INSTRUCTION MANUAL

FOR

ONAN ELECTRIC GENERATING PLANTS

Series

EF

Onan

DIVISION OF STUDEBAKER-PACKARD CORPORATION
MINNEAPOLIS 14, MINNESOTA

963-2

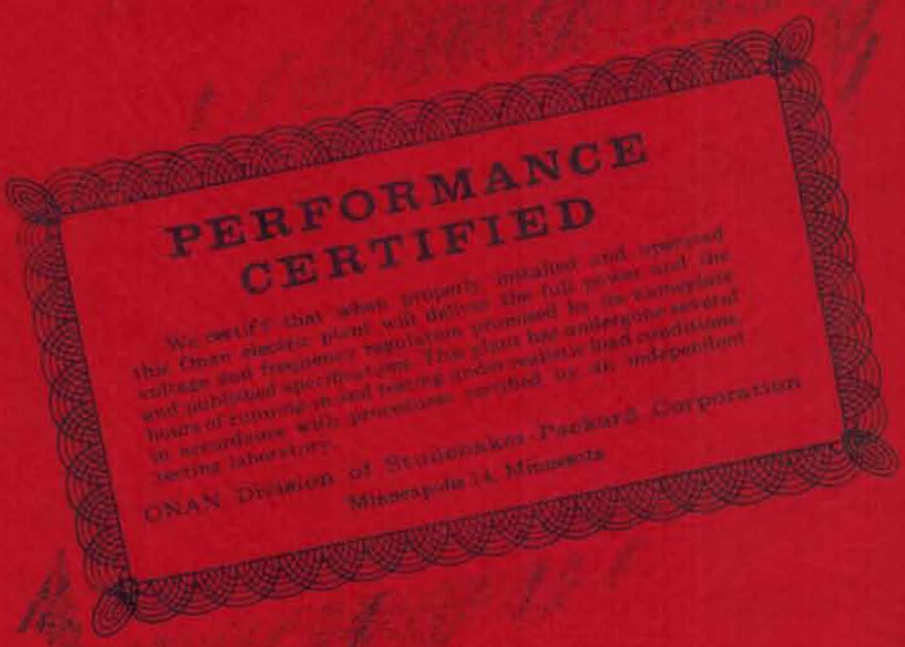
Price $1.00

Printed in U.S.A.

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 name-plate.

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



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 to approximately 4100 running miles on an automobile.

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.

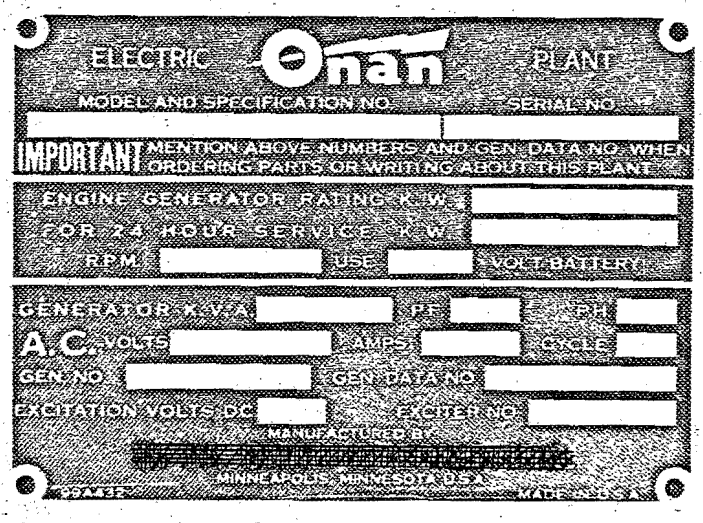
	GENERATING PLANT RUNING HOURS	AUTOMOBILE RUNNING MILES		GENERATING PLANT RUNNING HOURS	AUTOMOBILE RUNNING MILES
DAILY AVERAGE	1 Hr.	41 Mi.		30 Hrs.	1,230 Miles
	4 Hrs.	164 Mi.	MONTHLY	120 Hrs.	4,920 Miles
	6 Hrs.	246 Mi.	AVERAGE	180 Hrs.	7,380 Miles
	8 Hrs.	328 Mi.		240 Hrs.	9,840 Miles
	7 Hrs.	287 Mi.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

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.

Each Onan generating plant of the EF series is a complete unit consisting of a spark ignition type driving engine, a self excited alternating current generator, and controls and accessories according to the particular model and purchaser options.

The electrical characteristics of the plant vary according to the particular model and are noted on the Onan nameplate attached to the unit. If it ever becomes necessary to contact a dealer or the factory regarding the plant, be sure to mention the complete Model and Spec. No., and the Serial No. as given on the Onan nameplate. This nameplate information is necessary to properly identify the plant among the many types and variations manufactured. Refer to the engine nameplate when requesting engine information from its manufacturer.

Each generating plant is given a complete running test under various electrical load conditions, and is carefully inspected before leaving the factory. Inspect the plant carefully for any damage which may have occurred in shipment. Any such damage must be repaired before putting the plant in operation.



ENGINE

The engine is a Ford industrial V8 spark ignition type and is described in the Ford manual. The specific engine used may have variations due to optional features of the generating plant. Basically the engine is an 8 cylinder, V type, overhead valve, water cooled type. The cylinder bore is 3.75 inches, piston stroke is 3.30 inches, and displacement 292 cubic inches. The standard oil capacity is 5 U.S. quarts, plus 1 quart for the oil filter. A 12 volt battery is used for starting and control circuits, except on special models that require 36 volt current. Accessories, safety devices, indicating gauges, types of fuel used, and cooling method may vary according to the model and purchaser options.

GENERATOR

The generator produces alternating current as noted on the plant nameplate. The generator consists of a 4 pole revolving field type alternator and, except on special models, a "static" type exciter with magnetic amplifier regulation. The alternating current output is generated in the alternator stator winding attached directly to the rear end of the engine. The rotating field of the generator is attached to the engine flywheel, and so turns at engine speed. The speed at which the rotor turns determines the current frequency - thus the 60 cycle plant must operate at approximately 1800 rpm, and the 50 cycle plant at approximately 1500 rpm. The outer end of the rotor turns in a large ball bearing.

The stationary exciter is used on all models that use a separate automotive type starter and battery charging generator. The exciter components are mounted on a metal frame attached to the alternator end bell, and are protected by a sheet metal enclosure. The design of the exciter and regulator provides for voltage regulation of plus or minus 3% between no load and full load conditions. Stable generator output is established within 2 seconds after a change in load. The exciter has no moving parts, and requires no external voltage regulator.

The rotating exciter, used on special models designed to meet requirements of Pennsylvania, is a dc generator of 4 pole, revolving armature design. The dc output is used for exciting the alternator field. A separate ac voltage regulator is used. A series winding of the exciter permits its use as a permanently connected cranking motor. The exciter is attached to the outer end of the alternator, thus eliminating the necessity of drive belts, etc.

CONTROLS

Controls vary considerably, depending upon the particular model and purchaser options. Engine controls provide for proper control of starting and stopping, and for checking performance during operation. Most models are provided with safety stopping devices to protect the plant from damage under adverse operating conditions. Special plants are specifically designed to continue running and supply power in an emergency even if conditions are such as to risk extensive plant damage.

The electrical output portion of the controls differ also according to optional features. Meters for checking the voltage and applied load, running time meter, circuit breaker, etc. may be included.

Installation of the generating plant involves its location, connection of fuel source, exhaust line, battery installation, and electrical connections. Some special models may require connection to a source of cooling water, when no radiator is used. Each installation must be considered on an individual basis - use these instructions as a general guide. A typical standby installation is illustrated.

LOCATION. - In the average installation, the location has been preselected. However, local codes or regulations may require that minor alterations be made to make the site suitable. For standby service a warm, indoor site is usually required. The location should be dry, well ventilated, and reasonably dust free. Normally, the plant should be installed near the main fuse or entrance switch box. Provide for sufficient clearance (24 inches recommended) on all sides for convenience in servicing the plant.

MOUNTING. - The plant is mounted on a rigid base which provides proper support. For ease in draining oil, and other servicing, the plant may be mounted on raised concrete or heavy timber pedestals. Tie down bolts can be used as desired.

For mobile service, bolt the plant securely in place so that it can not shift in transit. Extra support for the vehicle floor may be required, to prevent the mounting bolts from tearing loose on rough roads or in turning sharp corners.

VENTILATION. - Ventilation is of vital importance, particularly for a radiator cooled plant. The generator creates a certain amount of heat which is blown out to the side of the generator. Considerable engine heat is created that must be removed. If the plant is installed in a small room or compartment, or in a boiler room, etc. special precautions against over heating must be taken.

Cooling air is blown out through the front of the radiator. Separate openings for inlet of cooling air and heated outlet air are necessary for any enclosure or room. The outlet opening should be at least as large in area as the radiator area. The usual method of exhausting the heated air is to construct a duct from the front of the radiator to an outside wall opening. If any turns are necessary in the duct work, use radius type construction and increase the size accordingly.

The air inlet opening should be at least as large as the outlet opening, preferably toward the generator end of the plant. Under normal conditions a flow of approximately 6140 cubic feet of air per minute will provide proper cooling (1535 cu.ft. if the plant is "city" water cooled).

It is frequently necessary to prevent back flow of cold outside air during periods of shut down. Adjustable or flow-actuated shutters may be necessary. Automatic motor controlled shutters can be installed if unattended starting is planned.

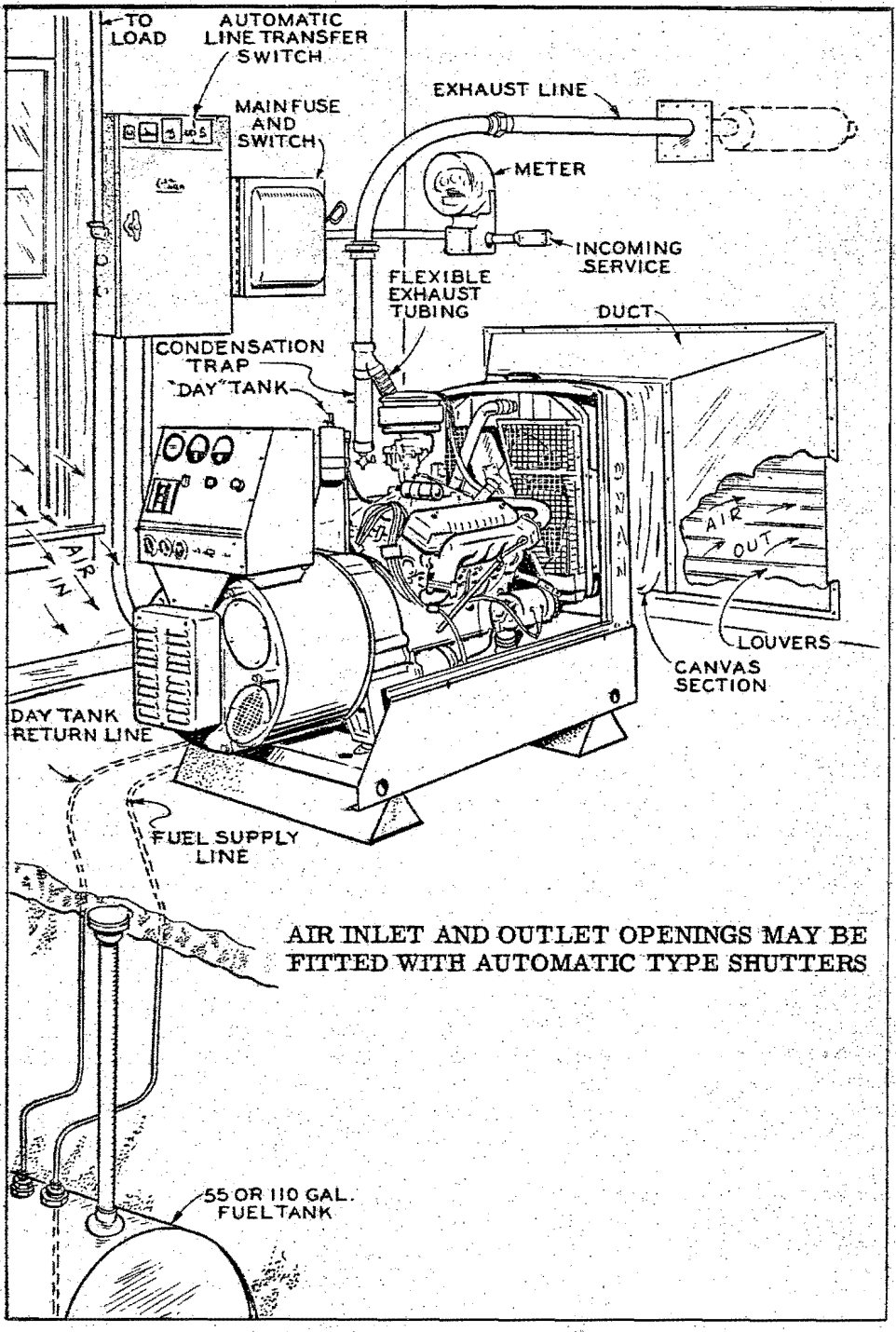


Fig. 1 Typical Standby Installation

"CITY" WATER COOLING. - If the plant is designed for pressure water cooling, refer to the outline drawing supplied for piping connections, etc.

EXHAUST. - The engine exhaust gases are deadly poisonous and must be piped outside any enclosure. The engine exhaust outlet is 1-1/2 inch pipe size. Do not use smaller pipe - increase the size one pipe size for each additional 10 feet in length. Use a length of flexible tubing between the engine exhaust outlet and any pipe extension. Avoid sharp (standard) pipe elbow turns. Sweeping (long radius) type elbows help to keep back pressure to a minimum.

If the exhaust line runs upward, install a condensation trap at the low point, with provision for periodic draining.

