

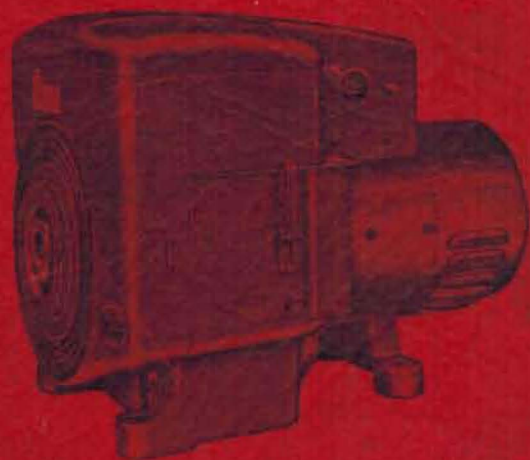
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# INSTRUCTION MANUAL

FOR

## ONAN ELECTRIC GENERATING PLANTS

*Series*  
**CCK**



2-60

**D. W. ONAN & SONS INC. • MINNEAPOLIS 14, MINN.**

927-6

*Price \$1.00*

Printed in U. S. A.  
A-F



## GENERAL INFORMATION

**THE PURPOSE OF THIS BOOK.** This instruction book is furnished so that the operator may learn of the characteristics of the plant. A thorough study of the book will help the operator to keep the plant in good operating condition so that it will give efficient service. An understanding of the plant will also assist the operator in determining the cause of trouble if it occurs.

**KEEP THIS BOOK HANDY.** Such simple mistakes as the use of improper oil, improper fuel, or the neglect of routine servicing may result in failure of the plant at a time when it is urgently needed. It is suggested that this book be kept near the plant so that it may be referred to when necessary.

**SERVICE.** If trouble occurs and the operator is unable to determine the cause after a thorough study of this book, or if he is unable to determine what repair parts are required, needed information will be furnished upon request. **WHEN ASKING FOR INFORMATION, BE SURE TO STATE THE MODEL, SPEC., AND SERIAL NUMBERS OF THE PLANT. THIS INFORMATION IS ABSOLUTELY NECESSARY AND MAY BE OBTAINED FROM THE NAMEPLATE ON THE PLANT.**

### 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 official of the Manufacturer.

### IMPORTANT

RETURN WARRANTY CARD ATTACHED TO UNIT.



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## ENGINE SERVICE CHART

FOR DETAILED SERVICE INSTRUCTIONS, SEE PERIODIC SERVICE.

The following recommended Engine Servicing Chart may be used as a guide to estimating servicing requirements of ONAN Gasoline Engines.

The chart is based on the Units operating under favorable conditions, such as: use of recommended fuel and oils, etc.

SERVICE & PARTS REQUIRED	HOURS OF OPERATION													COMPLETE RECONDITIONING						
	100	200	300	400	500	600	700	800	900	1000	1500	2000	2500		3000	3500	4000	4500	5000	
Oil change (Check daily) . . . . .	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	COMPLETE RECONDITIONING
Clean and gap plugs . . . . .	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
*Air cleaner . . . . .	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Ignition points . . . . .																				
†Clean carbon . . . . .																				
Clean carburetor . . . . .																				
Check tappets . . . . .																				
Grind valves . . . . .																				
Clean oil base . . . . .																				
Clean crankcase breather . . . . .	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Clean engine . . . . .																				
Replace spark plugs . . . . .	AS REQUIRED																			
Replace valves . . . . .	AS REQUIRED																			
Replace points . . . . .	AS REQUIRED																			
Replace piston rings . . . . .	AS REQUIRED																			

\* Check the air cleaner often. Thoroughly clean and put in fresh oil at least every 100 hours.

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

Periodic Inspection: For loose or poor connections, fittings, etc.

† Recommended fuel: Use regular grade gasoline of at least 68 Octane - Do not use premium type. If a high lead content fuel is used, it will be necessary to remove the lead deposits more frequently.

Keep engine clean.

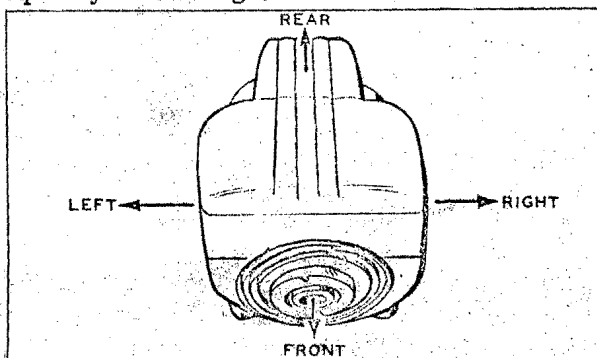
**INTRODUCTION.** - This instruction manual is supplied to assist in the proper installation, operation, and servicing of the CCK series electric generating plants. Unless otherwise stated, these instructions apply to all standard plants of the CCK series.

The plant model and specification, serial number, and electrical characteristics appear on the nameplate. The manufacturer produces many types of generating plants, industrial engines, and separate generators. Basic differences such as voltage, type of cooling, optional equipment, and manufacturing improvements are incorporated in the model and specification numbers. Consequently the MODEL and SPEC. NO. on the plant nameplate should always be mentioned in any reference to the plant if contacting a dealer or the factory.

Some details of these instructions may not apply to special models having modifications specified by the purchaser. Due to the wide variety of uses for which these plants are suitable, these instructions must be of a general nature. The use of auxiliary or special equipment, special installation requirements, or unusual operating conditions may require the operator of this generating plant to modify these instructions. However, by using the instructions and recommendations given in this manual as a general guide, it will be possible to make a good installation, and to properly operate and maintain the plant.

The engine end is designated as the "Front End" of the plant. "Left Side" and "Right Side" of the plant are determined by viewing from the front end. Cylinder number one (nearer the timing gears) is on the "Left Side" of the plant.

Instructions apply to both 60 cycle and 50 cycle alternating current plants, the main difference being in the operating speed. Most appliances can be used on either 50 or 60 cycle frequency current but it is advisable to check appliances before purchasing to assure that they are adaptable to the current frequency and voltage.





## GENERAL DESCRIPTION

Each CCK generating plant is a complete electric power plant, consisting of an internal combustion engine, and a self excited electric generator directly connected to the engine. Controls and accessories suitable for a normal installation and according to the particular model are supplied.

Each generating plant is given an actual running test at the factory and is carefully checked under various electrical load conditions before shipment, to assure that it is free of any defect and that it meets all performance requirements. Inspect the plant carefully for any damage which may have occurred in shipment. Any part so damaged must be repaired or replaced before putting the plant into operation.

The alternating current (ac) plant generates current similar to that supplied by most commercial power lines. This type plant must be operated whenever electric power is desired. The ac plant produces its full rated capacity in alternating current plus approximately 135 watts of direct current (dc). The dc is used as excitation current and, on electrically cranked plants, to charge the starting batteries. A small auxiliary load may be taken from the starting battery while the plant is idle, depending upon the charge condition of the battery. The ac plant will not be damaged by operating it with no load connected or with the starting battery, on remote plants, disconnected.

The direct current (dc) plant is made in two basic types: (1) for direct service application as a power source for lights, power tools, etc.; and (2) a specially designed generator for lifting magnet service.

The dual purpose plant produces alternating current, plus 32 volt dc for battery charging. When the maximum battery charging current is in use, the alternating current maximum output is reduced to 2250 watts.

**TYPES OF PLANTS.** - The portable type of plant is designed for applications where portability is important. A rope-recoil starter serves for convenient hand cranking, and the plant can not be connected to batteries for electric cranking. A carrying frame, a grounding stud and a pilot light are all desirable features of this portable type plant.

The manual type of plant is designed for applications where the mounting location is somewhat permanent, either stationary or in a vehicle. Load wires must be connected directly to the output leads (except when an optional receptacle plate is added). A rope-recoil starter serves for convenient hand cranking, and the plant can not be connected to batteries for electric cranking.

The remote control type plant is designed for applications where the installation will be more or less permanent. When properly connected to a 12-volt battery (or two 6-volt batteries in series), the plant may be cranked electrically at the plant, from one or more remote control



switch location, or through automatic controls. In the event of failure of the starting battery current, the plant may be cranked manually. The remote control type plant has a built-in charging circuit for keeping the starting battery in a well charged condition. Solderless terminals, in the plant control box, serve for connecting the electrical load wires to the generator output leads.

### CHART OF AC PLANT TYPES

<u>PLANT FEATURE</u>	<u>MANUAL</u>	<u>PORTABLE</u>	<u>REMOTE</u>
Typical example:	5CCK-1 <u>M</u> /1A	5CCK-1 <u>P</u> /1A	5CCK-1 <u>R</u> /1A 5CCK-1 <u>R</u> <sup>*</sup> <u>V</u> /1A
Ignition:	Magneto	Magneto	Battery
Oil Capacity: (U. S. Quart)	4 Quart ★	4 Quart ★	4 Quart
Fuel Tank (U. S. Gallon)	Separate (5) (Mtd. Optional)	Mounted (4)	Separate (5)
Cranking and Choking:	Manual	Manual	Electric
Gasoline Carburetor:	Standard	Standard	Standard
Gas-Gasoline Carburetor:	Optional	Optional	Optional
Engine RPM (60 cycle):	1800(nominal)	1800(nominal)	1800(nominal)
Engine RPM (50 cycle):	1500(nominal)	1500(nominal)	1500(nominal)
Load Connection:	4" Outlet Box	Receptacles	Terminals
Carrying Frame Only:	Optional †	Standard	Optional †
Two-Wheel Dolly:	Optional †	Optional	Optional †
Housing:			Optional for Vacu-Flo
NOTE †	- Carrying Frame or Dolly Accessory does not provide for separate fuel tank or batteries on these models.		
*	Letter V here indicates Vacu-Flo cooling.		
★	- Oil capacity is 3 quarts Prior to Spec D models.		

## ENGINE DETAILS

The engine is a horizontally opposed 2 cylinder, air cooled, 4 stroke cycle, L head internal combustion type. Standard models burn gasoline fuel. Some special models are equipped with a combination type carburetor for burning either gasoline or gas fuel.

The cylinder bore is 3-1/4 inches, the piston stroke 3 inches, piston displacement 50 cubic inches, compression ratio 5.5 to 1. The cast iron cylinder and crankcase is a single casting.

The engine speed is controlled by a flyball type governor built into the camshaft gear. The governor is externally adjustable. The governor function is supplemented by a speed booster. The booster is operated by manifold vacuum and serves to improve stability under load conditions.

Ignition current on manual and portable type plants is supplied by a high tension, flywheel magneto. Ignition current on remote control type plants is supplied by the starting battery.

The engine is cooled by air forced around the cylinder walls and head. Plants which are "pressure cooled" have blower fins on the flywheel which draw air in through the opening at the front of the blower housing. Special models of the remote control type plants may be Vacu-Flo Cooled and have blower fins which expel heated air out through the duct at the front of the blower housing, as desirable for small enclosure installations. The letter "V" appears in the model of Vacu-Flo cooled type plants. (Example: 5CCK-3RV/1A).

The engine has aluminum alloy 3 ring pistons, and full floating type piston pins. The counterbalanced crankshaft turns in two unusually large main bearings which are replaceable-precision-sleeve type. The connecting rods are aluminum alloy with integral bearing. Special models may have forged steel connecting rods and replaceable rod bearings.

The exhaust valves and seats are Stellite faced. Valve tappets are adjustable self-locking. A positive rotator for each exhaust valve provides long trouble free performance (Rotators not on "Spec A" models).

The gear type oil pump supplies pressure lubrication to main and connecting rod bearings. Oil pressure is controlled by an externally-adjustable spring loaded relief valve.

## GENERATOR DETAILS

The alternating current generator is a revolving armature, self excited, inherently regulated type. The inherent design of the generator with saturated, 4 pole, shunt wound field, assures close regulation of voltage between no load and full load conditions. A special series winding in the field of the remote starting models permits the generator to be used as a starting motor.

The armature is connected directly to the engine crankshaft through a taper fit and held in place by a stud which passes through the hollow center of the shaft. A large ball bearing supports the outer end of the armature. The armature for the ac plant contains both ac and dc windings, the ac windings connecting to the collector rings, the dc windings connecting to the commutator.

Two basic sizes of ac generators prevail in the CCK series. The smaller generator uses a 4-1/2 inch stack of laminations, rated output is 3500 watts for either 60 cycle or 50 cycle and voltage regulation is within plus or minus 3% of nameplate rating. The larger generator uses a 7-1/2 inch stack of laminations, rated output is 5000 watts for 60 cycle or 4250 watts for 50 cycle and voltage regulation is within plus or minus 5% of nameplate rating.

The direct service direct current generator is a 4 pole, compound wound, commutating pole type rated at 5000 watts, 115 volts.

The magnet service generator is a 4 pole type especially designed for such service. The generator is rated at 5000 watts. Voltage is adjustable from 230 to 250 volts by means of the required rheostat.

## CONTROLS

The manual type plants have a manual choke on the carburetor and a stop button on the blower housing.

The portable type plants have receptacles and a pilot light in addition to a manual choke and stop button.

The ac remote type plants have an electric choke on the carburetor, a start-stop switch, a charge ammeter, and a switch for manual or electric start located on the control box mounted over the generator. The controls are designed so that auxiliary automatic or line transfer control equipment may be connected.

The magnet service remote type plants have an electric choke, 12 volt automotive type starter, 12 volt automotive type charge generator, and separate start and ignition switches for mounting at a convenient control point.

## SPECIAL ACCESSORIES

The following special accessories are not standard equipment but are available at extra cost from your dealer. When ordering any of the following special accessories, always be sure to give the Model and Serial numbers of the plant on the order.

**GASEOUS FUEL CONVERSION KITS.** - These kits contain parts and instructions which permit the use of Butane, Propane or natural gas as well as gasoline.

**AUTOMATIC CONTROLS (AC Remote Start Plants Only).** - A separate control is available for either 50 or 60 cycle a. c. units that will automatically start and stop the plant as the load requires.

**LINE TRANSFER CONTROLS (AC Remote Start Plants Only).** - Line transfer controls are available for use with either 50 or 60 cycle units in standby service. When regular power service fails, the line transfer control automatically starts the standby plant and takes over the load. The plant stops automatically when regular service is restored.

**UNDERGROUND FUEL TANKS AND LINES.** - 55 gallon and 110 gallon fuel tanks and 5/16 inch and 3/8 inch copper fuel lines in either 25 or 50 foot length are available for installing the fuel tank underground.

**REMOTE START-STOP SWITCHES.** - Additional remote start-stop switches are available from your dealer.

**3-CONDUCTOR CABLE.** - This #18-wire 3-conductor cable is designed for remote start-stop station installation and is adequate size for switches within 250 feet wire distance.

**TWO-WHEEL DOLLY.** - The dolly makes the plant portable by one man. The dolly is designed to assemble to the tubular carrying frame as furnished on the portable type plant. The dolly has semi-pneumatic tires and adjustable folding handles with hand grips.

**FUEL RESERVOIR (DAY) TANK.** - This tank with fittings can be mounted on the plant and serves to assure quick starting of standby plants by replenishing by gravity feed, fuel lost from the carburetor during shut-down periods.

**COLD WEATHER SHUTTER.** - Fits Vacu-flo plants. Limits air flow.

## CAUTION

EXHAUST GASES FROM INTERNAL COMBUSTION ENGINES ARE DEADLY POISONOUS. EXCESSIVE INHALATION WILL CAUSE SERIOUS ILLNESS OR DEATH. NEVER OPERATE THE PLANT INSIDE A BUILDING OR OTHER CONFINED SPACE WITHOUT PIPING ALL EXHAUST GASES OUTSIDE THE ENCLOSURE.

LOCATION. - The preferable ambient air temperature for best engine performance is well above freezing, and the preferable ambient air temperature for most efficient generator operation is well under 100°F. and should not exceed 110°F. if conditions permit controlling the temperature.

If the generating plant is to be installed in a permanent location, choose a site for mounting the plant that will be more or less centrally located in relation to the electrical load. Plan to avoid running wiring which carries a heavy electrical load for a long distance. The greater the distance, the larger the wire must be. The selected site should be in a clean, dry, well ventilated location, preferably heated in extremely cold weather. A dusty or damp location will necessitate more frequent servicing.

MOBILE INSTALLATION. - The generating plant must be securely bolted to the floor or other rigid member if it is to be mounted in a vehicle. Do not neglect the piping of the poisonous exhaust gases to the outdoors. Keep the exhaust piping several inches away from inflammable materials and support the piping securely so that it will remain permanently in place.

## CAUTION

Do not run the vehicle inside a closed building and operate the generating set. Be sure that the exhaust lines are carefully extended to the outside of the building.

If the vehicle is a closed one, proper ventilation must be provided. Several small openings will suffice but there must be at least 3-1/2 square feet of inlet area and a similar amount for an outlet if the plant is the pressure-cooled type. Prevent recirculation of heated air wherever possible. The vacuum-cooled type plant is more easily adapted to small enclosure installation, since heated air can be ducted outside.

Support all permanent wiring within the vehicle so that vibration will not wear away the insulation or break the wires.

Do not store other items loosely near the generating plant in such manner as to risk damaging the plant while the vehicle is in transit.

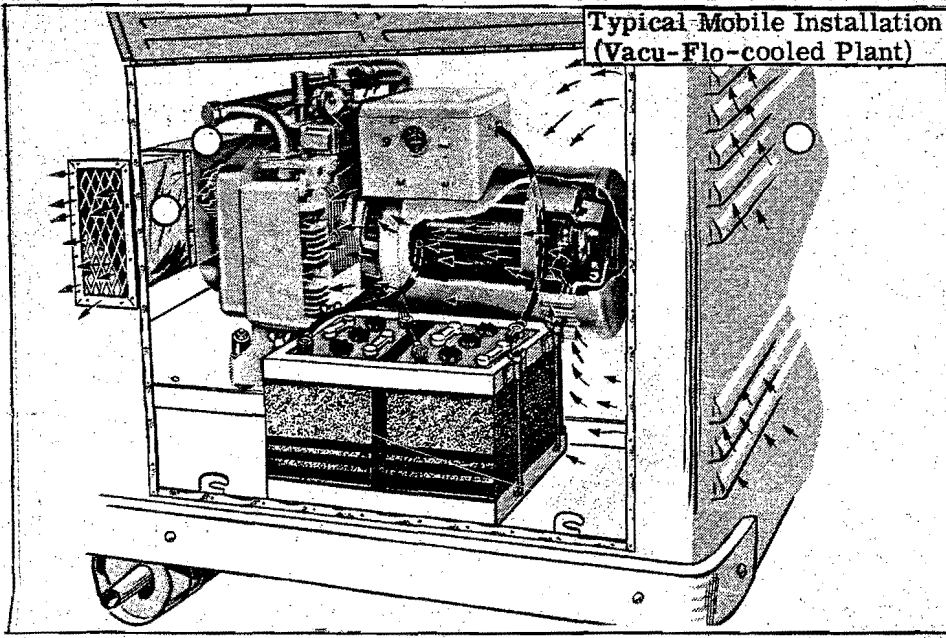
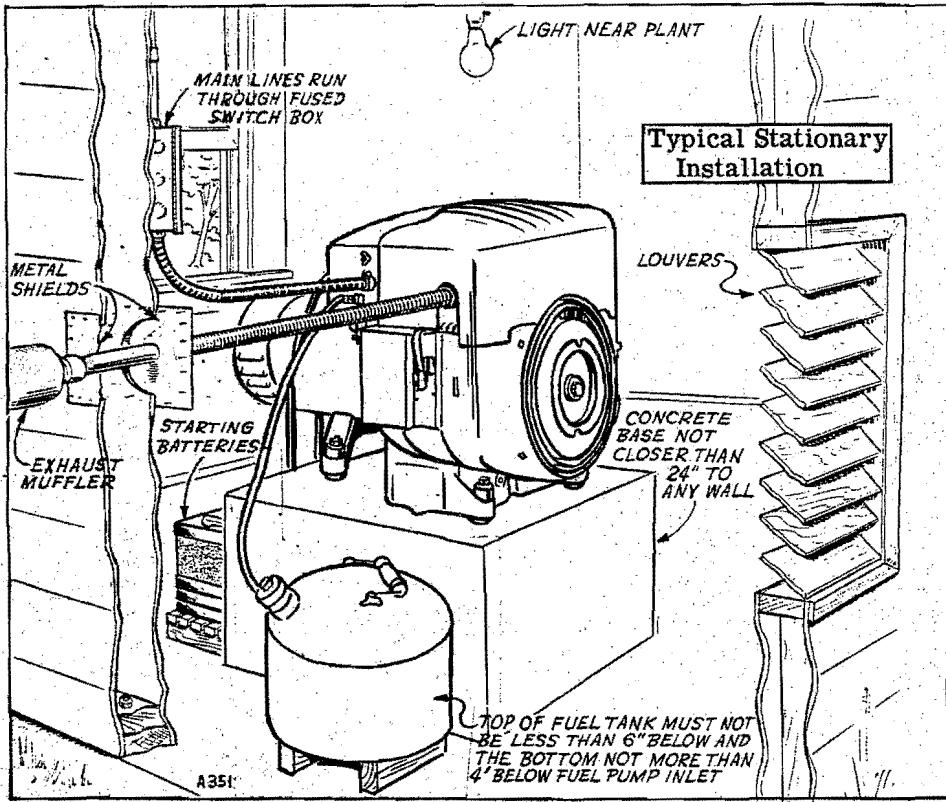


FIG. 1 - TYPICAL INSTALLATION

Plants mounted in vehicles must also be grounded. Review the applicable sections in the National Electrical Code and local regulations to determine the steps to be taken for grounding the set.

**VENTILATION (PRESSURE-COOLED PLANT).** - Provide ample ventilation. There must be a constant supply of fresh air for cooling the plant. In a large room, or out of doors, cooling will be no problem. There should be at least two openings, preferably at opposite ends of the enclosure, to provide ample ventilation. The openings should be adjustable so that the volume of air can be controlled for cold weather operation. The area of the air inlet should be at least 3-1/2 square feet. The area of the air outlet should be at least as large as that of the air inlet.

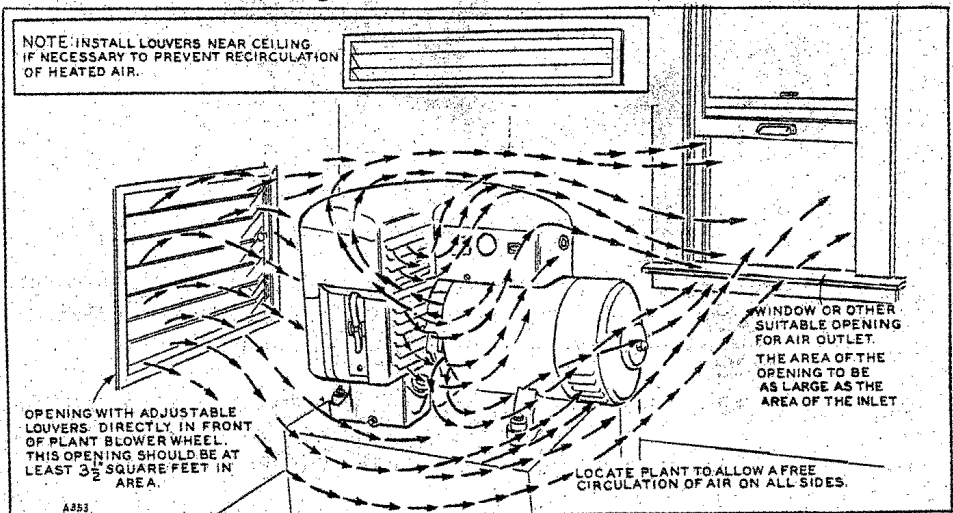


FIG. 2 - VENTILATION (PRESSURE-COOLED PLANT)

The installation of additional openings may be necessary under some conditions to prevent recirculation of heated air. If this becomes necessary, air outlets in the roof or in the wall near the ceiling will help. The size of the air inlet can be increased or an additional air inlet installed nearby.

If the unit is to be operated where flying lint, chaff or dust is likely to be carried to the intake air stream, air inlet and outlet openings should be made with reference to the prevailing wind. In such installations the air inlet should be screened and the screen kept clean to prevent restriction of air flow.

**PERMANENT MOUNTING BASE.** - Mount the plant on a substantially level concrete or timber or structural steel base, preferably at least 12 inches high. Locate the base so as to provide at least 24 inches space on all sides for convenience in



servicing. Use the rubber mounting cushions to minimize vibration. Space the 5/16 inch diameter mounting bolts to agree with distances shown on the Dimensional Outline illustration. Space the front two bolts for the oil base 12 inches apart, and the rear two bolts for the generator

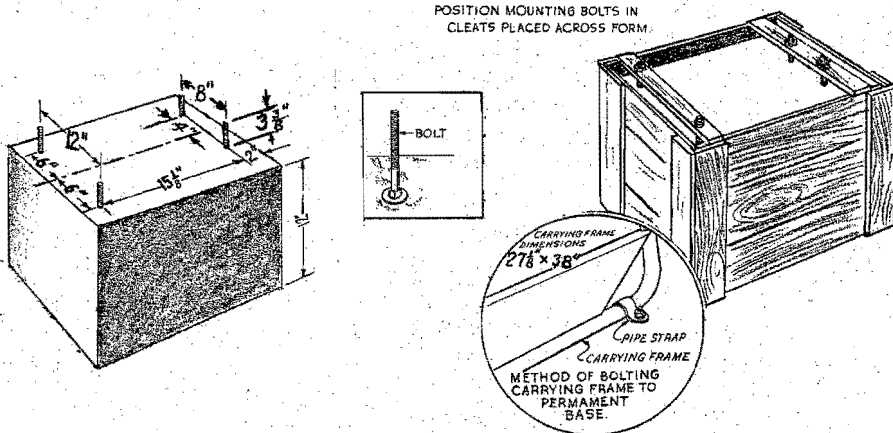


FIG. 3 - MOUNTING BASE

support 8 inches apart. Front center to rear center mounting distance is 15-1/8 inches. Be sure the mounting base is smooth and level so as to avoid excessive strain on any one of the four mounting feet.

**MOUNTING CUSHIONS.** - Install the mounting cushions as illustrated. The metal spacer and the flat washer at each end, prevents excessive compression of the rubber cushions.

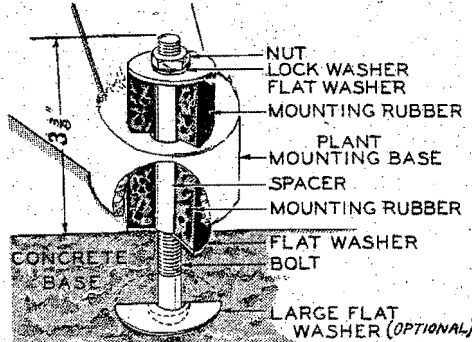


FIG. 4 - MOUNTING CUSHIONS

**EXHAUST.** - Pipe the exhaust gases outside the enclosure, using 1 inch pipe or larger. Increase the pipe size used, one size for each additional 10 feet in distance. Avoid sharp bends if possible by using bent pipe or sweeping elbow where necessary. Connect the flexible exhaust tube to the plant exhaust outlet, a sufficient length of pipe to conduct the gases outside the enclosure, and the muffler to the pipe

outside the enclosure. Insulate or shield the exhaust pipe if it comes close to or passes through a flammable wall or other material. If the exhaust line must be inclined upward from the plant, construct a condensation trap of pipe fittings and install it at the point where the upward pitch begins. Drain the trap periodically.

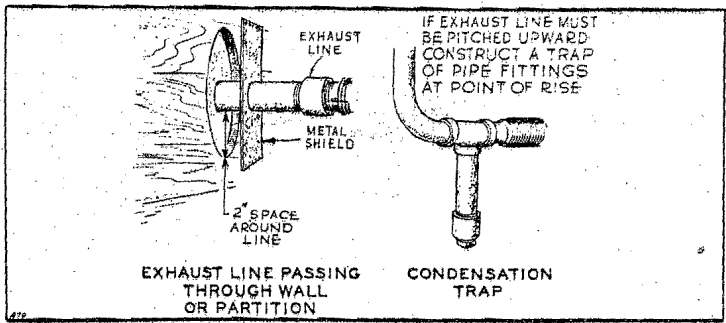


FIG. 5 - EXHAUST INSTALLATION

If exhaust noise from the standard muffler will be objectionable, an underground muffler may be constructed. Do not use an underground muffler if there is any danger of its filling with water at any time. Use a heavy metal drum or pail and weld suitable fittings for inlet and outlet pipes. Do not use a container which contained any flammable liquid without first making sure that all explosive vapors have been driven out. Remove the bottom of the drum, or drill holes in the bottom, to allow condensation from the exhaust gases to drain away. The muffler exhaust pipe should extend at least 24 inches above ground, with a gooseneck fitting on the end to prevent entry of rain or snow.

**OIL DRAIN EXTENSION.** - The addition of an oil drain extension pipe and coupling will provide for cleanliness and convenience in draining oil from the oil base. Before filling the oil base with oil as directed under Preparation, remove the drain plug from the oil base and install a 3/8 inch pipe nipple and coupling in its place. Install the drain plug in the coupling. When draining the oil, remove only the plug.

