANT. - None of the terminals are grounded. Both 240 volt, three phase and 240 volt, single phase current are obtainable.

For a 3 phase, 3 wire circuit, connect one load wire to each of the three load terminals, "M1", "M2" and "M3". If only 3 phase current is used, the full rated capacity of the generator may be used. To reverse the direction of rotation of the connected load, reverse any two terminal connections.

Three, 240 volt, single phase circuits may be obtained by connecting the two load wires of each circuit to any two terminals. It is not advisable

to use only one of the three, 240 volt single phase circuits. Use all three and connect an equal load to each of the three circuits to prevent unbalancing the generator. The load on any one of the three single phase circuits must not be more than 1/3 the rated capacity of the plant.

If both three phase and single phase current are used at the same time, determine the current available on each single phase circuit as follows: Subtract the 3 phase load from the plant rated capacity and divide the remainder by three.

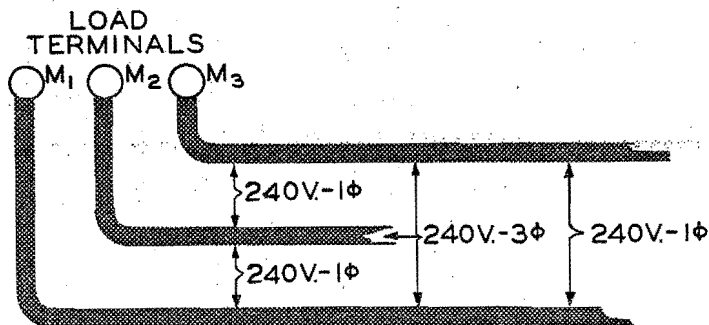


FIG. 9 - 3 PHASE, 3 WIRE LOAD CONNECTIONS

D. 3 PHASE, 4 WIRE PLANT. - "M0" terminal is grounded. Terminals "M1", "M2" and "M3" are "hot".

The four wire plant produces single phase current of one voltage, and three phase current of a different voltage. As indicated on the plant nameplate, the single phase current is the lower voltage, and the three phase current is the higher voltage.

For a 3 phase, 3 wire circuit, connect one load wire to each of the three ungrounded load terminals, "M1", "M2" and "M3". Terminal "M0" is not used. To reverse the direction of rotation of the connected load, reverse any two terminal connections. If only 3 phase current is used, the full rated capacity of the generator may be used.

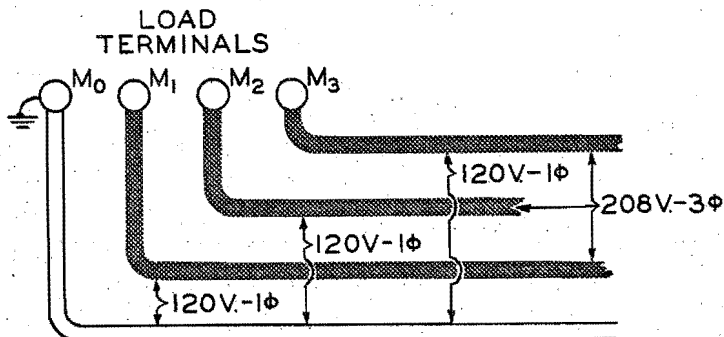


FIG. 10 - 3 PHASE, 4 WIRE LOAD CONNECTIONS

Three single phase circuits may be obtained by connecting the neutral (white) load wire to the plant "M0" (ground) terminal and the "hot" (black) load wire to any one of the three "hot" plant terminals ("M1" or "M2" or "M3"). Up to one third the rated capacity of the generator is available on each single phase circuit, if no 3 phase load is connected.

If both single phase and three phase current is used at the same time, use care not to over-load any one of the single phase circuits. Subtract the amount of the three phase load from the rated capacity of the generator. Then, divide the remainder by three to determine the amount of single phase load which may be connected to any single phase circuit.

GROUNDING, ALL PLANTS. - If grounding is called for in local electrical codes, or if radio interference necessitates it, provide a separate ground. Also the operator will desire to protect himself from possible dangerous electrical shocks by grounding the generator plant and branch circuits. Radio interference may result if the plant is grounded to a water pipe or to a ground used by a radio. Drive a 1/2" diameter rod or pipe into the ground as near to the plant as possible. Make certain that the ground rod will always penetrate moist earth. Fasten an approved ground clamp to the rod. Run a wire (number 8 or larger) (never smaller than 2 sizes smaller than the largest wire used in the system) from the clamp to the plant ground terminal.

The installation must be mechanically secure, and must have low resistance electrically. Comply with national and local electrical codes.

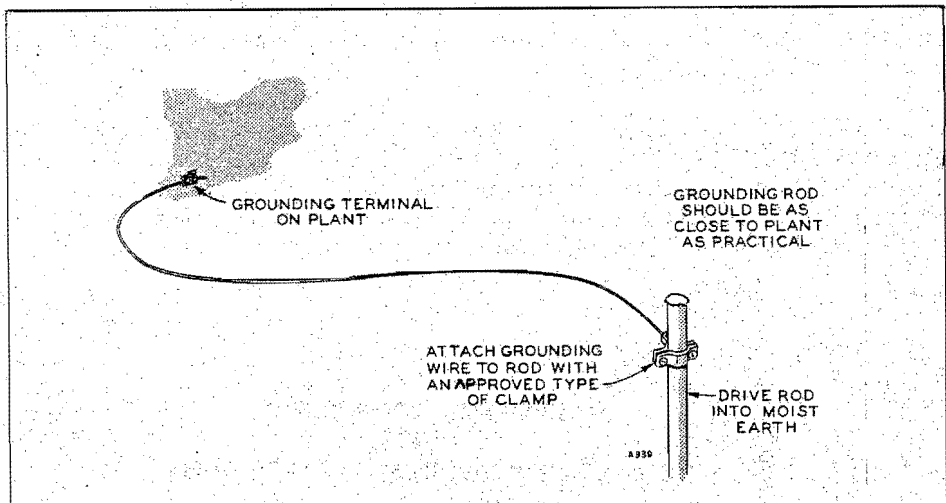


FIG. 11 - PLANT GROUNDING

CHECKING NEUTRAL BRUSH RIG POSITION. - Witness marks show the neutral brush rig position as adjusted at the factory. Details are given in the Maintenance And Repair section of the manual. Check the brush rig position and see that all generator brushes are in place in their guides.

RECHECK. - Carefully recheck all instructions to see that nothing has been left undone. Then supply the engine with proper oil and fuel as described under Preparation, Operation, and Periodic Service in the manual.

Bleed the air from the fuel system as instructed under Preparation in the manual.

REMOTE CONTROL CONNECTIONS (AC PLANTS ONLY). - One or more remote control start-stop stations may be installed at various points. The wire length from the plant to the switch determines the wire size necessary. Use No. 18 wire up to 85 ft., No. 16 wire up to 135 ft., No. 14 wire up to 215 ft. and No. 12 wire up to 350 ft.

A small four place terminal block is mounted in the control box. To provide for remote control of starting and stopping, connect the START-STOP remote switch to this terminal block.

Connect the switch common (center) terminal to the No. 1 terminal of the plant. Connect another terminal of the switch to the terminal block number 2 position. Connect the remaining switch terminal to the terminal block number 3 position. Number 2 is the stopping circuit, number 3 is the starting circuit, and number 1 is grounded. The plant B+ terminal is used only with line transfer equipment. If additional remote switches are installed, they must be connected in a parallel circuit.

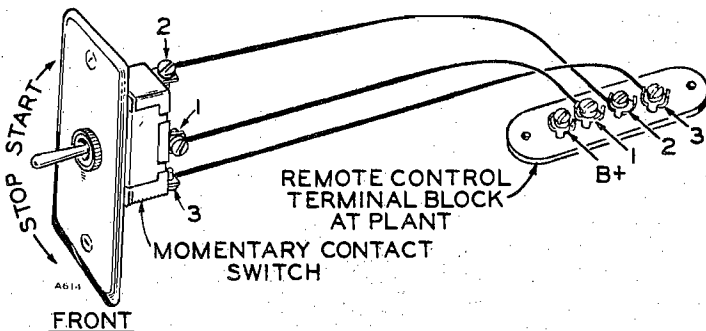


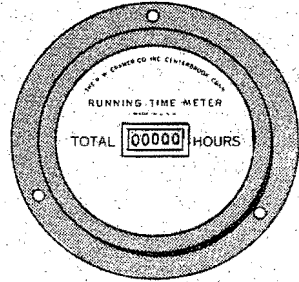
FIG. 12 - REMOTE START-STOP STATIONS

HIGH AIR TEMPERATURE CUT-OFF SWITCH. - A thermostatic safety switch is mounted inside the air shutter duct ahead of the shutter. If the discharged air temperature reaches 200⁰ F. the thermostatic switch contacts will close and automatically stop the plant. The switch will open and permit operation again when the temperature drops to 160⁰ F.

NOTE: If the thermostatic switch has stopped the unit, provide for more cool air to enter the unit and check for shutter opening failure. The unit cannot be started until the switch has re-set itself.

RUNNING TIME METER

To facilitate changing oil and servicing at proper intervals install a running time meter. Specify plant model with inquiry!



RECOMMENDED FUEL. - No. 2 Furnace Oil. Premium diesel fuels not required.

Alternates No. 1 Furnace Oil (distillate and range oil) and kerosene may be used but one quart (U. S. Measure) of SAF No. 30 lubricating oil should be added to each 25 gallons of such fuel to provide lubrication for fuel injection equipment.

SPECIFICATIONS. - (Specifications may be changed without notice).

GRAVITY (Minimum) A.P.I.	30
VISCOSITY (Saybolt Universal at 100°F.)	30.5 to 45 Seconds
CETANE NUMBER	43 Minimum
SULPHUR (by weight)	1% Maximum
CONRADSON CARBON (10% Bottoms)	0.15% Maximum
FLASH POINT	130°F. Minimum or legal Minimum
WATER AND SEDIMENT (by volume)	None
POUR POINT	Must be 10° lower than minimum temperature at which fuel oil is to be used.

Use fuel with low sulphur content to minimize ring sticking and bearing corrosion. Keep fuel supplies in clean containers and adequately protected from rain, snow and dirt. **KEEP THE FUEL SYSTEM CLEAN.** If removal of any part becomes necessary, wrap it in clean paper, never in cloth or waste. Use clean diesel fuel for cleaning parts.

RECOMMENDED OIL. - Use detergent lubricating oils classified by the American Petroleum Institute as Service "DG", or, as marketed by most manufacturers, "MS/DG". If sulphur content of fuel is higher than recommended maximum, use Service "DS" lubricating oil (or series III, having more detergent and other additives).

Use SAE No. 30 grade (viscosity) oil in the crankcase, and air cleaner, as instructed under Periodic Service. Multiviscosity oils, as 5W-20 or 10W-30, are not recommended, especially at higher temperatures, as the oil consumption increases greatly. At low temperature where cold starting may be difficult and high oil consumption is not a factor, the use of multiviscosity oil may be justified. **CAUTION: DO NOT START ENGINE UNTIL CRANKCASE IS FILLED - CHECK OIL LEVEL INDICATOR BEFORE STARTING ENGINE.**

OIL CAPACITIES. - Crankcase (Includes Filter) - 6 quarts U.S. Measure
 Oil Filter ----- 1 pint U.S. Measure
 Air Cleaner ----- Fill to level indicated.

PREPARATION FOR STARTING. - Fill the fuel tank with clean fuel.

Fill the crankcase with 6 quarts (U. S. Measure) of the recommended viscosity and service grade of lubricating oil. This includes oil for the filter. If the preparation is for cold temperature operation, do not put the oil into the crankcase until just before starting.

NOTE: SAE No. 10W oil may be used at temperatures below 40°F. See Cold Temperatures under Abnormal Operating Conditions section.

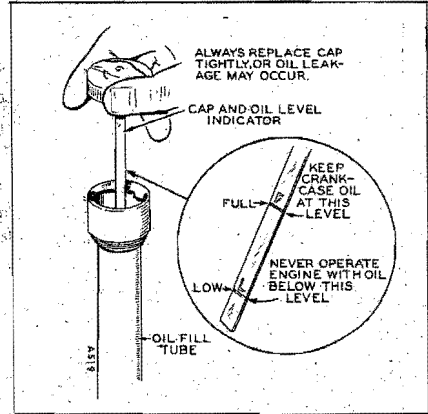


FIG. 13 - OIL LEVEL INDICATOR

CAUTION: BE SURE TO REPLACE OIL FILL CAP SECURELY OR AIR LEAKAGE AT THIS POINT MAY REDUCE CRANKCASE VACUUM, RESULTING IN OIL LEAKAGE AT THE OIL SEALS, OR OIL CARRY OVER PAST THE BREATHER.

Open the room air inlet ventilator, except as necessary to control the air flow for cold temperature operation.

See that the main line switch or circuit breaker is in the OFF position.

Lubricate the governor linkage ball joint with powdered graphite. Place a drop of SAE No. 30 oil on the other governor linkage joints.

Open the fuel shutoff valve at the fuel tank.

AIR CLEANER. - Fill the air cleaner cup to the level indicated with oil of the same SAE No. as used in the engine crankcase, except as noted for cold temperature operation. **DO NOT OVER-FILL.** The excess oil will be drawn into the combustion chamber by the air stream and may result in serious damage due to too heavy a charge in the combustion chamber causing the engine to "run-away" (Exceed its maximum safe operating speed).

BLEED FUEL SYSTEM. - Before starting a new engine, an engine that has been idle for a long period of time or an engine that has run out of fuel, it is necessary to bleed the fuel system.

Remove the bleed plug (small screw) from the top of the fuel filter. Then work the primer lever on the transfer pump until fuel fills the filter. Allow fuel to flow freely at the opening until there are no air bubbles in evidence. Replace the bleed plug on the fuel filter. See the illustration **BLEEDING THE FUEL SYSTEM.**

NOTE: If the cam is on the high side the transfer pump will not operate. To correct, turn the crankshaft over one complete revolution. Leave the primer lever at the down position when through priming the fuel system. The pump will not operate with the lever at up position.

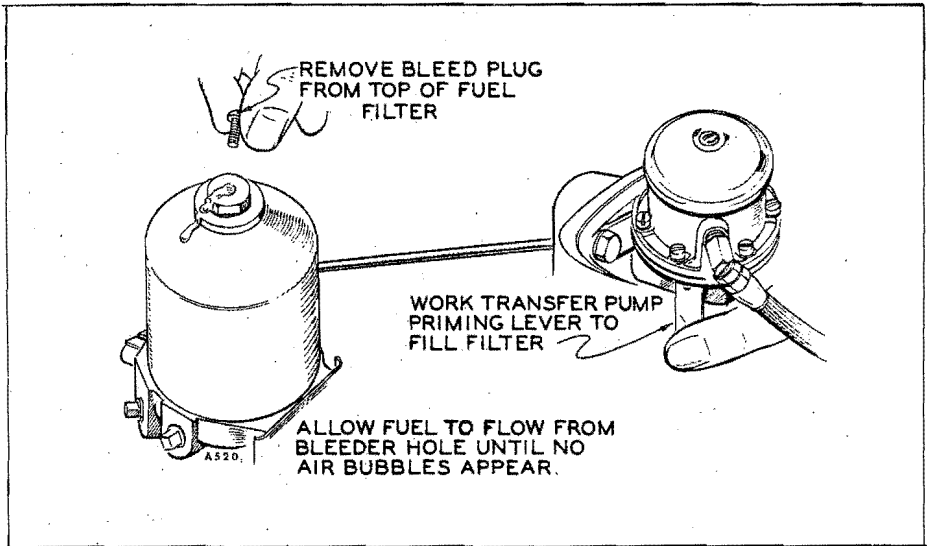


FIG. 14 - BLEEDING THE FUEL SYSTEM

Important!

Always GIVE THESE NUMBERS
WHEN ORDERING REPAIR PARTS OR
REQUESTING SERVICE INFORMATION
FOR YOUR UNIT!
WRITE IN NUMBERS SHOWN ON PLANT NAMEPLATE

MODEL & SPEC. NO.		SERIAL NO.	
ELECTRIC <i>Evan</i> PLAN		SERIAL NO.	
MODEL AND SPEC. NO.		SERIAL NO.	
IMPORTANT (PLEASE READ CAREFULLY WHEN ORDERING PARTS)			
A. C. VOLTS	FLY WHEEL	WATTS	
A. C. AMPERES	CYCLE	PHASE	
D. C. VOLTS	AMPERES	WATTS	
REF. NO.	DIS. J. NO.		
R. P. M.	TYPE	VOLT BATTERY	

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INJECTION PUMPS

- Injection pumps are highly precision built -- Close fits must hold high pressure.
- Fuel supplied to the injection pump must be clean!
- Avoid tampering with injection pump unnecessarily!
- Before disassembling, clean your hands, then dip hands in clean diesel fuel to avoid corrosion of lapped fit parts!
- Consult your dealer for latest exchange service or repair information!

STARTING THE PLANT

GENERAL. - These starting instructions apply to starting at temperatures of 50°F. and above. Instructions for starting at lower temperatures are given under Abnormal Operating Conditions section. Begin Spec C, a line transfer control gives suitable operation.

Check the entire installation to see that all connections and preparation have been made.

PRE-HEAT. - Hold the air heater switch at "ON" position up to two minutes if necessary.

CRANK. - Throw the momentary contact switch to START position and hold there until the engine is running fast enough to build up generator voltage. The engine will stop if the start switch is released too soon as current to the governor will be cut off. The engine cranks against compression and starts on compression.

A sharp fuel knock during starting is normal but should diminish as operating temperature is reached. If fuel knock continues, adjust the nozzle opening pressure as instructed under Adjustments section. At cold ambient temperatures, control ventilation so that operating temperature is not delayed.

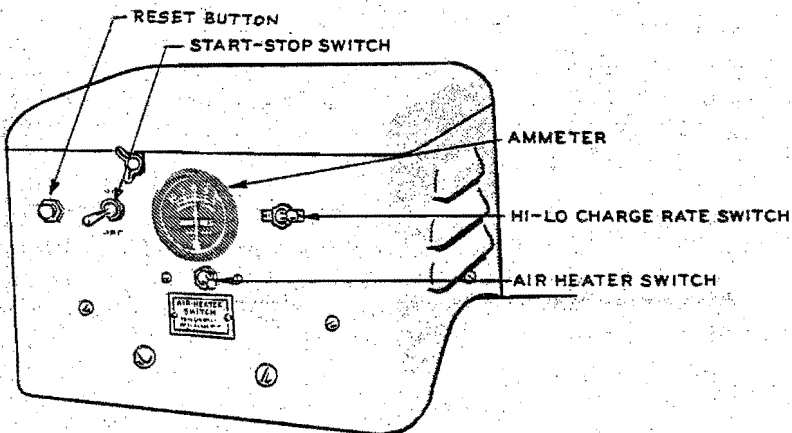


FIG. 15 - CONTROL PANEL

GENERAL FALSE START. - Begin Spec C units, push the reset switch after an automatic shut-down. If the engine fails to fire within about 1 minute, release the start switch and check the fuel system. If the engine still fails to fire, check for pre-heat circuit failure, and check governor operation. The air heaters and glow plugs heat only when cranking or pre-heating. The governor spring solenoid plunger should pull all-the-way in for starting and running.

