SERVICE MANUAL

MAINTENANCE AND REPAIR
FOR
ELECTRIC GENERATING PLANTS

AK

SERIES

Onan®

925-500

ONAN
DIVISION OF STUDEBAKER-PACKARD CORPORATION
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INTRODUCTION

THIS SERVICE MANUAL CONTAINS INFORMATION FOR THE PROPER SERVICING OF THE AK SERIES ELECTRIC GENERATING PLANTS. UNLESS OTHERWISE STATED, THESE INSTRUCTIONS APPLY TO ALL STANDARD PLANTS OF THE AK SERIES. FOR INSTALLATION, PREPARATION AND OPERATING INSTRUCTIONS, REFER TO OPERATORS MANUAL.

Electrical output characteristics of the plant appear on the nameplate, with the model designation and the serial numbers. The plant model and specification numbers are separated by a diagonal line (/). The plant specification consists of a Number which indicates optional equipment as ordered by the purchaser; and of a Letter at the end, which is advanced to coincide with production modification by the manufacturer. Reference to the nameplate spec letter may be necessary for the operator to select the instructions in this manual which apply to the model in question.

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. However, by using the instructions and recommendations given in this manual as a general guide, it will be possible to properly maintain the plant.

Instructions for 60 Cycle, 1800 rpm plants apply also for 50 Cycle, 1500 rpm plants and instructions for 60 Cycle, 3600 rpm plants apply also for 50 Cycle, 3000 rpm plants except for current frequency and operating speed. Be sure appliances are adaptable to the current frequency of the plant.

THE ENGINE END IS DESIGNATED AS THE "FRONT END" OF THE PLANT AND THE CARBURETOR SIDE IS DESIGNATED AS THE "LEFT SIDE" OF THE PLANT.

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DESCRIPTION

GENERAL

Each AK 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.

The manual type of plant is designed for manual starting only, and can not be connected to batteries for electric starting. The remote control type plant is designed for electric starting. When properly connected to a 12 volt battery, the plant may be started electrically at the plant, from one or more remote control switch points, or through automatic controls. The remote control type plant has a built-in charging circuit for keeping the starting battery in a well charged condition.

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.

ENGINE DETAILS

TYPE: Vertical 1 cylinder, L head, 4 stroke cycle
BORE: 2-1/2 inch
STROKE: 2-1/2 inch
DISPLACEMENT: 12.2 cubic inches
HORSEPOWER: 1.85 at 1800 rpm
2.5 at 2400 rpm
3.7 at 3600 rpm
COMPRESSION RATIO: 5.5 to 1
CYLINDER and CRANKCASE: Integral, cast iron
MAIN BEARINGS: Precision sleeve type, babbitt faced, steel backed
CAMSHAFT BEARINGS: Sleeve type, babbit faced, steel backed
PISTON: 3 ring, aluminum alloy, full floating type piston pin
CONNECTING RODS: Aluminum alloy, integral bearing
LUBRICATION: Units of 3000 rpm or over - Pressure, gear driven, gear type oil pump
Units under 3000 rpm - Positive splash type
COOLING: Air, pressure flow (Vacu-flo optional)
SPEED CONTROL: Internal centrifugal flyball type governor, external adjustments.
IGNITION: Flywheel type magneto, shielded system

The exhaust valve is stellite faced, seats on a stellite replaceable seat, and a positive rotator for the exhaust valve (except on gas fueled models) is used. Tappets are adjustable, self locking.

GENERATOR DETAILS

All generators of this series generating plants are revolving armature, self excited type. All have four poles except 3000 and 3600 rpm ac plants, which have two poles. The machined steel ring frame mounts the pole shoes and field coils. The armature is directly connected to the engine crankshaft through a taper fit and held in place by a stud which passes through the hollow center of the shaft.

AC GENERATORS. - The alternating current generator field is shunt wound. Remote control models have an additional series winding which permits use of the generator as a motor for cranking the plant. The armature contains both ac and dc windings. The direct current is used for energizing the field, and for charging the starting battery of remote control plants.

DC BATTERY CHARGING GENERATORS. - The battery charging type generator field is shunt wound and has an additional series winding which permits use of the generator as a motor for cranking the plant.