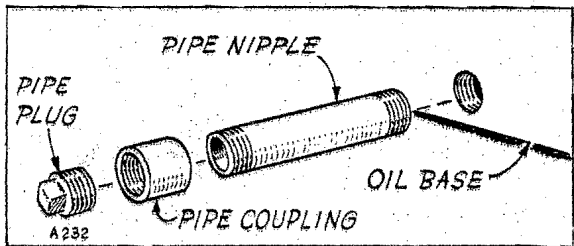


FIG. 6 - OIL DRAIN EXTENSION

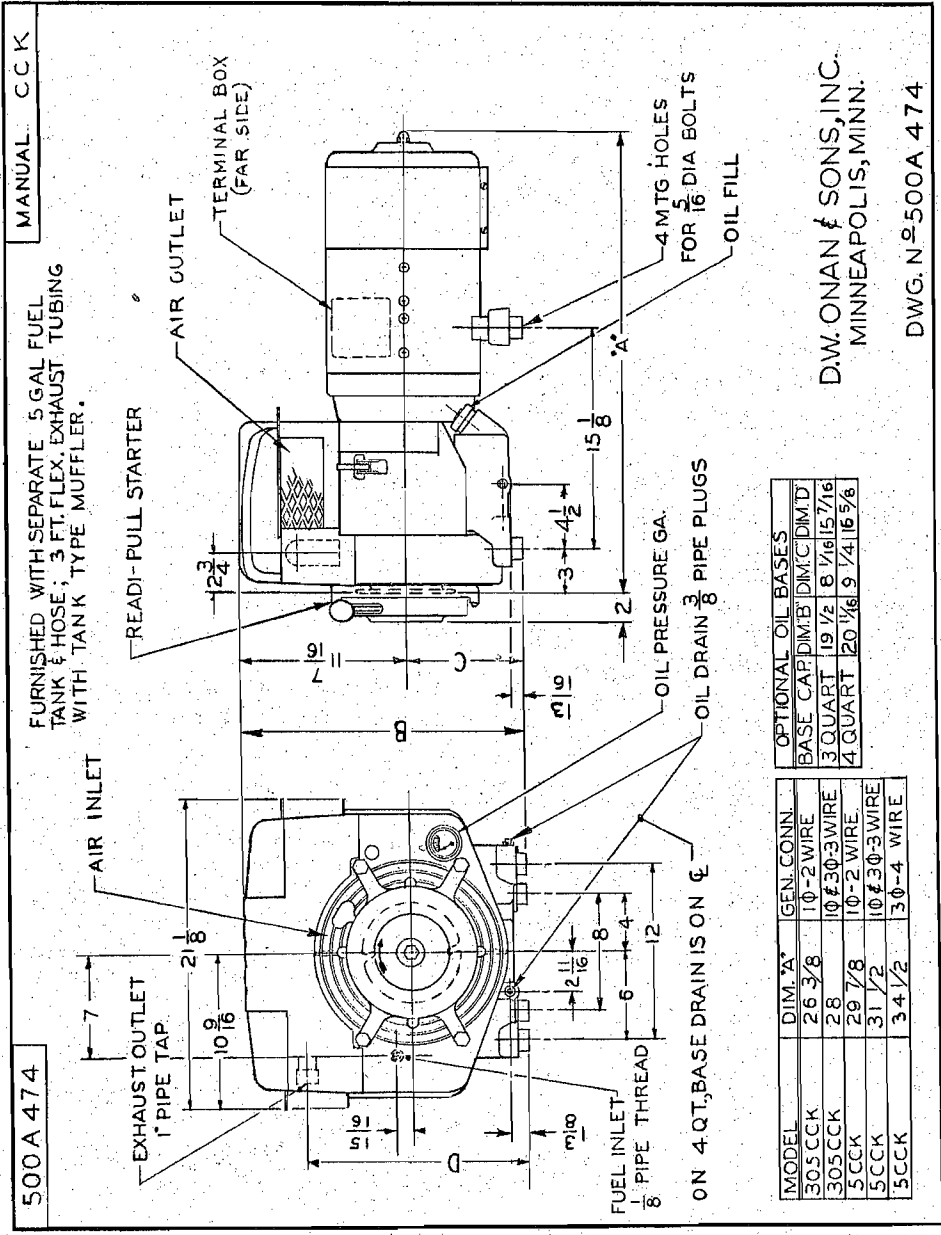


FIG. 7 - DIMENSIONAL OUTLINE FOR MANUAL PLANTS

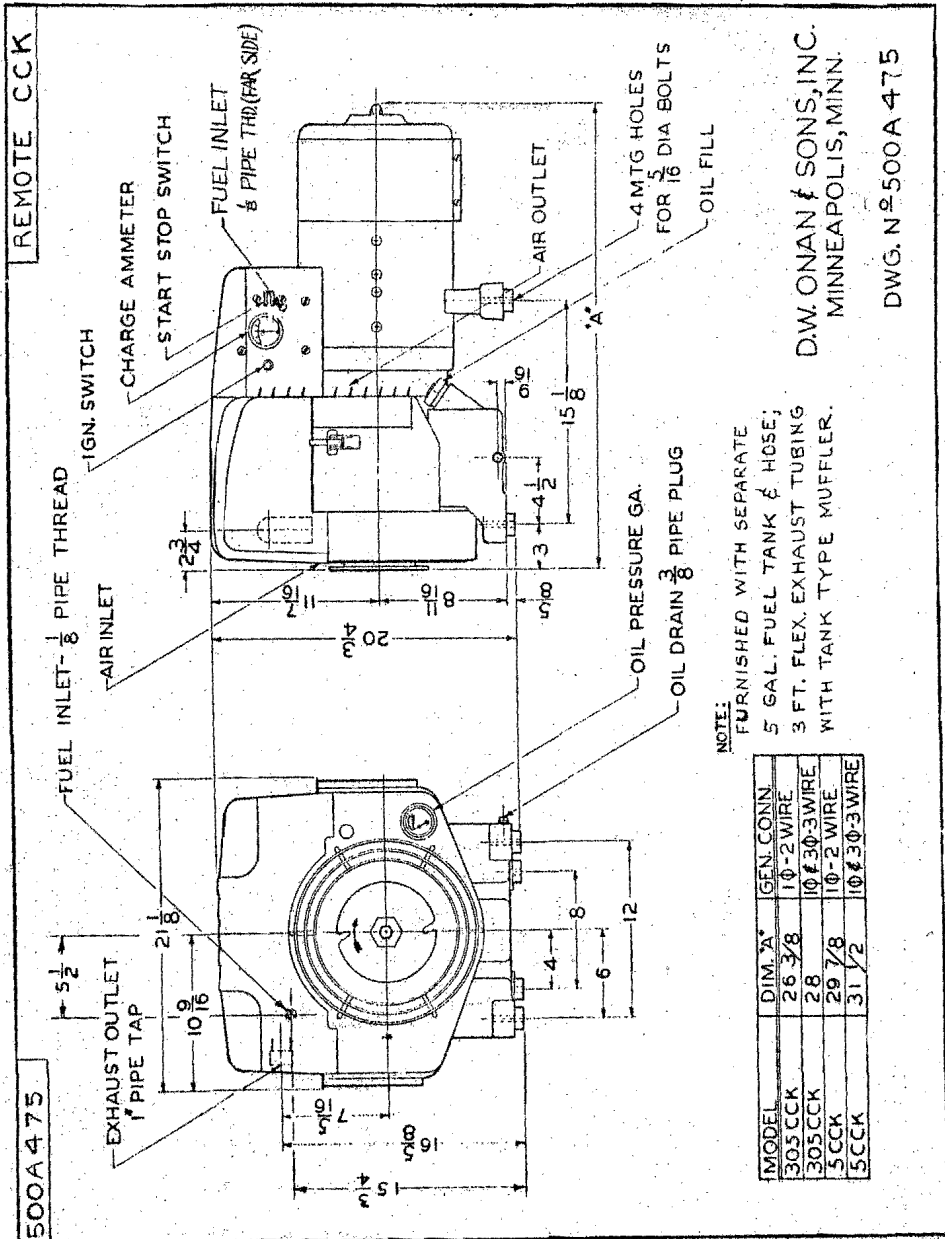


FIG. 8 - DIMENSIONAL OUTLINE FOR REMOTE PLANTS

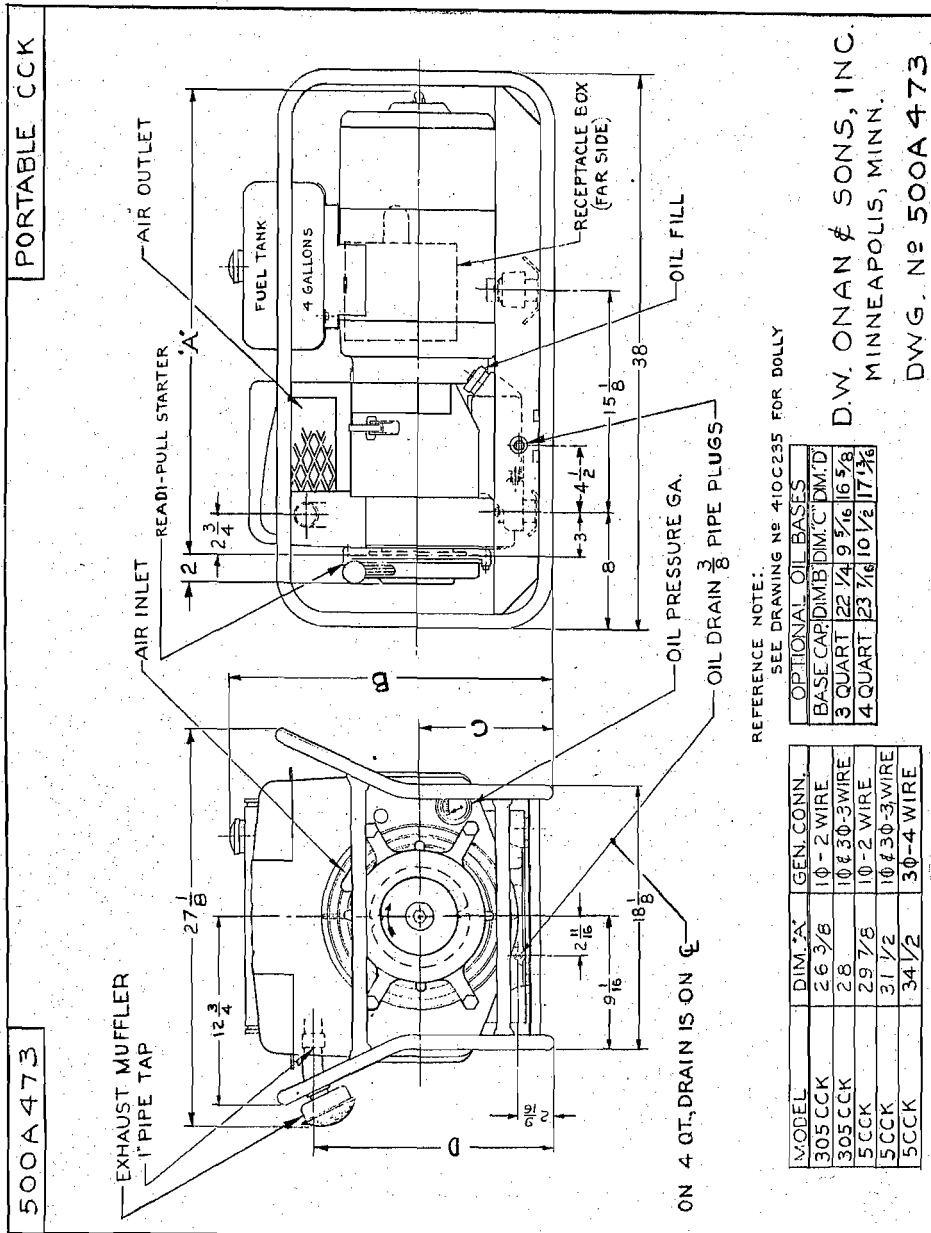


FIG. 9 - DIMENSIONAL OUTLINE FOR PORTABLE PLANTS

**BATTERY, AC REMOTE CONTROL PLANT.** - A 12-volt battery is required. If two 6-volt batteries are used, the batteries must be connected in series by connecting a short cable between the positive post of one battery and the negative post of the other battery.

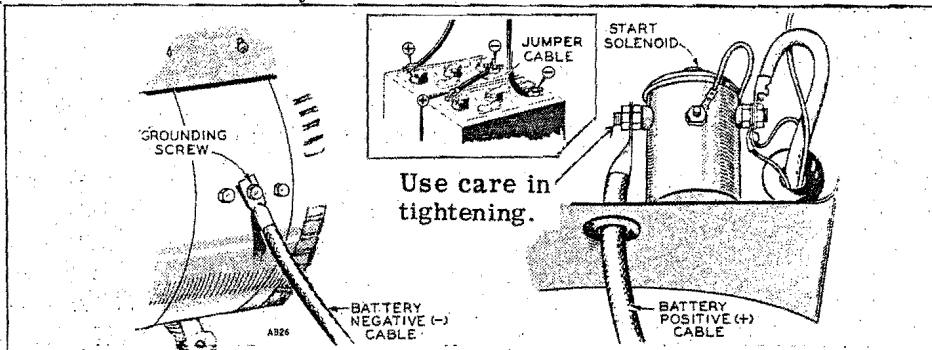


FIG. 10 - BATTERY CONNECTION - AC REMOTE PLANTS

Connect one of the long battery cables between the positive (+) battery post and the BATTERY terminal on the start solenoid in the control box. To avoid internal damage to the start solenoid, use care in tightening the cable terminal nut. Connect the other battery cable between the negative (-) battery post and the ground terminal (screw, stud, or solderless type) on the generator.

Connect the 32 volt battery for the dual purpose plant in the same manner, using a fused double pole switch between the plant and the battery. Refer to the wiring diagram. Be sure all electrical connections are tight. Coat battery clamps and posts with a light coating of grease or vaseline to minimize corrosion.

**BATTERY, MAGNET SERVICE PLANT.** - A 12 volt battery (or two 6 volt batteries in series) is required. Connect the battery positive cable to the engine start solenoid switch terminal. Connect the battery negative cable to the ground point on the oil base as shown.

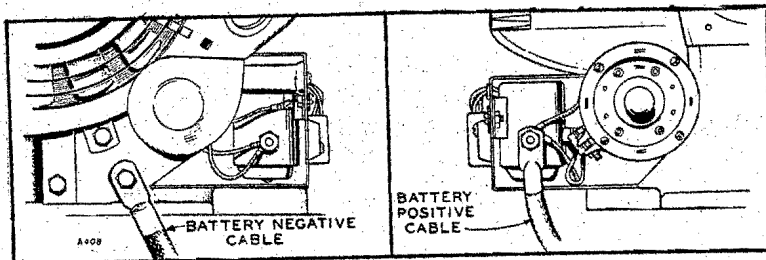
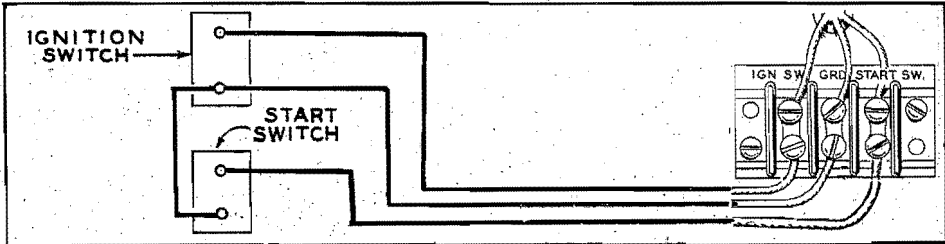


FIG. 11 BATTERY CONNECTION, MAGNET SERVICE PLANT

**START AND IGNITION SWITCHES, MAGNET SERVICE PLANTS.** - The magnet service plant is supplied with separate ignition toggle and start push button switches. These switches can be mounted at any convenient point where the operator will be able to know when the plant starts. Accidental closing of the start switch while the plant is running may damage the starter. Connect the ignition toggle switch across the plant terminals marked IGN. SW. Connect the start switch across the plant terminals marked START SW. Note that the center plant terminal is common to both circuits, thus permitting use of only three wires. Use #18 or larger wire.

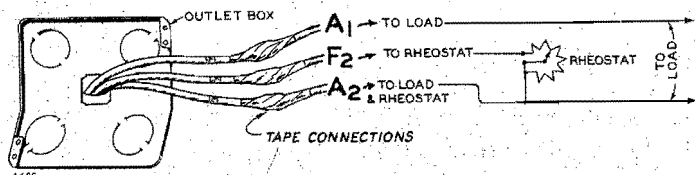


**FIG. 12 START & IGNITION SWITCHES, MAGNET SERVICE PLANT WIRING.** - If necessary to install wiring, follow specifications of local and national electrical codes. If in doubt, consult a licensed electrician. Use sufficiently large, insulated wire between the plant and the load. Install a circuit breaker or a fused main switch in the load line near to the plant. REFER TO THE APPLICABLE PLANT WIRING DIAGRAM.

Where connections are made by joining two wires, always be sure to tape the connections thoroughly. Apply two layers of half-lapped electrician's tape and two layers of half-lapped friction tape, extending both well beyond the ends of the connection.

The wire size will depend largely on the distance and permissible voltage drop between the plant and the load and the amount and kind of load. Consult a competent electrician. Check national and local codes before installing.

**CONNECTING THE LOAD WIRES, MAGNET SERVICE.** - The magnet service plant has generator leads marked A1, F2, and A2. extending into the outlet box. Connect the voltage control rheostat between leads F2 and A2. Connect the magnet (load) wires to generator leads A1 and A2.



**FIG. 13 LOAD WIRES, MAGNET SERVICE PLANT**



WIRING TABLE - 115 VOLT

Unity Power Factor, 2% Voltage Drop (2.3 Volts)

WIRE SIZE NO.	14	12	10	8	6	4	2	
Watts	Amps	* Distances expressed in feet per wire size.						
100	.87	510	810	1280	2040	3250	5300	8200
200	1.74	255	405	640	1020	1625	2650	4100
300	2.61	170	270	430	680	1080	1770	2730
400	3.48	125	200	320	510	810	1325	2050
500	4.35	100	160	255	410	650	1060	1640
750	6.52	65	100	170	275	430	710	1090
1000	8.69	50	80	125	205	325	530	820
1500	13.04	35	55	85	140	215	350	550
2000	17.38	25	50	65	100	160	265	410
2500	21.73	20	35	50	80	130	210	350
5000	43.36			25	40	65	105	160

\* Above figures represent a point to point distance for a 2 wire run. If 4% voltage drop is permissible, double the distance listed. If only 1% voltage is allowable, divide the distances listed by 2.

Single Phase 115 Volt A. C. - Use 115 Volt table above.

Single Phase 115-230 Volt, A. C. 3 Wire - Use 115 Volt table above for each 115 Volt circuit.

Single Phase 230 Volt A. C. - Double the distances listed in the 115 Volt table above. Use Amps Column.

Three Phase 230 Volt circuit - Multiply the distances in the 115 Volt Table by 2-1/4 for the same load. Use the Amps Column.

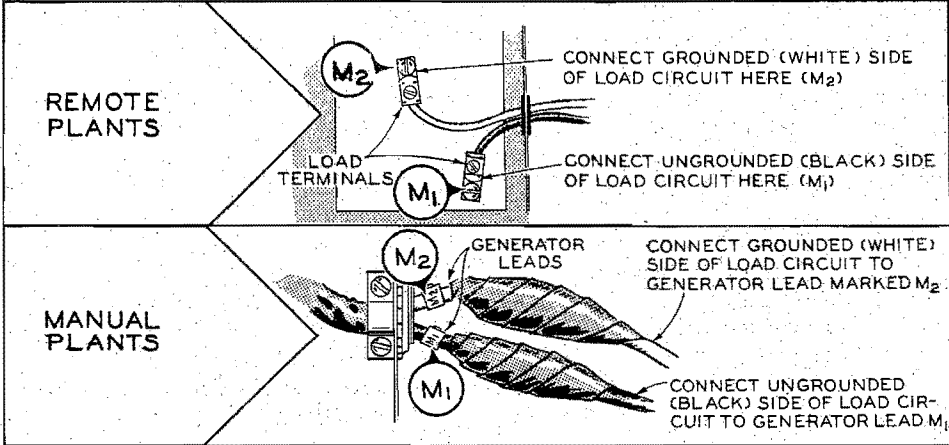
CONNECTING THE LOAD WIRES, AC REMOTE PLANTS. - The ac load terminals are located inside the control box and are marked. The same markings appear on the wiring diagram. These terminals are of the solderless type and connections are made by simply inserting the end of the load wire into the connector and tightening the screw. Thoroughly strip 1/2 of an inch of insulation from the end of each wire before inserting it into a terminal. Load wires enter the control box through a grommeted hole. Be sure connections are clean and tight.

Leave the load line switch open until the plant has been started and checked. No damage to the generator or controls will result from running the plant with no load connected.

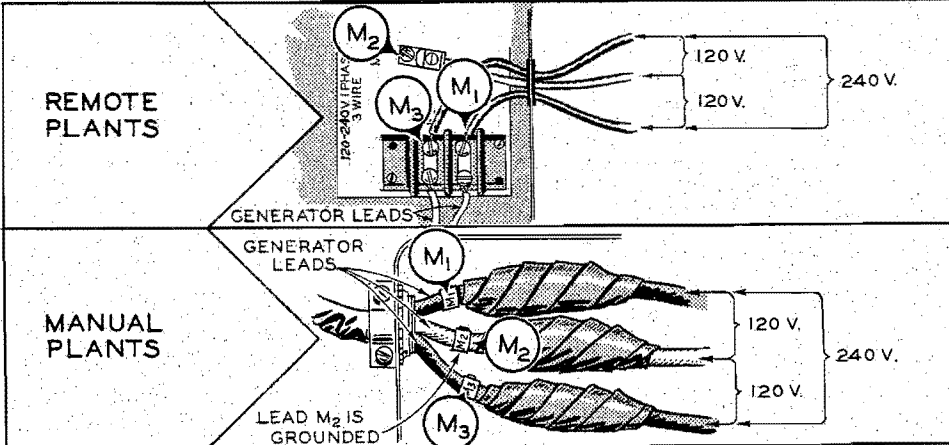
1 Phase, 2 Wire - AC Remote

On single phase, two wire plants, connect the load wires to the plant by connecting the ground (white) load wire to the control box terminal marked "M2". Connect the "hot" ungrounded (black) load wire to the control box terminal marked "M1".

SINGLE PHASE, TWO WIRE CONNECTIONS



SINGLE PHASE, THREE WIRE CONNECTIONS



THREE PHASE, THREE WIRE CONNECTIONS

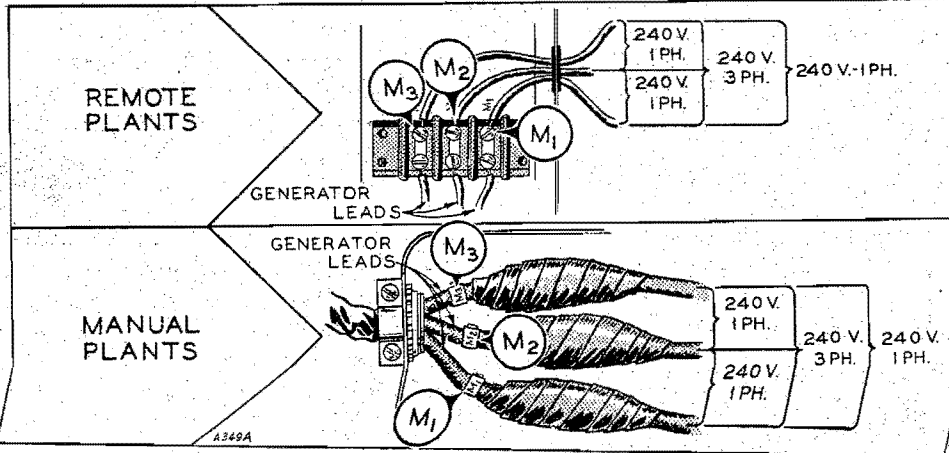


FIG. 14 - A C LOAD WIRE CONNECTIONS

### 1 Phase, 3 Wire - AC Remote

On single phase, three wire plants, connect the load wires to the plant by connecting the ground (white) load wire to the control box terminal marked "M2". Connect one of the "hot" ungrounded (black) load wires to the control box terminal marked "M1", and connect the remaining "hot" ungrounded (black) load wire to the control box terminal marked "M3".

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

One 240 volt circuit is available. This circuit is across "M1" and "M3". "M2" is not used with a 240 volt circuit. If only 240 volt current is used, the full rated capacity of the plant may be used.

Both 120 volt current and 240 volt current may be used at the same time. However, the total of either 120 volt load plus 1/2 the 240 volt load should not exceed 1/2 the capacity of the plant. For example: a total of 2500 watts is available on each 120 volt circuit of a 5000 watt single phase 3 wire plant. If 2000 watts of current is used on either 120 volt circuit, only 1000 watts of 240 volt current can be used at the same time. To determine the current available on each 120 volt circuit when the 240 volt load is known, subtract the 240 volt load from the plant rated capacity and divide the remainder by two.

### 3 Phase, 3 Wire - AC Remote

For three phase current, connect one load wire to each of the three generator terminals "M1", "M2", and "M3". If a test run indicates wrong rotation of 3 phase motors in the load circuit, reverse the connections at any two generator terminals.

Single phase current can be obtained between any two terminals. Three such single phase circuits are thus available: "M1 and M2", "M1 and M3", "M3 and M2". Not more than one third the capacity of the generator is available on each single phase circuit.

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 generator. Divide the remainder by three, to determine the amount of single phase load which may be connected to each of the single phase circuits.

### 4 Wire Plant - AC Remote

The four wire plant is designed to produce single phase current of one voltage, and three phase current of different voltage. As indicated on the plant nameplate, the single phase current is the lower voltage, and

the three phase current is the higher voltage.

For single phase current, connect the "hot" load wire to any one of the terminals "M1", "M2", or "M3". Connect the ground (white) load wire to the terminal marked "M0". Up to one third the rated capacity of the generator is available on each single phase circuit, if no 3 phase load is connected.

For three phase current, connect the "hot" load wires to the terminals marked "M1", "M2", and "M3", one wire to each terminal. Connect the ground load wire, if used, to the plant terminal marked "M0".

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

CONNECTING THE LOAD WIRES, AC MANUAL PLANTS. - Manual type plants have generator output leads which extend into an outlet box. Connections to the output leads may vary between different installations. The user should install a circuit breaker or a fused switch in the main load line to provide for automatic disconnecting of the load.

If the application is essentially stationary, the user may desire to connect the load leads within the outlet box on the plant, using bolts or connectors and taping each lead. If the main load lines are to be run in rigid conduit, install a short length of flexible conduit between the outlet box and the rigid conduit. Flexible conduit may be used entirely if so desired. If conduit is not used, install a Romex connector, or a similar load conductor securing device, to hold the load wires where they enter the outlet box.

Manual type plants have marking ("M1", etc.) on the generator leads which correspond to the same markings on the control box output terminals of the remote type plants. The instructions for connecting the load wires are not repeated here. Please refer to the instructions CONNECTING THE LOAD WIRES, AC REMOTE PLANTS and select the paragraphs which apply to the model in question.

CONNECTING THE LOAD WIRES, AC PORTABLE PLANTS. - The portable type plant is designed for applications which require plant operation at various locations. These plants have outlet receptacles of the grounding type which serve for easy connection and disconnection of the load. *Matching electrical plugs or caps must be provided on the load wires,*

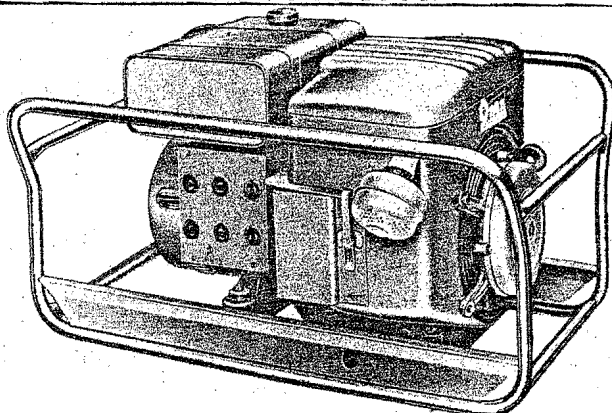


FIG. 15 - LOAD RECEPTACLES - PORTABLE PLANTS

**GROUNDING, ALL PLANTS.** - If grounding is called for in local electrical codes, or if radio interference necessitates it, provide a separate ground. Also the operator will desire to protect himself from possible dangerous electrical shocks by grounding the generator plant and branch circuits. Radio interference may result if the plant is grounded to a water pipe or to a ground used by a radio. Drive a 1/2" diameter rod or pipe into the ground as near to the plant as possible. Make certain that the ground rod will always penetrate moist earth. Fasten an approved ground clamp to the rod. Run a wire (number 8 or larger) (never smaller than 2 sizes smaller than the largest wire used in the system) from the clamp to the plant ground terminal. If no separate grounding terminal is provided on the plant, connect to the BATTERY NEGATIVE or to the grounded load line wire.

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

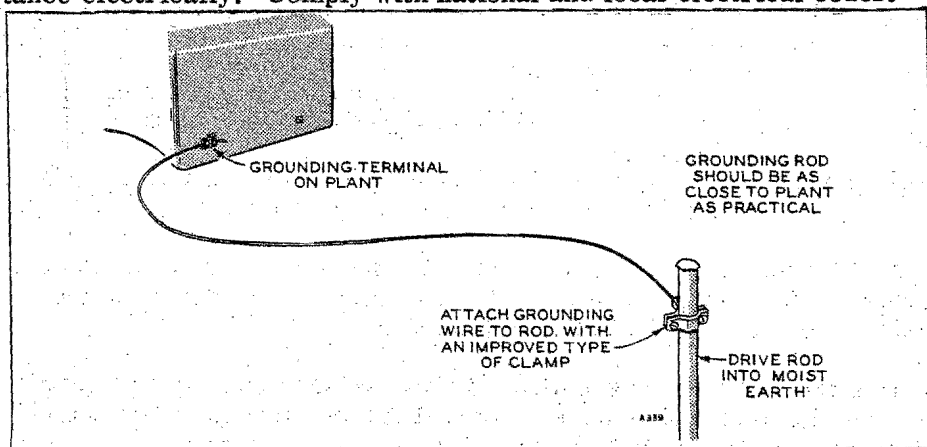


FIG. 16 - PLANT GROUNDING

**REMOTE CONTROL SWITCH, AC PLANTS.** - One or more remote control switches may be connected to provide remote control of starting and stopping remote plants. The wire length from the plant to the switch determines the wire size necessary. For distances up to 250 feet use #18 wire. Use #16 wire up to 400 feet, or use #14 wire up to 630 feet.

The four place terminal block, located in the control box, is marked "REMOTE CONTROL", B+, 1, 2, and 3 appears in the illustration. Terminal number 1 is used as a common ground, terminal number 2 connects to the stopping circuit of the plant and terminal number 3 connects to the starting circuit of the plant. The terminal marked B+, is to be used only with an automatic control installation.

Connections for two styles of momentary contact toggle switches for use as Remote Start-Stop Stations are illustrated. Connect all number "2" or "OFF" switch terminals to the number "2" terminal on the plant terminal block. Likewise, connect together all number "3" or "ON" terminals and also, all number "1" or "SINGLE" (not marked) terminals. If the switch is to be mounted vertically, start position should be upward to conform with operation at the plant when a toggle switch is used.

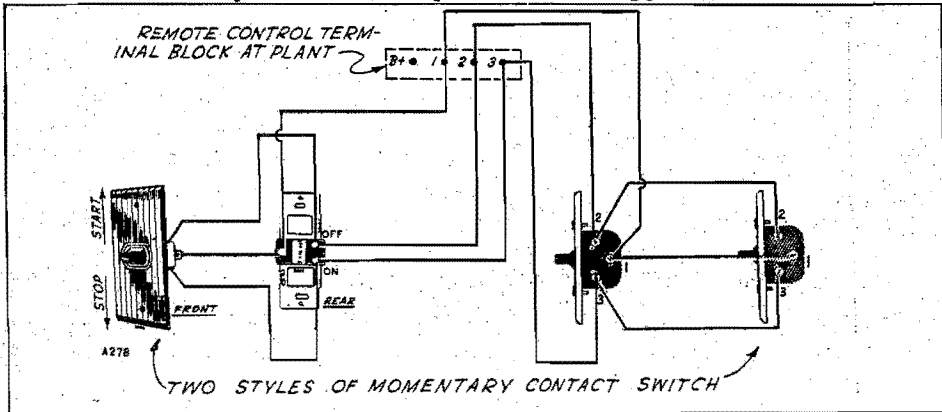


FIG. 17 - REMOTE START-STOP STATIONS

**SEPARATE FUEL TANK.** - The separate fuel tank has a capacity of 5 gallon (U.S. Measure).

Install the fuel tank so that the bottom of the tank will be less than 4 feet below the fuel pump. The top of the tank must not be above the fuel pump. Refer to the Typical Installation illustration.