If the engine fires but fails to keep running, or runs rough, bleed the fuel system to remove all air. If there is air in the system, check the suction line for air leaks. Normally the injection pump will dispose of air in the fuel through its continuous-bleed line.

If nozzle or injection pump fails, install a new part since a specialized repair is required. Avoid trouble by keeping fuel clean.

If cranking fails, check for a discharged battery and loose connections.

For other causes refer to the Troubles And Remedies section.

POINTS TO CHECK AFTER STARTING THE PLANT

OIL PRESSURE. - The pressure reading on the gauge should be 20 to 40 pounds at normal operating temperature. The reading will be higher with a cold engine. If pressure drops below 20 pounds, stop the plant at once and determine the cause. Correct the trouble before restarting the plant. Check first, for a faulty gauge. The oil pressure switch will automatically stop the plant when the oil pressure fails. The switch does not protect against a diminishing or LOW oil supply.

BATTERY CHARGING RATE (AC PLANTS). - A two way switch permits the selection of two charging rates, a high rate of 5 amps, and low rate of 1 to 2 amps. Use the high rate if the battery condition is down or the plant is to be run for only a short period of time. Use the low rate if the battery condition is up or the plant is to be run for a long period of time.

Keep the battery in a well charged condition at all times. The battery needs recharging if the specific gravity reading is 1.200 or lower. Keep the level of the fluid in the battery above the separators at all times. Fill each cell with clean distilled water to a point $\frac{3}{8}$ of an inch above the separators or as otherwise specified by the battery manufacturer.

ENGINE SPEED. - Engine speed was set at the factory. Adjust only when necessary. Refer to Adjustment section.

BLACK SMOKY EXHAUST. - Black smoke coming from the exhaust at less than rated generator capacity indicates faulty combustion, probably due to loss of compression or faulty injection. Continued operation under this condition may result in stuck rings, blow-by at the rings, or premature blackening of the crankcase oil from carbon. Refer to Troubles And Remedies section.

Black smoky exhaust is a normal condition with an overloaded generator. Remedy this condition by reducing the load.

ENGINE RACES. - Remedy the cause of too much fuel being injected into the combustion chamber. Reduce speed or stop the engine at once to avoid damage. Use quickest method to reduce speed, temporarily apply overload or close throttle enough by holding governor arm or link, or injection pump throttle lever.

See that governor linkage and levers are secure. See that governor solenoid plunger is not jammed. If governor is not at fault, test run with air cleaner oil cup removed and with breather hose disconnected to determine if oil carry over is the cause. See that air cleaner oil cup is not filled above oil level bead. Service crankcase breather valve and see that oil fill cap is air tight and that no other air leak destroys crankcase vacuum.

VALVE CLEARANCE. - Check the valve clearance at the end of the first 50 hours of running time. Check only as needed thereafter. Refer to **TABLE OF CLEARANCES** under Maintenance And Repair section.

STOPPING THE PLANT

OPERATION CAUTION!

CARBON DEPOSITS IN THE EXHAUST SYSTEM MAY OCCUR IN ENGINES CONSISTENTLY OPERATED AT VERY LIGHT LOAD!

The recommended remedy is to apply a dummy load consisting of lights or heating elements to create a total load greater than 1/2 the rated generator capacity. An alternate recommendation is to operate the plant at full load for about 5 minutes just before stopping.

If at least 1/2 rated capacity was being used from the plant, reduce the AC load and let the plant run for a few minutes at no load to allow the engine time to cool gradually before stopping.

Throw the Start-Stop switch to STOP position. This de-energizes the governor spring solenoid, the spring relaxes and the governor arm moves to stop position, shutting off the fuel supply.

If for any reason the plant will not stop when the Start-Stop switch is thrown to STOP position, stop the plant by pulling the governor arm to stop position by hand.

CONTROLS AND THEIR FUNCTIONS (AC PLANTS)

GENERAL. - An understanding of the purpose and function of each control component, as explained here, is beneficial for locating and correcting troubles that might occur. Trace the circuits on the wiring diagram as you read.

STARTING PILOT RELAY. - This relay operates only while the start switch is at start position. On Spec A and Spec B units, it closes the circuit of the governor solenoid relay, the manifold heater and glow plug relay, and built-in start solenoid pilot relay. Beginning with Spec C units, it closes the circuit of the separate start solenoid pilot relay and the stop relay. These relays operate on battery current. The starting pilot relay assures positive action of the other relays, especially during remote starting.

GOVERNOR SOLENOID RELAY (Specs A and B). - This relay completes the circuit to energize the governor solenoid. This pulls the governor spring, the throttle opens and fuel is supplied to the cylinders. The start switch must be held closed until the generator voltage builds up enough to continue holding the governor solenoid.

MANIFOLD HEATER AND GLOW PLUG RELAY. - This relay operates to complete the heating circuit. The manifold heaters warm the intake air stream to aid starting. Glow plugs, installed one in each cylinder head, help to ignite the fuel in the combustion chamber during the starting period. This relay operates whenever the start switch is at START position or the heater switch is at ON position. Begin Spec C units, the jumper must be in place between terminals H and 3.

START SOLENOID. - This solenoid feeds battery current to the starter for cranking.

LATCHING STOP RELAY (Begin Spec C). - When any safety switch operates, the latching stop relay becomes energized. This breaks the circuit to the governor solenoid. This also energizes its coil to electrically latch-in the latching stop relay. To reset this relay, push the reset switch.

RESET SWITCH (Begin Spec C). - This switch serves to break the circuit to the latch relay coil of the latching stop relay.

START DISCONNECT RELAY. - This relay opens the start solenoid pilot relay which terminates the cranking cycle.

GOVERNOR SOLENOID. - The solenoid operates the governor and must be energized to run - deenergized to stop.

START SOLENOID PILOT RELAY (Begin Spec C). - This relay controls the start solenoid.

TIME DELAY RELAY (Begin Spec C). - The relay delays action of the latching stop relay to allow for oil pressure build-up when starting.

STOP RELAY. - This relay controls the governor solenoid. Begin Spec C units, the latching stop relay is in the governor solenoid circuit. Also begin Spec C units, a resistor is in series with the stop relay coil during cranking when battery voltage energizes the stop relay. Pressing the start-stop switch to STOP position grounds out the coil of the stop relay. This breaks the circuit to the governor solenoid to stop the engine.

REVERSE CURRENT RELAY. - This relay has a shunt coil which is energized by the generator dc output. This closes the relay when generated voltage is higher than battery voltage, to charge the battery. A reverse current winding on this relay bucks the shunt winding to open the relay contacts when battery voltage becomes higher than generated voltage. This occurs when stopping the unit. It prevents discharge of battery.

HI-LO CHARGE SWITCH. - This switch controls the charging current to the starting battery by cutting resistance in or out of the circuit.

MANIFOLD HEATER AND GLOW PLUG SWITCH. - This switch permits manual operation of the heaters and glow plugs prior to starting. Begin Spec C units, the jumper must connect terminals H and 3, except when a line transfer control is used!

CHARGE AMMETER. - The ammeter indicates ampere rate of charge to or discharge from the starting battery.

START-STOP SWITCH. - This switch completes the start circuit at START position and the stop circuit at STOP position. CAUTION: Never release start switch while cranking hesitates on first compression strokes. High amperage arcing may damage start solenoid!

REMOTE TERMINAL BLOCK. - The terminal block facilitates installation of remote start-stop stations at convenient points. Begin Spec C, the jumper between H and 3 terminals must be removed only when a line transfer control is used. Then preheat cycle is controlled from the line transfer control.

COLD TEMPERATURE SUGGESTIONS

Full diesel engines fire on compression alone and starting problems may occur at temperatures of 50°F. and below. Read the following paragraphs for cold weather starting aids.

If the engine temperature is expected to drop low enough to require a lighter oil for starting, drain the crankcase oil while warm from running. Be sure to add oil before the next start.

To aid starting under cold conditions, use a viscosity oil in the crankcase just light enough to permit cranking and adequate lubrication. If necessary to use very light oil (as "Service DG", SAE No. 5W), and if heavy duty or continuous operation is expected, change the oil to SAE No. 30 as soon as the engine reaches operating temperature.

Be sure the fuel used has a low pour point (at least 10 degrees lower than the prevailing temperature) and will flow freely and not congeal in the lines. Fuel tends to congeal in the filters and fuel lines at low temperatures. If trouble of this nature occurs, warm the fuel or change to a No. 1 diesel fuel (or alternate) having a lower pour point.

The lowest temperature at which the fuel will flow through a pipe is known as the pour point or congealing point.

Fuel does not flow freely in cold weather and air locks may occur often. When bleeding the fuel system be sure to clear all air pockets.

The fuel in the combustion chamber is ignited by the rise in temperature of the air in the chamber due to compression. The glow plug helps ignite the fuel during the starting period. Also, two air heaters warm the intake air. Under cold conditions, preheat up to 2 minutes just before starting, by holding the heater switch at ON position.

Any means of increasing the temperature of the air being drawn into the combustion chamber will aid starting.

In extremely cold weather, heating the oil used in the air cleaner to around the boiling point of water should be helpful. The oil should be heated and then poured into the air cleaner cup. Heating should not be attempted while the oil is in the air cleaner as direct heat will damage the air cleaner unit.

CAUTION: DO NOT HEAT OIL OVER AN OPEN FLAME AND DO NOT OVERHEAT IT.

Crank the engine a few revolutions by hand to free it up before attempting to start it.

The battery capacity decreases with lowering temperatures. Because of this it is necessary to keep the battery fully charged at all times in order to crank a cold engine fast enough to start it. A temporary addition of a 12 volt battery, connected in parallel, during the starting period will improve cranking speed. Install this battery permanently if conditions require it. (Applies only to 12 volt system).

Check the charged condition of the battery often with a hydrometer. Batteries will freeze between temperatures of 20°F. above zero and 50°F. below zero, depending on the state of charge.

Drain, clean and replace element in the fuel filter only as necessary to keep the fuel clean. Remember that any foreign particles that enter beyond the filter during cleaning will be forced into the injection pump and will probably cause trouble.

Keep all fuel tank screens clean.

Keep supplies of fuel free of water. If fuel containing water is used, it may freeze and close off the fuel supply.

Let the engine warm up so that oil circulates freely before applying the load. Watch the oil pressure.

HOT TEMPERATURE SUGGESTIONS

Keep the level of the oil in the engine crankcase at or near the full mark at all times.

Be sure there is ample ventilation so that radiated heat from the engine is not recirculated. Provide more or larger air inlets if necessary.

Keep all cooling surfaces clean and free of dust, dirt and grease or oil.

DUST AND DIRT

Check plant operation more often and service as needed.

Service the air cleaner as often as necessary to assure a free passage of air. Sufficient fresh air is necessary for full power output.

Check the commutator and brushes of the generator often and see that the brushes ride freely in their holders and make good contact. See GENERATOR under Maintenance And Repair for service instructions.

Keep supplies of fuel and oil in airtight containers.

Keep the plant as clean as practicable.

ONAN ENGINE SERVICE CHART

The following recommended Engine Service Chart may be used as a guide for servicing ONAN Diesel Engines.

The chart is based on favorable operating conditions. The actual service period may be somewhat longer or shorter than shown - depending on operating conditions.

HOURS OF OPERATION

SERVICE REQUIRED

	100	200	300	400	500	600	700	800	900	1000	2000
Change oil (check level daily).....	X	X	X	X	X	X	X	X	X	X	
*Service air cleaner	X	X	X	X	X	X	X	X	X	X	
Clean crankcase breather	X	X	X	X	X	X	X	X	X	X	
Replace oil filter cartridge	X	X	X	X	X	X	X	X	X	X	
Inspect generator brushes, commutator, slip rings		X		X		X		X		X	
Clean primary fuel filter										X	X
Drain sludge at secondary filter .										X	X
Check valve tappets	X									X	X
Clean engine and oil base											X
Clean injection nozzles	As Required										
Replace secondary fuel filter cartridge .	As Required										
Grind valves & remove deposits.	As Required										
Replace valve, piston rings, etc. .	As Required										

* Check the air cleaner often. Thoroughly clean and put in fresh oil at least every 100 hours. Install a heavy duty air cleaner if necessary.

If it is necessary to remove parts for inspection and gaskets are disturbed they should be replaced with new ones.

Periodic Inspection: For Loose or Poor Connections, Fittings, etc.

Recommended Oil: Heavy Duty Detergent or Oil designated for Service DG, DS or MS/DG. Use the proper SAE number oil for the lowest temperature at the engine as expected at the time of starting. Above 40°F. (4°C.) use SAE 30. Below 40°F. (4°C.) use SAE 10.

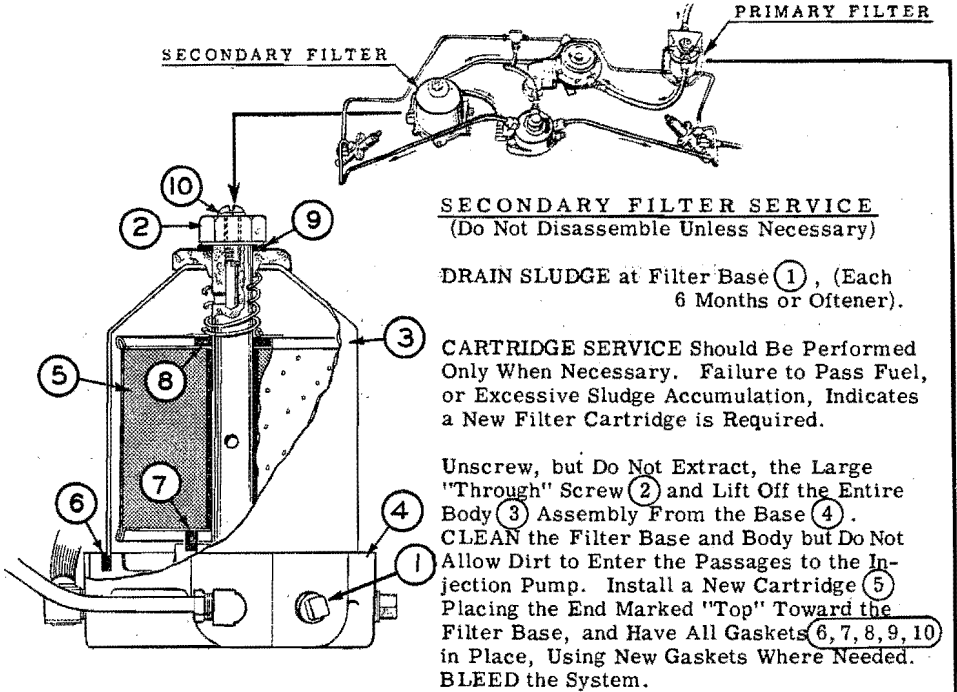
Recommended Fuel: No. 2 furnace oil. Premium diesel fuels are not required.

Alternate Fuel: No. 2 furnace oil (distillate and range oil) and kerosene may be used but one quart (U.S. Measure) of SAE No. 30 lubricating oil should be added to each 25 gallons of such fuel to provide lubrication for fuel injection equipment.

Keep engine clean.

**THE BEST PROTECTION AGAINST FILTER TROUBLE
IS THE USE OF CLEAN FUEL**

Filters Should Be Cleaned Only When Necessary. The Primary Filter May Have To Be Cleaned Several Times Before It Becomes Necessary To Clean The Secondary Filter.

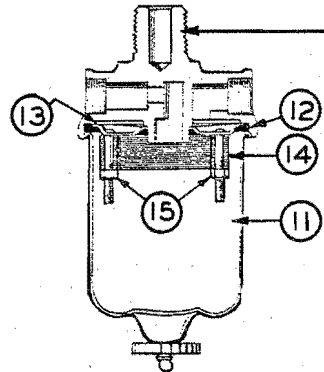


PRIMARY FILTER SERVICE

EMPTY WATER and SEDIMENT from Bowl (11) (Each 6 Months or 1200 Operating Hours). The Bowl Supports the Strainer Element and Gasket. CATCH THEM !

Bowl to Cover Gasket (12) is Reusable with Successive Emptyings of Bowl. However, Renew Both Bowl to Cover Gasket (12) and Strainer to Cover Fiber Gasket (13) with Each Cleaning of Brass Disc Strainer Element (14).

CLEAN Strainer ELEMENT (14) Only When It Will Not Pass Fuel ! Loosen Nuts (15) and Carefully Separate Discs. Submerge and Swish in Clean Diesel Fuel or Suitable Solvent. Have Clean Hands ! Rinse Thoroughly in Clean Fuel. Either Dry with Compressed Air or Leave Element Wet. Retighten Nuts. Prevent Dirt from Entering Internal Area of Discs.



WHEN CLEANING FUEL SYSTEM INTERNAL PARTS, "SWISH" THEM THOROUGHLY IN CLEAN DIESEL FUEL. DO NOT ATTEMPT TO WIPE DRY. HAVE HANDS CLEAN. BE THOROUGH !

GENERAL. - Certain services must be performed periodically if the plant is to continue operating efficiently and economically. Service periods are based on hours of running time under normal operating conditions. For extreme conditions of load, temperature, dust, dirt, etc., service more often. The operator should enter dates serviced on a service chart.

DAILY SERVICE

Perform the following services daily or at the end of each 8 hours of running time, whichever occurs first.

FUEL. - Check the fuel supply often enough to avoid running out of fuel. Use only clean containers and clean fuel as recommended under Preparation or Abnormal Operating Conditions sections.

CRANKCASE OIL. - Check the oil level in the crankcase. Fill to the full mark with SAE No. 30 oil (A. P. I. Service "DG") or as otherwise recommended for low temperature starting. Replace the fill cap securely.

AIR CLEANER. - Check the oil level in the air cleaner cup. If necessary add oil of the same SAE No. as used in the engine crankcase.

CLEANING. - Keep the plant clean.

WEEKLY SERVICE

Perform the following services weekly or at the end of each 50 hours of running time, whichever occurs first.

CRANKCASE OIL. - Change the crankcase lubricating oil every 100 hours of running time unless sludge formation or condensation forms during cold weather operation. Then, change oil more often. Change the oil filter cartridge each time the crankcase oil is changed. Remove the old oil from the filter before replacing the cartridge.

GOVERNOR LINKAGE. - If available, use only powdered graphite on the governor linkage ball joint, otherwise, use a light non-gummy oil. On other joints of the governor to throttle linkage, place a drop of SAE No. 30 oil. Do not put oil on the governor spring solenoid plunger, instead keep it clean and dry.

BATTERY. - Check the level of the fluid in the starting batteries. Add distilled water, if necessary, to bring the fluid to 3/8" above the separators, or as otherwise recommended by the battery manufacturer.