CONTROLS

AC MANUAL AND PORTABLE TYPE PLANTS. - These plants are started by manually cranking with a pull rope. The carburetor is manually choked. Electrical load is connected to the plant by plugging into receptacles mounted on the plant. The plant is stopped by pushing a stop button on the plant blower housing. This type plant cannot be connected to batteries for electric starting.

AC REMOTE CONTROL PLANT. - The remote control ac plant is designed for electrical starting. Remote control switches can be connected to provide for control of starting and stopping from convenient stations. Automatic (load demand) or line transfer (power failure) equipment can be connected for unattended control of starting and stopping. Certain models require the addition of an additional start disconnect relay for such service. The remote control plant, using battery power for cranking, has a battery charging circuit. Some models are provided with a high-low charge rate switch and ammeter - others have a single charge rate with no ammeter.

BATTERY CHARGING PLANT. - The battery charging plant is equipped for electrical starting at the plant. The control box is mounted over the generator and contains a reverse cur-

rent relay, start solenoid, a charge rate ammeter, start switch, stop switch, and battery connection terminals. The battery charge rate is adjustable by changing the governed speed. The carburetor on electric start models is manually choked. On models modified for remote starting the carburetor is electrically choked.

STANDARD ACCESSORIES

Accessories supplied vary according to the particular model, and may include: manual starting rope, muffler, fuel tank, and mounting cushions. Plants intended for permanent installations are usually provided with a separate fuel tank and connecting line, and a flexible exhaust tube.

OPTIONAL ACCESSORIES

PULL-ROPE RECOIL STARTER KIT. - For added convenience and easier hand-starting, a Pull-Rope Recoil Starter Kit is available which can be easily aligned concentric with the crankshaft and mounted on the engine blower housing. The starter adds approximately 2-3/4 inches to the overall length of the plant. This equipment does not apply to vacuum-type-cooled plants.

GAS CARBURETOR. - A carburetor for gas only can be installed at the factory in place of the regular gasoline carburetor. The output capacity of the plant might be reduced with gas fuel.

LINE TRANSFER CONTROL.*- The line transfer control is designed to provide for automatic switching to the generating plant in case of failure of a normal source of power, such as a commercial power line. The control disconnects the "failed" power source, starts the emergency generating plant, and connects the load line to the plant output. When the normal power source is restored, the control disconnects the load from the generating plant. stops the plant, and connects the load back to the normal power source.

AUTOMATIC CONTROL.* - The automatic control provides for automatic starting of the generating plant when an electric load is switched on, and stopping of the plant when the load is turned off.

* - Separate instruction manuals with service and repair information for all types of controls are available on request.

Satisfactory performance of this generating plant is dependent on correct adjustments. However, adjustments cannot fully compensate for low engine power, neglect of periodic servicing, etc.

GOVERNOR. - The governor controls the speed of the engine. Always have the starting batteries (where used) properly connected when operating the plant.

On ac generating plants, engine speed determines the output voltage and current frequency of the generator. By increasing the engine speed, generator voltage and frequency are increased, and by decreasing the engine speed, generator voltage and frequency are decreased. An accurate voltmeter is required to adjust the governor of ac plants. A small speed drop not noticeable without instruments will result in an objectionable voltage drop.

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

A binding in the bearings of the governor shaft in the ball joint, or in the carburetor throttle assembly will cause slow governor action or poor regulation. Looseness or excessive wear in the governor mechanism 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.

When the plant is stopped, tension of the governor spring should hold the carburetor throttle arm at the wide open position, pushed toward the generator end of the plant. At wide open position, the lever on the throttle shaft should just touch the carburetor body or clear it by no more than 1/32 inch. This setting can be obtained by increasing or decreasing the length of the connecting linkage as necessary, by turning the ball joint on the threads of the link. Be sure to retighten the ball joint to the governor arm. This operation synchronizes governor action with the carburetor throttle action.

ADJUSTING THE GOVERNOR, AC PLANT. - Refer to the illustration, Governor Adjustment. Connect the voltmeter across the output of the generator. With no electrical load connected, start the plant and adjust the speed adjusting nut go give a voltmeter reading of approximately 126 volts maximum for a 120 volt plant. Apply a full rated electrical load and again observe the voltage reading, which should be approximately 108 volts

minimum. For 240 volt plants, 252 V. at n.l. is maximum and 216 V. f.l. is minimum. The correct sensitivity adjustment gives the closest regulation without causing a hunting condition. If the voltage spread between no load and full load is too great, move the end of the speed spring closer to the governor shaft. Test the governor action at various loads. If voltage regulation is good, but there is a tendency toward hunting at times, the sensitivity adjustment is too close and the sensitivity stud must be turned outward slightly. Any change in the sensitivity adjustment will require a speed readjustment.