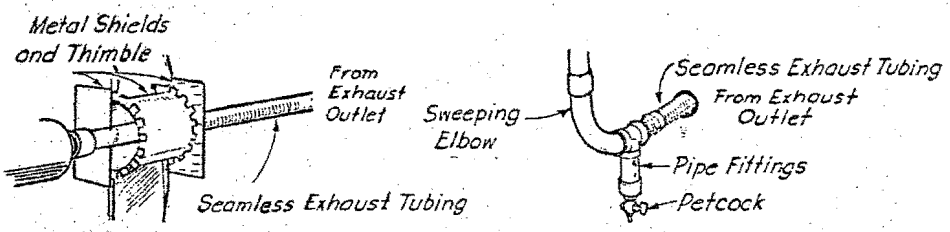


Fig. 2 Exhaust

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. Consult local regulations governing such exhaust lines.

FUEL LINE, GASOLINE. - For most permanent installations, an underground fuel tank is required. Check local regulations governing its installation. Lift of fuel from the tank to the plant fuel pump should not be more than 6 feet. Horizontal fuel travel should not exceed 50 feet. Most underground tanks require a suction tube extending down to within an inch or two of the tank bottom. Be sure the fuel supply line is connected to the suction tube. All supply line connections must be air tight. The plant fuel pump inlet is threaded for a 1/8 inch pipe thread fitting.

"DAY" FUEL RESERVOIR TANK. - In standby service, the generating plant may stand unused for many days. In this period of shut down, sufficient gasoline may evaporate from the carburetor to lower its fuel level considerably. Prolonged cranking will then be necessary to pump enough gasoline into the carburetor for the engine to start. Where automatic, unattended starting

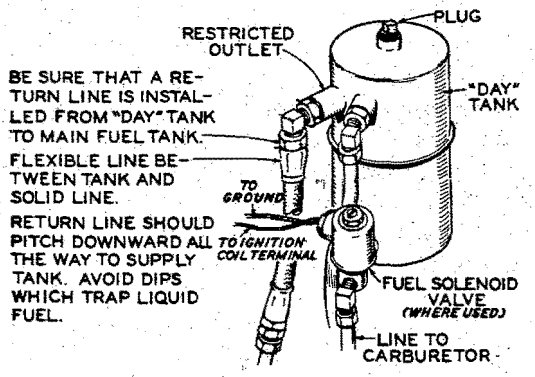


Fig. 3 Reservoir Tank

after extended shut down is necessary, an auxiliary gravity feed fuel tank should be installed. Fuel from this tank, installed between the fuel pump and the carburetor, flows by gravity to the carburetor, thus replacing any fuel lost through evaporation and promotes quick starting. See that a fuel return line is connected to the restricted outlet of the reservoir tank, to return excess fuel to the supply tank. Connect the fuel supply line to the plant fuel pump in the normal manner.

FUEL, GAS. - If the plant is equipped for gas fuel, fuel connections must conform to local regulations. In many localities, presence of foreign matter in the fuel supply will require a filter in the line ahead of the pressure regulator. An electric solenoid type valve may be required (it is recommended even where not mandatory) and should be connected as shown on the plant wiring diagram.

The regulator supplied for natural gas use is designed to operate on a line pressure of not more than 5 lbs. Use an approved flexible section to connect the supply plant to the plant inlet connection point.

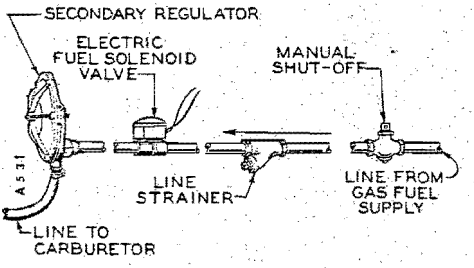


Fig. 4 Gas Fuel

Some plants are equipped to burn liquified petroleum gas (LPG) fuel. Such plants use a combination heat exchanger-pressure regulator. A separate installation diagram is supplied, showing line connections, etc.

BATTERY CONNECTION. - A 12 volt, "long" type battery is required for those plants that use a separate automotive type starter and battery charging generator. Space is provided inside the plant housing for the battery. Connect the starter solenoid cable to the positive battery post, and the grounded cable to the negative battery post.

Plants that have exciter cranking use the generator exciter as a cranking motor. Three 12 volt (or six 6 volt) batteries must be connected in series to provide the necessary 36 volt cranking current. Connect the battery positive to the start solenoid switch, and the battery negative to ground.

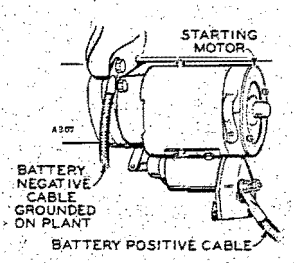
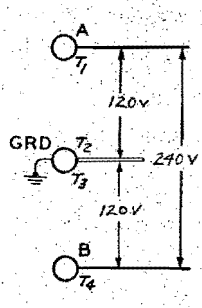


Fig. 5 BATTERY CONNECTIONS

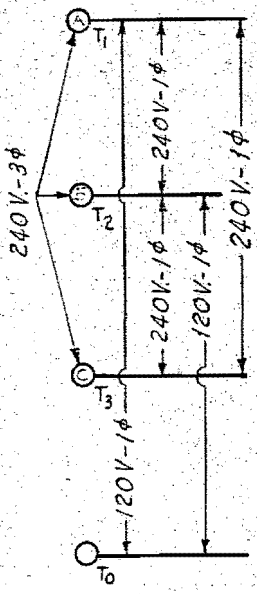
If the plant has the automotive type charge generator, a charge regulator circuit keeps the battery charged in normal service. However, if the plant is used infrequently, as in standby service, operating periods may be of short duration or infrequent enough to allow the battery to self discharge. A separate trickle charger should be used for such installations. Onan automatic line transfer switches include such a trickle charge circuit. If the plant uses exciter cranking (Pennsylvania models) the complete charging circuit is incorporated in the line transfer switch - not in the engine control circuit.

LOAD WIRE CONNECTIONS. - Load wire connections are to be made to a large terminal block mounted inside the control box. Access to the terminal block is gained by removing the screws from the instrument panel and swinging the panel out on its hinge. Bring the load wires in through one of the knock-out sections provided in the side of the box. All wiring must be in accordance with national and local electrical codes.



120/240 VOLT, SINGLE PHASE, 3 WIRE PLANT. - The load terminals are marked T1, T2-T3, and T4 from top to bottom. The T1 and T4 terminals are the "hot" terminals; the T2-T3 terminal is the neutral (ground). For 120 volt service, connect the "hot" (black) load wires to the T1 and T4 terminals, and the neutral (white) wire to the T2-T3 terminal. Two 120 volt circuits are obtained. Remember that ONLY ONE HALF the rated capacity of the plant will be available on either of the two separate 120 volt circuits. Balance the load as closely as possible between the two circuits. The two black wires will give 240 volt service.

120/240 VOLT, 3 PHASE, 4 WIRE DELTA-CONNECTED GENERATOR PLANT. - This type of generating plant is specially designed so that two types of loading can be applied to the generator; regular 240 volt, 3 phase, 3 wire operation; or, combination 240 volt, 3 phase, 3 wire and 120/240 volt, 1 phase 3 wire operation.



The load terminals are marked T1, T2, T3, and T0, from top to bottom. The T0 terminal is the center tap between T1 and T2. The T0 terminal of the generator is not grounded.

For 240 volt 3 phase 3 wire operation connect the three load wires to the three terminals T1, T2, T3, one wire to each terminal post. For 3 phase 3 wire operation the T0 terminal is not used and is normally not grounded.

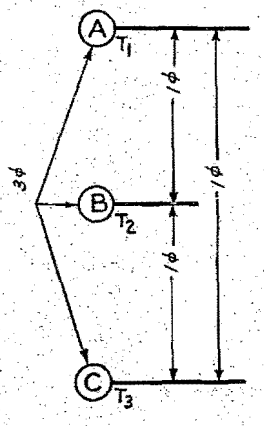
If it is desired to use combination single phase and three phase load simultaneously connect such single phase loads as follows:

For 120/240 volt, 1 phase, 3 wire operation, terminals T1 and T2 are the "hot" terminals; the T0 terminal is the neutral (which can be grounded if desired). For 120 volt service, connect the "hot" (black) load wires to the T1 and T2 terminals, and the neutral (white) wire to the T0 terminal. Two 120 volt circuits are thus obtained. The two black wires connected to T1 and T2 will give one 240 volt circuit.

Any combination of single phase and three phase loading can be applied to the generator simultaneously as specified above as long as no terminal current exceeds the rated NAMEPLATE current of the generator.

Combination single phase and three phase loads applied to a three phase generator are unbalanced loads which cause the phase voltages to be unequal. These unbalanced loads will not create voltage unbalance of the phase voltages of greater than 5 per cent so long as no terminal current exceeds the rated current of the generator.

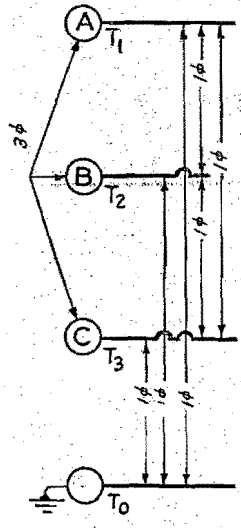
This generating plant may be used with an ONAN automatic line transfer control, for standby plant operation. The T0 terminal of the ONAN automatic line transfer control is always grounded. Connecting the generating plant T0 lead to the line transfer T0 terminal grounds the generator. If used in conjunction with an ONAN Automatic line transfer control on a 3 phase 3 wire circuit, the line transfer T0 terminal should be left open and not used.



3 PHASE, 3 WIRE PLANT CONNECTIONS.- None of the terminals are grounded. For three phase current, connect a separate load wire to each plant terminal, T1, T2 and T3, one wire to each terminal. Reversing the connections between any two terminals will reverse the direction of rotation of 3 phase motors. Use a phase sequence indicator to assure in-phase connection.

On connections for single phase current, connect separate load wires to each of any two plant terminals, one wire to each terminal. Three single phase load circuits are thus available.

If both single and 3 phase current is to be used at the same time, use care not to overload any one circuit. Subtract the amount of the 3 phase load from the plant capacity. Divide the remainder by 3, and this is the load that may be taken from any one circuit for single phase current. For example, a 3 phase 10,000 watt load is used. This leaves 30,000 watts available for single phase, if the plant capacity is 40,000 watts. One third of this 30,000 watts is 10,000 watts, which is the amount that may be taken from each of the 3 single phase circuits. Do not attempt to take all 30,000 in this example off one circuit, as overloading of generator will result.



3 PHASE, 4 WIRE WYE-CONNECTED PLANT. - The four wire plant is designed to produce single phase current of one voltage, and three phase current of different voltage. As shown on the plant nameplate, the single phase current is the lower voltage and the three phase current is the higher voltage.

The load terminals are marked T1, T2, T3, and T0 from top to bottom. The T1, T2, and T3 terminals are the "hot" terminals, and the T0 terminal is the ground terminal.

For three phase current, connect the three load wires to the terminals T1, T2, and T3, one wire to each terminal post. If a test run indicates reverse rotation of motors in the load circuit, reverse the connections of any two terminals.

For single phase current, connect the "hot" load wire to any one of the terminals T1, T2, or T3. Connect the ground wire to the T0 terminal. Three single phase circuits are thus available.

NOTE

On three phase, four wire models (or single phase, three wire models) the voltage shown on the panel voltmeter applies to the higher nameplate rated voltage - actually the line-to-line voltage. The lower nameplate rated voltage (line to neutral) will be in proportion.

If both single 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 plant. Divide the remainder by three to determine the amount of single phase load which may be connected to any single phase circuit.

REMOTE CONTROL CONNECTIONS. - A small four place terminal block is mounted on the bottom inside surface of 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.

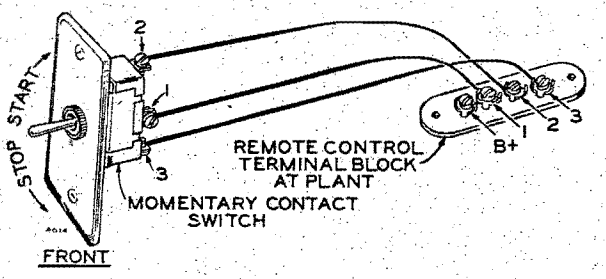


Fig. 6 Remote Control Connections

For remote control distances, #18 wire can always be used up to 75 feet in wire length. For greater distances, larger wire will be necessary, as indicated.

MAX. DISTANCE	WIRE SIZE
75	#18
120	#16
200	#14

AUXILIARY SIGNALS. - If the plant is installed in a location that is not regularly attended, and emergency stopping of the plant could go unnoticed, auxiliary signals can be connected in the emergency stop relay circuit. Connection points are shown on the engine control wiring diagram.

CRANKCASE OIL. - Normal refill oil capacity is 5 U.S. quarts. An extra quart will be required after an oil filter element change. Select the SAE number according to the lowest expected temperature for starting purposes. Use a good quality oil that is designated for MS or DG service.

TEMPERATURE	SAE NUMBER
Above 100°F.	50
Above 32°F. (0°C.)	30
32°F. to -10°F. (0°C. to -23.3°C.)	10
Below -10°F. (23.3°C.)	5W

NOTE

When adding oil between changes, always use oil of the same brand. When mixed together, detergent oils of different manufacturers sometimes form chemical compounds harmful to engine parts.

AIR CLEANER. - Remove the air cleaner top and fill the reservoir cup to the line indicated on the cup with oil of the same SAE number as used in the crankcase. On housed plants, because of close top clearance, it is necessary to remove the air cleaner from the carburetor. Be sure the air cleaner is properly reinstalled before running the plant.