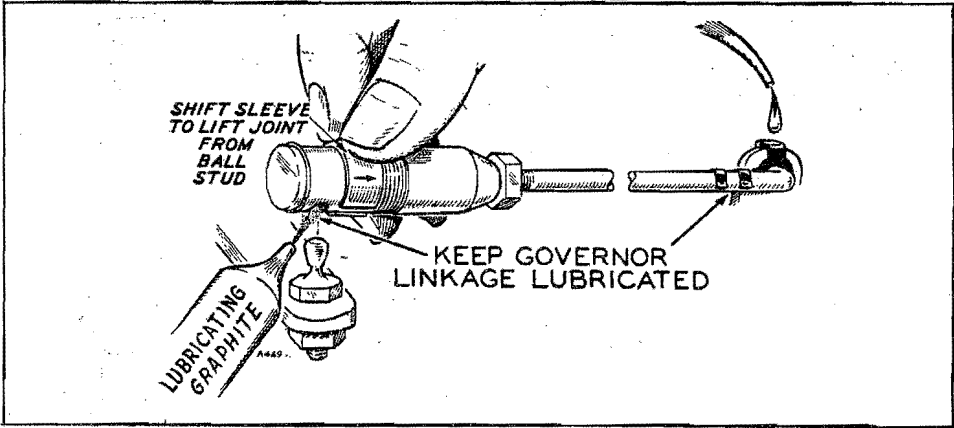


FIG. 17 - GOVERNOR LINKAGE

AIR CLEANER. - Thoroughly clean the air cleaner cup in diesel fuel and refill the cup to the level indicated on the cup with oil of the same SAE No. as used in the engine crankcase, except as noted under Abnormal Operating Conditions section.

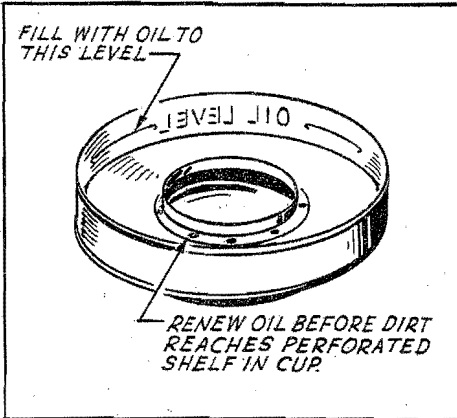


FIG. 18 - AIR CLEANER

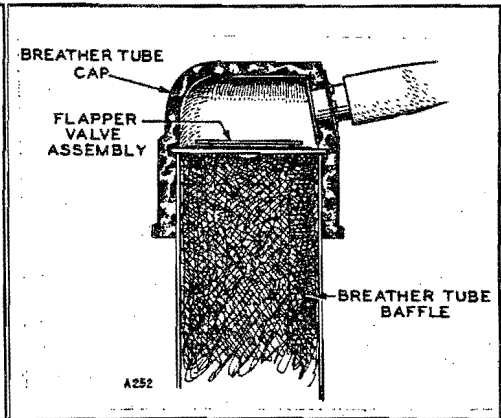


FIG. 19 - BREATHER VALVE

CRANKCASE BREATHER VALVE. - The breather valve helps maintain a partial vacuum in the engine crankcase while the engine is running. If the flapper valve is not working properly, or if there is an air leak, the vacuum may be destroyed and excessive oil consumption or oil leakage may result.

Each 100 operating hours, lift off the rubber breather cap. The breather valve is a flapper type check valve and will usually lift off with and remain inside the cap. To inspect and thoroughly clean the breather valve, work it out of the cap groove. If a screw driver or blunt tool is used, work the end at least 1/2 inch past the edge of the valve before prying because a short bite may accidentally chew the valve diaphragm.

Clean the valve thoroughly with diesel fuel or other solvent. Replace the valve with a new one if the flapper diaphragm is worn or damaged so as to prevent proper seating to the perforated disc.

If the metal mesh type baffle in the breather tube is badly restricted by sludge, etc., lift it out and clean it or install a new baffle. Avoid crushing the baffle. Do not remove the breather tube from the crankcase.

Install the valve on the breather tube, making sure it is diaphragm-side up, then press the cap all-the-way down over the valve and breather tube.

INSPECTION. - Tighten all loose nuts, bolts, connections, etc.

VALVE CLEARANCE. - Check the valve clearance at the end of the first 50 hours of running time. Reset the valve clearance if necessary.

MONTHLY SERVICE

Perform the following services monthly or at the end of each 200 hours of running time, whichever occurs first.

GENERATOR. - Check the generator brushes. Brushes worn to 5/8 inch in length should be replaced.

Check the commutator (and collector rings, ac plants). Brush surfaces must be smooth and cylindrical to assure good brush contact. See **GENERATOR** under Maintenance And Repair section for repair instructions.

EXHAUST. - Inspect exhaust connections. Tighten or replace parts requiring it. Remove carbon deposits if conditions require.

VALVES. - Valve grinding is a service that must be performed periodically if the engine is to continue operating efficiently. Hard starting, low power or excessive fuel or oil consumption, indicate a low compression condition. An engine in good running condition should have a compression reading of at least 370 pounds per square inch at 70°F. Because only specialized Diesel repair shops are likely to be equipped to measure compression, symptoms of low compression can usually be the guide for determining repair intervals.

Loss of compression may be due to a poor valve condition, worn or sticking piston rings, worn piston ring grooves, or to worn cylinder walls. If the exhaust valve is leaking, it can be heard at the exhaust outlet on the plant. If the intake valve is leaking, a hissing noise will be heard at the air cleaner opening. A compression leak past the piston rings can be heard at the oil fill opening. Refer to Maintenance And Repair section.

FUEL SYSTEM. - Necessary fuel filter service is dependent upon the cleanliness of the fuel used. Engine operation is the best indication of necessary filter service. Refer to the page herein on **SERVICING THE FUEL FILTER**. The primary filter may have to be serviced several times before it is necessary to service the secondary

filter. The factory recommends having a spare secondary fuel filter cartridge (element) on hand for use if trouble occurs. More damage may result from dirt getting into the fuel system during periodic servicing of the filters than might be gained by a periodic service aimed at preventing trouble.

Fuel filter must be assembled air tight. Bleed the fuel line in accordance with instructions under Preparation section, after the fuel filter is serviced.

The injection pump is an expensive part of the machine. Remember a particle of grit as fine as face powder can score the pump plunger and destroy its seal in the bore. Water and sediment will settle to the bottom of the primary filter bowl when the plant is stopped. To determine if plant failure is due to air leakage before the transfer pump, temporarily test by raising the fuel supply to give gravity feed rather than suction.

SEMI-YEARLY SERVICE

Perform the following services every six months or after each 1200 hours of running time, whichever occurs first.

GENERATOR. - Check the generator brush rig to see that it has not shifted from its original position. Operation of the generator with the brushes out of "neutral" position causes rapid brush wear and excessive arcing of the brushes. A chisel mark on the brush rig ring against the support in the end bell was made at the factory to indicate the "neutral brush position".

The generator has a double-sealed pre-lubricated bearing which does NOT require future greasing.

EXHAUST. - Inspect the exhaust system for carbon deposits. Carbon removal is necessary especially if the plant is consistently operated at very light load. Operating at full load for about 5 minutes just prior to stopping the plant will help eliminate carbon accumulation.

GOVERNOR. - The governor is set at the factory to maintain close regulation of engine speed and generator voltage, within the limits given herein, and according to the plant nameplate rating. The governor seldom requires additional adjustment. If necessary, it should be adjusted by someone properly equipped and experienced with generating plants. Study carefully the following paragraphs and check each point in the order given.

A. GOVERNOR ADJUSTMENT PROCEDURE. - Check the position of the governor arm, the throttle lever, and the governor linkage. Make adjustments as instructed under **GOVERNOR ARM AND LINKAGE** and **THROTTLE LEVER AND THROTTLE LEVER STOP**, if necessary.

After the governor arm, throttle lever and linkage have been carefully adjusted as instructed, start the plant and check the no load rpm. Correct as instructed under **SPEED ADJUSTMENT**, if necessary.

When all other adjustments have been completed, check the rpm between no load and full load. Make adjustments as instructed under **SENSITIVITY ADJUSTMENT**, if necessary.

B. GOVERNOR ARM AND LINKAGE. - Check the governor arm and linkage and the throttle lever for a binding condition and for excessive slack or wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness will cause a hunting condition and regulation will be erratic. Work the arm back and forth several times by hand while the plant is stopped. If either of these conditions exist, find out at which point the trouble lies and adjust or replace the part as required.

The correct linkage length adjustment causes the flyballs to operate at a satisfactory radius on the governor cup race. If new parts are being installed, turn the ball joint on the governor link leaving about $5/8$ inch of threads visible. Readjust later if necessary to attain speed and sensitivity regulation. Then, when the ball joint is disconnected (shift sleeve to release) from its ball stud, the end of the governor arm should have about $1/2$ inch additional travel available in the direction pulled by the spring, before the flyballs are held all-the-way in by the governor cup and yoke.

C. THROTTLE LEVER AND STOP SCREWS. - One extended pump assembly screw serves as a fixed throttle lever bumper at engine **STOP** position.

The screw at full throttle or **RUN** position serves to stop the throttle lever at smoke point when load is gradually increased above rated load while running at rated speed. This screw also affects starting performance. On many installations the load requirement is nearly constant between successive operations. In these cases set the full-throttle stop

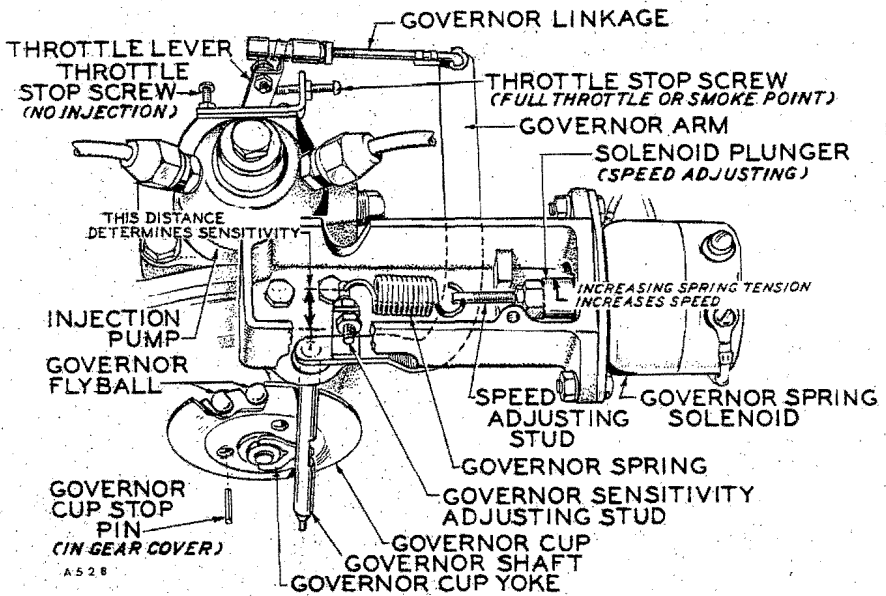


FIG. 20 - GOVERNOR ADJUSTMENTS

screw just far enough away from the lever to not disturb governor regulation at peak load, so that during cranking the least amount of fuel is injected.

Do not change the position of the throttle lever where it is clamped to the throttle shaft. On most engines the throttle lever is approximately straight up at rated load operation. If lever adjustment is necessary, loosen the lever screw, attain the correct lever position, retighten the screw, then if necessary, adjust the governor linkage length. When re-assembling the pump the throttle shaft control finger must be engaged (see injection pump instructions). One method to again determine the correct lever position is to remove and reconnect the nozzle to watch the fuel spray while holding the throttle shaft and cranking the engine. At stop position no fuel should be injected.

D. GOVERNOR SPRING. - Because springs may become fatigued and lose their original tension from long usage it is sometimes necessary to replace the governor spring to get proper regulation.

It is difficult to determine whether or not a spring is fatigued. Usually if all other adjustments have been properly made and regulation is still erratic, the trouble can be corrected by replacing the governor spring and resetting the sensitivity and speed adjusting screw.

E. GOVERNOR SPEED ADJUSTMENT. - The speed at which the engine operates is determined by the tension applied to the governor spring. Engine speed also determines the output voltage of the generator. Increasing spring tension increases engine speed and generator voltage. Decreasing spring tension decreases engine speed and generator voltage.

To increase speed turn solenoid plunger farther onto the stud for more spring tension when solenoid engages plunger. To decrease speed turn plunger farther off the stud. Lock the adjustment with the nut.

Speed tests and voltage tests should be made when the plant is warm, running for at least one hour before the final test is made. Voltage limits for circuits of voltages other than shown below, will be multiples of those shown. Always check the voltage of each phase to detect an abnormal condition or fault. On 4 wire plants, the lower voltage (line to neutral) is always correct when regulation is correct for the higher rated voltage (line to line). Check engine speed with a tachometer.

Nominal engine speed and generator voltage should be as follows:

AC PLANTS: Maximum no load engine speed should not be more than 1920 rpm for 60 cycle plants, nor more than 1710 rpm for 50 cycle plants.

Maximum no load voltage should not be more than 126 volts for 120 volt circuits, nor more than 252 volts for 240 volt circuits. Voltage limits for circuits of other voltages will be multiples of these shown.

Minimum engine speed at full rated generator capacity should not be less than 1710 rpm for 60 cycle plants, nor less than 1500 rpm for 50 cycle plants.

Minimum voltage at full rated generator capacity should not be less than 110 volts for 120 volt circuits nor less than 220 volts for 240 volt circuits.

Maximum speed drop from no load to full load should not be more than 60 rpm.

F. GOVERNOR SENSITIVITY ADJUSTMENT. - The position of the sensitivity adjusting screw controls the travel and leverage of the governor spring and determines the rpm spread between no load and full load. This rpm difference should not be more than 60 rpm (for ac output). Check with a tachometer.

For more speed drop from no load to full load, turn the sensitivity screw out. For less speed drop from no load to full load, turn the sensitivity screw in. Always recheck engine speed after making a sensitivity adjustment. Retighten the nuts to lock the final adjustment.

A hunting condition (engine alternately increasing and decreasing speed) may result from the rpm between no load and full load being too low. If this condition exists, turn the sensitivity screw out until the condition is corrected. Regulation is better with the end of the spring held closer to the governor shaft but the tendency to hunt is increased. Make the adjustment that gives the best regulation with no hunting. A more likely cause of the engine hunting is insufficient fuel supplied to the injection pump.

ADJUSTING VALVE TAPPET CLEARANCE. - Remove the top plate from each rocker box.

Turn the crankshaft until the valves of the left hand (number 1) cylinder open and close and continue about 1/2 turn until the TC (Top Center) mark on the flywheel and the mark on the edge of the flywheel housing timing hole are in alignment. This will be the compression stroke for that cylinder.

Valve tappet clearance is for cold setting. The push rods are the steel type and valve tappet clearance is 0.015" for both intake and exhaust. Place a 0.015" feeler gauge between the exhaust valve stem and the rocker arm and turn the self-locking screw in or out with a wrench as required to correct the clearance. The feeler gauge should have just a slight drag on it when moved back and forth if the clearance is correct.

Turn the flywheel over one complete revolution and again align the TC mark and the timing hole mark. Then adjust valve tappet clearance for the right hand (number 2) cylinder in the same manner.

Reinstall all parts removed.

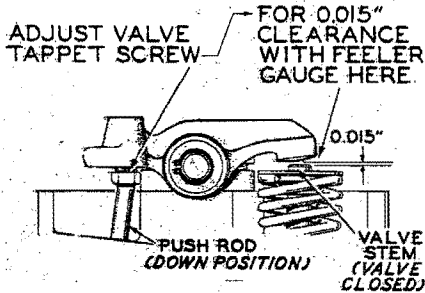


FIG. 21 - VALVE TAPPET CLEARANCE

NOZZLE ADJUSTMENT. - A nozzle adjustment is recommended only as a measure of correcting a fuel knock resulting from a change in the type of fuel used. Then both nozzles may require adjusting. Otherwise the original setting should not be disturbed. The adjustment is made as follows:

Start the unit and allow it to run until thoroughly warmed up. Then apply a full load.

Remove the top cover (A) and gasket from the nozzle holder. See the illustration **NOZZLE ADJUSTMENT**.

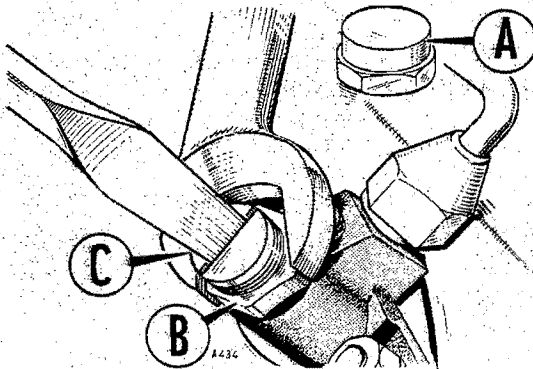


FIG. 22 - NOZZLE ADJUSTMENT

Loosen the locknut **B** just enough to allow the adjusting screw **C** to turn.

Insert a screwdriver into the screwdriver slot of the adjusting screw **C**. Hold a wrench on locknut **B** and turn the screw **C** in first one direction and then the other until fuel knock is least noticeable. **CAUTION:** Do not turn the adjusting screw **C** more than one turn in either direction from its original position.

Lock the adjusting screw locknut **B** securely after making an adjustment. Then replace the cover **A** securely, being sure the two thin washers are in place under the cover and locknut.

NOTE: Nozzles are adjusted at the factory to operate at 1750 to 1800 pounds (per sq. inch) pressure. Nozzle pressure should be the same for both nozzles. If necessary, have the nozzles checked on a nozzle tester to assure even pressure.

TIMING THE INJECTION PUMP TO THE ENGINE. - Correct timing is 8° Before Top
Center (B. T. C.) - Port Opening (PO),

The fuel injection pump is timed to the engine at the factory and should not require future retiming. However, when new parts are installed or if trouble occurs, see that timing is correct. The pump will be out of time also if engine parts which drive the pump are incorrectly assembled.

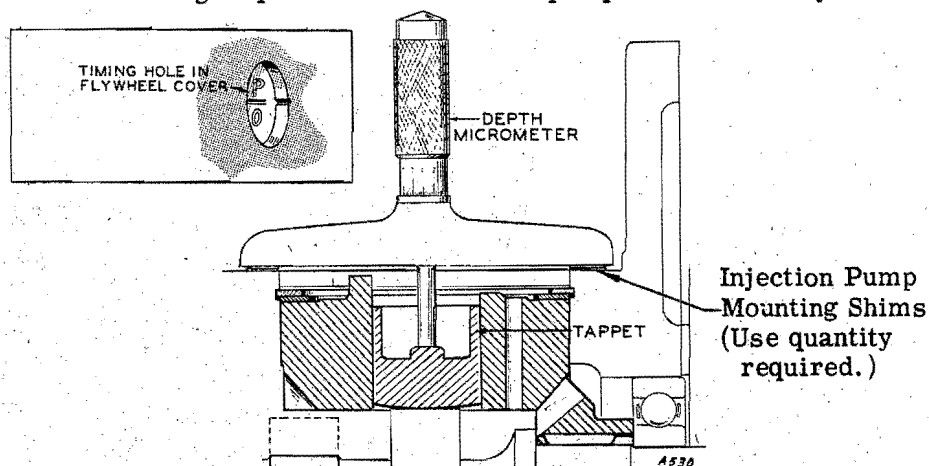


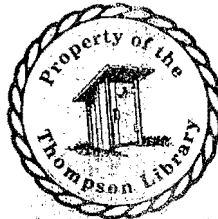
FIG. 23 - TIMING THE INJECTION PUMP TO THE ENGINE

Use the hand crank to align the PO mark on the flywheel with the mark inside the timing hole in the flywheel housing.