If a tachometer is used for adjusting the governor, engine speed at full load for a 60 cycle plant should be about 1800 rpm for a 4 pole generator, and 3600 rpm for a 2 pole generator, with a spread of not more than 100 rpm between no load and full load. Engine speed at full load for a 50 cycle plant should be about 1560 rpm for a 4 pole generator, and 3000 rpm for a 2 pole generator.

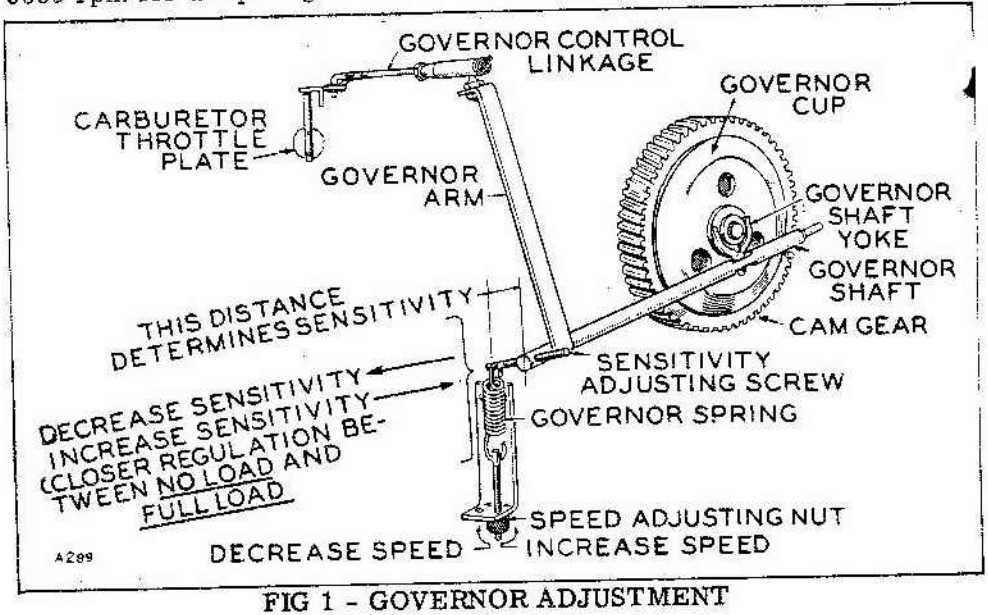


FIG 1 - GOVERNOR ADJUSTMENT

AUTOMATIC IDLE ADJUSTMENT. - Some 3600 rpm models are equipped with a special idle device to drop the engine speed to approximately 1800 rpm when the plant is operating at no load (without an electrical load connected). The idle device automatically restores operating speed when an electrical load (100 watts or more) is connected.

Refer to the illustration. Temporarily disconnect the flexible joint A from the lever B. Its socket part slips off the ball part. Snap the idle switch, on the outlet box, to its OFF position. Adjust the governor for normal 3600 rpm operation under no load to full load conditions, with

nuts H loosened. Tighten lock nuts H, with spring E as close to the end of the sensitivity screw as possible. Reconnect joint A to lever B. Turn the stop adjusting screw F down for maximum lever movement.

Snap the idler switch to its ON position. With all electrical load removed, the solenoid should pull up and provide sufficient tension on spring E to override the tension of the regulating governor spring and reduce the engine speed to about 1800 rpm. If idle speed is too high, linkage C or D is too long. If idle speed is too low, linkage C or D is too short. With a full electrical load connected, the solenoid plunger should drop downward. Adjust screw F so spring E is firm but not stretched. Be sure all locknuts are tightened.

NOTE

Never operate the plant with the solenoid plunger G removed unless the control toggle switch is at its OFF position.