RADIATOR. - The capacity of the cooling system is 24 quarts (U.S. measure). Check to see that the radiator drain and both cylinder block drains are closed. Fill the radiator to within an inch or two of the bottom of the filler neck. Use clean soft (alkali free) water, such as clean rain water. The use of a good rust and scale inhibitor is recommended.

If the plant will be exposed to freezing temperatures (below 32°F. or 0°C.), use a standard anti-freeze solution. Use the correct proportion of anti-freeze, as recommended by the anti-freeze manufacturer, to protect at least 10 degrees F. below the lowest expected temperatures.

FUEL, GASOLINE. - Some special model plants are equipped with a mounted 20 gallon capacity fuel tank. Do not fill the tank completely full of cold gasoline. Expansion of the gasoline as the plant warms up may cause the gasoline to overflow, creating a fire hazard. Allow an inch or two of expansion space.

Use fresh, "regular" grade of gasoline. Do not use a highly leaded "premium" grade of gasoline. The use of highly leaded gasoline will require more frequent lead removal, valve, and spark plug servicing. The engine is designed to operate at highest efficiency and economy

when using "regular" grade gasoline. However, do not use a low octane fuel, such as "stove gas". The use of such fuel may cause serious damage to the engine.

Observe the usual safety precautions when handling gasoline. Special precautions must be taken when the fuel tank is near the plant. Never fill the tank while the plant is running.

FUEL, NATURAL GAS. - If gas fuel is to be used, see that all fuel connections are leak proof. See that the line pressure at the regulator inlet does not exceed 5 pounds per square inch. In some localities, presence of foreign matter in the fuel may require the installation of a trap or filter. Consult the fuel supplier.

A special carburetor fitting is used on plants equipped for gas fuel operation. See that the float lock screw (See Figure 12) is turned up tightly to prevent the float from vibrating inside the carburetor. If an emergency source of gasoline is also connected, see that the gasoline shut-off valve on the carburetor is closed. See that the electric choke is adjusted for gas operation as described in the paragraph on Carburetor-Gas.

GAS-GASOLINE TOGGLE SWITCH. - If the plant is equipped to burn both gas and gasoline fuel, a toggle switch is provided to disconnect the gas fuel solenoid valve. The switch is mounted near the carburetor. See that the switch is at the appropriate position for the type of fuel to be used.

STARTING. - For the initial start, check over the installation carefully and make sure that all requirements for PREPARATION have been met. See that no electrical load is connected (circuit breaker at "OFF" position)for the first start.

Press the "START-STOP" switch in its "START" direction, holding in contact to crank the engine. For the first start, or if the plant has run out of fuel, extensive cranking may be necessary to pump fuel to the carburetor and fill it. Automatic choking is provided. Hold the start switch in contact until the plant reaches running speed.

NOTE

After the factory test run, protective oil was sprayed into the cylinders. It may be necessary to remove the spark plugs and clean them in gasoline. Dry the plugs thoroughly before reinstalling them. Burn-out of this oil may cause temporary heavy exhaust smoking.

If the plant is equipped for use of gas fuel, the final test run was made on gas fuel. On the initial start, it may be necessary to press the gas pressure regulator priming button momentarily to start gas flow.

The spark plug gaps were adjusted for the type of fuel specified. For gasoline fuel, correct gap is .028-.032". For gas fuel, the correct gap is .018".

CHECKING OPERATION. - As the engine warms up, observe the indicating gauges for proper operation. On the initial run, check the radiator coolant level. The thermostat may have permitted an air pocket to form, preventing complete filling.

Throw the circuit breaker to its ON position, to energize the output terminals. Check the electrical performance of the plant. If an automatic line transfer switch is part of the installation, check the entire installation and performance.

STOPPING. - If practicable, allow the plant to run a few minutes at no load before stopping. This will allow the engine to cool off slightly and prevent an undesirable temperature rise when ventilation stops. Press the START-STOP switch to the STOP position.

EXERCISE PERIOD. - When the plant is used infrequently, as in standby service, it should be given an exercise run regularly. The exercise run should be for at least 15 minutes, preferably every day or two. If a "DAY" reservoir tank is used, time between exercise periods can be extended but should not exceed 1 week. An "exerciser clock" is available as an accessry, and will provide for automatic, unattended, regular exercise runs.

NORMAL OPERATING FUNCTIONS

The generating plant control panel includes various indicating gauges, instruments, etc. for checking operation. Equipment varies according to model and purchaser options.

OIL PRESSURE GAUGE. - The oil pressure gauge registers the engine oil pressure while in operation. Normal pressure is 40 to 60 psi at operating temperature. Pressure may be considerably higher until operating temperature is reached.

WATER TEMPERATURE GAUGE. - The water temperature gauge registers the engine coolant temperature during operation. Normal temperature range is 140° to 170°F.

CHARGE AMMETER. - The small ammeter registers the battery charging current. The rate of charge during operation depends upon the charge condition of the starting battery. Normally, the charge rate will be 5 to 10 amperes when the plant starts. The rate will gradually fall to almost zero as the battery becomes fully charged.

STOP RELAY RESET BUTTON. - If one of the plant safety devices operates to stop the plant, an emergency stop relay is energized. After correcting the cause of the emergency stop, the RESET BUTTON must be pressed in to de-energize the relay and permit starting again.

START-STOP SWITCH. - The start-stop switch is a double throw, normally open momentary contact type. Push the switch up to start, down to stop.

RUNNING TIME METER. - The running time meter registers the number of hours, to 1/10th, that the plant has actually run. Use it to keep a record and schedule of periodic service, etc.

AC AMMETER. - The ammeter (two are provided on single phase models) registers the amount of load connected to the plant. On single phase models, each ammeter indicates the amount of load connected to its respective circuit. On three phase models, the ammeter indicates the load for one phase only, according to the position of the selector switch.

AC VOLTMETER. - The voltmeter indicates the voltage of the generator output. On single phase models, the voltage shown will always refer to the higher nameplate rated voltage. On three phase models, voltage shown will be for the same phase as the ammeter reading, as determined by the selector switch position. On three phase, four wire models the three phase voltage only is shown.

SELECTOR SWITCH. - The selector switch is provided on three phase models. It can be turned by hand - its position determines which phase of the generator output is indicated on the ammeter and voltmeter.

CIRCUIT BREAKER. - The circuit breaker protects the generator from damage in case of severe overloading. If overloading occurs, the circuit breaker automatically trips to break the generator exciter circuit. After correcting the condition that caused the breaker to trip, the breaker must be reset by hand. The circuit breaker can be used as an output connect - disconnect switch.

TACHOMETER. - A tachometer indicates engine speed in revolutions per minute. It is valuable in adjusting and checking speed, especially when rigid performance standards must be maintained.

FREQUENCY METER. - A frequency meter indicates the frequency of the generator output current. Its use is similar to that of a tachometer - it provides for checking or adjusting the plant. The speed at which the generator turns determines the frequency of its current.

SAFETY DEVICES. - The plant is equipped with safety features that automatically stop the plant under dangerous operating conditions. Some such safety devices are standard equipment, others are optional. Optional signals that call attention to improper operation are available.

1. High Water Temperature Switch. - The high water temperature switch is a thermostatic switch mounted in the engine cooling system. The switch acts to stop the plant if the engine coolant temperature should rise to high. Refer to ADJUSTMENTS.

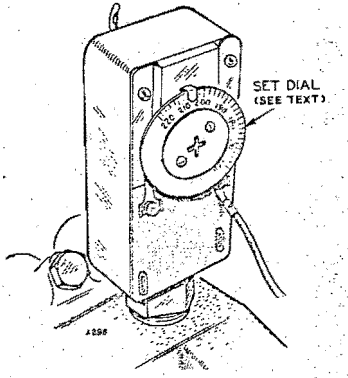


Fig. 7 High Water Temperature Switch

2. Over Speed Switch. - The over speed switch is a centrifugal type, mounted on the generator rotor shaft. If the governor drive belt should break, or for any reason the speed should rise to a dangerous point, the over speed switch stops the plant.

3. Low Oil Pressure Switch. - The low oil pressure switch acts to stop the plant in case of oil pressure failure. It is not intended to warn of need for adding oil.

NOTE

If one of the safety devices operates to stop the plant, the emergency stop relay is activated to accomplish the stopping. It is necessary to press the reset button before the plant can be started again.

WARNING SIGNAL OR LIGHT. - Warning devices are connected to operate when a safety device has caused an emergency stop. The warning device can be a signal light, or an audible horn. Pressing the reset button disconnects the warning signal.

VOLTAGE REGULATOR RHEOSTAT. - The voltage regulator rheostat provides for adjusting the ac output voltage under normal operating conditions. Turn the rheostat clockwise to increase the voltage, counterclockwise to decrease the voltage. Refer to MAINTENANCE for directions for voltage adjustment on plants with spec. letter A.

CITY WATER COOLING. - The city water cooled plant is equipped with a hand adjusted rate-of-flow valve that should be adjusted to provide proper cooling with the minimum flow of water. Final adjustment should be made under the maximum load the plant will carry, the plant thoroughly warmed up, and the water temperature stabilized. Too little water flow can cause a dangerous rise in the engine temperature - too much water flow can cause over cooling, waste of water, etc.

HIGH ALTITUDE OPERATION. - If the unit is to be operated at an altitude of 2500 feet or more above sea level, the carburetor main jet adjustment should be "leaned" slightly to obtain maximum possible power. The carburetor was adjusted for best performance at the factory altitude of approximately 860 feet.

Because the air becomes less dense as the altitude increases, less fuel is required to maintain the proper air-to-fuel ratio. Consequently, any engine will develop less power at higher altitudes. The usual altitude de-rating amount is approximately 4 per cent for each 1000 feet above sea level.

LOW TEMPERATURES

CRANKCASE OIL. - For cold weather operation, select the SAE number of the crankcase oil according to the lowest temperature expected before the next scheduled oil change. See PREPARATION. When changing to a lighter oil for cold weather, change the oil filter element at the same time (which will require an extra quart). After changing to a lighter oil, always run the plant for a few minutes to circulate the lighter oil through the engine.

If an unexpected temperature drop takes place, use caution in attempting to start the plant after a shut down period. Do not attempt to start a plant that is so "stiff" that it will not crank properly. Congealed oil may not flow readily, resulting in lack of lubrication to vital parts and causing serious damage. In an emergency, apply heat directly to the engine oil pan to warm the oil. When the oil is sufficiently fluid, start the plant and allow it to thoroughly warm up. Stop the plant and change the oil (and oil filter element) to the proper SAE number.

RADIATOR. - If there is a possibility of the temperature falling below 32°F. (0°C.) the coolant must be protected against freezing. Use a good anti-freeze compound in the proportion recommended by the anti-freeze manufacturer, protecting to at least 10 degrees F. below the lowest expected temperature. The capacity of the cooling system is approximately 24 U.S. quarts.

Set the high water temperature cut-off switch to operate at a temperature several degrees below the boiling point of the anti-freeze solution used, taking into consideration the altitude at which the plant is operating.

If the cooling system is drained to prevent freezing, be sure to remove the radiator cap while draining. Failure to remove the cap may form a vacuum in the cooling system preventing complete draining. Be sure the cylinder block drain cocks (one on each side of the engine) are opened for complete draining.

GASOLINE FUEL. - Use fresh, clean winter grade (not highly leaded, or premium) gasoline for best starting in cold weather. If the fuel tank is subject to considerable temperature variations, keep the tank nearly full in order to cut down condensation of moisture inside the fuel tank. Such condensation can cause trouble by ice formation in the fuel system. Avoid filling the tank entirely full of cold gasoline. Expansion of the fuel as it warms up may cause it to overflow and create a fire hazard.

GAS FUEL. - Certain types of LPG fuel do not vaporize readily at low temperatures. Heat exchanger equipment may be necessary. Consult the fuel supplier if lowered performance is observed at low temperatures.

BATTERY. - Check the charge condition of the starting battery often enough to assure that it is always in a well charged condition. The charging circuit is designed to keep the battery well charged in normal service, but frequent starting with short operating periods may cause the charge condition to drop to a point where there will not be enough power to crank the engine at low temperatures.

The cranking power of a battery drops to about 2/5 of its normal power at 0°F., and the cranking load is greatly increased. If practicable, remove the battery to a warm place during shut down periods in extremely cold weather. It takes but a few minutes to connect the battery for starting, and its cranking power will be much greater if warm.

IGNITION. - The ignition system must be in good condition for prompt starting in cold weather. The distributor breaker points and condenser, and the spark plugs are particularly important. See that the breaker points are in good condition (not burned or pitted) and are properly adjusted.

VENTILATION. - An installation detail that is easily over-looked is protection from a back flow of cold outside air during periods of shut down. Ventilating openings should be constructed to enable them to be closed when the plant is not running. If the installation provides for automatic, unattended starting and operation, automatic shutters may be necessary.

HIGH TEMPERATURES

LUBRICATION. - As indicated under PREPARATION, use SAE No. 30 oil for temperatures above 32°F. Keep the oil level at or near the FULL mark on the level indicator. However, do not over fill the crankcase. Use the same SAE number oil to service the air cleaner.

COOLING. - A constant supply of fresh air must be provided for proper cooling. See that nothing obstructs the flow of air to the plant, and see that the radiator air outlet flow is not obstructed in any way. Keep the radiator well filled. Use a good rust inhibitor to keep the cooling system clean and free of rust and scale formation. See that the fan belt tension is properly adjusted. Be sure the high water temperature switch is properly adjusted.

BATTERY. - Check the level of the electrolyte frequently. Add approved water as often as necessary to keep the level at the point recommended by the battery manufacturer.

NOTE

REDUCING BATTERY SPECIFIC GRAVITY FOR LONGER BATTERY LIFE

Standard automotive type storage batteries will self discharge very quickly when installed where the ambient temperature is always above 90°F., such as in a boiler room, or in tropical climates. To lengthen battery life, dilute the electrolyte from a normal 1.275 specific gravity reading at full charge to a 1.225 reading.