A distance (approximately $5/8$ inch) is marked in thousands of an inch

on the bottom of each pump. Use the proper number of .005" thick mounting shims under the injection pump so that, when the flywheel is stopped exactly at its PO mark, the distance from the tappet to the top of the shims is within .003 inch of the figure marked on the bottom of the injection pump. Use a depth micrometer (measuring tool) to measure the distance. This should result in fuel injection ending (Port Opening) when the flywheel is within 1 degree of the PO timing mark.

To install the injection pump refer to the instructions in Maintenance And Repair section. Then, bleed the fuel system as instructed in Preparation section.



GENERAL. - Repairs should be made by a competent mechanic familiar with diesel engines and electric generator plants. Refer to the Troubles And Remedies section for service diagnosis. Before re-finishing to use an oversize or undersize part be sure the size desired is available. Maintain fits and clearances as given in the Table of Clearances.

TABLE OF CLEARANCES

	MINIMUM	MAXIMUM
Valve Rocker Arm Clearance - Cold .....		.015"
Valve Face Angle		44°
Valve Seat Angle		45°
Valve Stem Clearance in Guide - Exhaust ..	.003"	.0045"
Valve Stem Clearance in Guide - Intake ...	.0015"	.003"
Valve Seat Width	3/64"	1/16"
Valve Guide Height Above Head		13/16"
Crankshaft Main Bearing Clearance .....	.0025"	.004"
Crankshaft Rod Journal - Standard Size ...	2.3745"	2.3750"
Crankshaft Endplay .....	.015"	.020"
Camshaft Bearing Clearance .....	.001"	.003"
Camshaft Endplay .....	.003"	
Connecting Rod Bearing Clearance - Forged Steel Rod with Precision Type Bearings (Measured in line with length of rod) .....	.001"	.003"
Connecting Rod Endplay .....	.002"	.011"
Timing Gear Backlash .....	.001"	.006"
Oil Pump Gear Backlash .....	.003"	.005"
Piston Clearance in Cylinder (at bottom of skirt) .....	.0035"	.0055"
Piston Pin Clearance in Piston - tap fit ...	.0000"	.0003"
Piston Pin Clearance in Rod Bushings ...	.0002"	.0007"
Top Compression Ring Gap in Cylinder ...	.010"	.020"
Other Compression Rings and Oil Ring Gap in Cylinder .....	.010"	.015"
Injection Pump Timing- 8° BTC - P. O. ...	Shim to PO distance on pump.	
Exhaust Valve Head to Face of Cylinder Head (Maintain by grinding new seat) ....	.030"	
Cylinder Bore - Standard Size	3.5015"	3.5025"
Crankshaft Main Bearing Journal-Std. Size.	2.7495"	2.7500"
Piston Pin - Standard Size	1.1875"	1.1877"
Injection Nozzle Opening Pressure	1750 Lbs. minus 0, plus 50	

ASSEMBLY TORQUES

Assembly torques as given here require the use of a torque indicating wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts, and screws often. Tighten as needed to prevent them from working loose. Specially designed "Place Bolts" do not require a lock washer nor a gasket under their heads.

CYLINDER HEAD STUDS AND NUTS. - 70 pounds foot torque.
 CONNECTING ROD PLACE BOLTS (no locks). - 40 to 45 lbs. foot torque.
 ARMATURE THRU STUD AND NUT. - 40 to 45 pounds foot torque.
 NOZZLE HOLDER. - 15 to 20 pounds foot torque.
 BEARING PLATE PLACE BOLTS (no locks) . - 45 to 50 pounds foot torque.
 INJECTION PUMP. - 20 to 25 pounds foot torque.
 INJECTION PUMP DELIVERY VALVE CAP. - 20 lbs. ft. torque maximum.

ENGINE

CYLINDER. - The cylinder can be removed over the pistons without loosening the connecting rods. Base gaskets of different thicknesses space each cylinder and affect compression ratio. Use the THINNEST gasket or combination of gaskets which PREVENTS the piston from extending above the cylinder. Support the cylinder as illustrated, to measure the piston travel at top center so that compression ratio is the same for both cylinders.

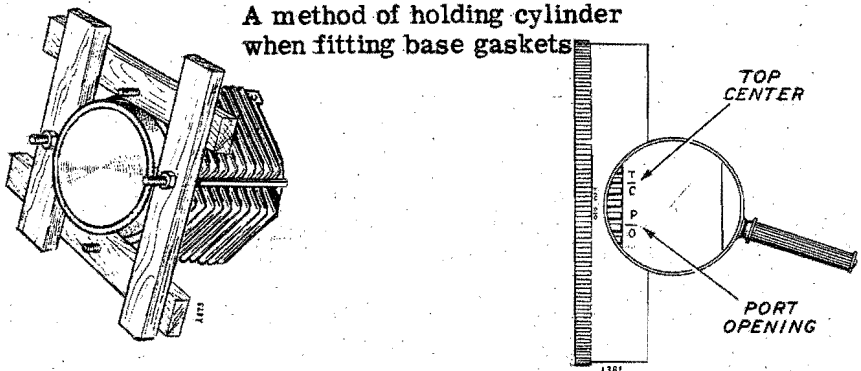


FIG. 24 - CHECKING PISTON TRAVEL IN CYLINDER

The cylinder bore of a new engine is 3.5015 to 3.5025". If the new engine was bored to oversize originally the bore will be .005" oversize. If the cylinder bore measures more than .005" out of true, the cylinder should be refinished to use the next available oversize piston. Pistons and piston rings are available in .010", .020", and .030" oversize. Use standard size rings with .005" oversize.

If the cylinder does not need refinishing, remove any existing ridge from the top of the cylinder wall.

PISTONS AND RINGS. - Remove all carbon deposits. Rings must work freely in the piston grooves. Lubricate cylinder wall before installing piston.

Fit each ring singly to the cylinder at the bottom of its travel. Refer to Table of Clearances for proper gap. The proper size ring requires little or no filing.

Install the compression rings with the beveled inside edge (marked "TOP") nearer the closed end of the piston. Install the oil control ring with the beveled outside edge nearer the closed end of the piston. Apply oil liberally and space the ring gaps equally around the piston, with no gap directly in line with the piston pin.

Install a new piston if the piston is badly scored or burned, has badly worn ring grooves, is very loose in the cylinder or is worn so that a .002" oversize pin will not correct the fit.

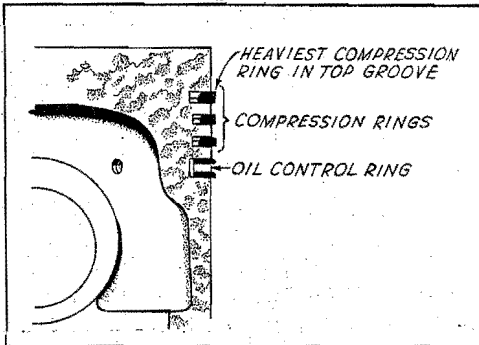


FIG. 25 - PISTON RINGS

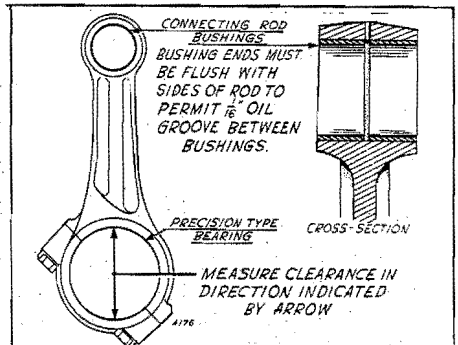


FIG. 26 - CONNECTING RODS

CONNECTING RODS. - The rods are forged steel with replaceable bushings and bearings. Observe and mark each rod and cap to assure reinstalling them together and to the same journal of the crankshaft.

For fits refer to the Table of Clearances. Bearings and rods are available in undersize and piston pins are available in oversize. See the parts list.

When replacing the connecting rod pin bushings, install a bushing from each side, flush with the rod, to allow a 1/16" oil groove at the center, then finish ream the bushings.

The rod lower bearings are precision type and require no reaming.

The connecting rod and cap for the cylinder farthest from the timing gears is numbered 2, for identification as to position. See that rod and cap reference marks align, and that the rod is centered on the piston pin. Coat the crankshaft journal with oil before installing the rods. Crank the engine by hand to be sure that the rods are free. If necessary, rap the rod cap sharply to set the rod squarely on its journal.

VALVE SERVICE. - The valves are of the overhead type and are located in the heads. If the cylinder heads stick, rap sharply with a heavy soft hammer to loosen. Do not use a pry.

Clean all carbon deposits and gasket surfaces. Replace any valves that are badly burned or pitted, have badly worn or warped stems, or that will have a thin edge when refaced. Replace valve guides that are badly worn.

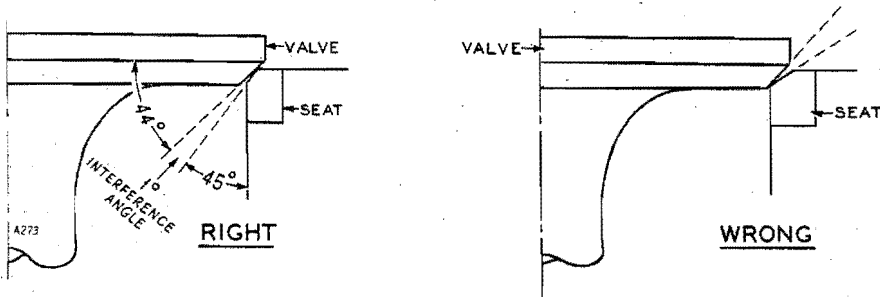


FIG. 27 - VALVE GRINDING

The valve FACE angle is 44° . The valve SEAT angle is 45° . This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life.

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite-faced valves and seats are used. Valve faces should be finished in a machine to 44° . Valve seats should be ground with a 45° stone, and the width of the seat band should be $3/64$ to $1/16$ of an inch wide.

When installing a NEW exhaust valve insert seat, maintain a minimum clearance of 0.030" from the exhaust valve head to the face of cylinder head by grinding the seat.

Remove all grinding dust from engine parts and place each valve in the cylinder head. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Reassemble all parts removed and adjust the valve clearance.

GEAR COVER. - Remove the gear cover mounting screws, then tap the gear cover gently with a soft hammer to loosen it.

When installing the gear cover, work the governor shaft to check for no binding. If the governor shaft collar was loosened, see that the governor-shaft-end-thrust ball has not been lost. Governor shaft end play should be .010" to .020". Have the governor yoke turned so that the smooth side contacts the governor cup.

Position the governor cup so that the metal lined (smoothest) hole in the cup will engage with the stop pin located in the gear cover. The distance from the end of the stop pin to the mounting face of the gear cover should be 3/4 inch. Carefully center the gear cover so as to avoid any off cen-

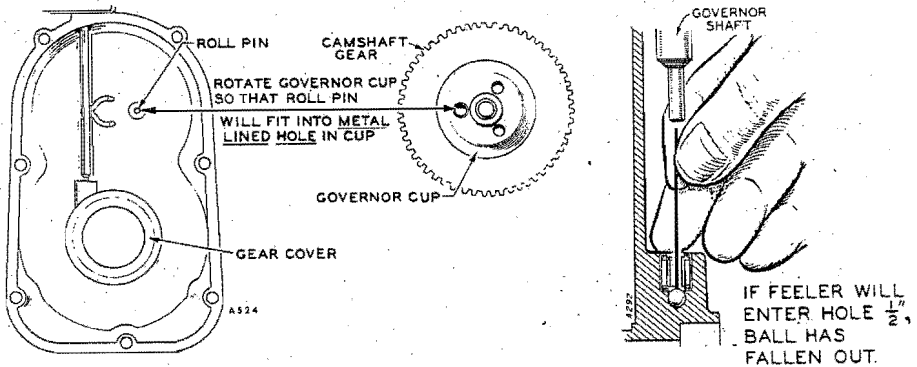


FIG. 28 - INSTALLING THE GEAR COVER

ter effect between the oil seal and the crankshaft. Hold in the centered position while tightening the mounting screws securely. Avoid damaging the oil seal.

GOVERNOR CUP. - With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the fly balls (10 in all) while sliding the cup off.

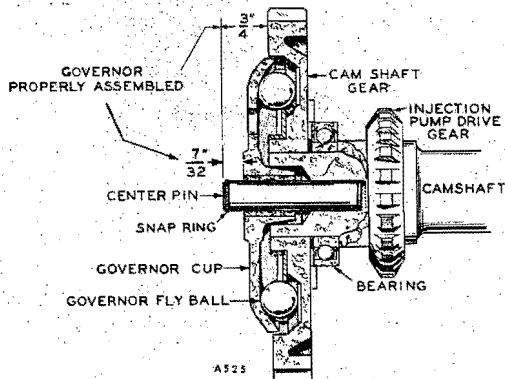


FIG. 29 - GOVERNOR CUP

Replace with a new part, any fly ball which is grooved or has a flat spot, the ball spacer if its arms are worn or otherwise damaged, and the governor cup if the race surface is grooved or rough. The governor cup must be a free spinning fit on the camshaft center pin, but without any excessive looseness or wobble.

When installing the governor cup, tilt the engine so the gear is up, put the 10 flyballs in place, and install the cup and snap ring on the center pin.

The camshaft center pin extends out $3/4$ " from the end of the camshaft. This distance provides an in and out travel distance of $7/32$ " for the governor cup, as illustrated. Hold the cup against the fly balls when measuring. If the distance is less (the engine may race especially at no load), remove the center pin and press a new pin in only the required amount. Otherwise, grind off the hub of the cup as required. The camshaft center pin can not be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the fly balls properly while stopped.

CAMSHAFT. - After removing parts (pump, tappets, injection pump, driven gear and tappet) operated by the camshaft, remove the camshaft as an assembly with governor cup, etc. attached. Remove the washer from the crankshaft, then carefully pry behind the camshaft gear to work the camshaft out of the crankcase.

If a lobe of the camshaft has become slightly scored, dress it smooth with a fine stone. A badly worn or scored camshaft must be replaced with a new one. Refer to GOVERNOR CUP paragraph for center pin instructions. Refer to CAMSHAFT GEAR paragraph for reinstallation.

CAMSHAFT GEAR. - The camshaft gear is available only as part of a matched gear set. Remove the camshaft and gear assembled. The gear is keyed and pressed on to the camshaft. After removing the governor cup, etc., use a hollow tool or pipe of the proper diameter to fit inside the gear bore and over the camshaft center pin. Press the camshaft out of the gear bore, taking extreme care not to press on the camshaft center pin.

When installing a camshaft gear to the camshaft, be sure the spacing washer is against the ball bearing inner race and have the key properly in place. Assemble the governor cup, etc. and have the large thrust washer in place around the ball bearing outer race before installing to the engine.

When installing to the engine, be sure the marked tooth of the camshaft gear meshes with the marked tooth of the crankshaft gear, as illustrated.

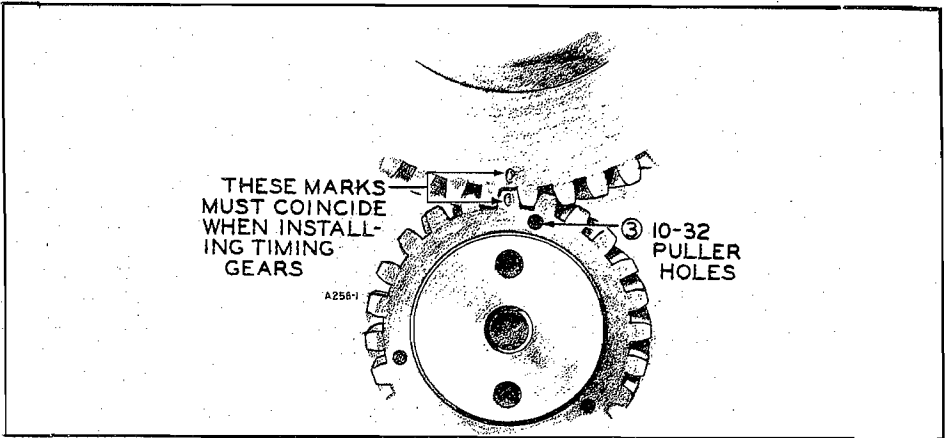


FIG. 30 - TIMING GEAR MARKS

CRANKSHAFT GEAR. - The crankshaft gear is available only as part of a matched gear set.

The crankshaft gear is keyed and a drive fit to the crankshaft and is fastened with a lock ring. The gear has three 10-32 tapped holes for attaching a gear pulling ring, or a bolt-on type puller. Use care not to damage any teeth if the gear is to be reused.

When installing a crankshaft gear, see that its key is in place, have the "o" timing mark outward and meshed with the "o" marked tooth on the camshaft gear, and drive the gear on up to the crankshaft shoulder.

CRANKSHAFT. - See that the oil passages of the crankshaft are clean and free of obstructions. These oil passages conduct oil from the main bearing journals to the connecting rod journals. If the bearing journals become worn out of round or scored, refinish to use undersize bearings. If either oil seal contact surface becomes grooved or scored, refinish and polish smooth.

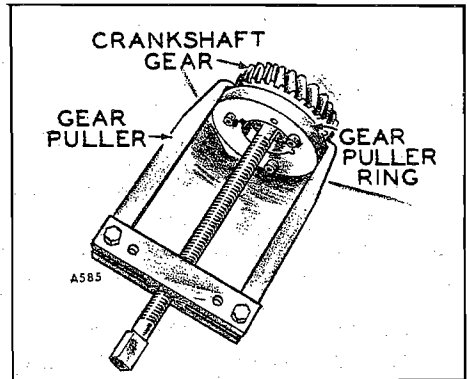


FIG. 31 - REMOVING THE CRANKSHAFT GEAR

When installing the rear bearing plate, use sufficient gaskets to provide crankshaft end play of .015" to .020", and a minimum camshaft end play of .003". Crankshaft end play is measured between the rear bearing flange and the crankshaft thrust surface. Camshaft end play is measured between the camshaft gear and the crankshaft gear washer while both gears are pressed all the way inward.

CAMSHAFT BEARINGS. - The front camshaft bearing is a ball bearing which remains on the camshaft during removal. To remove the ball bearing press the injection pump drive gear off. The rear camshaft bearing is a babbitt lined sleeve, pressed into the crankcase. Press or drive the old bearing out and avoid damaging the bore in the crankcase. The new bearing may be damaged if used to press the old bearing out. With its notch toward the inside and top of the crankcase, press the new rear camshaft bearing in flush with the bottom of the expansion plug recess. Finish the bearing to size after installation for a clearance of .001" to .003". Install a new expansion plug, using sealing compound and expanding into place with sharp blows at its center.

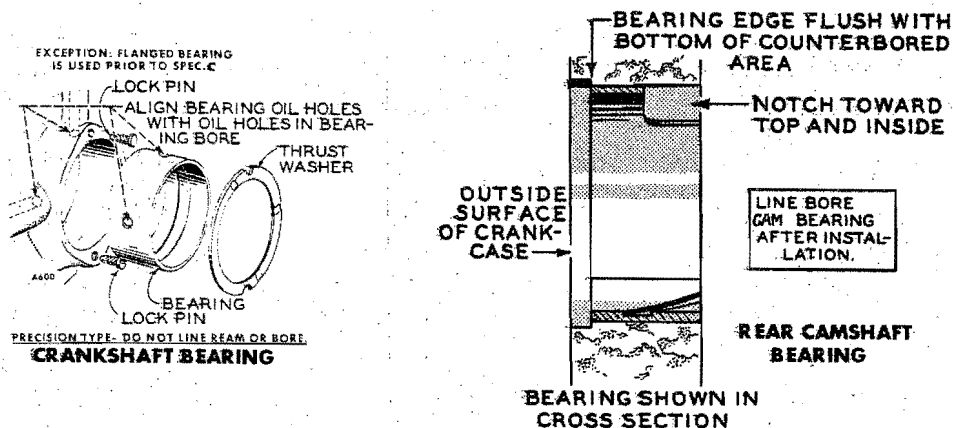


FIG. 32 - BEARING INSTALLATION

MAIN BEARINGS. - The crankshaft main bearings are of the sleeve type. The "bronze" faced main bearing and separate thrust washer is original equipment, beginning on Spec C models. When used to replace the flanged aluminum bearing as used on models prior to Spec C, you must drill one additional hole and install a second lock pin to prevent each thrust washer from riding on the crankshaft.