Follow the instructions supplied with the fuel tank and cap, according to the installation requirements. Connect the pipe thread end of the fuel line to the fuel filter and bracket elbow.

Note that one end of the shorter flexible fuel line has a swivel connector fitting, and the other end is solid to the line. Connect the solid end to the filter outlet, and the swivel end to the fuel pump inlet. Take care to start threads straight. The threads on the two ends are different and may be damaged if the ends are reversed.

**UNDERGROUND FUEL TANK.** - Comply with local codes governing underground gasoline tank installations.

If the fuel lift for the fuel pump on the engine is greater than the recommended maximum of 4 feet, then an auxiliary electric fuel pump should be installed ahead of the engine pump to provide a dependable supply of fuel.

**FUEL RESERVOIR (DAY) 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 may then be necessary in order to pump enough gasoline into the carburetor for the engine to start. On installations where automatic, unattended starting after extended shut-down is necessary, an auxiliary, gravity feed fuel tank should be installed. Fuel from this tank flows by gravity to the carburetor, thus replacing any fuel lost through evaporation and promotes quick starting after an idle period.

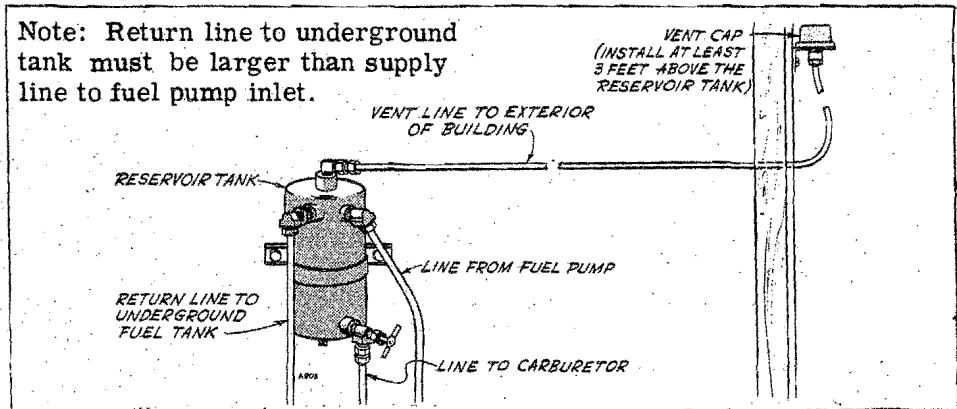


FIG. 18 - FUEL RESERVOIR "DAY" TANK

**CARRYING FRAME (OPTIONAL ACCESSORY).** - The welded tubular steel frame is standard equipment on the portable type plants. The frame may be added to the manual or the remote type plants but it does not provide for the separate fuel tank or for the remote-starting batteries. Use the existing mounting cushions and spacers. Use a bonding strap or other suitable grounding conductor between the plant and the carrying frame.

**2-WHEEL DOLLY (OPTIONAL ACCESSORY).** - The dolly is designed to assemble to the carrying frame as furnished on the portable type plant. The dolly has



semi-pneumatic tires and adjustable folding handles with hand grips.

**READI-PULL STARTER.** - Refer to the separate section in this publication for installation, operation and maintenance of the Readi-Pull rope recoil starter. The starter may be positioned in various directions of rope pull as illustrated under **MAINTENANCE AND REPAIR.**

The air housing on vacuum-cooled units does not permit the use of a Readi-Pull starter. Vacuum-cooled units are all electrically cranked.

## RUNNING TIME METER

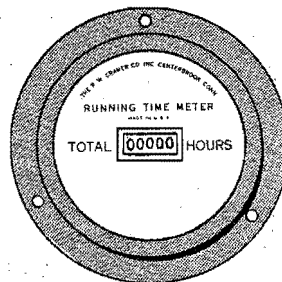
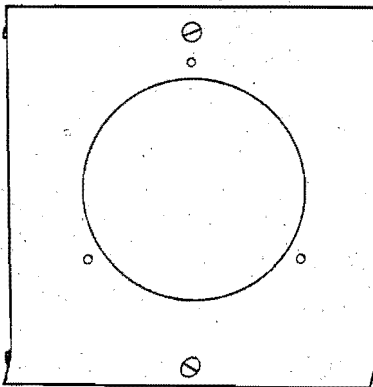
**Don't Guess** - Know how many hours your plant runs, so that you can change oil and service the plant at proper intervals.

This meter will be an investment rather than an expense. Simple to connect. This meter runs only when the plant is operating.

PART NO.	USED WITH PLANT
302-212	60 Cycle, 120 V. A. C.
302-102	50 Cycle, 120 V. A. C.
304-99	Resistor - adding to either meter above makes it suitable for 240V. use.

Meters listed above are 3-1/2 inch diameter, and are for flush mounting on panel; fit into 2-29/32 inch hole. For wall mounting, order separately:

301-500 Instrument Box



GAS REGULATOR (OPTIONAL EQUIPMENT).

1. The gas regulator supplied is a secondary (atmospheric) type, designed to operate on a line pressure of 3 to 8 ounces. If the line pressure is more than 8 ounces, consult the fuel supplier regarding the installation of a primary regulator.
2. Some local regulations require installation of an electric solenoid type valve, and a filter in the supply line. Be sure to install a manual shut-off valve in the line.
3. Assemble the pipe fittings to the regulator as illustrated, and install the regulator to the gas supply line. Turn the regulator to an upright position, and support the line securely.
4. Turn on the gas supply valve. Blow into the open vent hole (F).
5. Put a soap bubble over the regulator outlet nipple (E) and turn the adjusting screw (G) out until the fuel seeps through slowly, making the soap bubble grow. If fuel pressure is quite low it may be necessary to remove the adjusting screw before fuel will flow.
6. Turn the adjusting screw in just to the point where the soap bubble holds. If the screw projects above the casting surface, turn it just flush. No further operating adjustment will be necessary. Install the vent fitting in the hole (F).
7. Connect the fuel hose between the regulator and the carburetor, running the hose beside the engine rear adapter casting. If the hose is a tight fit, lubricate with wet soap. Tighten hose clamps securely.
8. See that the float lock (D) is turned in to its limit, and that the choke is locked wide open.

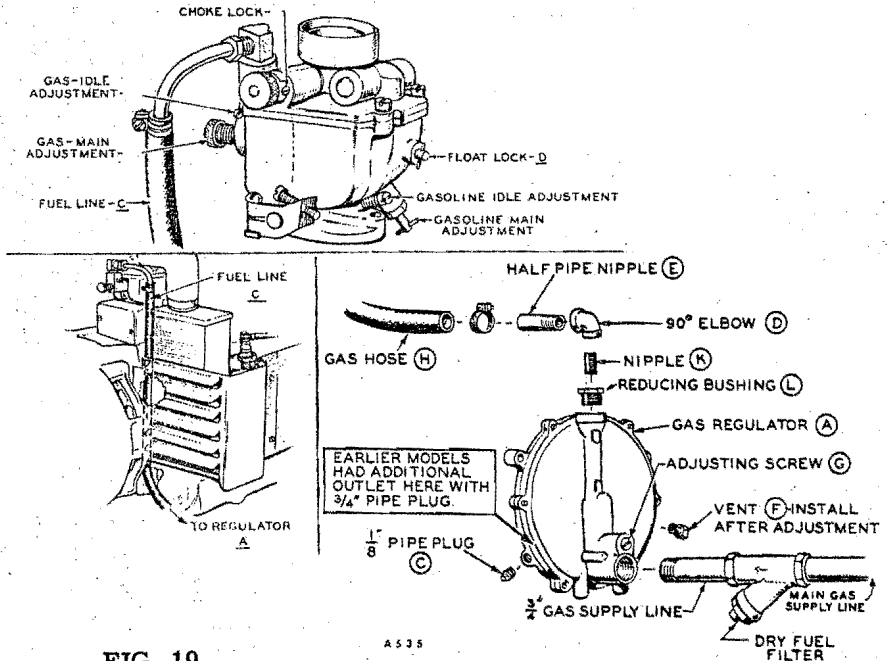
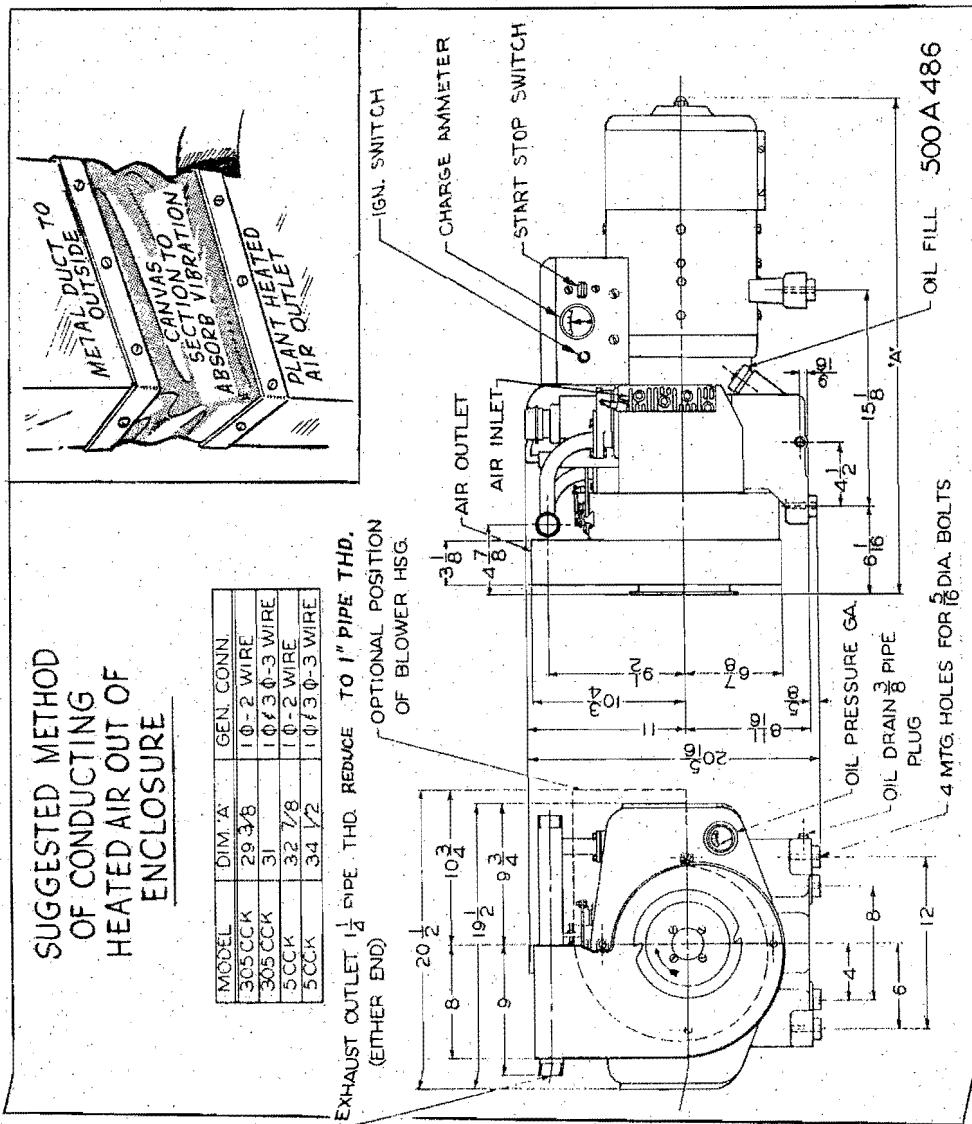


FIG. 19  
GAS REGULATOR CONNECTION

A 535

VACU-FLO COOLING (Optional Equipment). - Cooling air is drawn past the engine and out through the front of the blower housing on plants which are Vacu-Flo cooled (also referred to as suction cooled). This type of cooling is desirable where the plant must be installed in a small enclosure. Provide AT LEAST 140 square inches of free (net) air inlet area. Install duct work to exhaust heated air outside of the enclosure, using flexible material next to the engine air ducting scroll. Vacu-Flo type cooling is available only for remote type plants, all of which have battery ignition. Conversion in the field to Vacu-Flo cooling is not practical.



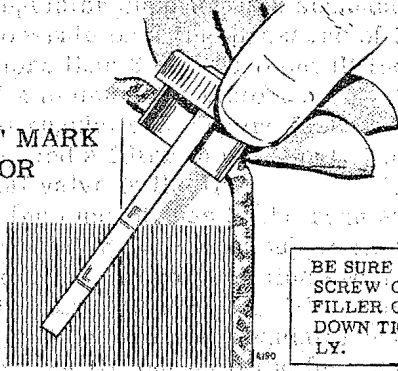
SUGGESTED METHOD OF CONDUCTING HEATED AIR OUT OF ENCLOSURE

MODEL	DIM. 'A'	GEN. CONN.
305 CCK	29 3/8	10-2 WIRE
305 CCK	31	10 1/2 0-3 WIRE
5 CCK	32 7/8	10-2 WIRE
5 CCK	34 1/2	10 1/2 0-3 WIRE

EXHAUST OUTLET 1/4 PIPE THD. REDUCE TO 1" PIPE THD. (EITHER END)  
 OPTIONAL POSITION OF BLOWER HSG.

FIG. 20 - VACU-FLO COOLING

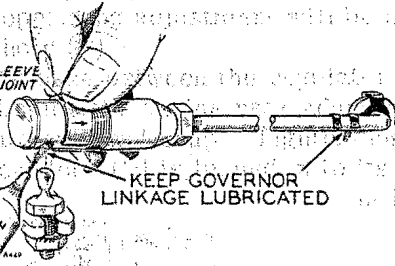
FILL TO "F" MARK ON INDICATOR



BE SURE TO SCREW OIL FILLER CAP DOWN TIGHTLY.

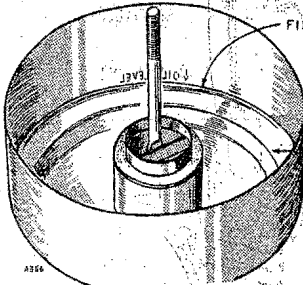
FIG. 21 - CRANKCASE OIL LEVEL

SHIFT SLEEVE TO LIFT JOINT FROM BALL STUD  
LUBRICATING GRAPHITE

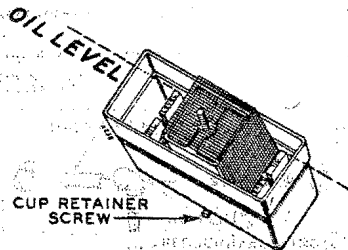


KEEP GOVERNOR LINKAGE LUBRICATED

FIG. 22 - GOVERNOR LINKAGE LUBRICATION



FILL WITH OIL TO THIS LEVEL  
RENEW OIL BEFORE DIRT REACHES SHELF IN CUP



CUP RETAINER SCREW

FIG. 23 - AIR CLEANER SERVICE

OPEN VALVE ALL THE WAY TO BACK SEAT

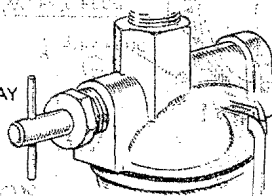


FIG. 24

GAS REGULATOR CONNECTION

FIG. 24 - FUEL SHUT-OFF VALVE

## CAUTION

DO NOT ATTEMPT TO START OR OPERATE THE PLANT UNTIL IT HAS BEEN PROPERLY PREPARED FOR OPERATION WITH OIL AND FUEL AS DIRECTED IN THIS SECTION.

**CRANKCASE LUBRICATION.** - Use detergent oils classified by the American Petroleum Institute as Service "DG" or, as marketed by most manufacturers, "MS/DG". The use of Service "DS" is satisfactory, but its higher cost is not justified.

Multiviscosity oils such as 5W-20 or 10W-30 are not recommended, as the oil consumption increases greatly (in some cases consumption may be more than doubled). At low temperatures where cold starting may be difficult and high oil consumption is not a factor, the use of multiviscosity oil may be justified. Do not use a non-detergent oil unless unavoidable.

TEMPERATURE	SAE NUMBER
Above 90°F. (32°C.)	50
30°F. to 90°F. (-1°C. to 32°C.)	30
0°F. to 30°F. (-18°C. to -1°C.)	10W
Below 0°F. (-18°C.)	5W; or 10W plus 10% kerosene.

## NOTE

For temperatures below 0°F. (-18°C.) if SAE number 5W oil is not available, use SAE number 10W oil diluted with 10% kerosene. Use 4 ounces of kerosene to each quart of oil. Mix the oil and kerosene thoroughly just before pouring it into the engine. Fill the engine to the full (F) mark on the indicator. Do not over fill.

When using a detergent type oil, always use oil of the same brand when adding oil between oil changes. When mixed together, detergent oils of different manufacturers sometimes form chemical compounds that are harmful to internal engine parts.

Lubricate the governor arm ball joint with a dry type lubricant such as powdered graphite to assure best performance and longest life of the ball joint. If graphite is not available, use light non-gummy oil.

**AIR CLEANER.** - Remove the oil cup from the bottom of the air cleaner. Add oil of the same SAE number as used in the crankcase, to the level indicated inside the cup, FIG. 23. Reinstall the cup.

**GASOLINE FUEL.** - The portable type plant has a 4 gallon rectangular tank mounted over the generator. The stationary type plant has a 5 gallon separate tank. Measures are U.S. Standards. Fill the tank nearly full with clean, fresh, automotive type gasoline of at least 68 octane rating. Do not use a highly leaded premium type gasoline, as its use will necessitate more frequent carbon removal and spark plug and valve service. Do not fill the tank entirely full of cold gasoline. Expansion of the fuel as the plant warms up may cause the gasoline to overflow and result in a fire hazard. Observe the usual precautions when handling gasoline. **NEVER FILL THE TANK WHEN THE PLANT IS RUNNING, BECAUSE OF FIRE HAZARD.**

Open all of the fuel shut-off valves all the way to backseat and inspect the fuel system for leaks.

If the preceding instructions have been followed, the plant should be ready for operation. Before starting the plant, however, carefully study the sections OPERATION and ABNORMAL OPERATING CONDITIONS immediately following.

**GAS FUEL.** - If the plant will be run on gas fuel, see that the spark plugs are adjusted to 0.018 inch gap. See that the regulator is properly adjusted as directed under INSTALLATION. If the BTU rating of the gas to be used differs from that used in the test run at the factory (1000 BTU), it will probably be necessary to make carburetor gas adjustments. Refer to the ADJUSTMENTS section.

**BEFORE INITIAL START.** - Clean the spark plugs in gasoline before the initial start to dispose of preservative oil placed in the cylinder before factory shipment.

Long storage periods may cause the oil pump to lose its prime. If this condition occurs, stop the engine, remove the oil relief valve, add oil to the pressure line and reinstall the valve. Check the oil pressure.

BEFORE ATTEMPTING TO START THE PLANT, MAKE SURE THE PLANT HAS BEEN PROPERLY INSTALLED AND PREPARED FOR OPERATION AS DIRECTED IN THE PREVIOUS SECTIONS.

**STARTING AC REMOTE CONTROL PLANTS.** - For the initial start (or if the plant has run out of fuel) it will be necessary to pump gasoline to the carburetor. It usually takes about 30 revolutions (or fuel pump primer strokes) to properly fill the carburetor with gasoline.

To start the plant, push the START-STOP switch to its START position. The plant may hesitate for several seconds before cranking past compression on the first revolution. **HOLD THE STARTING SWITCH CLOSED FOR THIS HESITATION PERIOD.** The engine will crank over compression and then gain normal cranking speed. As the plant starts, release the start switch, making sure the switch handle returns to its center position.

**STARTING THE MAGNET SERVICE PLANT.** - The magnet service plant uses an automotive type system. To start the plant, snap the ignition switch to its ON position and push the START switch to crank the engine. As soon as the engine starts, release the start switch. As with any automotive starter, damage may occur if the starter is engaged while the engine is running.

**STARTING THE REMOTE CONTROL PLANT MANUALLY.** - If the battery charge condition is too low to crank the engine but is sufficient to supply ignition current, the plant may be started manually. Snap the control box switch to its MANUAL START position. Crank the engine with a smooth fast pull the full length of the starting rope. Do not jerk the rope. Repeat the cranking as necessary. After starting, return the control box switch to the ELECTRIC START position, to avoid discharging the battery. If the plant will not run at the ELECTRIC START position, but will at the MANUAL START position, a control fault is indicated, and proper repairs should be made to avoid further damage to the controls.

**STARTING MANUAL AND PORTABLE PLANTS.** - To limit manual cranking required, work the fuel pump priming lever to assure adequate fuel in the carburetor. Always leave the priming lever all-the-way inward to not restrict the normal operation of the pump. Adjust the manual carburetor choke as necessary for the temperature conditions. If the plant has been



standing idle in cold weather, the carburetor choke may have to be completely closed for the first cranking. In hot weather, or if the plant is still warm from recent operation, little or no choking should be required. Avoid overchoking. On plants not equipped with a recoil starter, wind the start rope on the flywheel rope sheave in a clockwise direction to within a few inches of the rope handle. Crank the engine with a strong, fast pull the full length of the rope. If the plant fails to start at the first cranking, change the choke setting and repeat the cranking. As the plant starts, adjust the choke position to the point where the plant runs smoothly. As the plant warms up, gradually open the choke all the way.

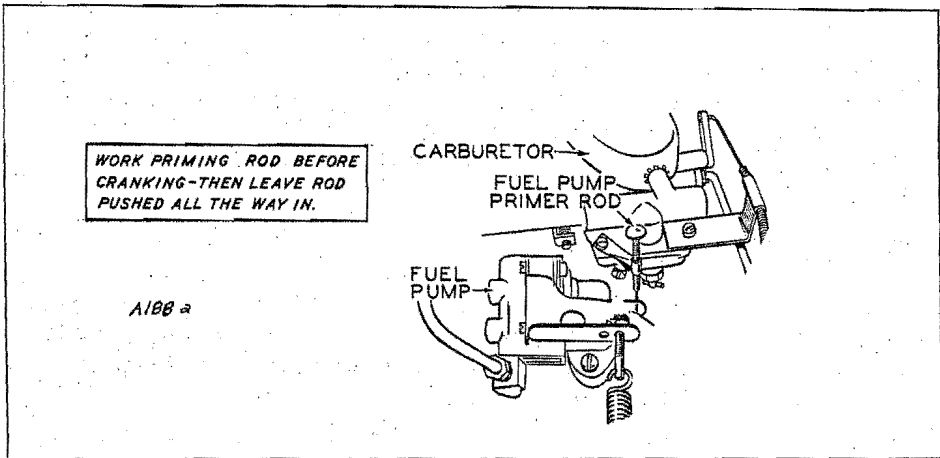


FIG. 25 - PRIMING THE FUEL PUMP

**APPLYING THE LOAD.** - Best results are obtained if the plant is allowed to thoroughly warm up before applying a heavy load. Load wires should be connected before operating, according to the model in question, as instructed under **INSTALLATION**.

Apply the load to the remote control type plant by throwing the main line switch to the ON position. If no main line switch was installed, throw the switch for the individual load to the ON position. When possible apply portions of the load in steps.

Procedure for applying the load to the manual type plant will depend upon the installation and application. If no plug-in receptacles were added at the plant, load application as given for remote control type plants will apply.

On the portable type plant, plug-in receptacles serve to apply the load by inserting the load plug directly into the receptacle at the side of the generator. Twist plug part of a turn in the receptacle to secure the connection.

**RHEOSTAT CONTROL, MAGNET SERVICE.** - Be sure the field rheostat is turned to its maximum resistance position (minimum generator voltage) before starting the plant. After connecting the magnet by operating the magnet controller, adjust the rheostat to give a generator voltage of 250 volts, or to the rated voltage of the magnet. When first connected, the the magnet resistance is comparatively low, so more rheostat resistance is needed to keep the voltage at the proper value. As the magnet warms up in use, the rheostat must be readjusted to bring the voltage up to normal.

**BATTERY CHARGE RATE.** - The battery charge rate is automatically controlled by a voltage regulator. On AC plants, the high charge rate was set at the factory for average operating conditions. If frequent starts and short operating periods require an increased high charge rate, adjust by moving the slide clip on the adjustable resistor in the control box. On plants with a separate charging generator, failure of charge current could be due to a blown fuse in the voltage regulator.

**STOPPING THE PLANT.** - To stop the manual and portable type engine, press the STOP button on the blower housing until the engine has come to a complete stop. The high tension magnet provides a firing spark even when the engine is running at very few rpm. Release of the STOP switch too soon will allow the plant to again pick up speed and continue to run.

To stop the ac remote control plant, push the START-STOP switch to the STOP position. To stop the magnet service plant, snap the ignition switch to its OFF position.

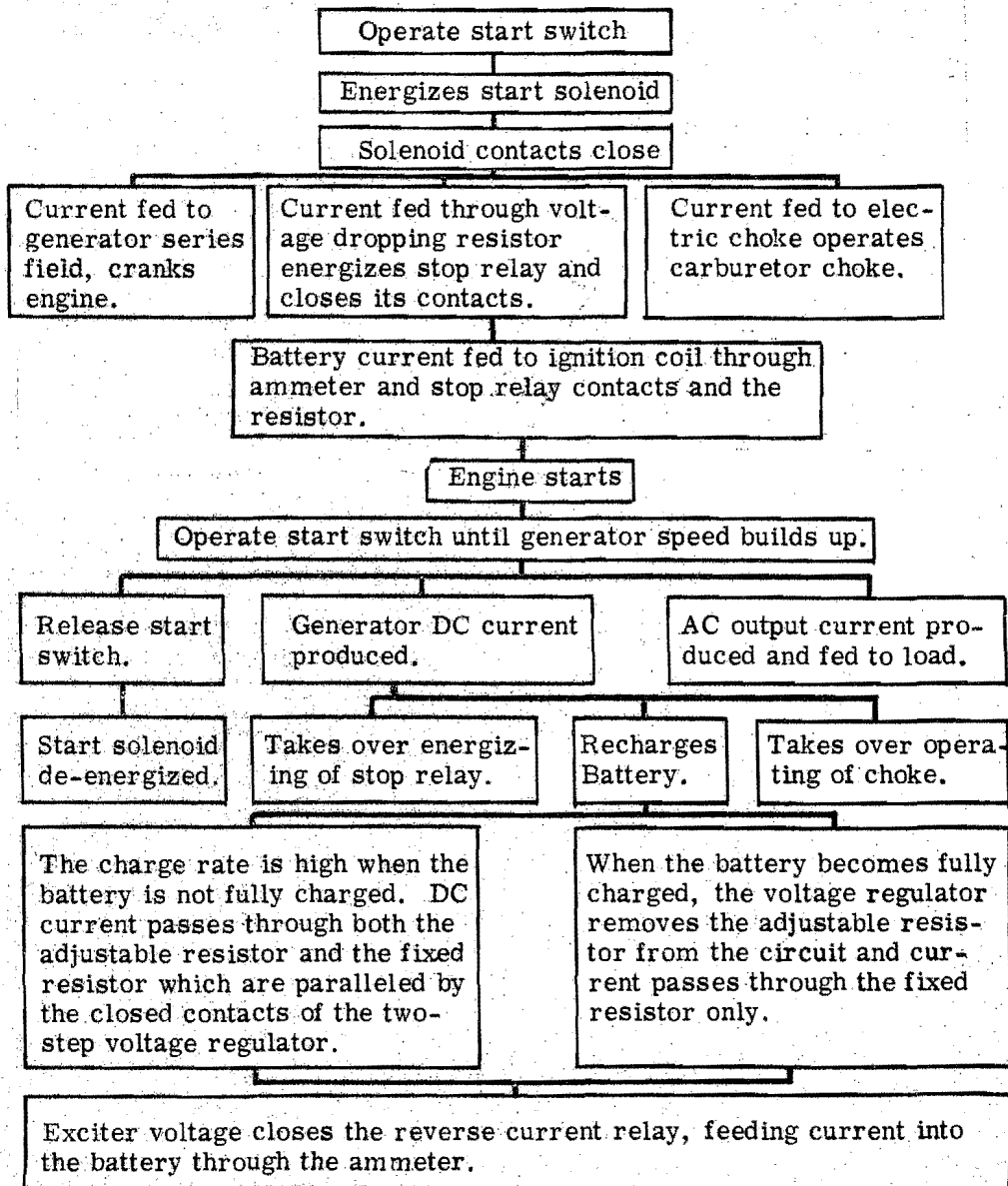
In an emergency, if the STOP button fails to work, the plant may be stopped by closing the fuel shut-off valve.

**CHANGING TO GASOLINE OPERATION.** - Engines having a combination gas-gasoline carburetor can be switched to gasoline operation by the following procedure: (1) Shut off the supply of natural gas or Propane-Butane vapor; (2) Open the gasoline shut-off valve; (3) Unscrew the carburetor float lock all the way outward to back seat (necessary to prevent leakage); (4) Set the spark plug gap as given in the Table of Clearances; (5) See that the choke is free and works easily; (6) Start the engine in the manner described for the engine. If the engine runs unevenly under half or full load due to faulty carburetor adjustment, the main jet needs adjusting. This is not the same main adjusting screw used for gaseous fuel. Another adjusting screw is provided for this purpose. See the illustration, Carburetor Adjustments under ADJUSTMENTS.

*To change back to natural, Propane or Butane operation, reverse the above procedure and reset the spark plug gap.*

FUNCTION OF THE CONTROLS. - Reference to the plant wiring diagram, and a thorough understanding of how the controls work, will aid in diagnosing trouble if failure occurs.

This chart explains function of controls during remote plant starting:



**DUAL PURPOSE PLANT.** - The charging rate to the battery is controlled by a HIGH-LOW charge switch located near the ammeter on the plant control box. When this switch is at the HIGH position, the charging rate is about 20 amperes. When the switch is at the LOW position, the charging rate is about 3 amperes.

The total ac load on the dual purpose plant should not exceed 2250 watts when the charge switch is at the HIGH position. When the charge switch is at the LOW position, the full ac capacity of 3,000 watts can be used.

The plant produces alternating current (ac) as well as direct current (dc) and must operate at about 1800 rpm (for 60 cycle plants) in order to produce the correct current frequency. **NEVER INCREASE ENGINE SPEED TO INCREASE THE CHARGING RATE.** Engine speed should be adjusted only as necessary to obtain the correct ac output frequency.