The cranking power of the battery is reduced somewhat when the electrolyte is diluted, but if the temperature is consistently above 90°F., the reduced cranking power will hardly be noticed, and lengthened battery life will be a distinct advantage. Adjust the electrolyte as follows:

1. Fully charge the battery. Do not bring an open flame or burning cigarette near the battery during charging, as the gas released during charging is highly inflammable.
2. While the battery is still on charge, use a hydrometer or filler bulb to draw off all the electrolyte above the plates in each cell. DO NOT ATTEMPT TO POUR OFF!! Avoid skin or clothing contact with the electrolyte. Dispose of the removed electrolyte.
3. Refill each cell with pure distilled water, to the recommended level.
4. Continue charging for one hour at a 4 to 6 ampere rate.
5. Use a reliable hydrometer to test each battery cell. If the specific gravity is still above 1.225, repeat steps 2, 3, and 4 until the reading of the fully charged battery is not over 1.225. Most batteries require repeating steps 2, 3, and 4 two times.

DUST AND DIRT

AIR CLEANER. - Clean the air cleaner and change its oil as frequently as the conditions require. The air cleaner function of trapping air borne dust and dirt is very important in promoting longer engine life.

RADIATOR. - Keep the radiator cooling fins clean and free of dust, chaff, leaves, etc. Clogged cooling fins will reduce the effective cooling area of the radiator and may result in improper cooling.

GENERAL. - Keep the entire plant as clean as practicable. Wipe off accumulations of dust, dirt, and spilled oil. Keep the generator commutator, slip rings, and brushes clean. Keep supplies of fuel and oil in air tight containers. Change the crankcase oil, and the oil filter element more frequently, as conditions require.

GENERAL. - Follow a definite schedule of inspection and servicing to help in keeping the plant in good running condition, and to keep operating expenses to a minimum. Service periods outlined in this section are for normal service and operating conditions. For extreme conditions, such as continuous heavy duty, extremely high or low temperatures, etc., service more frequently. For periods of little use, service periods can be lengthened accordingly. Keep a record of the operating hours each day to assure servicing at the proper intervals. See Maintenance section for Ford's Service Schedule and additional maintenance.

DAILY SERVICE
(Normal 8 hours Operation)

FUEL. - If the plant is operated on gasoline fuel, check the fuel supply often enough to avoid running out of fuel. If the plant stops from lack of fuel, it will be necessary for the fuel pump to first pump enough fuel to the carburetor to permit starting again. This may require considerable cranking, depending upon the distance of fuel travel from the tank to the fuel pump.

CRANKCASE OIL. - Check the oil level, on the level indicator. Do not allow the oil level to fall below the "ADD OIL" mark on the indicator. Add oil of the proper SAE number, as necessary to bring the level to or near the "FULL" mark on the indicator. Do not over fill.

AIR CLEANER. - Service the air cleaner as often as required by the operating conditions. Under extremely dusty conditions, it may be necessary to clean the air cleaner and renew its oil several times during a day's operation. Under dust free conditions, every 100 hours or even less frequent servicing may be sufficient.

To service the air cleaner, remove it from the top of the carburetor. Disassemble the top section from the cup section and pour out the dirt laden oil. Clean reservoir cup and filter element with solvent and allow to dry. Refill to the indicated level with clean oil and reassemble the cleaner. When reinstalling to the top of the carburetor, tighten just enough to assure that no air will leak in around the clamping point.

RADIATOR. - Check the level of the coolant in the radiator, and add liquid as necessary to bring the level up to normal. If freezing weather prevails, and a non-permanent type anti-freeze is used, test the protective strength of the solution. The high water temperature switch will not protect against evaporation.

CLEANING. - Keep the plant clean as practicable. A clean plant is easier to service and will give better service. Wipe off spilled oil, dust, dirt, etc.

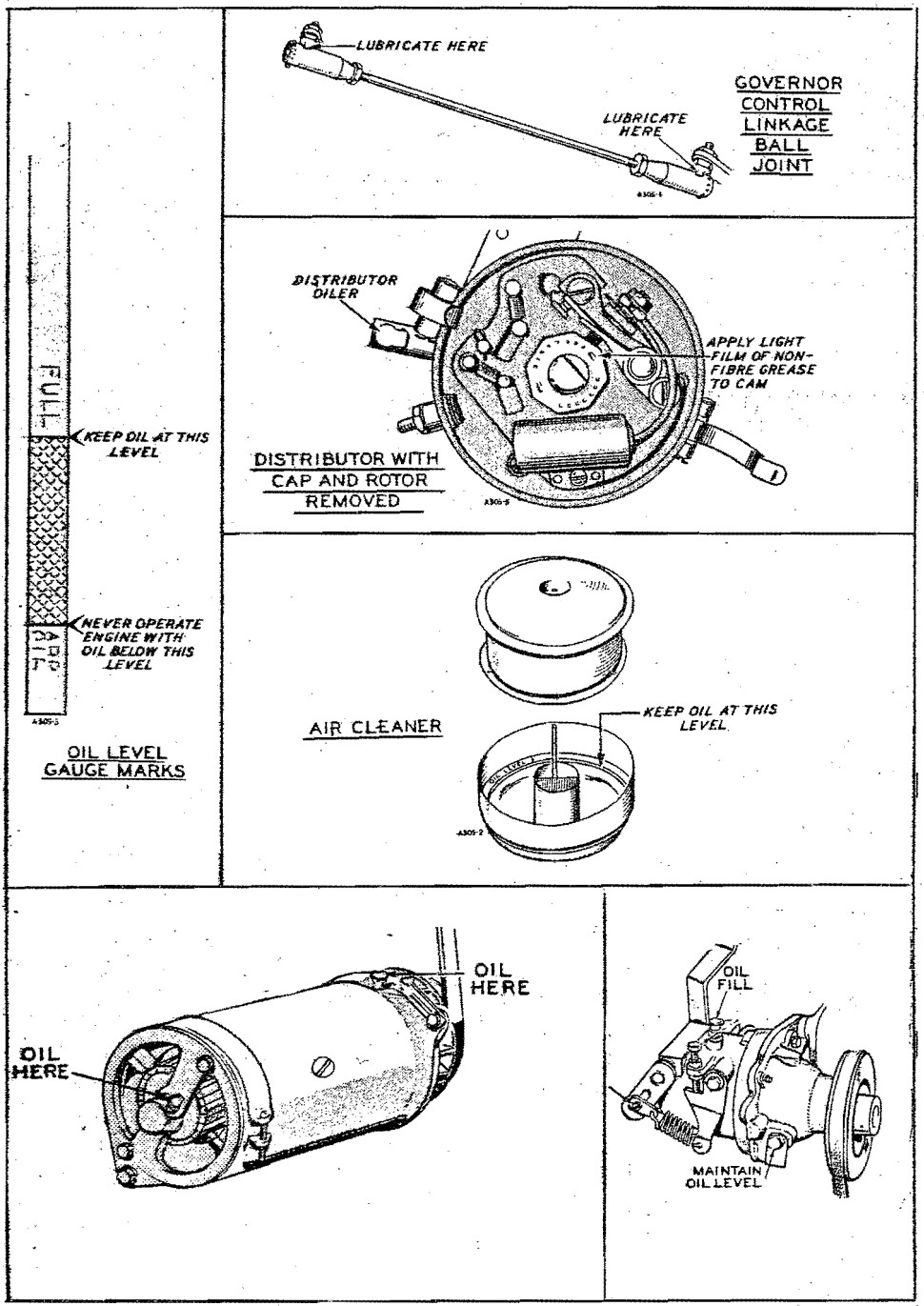


Fig. 8 Lubrication Points

WEEKLY SERVICE
(Normal 50 hours Operation)

CRANKCASE OIL. - With a new (or reconditioned) engine, drain the crankcase and refill to the proper level after the FIRST 15 HOURS OF OPERATION. Drain and refill the crankcase again after the next 50 hours of operation. If the plant is operating under temperature conditions of 32°F. (0°C.) or lower, continue to change the crankcase oil at 50 hour intervals.

Such cold weather operation, particularly when operating periods are of short duration, is likely to cause sludge formation which tends to quickly contaminate the oil. Always drain the old oil, when changing it, only when the engine is warm from recent running.

Under normal temperature (above 32°F.) and operating conditions, change the crankcase oil every 100 operating hours.

OIL FILTER. - The oil filter is a full-flow type, and if allowed to become filled with sludge to the point where no oil can flow through it, a by-pass valve opens to provide lubrication to the engine.

Under normal operating conditions, change the oil filter element each alternate crankcase oil change. However, under cold operating conditions or dusty and dirty conditions, change the filter element at each oil change.

Place a drip pan under the oil filter. Remove the center bolt and remove the filter housing and element as a unit. After discarding the dirty filter element and all the gaskets, clean the metal parts with solvent, making sure the radial holes in the center bolt are not clogged. Place a new gasket next to the head of the center bolt and insert the center bolt in the housing. Install the spring and retainer assembly over the center bolt (retainer facing the threaded end of bolt). Install a new gasket and element over the bolt.

With the openings in the diaphragm positioned at the top, install a new housing gasket in the crankcase recess. Position the filter and tighten the center bolt just enough to cause the filter housing to contact the gasket. Rotate the housing to assure even seating, then tighten the center bolt to 20-25 pounds-foot torque. Overtightening the center bolt may cause distortion of the filter housing and cause oil leakage. Check for oil leakage after the engine has warmed up.

GOVERNOR. - Check the governor oil level. Remove the oil level plug (Fig. 8) and add oil, of the same SAE number as used in the crankcase, until the oil reaches the plug level. Do not overfill.

GOVERNOR LINKAGE. - Inspect the ball joints of the governor arm and carburetor throttle linkage. Keep these points free of dust. Lubricate with a "dry" type of lubricant, such as powdered graphite. If a "dry" lubricant is not obtainable, use only a light machine oil of non-gumming quality.

BATTERY GENERATOR. - Put two or three drops of oil in the battery charging generator oilers, one at each end of the generator. Do not over lubricate.

STARTER. - The starting motor does not require any lubrication if it does not have an oiler at its outer end.

BATTERY. - See that the battery connections are clean and tight. Corrosion at the terminals can be removed by flushing with a weak baking soda and water solution. Flush clean with clean water and dry thoroughly. A light coating of grease or asphalt paint will retard such corrosion.

Keep the electrolyte at the proper level above the plate separators by adding clean water which has been approved for use in batteries. In freezing weather, run the plant for at least 20 minutes after adding water, to mix the water with the electrolyte and prevent its freezing.

MONTHLY SERVICE
(Normal 200 hours Operation)

FUEL SYSTEM. - Remove the drain plug at the bottom of the carburetor to drain off any sediment. Install the plug securely. Remove the filter bowl and screen from the fuel pump, clean thoroughly, and replace. After servicing is completed, inspect carefully against leaks.

SPARK PLUGS. - Remove the spark plugs, clean them and adjust the gap to 0.028-0.032 inch when using gasoline fuel or to 0.018 inch when using gas fuel. Replace with a new one any plug which will not pass a standard compression firing test.

DISTRIBUTOR. - Examine the distributor breaker points. If burned or pitted, replace with a new set. See that the point gap is set at 0.014" to 0.016" at widest separation. Apply a very small amount (about the size of a match head) of high temperature grease on the breaker cam surface. Put a few drops of oil in the oiler cup on the side of the distributor.

COMPRESSION TEST. - Use a compression gauge to test the engine compression. Low compression on one cylinder may indicate a leaking valve. Unusually high compression on all cylinders may indicate a build-up of lead deposits, necessitating removal

of the cylinder heads and scraping deposits out. Normal new engine compression with the throttle wide open, engine at operating temperature, all spark plugs removed, and battery fully charged, is approximately 155 lbs.

EXHAUST. - Inspect all exhaust connections carefully for leaks. Tighten or make any other necessary repairs.

GENERATOR. - Examine the generator brushes and the slip rings. The slip rings acquire a brown glossy appearance, which is normal. Do not attempt to maintain a bright metallic appearance. Wipe clean with a dry, lint free, hard finish cloth. Slight roughness or a heavy coating can be remedied by lightly sanding with #00 sandpaper - never use emery or carborundum cloth or paper. Wipe out all carbon and sanding dust.

Brushes gradually wear so that eventually they can become too short to properly function. Brush wear will be more rapid under dusty conditions. Replace brushes in sets, when worn to 1/2 inch in length. Never lubricate brushes or slip rings.

The generator bearing is a permanently lubricated and sealed type and requires no lubrication service.

THREE MONTH SERVICE
(Normal 600 hours Operation)

VALVE TAPPETS. - Remove the rocker arm covers and check the tappet clearances. Adjust as necessary to a clearance of 0.016 inch for the intake valves, and 0.019" for the exhaust valves. Tappets should be adjusted with the engine at operating temperature.

CAUTION

When replacing the rocker arm covers, tighten the cover nuts to only 2 to 2.5 lb. ft. torque. Overtightening the cover nuts will distort the cover.

SEMI-YEARLY SERVICE
(Normal 1200 hours Operation)

COOLING SYSTEM. - Drain the cooling system. Flush thoroughly and if necessary, use a good cleaning solution. Refill, using a good rust inhibitor or anti-freeze containing inhibitor.

OIL PAN. - Remove the engine oil pan and clean thoroughly of all sludge, etc. Do this at a time to coincide with a regularly scheduled oil change.

CARBURETOR, GASOLINE. - The carburetor has main and idle adjusting needle valves (Fig. 9). The main adjusting needle, at the bottom of the carburetor, affects the operation at the heavier load conditions. The idle adjusting needle, at the side of the carburetor, affects the operation at the light and no load conditions.