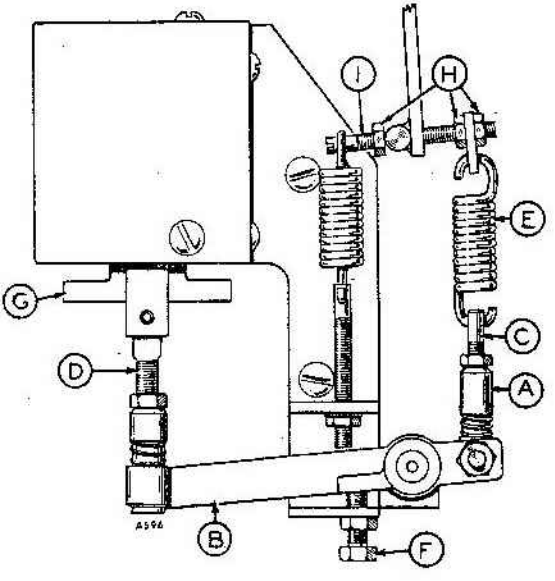


FIG 2 - AUTOMATIC IDLE ADJUSTMENT

ADJUSTING THE GOVERNOR, BATTERY CHARGING PLANT. - To adjust the governor on the battery charging generator, turn the knurled speed adjusting nut (spring tension nut) to give the desired charging rate. The

rate of charge is shown on the control box ammeter. The ability of the governor to keep the charge rate steady at the desired rate depends on the distance between the center of the governor arm shaft and the governor arm end of the spring. If the governor tends to "hunt" or alternately increase and decrease speed, turn the sensitivity adjusting stud outward to move the end of the spring slightly farther from the center of the governor shaft. Any change in the sensitivity adjustment will require a compensating change in the speed (spring tension) adjustment. Increasing sensitivity results in a slight decrease in engine speed. The desired adjustment is a setting which gives the closest regulation without hunting. Maximum speed at full load operation of battery charging plants is approximately 2400 rpm, as specified on the nameplate.

ANTI-FLICKER MECHANISM. - The anti-flicker mechanism is used on 1500 and 1800 rpm ac plants to compensate for a power surge during the power stroke of the engine. The breaker points, located on the left side of the crankcase just behind the gear cover, are connected to a generator field resistor. A condenser connected across the breaker points prevents sparking and burning of the contacts.

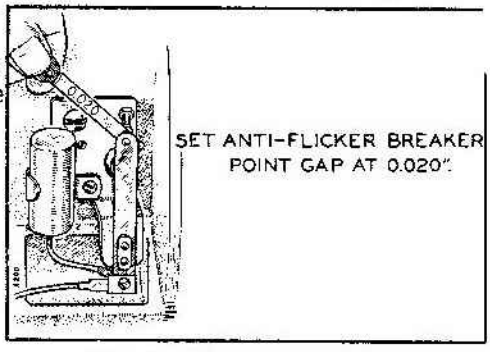


FIG 3 - ANTI-FLICKER

Burned or pitted contact points are usually an indication of a defective condenser. The breaker points gap at full separation should be 0.020". If points and condenser are in good condition but light flicker is excessive, check for a defective resistor.

CARBURETOR. - Refer to MAINTENANCE AND REPAIR-CARBURETOR if it becomes necessary to remove the carburetor for repairs. A small piece of foreign matter lodged in a jet may cause hard starting and poor operation. Dirty gasoline may cause the jets to wear larger, resulting in excessive gasoline consumption. Before tampering with jet settings, mark the existing adjustment or count the number of turns the needle was backed out from its seat.

The carburetor is a side (horizontal) draft type and has two adjusting needles. The "idle" needle is located nearer the cylinder head. The "main" needle is located on the top nearer the air cleaner. Turning a needle inward gives a leaner fuel mixture for that jet.

The correct setting for the main jet needle gives the best stability at full rated load operation. The correct setting for the idle needle gives the best stability at no load operation.

Full load and no load operating conditions are necessary when making carburetor adjustments.

On alternating current plants, to obtain a full rated load condition, connect an ac load equal to the watts or amperes shown on the nameplate. To obtain a no load condition, disconnect all ac load, leaving starting batteries (where used) connected and governor properly adjusted.

On battery charging (dc) plants, to obtain a full rated load condition, leave batteries connected, and increase engine speed to the point where ammeter reading compares with rated amperes shown on the nameplate. To obtain a no load condition, leave batteries connected, decrease engine speed to the point where ammeter reading is zero or as low as possible.