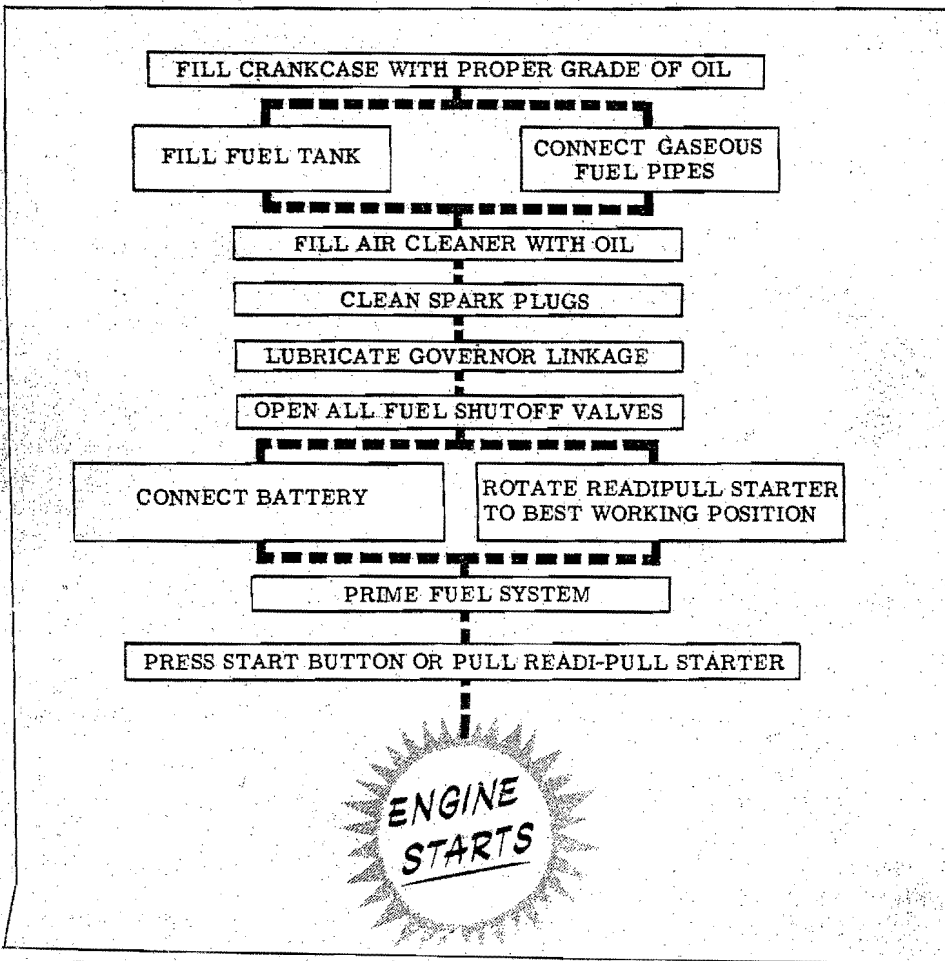


FIG. 26 - STEPS TO FOLLOW IN STARTING THE PLANT

Abnormal operating conditions are those elements and ambient temperatures to which a generating set may be exposed and which tend to shorten the lifetime of the component parts of the machine. Subzero temperatures, equatorial exposure, and extremely dusty atmosphere are typical examples. The following preventive maintenance should be performed to help avoid unnecessary breakdown of equipment.

### LOW TEMPERATURES

**LUBRICATION.** - Directions for the proper grade of oil to use in cold weather are given in the PREPARATION section.

When changing oil in cold weather, be sure to drain the oil only when the oil is warm from running.

If an unexpected drop in the temperature causes oil in the crankcase to become too thick to run freely from the oil drain, do not attempt to start the plant. If the plant is started when the oil is congealed, serious damage may result from improper lubrication. Remove the plant to a warm location, or apply heat externally until the oil is sufficiently warm.

**FUEL.** - Fresh winter grade, automotive type gasoline is an aid to starting in cold weather. Premium highly-leaded gasoline should not be used. Keep gasoline supplies free of moisture condensation. Leave room in the fuel tank to compensate for expansion.

**AIR CLEANER.** - The oil in the air cleaner should be the same grade as that used in the crankcase. If frost forms in the air cleaner and restricts the flow of air, empty the air cleaner oil cup and run the plant with the air cleaner dry. Refill the cup when temperature conditions again permit the use of oil in the normal manner.

**IGNITION.** - Cold weather starting is aided by a properly serviced ignition system. See that the ignition breaker points are clean and properly adjusted. Clean and adjust the spark plugs.

**BATTERY.** - If the plant uses starting batteries, keep the batteries in a well charged condition. A discharged battery may freeze at 20°F. A fully charged battery will not freeze at -90°F. If the plant is to remain in a cold location during an extended shut-down period, store the battery in a warm place. Give the battery a freshening charge each 30 days.

**ELECTRIC CHOKE.** - It may be necessary to readjust the electric choke on remote type plants for easier starting at lower ambient temperatures. Refer to the ADJUSTMENTS section.

**COOLING.** - The flow of air to the engine may be partially obstructed to keep the engine at operating temperature, if desired. However, use extreme care to avoid overheating.

## HIGH TEMPERATURES

**LUBRICATION.** - In temperatures above 90° (32°C.) for continuous operation use SAE number 50 oil. Keep the oil level close to the full level, and change the oil at least every 100 operating hours.

**COOLING.** - The engine and generator of this plant depend upon a constant supply of fresh air for proper cooling. See that nothing obstructs the circulation of air to and around the plant. Keep cooling fins clean and unobstructed. Make sure that the blower housing and cylinder air housings are properly in place and are undamaged. Keep the ignition timing properly adjusted.

**BATTERY PREPARATION FOR REMOTE START AC PLANT.** - For a usual plant installation, follow the instructions for Batteries under INSTALLATION. However, standard automotive type batteries will self-discharge rapidly when installed where the ambient temperature is consistently above 90° F., such as in a boiler room. Battery life is considerably shorter under such high temperature conditions. To lengthen battery life, reduce the electrolyte from a normal 1.275 specific gravity reading at full charge, to a 1.225 reading. Attach a tag to the battery, noting that the specific gravity has been reduced.

The cranking power of the battery is somewhat reduced when its electrolyte is diluted for longer life, but if the temperature is consistently high the reduced power will not be noticed.

1. Fully charge the battery. DO NOT BRING AN OPEN FLAME OR BURNING CIGARETTE NEAR THE BATTERIES ON CHARGE BECAUSE THE GAS RELEASED DURING CHARGING IS VERY FLAMMABLE.
2. While battery is on charge, use a hydrometer or filler bulb to siphon off all of the electrolyte above the plates in each cell. Do not attempt to pour off!! Dispose of the removed electrolyte. AVOID SKIN OR CLOTHING CONTACT WITH ELECTROLYTE.
3. Fill each cell with pure distilled water.
4. Recharge the batteries for one hour at a 4 to 6 ampere rate.
5. Use a reliable battery hydrometer, to test each cell. If the specific gravity is above 1.225, repeat steps number 2, 3, and 4 until the highest specific gravity 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

CLEANLINESS. - Keep the engine as clean as practicable. Service the air cleaner as frequently as conditions require. Keep oil and gasoline supplies in air tight containers. Do not allow cooling fins of cylinders or cylinder heads to become dirty or obstructed. Keep the generator commutator, brushes, and brush guides clean.

LUBRICATION. - Change the crankcase oil every 50 operating hours, instead of every 100 operating hours, during severely dusty operating conditions.

# Important !

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

MODEL & SPEC. NO.

SERIAL NO.

The nameplate contains the following fields and labels:

- MODEL & SPEC. NO.
- SERIAL NO.
- A.C. VOLTS
- KVA
- PHASES
- D.C. VOLTS
- AMPS
- RATED SPEED
- RATED EFFICIENCY
- D.W. GRACE & SONS, INC.

Follow a definite schedule of inspection and servicing to assure the best performance and long life of the plant. Service periods outlined below are for average service and normal operating conditions. Under unusual service or abnormal operating conditions, service the plant more frequently. Keep a record of the hours the plant is operated each day to assure servicing at the proper time.

### DAILY SERVICE

If the plant is operated more than 8 hours daily, perform the following services each 8 hours of operation.

**FUEL.** - Check the fuel supply often enough to avoid running out of fuel.

**NEVER FILL THE FUEL TANK WHILE THE PLANT IS RUNNING.** Use clean, fresh, regular automotive type gasoline of at least 68 octane rating. Use of a highly leaded premium grade of gasoline is not recommended.

**CRANKCASE OIL LEVEL.** - Remove the oil fill cap and check the crankcase oil level. Add oil as necessary to keep the oil level at the full mark on the gauge. Recommended grades of oil are given under **PREPARATION**. Avoid overfilling which will allow the connecting rod to strike the oil and cause oil foaming which interferes with efficient lubrication.

The oil fill cap gasket must always be in good condition and the cap must always be securely tightened in place. Air leakage into the crankcase at this point will cause oil carry-over at the breather, excessive oil consumption and possible oil leakage around the seals.

**AIR CLEANER.** - Turn the thumb screw, located at the bottom of the air cleaner cup, out as far as it will go and remove the cup. Add oil as necessary to raise the level to the indicated level with oil of the same SAE number as used in the engine crankcase, except as instructed under **ABNORMAL OPERATING CONDITIONS**.

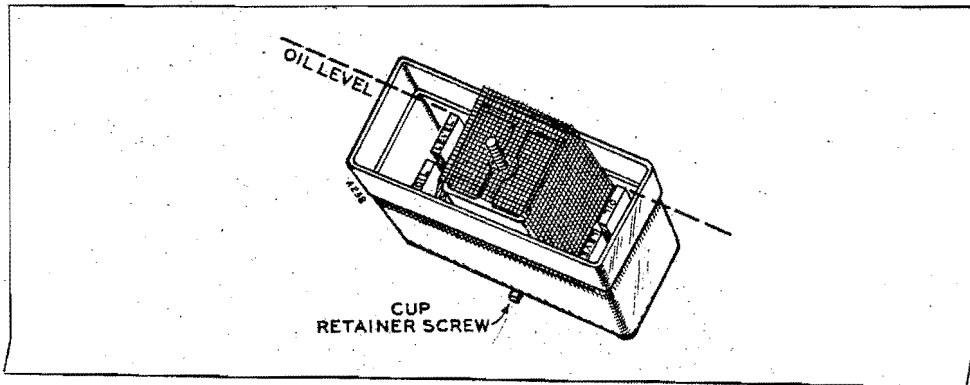


FIG. 27 - AIR CLEANER SERVICE



**CLEANING.** - A clean plant will give more satisfactory service. Wipe off dirt and any spilled oil.

### BI-WEEKLY SERVICE

If the plant is operated more than 50 hours weekly, perform the following services each 100 hours of service.

**CRANKCASE.** - If using diluted oil, or highly leaded gasoline, change the crankcase oil each 50 hours of operation. Under normal conditions and when using oil which is not diluted, change the crankcase oil each 100 hours of operation. Do not drain the oil when the plant has been standing idle. Run the plant until the oil is thoroughly warmed up, then stop the plant and drain the oil.

**AIR CLEANER.** - First remove the air cleaner oil cup, then remove the air cleaner from the engine and thoroughly clean them in gasoline or other suitable solvent. Allow the element to dry or dry it with compressed air before reinstalling it. Refill the cup to the level shown in the cup with oil of the same grade used in the engine crankcase except as instructed under **ABNORMAL OPERATING CONDITIONS.**

**GOVERNOR LINKAGE.** - Put a drop or two of lubricating oil at the point where the link engages the carburetor throttle arm.

Lubricate the governor arm ball joint with a dry type lubricant such as powdered graphite to assure best performance and longest life of the ball joint. If graphite is not available, use a light non-gummy oil.

**SPARK PLUGS.** - Clean the spark plugs and reset the gap as given in the Table of Clearances. Test the plug under compression on a plug testing machine, if one is available. Replace a defective plug with a new one.

**BATTERY.** - If the plant uses a starting battery, keep the connections tight and clean. Keep the electrolyte at the proper level above the separators by adding clean water. Distilled water is recommended for use in batteries. If distilled water is not obtainable, use clean soft water such as filtered rain water. Do not use water which contains alkali or minerals. Use a hydrometer to check the charge condition before adding water. In freezing weather, add water only before running the plant, to assure mixing the water with the electrolyte.

**DOLLY WHEELS.** - The bearings of some of the dolly wheels are lubricated through the Zerk fittings on the hubs. Use an approved wheel bearing lubricant. One or two shots from a high pressure gun will usually be sufficient.

## MONTHLY SERVICE

If the plant is operated more than 200 hours monthly, perform the following services each 200 hours of operation.

**FUEL SYSTEM.** - On plants with a separate fuel tank, drain the fuel tank and remove the shut-off valve and filter assembly. Carefully clean the filter screen. Tighten connections well when reassembling. Empty the fuel filter bowl of any sediment which may have accumulated.

**BREAKER POINTS.** - Remove the breaker box cover and inspect the breaker points. If they appear to be too badly burned or pitted, discard them and install a new set. Dress the old points with a fine stone providing they still appear servicable.

Adjust the breaker point gap to 0.020 inch at full separation after dressing the points or changing them. Place a drop of light lubricating oil on the breaker arm pivot after installing new points.

The ignition condenser is faulty and should be replaced if the following conditions persist: (1) Excessive arcing at the breaker points; (2) Breaker points continually burn over; (3) Yellow colored spark at the points.

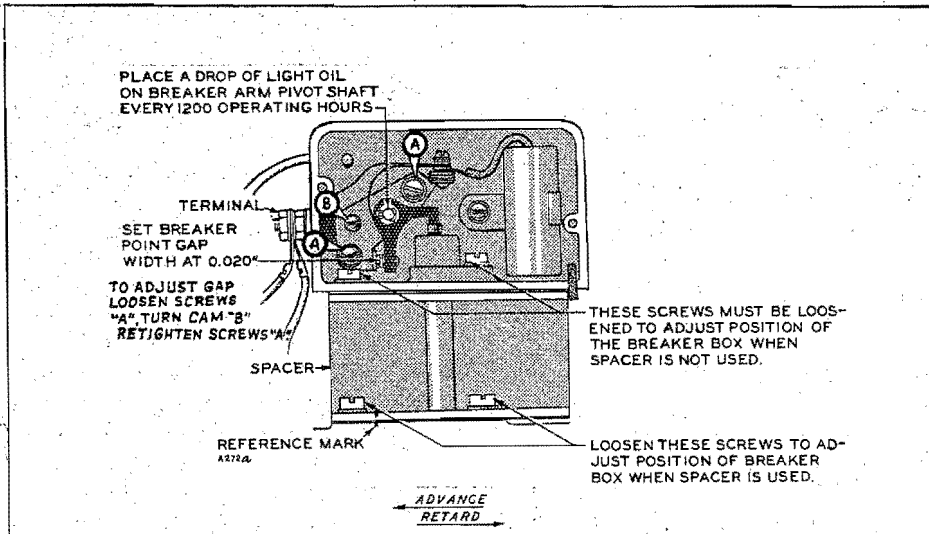


FIG. 28 - SERVICING THE BREAKER POINTS

**EXHAUST SYSTEM.** - Inspect all exhaust line connections carefully. Make any necessary repairs or replacements.

**CARBON REMOVAL.** - Regular removal of carbon deposits from the combustion chamber helps to keep engine efficiency high. The frequency with which it is advisable to remove carbon will vary considerably with the type of fuel used, the type of oil used, and operating conditions. Use of highly leaded gasoline necessitates frequent removal of carbon and lead deposits from the cylinder head, top of piston and valves, and top surface of the cylinder block.

**VALVE GRINDING.** - Valve grinding is a service that should be done if your plant is to continue running efficiently. Whenever the engine begins to lose power or to use more fuel or oil than it normally does, check the compression to determine the need of repairs.

Check the compression of each cylinder with a reliable compression gauge while the engine is still warm and as soon after stopping the engine as you can. The compression of each cylinder in a new engine at sea level is about 90 lbs. at hand cranking (105 lbs. elec. cranking) speed. Compression readings of the cylinders should be within 10 lbs. of each other and high enough to assure no loss of power. A low compression reading may point to a poor valve condition, worn or sticking piston rings, worn piston ring grooves, or worn cylinder walls. An excessively high compression reading may point to a heavy carbon formation within the cylinders.

If readings indicate a compression loss, remove the spark plugs and squirt only enough SAE number 50 oil into each cylinder to seal the rings. Take the compression readings again. If the readings remain about the same, the valves probably need servicing. However, if the readings have increased quite a bit, the valves are probably in good condition.

Loss of compression may be due to worn or sticking piston rings, worn piston ring grooves, or worn cylinder walls. Follow instructions given in the Maintenance and Repair section when making repairs.

**CRANKCASE BREATHER VALVE.** - If the engine begins to leak oil, the valve in the breather tube may be sticking. Lift the rubber cap from the breather tube. Then lift out the valve and inspect it. Frequently the breather valve (check valve) will lift off with and remain inside the rubber cap. Pry it out. First soak then wash the valve in kerosene or suitable solvent so that the disc will work freely. Run the engine and hold the valve assembly in place to prove it opens and closes. Replace a faulty valve with a new one. If the metal mesh type baffle, used in the breather tube of later engines, is completely restricted by sludge, etc., lift it out with a hooked wire, clean and reinstall it or a new one, leaving only 2-1/4" of empty space in the top of the breather tube. Avoid crushing the baffle or allowing shreds to fall into the crankcase. An internal retainer ring stops the baffle from falling through. Reassemble the valve as illustrated.

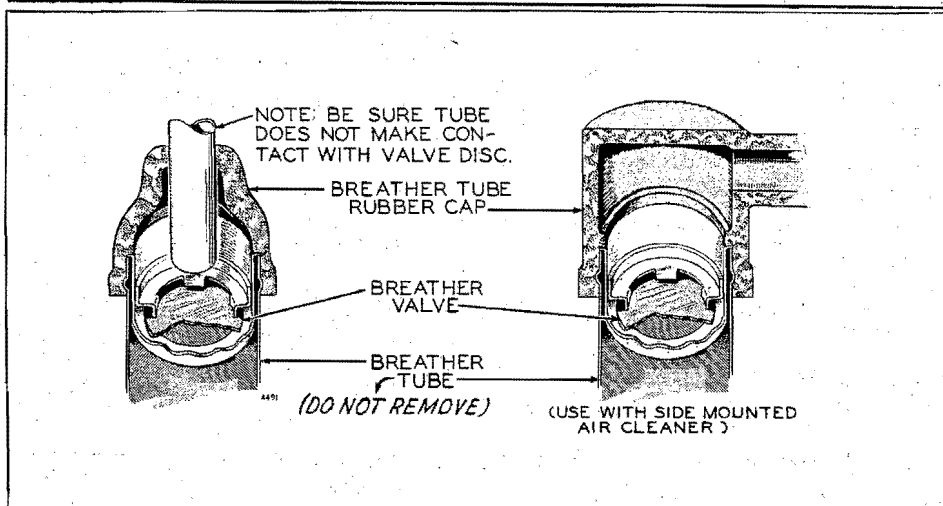


FIG. 29 -SERVICING THE CRANKCASE BREATHER VALVE

**GENERATOR.** - Check the condition of the commutator (and collector rings on AC plants). Clean the brush contact surface with a dry, lint free cloth. If heavily coated, or slightly rough, sand smooth with #00 sandpaper. Do not use emery or carborundum cloth or paper.

Install new commutator brushes and other rectangular brushes when the old ones are worn to  $5/8$ " or less in length.

See that all connections are tight. Remove carbon dust from the generator.

**NEUTRAL BRUSH POSITION.** - Brushes will arc excessively and brush wear will be rapid if the brush rig is moved from its original "neutral" position as marked at the factory.

#### CAUTION

If a new armature or brush rig is installed, the "neutral brush position" must be re-located and re-marked. Neutral brush position is that point at which the least arcing of the brushes occurs. If a voltmeter is available, the brush rig should be set at the point where highest voltage is generated. If a voltmeter is not available, set the brush rig at the point where the brushes show the least arcing.

**GENERATOR BEARING.** - The generator bearing is pre-lubricated and sealed. It requires no periodic servicing during its service life.

**GENERAL.** - Generating plant satisfactory performance is dependent upon correct adjustments. Adjustments can not fully compensate for troubles such as low engine power due to engine condition.

**GOVERNOR AND BOOSTER ADJUSTMENT.** - The governor and booster controls the speed of the engine. A speed adjustment includes adjusting both devices. Refer to the Governor and Booster illustrations.

Carefully study the related subjects in the following paragraphs and check each point in the order given before attempting adjustments on the governor:

1. **GENERAL.** - Before making final governor adjustments, run the plant about 15 minutes under light load to reach normal operating temperature. (If the governor is completely out of adjustment, make a preliminary adjustment at no load to first attain a safe voltage operating range.)

On a c generating plants, engine speed determines the output voltage and current frequency of the generator. By increasing the engine speed, generator voltage and frequency is increased, and by decreasing the engine speed, generator voltage and frequency is decreased. An accurate voltmeter or frequency meter (preferably both) should be connected to the generator output in order to correctly adjust the governor of the a c plant. A small speed drop not noticable without instruments will result in an objectionable voltage drop. The engine speed can be checked with a tachometer.

The governor arm is fastened to a shaft which extends from the gear cover, and is connected by a ball joint and link to the carburetor throttle arm. Flyballs behind the cup on the camshaft gear, actuate the governor arm. If the carburetor has been removed, or the governor disassembled, it may be necessary to readjust the governor.

The speed booster is a separate auxiliary device which supplements the function of the governor. The speed booster is adjusted to increase governor action as the load on the generator is increased. The booster serves to maintain or increase the speed at the higher loads. This results in more nearly constant output voltage.

The booster is mounted on the intake manifold and is operated by engine vacuum through a small passage in the manifold. When the plant is operating at about half load or less, the engine vacuum is sufficient to cause the diaphragm to overcome the tension of the internal booster spring. Under these conditions, there is no tension on the booster external spring and the booster does not affect the governor operation.

As the load on the plant is increased, the engine vacuum becomes less, and booster internal spring tension overcomes the pull of the diaphragm, and tension is put on the booster external spring. The tension on the external spring "helps" the regular governor spring in its function, thus causing a slight increase in engine speed as the load is increased.

A binding in the bearings of the governor shaft, in the ball joint, or in the carburetor throttle assembly will cause erratic governor action or alternate increase and decrease in speed (hunting). A lean carburetor adjustment may also cause hunting. Springs of all kinds have a tendency to lose their calibrated tension through fatigue after long usage. If all governor and carburetor adjustments are properly made, and the governor action is still erratic, replacing the spring with a new one and resetting the adjustments will usually correct the trouble.

2. STEPS TO FOLLOW. - This gives the procedure only briefly. Refer to the details on each subject herein.

- a. Adjust the carburetor main jet for the best fuel mixture while operating the plant with a full rated load connected.
- b. Adjust the carburetor idle needle with no load connected.
- c. Adjust the length of the governor linkage.
- d. Check the governor linkage and throttle shaft for binding or excessive looseness.
- e. Adjust the governor spring tension for rated speed at no load operation with booster disconnected (or held inoperative).
- f. Adjust the governor sensitivity.
- g. Recheck the speed adjustment.
- h. Set the carburetor throttle stop screw.
- i. Set the vacuum speed-booster.

3. LINKAGE. - The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle shaft and lever is adjusted by rotating the ball joint. Adjust this length so that with the engine stopped and tension on the governor spring, the stop on the carburetor throttle shaft just contacts the underside of the carburetor bowl, as illustrated. This setting allows immediate control by the governor after starting. It also synchronizes the travel of the governor arm and the throttle shaft.

4. SPEED ADJUSTMENT. - With the warmed-up plant operating at no load, and with the booster external spring disconnected (or otherwise held inactive), adjust the tension of the governor spring. Refer the Voltage Chart and the Speed Chart and select the column which corresponds to the nameplate of the plant in question. Turn the speed adjusting nut to obtain a voltage and speed reading within the limits shown.

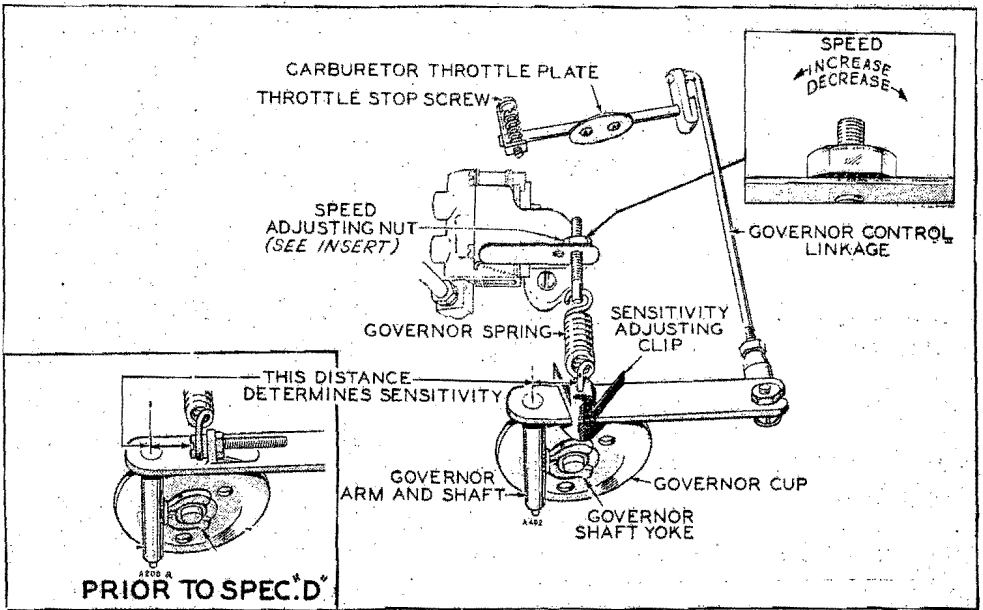


FIG. 30 - GOVERNOR ADJUSTMENTS

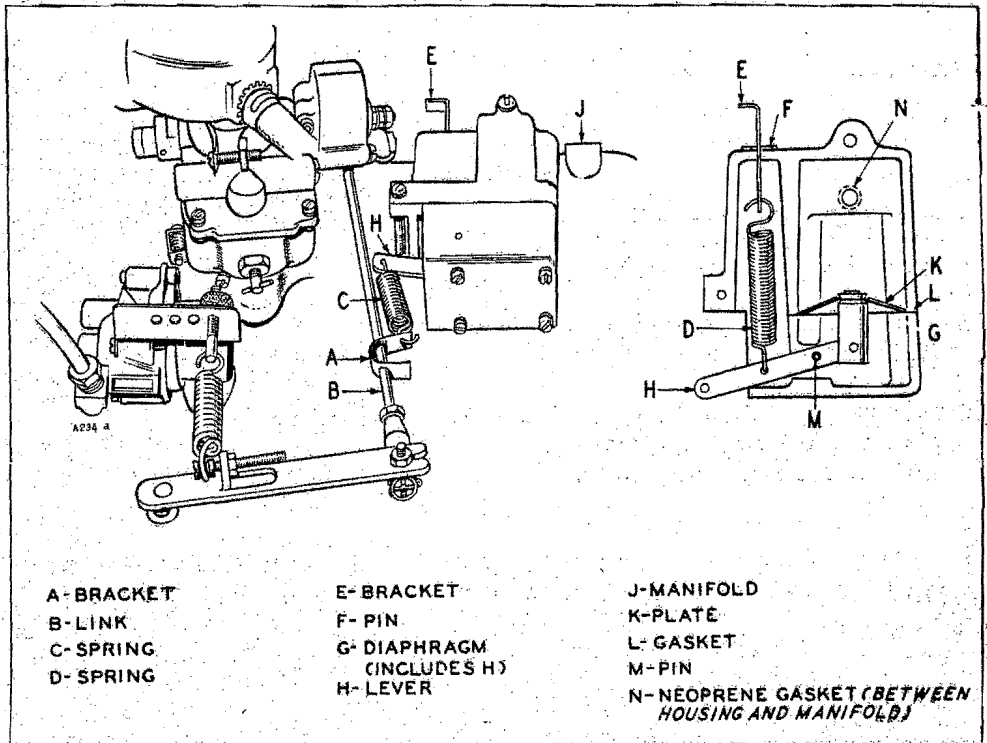


FIG. 31 - SPEED-BOOSTER ADJUSTMENTS

## VOLTAGE CHART FOR CHECKING GOVERNOR REGULATION →

DIRECT CURRENT TYPES OF PLANTS →	115 VOLT DC	250 VOLT DC MAGNET SERVICE
Maximum No Load Volts	120	270
Minimum Full Load Volts Without Booster	110	240
Maximum Voltage Drop From No Load to Full Load	10	30
Preferred Voltage Regulation, No Load to Full Load	120-110	265-245
Preferred Voltage Spread	—	20

## SPEED CHART FOR CHECKING GOVERNOR REGULATION →

DIRECT CURRENT TYPES OF PLANTS →	115 VOLT DC	250 VOLT MAGNET SERVICE
Maximum No Load Speed RPM (Revolutions Per Minute)	2000 ★	2000 †
Minimum Full Load Speed Without Booster RPM (Revolutions Per Minute)	1800 ★	1800 †
Maximum Speed Drop From No Load Operation to Full Load Operation RPM (Revolutions Per Minute)	200	200

Note ★ - For models prior to Spec "D", speed is 2400-2700 rpm.

Note † - For models prior to Spec "D", speed is 2500-2750 rpm.



VOLTAGE CHART FOR CHECKING GOVERNOR REGULATION →

ALTERNATING CURRENT TYPES OF PLANTS →	120 VOLT, 1 PHASE, 2 WIRE OR 120/240 V., 1 PHASE, 3 WIRE	240 VOLT, 1 PHASE, 2 WIRE OR 240 VOLT, 3 PHASE, 3 WIRE
NOTE: Output rating is at UNITY power factor load.		
Maximum No Load Volts	126	252
Minimum Full Load Volts Without Booster	110	220
Maximum Voltage Drop From No Load Operation to Full Load Operation	16	32
Preferred Voltage Regulation, No Load to Full Load Operation	118-114	236-228
Preferred Voltage Spread	4	8

SPEED CHART FOR CHECKING GOVERNOR REGULATION →

ALTERNATING CURRENT TYPES OF PLANTS →	FOR ALL 60 CYCLE PLANTS	FOR ALL 50 CYCLE PLANTS
Maximum No Load Speed RPM (Revolutions Per Minute) Cycles (Current Frequency)	1920 64	1710 57
Minimum Full Load Speed Without Booster RPM (Revolutions Per Minute) Cycles (Current Frequency)	1710 57	1500 50
Maximum Speed Drop From No Load Operation to Full Load Operation RPM (Revolutions Per Minute) Cycles (Current Frequency)	90 3	90 3
Preferred Speed Regulation, No Load to Full Load Operation RPM (Revolutions Per Minute) Cycles (Current Frequency)	1830-1770 61-59	1590-1530 53-51
Preferred Speed Spread RPM (Revolutions Per Minute) Cycles (Current Frequency)	60 2	60 2

5. **SENSITIVITY ADJUSTMENT.** - Refer to the Governor Adjustment illustration, and to the Voltage and Speed Charts. Check the voltage and speed, first with no load connected and again with a full load. Adjust the sensitivity so as to give the closest regulation (least speed and voltage difference between no load and full load) without causing a hunting condition.

To increase sensitivity (closer regulation), shift the adjusting clip toward the governor shaft. On earlier models, prior to spec. D, turn the adjusting stud counterclockwise. An adjustment for too much sensitivity will cause alternate increase and decrease of engine speed (hunting).

To decrease sensitivity, shift the adjusting clip toward the outer end of the governor arm. On earlier models turn the adjusting stud clockwise. Too little sensitivity will result in too much difference in speed between no load and full load conditions.