Under normal circumstances, the factory carburetor adjustments should not be disturbed. If the adjustments have been changed, an approximate setting of 1-1/2 turn open for the idle needle and 1 turn open for the main needle will permit starting. Adjust temporarily for smoothest running. Allow the engine to thoroughly warm up before making final adjustments.

An engine speed indicator (tachometer, or frequency meter) should be used.

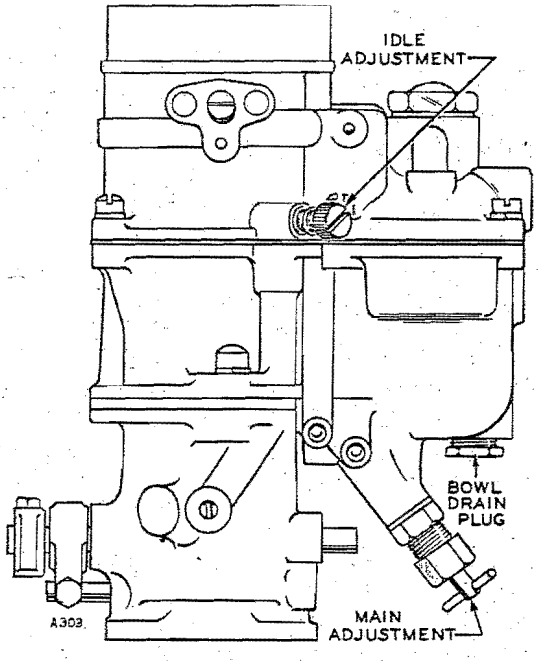


Fig. 9 Gasoline Carburetor Adjustments

To adjust the "idle" (no load) needle, see that no load is connected to the generator. Slowly turn the idle adjusting needle out until the engine speed drops slightly. Turn the needle in just to the point where the speed returns to normal.

To adjust the main needle, apply a full electrical load. Turn the main needle in until the engine speed begins to drop. Slowly turn the needle out until the speed no longer rises. Try various electrical loads. If the engine speed fluctuates at any load, turn the main adjusting needle out slightly. Do not turn out more than 1/2 turn beyond the original

full load setting. If stable speed can not be obtained by such carburetor adjustment, a change in the governor sensitivity adjustment will probably be necessary.

ELECTRIC CHOKE. - A 12 volt electric choke with vacuum booster is used on gasoline plants as shown in Figure 10. The adjustable choke cover is held in place by the three outer screws. The perimeter of the cover is divided into sections by small raised marks. One of the marks is labeled zero and the twelfth mark from the zero mark is labeled with an asterisk(*). The asterisk mark indicates the normal adjustment setting. A long raised line on the top of the choke housing is used as the reference mark. The normal setting for the choke is made when the asterisk mark lines up with the reference line as shown.

If over-choking occurs, loosen the three locking screws and turn the choke cover slightly to the left (counterclockwise). Do not turn very far. One or two notches will usually be sufficient. Tighten the three locking screws. To increase the choking action, turn the choke cover slightly to the right (clockwise).

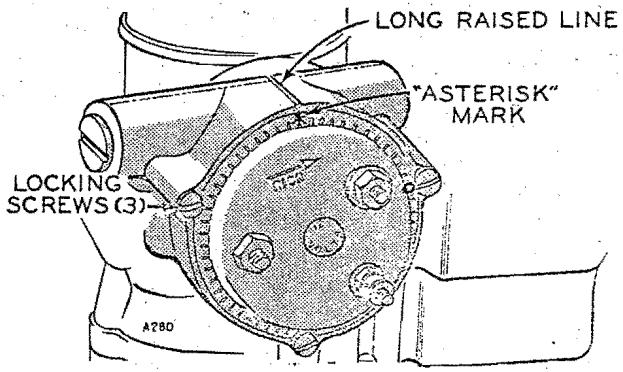


Fig. 10 Electric Choke

COUNTERWEIGHTED CHOKE, GAS OPERATION (Prior to Spec C). - When the engine is warm, the Zenith electric choke cannot give choking action immediately when the engine is stopped. The counterweighted choke, located at the carburetor inlet, aids starting. The correct position of the weight, on the choke plate shaft, holds the choke closed while the engine is stopped, and permits the choke to be held open by the air stream to the carburetor while the engine is running.
Refer to Figure 11. for correct choke adjustment. After adjustment proper operation of the choke should be checked by determining that, (1) the butterfly valve freely closes when released, (2) the butterfly snaps open as soon as the engine starts.

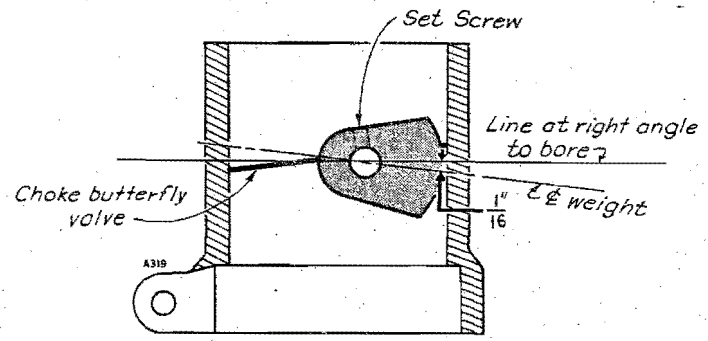


Fig. 11 Counterweighted Choke (Prior to Spec C)

SOLENOID PRIMER, GAS OPERATION (Begin Spec C). - The primer is located on the center of the atmospheric gas pressure regulator. Battery current operates the primer automatically when the engine is being cranked. The armature of the primer opens the valve of the regulator to permit a good volume lazy flow of gas vapor to the carburetor for quick starting. This is a choking effect. To adjust primer loosen lock nut and turn primer in (clockwise) to richen, or out (counter-clockwise) to lean. Tighten lock nut after adjustment. To check for amount of prime, remove hose at carburetor and watch vapor at end of hose when primer is operated; vapor should come out of hose in a good volume lazy flow.

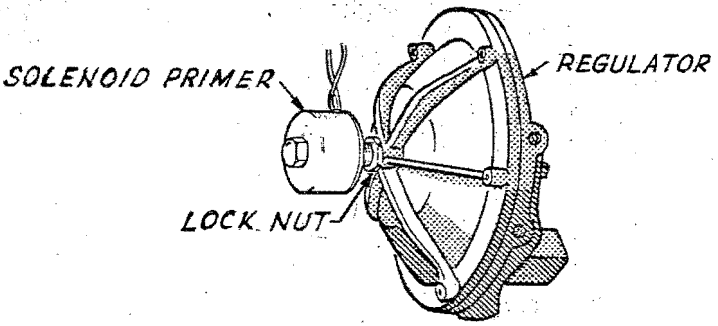


Fig. 11A Solenoid Primer (Begin Spec C)

CARBURETOR, GAS. - If the plant is equipped for gas fuel, see that the gasoline shut off is closed and that the float lock screw at the bottom of the carburetor is turned upward to its limit. The electric choke must be adjusted so that the adjustable cover is turned 10 to 12 notches counterclockwise from the zero mark, as shown on Figure 12. When properly adjusted, the electric choke will be completely open even at very low temperatures.

With the "idle" adjusting screw turned inward to its seat, and with the plant operating at full load, turn the main gas adjusting screw in until

the engine speed begins to drop. Then turn the adjusting screw out (counterclockwise) until the speed returns to normal. Set the lock nut securely to prevent any change in the setting from vibration.

Check to see that the anti-dieseling control is properly connected and that the throttle stop screw is properly adjusted, Fig. 15.

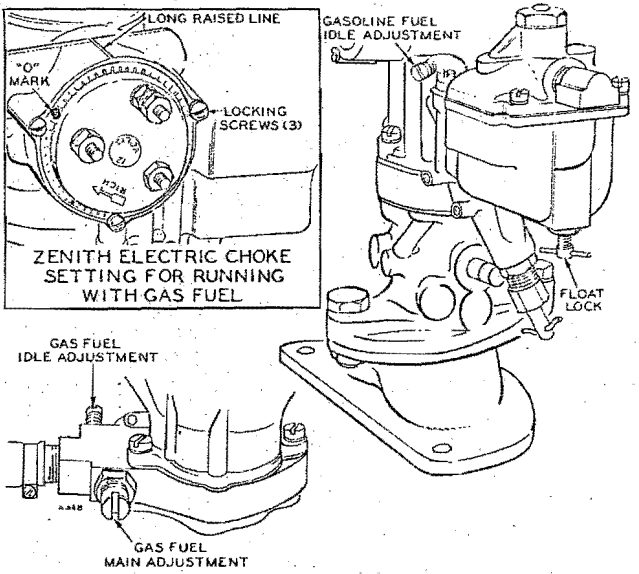


Fig. 12. Gas-Gasoline Carburetor Adjustments

HIGH WATER TEMPERATURE SWITCH. - The switch operates to stop the engine if the coolant temperature rises to high. This prevents overheating which would cause serious damage to the engine. The engine may be started again when the temperature drops about 10^{o}. (1) Adjustable temperature switch used prior to Spec C was set at the factory at 205^{o}. The dial adjustment should be set at a temperature several degrees below the boiling point of the coolant. Lower the setting 3^{o} for each 1000 feet above sea level. Do not set the switch to operate at too low a temperature or the engine may be stopped before it reaches operating temperature. (2) Non-Adjustable switch used begin Spec C is fixed to operate at 202^{o}F. plus or minus 2^{o}. The pressure radiator cap prevents coolant boiling at high altitudes.

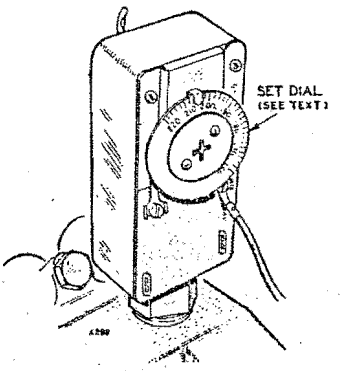


Fig. - 13 High Water Temperature Cut-off Switch

FAN AND GOVERNOR BELTS. - Separate belts are used to drive the generator and the governor. The radiator fan is driven by the generator belt, and the water pump is driven by the governor belt. Belts should be inspected and replaced if cracked or if they show signs of fraying. Keep belts adjusted for proper tension of approximately 1/2 inch deflection at the point of longest span between pulleys. Belts too tight will cause strain on bearings of the driven mechanism. Belts too loose cause slipping and improper operation.

ANTI-DIESELING CONTROL. - Normally the factory adjustments should not be changed. Adjustment procedure is included with governor adjustment.

The anti-dieseling control (governor over-ride) is a device to hold the throttle closed during stopping of the plant. This insures prompt stopping and prevents back firing. A spring and linkage holds the throttle closed during stopping and shut down. A solenoid is energized to overcome the spring tension and permits the governor to open the throttle during starting and running. The anti-dieseling control spring tension must be adjusted so that it is slightly stronger than the spring in the governor's jointed lever and weaker than the pull of the solenoid.

GOVERNOR (Includes Anti-dieseling Control). - The governor controls the speed of the engine, and therefore the frequency of the current. Plant speed affects AC output voltage. Either a tachometer or frequency meter may be used to check engine speed for proper governor adjustment.

1. Governor Linkage. - With the engine stopped, the throttle held wide open, and tension on the governor spring, adjust the governor linkage length by rotating the ball joint on the link so that the carburetor stop lever clears the stop pin by not less than 1/32 inch.

2. Anti-diesel Control. - Move stops (set screws on wire link) away from carburetor so that they have no purpose until completing speed adjustments.

3. Warm Up. - Start the plant and allow it to reach operating temperature.

4. Speed. - Adjust the speed. With no electrical load connected, adjust the speed screw to attain the proper no load (n.l.) speed as shown in the speed chart. Apply a full rated load at 0.8 power factor and again check the speed. Be sure the voltage is safe for the load applied. An incorrect speed drop from full load to no load necessitates a sensitivity adjustment.

Although the plant is rated at 80% power factor load, the speed and volt-

age regulation at full load may be made by connecting the type of load that corresponds with the application.

SPEED CHART FOR CHECKING GOVERNOR REGULATION

		SPEED RANGE LIMITS		SPEED SPREAD (WITHIN RANGE) PREFERRED	LIMITS	
		MAX.	MIN.	F.L. *TO N.L.	MAX.	MIN.
FOR ALL 60 CYCLE PLANTS	CYCLE	63	59	59 - 61	3	1.5
	RPM	1890	1770	1770 - 1830	90	45
FOR ALL 50 CYCLE PLANTS	CYCLE	53	49	49 - 51	3	1.5
	RPM	1590	1470	1470 - 1530	90	45

* Speed Regulation for Full Rated Load is at 0.8 Power Factor.

5. Sensitivity. - If the plant tends to hunt (alternately increase and decrease speed) under load conditions, increase very slightly the distance between the governor main shaft and the sensitivity screw on which the spring link pivots. For best regulation, keep the sensitivity screw up as closely as possible without causing hunting.

Any change in the setting of the sensitivity screw will require correcting the speed screw adjustment. Decreasing sensitivity by turning the screw clockwise causes a slight speed increase which can be corrected by turning the speed screw slightly counterclockwise to decrease spring tension.

6. General. - Be sure that all lock nuts are tightened as adjustments are completed. The governor can not operate properly if there is any binding, sticking, or excessive looseness in the connecting linkage or carburetor throttle assembly. A lean fuel mixture, or a cold engine may cause hunting. If a voltage drop is excessive when a full load is applied, and adjustments are correctly made, it is probable that the engine is low on power and should be repaired as necessary.