Main bearings are available in standard, 0.002 inch and 0.020 inch under-size, and do not require finishing to size after installation. When driving or pressing the bearing in, align the oil passages in the bearing and bore. Oil the bearings. When installing the crankshaft, install a thrust washer at each end with grooved side against crankshaft and engaged with lock pins (coat with oil to hold while assembling). Measure the crankshaft end-play, see Table of Clearances.

OIL SEALS. - Oil seal removal and installation is easier when using a pilot tool for driving the seals in place. Install the rear bearing plate oil seal flush with the outer surface of the plate. Install the gear cover oil seal flush with the outer edge of the oil seal opening. Support the gear cover to prevent distortion. Both seals must be installed with the open side of the seal facing inward.

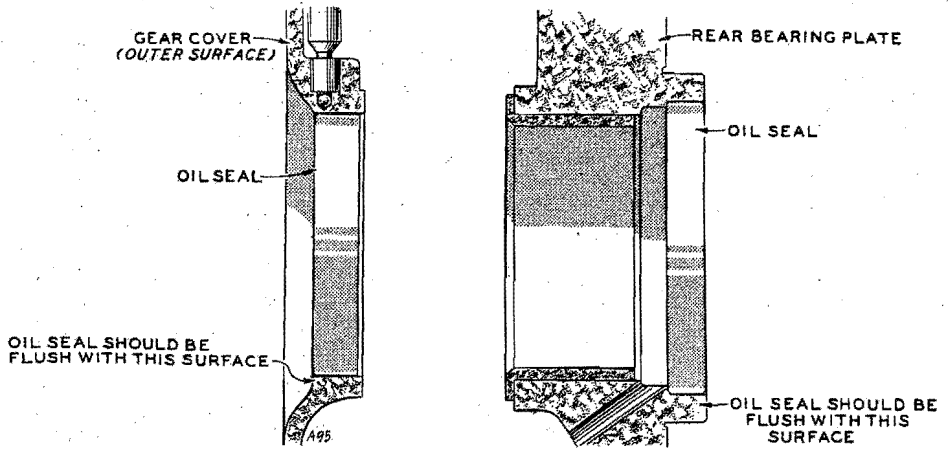


FIG. 33 - OIL SEAL INSTALLATION

OIL PUMP. - If the oil pump is to be removed, it must be turned off the oil intake pipe. If the oil pump fails to function properly, install a complete new pump. Except for gaskets, component parts of the oil pump are not individually available.

When installing the oil pump, be sure its mounting gasket is in good condition, and properly in place. Turn the intake pipe and cup in tightly and at the correct angle to have the intake cup parallel to the bottom of the crankcase.

CAUTION: Be sure the oil pump is primed with oil.

OIL PRESSURE RELIEF VALVE. - The oil pressure relief valve is not adjustable. If the valve becomes stuck open or closed, remove and clean. Remove the hex head screw (cap) and copper washer, as illustrated. Lift out the pressure spring. The valve can be removed with a long 3/8-16 screw.

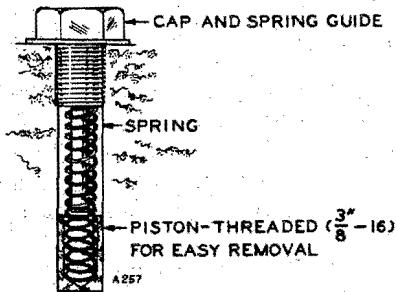


FIG. 34 - OIL PRESSURE RELIEF VALVE

OIL PRESSURE SWITCH. - The oil pressure switch makes contact when the oil pressure drops to 9 to 11 pounds.

When the switch closes the governor solenoid is grounded out and the throttle closes. It is not intended to give adequate engine protection in case of a gradually diminishing oil pressure or too low oil level. A defective switch that is stuck closed will prevent starting.

ROCKER ARM PUSH RODS AND PUSH ROD SHIELDS. - The push rod shields are a drive fit into the collars at the crankcase and a loose fit into the rocker box. "O" rings must be installed on the shields after the rocker box is in place. Turn the crankshaft until the rocker arm lifts and press the "O" rings into place with a blunt tool.

To lift out the push rod tappets from the crankcase, insert a bent wire into the drilled hole in the tappet.

FUEL TRANSFER PUMP. - A transfer pump of the diaphragm type is used to transfer fuel from the fuel tank through the filter to the injection pump. If fuel does not reach the filter, make the following checks before removing the fuel pump. Check the fuel tank to see that there is enough fuel in it and the shut-off valve is open. Disconnect the fuel line at the transfer pump outlet and work the priming lever on the pump. Fuel should spurt out of the line at the pump. If priming lever does not operate, crank engine one revolution. If there is enough fuel in the tank, the shut-off valve open, and the line between the tank and pump is clear but fuel does not spurt out of the transfer pump outlet, repair or replace the pump. The fuel pump valves are staked in place making them not individually replaceable. Check for diluted lubricating oil.

STARTER. - The starter is a clutch-engaging automotive type. Maintenance includes installing new brushes and refinishing the commutator as necessary to provide full brush contact. Automotive practices apply.

As shown on the wiring diagram, an auxiliary field winding in the ac generator is energized by battery voltage during cranking to provide prompt disengaging of the starter. See that this wire and the starter, connect to the same (large) solenoid terminal.

FLYWHEEL. - The flywheel is keyed and a taper fit to the crankshaft. Loosen the mounting screw a few turns then hit the screw sharply to jar the flywheel loose.

When installing the flywheel, be sure the key is in good condition and is properly fitted in place. See that the taper surfaces of the crankshaft and of the flywheel are clean and free of nicks. The flywheel must run

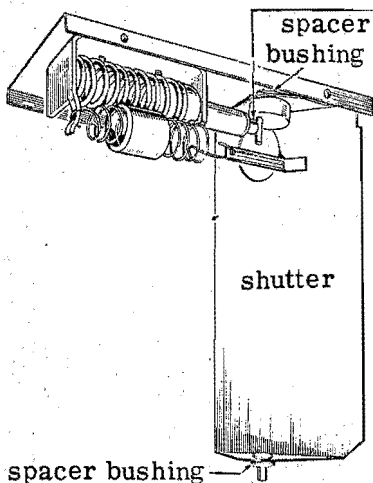
true. Any unbalance will set up harmful vibration.

RING GEAR INSTALLATION. - To remove the ring gear, saw part of the way through then break it using a cold chisel and heavy hammer.

To install a new ring gear, place it in an oven heated to 380 - 400°F. for 30 to 40 minutes. **CAUTION: DO NOT HEAT WITH A TORCH.** When heated properly the ring will fall into place on the flywheel. If it does not go on all the way by itself, drive into place with a hammer. Do it fast. Avoid damaging the gear teeth. The ring will contract rapidly and may shrink to the flywheel before it is in place. If this occurs a new ring gear may be required.

ENGINE AIR SHUTTER. - This thermostatically controlled air-discharge shutter reduces the flow of air circulated by a cold engine. Thus, the engine reaches operating temperature faster. The shutter also reduces undesirable back flow of cold air to the room when the engine is stopped.

Heated engine air actuates the thermostat ("Vernatherm" power-element) causing its plunger to engage with and open the air shutter. The mounting screws for the power-element bracket pass through slotted holes which permit adjustment for less or more cooling. If the original adjustment has been disturbed, begin by mounting the power-element to just engage the shutter. When the discharged engine cooling air reaches 120°F. the shutter begins to open and at 140°F. the shutter will be completely open. Cooler air retracts the power-element plunger and the shutter spring closes the air shutter. Spacer bushings are used to prevent binding between the duct and both ends of the shutter.



Adjust the Vernatherm power element to rest on the roll pin with shutter closed at ambient temperature.

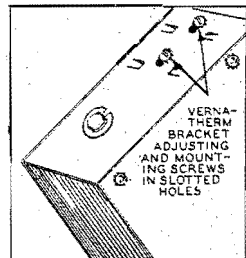


FIG. 35 - ENGINE AIR SHUTTER

INJECTION PUMP. - This is orientation. The injection pump is designed specially for use on this engine. The injection pump meters, delivers and distributes fuel to the appropriate cylinder.

The control sleeve, located inside the injection pump, meters the fuel to be injected by the pump's plunger. The purpose of the governor and related parts is to hold the control sleeve at the proper throttle position.

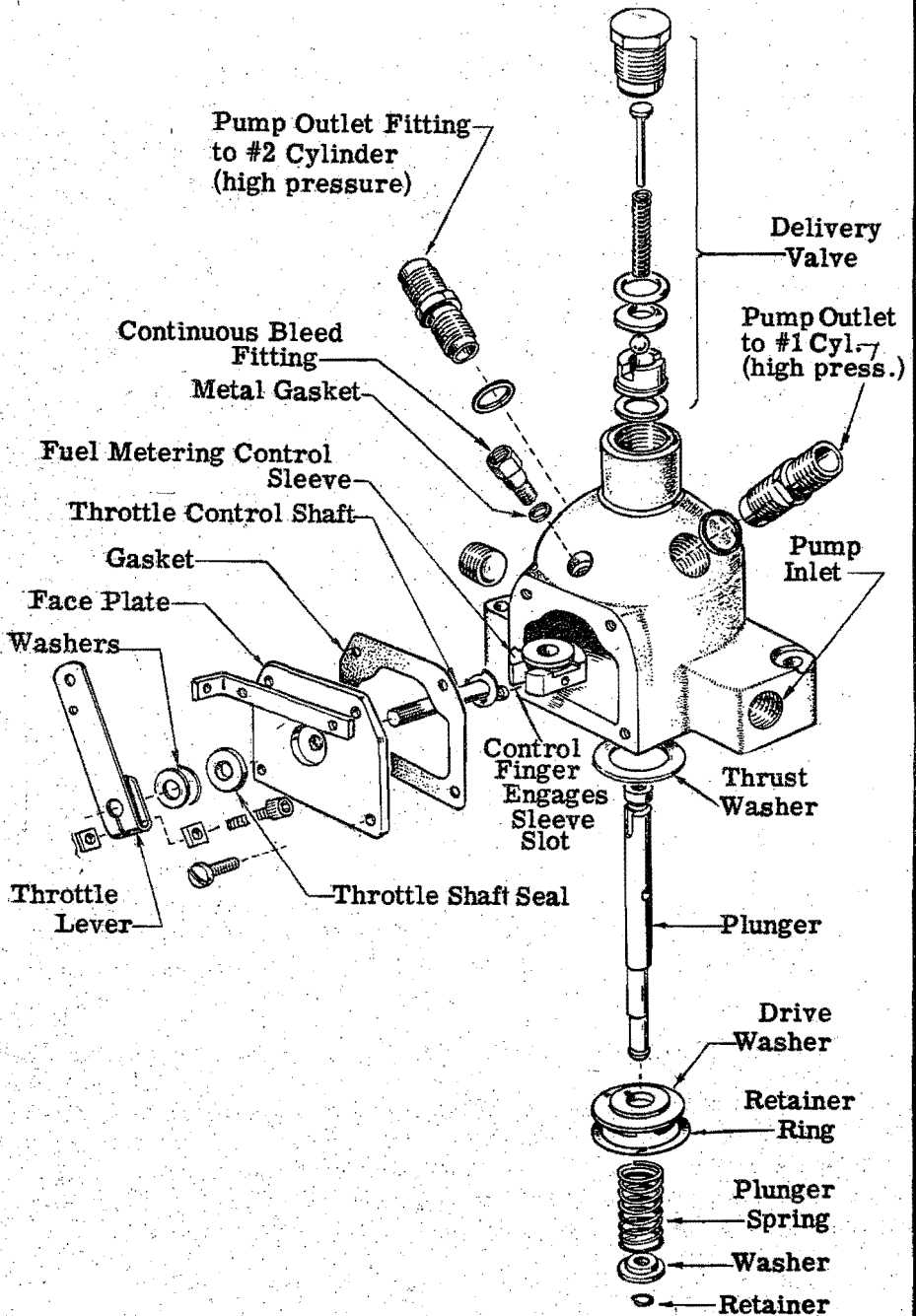
Fuel injection begins earlier when more fuel is to be injected. To inject more fuel the governor varies the control sleeve position so that port closing occurs earlier and a longer stroke of pumping occurs.

Fuel injection always ends at the same time, regardless of throttle position. This time is called Port Opening (PO). Port opening is the stage in the operating stroke of the injection pump when the fuel spillback passages align, fuel pressure collapses and the nozzle closes. The "port" is the fuel passage in the pump's plunger. Mounting shims under the injection pump serve to properly space the injection pump so that when Port Opening occurs the flywheel will be 8° B.T.C. Therefore, engine timing is 8° before top center (B.T.C.) - port opening (PO).

The injection pump is actuated by the engine camshaft. Fuel metering and fuel distribution depend on rotating motion and fuel delivery (pumping or injection) and timing depend on lifting motion of the pump's plunger.

Rotary Motion - The camshaft has a gear to drive the pump's plunger for rotary motion. The plunger rotates 1 turn for each revolution of the camshaft or 1 turn for 2 revolutions of the crankshaft. As the plunger rotates $1/2$ turn the fuel passage is aligned to distribute fuel to the number 1 cylinder, then to the number 2 cylinder on the following $1/2$ turn of the plunger. When the control sleeve, located around the plunger inside the pump, is moved by the throttle lever slightly against the direction of pump plunger rotation, the Port Closing (PC) occurs earlier and a longer pumping stroke injects more fuel. Port Closing is covering the fuel passage in the plunger to prevent fuel back flow and begin the pumping stroke. Likewise, the opposite position of the control sleeve causes later Port Closing, a shorter pumping stroke and less fuel injected. At throttle STOP position the port is never closed and no fuel is injected.

Lifting Motion - The engine camshaft has two lobes on opposite sides which lift the plunger of the injection pump 2 times during 1 revolution of the camshaft. Therefore, injection occurs in cylinder number 1 with one revolution of the crankshaft, then in cylinder number 2 with the following revolution of the crankshaft. Remember that the camshaft and pump turn at $1/2$ crankshaft speed.



A546.

FIG. 36 - INJECTION PUMP

INSTALLING THE INJECTION PUMP DRIVE GEAR AND TAPPET. -

Have the camshaft properly installed. Turn the flywheel to align the PO mark exactly, and with number 1 piston (cylinder nearer timing gears) on its compression stroke. Install the driven gear in the crankcase, engaging with the camshaft gear so that the drive lug is exactly 90 degrees from the camshaft center line and is toward number 1 cylinder.

Install the thrust washer and snap ring, then lower the tappet into place. **CAUTION:** Always remove the injection pump tappet before removing the driven gear from the crankcase, to avoid loosing the tappet into the oil sump.

INSTALLING THE INJECTION PUMP. - Turn the injection pump plunger

so that its washer slot will engage easily with the off set lug on top of the driven gear in the crankcase. As instructed under Timing in the Adjustments section, have the proper number of .005" thick injection pump mounting shims installed so that when the flywheel is exactly aligned at PO the distance from the tappet to the top of the shims is within .003" of the PO distance marked on the bottom of the pump.

Mount the injection pump and connect the fuel lines, then bleed the fuel system as instructed under Preparation section.

It is possible to prove whether or not PO is occurring within the 1 degree limit of the PO flywheel mark. This method is "flowing the pump" and is explained in the factory Service Bulletin ENG.27 but is not recommended for field practice.

CAUTION: If any part of the fuel system beyond the secondary filter is opened, place all removed parts in a pan of clean diesel fuel. When installing new or used parts, flush them thoroughly and install while still wet.

INJECTION PUMP DISASSEMBLY AND ASSEMBLY. - Since most fuel

system troubles are not a faulty injection pump, all other components should be proven satisfactory before condemning the injection pump. Injection pump disassembly is discouraged as a field practice because it is a specialized repair and an expensive part of the machine. However, the factory Service Bulletin ENG.27 contains some general instructions.

GENERATOR

The generator normally needs little care other than **periodic inspection** of the armature ball bearing and a periodic check of the brushes, commutator and collector rings. If a major repair job on the generator should become necessary, have the equipment checked by a competent electrician, one who is thoroughly familiar with the operation of electric generating equipment. Continuity tests may be performed without disassembly of the generator.

GENERATOR ASSEMBLY. - The generator should be disassembled in the following manner and all leads that must be disconnected should be tagged and marked before removal.

Disconnect the battery to prevent accidental starting of the unit.

Remove the band from the end bell. On generators having constant-pressure type brush springs, remove all brushes and springs from their holders. On other generators lift each brush into its holder until the spring rests against its side and holds it in place.

Remove the cap nuts at the outboard end of the end bell, place a pinch bar against the generator adapter and pry against the generator frame until loose. Alternate from one side to the other if necessary.

Carefully slide the frame (together with coils, end bell and brush rig) off the studs, being careful not to let it rest or drag on the armature. Hold the end bell along with the frame as the end bell is loose on the frame.

The armature has a disc drive, and is removed by detaching at the fly-wheel.

If necessary to remove the brush rig, disconnect all leads necessary (be sure they are marked), remove the end bell from the frame assembly, remove the four cap screws that mount the brush rig ring and remove the brush rig.

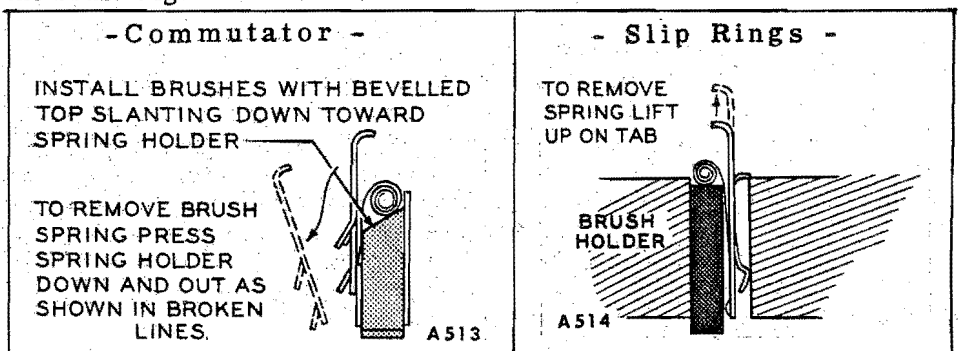
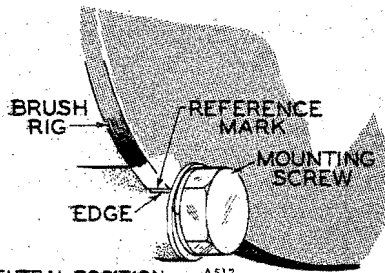


FIG. 37 - BRUSHES AND SPRINGS

BRUSHES AND SPRINGS. - Inspect brushes periodically. Brushes worn to 5/8 inch should be replaced. Replace springs if damaged or if proper tension is questionable. Rapid brush wear may be caused from high mica between commutator bars, rough commutator or collector rings, or from a deviation from "neutral" position in the adjustment of the brush rig. NEVER bend the constant-pressure type spring over the edge of its support.