Any change in the sensitivity adjustment usually requires a compensating speed (spring tension) adjustment.

6. **THROTTLE STOP SCREW.** - The throttle lever stop screw should be set at  $1/32$  inch distance from the manifold when the engine is operating with no load connected. Refer to the illustration, Throttle Stop Lever Position.

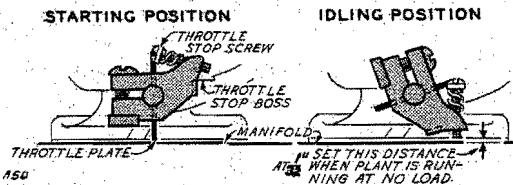


FIG. 32 - THROTTLE STOP LEVER POSITION

7. **SPEED-BOOSTER ADJUSTMENT.** - After satisfactory performance under various loads has been attained by governor adjustments without the booster, the booster can be connected. Connect the booster external spring to the bracket on the governor link (rod). With the plant operating at no load, slide the bracket on the governor link just to the position where there is no tension on the external spring.

Apply a full rated electrical load to the generator. The output voltage should stabilize at nearly the same reading for full load as for no load operation. The speed may remain about the same or increase when the load is applied, resulting in a frequency 1 or 2 cycles HIGHER THAN the no load frequency. (1 cycle is equal to 30 rpm for a 4 pole generator.) If the rise in frequency is more than 2 cycles, lessen the inter-

nal spring tension. If there is a drop in the frequency, increase the booster internal spring tension. To increase the tension, pull out on the spring bracket, and move the pin to a different hole.

With the booster disconnected, a maximum drop of 3 cycles from no load to full load is normal. With the booster in operation a maximum INCREASE of 2 cycles from no load to full load is normal. A drop of 1 cycle at 1/4 load is permissible, giving an over all spread of 3 cycles, maximum.

The effect of the booster is limited by the general condition of the engine. The booster can not compensate for a loss in engine vacuum caused by leaky valves, worn piston rings, etc.

The booster requires little maintenance other than using a fine wire to clean the small hole in the short vacuum tube which fits into the hole in the top of the engine intake manifold. Do not enlarge this hole. If there is tension on the external spring, when the plant is operating at no load or light load, it may be due to improper adjustment, restricted hole in the small vacuum tube, or a leak in the booster diaphragm or gasket.

**OIL PRESSURE RELIEF VALVE ADJUSTMENT.** - The oil pressure of the plant can be easily adjusted by means of the slotted stud and locknut located just below the governor linkage, as illustrated. Oil pressure reading when the plant is thoroughly warmed up is from 25 to 40 pounds. To increase oil pressure, loosen the locknut and turn the stud in. To decrease oil pressure, loosen the locknut and turn the stud out. Be sure to tighten the locknut securely after making an adjustment.

Low oil pressure may point to worn or poorly adjusted main or connecting rod bearings, a weak or broken by-pass spring, a defective gauge or a poor adjustment. Check the oil pressure gauge before making any other test, it may be defective.

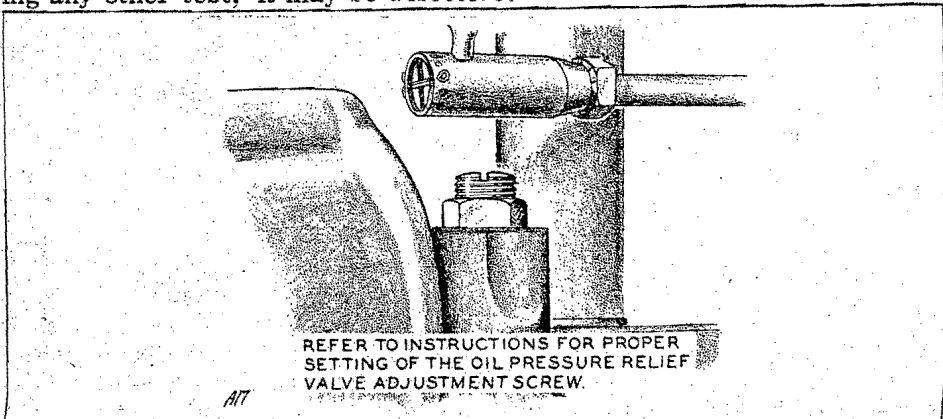


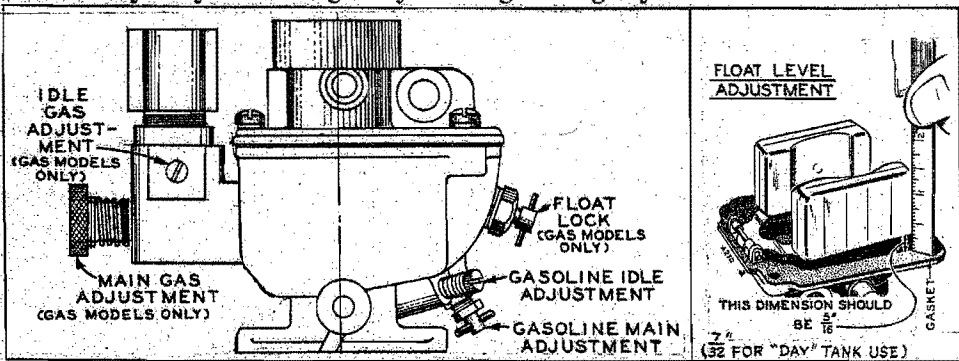
FIG. 33 - OIL PRESSURE RELIEF VALVE ADJUSTMENT

**CARBURETOR ADJUSTMENTS, GASOLINE.** - The carburetor has adjustable main and idle needle valves. Refer to the illustration, Carburetor Adjustments. During the test run of a new generating plant, the factory performs carburetor adjustments which under normal circumstances should not be disturbed. The carburetor is simple in construction and normally needs little attention other than a periodic cleaning, as instructed under **MAINTENANCE AND REPAIR**.

The correct setting for the main jet needle gives the best stability at full rated load operation. The main needle setting will be about 1-3/4 turns open.

The correct setting for the idle needle gives the best stability at no load operation. The idle needle setting will be about 1/2 to 1 turn open.

Before tampering with jet settings, mark the existing adjustment or count the number of turns the needle was backed out from its seat. NEVER force the needle against its seat more than "finger tight" because they may be damaged by seating too tightly.



**FIG. 34 - CARBURETOR ADJUSTMENTS**

If the carburetor is entirely out of adjustment, open the main needle about 2 turns and the idle needle about 1 turn, to permit starting. Make final adjustments after the plant reaches normal operating temperature.

To make the final adjustment, slowly turn the main needle inward (clockwise) for leaner mixture, until the plant begins to lose speed, or the voltage drops. Then turn the needle outward (counterclockwise) slowly to the point where the plant will carry the rated full load. Check the operation at various loads. If there is a tendency to hunt (alternately increase and decrease speed) at any load, turn the adjusting needle out for richer fuel mixture, until the hunt is corrected, but do not turn the adjusting needle out more than 1/2 turn beyond the point where maximum generator output is obtained. Make the final adjustment of the idle needle while the plant is warm and operating at no load. Slowly turn the idle adjusting needle inward (clockwise) until the plant loses speed from

lack of fuel. Then turn the needle slowly outward until the plant runs smoothly.

A substantial change in a carburetor adjustment requires a compensating adjustment of the governor speed.

The throttle idle stop screw should be adjusted to clear the manifold by  $1/32''$  when the plant is operating at desired speed and no load condition. This setting helps prevent hunting during changes in load.

**CARBURETOR ADJUSTMENTS, GAS FUEL.** - When operating on gas fuel, follow the procedure given for gasoline fuel, using the gas fuel adjusting screws. Always be sure the carburetor choke is locked in its wide open position.

**ELECTRIC CHOKE ADJUSTMENT.** - The a c remote control type plant is equipped with a thermal action electric choke. A thermostatic coil (bi-metal) engages the choke shaft and is set at the factory to give the correct choking action for average temperature conditions. When the plant starts, current from the generator is supplied to a small heating element in the choke cover. This heating element causes the thermal coil to wind tighter and turn the choke shaft, gradually opening the choke as the plant warms up. When the plant is stopped the thermal coil cools off, causing the choke shaft to return to the correct position for the next start.

The thermal coil (bi-metal) is installed in the choke body in a counterclockwise direction as viewed starting from the inside turn. The thermal coil tends to coil tighter when heated, expands in cooling. An inspection hole in the circumference of the choke bracket (housing) permits inspection during assembly to see that the fork of the choke cover straddles and holds the loop in the outer coil of the bi-metal.

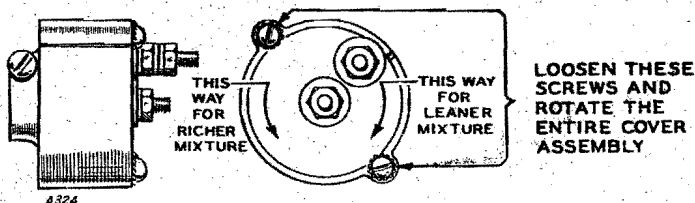


FIG. 35 - ELECTRIC CHOKE ADJUSTMENT

Extreme temperature may require a slight readjustment of the choke setting. To adjust the choke, loosen the two screws which retain the choke cover to the choke body. For less choking action, turn the cover assembly slightly in a clockwise direction, looking at the thermal unit end. For more choking action, turn the cover assembly slightly in a counterclockwise direction.

Approximate settings for the choke are given in the following table.

<u>TEMPERATURE (Degrees Fahrenheit)</u>	<u>POSITION OF CHOKE PLATE</u>
58	Closed
66	1/4 Open
72	1/2 Open
76	3/4 Open
82	Wide Open

Successive trials at various positions are necessary to set the choke at the best position at temperatures below 32°F.

If the choke does not operate properly, check to see that the heating element heats properly. There must be no binding of the choke shaft or thermal coil. Be sure to retighten the lock screws after any adjustment.

A knob at the opposite end of the choke shaft, may be used to manually operate the choke in the event the electric element burns out or the choke does not operate for any reason. Turn the knob in the direction shown on the knob. If electric choke failure occurs, the choke will remain at closed position. By removing the thermostatic coil, to permit an emergency run, the air stream will hold the choke at open position.

If the engine starts between 6 and 15 seconds of cranking, the choke is properly adjusted.

If the engine starts sooner than 6 seconds of cranking, and runs roughly after a minute or two of operation, the choke is set too rich.

If the engine starts after 15 seconds of cranking and assuming that fuel, ignition and compression are adequate, but the engine sputters, spits or stops before it warms up, then the choke is set too lean.

GENERAL. - Refer to the Service Diagnosis section for assistance in locating and correcting troubles which may occur. If a major repair or overhaul becomes necessary, the engine should be carefully checked and necessary repairs made by a competent mechanic. Major generator repairs should be made by a competent electrician. Maintain factory limits and clearances as given in the Table of Clearances, replacing worn parts when necessary. Avoid accidental shorts by disconnecting the battery when servicing control parts.

TABLE OF CLEARANCES

All clearances given at room temperature of 70°F.

	MINIMUM	MAXIMUM
Intake Valve Tappet Clearance at 70°F.	0.015"	0.017"
Exhaust Valve Tappet Clearance at 70°F.	0.015"	0.017"
Intake Valve Stem Clearance in Guide	0.001"	0.0025"
Exhaust Valve Stem Clearance in Guide	0.0025"	0.004"
Valve Seat Width	1/32"	3/64"
Valve FACE Angle		44°
Valve SEAT Angle		45°
Valve Interference Angle		1°
Crankshaft Main Bearing Clearance -		
Aluminum Alloy, Flanged - Prior Spec "F"	0.002"	0.003"
"Bronze" Faced - Begin model Spec "F"	0.0025"	0.0035"
Crankshaft End Play	0.006"	0.012"
Camshaft Bearing Clearance	0.0015"	0.003"
Camshaft End Play	0.003"	
Connecting Rod Bearing Clearance		
(Alum. Rod)	0.002"	0.003"
Connecting Rod End Play	0.002"	0.016"
Timing Gear Backlash	0.002"	0.003"
Oil Pump Gear Backlash	0.002"	0.005"
Piston Clearance in Cylinder, Conformatric		
Type (measured at bottom of skirt)		
Interference	0.0005"	
Clearance		0.0015"
Piston Pin Clearance in Piston at 70°F.	Thumb Push Fit	
Piston Pin Clearance in Rod at 70°F.	0.0001"	0.0006"
Piston ring gap in cylinder	0.010"	0.023"
Breaker Point Gap at Full Separation		0.020"
Spark Plug Gap - For Gaseous Fuel		0.018"
Spark Plug Gap - For Gasoline Fuel		0.025"
Crankshaft Main Bearing Journal -Std. Size	1.9995"	2.000"
Crankshaft Rod Bearing Journal -Std. Size	1.6255"	1.6260"
Cylinder Bore - Standard Size	3.248"	3.249"

## ASSEMBLY TORQUES

Assembly torques as given here require the use of a torque wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts and screws often. Tighten as needed to prevent them from working loose.

## LB. FT. TORQUE

Cylinder Head Capscrews .....	25 to 30
Rear Bearing Plate Nuts .....	18 to 20
Connecting Rod Bolts .....	29 to 31
Flywheel Capscrew .....	40 to 45
Armature thru Stud and Nut .....	45 to 50
Other 5/16 inch Cylinder Block Studs and Nuts ..	10 to 12

## ENGINE

**CARBURETOR.** - Carburetor maintenance should consist of regular cleaning. Some types of gasoline have a tendency toward formation of gum deposits inside the carburetor. This gum formation can usually be removed by soaking in alcohol or acetone. A fine soft wire may be used to clean jets.

See that the float is not damaged. If necessary to reset the float level, use a small screw driver to bend the lip of the float. With the carburetor casting inverted and the float resting lightly against the needle in its seat, clearance between the bowl cover gasket and the free end of the float should be 5/16" (7/32" if a "DAY" reservoir tank is used).

Carburetor adjustments appear in the ADJUSTMENT section herein. Be sure the throttle assembly works freely. When reinstalling adjusting needles, do not force them into their seats.

**MAGNETO STATOR INSTALLATION.** - The magneto stator assembly is mounted on the gear cover and the flywheel must be removed to expose it. The stator has 2 pairs of mounting holes. The innermost holes give 19° spark advance as required for engines with speed range of 1500 to 2400 rpm. The outermost holes give 25° spark advance as required for engines with speed range of 2500 rpm and above. Connect the smaller coil lead (ground) to the stator mounting screw. Connect the stator larger lead to the insulated terminal on the blower housing which also connects to the ignition coil and breaker points. *Be sure the larger lead is held in place to prevent rubbing on the flywheel.*



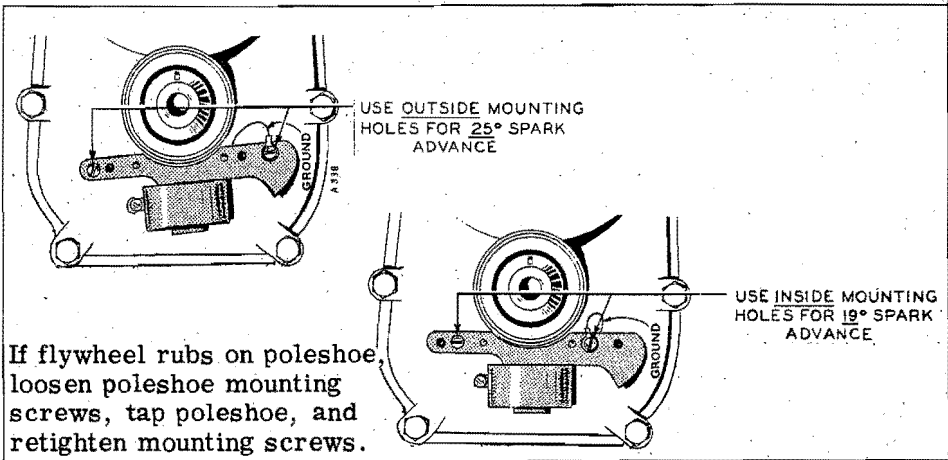


FIG. 36 - MAGNETO STATOR INSTALLATION

IGNITION COIL INSTALLATION. - Coil connections differ between magneto ignition plants and battery ignition plants. Refer to the illustration which applies. The ignition coil is grounded on magneto ignition plants but not grounded with battery ignition. The spark occurs at the build-up of magneto current and at the collapse of battery current.

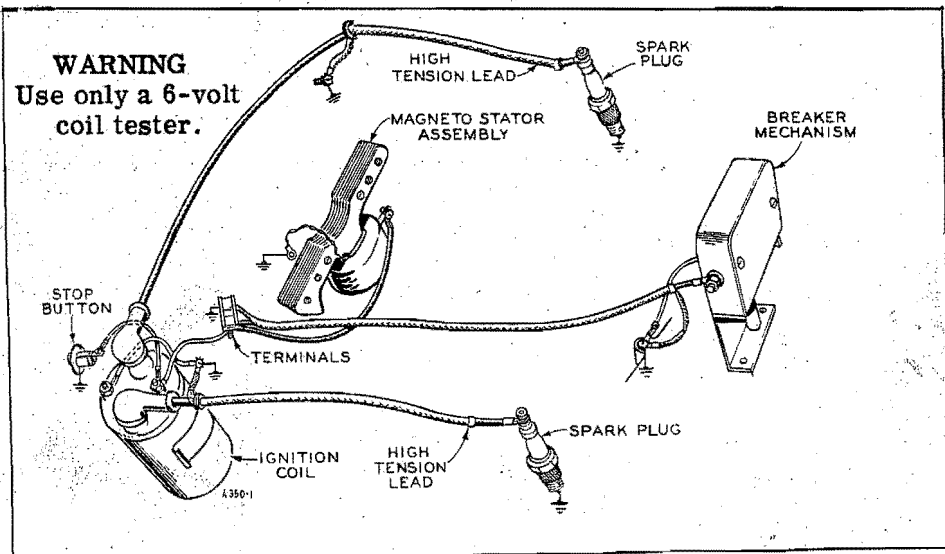


FIG. 37 - COIL INSTALLATION AND ELECTRICAL CIRCUIT FOR MAGNETO IGNITION

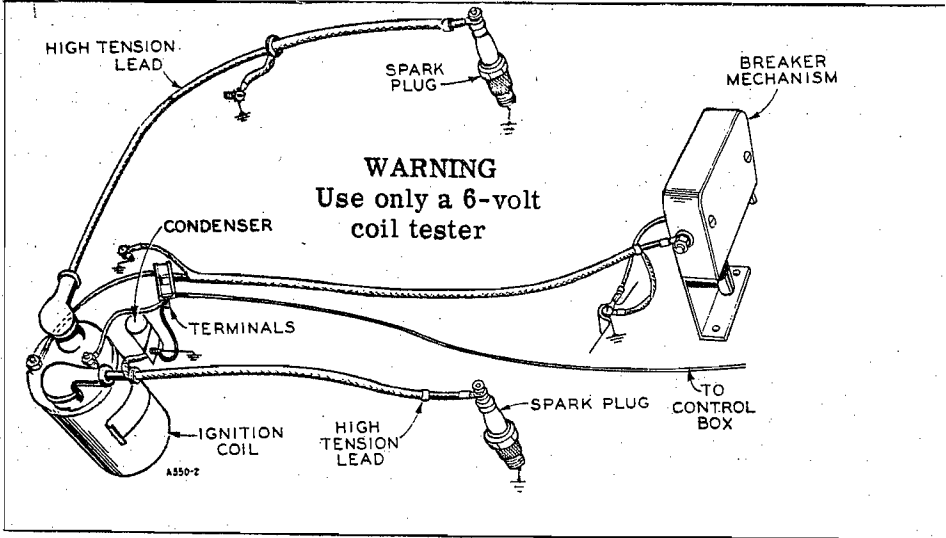


FIG. 38 - COIL INSTALLATION AND ELECTRICAL CIRCUIT FOR BATTERY IGNITION

**TIMING THE IGNITION.** - Ignition timing procedure is the same for manual-start type plants with magneto ignition as for remote-start type plants with 12 volt battery ignition.

The spark advance is  $19^{\circ}$  before top center for all models with engine speeds ranging from 1500 to 2400 rpm. Models with engine speeds of 2500 rpm and up use the  $25^{\circ}$  spark advance. The correct timing is stamped on the cylinder block near the breaker box.

Timing procedure follows:

1. Remove the cover from the breaker box. If the timing is very far off, attain an approximate setting by loosening the mounting screws and shifting the breaker box (and spacer if used) to align the witness marks on the cylinder block and breaker box (or spacer).
2. Crank the engine over slowly by hand in the direction of crankshaft rotation until the witness mark on the flywheel and the "TC" mark on the gear cover are exactly in line. See the illustration Ignition Timing.
3. Adjust the ignition breaker point gap width to 0.020 inch at full separation.

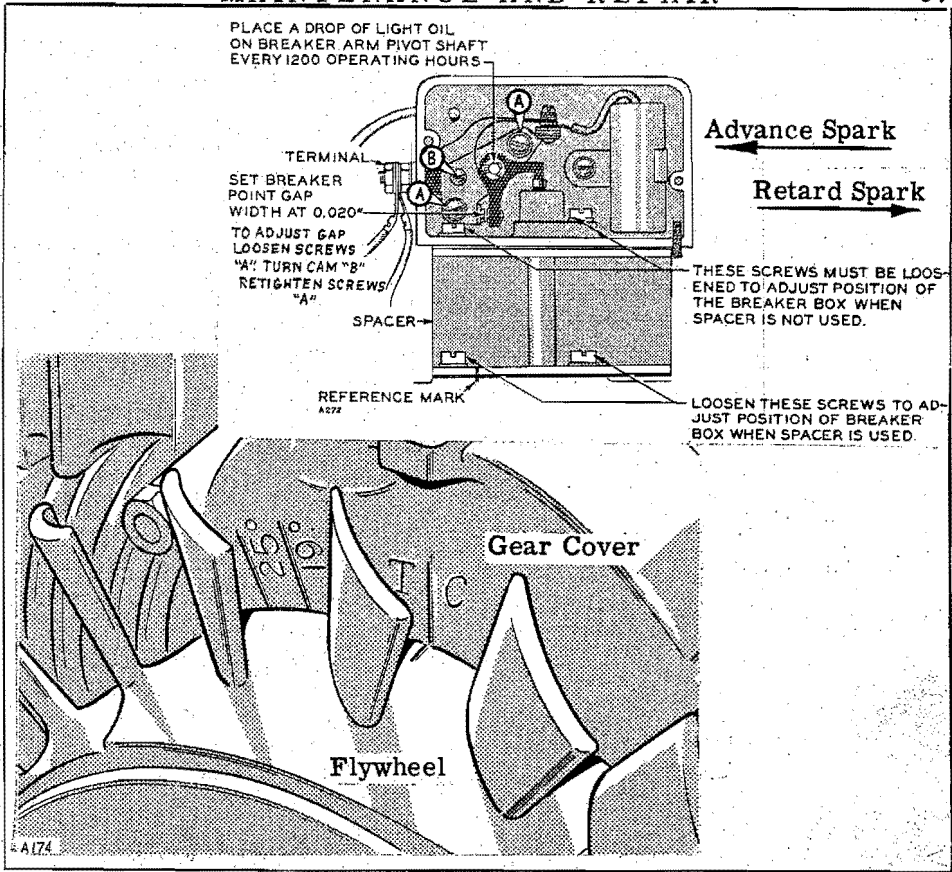


FIG. 39 - IGNITION TIMING

4. Turn the flywheel to the left, against crankshaft rotation, until the timing mark is about two inches past the 25° mark on the gear cover.
5. Turn the flywheel slowly to the right and note whether the ignition points just separate when the mark on the flywheel aligns with the correct degree mark (19° or 25°) on the gear cover. If the marks align as the points break, timing is correct. If they do not, loosen the breaker box mounting screws and shift the whole breaker box assembly slightly toward the air cleaner to retard the timing (points breaking too soon), or shift it slightly away from the air cleaner to advance the timing (points not breaking soon enough). Tighten the breaker box mounting screws securely after making an adjustment. Refer to the illustration, Ignition Timing.

To accurately check the time at which the spark occurs, an automotive type timing light may be used when the engine is running.

To accurately check the time at which the spark occurs when not running the engine, connect a continuity test lamp set across the ignition

breaker points. Touch one test prod to the breaker box terminal (to which the lead to the coil is connected), and touch the other test prod to a good ground on the engine. Turn the crankshaft against rotation (backwards) until the points close. Then slowly turn the crankshaft with rotation. The lamp should go out just as the points break.

6. Reinstall the breaker box cover.

**FLYWHEEL.** - To remove the flywheel turn the flywheel mounting screw outward about 2 turns. Use a screw driver behind the flywheel to take up the crankshaft end play. Then strike a sharp end-wise blow on the head of the capscrew with a heavy soft faced hammer to loosen. A suitable puller (with claws or with bolts to agree with flywheel) may be used to pull the flywheel.

Do not drop the flywheel. A broken fin will destroy the balance.

A magneto flywheel which has lost its magnetism can be remagnetized. The spark should jump a  $3/16$  inch gap with ease as tested by holding the spark plug wire away from a clean metal part of the engine while cranking.

**VALVE SERVICE.** - Properly seated valves are essential to good engine performance. The aluminum cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head, rap sharply on the edge with a soft faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. Valve locks are the split, tapered type, the smaller diameter of which must face toward the valve head. Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

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

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. *Valve faces should be finished in a machine to  $44^{\circ}$ . Valve seats should be ground with a  $45^{\circ}$  stone, and the width of the seat band should be  $1/32$  to  $3/64$  of an inch wide. Grind*

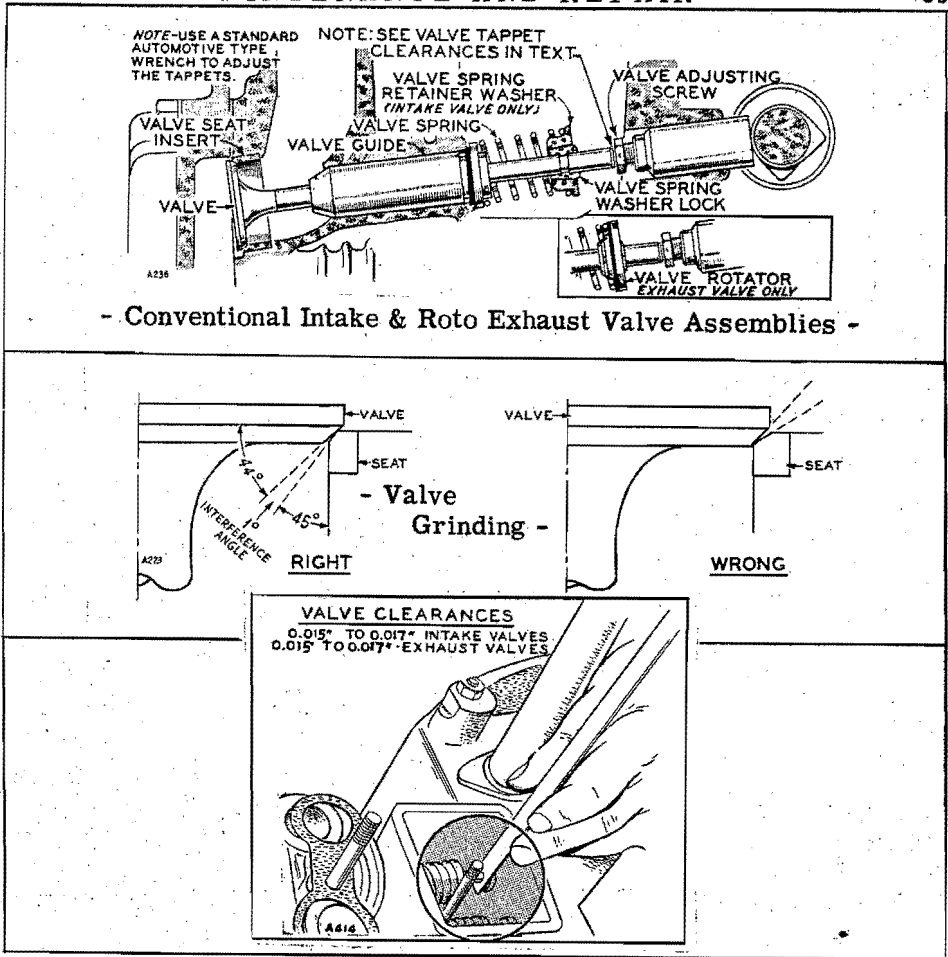


FIG. 40 - VALVE SERVICE

only enough to assure proper seating.

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

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance.

The positive type exhaust valve rotocaps serve to prolong valve life and need for valve service. When functioning properly the exhaust valve is rotated a fraction of a turn each time it opens. While at open position the valve can be rotated freely but in only one direction. Try it. If

rotocaps are faulty, install new rotocaps.

**TAPPET ADJUSTMENT.** - These plants are equipped with adjustable tappets. To make a valve adjustment, remove the valve covers. Crank the engine over slowly by hand until the left hand intake valve, when facing the flywheel, opens and closes. Continue about 1/4 turn until the mark on the flywheel and the "TC" mark on the gear cover are in line. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left hand cylinder. Clearances are shown in the Table of Clearances herein. For each valve the thinner gauge (minimum) should pass freely between the valve stem and valve tappet but the thicker gauge (maximum) should not. Refer to the illustration, Valve Service.

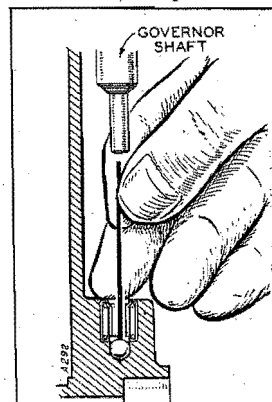
To correct the valve clearance, simply turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking and will stay where set.

If valve clearance can no longer be held within given limits, replace the valve.

To adjust the valves on the right hand cylinder, crank the engine over one complete revolution and again line up the mark on the flywheel and the "TC" mark on the gear cover. Then follow the adjustment given for the valves of the left hand cylinder.

**GEAR COVER.** - After removing the mounting screws, tap the gear cover gently with a soft faced hammer to loosen it.

When installing the gear cover, make sure that the pin in the gear cover engages the metal lined



IF FEELER WILL ENTER HOLE  $\frac{1}{2}$ " BALL HAS FALLEN OUT.