7. Output. - Check the AC output voltage. It should be plus or minus 3% of the rated voltage.

8. Anti-diesel Control. - (a) See that the wire linkage is securely attached to the solenoid plunger. Do not shorten or lengthen this connection unless the spring tension at the opposite end can not be fully adjusted by its stud. (b) Set the stop (or over-ride set screw, located nearer the solenoid) on the wire linkage

about 1/32 inch from the slotted over-ride lever on the carburetor so that it does not interfere with wide open throttle when the solenoid is fully engaged (plunger all the way in) as when plant is running. (c) See that the anti-dieseling control spring tension is just enough to "break" the governor's jointed lever and hold the throttle closed during stopping. The spring tension adjusting stud serves also to rotate the spring as necessary to hold the linkage stops horizontally to engage flat against the over-ride lever. (d) Set the no load stop (located nearer the spring) on the wire linkage 1/32 inch away from the over-ride lever while the plant is running at rated speed with electrical load removed (no load). Start and stop the plant to check the adjustments.

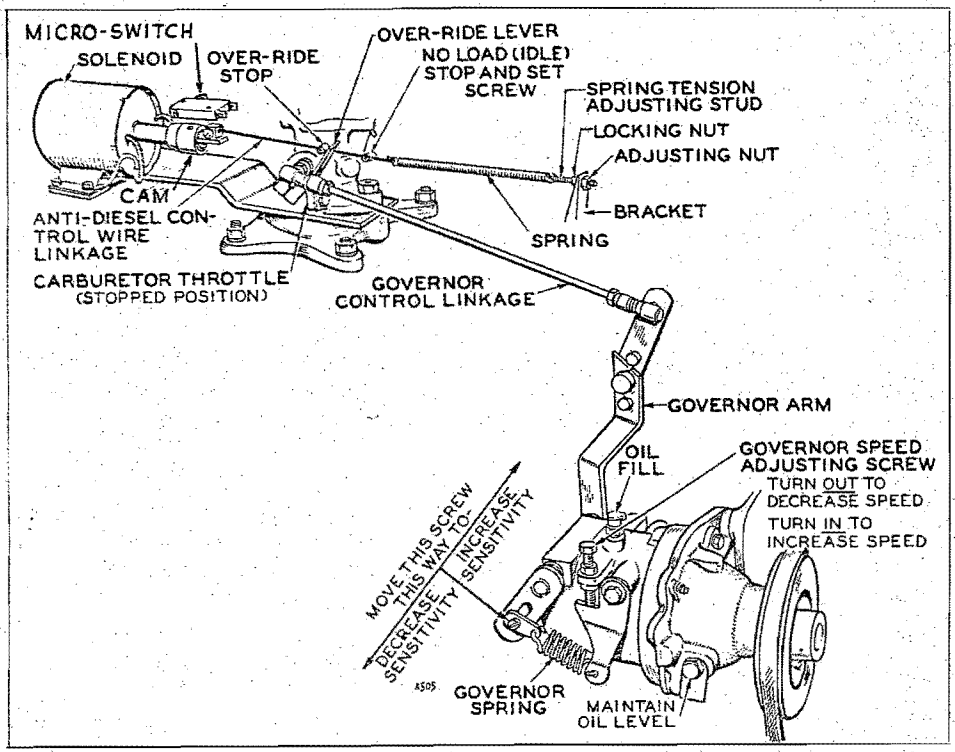


Fig. 14 Governor Adjustments

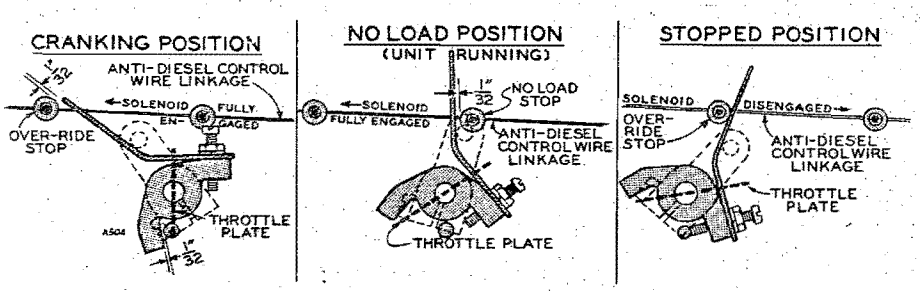


Fig. 15 Throttle Stop Adjustments.

9. Throttle stop adjustment. - With the plant stopped, see that the throttle stop lever screw (attaching the over-ride lever) engages the carburetor stop projection by 1/4 to 1/2 turn. This can be done by backing off the screw until it just clears the carburetor stop, then turning in 1/4 to 1/2 turn. This provides a "cracked open" throttle for good starting characteristics. Do not turn in so far as to cause the plant to "diesel" and refuse to stop, thus defeating the purpose of the anti-dieseling control.

DISTRIBUTOR POINT GAP. - The proper condition, alignment, and point gap adjustment are important factors governing engine performance and long point life. They should be cleaned and inspected every 100 hours of operation. Points should be replaced whenever a burned condition or excessive metal transfer between the points exists. The distributor points and the inside of the distributor cap should be cleaned with a stiff bristle brush using a good solvent such a chloroform or carbon tetrachloride. Do not use a file, sandpaper, or emery cloth to clean or remove pits from distributor points. Any abrasion of the point surfaces only causes them to burn faster.

NOTE: If it is necessary to replace the distributor cap or spark plug wires, insert the wires in the proper cap sockets in a counter-clockwise direction, in the firing order 1-5-4-8-6-3-7-2. The number one socket is identified by the number "1" on the cap. The cylinders are numbered from front to rear - right bank, 1-2-3-4; left bank 5-6-7-8.

To check the distributor point gap, crank the engine with the starter until the movable arm rubbing block rests on a high point of the cam, then check the point gap with a 0.015 inch feeler gauge. If the point gap requires adjustment, loosen the point assembly lock screws, insert the blade of a screw driver in the adjustment slots, and turn it to obtain a 0.015 inch gap. Tighten the lock screws, then recheck the point gap.

ANTI-DIESELING HOLDING SWITCH. - The micro switch, at the anti-dieseling solenoid, shorts across the resistor in the solenoid circuit, giving full battery voltage momentarily to pull in the plunger for engine starting and running.

The micro switch must be mounted at the proper distance from the solenoid plunger cam. Inspect by working the plunger by hand. Listen for the "click" as the switch is opened and held by the plunger. If the switch does not open, high voltage will burn out the anti-dieseling solenoid. If the switch opens too soon the plunger will not continue to hold fully in -- chattering will occur.

To adjust the switch position move its bracket slightly at the screws which mount the bracket and solenoid. Refer to Figure 14.

ENGINE

VALVE SERVICE. - The engine is equipped with the "FREE" ROTO type exhaust valves, Figure 16. The valve rotates by using a special valve spring retainer and cap. While the valve is lifted, it is free to rotate due to natural vibration and turbulence of the exhaust gases and this scuffing action prevents the formation of any troublesome deposits.

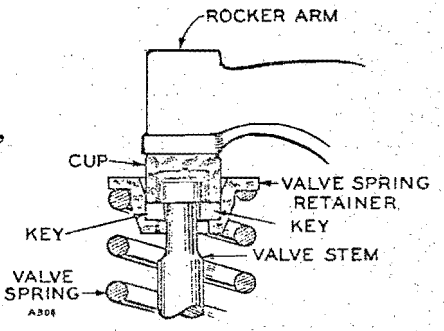


Fig. 16 Valve Rotators

The rotator mechanism has a clearance between the valve tip and the rotator cap, as shown in Figure 16. This clearance is required to obtain positive freedom of the valve during the lift cycle. Wear occurs principally on the keys and clearance should be checked at each reconditioning. Wear tends to increase the clearance and cause increased valve lash. Regular service stations have gauges to check the rotator clearance and where the clearance is too large it can be reduced by grinding off the cap to decrease its depth. The rotator parts tend to become matched parts within each assembly as they wear in. For this reason it is highly desirable to keep the parts from each assembly separate during the servicing operation and to reassemble them with their original valve wherever possible. In addition, each key should be installed in its original position and not turned over. If it is necessary to use a new valve, new caps and keys should be installed.

Maintaining the proper clearance between the end of the valve stem and the rocker arm is one of the most important factors governing long engine life and top performance. It is recommended that the valve clearance be checked and adjusted when necessary every 100 hours. The engine must be at normal operating temperature before adjusting the valve clearance. The intake valve stem clearance should be 0.016 inch and the exhaust valve stem clearance should be 0.019 inch. (NOTE: Work on one bank of cylinders at a time, leaving the other rocker arm cover installed. The valves are arranged from front to rear, on both banks, in order: E-I-I-E-E-I-I-E. Tighten the lock nut and recheck the clearance.

VALVE TIMING. - The camshaft is driven from the crankshaft by a silent timing chain. Proper valve timing is provided by installation of the timing chain as shown.

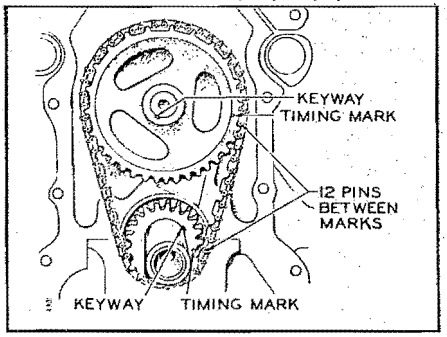


Fig. 17 Timing Chain

IGNITION TIMING. - Whenever the distributor points are replaced or adjusted, the ignition timing should be checked and adjusted if necessary. Proper adjustment of ignition timing must be maintained to obtain maximum engine power output and best possible fuel economy.

The crankshaft pulley has two grooved timing marks. The first mark which goes past the pointer with rotation is the only mark which is to be used to time the engine. See Figure 18. The pointer is bolted to the cylinder front cover.

Connect the timing light high tension lead to the No. 1 spark plug (front cylinder on right hand bank, viewing engine from the rear) and the other two leads to the proper battery terminals. If necessary, clean the dirt from the first timing mark, and chalk the mark and pointer to improve legibility.

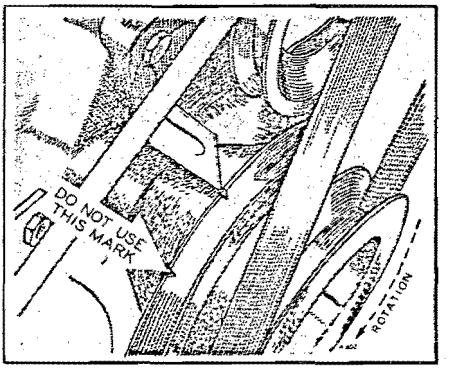


Fig. 18 Ignition Timing

Operate the engine at idle speed, and direct the timing light at the pointer, keeping the pointer in line with the center of the pulley and the light. The light should flash just as the first mark on the pulley lines up with the pointer. If the first mark on the pulley and the pointer do not line up, loosen the distributor body clamp, and rotate the distributor body until the first mark and the pointer are in line. (NOTE: Ignition timing is advanced by clockwise rotation of the distributor body, while counterclockwise rotation retards timing).

TESTING COMPRESSION. - Operate the engine at idle speed for 30 minutes to be sure it is thoroughly warmed up. Turn off the engine and remove all of the spark plugs from the engine. Install a compression gauge in a spark plug hole, and crank the engine about four revolutions with the starter. Record the gauge readings for each cylinder. Compare the gauge readings. The compression should be 150 pounds plus or minus 20 for each cylinder.

If the compression pressure is low on two adjacent cylinders, the possibility of a leak between the two cylinders is indicated. Such a leak is usually caused by a head gasket which is not sealing properly. If the compression pressures on all cylinders are low, or vary a great deal, the cause of the trouble can be narrowed down by squirting a liberal quantity of engine oil through the spark plug holes on top of the pistons of the low reading cylinders. Then crank the engine a few revolutions

to get the oil evenly distributed on the cylinder walls, and make a second compression test. If there is very little difference between the readings obtained in the two checks, sticking or poorly seating valves are indicated. However, if the readings on the low cylinders have improved considerably, it indicates the compression is being lost past the pistons and rings.

CYLINDER HEAD BOLT TIGHTENING. - When replacing the cylinder head, first coat the cylinder head bolts with head gasket sealer and then tighten the head bolts in the sequence shown

Tighten the head bolts in three progressive steps, as shown in Figure 19, using the proper torque as specified.

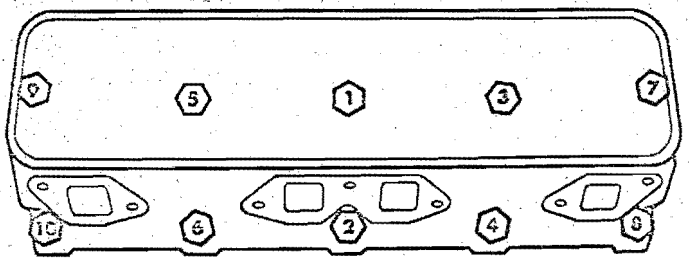


Fig. 19 Cylinder Head Bolt Tightening Sequence

HEAD BOLT TORQUE SPECIFICATIONS

HEAD BOLT TIGHTENING STEPS	TORQUE (FOOT - POUNDS)
1 (cold)	55
2 (cold)	65
Final (hot)	75

The final tightening of the head bolts should be made after the plant has been run for a minimum of 30 minutes at idle speed.

OIL FILTER CARTRIDGE REPLACEMENT. - The full flow type oil filter cleans all of the lubricating oil before it enters the oil passages in the cylinder block. This type of filtration assures that all of the oil is cleaned before it can reach vital bearing surfaces. If the filter element should become clogged, lubrication of vital engine parts is assured by the by-pass valve located in the hollow center bolt. The by-pass valve allows a sufficient quantity of unfiltered oil to enter the engine to prevent any damage to the moving parts. A top-opening, anti-drain-back diaphragm is positioned in the cylinder block to prevent oil from draining out of the filter and

back into the oil pan when the engine is stopped. This insures an immediate supply to the bearings when the engine is started again.