BRUSH RIG "NEUTRAL" POSITION. - Check the witness mark on the brush rig and if necessary align it with the boss in the end bell. If the brush rig is adjusted so that there is arcing of the brushes, brush wear will be rapid, voltage and current will not hold steady, and the generator may overheat.



FOR PROPER NEUTRAL POSITION
ALIGN YELLOW PAINT OR CHISEL
REFERENCE MARK ON BRUSH RIG
TO TOUCH EDGE OF END BELL NEAR
BRUSH RIG MOUNTING SCREW.

FIG. 38 - BRUSH "NEUTRAL" POSITION

Whenever a new brush rig or armature is installed, the brush rig must be adjusted to the point where the brushes do not arc regardless of where the witness mark falls. This is commonly known as the "neutral" brush position.

COLLECTOR RINGS (AC Units). - If the collector rings become grooved or out of round, or the brush surface becomes pitted or rough so that good brush seating cannot be maintained, remove the armature and refinish the collector rings in a lathe.

If the commutator appears to be rough or scored refinish it at the same time. Remove or adequately shield the ball bearing during refinishing.

COMMUTATOR. - The commutator bars wear down with usage so that the mica between them must be undercut. This should be done as soon as the mica on any part of the commutator touches the brushes. A suitable undercutting tool can be made from a hack saw blade. Avoid injury to the surfaces of the copper bars. Leave no burrs along the edges of the bars. The mica must also be undercut whenever the commutator is refinished.

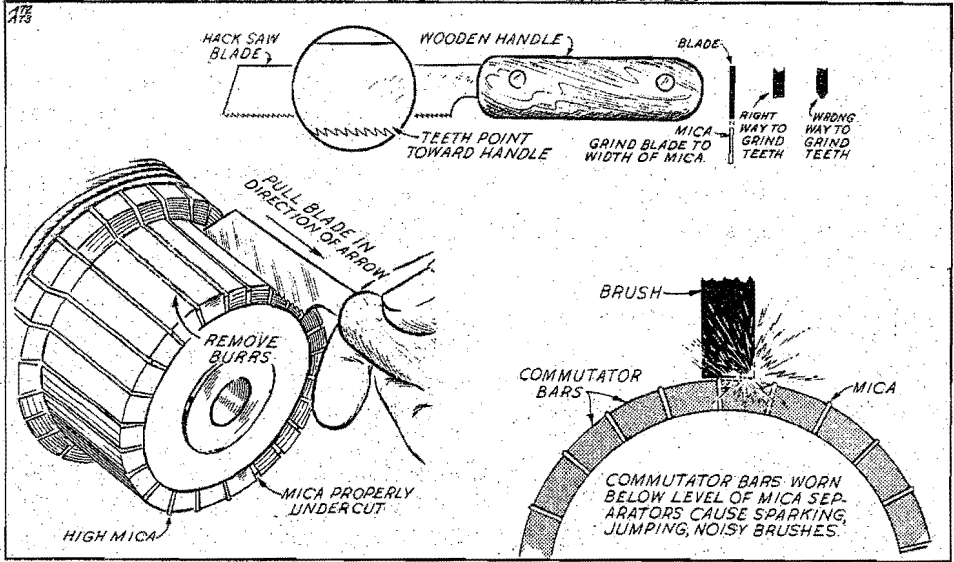


FIG. 39 - COMMUTATOR REPAIR

TESTING WINDINGS. - A test lamp set and an armature growler are required for the various tests. Before making any tests, remove constant pressure type brush springs, lift all brushes away from contact and disconnect the load circuit wires from the plant. If the armature tests defective, the practical repair is to replace it. If a field coil tests defective, replace the entire coil assembly unless the trouble is in one of the external leads. Then it can be repaired as the nature of the trouble requires.

ARMATURE GROUND TEST. - To test the armature for a grounded condition, lift or remove the brushes so that none contact the commutator or collector rings. Use a contin-

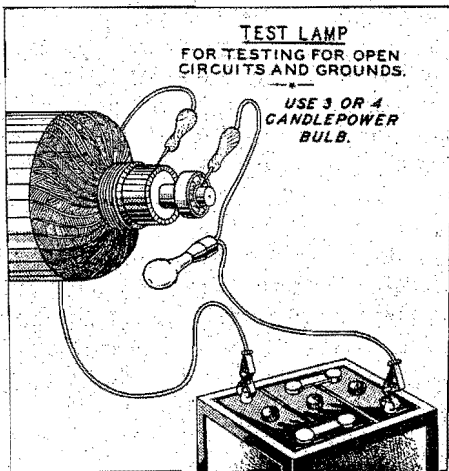


FIG. 40 - CONTINUITY TEST LAMP

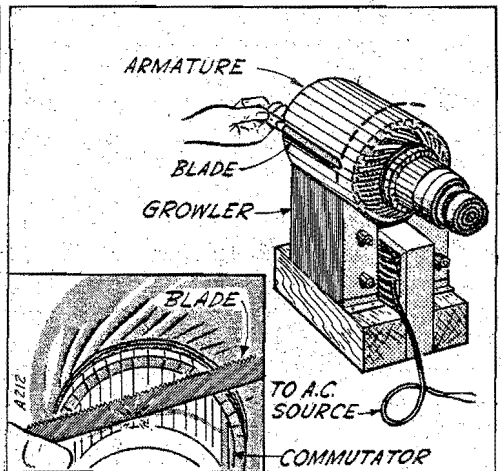


FIG. 41 - ARMATURE GROWLER

uity type test lamp set. Place one test prod on the commutator, and the other test prod on a bare, clean part of the armature shaft. The test prods must make good electrical contact. The test lamp should not glow. If the test lamp does glow, the dc winding or the commutator is grounded. To test the ac winding, place one test prod on one of the collector rings and the other test prod on the armature shaft. If the test lamp glows, the ac winding or a collector ring is grounded. Replace a grounded armature with a new one.

ARMATURE OPEN CIRCUIT TEST. - The armature ac winding may be tested for an open circuit without removal of the armature. Testing the dc winding requires removal and the use of an armature growler.

To test the ac winding, be sure all brushes are lifted or removed. Use a test lamp set. Place one test prod on each of the collector rings. If the test lamp does not glow, the ac winding is open circuited.

To test the dc winding, place the armature in a growler. With the growler current on, pass a smooth steel strip across the commutator segments. Repeat all around the commutator. At some point around the commutator, a spark should occur as the strip contacts two adjacent segments. Rotate the armature slightly and repeat the test. Continue until a spark is obtained between all adjacent segments. If no spark is obtained at some point, an open circuit is indicated. (NOTE: A short circuit in the winding might prevent sparking. This condition may be indicated by the short circuit test described in the next paragraph.) Replace an open circuited armature with a new one.

ARMATURE SHORT CIRCUIT TEST. - To test for a short circuit, place the armature in a growler. With the growler current on, hold a steel strip about 1/4 inch above the armature laminations. Pass the strip back and forth over the laminations. Cover as much of the lamination area as possible. If the strip is magnetically attracted to the armature at any point, a short circuit is indicated. After testing in one position, rotate the armature slightly in the growler and repeat the test. Continue until a complete revolution of the armature in the growler has been made. Replace a short circuited armature with a new one.

TESTING FIELD WINDINGS. - Use a test lamp set for all tests except a short circuit. Plants which do not have a separate starting motor, have a series field winding in addition to the shunt field winding. Disconnect all external leads of the coil assembly from the brush rig before testing. Tag and mark each lead before disconnecting to assure proper connections when reassembling.

TESTING FIELD WINDINGS FOR GROUNDS. - To test a coil assembly for a ground, disconnect its external leads and touch one test prod to the terminal of one of its leads and the other test prod to the generator frame. If the lamp lights, the coil assembly being tested is grounded. The ground may be in a coil, coil connection, or coil lead. Repair or replace as needed.

TESTING FIELD WINDINGS FOR OPEN CIRCUIT. - To test a coil assembly for an open circuit, disconnect its external leads and touch one test prod to the terminal of one coil winding lead and the other test prod to each of the other leads of that coil winding in turn. If the lamp does not light, the circuit being tested is open. If the fault lies in connection between coils or in a coil lead, the trouble can be repaired. If it is inside the coil proper, replace the entire coil assembly.

TESTING FIELD WINDINGS FOR SHORT CIRCUITS. - If one coil is short circuited it will run cooler than the others and it may be possible to locate the short-circuited coil by placing your hand on the generator frame at each of the pole shoe positions and noting at which pole shoe position the frame is cooler than normal. A more definite test is a comparative resistance test or a comparative voltage drop test. If the coil windings are short-circuited, replace the entire coil assembly.

BALL BEARING. - If replacement of the armature ball bearing becomes necessary, pull the bearing from the shaft with a suitable bearing puller. Be careful not to damage the armature shaft because it must remain true to serve as a turning center when refinishing the commutator or collector rings. Drive the bearing on to the shoulder on the shaft. Use a double-sealed pre-lubricated ball bearing.

GENERATOR ASSEMBLY. - Whenever installing a new armature, pole shoe, coil assembly or generator frame assembly, it is recommended that the field windings be repolarized to prevent a possible short circuit from occurring. If the polarity is not the same as the starting battery, the charge circuit will burn out. The field winding of the generator is polarized for a negative grounded starting system. This is done by lifting all generator brushes into their holders and momentarily touching the positive cable lug of a 12-volt battery to any positive brush terminal and the negative cable lug to the generator frame. This magnetizes the pole shoes with correct polarity for a negative grounded starting system. The pole shoes retain this magnetism (residual) indefinitely although it is possible for the pole shoes to lose it. It is this residual magnetism in the pole shoes that starts the current flowing in the proper direction in the field windings when the generator starts to operate.

If a new armature is installed, use shims behind the drive disc (not against the flywheel) as required to center brushes on the slip rings.

When installing the armature, the runout at the bearing end should not exceed .012" to avoid "wobble" and provide uniform air gap. Excessive runout may be caused by a nick or dirt on the flywheel or drive disc surface. Take any steps necessary to correct this.

CONTROLS

If any of the control panel equipment fails to function properly, replace the defective part with a new part of the same kind rather than try to repair the old part. No attempt should be made to repair such parts as meters, fuses, switches, relays, or receptacles. Check all electrical connections and contacts whenever servicing control equipment. Refer to Operation section for orientation on control parts.

Always disconnect the battery before servicing any control parts to avoid accidentally starting the unit. When removing any control part, tag and mark the connection point of each lead that has to be removed to assure correct connections when reassembling.

Feed through type condensers for radio frequency suppression are used at the ac output "hot" terminals. These condensers are not apt to fail. However, a shorted condenser may run hot, cause a severe voltage drop in that phase or circuit and should be replaced.

POSSIBLE CAUSE

REMEDIES

ENGINE CRANKS TOO STIFFLY

Load not disconnected from unit.	Disconnect load from unit when starting.
Too heavy oil in crankcase.	Use only recommended grades.
Engine stuck.	Disassemble and repair.

ENGINE WILL NOT START WHEN CRANKED

Air in fuel system.	Bleed the fuel system.
Lack of fuel or faulty injection caused by dirty fuel.	Keep fuel tank filled. Keep fuel clean. Use only recommended fuels.
Clogged fuel filter.	Keep supplies of fuel clean. Replace fuel filter element.
Poor fuel.	Use only recommended grades.
Poor compression due to leaky gasket, loose head, worn valves or piston rings.	Tighten cylinder head. Replace cylinder head gasket if necessary. Grind valves, replace if necessary.
Wrong injection pump timing.	Check the injection pump timing.

ENGINE CRANKS SLOWLY OR WILL NOT CRANK

Defective or discharged battery.	Replace or recharge battery.
Loose connections or broken wire in starter circuit.	Tighten loose connections. Replace terminals or wire where necessary.
Corroded battery terminals.	Clean corroded terminals. Replace cable if necessary.
Starter brushes worn excessively or making poor contact.	Replace brushes. See that brushes make good contact.
Short circuit in generator or load circuit.	Repair as needed.
Dirty or corroded points in start solenoid switch.	Replace switch.
Starter clutch faulty.	Replace clutch.

POSSIBLE CAUSE

REMEDIES

ENGINE FIRES BUT FAILS TO KEEP RUNNING

Air in fuel system.

Bleed the fuel system. Check for air leakage. To help locate air leakage, raise the fuel supply 2 ft. above pump level, if practical.

Governor spring solenoid de-energized and not opening throttle.

Allow engine to gain running speed before releasing the start switch. Check for open circuit to solenoid.

ENGINE RUNS BUT VOLTAGE DOES NOT BUILD UP

Poor brush contact.

See that brushes seat well on commutator and collector rings are free in holders, are not worn shorter than 5/8 inch and have good spring tension.

Open circuit, short circuit or ground in generator

Check and repair or replace as described under GENERATOR in the Maintenance And Repair section.

VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING

Speed too low.

Adjust governor to correct speed.

Injection pump fuel metering shaft not properly adjusted.

Adjust per Adjustments section.

Poor commutation or brush contact.

Refinish commutator or undercut mica if necessary. See that brushes are seated well on commutator and collector rings, are free in holders, are not worn shorter than 5/8" and have good spring tension.

Loose connections.

Tighten connections.

GENERATOR OVERHEATING

Short in load circuit.

Correct short circuit.

Generator overloaded.

Reduce load.

Improper brush rig position.

Adjust to "neutral" position.

POSSIBLE CAUSE

REMEDIES

ENGINE OVERHEATING

Improper lubrication.	See Low Oil Pressure.
Poor ventilation.	Provide ample ventilation at all times.
Dirty or oily cooling surfaces.	Keep the engine clean.
Retarded injection timing.	Retime.
Generator overloaded.	Reduce load.

VOLTAGE DROPS UNDER HEAVY LOAD

Engine lacks power.	See Engine Misfires at Heavy Loads.
Poor compression.	Tighten cylinder head, grind or replace valves, replace piston rings as needed.
Faulty injection.	Check fuel system. Dirty fuel is main cause. Use only recommended fuels.
Dirty air cleaner.	Clean. Refill with proper oil.
Dirty fuel filter.	Keep fuel clean. Service filter per Periodic Service.
Restricted exhaust line.	Clean or increase the size.

ENGINE MISFIRES AT LIGHT LOAD

Faulty injection.	Dirty fuel is main cause. Use only recommended fuels.
Poor compression.	Tighten cylinder head, grind or replace valves, replace piston rings - as needed.
Poor grade of fuel.	Use only recommended fuels.

ENGINE MISFIRES AT HEAVY LOAD

Faulty injection	Dirty fuel is main cause. Use only recommended fuels.
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POSSIBLE CAUSE

REMEDIES

ENGINE MISFIRES AT HEAVY LOAD (Cont.)

Dirty air cleaner.	Clean. Refill with proper oil.
Dirty fuel filter.	Service filter per Periodic Service.

ENGINE MISFIRES AT ALL LOADS

Leaky valves.	Refer to VALVE SERVICE under Maintenance And Repair.
Broken valve spring.	Replace.
Defective or dirty nozzle.	Install new nozzle.

LOW OIL PRESSURE

Defective oil pressure gauge.	Replace.
Oil too light or diluted due to leaking transfer pump diaphragm.	Drain. Refill with proper oil. Repair or replace transfer pump.
Oil too low.	Add oil.
Oil relief valve not closing.	Check by-pass. Clean or replace as needed.
Badly worn bearing.	Replace.
Sludge on oil cup screen.	Remove and clean screen and oil reservoir.
Badly worn oil pump.	Replace.

HIGH OIL PRESSURE

Defective oil pressure gauge.	Replace.
Oil too heavy.	Drain. Refill with proper oil.
Clogged oil passage.	Clean all lines and passages.
Oil relief valve stuck.	Clean by-pass. Replace if needed.

EXCESSIVE OIL CONSUMPTION - LIGHT BLUE SMOKY EXHAUST

Poor compression. Usually due to worn piston, rings, or cylinder.	Refinish cylinder. Install oversize piston and rings.
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POSSIBLE CAUSE

REMEDIES

**EXCESSIVE OIL CONSUMPTION - LIGHT BLUE
SMOKY EXHAUST (Cont.)**

Oil too light or diluted.	Drain. Refill with proper oil.
Too large bearing clearance.	Replace bearings necessary.
Engine misfires. Usually due to leaky valve or broken valve spring.	Reseat or replace as needed.
Faulty injection timing.	Check injection pump timing.
Oil level too high in crankcase.	Drain excess oil.
Crankcase breather valve sticking.	Free up disc. Replace valve if necessary.
Air leak at oil filler cap gasket.	See that cap fits tightly and gasket is not faulty.
Air leak at transfer pump body vent.	Vent hole should be plugged.

**BLACK, SMOKY EXHAUST - EXCESSIVE CONSUMPTION -
POSSIBLE LACK OF POWER UNDER LOAD**

Generator overloaded. Black smoky exhaust normal condition with overload.	Reduce load to within rated capacity. If smoky condition does not clear up, stop the unit at once and check for further trouble. Serious damage may result if trouble is not corrected.
Poor compression.	Tighten cylinder head, grind or replace valves, replace piston rings - as needed.
Poor grade or dirty fuel.	Use only clean recommended fuel.
Injection pump or nozzle not operating properly.	Install new nozzle or injection pump.
Faulty injection timing.	Check injection pump timing.

POSSIBLE CAUSE

REMEDIES

ENGINE RACES
(STOP UNIT AT ONCE AND DETERMINE CAUSE)

Governor linkage disconnected.	Replace linkage. Tighten mounting nut securely.
Too much oil in air cleaner.	Correct oil level. Check breather tube check valve, free disc or replace valve.

ENGINE STOPS UNEXPECTEDLY

Empty fuel tank.	Refill fuel tank as often as needed to prevent running out of fuel.
Dirt in fuel system.	Use only recommended fuel. Service filter per Periodic Service. Clean fuel tank. Fill with clean fuel. Bleed fuel system. Install new nozzle or injection pump if trouble not corrected.
Governor spring solenoid defective or open solenoid circuit.	Repair, adjust, or replace parts needed. For emergency run if solenoid is inoperative, tie plunger in.
Low oil pressure causing switch to operate.	See Low Oil Pressure.
Defective oil pressure switch.	Replace switch.

LIGHT POUNDING KNOCK

NOTE: DO NOT CONFUSE WITH NORMAL KNOCK FROM FIRING OF FUEL.

Loose connecting rod.	Adjust clearance or replace.
Low oil supply.	Add oil. Change if necessary.
Oil badly diluted.	Drain. Refill with proper oil.
Low oil pressure.	See Low Oil Pressure.

POSSIBLE CAUSE

REMEDIES

VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR UNIT

Too small line wire used for load and distance.

Install extra or larger wire or reduce the load.

VOLTAGE VARIES BETWEEN SINGLE PHASE CIRCUITS
OF 3 or 4 WIRE PLANTS

Shorted condenser which may run hot.

Replace condenser.

RADIO INTERFERENCE

Faulty condenser.

Replace.