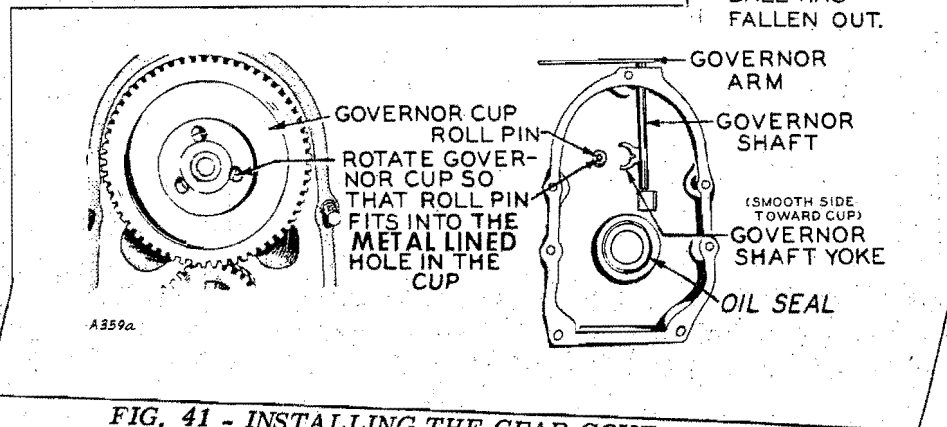


FIG. 41 - INSTALLING THE GEAR COVER

(smoothest) hole in the governor cup. Turn the governor cup so that the metal lined hole is at the 3 o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal. Adjust the roll (stop) pin to protrude to a point  $\frac{3}{4}$  inch from the cover's mounting surface.

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

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

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

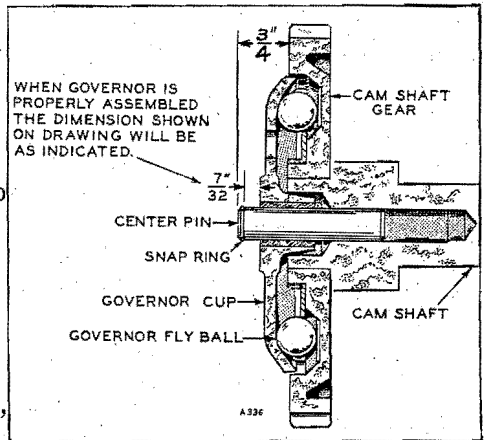


FIG. 42 - GOVERNOR CUP

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

**TIMING GEARS.** - If replacement of either the crankshaft gear or the camshaft gear becomes necessary, install both gears new, never one only. To remove the crankshaft gear, first remove the snap ring, then insert two long #10-32 steel screws into the tapped gear holes and tighten the screws alternately. As the screws are tightened, the screw ends will seat against the crankshaft shoulder and force the gear off the end of the crankshaft.

the gear off the end of the crankshaft.

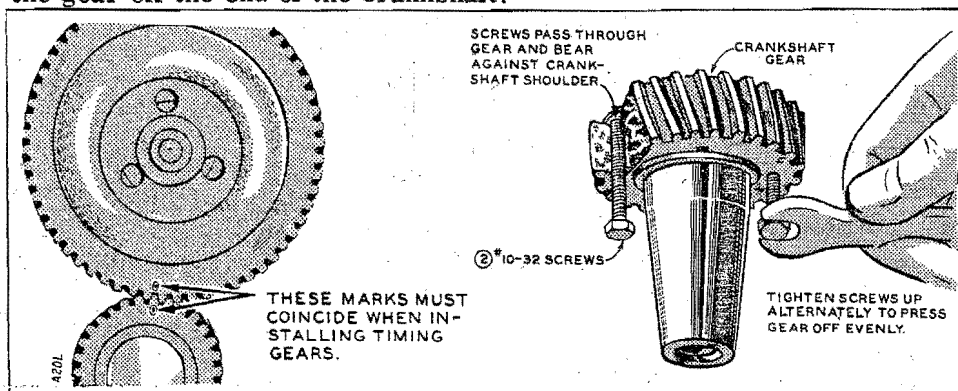


FIG. 43 - TIMING GEARS

The camshaft gear is pressed on and keyed to the camshaft. The camshaft and gear must be removed as an assembly, after first removing the crankshaft gear lock ring and washer. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies. Remove the operating plunger for the breaker points. Remove the fuel pump and tappets. After removing the governor cup assembly from the gear, the camshaft may be pressed out of the gear by use of a hollow tool or pipe which will fit over the camshaft center pin. Do not press on the center pin or damage it in any way. The governor ball spacer is a press fit to the camshaft gear.

When pressing a camshaft gear onto the camshaft, be sure the gear is started straight and that the key is properly in place. Install the governor cup assembly before installing the camshaft and gear in the engine.

Note that each timing gear is stamped with "O" mark near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. Be sure, when installing the camshaft gear and shaft assembly, that the thrust washer is properly in place behind the camshaft gear. Replace the retaining washer and lock ring to the crankshaft.

**CYLINDER.** - The cylinder wears very little in normal service. If through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and rings of one of the available oversizes. Pistons and rings are available in .010", .020", and .030" oversizes. An engine may have been fitted at the factory with .005" oversize pistons, and will be so indicated by the letter "E" following the engine serial number stamped on the cylinder block and on the plant nameplate. Use standard size rings on a .005" oversize piston. If the



cylinders are not being reconditioned, but new piston rings are being installed, remove any ridge which may have become formed at the top of piston ring travel in the cylinder bore.

**PISTONS AND RINGS.** - The piston and connecting rod assemblies are removed through the top of the cylinder. The pistons are fitted with two compression rings and one oil control ring with an expander. Inspect each piston. The piston ring grooves should be cleaned of any carbon deposits, and the oil return slots in the lower groove must be open.

If the pistons are badly scored, very loose in the cylinders, have badly worn ring grooves, or otherwise are not in good condition, install new pistons. Install new pistons if the old ones are loose on the piston pins and 0.002 inch oversize piston pins will not correct it. Handle pistons carefully to avoid nicking the walls. Any raised surface of this type must be dressed down carefully.

Conformatic type pistons are designed for very close fit in the cylinder bore. A slot on opposite sides of the piston behind the oil control ring permits oil return and allows for expansion. The piston is interchangeable as to which side should be nearer the oil base.

Inspect the rings carefully for fit in grooves, for tension, and for seating on cylinder walls. Install new rings where there is any doubt about the condition of the old rings.

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder at a position corresponding to the bottom of its travel. The gap between the ends of the ring should be as given in the Table of Clearances. Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on a .005" oversize piston. .010", .020", and .030" oversize rings are to be used on .010", .020", and .030" oversize pistons, respectively. Rings of the tapered type are usually marked "TOP" on one side, or identified in some other manner, and the ring must be installed with this mark toward the closed end of the piston. Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

The piston is fitted with a full floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connect-

ing rod in the engine. Correct piston to cylinder clearance appears in the Table of Clearances.

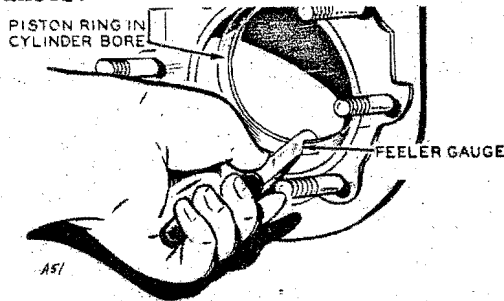


FIG. 44 - FITTING PISTON RINGS TO THE CYLINDER

**CYLINDER HEAD.** - Models using gaseous fuel have a high compression cylinder head. Beginning in 1959 this cylinder head has a  $3/32$ " radius boss visible on the thick edge near the spark plug to identify it from standard compression. Both heads must be of the same compression.

**CONNECTING RODS.** - The connecting rods should be serviced at the same time the pistons or piston rings are serviced. Rods must be removed with the piston. Rods are available in standard or 0.020 inch undersize.

The connecting rod bearing surface is aluminum alloy and proper clearance between the rod bearing surface and the crankshaft bearing surface is obtained by dressing the connecting rod cap. The correct clearance is shown in the Table of Clearances. Use a sheet of 320 grit or finer abrasive on a smooth flat surface. Place the ends of the connecting rod cap on the abrasive material and carefully dress the ends down as needed. Be sure the cap is held perfectly straight. Remove all abrasive from the cap before installing it.

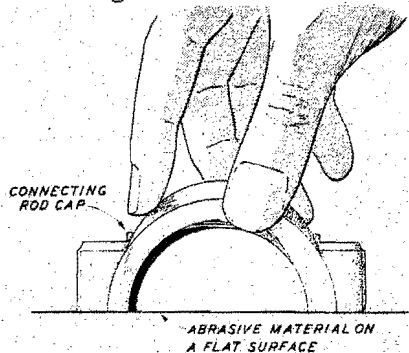


FIG. 45 - REDUCING CONNECTING ROD CLEARANCE

*The connecting rod and piston assembly must be properly aligned before reassembly to the engine. The aligning should be done on an accurate aligning gauge by a competent operator. Misalignment may cause rapid*

wear of piston, pin, cylinder and connecting rod.

Install the connecting rods and caps with raised lines (witness marks) aligned and with the caps facing toward the oil base. The rod and cap numbered "2" goes on the journal which is farther from timing gears. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft faced hammer to set the rod square on the journal.

**BEARINGS.** - Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable drive plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on bearings to reduce friction when installing and again lubricate with oil after installing.

New crankshaft main bearings are precision type which DO NOT require line reaming or line boring after installation. They are available in standard size or in 0.002 inch or 0.020 inch undersize. Expand the bearing bore by placing the casting in hot water or in an oven heated to 200°F. Be careful, if a torch is used, to apply only a little heat! If practical, cool the precision bearing to shrink it. Align the oil hole(s) in bearing with the oil hole(s) in bearing bore. The oil passage must be at least 1/2 open. The cold oiled precision bearing should require only light taps to position it. Install the flanged type bearing (used prior to Spec F) with its notch engaged with the stop pin. Install the bronze faced bearing (used beginning with Spec F) flush with the inside end of bore. If head of lock pin is damaged, use side cutters or "easy-out" tool to remove and install new pin. Apply oil to thrust washer (one used with each bearing, begin Spec F) to hold it in place while installing the crankshaft. Oil grooves in thrust washers must face the crankshaft, washers must be flat (not bent) and washer's two notches must fit over two lock pins to prevent riding on crankshaft.

Install the front camshaft bearing with its oil hole aligned with the hole in the bore (except bores without oil hole install with bearing groove at top). Press it in flush with the outside end of the bore. Install the rear camshaft bearing with its plunger notch facing out and aligned with the hole in the bearing bore. Press or drive it in flush with the bottom of the counterbore which receives the expansion plug.

The camshaft bearings must be line bored or line reamed after being installed in the cylinder block, to allow a clearance as shown in the Table of Clearances. For this service, consult a reliable machine shop, your dealer or factory. Install the expansion plug of the rear bearing.

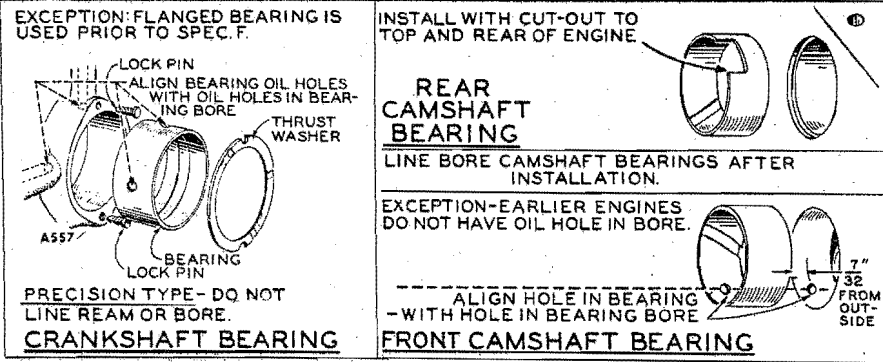


FIG. 46 - BEARING INSTALLATION

**OIL SEALS.** - The gear cover must be removed to replace its oil seal. Drive the old seal out from the inside of the gear cover.

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside.

When installing the gear cover oil seal, tap the seal inward until it is  $31/32$  of an inch from the mounting face of the cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. After the seal is in place, it is advisable to apply a thin coating of shellac or Permatex around the outer surface of the seal at the point where it comes in contact with the bearing plate boss. Use a seal expander, or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

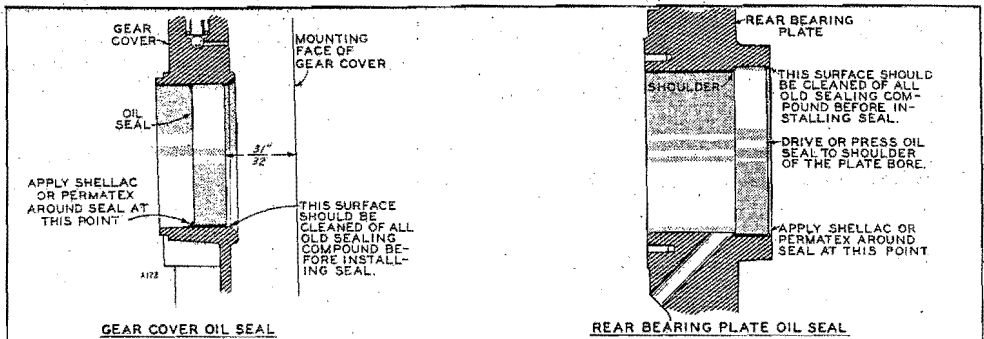


FIG. 47 - OIL SEAL INSTALLATION

**CRANKSHAFT.** - Inspect the bearing journals. If they are scored and can not be smoothed out by dressing down, the bearing journals should be refinished to use  $0.002''$  or  $0.020''$  undersize bearings or a new crankshaft should be installed. If a worn main bearing journal can not be fitted with an available precision type undersize

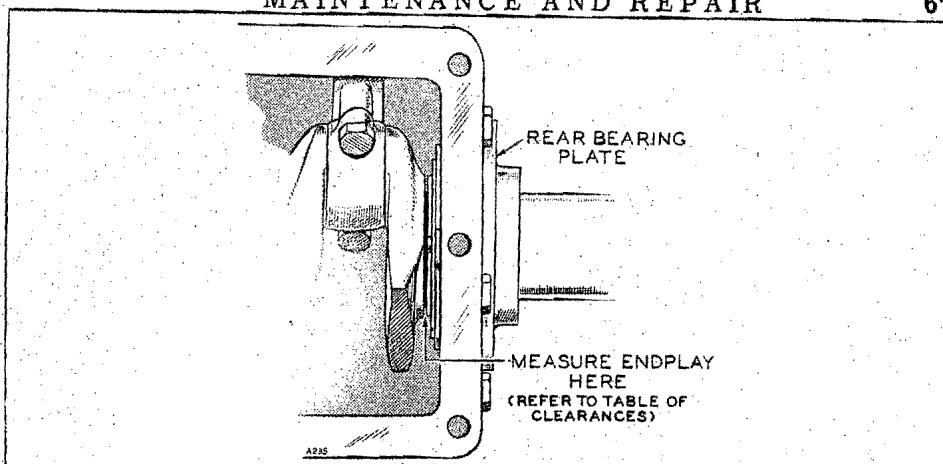


FIG. 48 - CRANKSHAFT END-PLAY

bearing, then refinish it to the next undersize. If a worn connecting rod bearing journal can not be fitted by dressing down the rod cap, then refinish it to take the undersize rod available.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. If necessary, clean them to assure proper lubrication of the connecting rods.

When installing the crankshaft, use gaskets as needed behind the bearing plate to assure end play as given in the Table of Clearances herein.

**OIL PUMP.** - To remove the oil pump, it is necessary to detach the intake cup assembly, as illustrated.

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly if required.

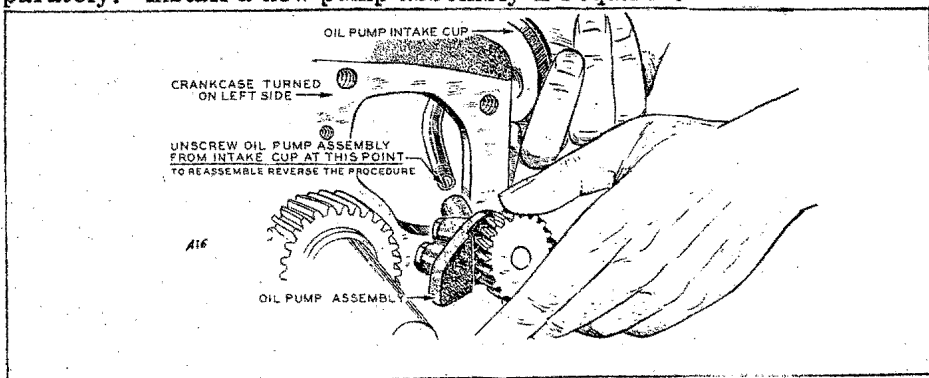


FIG. 49 - OIL PUMP REMOVAL

**FUEL PUMP.** - A diaphragm type fuel pump is used. If fuel does not reach the carburetor, check the fuel pump before dismantling it. The pump can be checked by disconnecting the fuel line at the carburetor, cranking the engine slowly by hand, and observing whether fuel comes from the line at the carburetor. If there is enough fuel in the tank, and the line between the tank and the pump is open but the pump fails, repair or replace it. Failure of the pump is usually due to a leaking diaphragm, valve or valve gasket, a weak or broken spring, or wear in the drive linkage. If the operator chooses to repair the pump rather than install a new one, the use of a complete repair kit is recommended.

**ALWAYS RETURN THE HAND PRIMING LEVER ALL-THE-WAY INWARD** so that the priming lever does not prevent the normal operation of the pump. If the fuel pump rocker arm is being lifted by the camshaft, the engine must be cranked 1 revolution before the priming lever will be effective.

Rotating the diaphragm 1/4 turn will disengage the drive link.

Diluted oil indicates a faulty fuel pump.

**GASKETS.** - Always use new gaskets when replacing any part that requires a gasket. Thoroughly clean the surface that the gasket contacts before installing the gasket.

**TESTING IGNITION COIL.** - A 6-volt tester may be used to test the ignition coil. To avoid burning out the coil, do not use a 12-volt tester and do not leave coil on tester over 15 or 20 minutes.

GENERATOR

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

**GENERATOR DISASSEMBLY.** - The procedure is mostly self-evident. Remove the band and endcover. Remove constant-pressure-type springs and lift all brushes.

Remove generator through stud nuts. Hold both the end bell with its brush rig and the frame assembly, since they are separate parts, and remove them as one assembly from the adapter. Screw driver slots in the adapter provide for prying the frame loose. Be careful not to let the frame assembly rest or drag on the armature.

Turn the armature nut out to the end of the armature through stud. While pulling outward with one hand under the armature, strike a sharp end-wise blow on the nut to loosen the armature. Remove the armature and blower as an assembly. The blower is a keyed and pressed fit on the armature shaft, and is a keyed and tapered fit to the engine crankshaft.

If the armature does not come loose, place a heavy brass rod on the armature shaft near the ball bearing and strike a sharp downward blow on the rod with a hammer. Rotate the armature 1/2 turn before repeating. Do not strike the commutator, collector rings, or bearing.

**BRUSHES AND SPRINGS.** - Inspect brushes periodically. Brushes worn to 5/8 inch should be replaced. Replace springs if damaged or if proper tension is questionable. Rapid brush

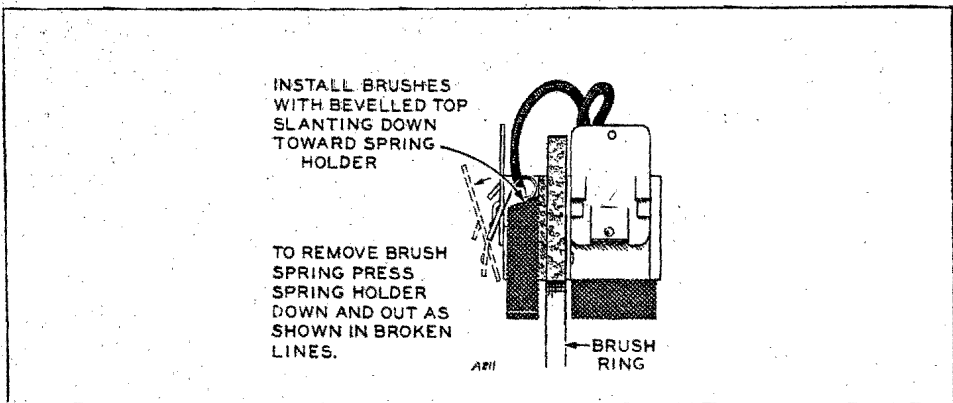


FIG. 50 - BRUSHES AND SPRINGS

wear may be caused from high mica between commutator bars, rough commutator or collector rings, or from a deviation from "neutral" position in the adjustment of the brush rig. NEVER bend the constant-pressure-type spring over the edge of its support.

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

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

**COLLECTOR RINGS (AC Units)** . - If the collector rings become grooved or out of round, or the brush surface becomes pitted or rough so that good brush seating cannot be maintained, remove the armature and refinish the collector rings in a lathe. If the commutator appears to be rough or scored refinish it at the same time. Remove or adequately shield the ball bearing during refinishing.

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

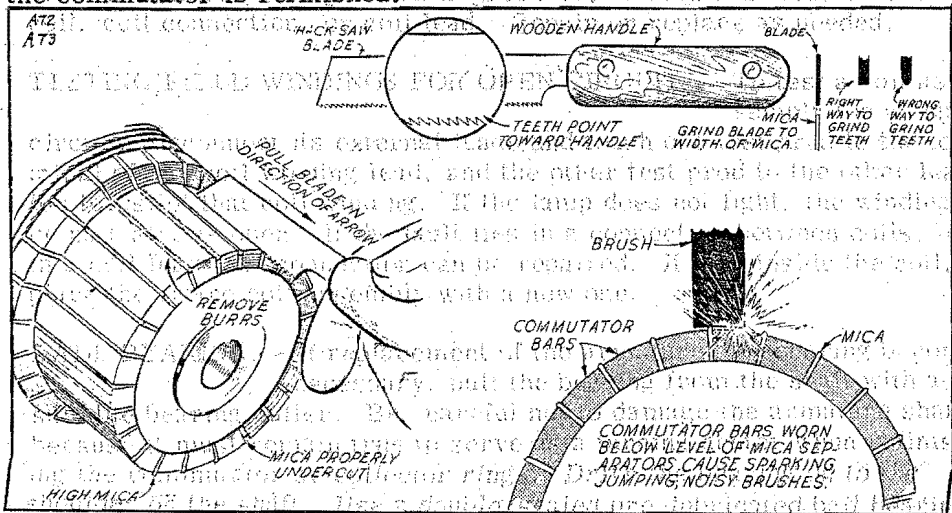


FIG. 51 - COMMUTATOR REPAIR



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

**ARMATURE GROUND TEST.** - To test the armature for a grounded condition, lift or remove the brushes so that none contact the commutator or collector rings. Use a continuity type test lamp set. Place one test prod on the commutator, and the other test prod on a bare, clean part of the armature shaft. The test prods must make good electrical contact. The test lamp should not glow. If the test lamp does glow, the dc winding or the commutator is grounded. To test the ac winding, place one test prod on one of the collector rings and the other test prod on the armature shaft. If the test lamp glows, the ac winding or a collector ring is grounded. Replace a grounded armature with a new one.

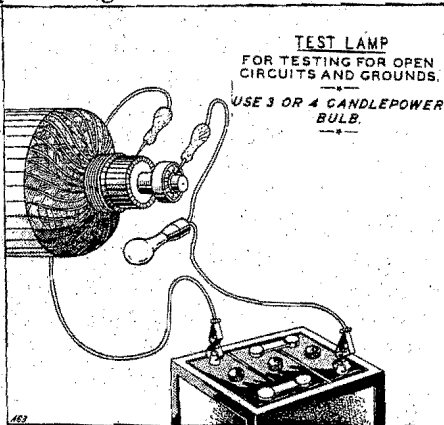


FIG. 52 - CONTINUITY TEST LAMP

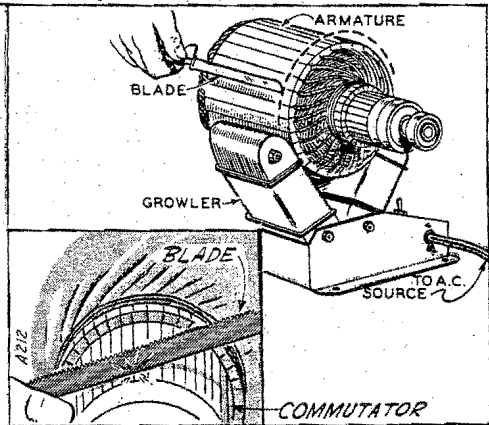


FIG. 53 - ARMATURE GROWLER

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

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

To test the dc winding, place the armature in a growler. With the growler current on, pass a smooth steel strip across the commutator segments. Repeat all around the commutator. At some point around the commutator, a spark should occur as the strip contacts two adja-

cent segments. Rotate the armature slightly and repeat the test. Continue until a spark is obtained between all adjacent segments. If no spark is obtained at some point, an open circuit is indicated. (NOTE- A short circuit in the winding might prevent sparking. This condition may be indicated by the short circuit test described in the next paragraph.) Replace an open circuited armature with a new one.

**ARMATURE SHORT CIRCUIT TEST.** - To test for a short circuit, place the armature in a growler. With the growler current on, hold a steel strip about 1/2 inch above the armature laminations. Pass the strip back and forth over the laminations. Cover as much of the lamination area as possible. If the strip is magnetically attracted to the armature at any point, a short circuit is indicated. After testing in one position, rotate the armature slightly in the growler and repeat the test. Continue until a complete revolution of the armature in the growler has been made. Replace a short circuited armature with a new one.

**TESTING FIELD WINDINGS.** - Use a test lamp set for all tests except a short circuit. The field coils of all a c plants are saturated shunt wound, the Remote Start plants having a series field winding in addition for cranking and battery charging purposes. When testing a field coil assembly, disconnect all of its external leads from their terminals. Tag and mark each lead to assure proper connections when reassembling.

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

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

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

GENERATOR ASSEMBLY. - When reassembling the generator, see that there are no nicks or dirt on the armature blower tapered surface. These conditions may cause an excessive run-out (wobble) at the bearing end. Run-out should be within 0.002". Tighten the armature through stud nut securely.

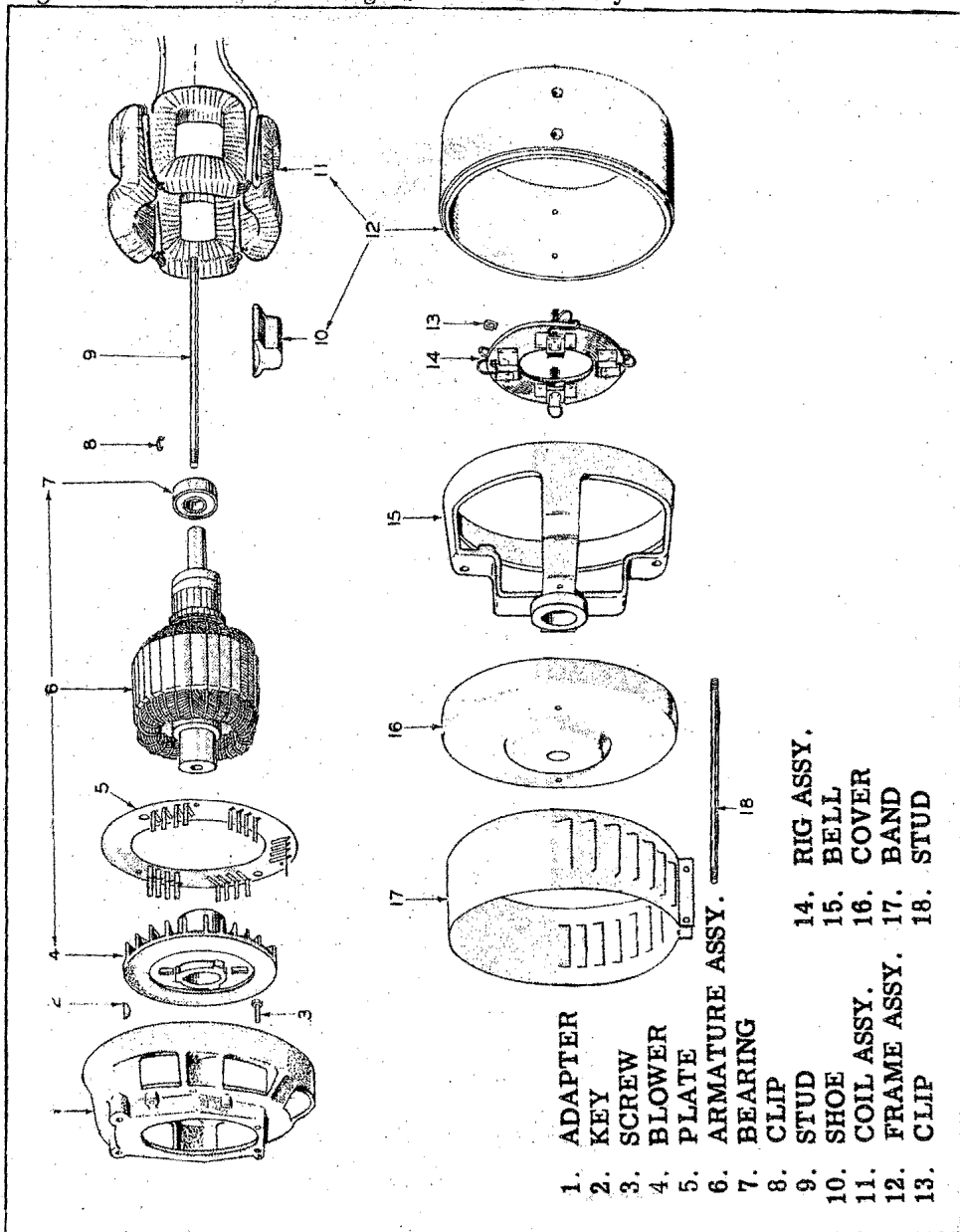
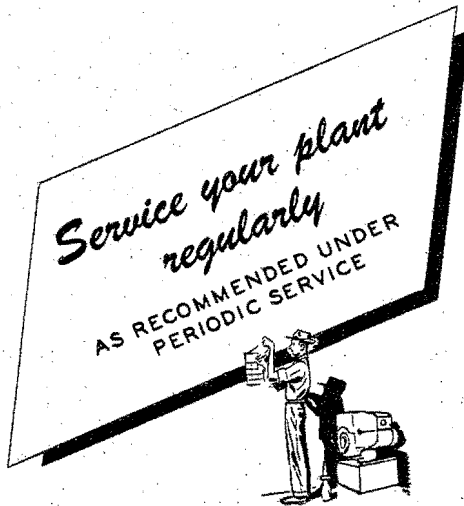


FIG. 54 - GENERATOR ASSEMBLY

## CONTROLS

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

Always disconnect the battery whenever servicing controls to avoid accidentally starting the plant. When disassembling controls, tag each lead that has to be removed and mark the connection point of the lead on the tag to assure correct connections when reassembling.



## SERVICING THE READI-PULL STARTER (FIG. 55)

**CAUTION:** The recoil spring may unwind and cause injury if let fly wildly when starter is disassembled or reassembled.

The sheave hub bearing (16) has a recess which was packed full of grease at the factory. Normally no additional lubrication is required. However, if the starter is disassembled for some other reason, add grease to the bearing and to the spring pawls (11) where they contact the ratchet arm (13).

To install a new rope or internal parts remove the starter from its mounting ring by removing the 4 clamping screws.

To install a new rope, rotate the sheave (10) with crankshaft rotation direction to fully tighten the spring (8), back up only as necessary to align the hole in the sheave with the slot in the cover (5), clamp the rope to the sheave, then when released the rope will wind on the sheave.