To adjust the carburetor, turn the adjusting needles in gently (finger tight) to their seats. Do not force them in, as they may be damaged by seating too tightly. Back the main needle out about 2-1/2 full turns. Back the idle needle out about 3/4 of a turn. Start the plant and allow it to thoroughly warm up under a full load condition.

Slowly turn the main adjusting needle inward (clockwise) for leaner mixture until the plant begins to lose speed, or the voltage drops. Turn the needle outward (counterclockwise) to the point where the plant will carry the 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. Adjust the idle needle with the plant warm. The batteries must be connected. Make the adjustment with no ac electrical load connected or while at lowest possible charge rate, as the case may be, depending on the type of plant in question. Slowly turn the idle adjusting needle inward (clockwise) until the plant loses speed from lack of fuel. Then turn the nee-

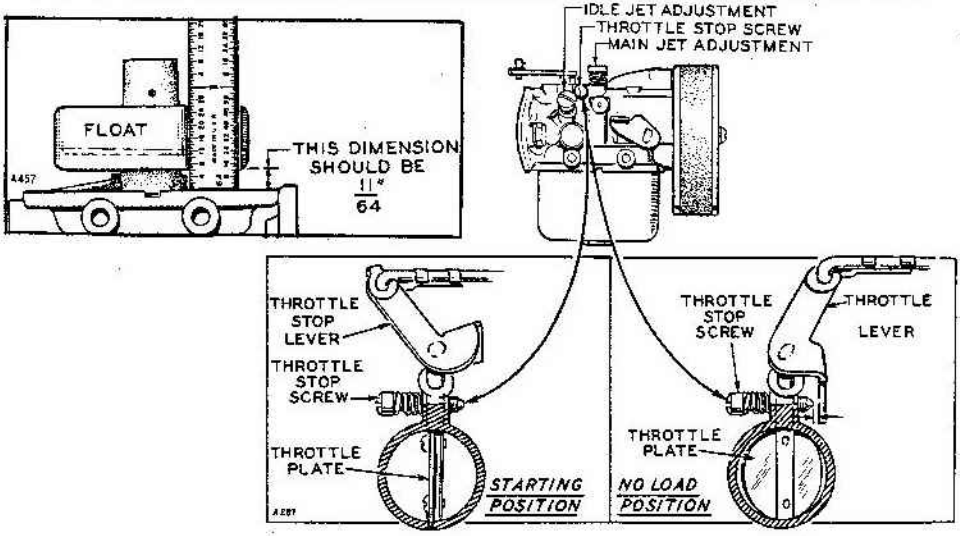


FIG 4 - GASOLINE CARBURETOR ADJUSTMENTS

dle slowly outward until the plant runs smoothly.

The throttle idle stop screw should be adjusted to clear the throttle shaft stop 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 FOR GAS FUEL ONLY. - To adjust the gas fuel carburetor, set the main adjusting screw about 1-1/2 turns open and the idle adjusting screw about 1-1/4 turns open to permit starting the engine. Further adjust the screws as necessary for best operation while allowing the engine to thoroughly warm up under an average load condition. Make the final adjustment of the main adjusting screw while operating with a full load connected. Turn the screw in until the plant voltage (or speed) begins to drop, then turn the screw slowly outward until the voltage (or speed) returns to normal, and operation is steady. If it is necessary to turn the screw out more than 1/2 turn after normal voltage is attained to prevent surging, it may be necessary to adjust the governor for slightly less sensitivity. Make the final adjustment of the "idle" screw for best operation after the load is disconnected.

The weighted carburetor choke should just close, but must be free to open with the air stream during operation. Some chokes are fitted with an adjusting screw - turn in for less choking action, turn out for more choking action.

GAS REGULATOR. - The regulator was factory adjusted to lock-off at a pressure of 4 ounces (7" water column). It will operate satisfactorily at incoming pressures between 2 and 4 ounces. If your gas supply pressure is within these limits, no regulator adjustment is required. If your gas supply pressure is under 2 ounces, the regulator will not operate. If your gas supply pressure is between 4 and 8 ounces, install an appliance regulator set for 2 ounces ahead of the regulator or adjust the regulator as follows:

Warning! A soap bubble placed over the regulator outlet will not accurately test the regulator lock-off. The soap bubbles resistance when multiplied by the greater area of the diaphragm is enough to shut off this very sensitive demand type regulator. A manometer must be used to shown complete regulator shut-off.