FUEL NOZZLE FAILURE

Jammed nozzle pintle, due to foreign material.

Replace with new nozzle. If not scored and pintle can be freed up, continue in service.

Fouled with carbon.

Clean and continue in service, using cleaning tool set available through the dealer.

NOTE: Do not disassemble the nozzle and holder assembly unless necessary. Check all other possible causes of plant failure first. Finger marks cause corrosion of highly polished, lapped fit parts as found in the fuel nozzle and the fuel injection pump. Avoid corrosion by cleaning your hands and dipping your hands in clean diesel fuel when servicing those parts. To remove the nozzle, use a closed end type of wrench and remove the serrated nozzle nut from the combustion chamber end of the nozzle holder. Keep removed parts clean by placing them in a basin of clean diesel fuel and assemble them wet rather than try to wipe them dry.



PREPARING UNITS FOR STORAGE OR EXTENDED OUT-OF-SERVICE PERIODS

Electrical generating plants are often taken out of service for extended periods of time. Plants remaining out of service more than 30 days should be protected against rust, corrosion, or the elements.

If the lubricating oil is dirty, drain it while hot, install a new oil filter element and attach a warning tag.

To protect cylinder walls set engine at top center. Plug exhaust and wrap air cleaner to prevent air circulation. Applying rust inhibitor oil to combustion chamber is not feasible.

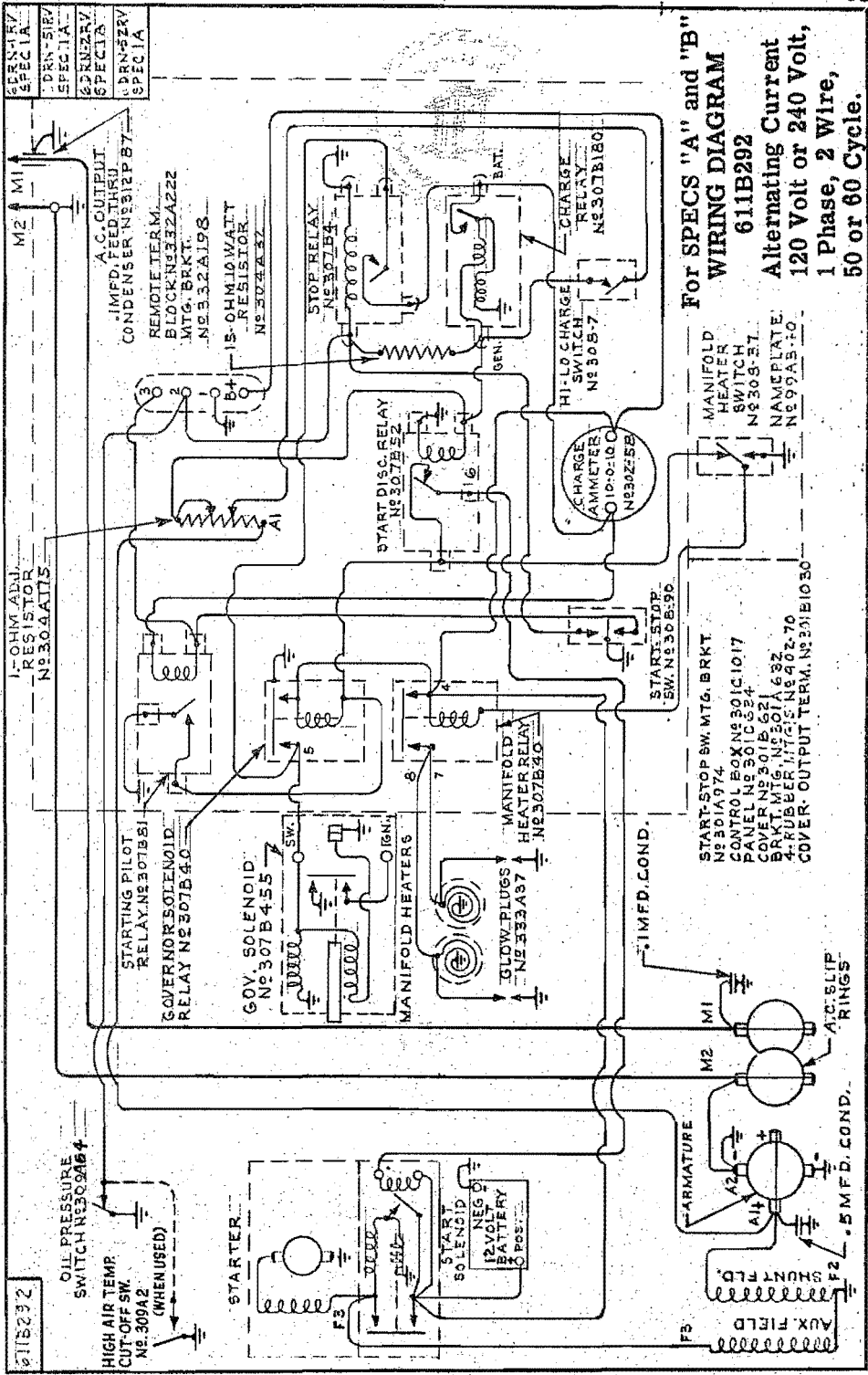
Wipe all exposed parts clean and coat with a film of grease all such parts liable to rust.

Disconnect the battery from the plant. An idle battery should be stored away from freezing temperatures and should be given a refreshing charge about every 40 days.

Clean generator brushes, brush holders, commutator and collector rings by wiping with a clean cloth. DO NOT coat with lubricant or other preservative!

The fuel supply and fuel system should be left filled but any possibility of fuel syphoning should be guarded against.

Plants being returned to service should be prepared according to preparation instructions for a new plant.



For SPECS "A" and "B"
WIRING DIAGRAM
 611B292
 Alternating Current
 120 Volt or 240 Volt,
 1 Phase, 2 Wire,
 50 or 60 Cycle.

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
 307B455
 307B51
 307B52
 309A2
 309A2
 301A97A
 301C1017
 301B624
 301A632
 402-70
 301E1030

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
 307B455
 307B51
 307B52
 309A2
 309A2
 301A97A
 301C1017
 301B624
 301A632
 402-70
 301E1030

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
 307B455
 307B51
 307B52
 309A2
 309A2
 301A97A
 301C1017
 301B624
 301A632
 402-70
 301E1030

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
 307B455
 307B51
 307B52
 309A2
 309A2
 301A97A
 301C1017
 301B624
 301A632
 402-70
 301E1030

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
 307B455
 307B51
 307B52
 309A2
 309A2
 301A97A
 301C1017
 301B624
 301A632
 402-70
 301E1030

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
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 309A2
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302A198
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 304A175
 304A32
 305-7
 307B40
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 301C1017
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302A198
 302A222
 302P B7
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 304A32
 305-7
 307B40
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 307B52
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 309A2
 301A97A
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 301A632
 402-70
 301E1030

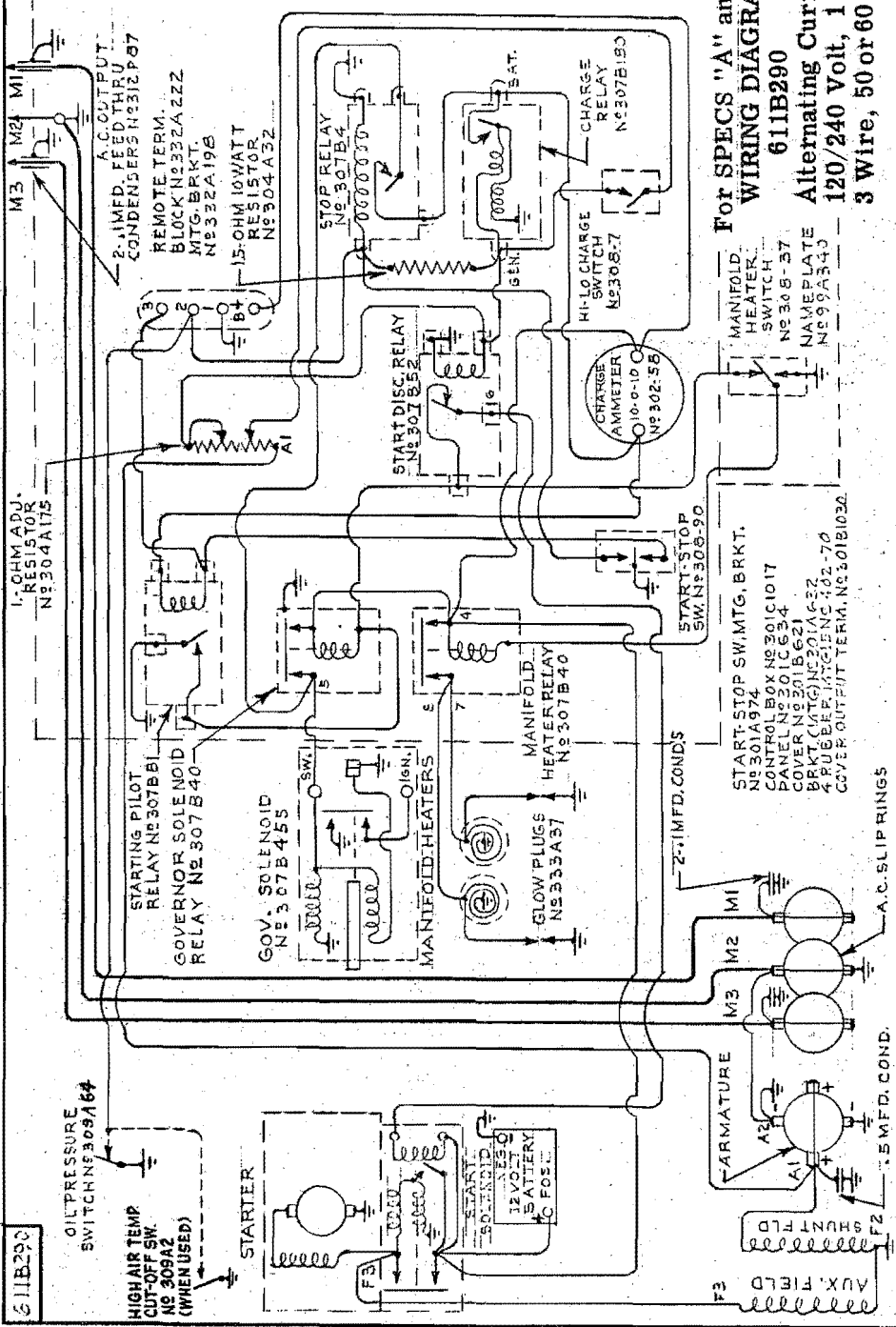
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 307B455
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 307B52
 309A2
 309A2
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 301C1017
 301B624
 301A632
 402-70
 301E1030

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
 307B455
 307B51
 307B52
 309A2
 309A2
 301A97A
 301C1017
 301B624
 301A632
 402-70
 301E1030

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
 307B455
 307B51
 307B52
 309A2
 309A2
 301A97A
 301C1017
 301B624
 301A632
 402-70
 301E1030

302A198
 302A222
 302P B7
 304A175
 304A32
 305-7
 307B40
 307B455
 307B51
 307B52
 309A2
 309A2
 301A97A
 301C1017
 301B624
 301A632
 402-70
 301E1030

611B290
SPEC. A
PRINTED
SPECIAL



For Specs "A" and "B"
WIRING DIAGRAM
611B290
 Alternating Current
 120/240 Volt, 1 Phase,
 3 Wire, 50 or 60 Cycle

START-STOP SW. MTG. BRKT.
 No. 301A974
 CONTROL BOX No. 301C1017
 PANEL No. 301C634
 COVER No. 301B621
 BRKT. CTG. No. 301A627
 4 RUBBER ISOLATING NC. 402-70
 GOV. OUTPUT TERM. No. 301B1032

ARMATURE
 A2
 A1
 SHUNT FLD
 F3
 AUX. FIELD
 F2
 2-1MFD. COND.
 A.C. SLIP RINGS

611B290
 OIL PRESSURE
 SWITCH No. 309A64
 HIGH AIR TEMP
 CUT-OFF SW.
 No. 309A2
 (WHEN USED)