To install a new recoil spring remove the sheave from the cover. Wind the spring, with its rivet heads outward, forming a coil small enough to be inserted in the recess of the starter cover. It may be necessary to tie the spring with a piece of wire to prevent its unwinding during installation unless other help is available. Place the spring in the cover recess in crankshaft rotation direction. Remove the tying wire if used. While holding the spring to prevent its unwinding install the inside end of the spring on the roll pin (7) in the cover. With the pull rope removed, install the sheave assembly in the cover so that the tab on the sheave enters the outside end loop of the recoil spring. Be sure the thrust washer (9) is in place. Then install the pull rope.

Spring breakage is much less common than spring fatigue due to long usage. In either case the spring should be replaced. Cleaning and lubricating the pawls, and ratchet arms in the rope sheave will improve a sluggish acting recoil. To temporarily extend the life of a fatigued spring, try rewinding it "inside out" (rivets heads inward).

To install a ratchet arm (13) in the sheave, the pawl (11) must first be removed. The ratchet arm will fit in only the correct position. The spring pawl must be installed with its flat edge against the ratchet arm.

The anti-back lash cogwheel (6) is an easy press fit on the starter cover.

- |                  |                 |                   |                     |
|------------------|-----------------|-------------------|---------------------|
| 1-ROPE AND GRIP  | 7-ROLL PIN      | 13-RATCHET ARM    | 19-WASHER           |
| 2-ROPE ONLY      | 8-RECOIL SPRING | 14-PIVOT ROLL PIN | 20-MOUNTING RING    |
| 3-GRIP ONLY      | 9-THRUST WASHER | 15-ROPE CLAMP     | 21-SPEED GRIP NUT   |
| 4-PLUG           | 10-ROPE SHEAVE  | 16-BEARING        | 22-RATCHET WHEEL    |
| 5-STARTER COVER  | 11-PAWL         | 17-SCREW          | 23-SPECIAL CAPSCREW |
| 6-COG WHEEL      | 12-PAWL SPRING  | 18-FLEXLOCK NUT   |                     |
| 6A-SPRING WASHER | 12A-SPIROL PIN  |                   |                     |

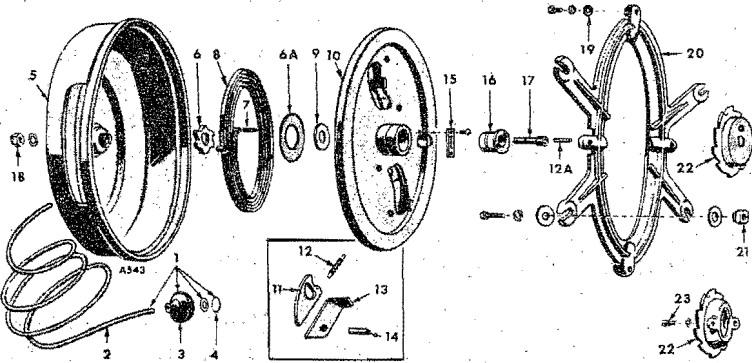


FIG. 55 - SERVICING THE REDI-PULL STARTER

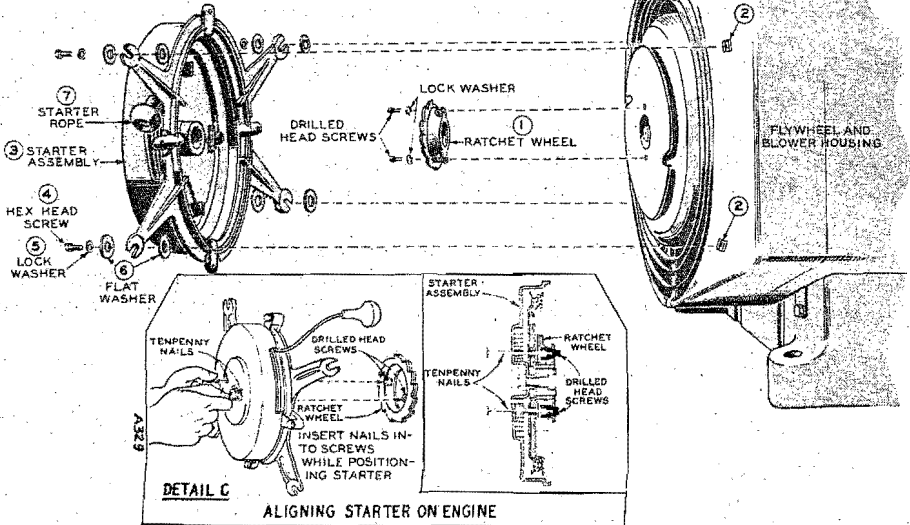
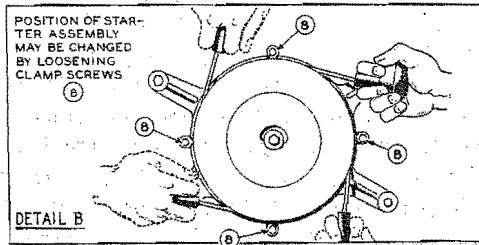
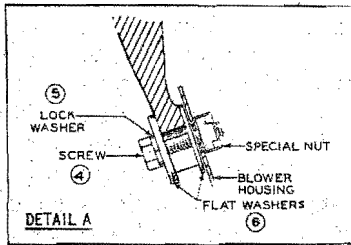


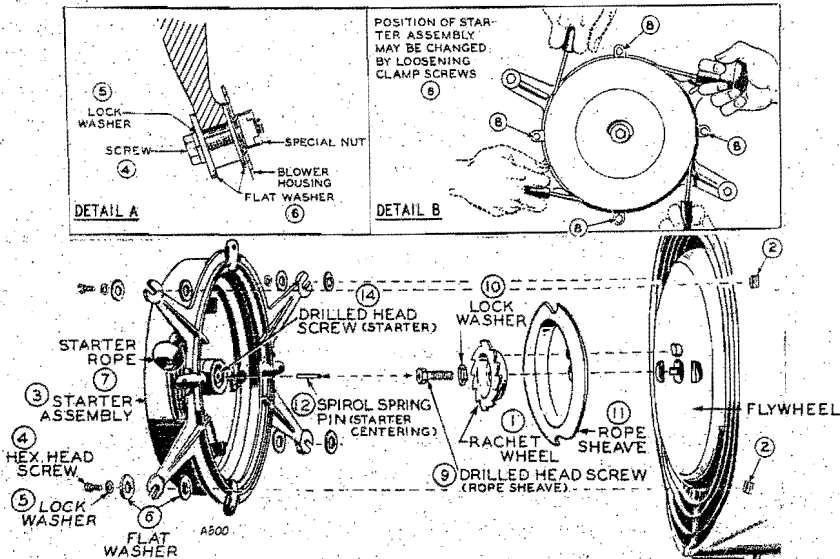
FIG. 56 - INSTALLING THE STARTER, UNITS PRIOR TO SPEC. D

INSTALLING STARTER, UNITS PRIOR TO SPEC. D. - For use with a Readi-Pull starter, the blower housing on the engine must be as rigid as possible. Examine the blower housing carefully. If the mounting holes are worn or if the blower housing is otherwise damaged, replace it with a new one. Proceed as follows to install the complete starter kit.

1. Refer to the installation drawing. Do not change the flywheel mounting screw. New screws (if furnished) are needed on other model engines only.
2. Install the new ratchet-wheel (1) to the blower wheel, using the two special head screws and lock washers provided. A 3/8 inch 12 point socket or closed end wrench fits these screws. Tighten securely.
3. Four special nuts are supplied for mounting the starter to the blower housing. If the blower housing is not already fitted with similar mounting nuts, remove the blower housing and install the nuts in the square holes (2) in the blower housing. See detail A. Reinstall the blower housing, tightening securely in place.
4. Note that there are two small holes drilled through the starter cover. See detail C. Pull slowly out on the starter rope while sighting through one of these holes. When the starter is turned a partial turn, the open-center roll pins in the starter rope sheave will align with these two holes. While holding in the aligned position, insert a ten penny common nail through each of the holes. Push the nails in up to their heads.
5. Install the starter assembly (3) to the blower housing, making sure that the nail ends enter the pilot holes in the ratchet wheel mounting screws. It will probably be necessary to turn the flywheel a partial revolution to allow proper alignment. While holding in position, mount the starter, using a hex head screw (4), lock washer (5), and two flat washers (6) at each mounting arm as shown in the detail drawing A. Tighten the mounting screws securely. Remove the nails.
6. The direction of pull on the starter rope is adjustable to fit the requirements of the individual installation. See detail B. To change the direction of pull, loosen the four clamp screws (8) and turn the starter in its mounting ring to the desired position. Tighten the four clamp screws securely. Try the starter several times, making sure that the pull rope will not rub against one of the clamp screws.
7. Occasionally check the operation of the starter, making sure the starter is properly centered (step 5 above). See that the blower housing mounting screws are tight. If the blower housing tends to shift, its mounting holes may have become worn oversize. If the blower housing tends to weave or distort during starter operation, installation of a new housing is recommended.

**INSTALLING STARTER, UNITS BEGINNING SPEC. D.** - See that the engine blower housing is in good condition. If the mounting holes are worn or if the blower housing is otherwise damaged, replace it with a new one. See Fig. 57.

1. Install the new ratchet wheel (1) against rope sheave (11) using lock washer (10) and flywheel mounting screw (9). Discard the large flat washer from engines so equipped. Engage drive hole with flywheel boss.
2. Four special nuts are supplied for mounting the starter to the blower housing. If the blower housing is not already fitted with similar nuts, remove the blower housing and install the nuts as shown in detail A. Reinstall the blower housing, tightening securely in place.
3. Install centering pin (12) in starter center screw (14) allowing 3/8" to protrude. For reinstalls readjust pin depth.
4. Center the starter assembly over the ratchet wheel with the centering pin engaging the center hole of the flywheel mounting screw. While holding in position, mount the starter, using a hex head screw, lock washer, and two flat washers at each mounting arm as shown in detail A. Tighten the mounting screws securely.
5. The direction of pull on the starter rope is adjustable to fit the requirements of the individual installation. See detail B. To change the direction of pull, loosen the four clamp screws (8) and turn the starter in its mounting ring to the desired position. Tighten the four clamp screws securely. Try the starter several times, making sure that the pull rope will not rub against one of the clamp screws.



**FIG. 57 - INSTALLING STARTER, UNITS BEGINNING WITH SPEC. D**



## POSSIBLE CAUSE

## REMEDY

## ENGINE CRANKS TOO STIFFLY

Too heavy oil in crankcase.	Drain. Refill with lighter oil.
Engine seized.	Disassemble and repair.

## ENGINE CRANKS TOO SLOWLY WHEN CRANKED ELECTRICALLY

Discharged or defective battery.	Recharge or replace.
Loose connections.	Tighten loose connections.
Corroded battery terminals.	Clean corroded terminals. Replace cable if necessary.
Brushes worn excessively or making poor contact.	Replace brushes or clean commutator.
Short circuit in generator or load circuit.	Repair or replace parts necessary. Disconnect load.
Dirty or corroded points in start solenoid switch.	Replace switch.

## ENGINE WILL NOT START WHEN CRANKED

Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or retune ignition.
Lack of fuel or faulty carburetion.	Refill the tank. Check the fuel system. Clean, adjust or replace parts necessary.
Clogged fuel filter.	Clean.
Cylinders flooded.	Ground spark plug cables. Crank engine with spark plugs removed.
Poor fuel.	Drain. Refill with good fuel.
Poor compression.	Tighten cylinder heads and spark plugs. If still not corrected, grind the valves. Replace the piston rings if necessary.
Wrong ignition timing.	Reset breaker points or retune ignition.

## POSSIBLE CAUSE

## REMEDY

## ENGINE RUNS BUT VOLTAGE DOES NOT BUILD UP

Poor brush contact.

See that brushes seat well on commutator and collector rings, are free in holders, are not worn too short, and have good spring tension.

Open circuit, short circuit, or ground in generator.

Refer to the GENERATOR section of Maintenance and Repair.

Residual magnetism lost.

Magnetize the field.

## VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING

Speed too low.

Adjust governor to correct speed.

Poor commutation or brush contact.

Refinish commutator or undercut mica if necessary. See that brushes seat well on commutator and collector 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.

## GENERATOR OVERHEATING

Short in load circuit.

Correct short circuit.

Generator overloaded.

Reduce the load.

Improper brush rig position.

Adjust.

## ENGINE OVERHEATING

Improper lubrication.

Change to proper oil.

Poor ventilation.

Provide ample ventilation at all times.

Dirty or oily cooling surfaces.

Keep the engine clean.

Retarded ignition timing.

Retime ignition.

Generator overloaded.

Reduce load.

## POSSIBLE CAUSE

## REMEDY

## VOLTAGE DROPS UNDER HEAVY LOAD

Engine lacks power.	See remedies under "Engine Misfires at Heavy Load".
Poor compression.	Tighten cylinder heads and spark plugs. If still not corrected grind the valves. Replace piston rings if necessary.
Faulty carburetion.	Check the fuel system. Clean, adjust or repair as needed.
Dirty carburetor air cleaner.	Clean.
Choke partially closed.	Choke plate must be wide open at operating temperature.
Carbon in cylinders or in carburetor venturi.	Remove carbon.
Restricted exhaust line.	Clean or increase the size.

## ENGINE MISFIRES AT LIGHT LOAD

Carburetor idle jet clogged or improperly adjusted.	Clean.
Spark plug gaps too narrow.	Adjust to correct gap.
Intake air leak.	Tighten. Replace gaskets if necessary.
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or retune ignition.

## ENGINE MISFIRES AT HEAVY LOAD

Defective spark plug.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or retune ignition.
Clogged carburetor.	Clean carburetor.

## POSSIBLE CAUSE

## REMEDY

## ENGINE MISFIRES AT HEAVY LOAD (Cont.)

Clogged fuel screen.	Clean.
Defective spark plug cable.	Replace.

## ENGINE MISFIRES AT ALL LOADS

Fouled spark plug.	Clean and adjust.
Defective or wrong spark plug.	Replace.
Leaking valves.	Grind valves.
Broken valve spring.	Replace.
Defective or improperly adjusted breaker points.	Adjust or replace breaker points.

## LOW OIL PRESSURE

Oil too light or diluted from leaking fuel pump diaphragm.	Drain, refill with proper oil. Repair or replace fuel pump.
Oil too low.	Add oil.
Oil relief valve not seating.	Remove and clean, or replace.
Badly worn bearings.	Replace.
Sludge on oil screen.	Remove and clean.
Badly worn oil pump.	Replace.
Defective oil pressure gauge.	Replace.

## 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.

## POSSIBLE CAUSE

## REMEDY

## ENGINE BACKFIRES AT CARBURETOR

Lean fuel mixture.	Clean carburetor. Adjust jets.
Clogged fuel filter.	Clean.
Air leak at intake manifold or carburetor flange.	Tighten mounting screws. Replace gaskets as necessary.
Poor fuel.	Refill with good, fresh fuel.
Spark advanced too far.	Reset breaker points or retime ignition.
Intake valve leaking.	Reseat or replace.

## EXCESSIVE OIL CONSUMPTION, LIGHT BLUE EXHAUST

Poor compression. Usually due to worn pistons, rings, or cylinders.	Refinish cylinders. Install oversize pistons and rings.
Oil leaks from oil base or connections. This does not cause smoky exhaust.	Replace gaskets. Tighten screws and connections. Check breather valve.
Oil too light or diluted.	Drain. Refill with proper oil.
Too large bearing clearance.	Replace bearings necessary.
Engine misfires.	Refer to "Engine Misfires at All Speeds".
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or retime the ignition.
Too much oil.	Drain excess oil.

BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION,  
FOULING OF SPARK PLUG WITH BLACK SOOT, POSSIBLE LACK  
OF POWER UNDER HEAVY LOAD

Fuel mixture too rich.	See that choke opens properly. Adjust jets properly. Adjust the float level.
------------------------	--

## POSSIBLE CAUSE

## REMEDY

BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION  
FOULING OF SPARK PLUG WITH BLACK SOOT, POSSIBLE LACK  
OF POWER UNDER HEAVY LOAD (Cont.)

Choke not fully open.	See that choke opens properly.
Dirty air cleaner.	Clean. Refill with proper oil.
Excessive crankcase pressure, causing excessive fuel pump pressure.	Clean breather valve.

## LIGHT POUNDING KNOCK

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

## ENGINE STOPS UNEXPECTEDLY

Empty fuel tank.	Refill.
Defective ignition system.	Check the ignition system. Repair or replace as needed. See that the STOP button lead is not grounded.

DULL METALLIC THUD. IF NOT BAD, MAY DISAPPEAR AFTER  
FEW MINUTES OPERATION. IF BAD, INCREASES WITH LOAD

Loose crankshaft bearing.	Replace unless one of the next two remedies permanently corrects the trouble.
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SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE  
FIRST STARTED.

Low oil supply.	Add oil.
Oil badly diluted.	Change oil.

POSSIBLE CAUSE	REMEDY
<b>PINGING SOUND WHEN ENGINE IS SUDDENLY OR HEAVILY LOADED</b>	
Carbon in cylinders.	Remove the carbon.
Spark advanced too far.	Reset breaker points or retime ignition.
Wrong spark plugs.	Install correct spark plugs.
Spark plug burned or carboned.	Clean. Install new plug if necessary.
Valves hot.	Adjust tappet clearance.
Fuel stale or low octane.	Use good, fresh fuel.
Lean fuel mixture.	Clean fuel system. Adjust carburetor jets properly.
Engine hot.	Check air circulation.

#### TAPPING SOUND

Valve clearance too great.	Adjust to proper clearance.
Broken valve spring.	Install new spring.

#### HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD

Loose piston.	If noise is only slight and disappears when engine warms up, no immediate attention needed. Otherwise replace parts necessary.
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#### VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR PLANT

Too small line wire used for load and distance.	Install larger or extra wires or reduce load.
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#### MOTORS RUN TOO SLOWLY AND OVERHEAT AT FAR END OF LINE BUT OK NEAR THE PLANT

Too small line wire used for load and distance.	Install larger or extra wires or reduce load.
---	---

## POSSIBLE CAUSE

## REMEDY

## NOISY BRUSHES

High mica between bars of commutator.

Undercut mica.

## EXCESSIVE ARCING OF BRUSHES

Rough commutator or rings.

Turn down.

Dirty commutator or rings.

Clean.

Brushes not seating properly.

Sand to a good seat or reduce load until worn in.

Open circuit in armature.

Install a new armature.

Brush rig out of position.

Line up properly.

## SPARK PLUG FOULED IN SHORT PERIODS OF TIME ON GASOLINE OPERATION

Wrong spark plug gap. (Spark plug may be set at 0.018" for gaseous operation, but not changed to 0.025" when switching over to gasoline operation.)

Clean spark plugs and set at 0.025".

## HARD STARTING, MISSING, POPPING, ERRATIC OPERATION ON GASEOUS FUEL OPERATION

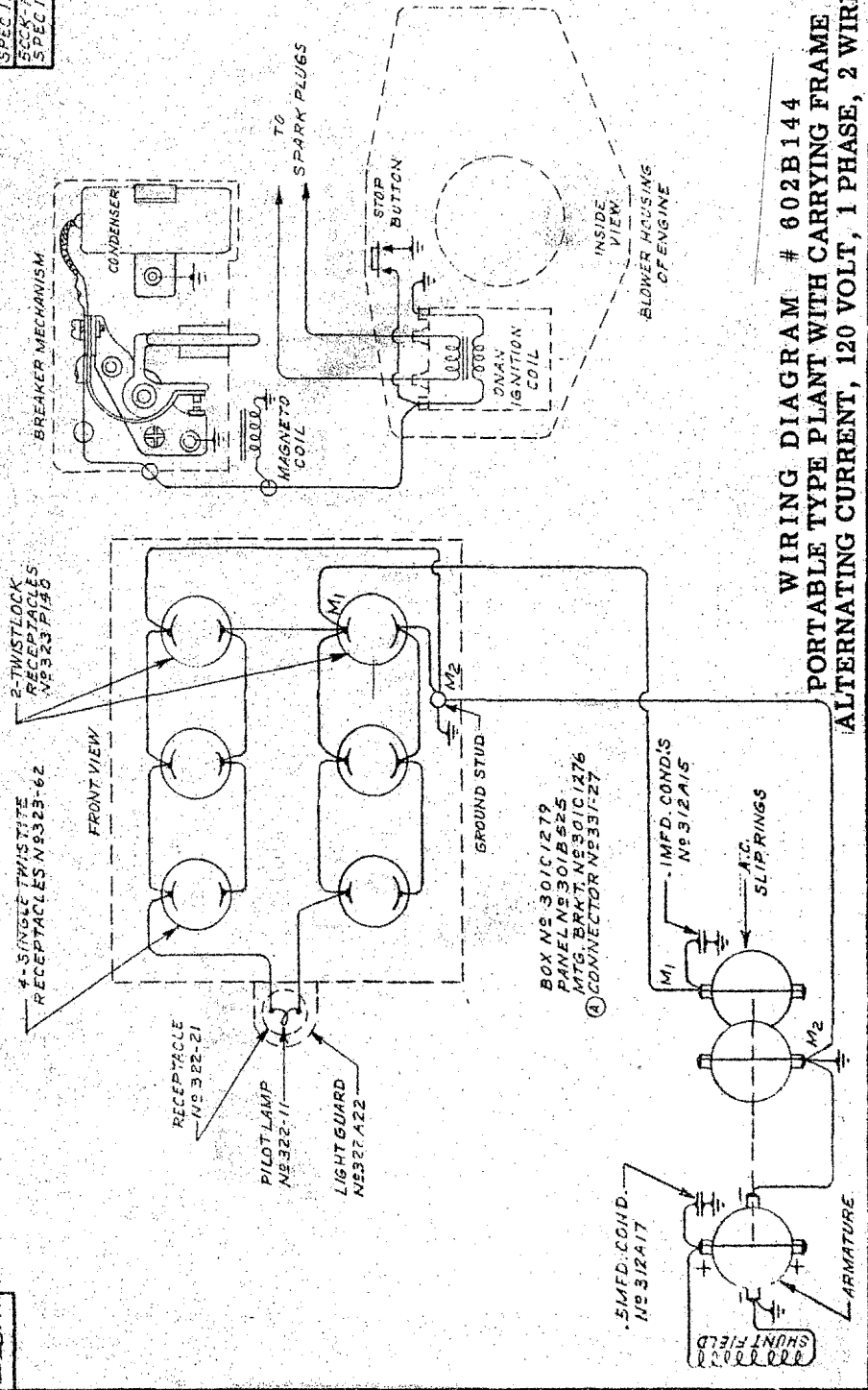
Spark plug gap too wide. (Spark plug gap set at 0.025" for gasoline operation but not changed to 0.018" when switching over to gaseous fuel operation.)

Set spark plug gap at 0.018".



602B742

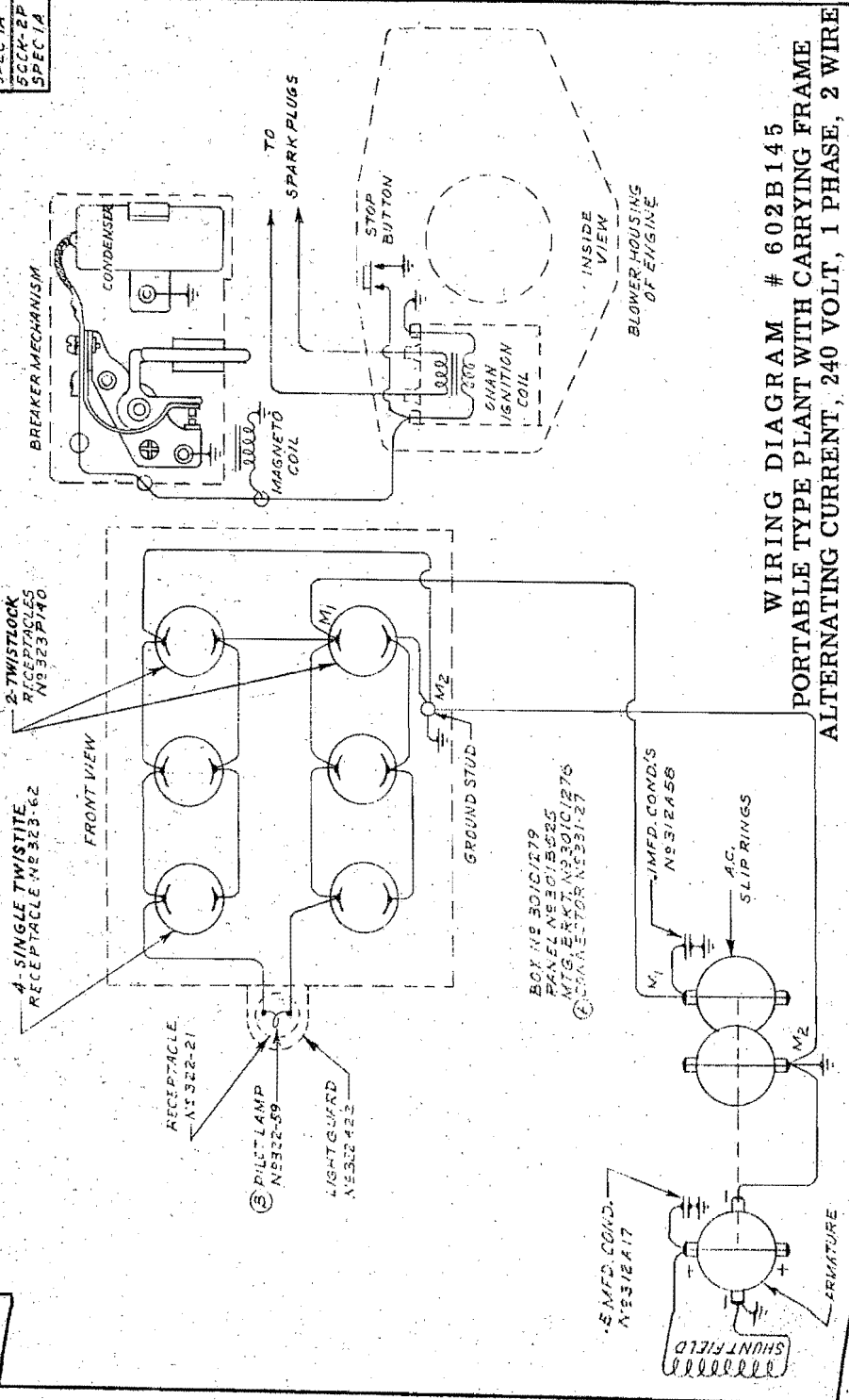
305CC-IP  
SPEC. A  
305CC-IP  
SPEC. A



**WIRING DIAGRAM # 602B144**  
**PORTABLE TYPE PLANT WITH CARRYING FRAME**  
**ALTERNATING CURRENT, 120 VOLT, 1 PHASE, 2 WIRE**

5352CR-2P  
SPEC 1A  
5352R-2P  
SPEC 1A

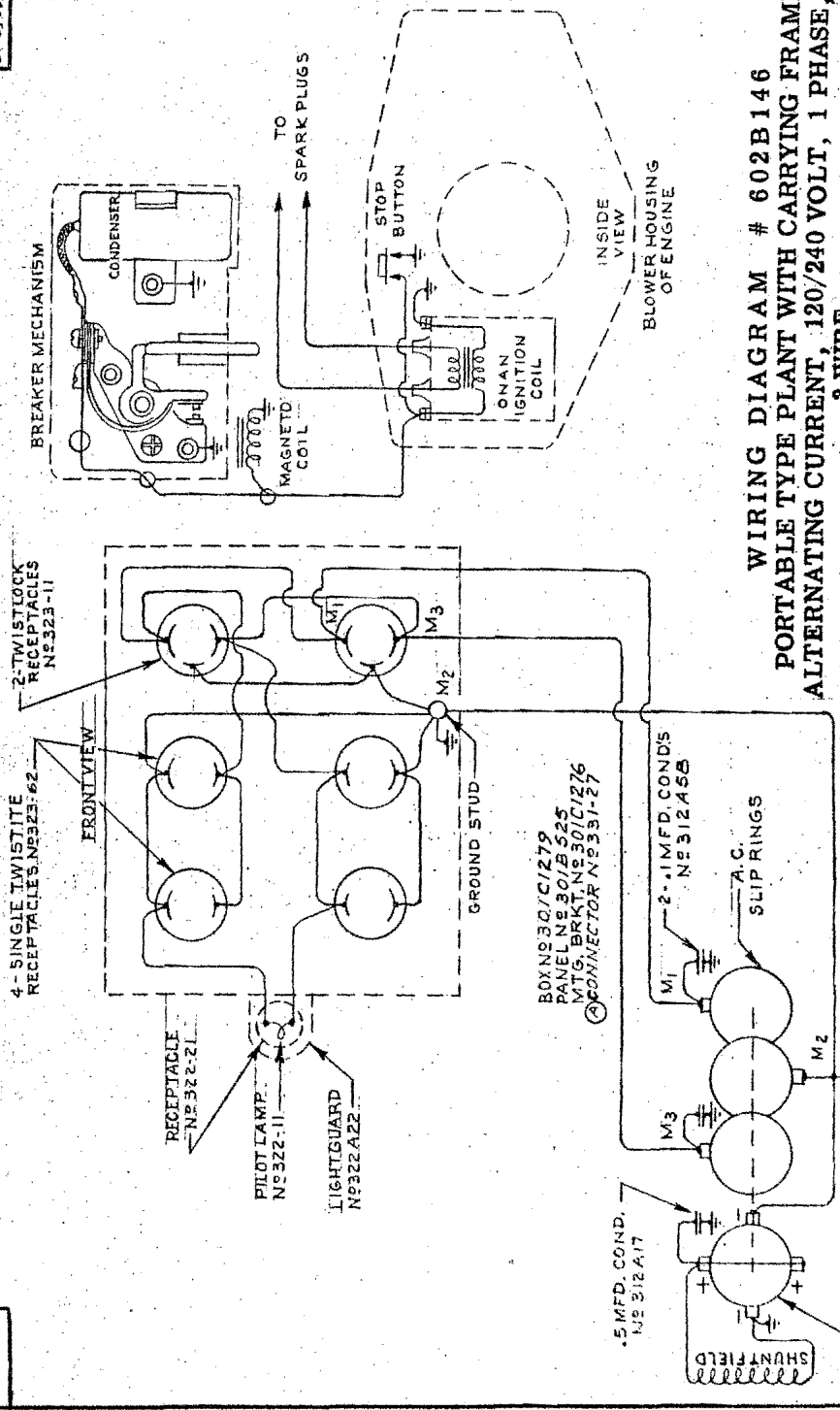
602B145



WIRING DIAGRAM # 602B145  
PORTABLE TYPE PLANT WITH CARRYING FRAME  
ALTERNATING CURRENT, 240 VOLT, 1 PHASE, 2 WIRE

3084500A  
3P-SPECIAL

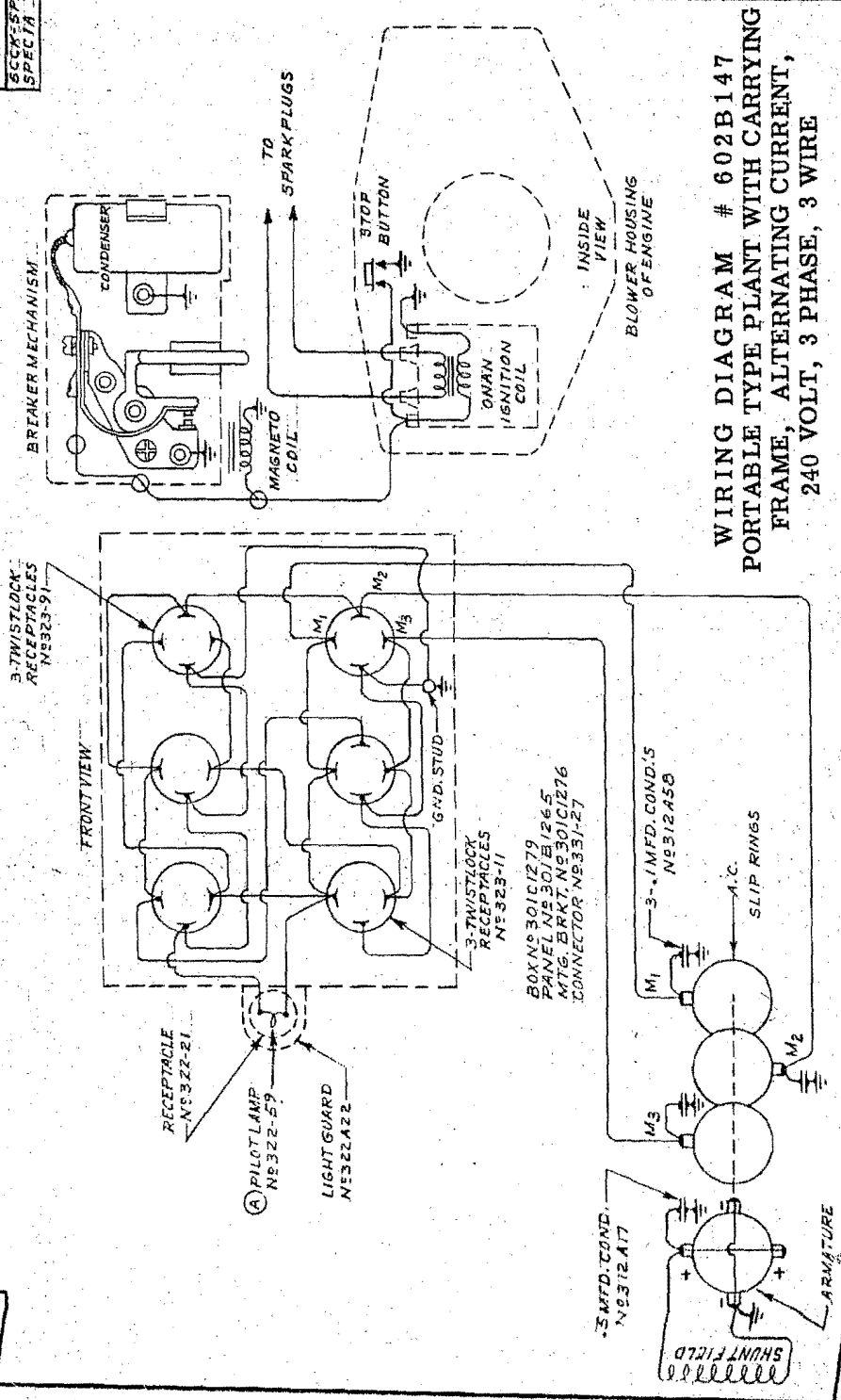
602B146



WIRING DIAGRAM # 602B146  
 PORTABLE TYPE PLANT WITH CARRYING FRAME  
 ALTERNATING CURRENT, 120/240 VOLT, 1 PHASE,  
 3 WIRE