1. Use a manometer which reads up to 14 inches water column. (Note: 1 ounce per square inch equals 1.73 inches water column. Likewise 1 inch water column equals 0.58 ounces per square inch).
2. Remove 1/8" pipe plug (C) and connect manometer.
3. With gas supply on and hose removed, alternately cover and uncover the regulator outlet with your hand. If the regulator locks-off com pletely, as desired, the manometer will hold a steady reading. If the manometer reading drops slightly each time you remove your hand, the regulator is leaking.

4. When necessary, adjust the lock-off screw (G) as follows: Turn the the adjusting screw (G) inward just far enough so the manometer reading remains constant when you repeatedly cover and uncover the regulator outlet with your hand.
5. Operate the engine to insure quick starting results.

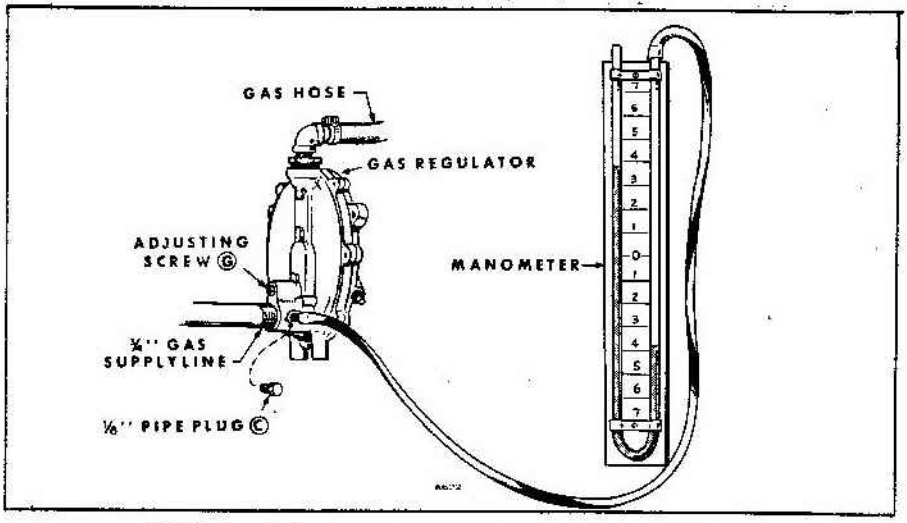


FIG 5 - GAS REGULATOR ADJUSTMENT

ELECTRIC CHOKE. - The ac remote control type plant is equipped with a thermal action electric choke. A thermostatic coil (bi-metal), set at the factory, engages the choke shaft 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.

At a temperature of 70°F., the choke should be approximately 1/8" from the fully closed position. The thermal coil is installed in the choke body in a clockwise direction as viewed starting from the inside turn. The thermal coil tends to coil tighter when heated.

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 counterclockwise direction, looking at the thermal unit end. For more choking action, turn the cover assembly slightly in a clockwise direction.

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 screw after any adjustment.

A manual operating lever and weight, fastened on the opposite end of the choke shaft, may be used to operate the choke in the event the electric element burns out or the choke does not operate for any reason. Turn the lever to its horizontal position to open the choke. Choking position of the lever is vertical. However, choking position on manually choked plants is horizontal.

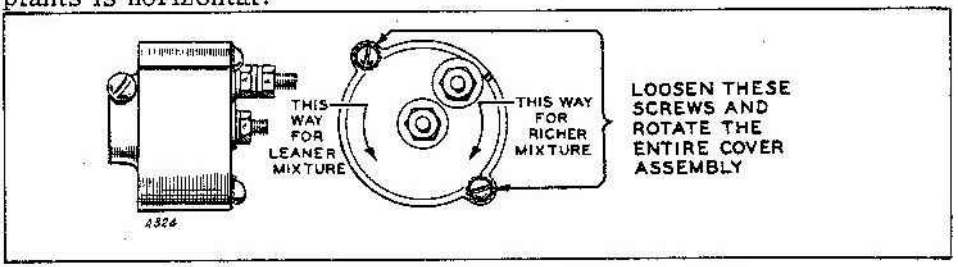


FIG 6 - ELECTRIC CHOKE ADJUSTMENT

MAINTENANCE AND REPAIR

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 repaired 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