The oil filter cartridge should be replaced every 100 hours, or if operating in below freezing temperatures or under severe dust conditions, whenever the oil on the dip stick is so black or dirty that the markings on the dip stick cannot be seen through the oil.

When changing the oil filter cartridge, place a drip pan below the filter. Remove the center bolt, then remove the filter housing and element as a unit. Discard the dirty filter element and all gaskets, then thoroughly clean all the metal parts in solvent. Make sure the holes in the center bolt are free of sludge and obstructions.

Place a new gasket on the center bolt, then insert the center bolt in the housing. Make sure the tangs on the spring retainer are engaged in the spring, then drop the spring and retainer assembly over the center bolt. Install a new gasket and filter cartridge over the center bolt. (NOTE: the pressed paper type of cartridge does not require a gasket above the spring retainer).

Make sure the holes in the anti-drain-back diaphragm are positioned at the top. Install a new gasket in the filter housing recess in the block. Position the filter assembly on the block, then tighten the bolt just enough to bring the filter housing in contact with the gasket. Rotate the housing slightly to assure even seating, then tighten the center bolt to 20-25 foot pounds torque (approximately 3/4 to one additional turn).

NOTE

BE SURE TO CHECK AROUND THE FILTER HOUSING AND CENTER BOLT FOR OIL LEAKS WITH THE ENGINE WARMED UP AND OPERATING.

CRANKCASE VENTILATOR. - The crankcase ventilating system permits clean, filtered air to circulate through the engine. As the air moves through the engine, it picks up corrosive blow-by gases and carries them to the outside. The air enters at the side of the engine through an oil-wetted filter. After ventilating the crankcase, push rod chamber and rocker arm covers, the air moves through the carburetor air cleaner. The air is then discharged through the engine exhaust system.

Remove the oil filler cap, and wash the air inlet filter mesh in solvent at least every 10 hours. Oil the wire mesh with light engine oil.

GENERATOR

The ac generator normally requires very little servicing. However periodic inspection, to coincide with engine maintenance will assure continued good performance.

BEARING. - The generator ball bearing is pre-lubricated and sealed. It requires no maintenance during its service life.

STATIONARY EXCITER. - The "static" exciter and regulator is used on units that have the separate automotive type starter and charging generator.

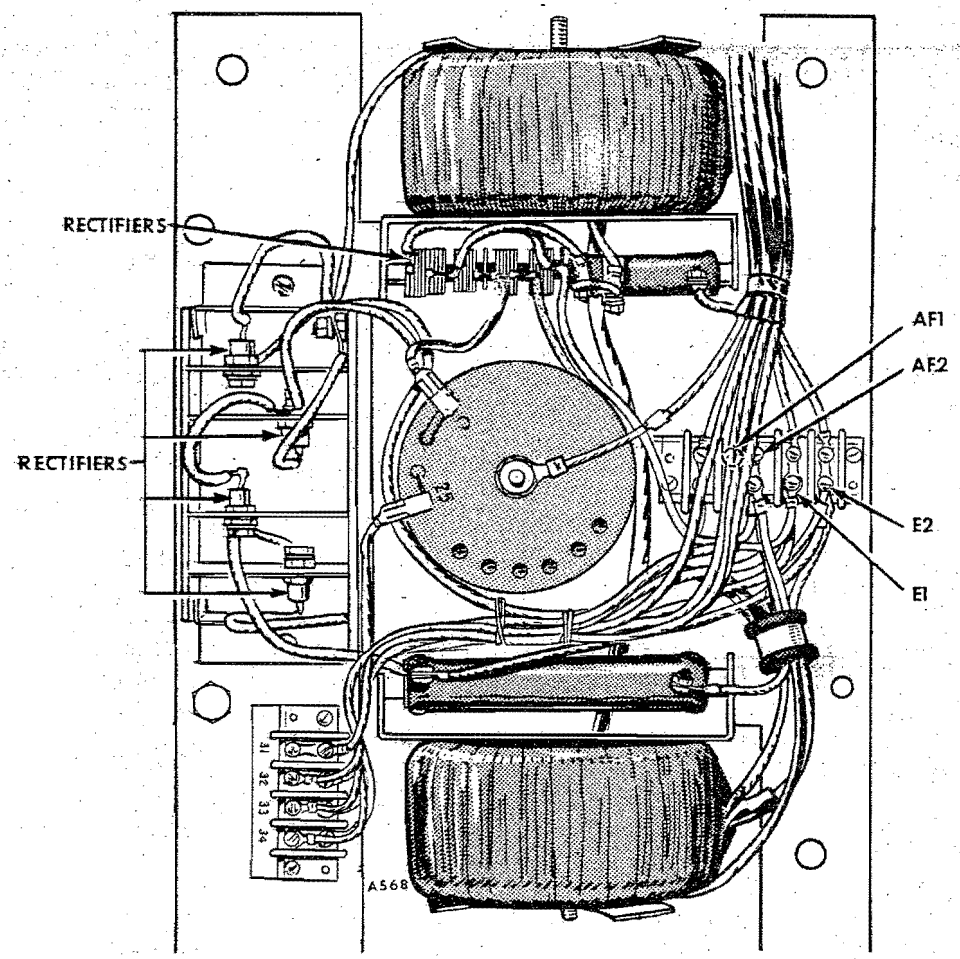


Fig. 20 Stationary Exciter

The exciter has no moving parts. Occasionally blow out any dust, etc. Check thoroughly to assure that all components are mechanically secure, and that all electrical connections are tight.

Generator Tests. - If the generator does not function properly, a few simple tests may isolate the cause.

1. Temporarily disconnect the two generator leads connected to the exciter terminals E1 and E2. Connect another source of ac power (such as the normal line when the plant is used for standby) to the exciter terminals E1 and E2.

If there is no dc voltage across terminals AF1 (+) and AF2 (—), the exciter is not functioning.

2. If dc voltage at terminals AF1 and AF2 is approximately 25 volts (no load condition) but there is no ac output at the generator main output terminals check the alternator for a grounded or open circuit, etc.

3. No terminal of the exciter should show a grounded circuit.

4. If ac voltage drops under load conditions, check the exciter rectifiers. Use a low voltage, battery powered "Multimeter" type ohmmeter. Disconnect one lead from, or remove, each rectifier for its test.

CAUTION

Note carefully the DIRECTION OF MOUNTING of any rectifier removed. It, or any replacement, must be remounted in its original direction.

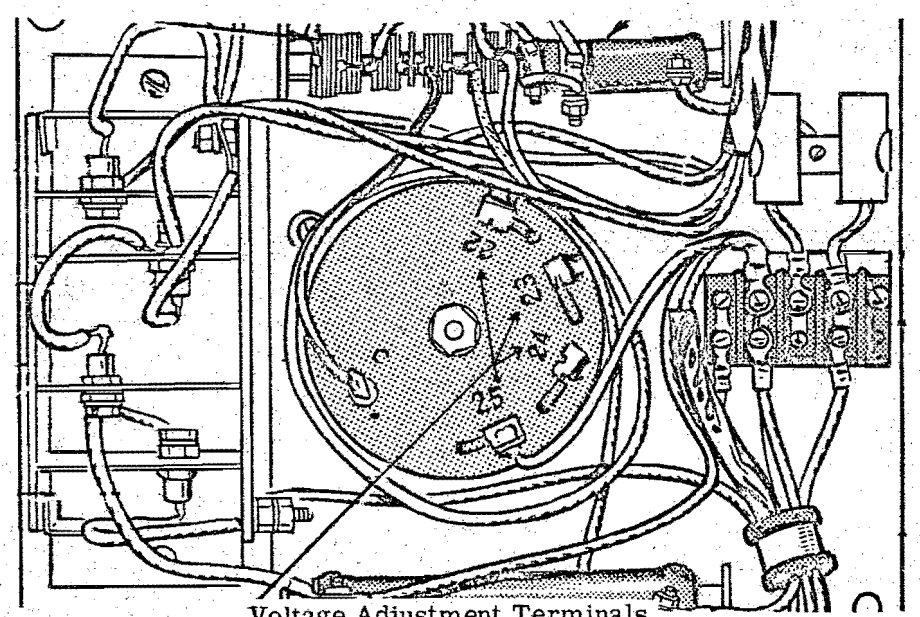
a. Connect the ohmmeter across the rectifier contacts and observe the meter reading.

b. Reverse the connections and compare the new reading with the first reading.

c. If one reading is considerably higher than the other reading, the rectifier can be considered satisfactory. However, if both readings are low, or if both show an "open" circuit, replace the rectifier with a new identical part.

5. If a hunting condition exists, which can not be corrected by a governor sensitivity or a carburetor fuel mixture adjustment, check the adjustment of the stabilizing resistor in the static exciter for a value of 80 ohms. A resistance too low may be the cause.

Output Voltage, Models ending with Spec. Letter A only. - Ordinarily if the engine is operating properly and at approximately the nameplate indicated speed, the generator output voltage will be correct. The exciter was connected for rated output during the factory test run. However if some local condition requires a slight change in the voltage, change exciter connections.



Voltage Adjustment Terminals
Models ending with Spec. Letter A only
Fig. 21 Voltage Adjustment

1. Be sure the engine is operating properly, and that the governor is properly adjusted for correct current frequency (speed), sensitivity, etc.

2. Stop the plant and remove the exciter cover.

3. Note a disc shaped terminal block at the center, with a lead connected to a terminal marked C, and a second lead connected to one of the terminals marked 22, 23, 24 or 25. Moving the second lead to an adjacent terminal (from 25 to 24, etc.) will change the generator output approximately 5 percent.

ROTATING EXCITER. - The rotating exciter is a dc generator, used on units that do not have the separate automotive type starter and charging generator.

1. Commutator. - After a long period of service, the commutator surface may become worn level with the mica insulation between the bars. Undercut the mica to a depth of approximately 1/32 inch. Sandpaper off any burrs formed along the edges of the bars. Do not use emery or carborundum abrasives.

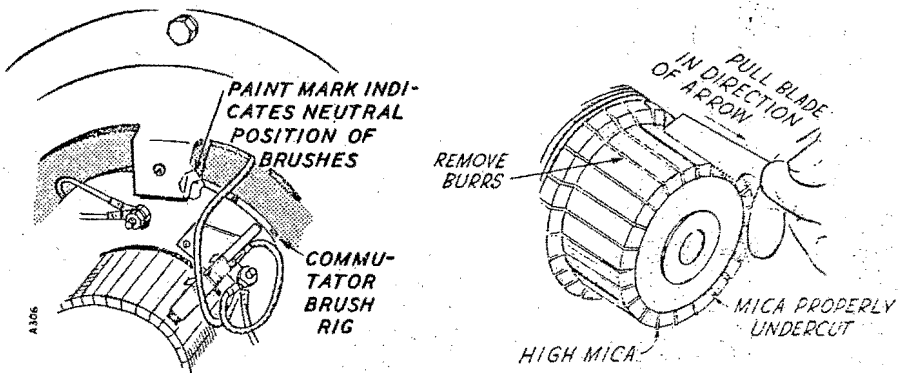


Fig. 22 Rotating Exciter

2. Exciter Brush Rig. - The exciter rig position is marked during the factory test run. If the brush rig position has been disturbed for any reason, it must be realigned. The correct position is indicated by a chisel mark on the outside edge of the insulating ring, which mark must align with the edge of the marked mounting boss inside the end bell.

VOLTAGE REGULATOR. - The voltage regulator is used only on those units that have the rotating exciter. Except for keeping the regulator free of dust, etc., the regulator should require no maintenance. No cleaning or lubricating materials should be used.

If a new regulator or related part is installed, some adjustment may be necessary.

1. Be sure the exciter brush rig position is correct, to give its highest voltage. This must be done with the manual (field) rheostat in operation - regulator not in operation.

2. Turn the field rheostat to its extreme counterclockwise position, to switch in the voltage regulator.

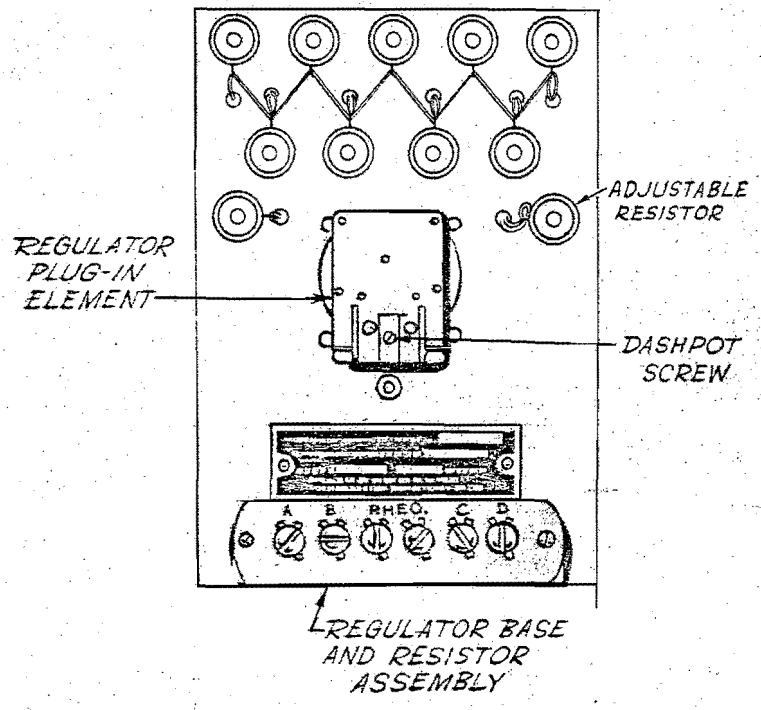


Fig. 23 Voltage Regulator

3. Observe the output voltage, which should be adjustable by use of the regulator rheostat, within a range of ten percent above and below the rated voltage.