3052CK-5A  
SPEC 1A  
3052CK-5P  
SPEC 1A

602B147



WIRING DIAGRAM # 602B147  
PORTABLE TYPE PLANT WITH CARRYING  
FRAME, ALTERNATING CURRENT,  
240 VOLT, 3 PHASE, 3 WIRE

3-TWISTLOCK  
RECEPTACLES  
NS323-21

FRONT VIEW

RECEPTACLE  
NS322-21

(A) PILOT LAMP  
NS322-59

LIGHT GUARD  
NS322-22

GND. STUD

3-TWISTLOCK  
RECEPTACLES  
NS323-21

BOX NS 301C1279  
PANEL NS 301B1265  
MTG. BRKT. NS 301C1276  
CONNECTOR NS 311-27

3-IMFD. COND.'S  
NS312-47

3-IMFD. COND.'S  
NS312-45

SLIP RINGS

A.C.

SHUNT FIELD

ARMATURE

BREAKER MECHANISM

CONDENSER

TO SPARK PLUGS

MAGNETO COIL

STOP BUTTON

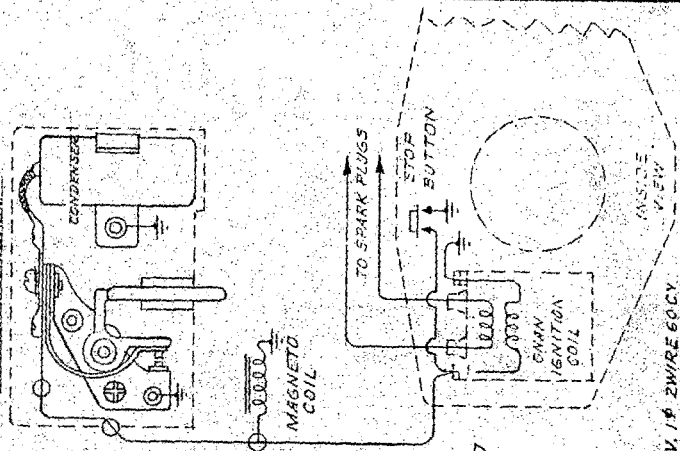
IGNITION COIL

INSIDE VIEW

BLOWER HOUSING OF ENGINE

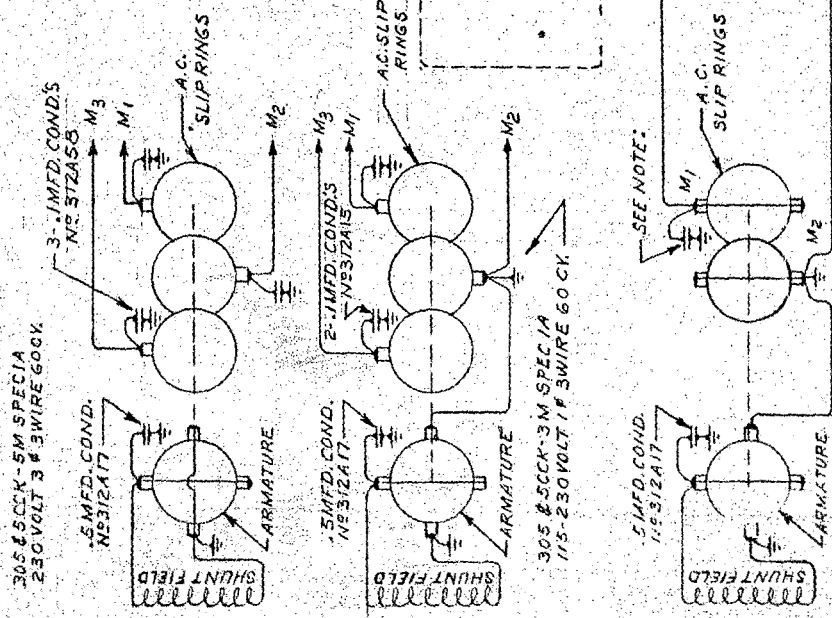
305CCX  
5CCX

602B143



④ CONNECTOR № 331-27  
BOX MFG. BRKT. № 301C1277  
COVER № 330-6  
BOX № 330-28  
(USED ON ALL MODELS  
SHOWN ON DIAGRAM)

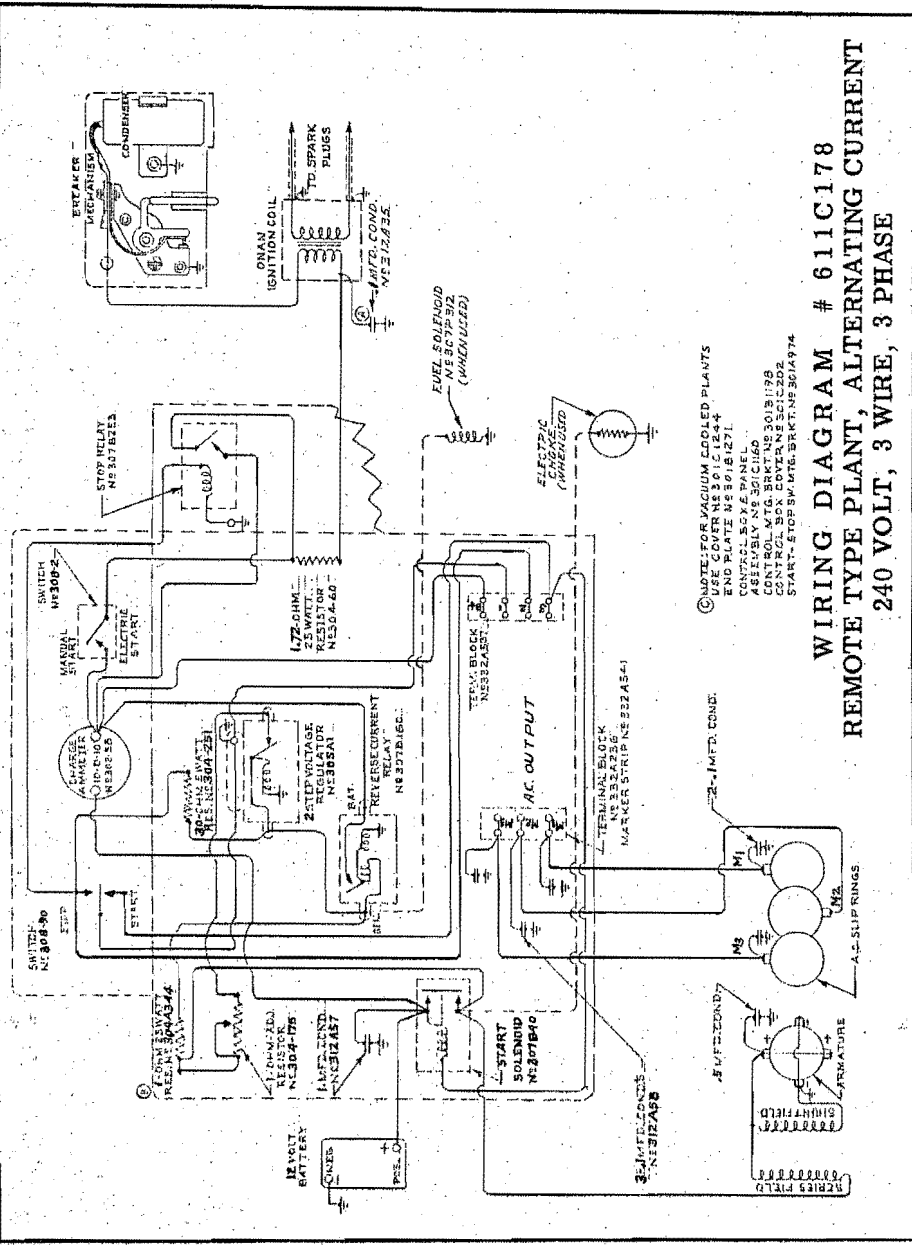
NOTE:  
305 & 5CCX-1M SPEC. A 115V. 1# 2WIRE 60CY.  
USE .1MFD. COND. № 312A15  
305 & 5CCX-2M SPEC. A 230V. 1# 2W. 60V.  
USE .1MFD. COND. № 312A58



**WIRING DIAGRAM # 602B143**  
**MANUAL TYPE PLANT, NOT IN CARRYING FRAME**  
**ALTERNATING CURRENT, 1 or 3 PHASE, 2 or 3 WIRE**

BOOK SPEC.

REVISIONS



**WIRING DIAGRAM # 611C178**  
**REMOTE TYPE PLANT, ALTERNATING CURRENT**  
**240 VOLT, 3 WIRE, 3 PHASE**

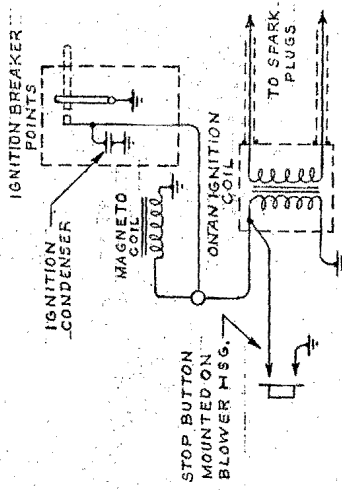
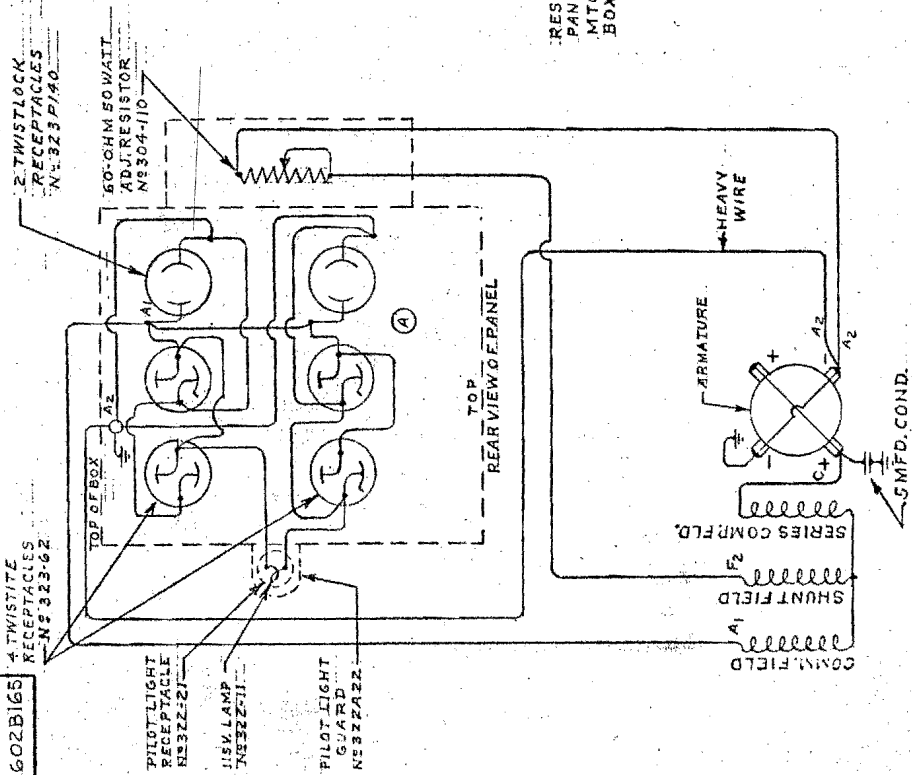
NOTE: FOR VACUUM COOLED PLANTS  
 USE COVER NS 301C1244  
 END PLATE NS 301B1271  
 CONTROL BOX PANEL  
 ASSEMBLY NS 301C160  
 3-01B1278  
 CONTROL BOX COVER NS 301C202  
 START-STOP SWITCH BRKT NS 301A974





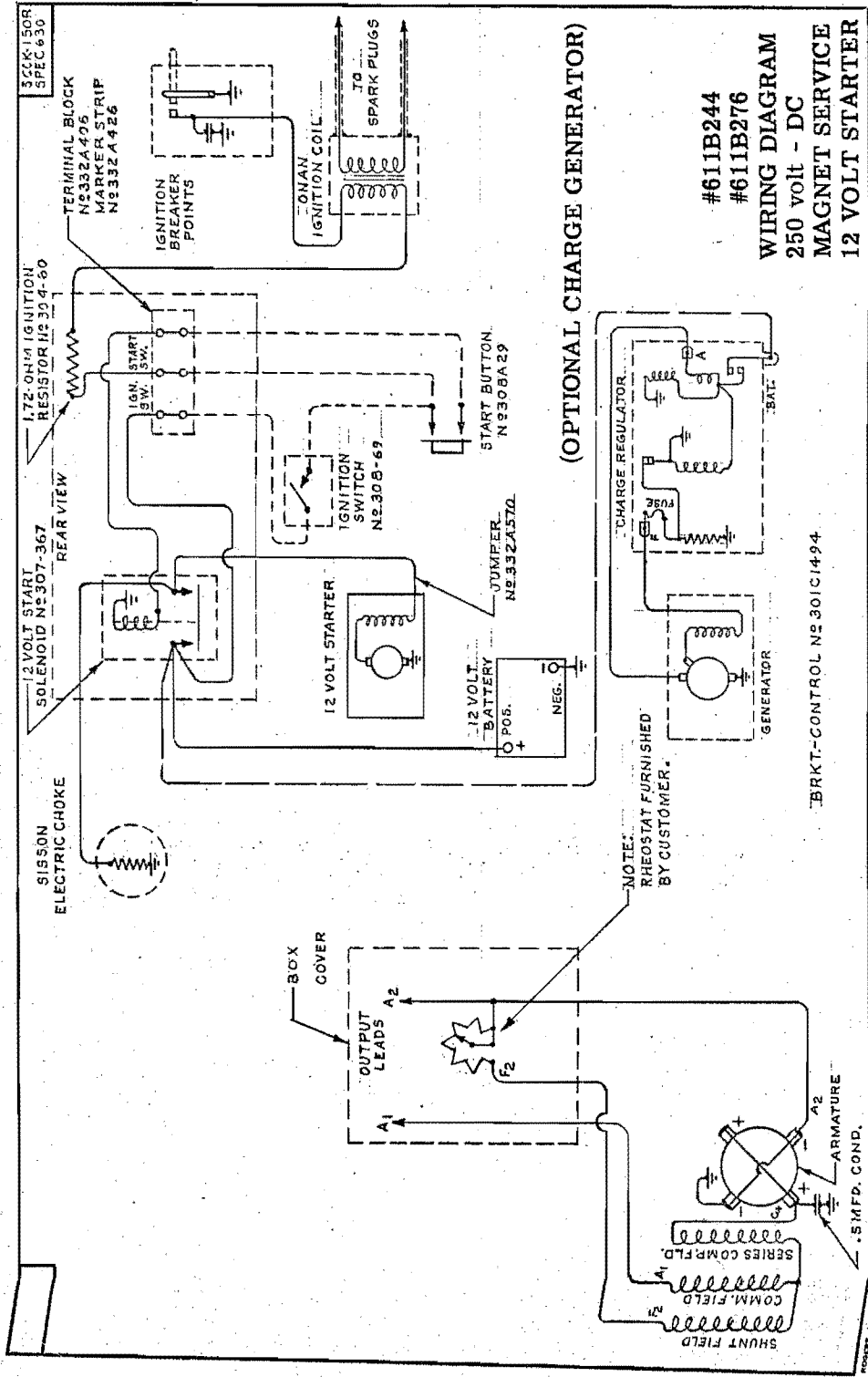


300K-115P  
SPEC 522C



RESISTOR BOX N° 301B482  
 PANEL N° 301B525  
 M.T.G. BRK T. N° 301B567  
 BOX N° 301C566

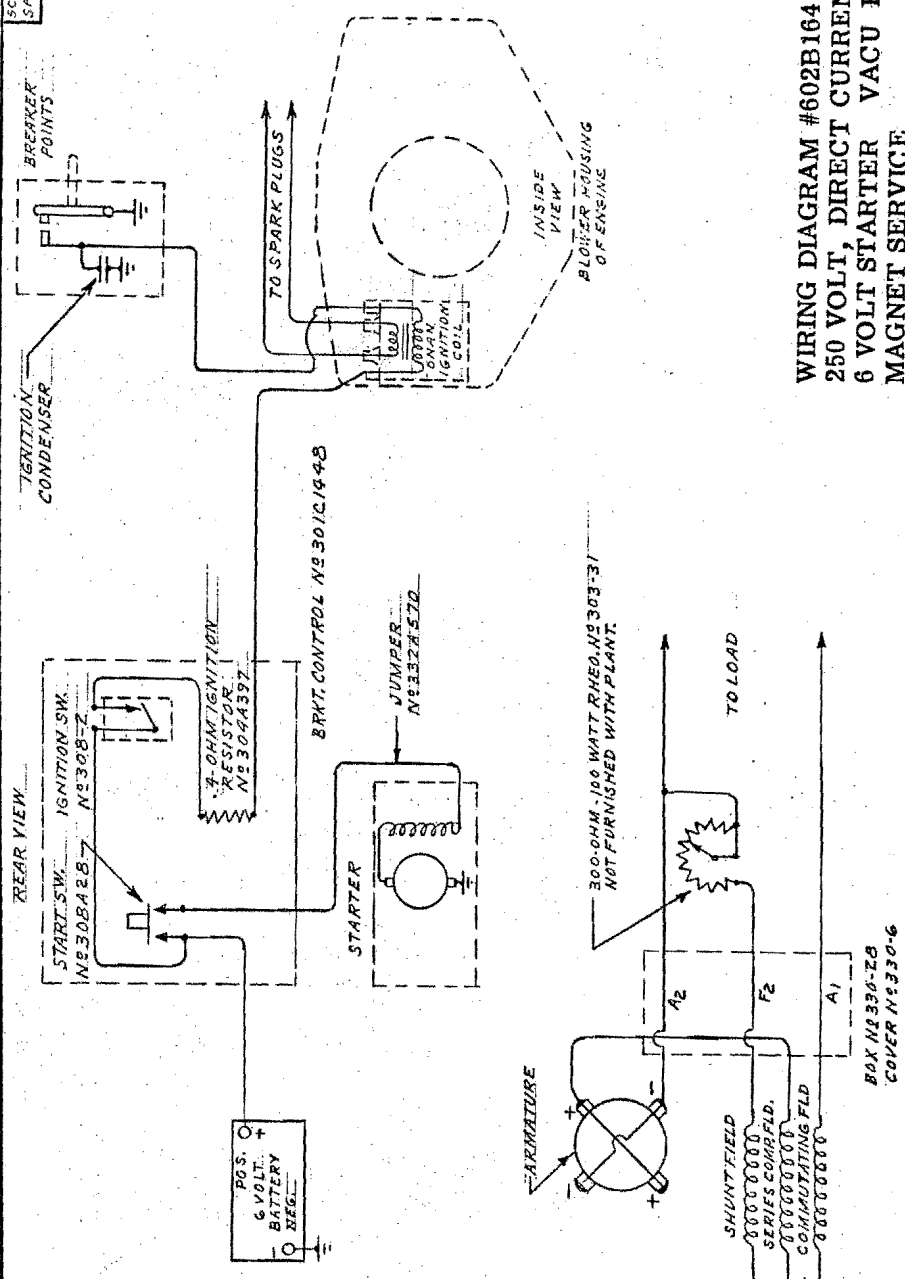
WIRING DIAGRAM #602B165  
 PORTABLE TYPE PLANT  
 115 VOLT, DIRECT CURRENT



#611B244  
 #611B276  
 WIRING DIAGRAM  
 250 VOLT - DC  
 MAGNET SERVICE  
 12 VOLT STARTER

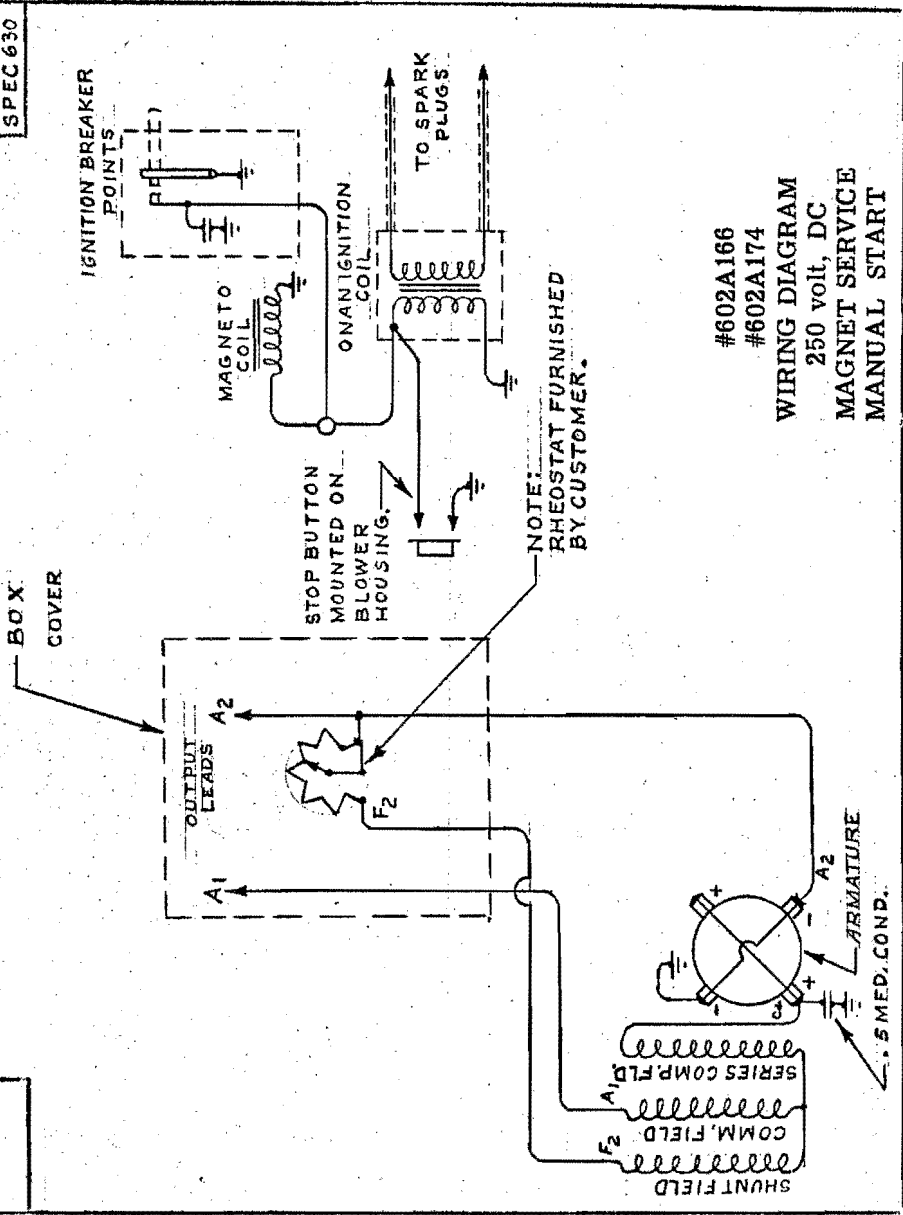
602B164

3CC-602B-1V  
SPEC 633C



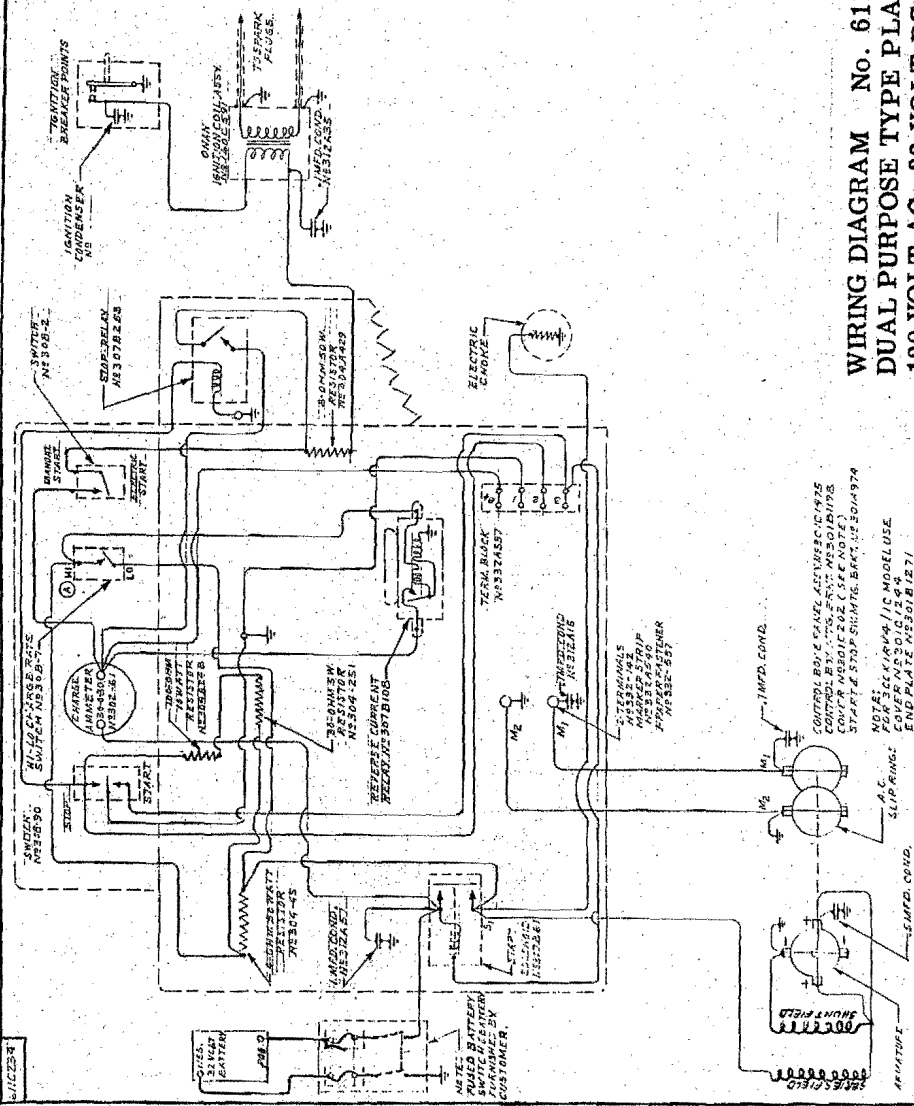
**WIRING DIAGRAM #602B164**  
**250 VOLT, DIRECT CURRENT**  
**6 VOLT STARTER VACU FLO**  
**MAGNET SERVICE**

SCCK-150M  
SPEC 630



#602A166  
 #602A174  
 WIRING DIAGRAM  
 250 volt, DC  
 MAGNET SERVICE  
 MANUAL START

SPEC. 1  
 611C234  
 12527C



**WIRING DIAGRAM No. 611C234  
 DUAL PURPOSE TYPE PLANT  
 120 VOLT AC, 32 VOLT DC**

CONTROL BOX & PANEL ASSEMBLY  
 CONTROL BOX, T.S. P.C. NS3041108  
 COVER NS3041108 (SEE NOTE)  
 START & STOP SWITCHES, B.A.T. NS304974  
 NOTE:  
 FOR 32 VOLT DC MODEL USE  
 END PLATE NS3041108  
 SLIP RINGS: NS3041108

611C234

NS 312A16





# ONAN

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

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