1-1 OHM ADJ.
 RESISTOR
 No. 304A175

A.C. OUTPUT
 2-1MFD. FEED THRU
 CONDENSERS No. 312P87
 REMOTE TERM.
 BLOCK No. 322A222
 MTG. BRKT.
 No. 322A198

STARTING PILOT
 RELAY No. 307B81
 GOVERNOR SOLENOID
 RELAY No. 307B40
 GOV. SOLENOID
 No. 307B455

STOP RELAY
 No. 307B4

START DISC RELAY
 No. 307B52

MANIFOLD
 HEATER RELAY
 No. 307B40

CHARGE
 RELAY
 No. 307B180

CHARGE
 AMMETER
 No. 302-58

START-STOP
 SW. No. 308-90

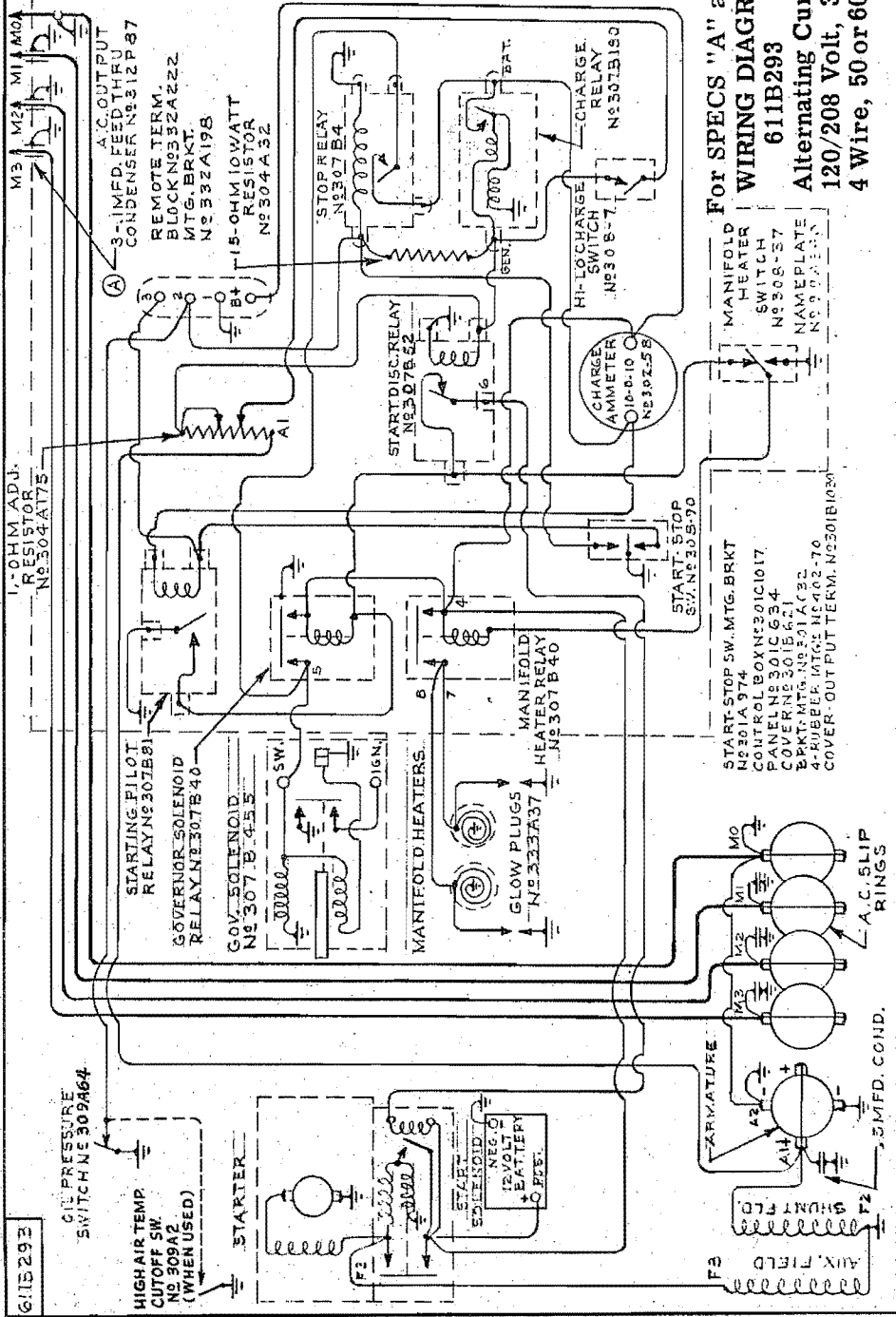
MANIFOLD
 HEATER
 SWITCH
 No. 308-37

HI-LO CHARGE
 SWITCH
 No. 308-7

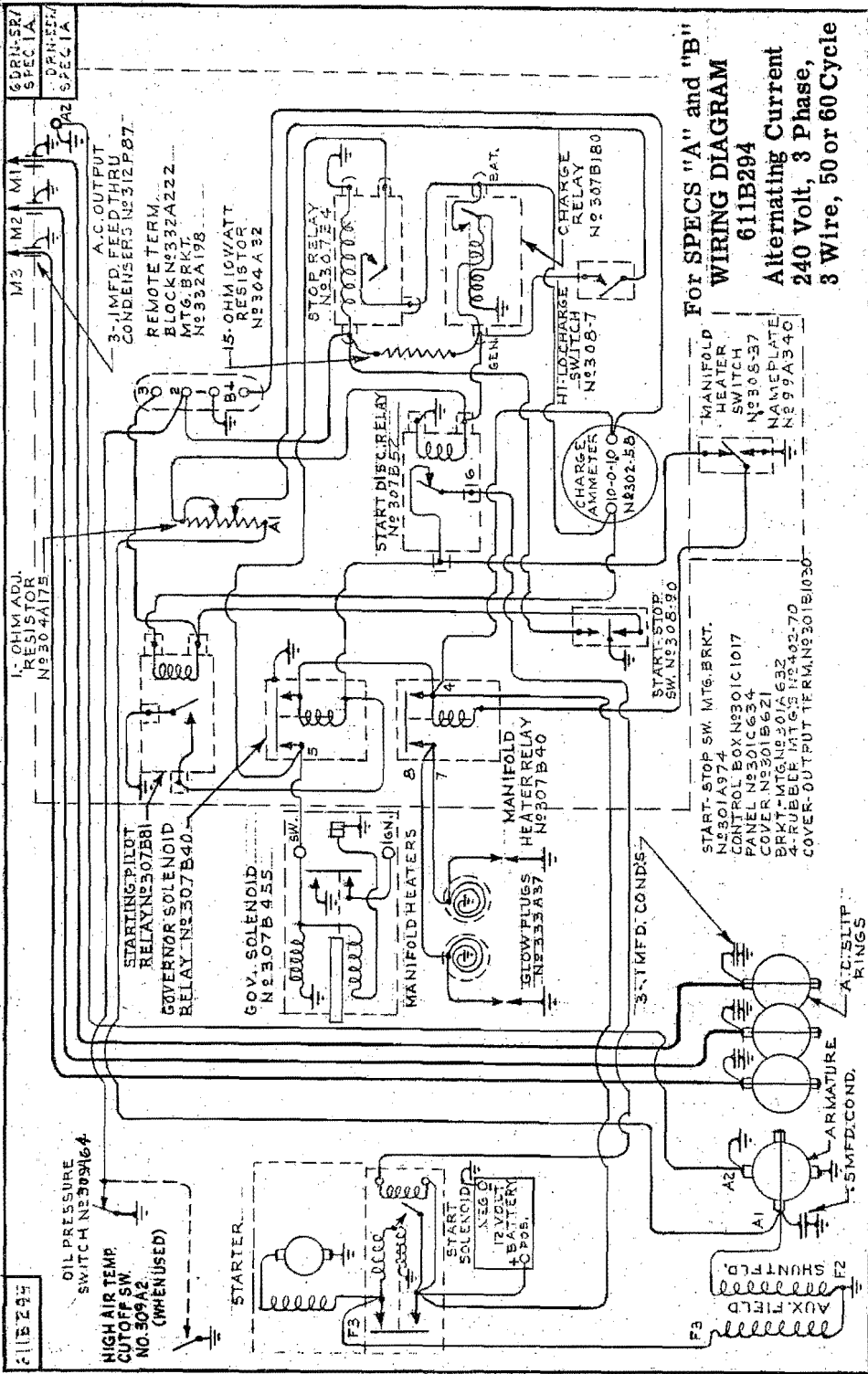
M3
 M2
 M1

F3
 F2

6DRN-4RV
SPEC 1A
DEN-5-17
SPEC 1A

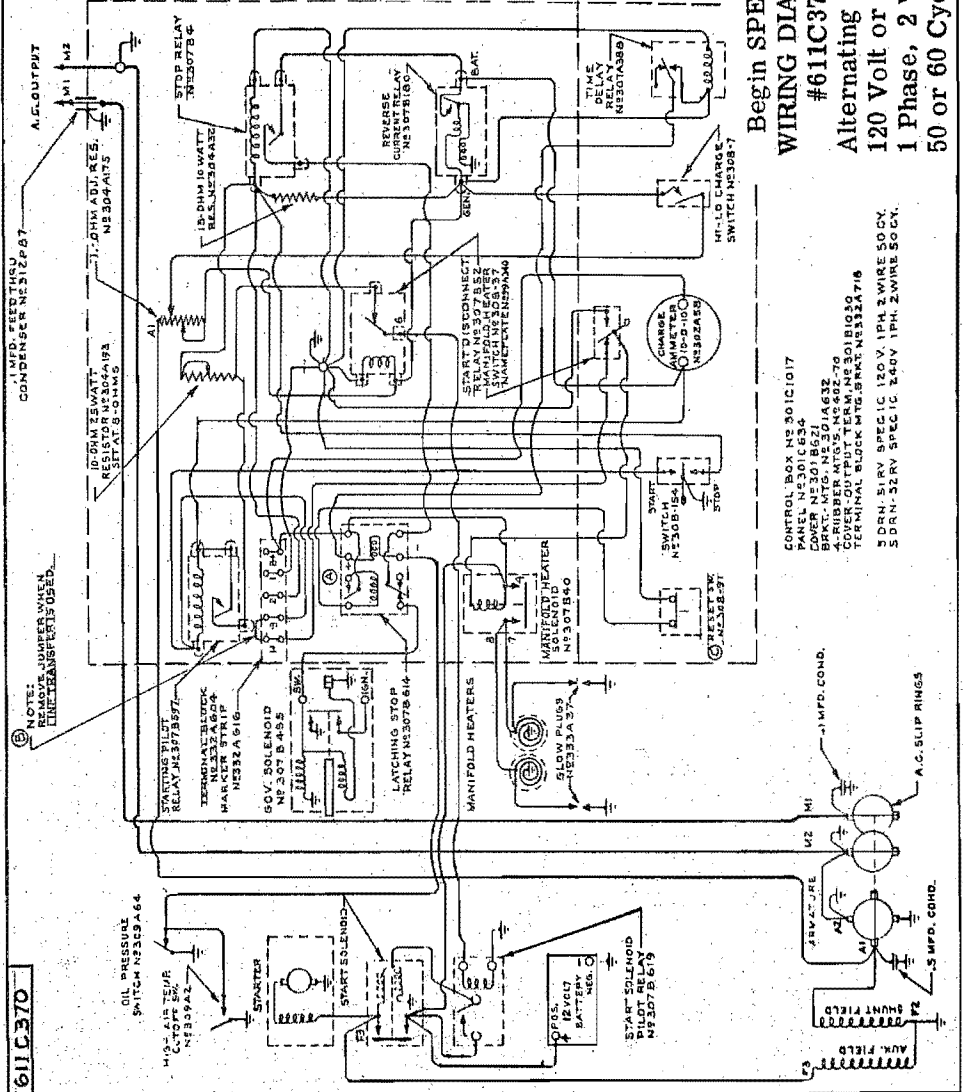


For SPECS "A" and "B"
WIRING DIAGRAM
611B293
 Alternating Current
 120/208 Volt, 3 Phase
 4 Wire, 50 or 60 Cycle



For SPECS "A" and "B"
WIRING DIAGRAM
611B294
 Alternating Current
 240 Volt, 3 Phase,
 3 Wire, 50 or 60 Cycle

CDRNEYEV, L.C.
 6DRN-2RV/IC
 5DRN-91RV/IC
 5DRN-52RV/IC



**Begin SPEC "C"
 WIRING DIAGRAM
 #611C370**

**Alternating Current
 120 Volt or 240 Volt,
 1 Phase, 2 Wire,
 50 or 60 Cycle.**

- CONTROL BOX NS301C1017
- COVER NS301B627
- BRAT-MTG. NS301A632
- NUMBER PLATE NS301A630
- TERMINAL BLOCK MFG. BRAT-NS32A718
- 5 DRN-51RV SPEC. IC 120V. 1PH. 2 WIRE 50CY.
- 5 DRN-32RV SPEC. IC 240V. 1PH. 2 WIRE 50CY.

NOTE:
 REMOVE RUBBER WHEN
 LINE TRANSFORMER IS USED.

611C370

OIL PRESSURE
 SWITCH NS309A64

HIGH AIR TEMP.
 CUTOFF RELAY
 NS307A42

STARTER

START SOLENOID

12 VOLT
 BATTERY
 NS307B679

START SOLENOID
 NS307B679

MANIFOLD HEATERS

MANIFOLD WATER
 SOLENOID
 NS307B50

MANIFOLD WATER
 TRANSDUCER
 NS307B54

REVERSE
 CURRENT
 RELAY
 NS307B18

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

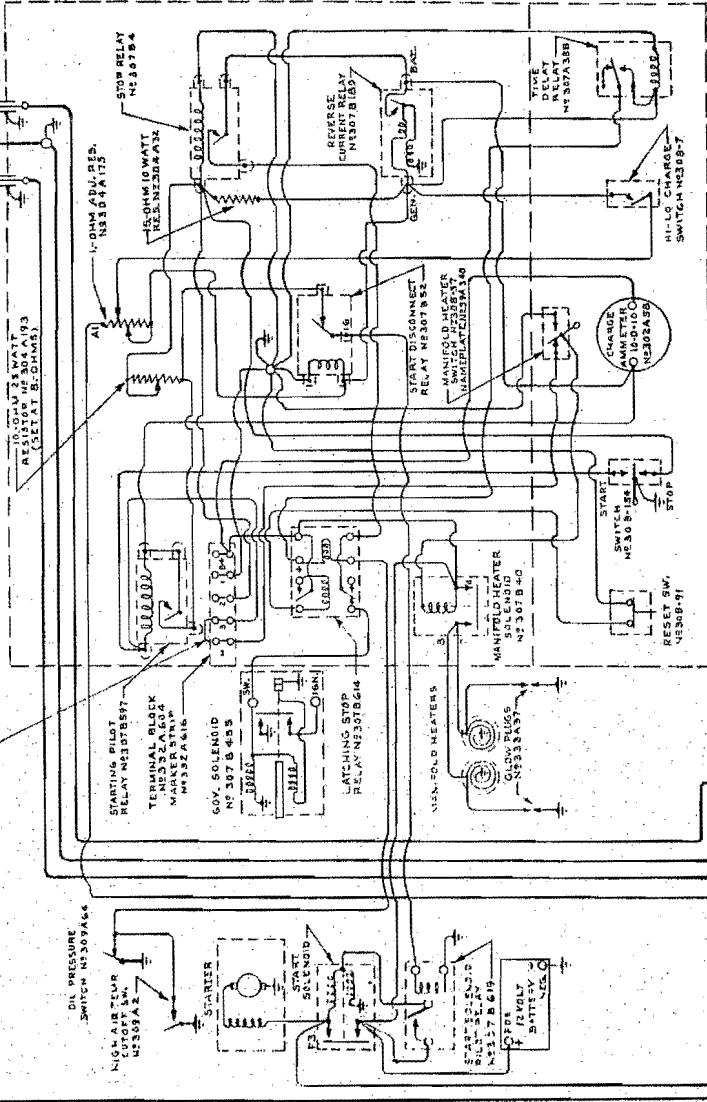
15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

15-DHM 10 WATT
 RES. (NE30848)

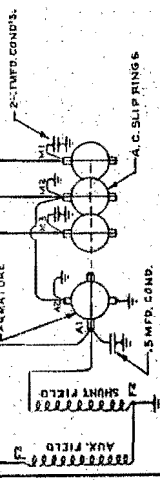
5DRH-3RV/1C
5DRH-33RV/1C

NOTE: JUMPER WHEN
LINE TRANSFER IS USED.

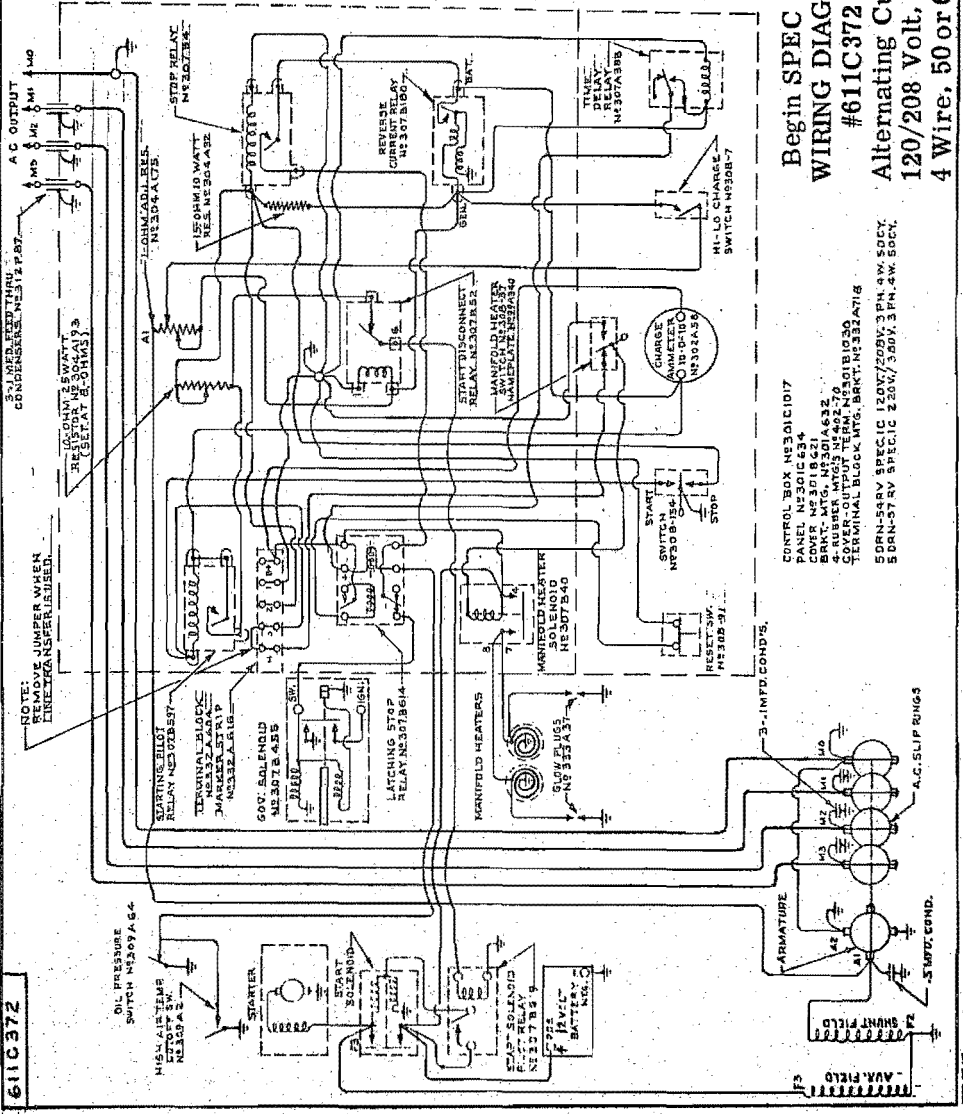


Begin SPEC "C"
WIRING DIAGRAM
#611C371
Alternating Current
120/240 Volt, 1 Phase,
3 Wire, 50 or 60 Cycle.

- CONTROL BOX N3301C1017
- PANEL N3391C634
- COVER N3301B321
- COVER N3301A4532
- 4-RUBBER WTS. N3442-70
- COVER-OUTPUT-TERM. N3301B3335
- TERMINAL BLOCK-WTG. 5DRH. N33324718
- 5DRH-33RV SPEC 1C 120-240V. 1PH. 3W. 50CY.



6DRN-2RV/IC
5DRN-54RV/IC
5DRN-57RV/IC



Begin SPEC "C"
WIRING DIAGRAM
#611C372
Alternating Current
120/208 Volt, 3 Phase,
4 Wire, 50 or 60 Cycle.

- CONTROL BOX N301C107
- PANEL N301C634
- COVER N301B621
- BATTERY N307B39
- SWITCH N307B39
- COVER-OUTPUT TERM. N301B1030
- TERMINAL BLOCK INT. BRKT. N332A718
- 5DRN-54RV SPEC. IC 120V/208V, 3PH, 4W, 50CY
- 5DRN-57RV SPEC. IC 220V/300V, 3PH, 4W, 50CY

611C372

NOTE:
REMOVING NUMBER FROM
CIRCUIT NUMBER SHOWN.

OIL PRESSURE
SWITCH N307A64

HIGH AIR TEMP
CUTOFF SW.
N307A2

STARTER

START
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

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SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
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SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
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STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

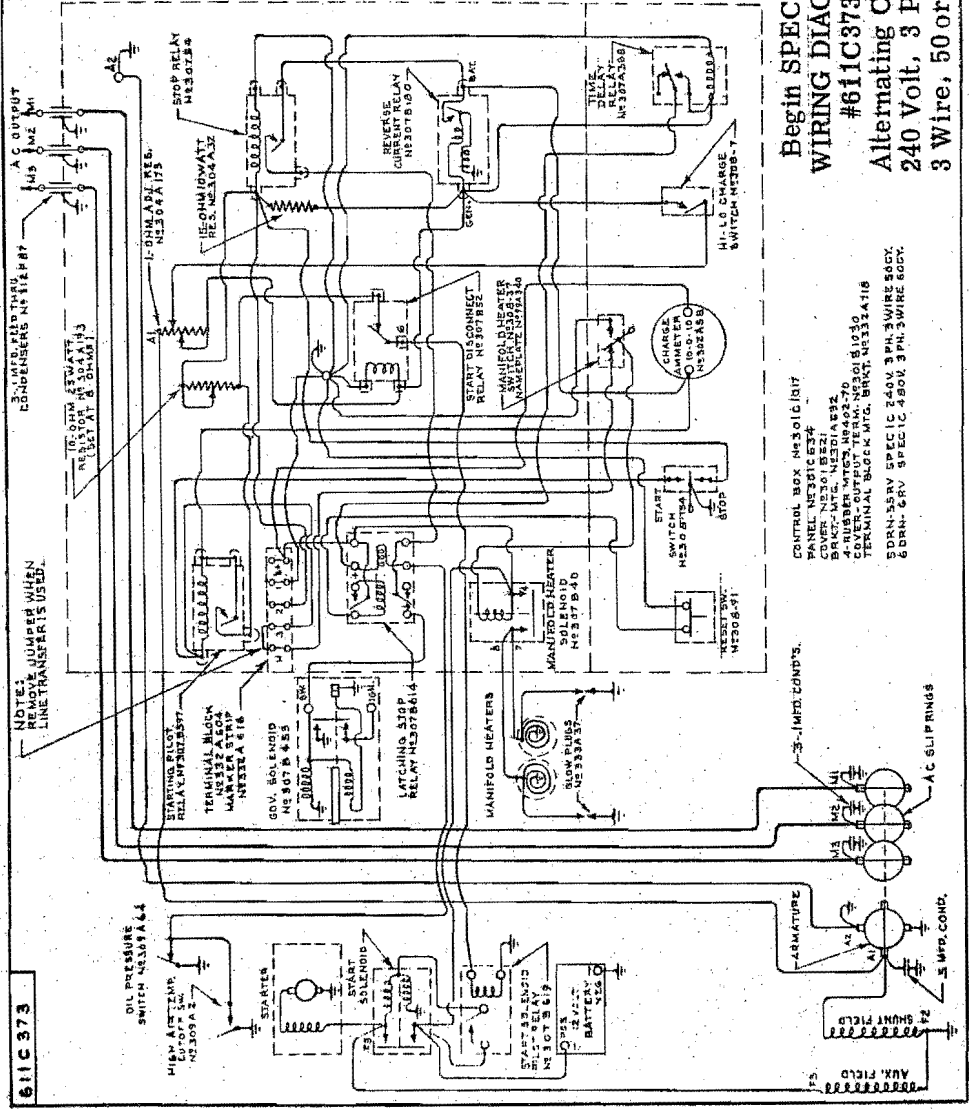
STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

STOP
SOLENOID
N307B45B

5DRN-55RV/1C
5DRN-6RV/1C
5DRN-55RV/1C

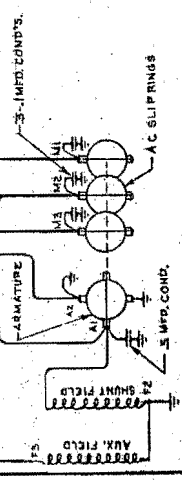


NOTE: REMOVE AIR FILTER WHEN LINE TRANSFORMERS USED.

611C373

Begin SPEC "C"
WIRING DIAGRAM
#611C373
Alternating Current
240 Volt, 3 Phase,
3 Wire, 50 or 60 Cycle.

- CONTROL BOX NS301C1017
- PANEL NS301C1017
- COVER NS301C1017
- 4-RUBBER WIPER NS402-70
- COVER-OUTPUT TERM. NS301C1017
- TERMINAL BLOCK MFG. UNCH. NS304A-16
- 5DRN-55RV SPEC 1 240V 3 PH. 3 WIRE 50CY.
- 6DRN-6RV SPEC 1 240V 3 PH. 3 WIRE 60CY.





5AC61

ONAN

- ★ **Electric Plants**
- ★ **Two-Bearing Generators**
- ★ **Air Cooled Engines**

THESE OUTSTANDING PRODUCTS, designed and built by Onan, are known the world over for their ruggedness and dependability!

WHENEVER YOU NEED an independent source of electric power for any purpose, be sure to see the complete line of Onan Gasoline or Diesel Engine-Driven Electric Plants and Onan Generators. You'll find a type and size to fit every job... portable or mobile... heavy duty primary or emergency standby. AC - 500 to 200,000 Watts. DC to 15,000 Watts. Battery Chargers to 5,000 Watts.

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