4. If the regulator rheostat does not permit the proper adjustment range, it may be necessary to adjust the regulator resistor. With the regulator rheostat at its center adjustment position, loosen and move the sliding clip on the adjustable resistor. Very little movement of the clip will be necessary to obtain the correct voltage.

5. If a fluctuating voltage condition exists only when the voltage regulator is in operation, but voltage is steady when regulated by the field rheostat, adjust the regulator dash pot screw. After removing the clamping bar holding the plug in unit in place, remove the screws holding the cover can. Turn the slotted screw at the center slightly until the fluctuating voltage condition just stops.

CAUTION

Do not attempt any other regulator adjustments. Never change the original settings of the regulator springs or contact fingers.

GENERAL. - Electrical generating sets are often taken out of service for extended periods of time. In many cases they are left to stand idle without being protected against possible damage from rust and corrosion or the elements. The factory recommends that any unit to be removed from service for 30 days or more be protected as follows:

FOR ONE MONTH:

1. While the engine is running treat the upper cylinders by spraying M 4834 A Engine Preservative Oil (SAE 10) or equivalent into the carburetor air intake for about two minutes. Open the throttle for a short burst of speed, then shut off the ignition and allow the engine to come to a stop while continuing to spray M 4834 A into the air intake.

2. Leave the spark plugs installed and cover all openings into the engine with dust-proof caps or shields.

3. Drain the oil, water, and gasoline. Attach a warning tag!

FOR INDEFINITE PERIOD:

1. Drain the crankcase completely and refill with M 4834 A Engine Preservative Oil, (SAE 10) or equivalent.

2. Run the engine until it is completely out of gasoline, then restart and run it on M 534 H or equivalent unleaded, undyed gasoline for at least 10 minutes.

3. While the engine is still running, treat the upper cylinders by spraying M 4834 A into the carburetor air intake for about two minutes. Open the throttle for a short burst of speed, shut off the ignition and allow the engine to come to a stop while continuing to spray M 4834 A into the air intake.

4. Drain the oil and gasoline. Drain the water at the bottom of the radiator and both sides of the block. Attach a warning tag!

5. Remove all grease and oil from the exterior surfaces of the engine.

6. Remove each spark plug and pour two tablespoonfuls of rust inhibitor oil (or SAE 50 motor oil as a substitute) into each cylinder. Crank the engine over slowly by hand to lubricate the cylinders. Stop the engine with the TC (top center) mark on the flywheel indicating at least one piston is at top center position. Replace the spark plugs.

7. Seal all openings in the engine and accessories with M 6471, Non-hydroscopic Adhesive Tape or equivalent. Mask off all areas to be used for electrical contact.

8. Make sure all surfaces are dry, then spray all taped openings, all engine accessories including ignition wiring, and all exterior surfaces of the engine with M 4858 B, Insulation Compound-Ignition, or equivalent.

Clean the generator brushes, brush holders, and collector rings by wiping with a clean cloth. Do not coat with lubricant or other preservative.

Remove, clean and replace the air cleaner.

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

Oil the governor to carburetor linkage with SAE 50 oil.

Where batteries are likely to be exposed to freezing temperatures, they must be removed and stored where there is no danger of freezing. A fully charged battery can withstand very low temperatures but an idle battery gradually loses its charge and may become discharged to the point where it will freeze. An idle battery should be given a freshening charge about every 40 days.

If the battery is not removed, disconnect the cables from the unit. Arrange the cables so that the lugs cannot come in contact with each other or with metal parts.

Provide a suitable cover for the entire unit, particularly if it will be exposed to the elements.

RETURNING TO OPERATION AFTER STORAGE. - Remove all protective coatings from external parts. Wipe the entire unit clean of accumulated dust or other forein matter.

Inspect the unit carefully for damage and for other conditions requiring attention. Service as needed. Keep the side panels and top plate on the housing except while servicing. They help direct the cooling air properly and reduce radio interference.

Remove all the masking tape.

Remove, clean and adjust spark plugs. While the plugs are out, crank the engine over several times by hand to distribute oil over the cylinder walls. If the cylinders are dry, put a tablespoonful of oil into each cyl-

inder and turn the engine over several times by hand to distribute the oil. Replace the spark plugs and gaskets.

Examine all fuel, oil and water lines and connections. Service as needed.

Refill the cooling system with clean, fresh water.

If anti-freeze was left in the cooling system, check the level and add a 50-50 solution of water and the type of anti-freeze originally used to bring the cooling liquid up to proper level.

Refill the crankcase and air cleaner with the correct amount and grade of oil.

Check carefully for leaks of water, fuel or oil after servicing the unit. Correct any leaks before starting the unit.

CAUTION

On the initial start (starting the plant for the first time after it has been installed or taken out of storage) check the oil pressure immediately. Long storage periods may cause the oil pump to lose its prime.

Connect the battery cables to the unit. Carefully recheck to make sure the unit is ready for operation. Then start the unit in the regular manner as described under OPERATION.

POSSIBLE CAUSE	REMEDY
GENERATOR OVERHEATING	
Overloaded.	Reduce load.
Brush rig out of position.	Be sure to line up marks.
VOLTAGE DROPS UNDER HEAVY LOAD	
Engine lacks power.	See remedies for engine missing under heavy load.
Poor compression.	Tighten cylinder head and spark plugs. If still not corrected, grind the valves. Replace piston rings, if necessary.
Faulty carburetion.	Check the fuel system. Clean, adjust, or replace parts necessary.
Restricted air cleaner.	Clean and refill.
Excessive choking.	See that choke opens properly.
Carbon or lead in cylinder.	Remove carbon.
Restricted exhaust line.	Clean or increase the size.
ENGINE MISFIRES AT LIGHT LOAD	
Carburetor idle adjustment set wrong or clogged.	Adjust, clean if needed.
Spark plug gaps too narrow.	Adjust to correct gap.
Intake air leak.	Tighten or replace gaskets.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime ignition.
Uneven compression.	Tighten cylinder head and spark plugs. If still not corrected, grind valves. Replace piston rings, if necessary.
Worn intake valve stems or guides.	Replace valves or guides.

POSSIBLE CAUSE	REMEDY
ENGINE MISFIRES AT HEAVY LOAD	
Spark plugs defective.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condensers, coil, etc., or retime ignition.
Clogged carburetor.	Clean jets.
Clogged fuel screen.	Clean.
Valve lash too tight.	Adjust.
Defective spark plugs, cables.	Replace.
ENGINE MISFIRES AT ALL LOADS	
Fouled spark plugs.	Clean and adjust.
Defective or wrong spark plug.	Replace.
Sticking valves.	Clean stems and guides.
Broken valve spring.	Replace.
Defective ignition wires.	Replace.
Defective or improperly adjusted points.	Adjust or replace breaker points.
Defective ignition condenser.	Replace.
Improper valve lash.	Adjust.
LOW OIL PRESSURE	
Oil too light.	Drain, refill with proper oil.
Oil badly diluted.	Drain, refill with proper oil.
Oil too low.	Add oil.
Oil relief valve not seating.	Remove and clean, or replace.
Badly worn engine bearings.	Replace.

POSSIBLE CAUSE	REMEDY
LOW OIL PRESSURE (Cont.)	
Sludge on oil inlet screen.	Remove and clean screen.
Badly worn oil pump.	Repair or replace pump.
Defective oil pressure gauge.	Replace engine or panel unit.
HIGH OIL PRESSURE	
Oil too heavy.	Drain, refill with proper oil.
Clogged oil passage.	Clean all lines and passages.
Oil relief valve stuck.	Remove and clean.
Defective oil pressure gauge.	Replace engine or panel unit.
PLANT STARTS BUT DOES NOT CONTINUE TO RUN	
Start button released too soon.	Hold in contact longer.
Defective charging generator.	Repair.
Defective panel equipment.	See Controls.
ENGINE BACKFIRES AT CARBURETOR	
Lean fuel mixture.	Clean or adjust carburetor.
Clogged fuel screen.	Clean screen.
Intake air leak.	Replace flange gaskets, tighten carburetor.
Poor fuel.	Refill with good, fresh fuel.
Spark too late.	Retime ignition.
Spark plug wires crossed.	Install wires correctly.
Intake valves leaking.	Grind or replace.

POSSIBLE CAUSE	REMEDY
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST	
Sludged rings, excessive bearing clearances, piston skirt collapsed, worn intake valve guides.	Replace worn parts.
Oil leaks from engine or connections. This does not cause smoky exhaust.	Replace gaskets or leaking tubing. Tighten screws and connections.
Oil too light or diluted.	Drain, refill with correct oil.
Too large bearing clearance.	Replace bearings.
Oil pressure too high.	Refer to symptoms of high oil pressure for remedies.
Engine misfires.	Refer to symptoms of engine misfires.
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., or retime ignition.
Unit operated at light or no load for long periods.	No remedy needed.
Too much oil.	Drain excess oil.
BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION, FOULING OF SPARK PLUGS WITH BLACK SOOT, POSSIBLE LACK OF POWER UNDER HEADY LOAD	
Fuel mixture too rich.	Be sure all jet gaskets are in place and tight; and float needle valve gasket is in place and tight. Adjust choke. Install needed carburetor parts, adjust float level.
Choke not open.	See that choke opens properly.
Dirty carburetor air cleaner.	Clean, refill to proper level.
LIGHT POUNDING KNOCK	
Loose connecting rod bearing.	Replace.

POSSIBLE CAUSE	REMEDY
LIGHT POUNDING KNOCK (Cont.)	
Low oil supply.	Add oil.
Low oil pressure.	Refer to symptom of low oil pressure for remedies.
Oil badly diluted.	Change oil.
ENGINE STOPS UNEXPECTEDLY	
Fuel tank empty.	Refill.
Fuel pump failure.	Repair or replace.
High water temperature.	See symptoms for engine overheating.
Defective ignition.	Check the ignition system. Repair or replace parts necessary.
DULL METALLIC THUD, IF NOT BAD, MAY DISAPPEAR AFTER FEW MINUTES OPERATION. IF BAD, INCREASES WITH LOAD.	
Loose crankshaft.	Replace bearings, unless one of the next three remedies permanently corrects the trouble.
SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE FIRST STARTED	
Low oil supply.	Add oil.
Low oil pressure.	Refer to symptom of low pressure for remedies.
Oil badly diluted.	Change oil.
PINGING SOUND WHEN ENGINE IS RAPIDLY ACCELERATED OR HEAVILY LOADED	
Carbon in cylinders.	Remove carbon.
Spark too early.	Retime ignition.
Wrong spark plugs.	Install correct plugs.
Spark plugs burned or carboned.	Install new plugs.

POSSIBLE CAUSE	REMEDY
PINGING SOUND WHEN ENGINE IS RAPIDLY ACCELERATED OR HEAVILY LOADED (Cont.)	
Valves hot.	Adjust tappet clearance.
Fuel stale or low octane.	Use good fresh fuel.
Lean fuel mixture.	Clean or adjust carburetor.
ENGINE CRANKS TOO STIFFLY	
Corroded terminals.	Clean and tighten terminals.
Too heavy oil in crankcase.	Drain, refill with light oil.
Weak battery.	Test and recharge or replace battery
Engine stuck.	Disassemble and repair.
Defective cable.	Install new cable.
ENGINE WILL NOT START WHEN CRANKED	
Faulty ignition.	Clean, adjust, or replace breaker points, plugs, condenser, coil, etc., retime ignition.
Lack of fuel or faulty carburetion.	Refill the tank, check the fuel system. Clean, adjust, or replace parts necessary.
Clogged fuel screen.	Clean.
Cylinders flooded.	Crank few times with spark plugs removed.
Poor fuel.	Drain, refill with good fuel.
Poor compression.	Tighten cylinder head and spark plugs. If still not corrected, grind the valves. Replace piston rings, if necessary.
Wrong timing.	Retime ignition.
Poor choking.	If plant is cold, adjust choke. If plant is warm, pull up on choke arm momentarily, while cranking.

POSSIBLE CAUSE	REMEDY
ENGINE RUNS BUT CURRENT DOES NOT BUILD UP	
Poor brush contact or dirty slip rings.	See that brushes seat well, are free in holders, are not worn too short, and have good spring tension.
Open circuit, short circuit or ground in generator.	See GENERATOR, replace part necessary.
CURRENT UNSTEADY BUT ENGINE NOT MISFIRING	
Speed too low.	Adjust governor to correct speed.
Poor brush contact.	See that brushes seat well on slip rings, are free in holders, are not worn too short, and have good spring tension.
Loose connections.	Tighten connections.
Fluctuating load.	Correct any abnormal load condition causing trouble.
TAPPING SOUND	
Tappet clearance too great.	Adjust or replace tappets.
Broken valve spring.	Install new spring.
HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD	
Loose pistons.	If noise only slight and disappears when engine warms up, no immediate attention needed. Otherwise replace worn parts.
VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR POWER UNIT	
Too small line wire for load and distance.	Install larger or extra wires or reduce load.
MOTORS RUN TOO SLOWLY AND OVERHEAT AT FAR END OF LINE BUT OK NEAR POWER UNIT	
Too small line wire for load and distance.	Install larger or extra wires, or reduce load.

POSSIBLE CAUSE	REMEDY
ENGINE OVERHEATING	
Low water in radiator.	Refill radiator.
Overloaded.	Remove part of load.
Improper lubrication.	See Low Oil Pressure.
Radiator obstructed.	Clean radiator.
Ignition timing late.	Adjust ignition timing.
Improper ventilation.	Provide for better air change.
STARTER WILL NOT CRANK ENGINE	
Discharged battery.	Test and recharge or replace battery.
Corroded terminals.	Clean and tighten terminals.
Loose connections.	Tighten connections.
Defective starter relay.	Clean contacts if necessary. Replace switch if necessary.

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

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