	MINIMUM	MAXIMUM
Tappet - Intake Valve	.010"	.012"
Tappet - Exhaust Valve	.010"	.012"
Valve Face, Angle	.44°	
Valve Seat, Angle	.45°	
Valve Interference Angle	1°	
Valve Stem in Guide - Intake	.0010"	.0025"
Valve Stem in Guide - Exhaust	.0025"	.0040"
Crankshaft End Play	.010"	.015"
Crankshaft Main Bearing	.0030"	.0040"
Crankshaft Main Bearing Journal - Standard Size	1.6860"	1.6865"
Crankshaft Rod Bearing Journal - Standard Size	1.3745"	1.3750"
Valve Seat Interference Width	1/32"	3/64"
Camshaft Bearing	.0015"	.0030"
Connecting Rod Bearing	.0015"	.0025"
Piston Pin in Rod - 72°F	Thumb Push Fit	
Piston Pin in Piston - 72°F	Hand Push Fit	
Piston to Cylinder - Cast Iron Block	.0015"	.0035"
Cylinder Bore - Standard Size - Cast Iron Block	2.5005"	2.5015"
Piston Ring Gap - Compression - Cast Iron Block	.007"	.017"
Piston Ring Gap - Oil - Cast Iron Block	.007"	.017"
Magneto Breaker Point Gap (full separation)	.022"	
Anti-Flicker Breaker Point Gap (full separation)	.020"	
Magneto Pole Shoe Air Gap	.010"	.015"
Spark Plug Gap - Gasoline Fuel	.025"	
Spark Plug Gap - Gas Fuel	.018"	
Ignition Timing Advance - 3000 and 3600 rpm	25°B.T.C.	
1800 rpm Plants	19°B.T.C.	
Cylinder Head Screw, Torque	24-26 lb. ft.	
Connecting Rod Screw, Torque	10-12 lb. ft.	

ENGINE

CARBURETOR. - Carburetor maintenance should consist of regular cleaning. Some types of gasoline have a tendency to form 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.

Carburetor adjustments appear in the adjustment section herein. See that the float is not damaged. Be sure the throttle assembly works freely. When reinstalling adjusting needles, do not force them into their seats. The carburetor for the 3600 rpm plant has a larger venturi than other models.

MAGNETO. - The high tension magneto supplies ignition current to the spark plug. Proper timing of the spark is accomplished by a breaker mechanism actuated by a cam on the crankshaft. To test the spark, disconnect the cable from the spark plug and support it so the end of the wire is 3/16 inch from a clean metal part of the engine, such as the spark plug base. Crank the engine with the hand rope, observing the spark, which should jump the 3/16 inch gap with ease. If there is no spark, or a spark that is weak or yellowish in color, make repairs as necessary.

Remove the air housings and blowerwheel on Vacu-Flo units or just the blower housing on pressure cooled units. Loosen the flywheel bolt a few turns. While pulling or prying outward on the flywheel, strike the flywheel bolt a sharp endwise blow to loosen the flywheel. Remove the flywheel bolt and carefully pull the flywheel off the crankshaft. Examine the magneto breaker contact points. Contact points which are not badly burned or pitted may sometimes be dressed smooth with a thin flexible abrasive stone or removed and dressed on any fine stone or hone. Badly burned or pitted points should be replaced with new ones. Adjust the gap between points at full separation as given in the Table of Clearances. A defective condenser must be replaced with a new one of proper capacity. A flywheel magnet which has lost its magnetism can be remagnetized. If the magneto backplate has been loosened or removed, see that the gap between the coil poleshoes and the flywheel is .010 to .015". Too wide an air gap would produce a weak spark.

TIMING THE IGNITION. - Proper timing of the spark is important for good engine operation. Refer to the Table of Clearances for the correct degree of spark advance before top center (TC) position of piston travel. If available, use a series type test lamp for accuracy.

See that the point gap is properly adjusted. Install the flywheel loosely with its key in place, and turn the flywheel in the direction of rotation to the position where the mark on the edge of the flywheel is in align-

ment with the proper degree mark on the gear cover. The points should just separate at this point. If they do not, remove the flywheel and loosen the magneto backplate mounting screws slightly. If the points do not separate soon enough, shift the entire backplate assembly slightly in a counterclockwise direction. If the points separate too soon, shift the backplate assembly clockwise. Retighten the backplate mounting screws and recheck the work for accuracy. When replacing the flywheel, always make sure the key is properly in place on the crankshaft.

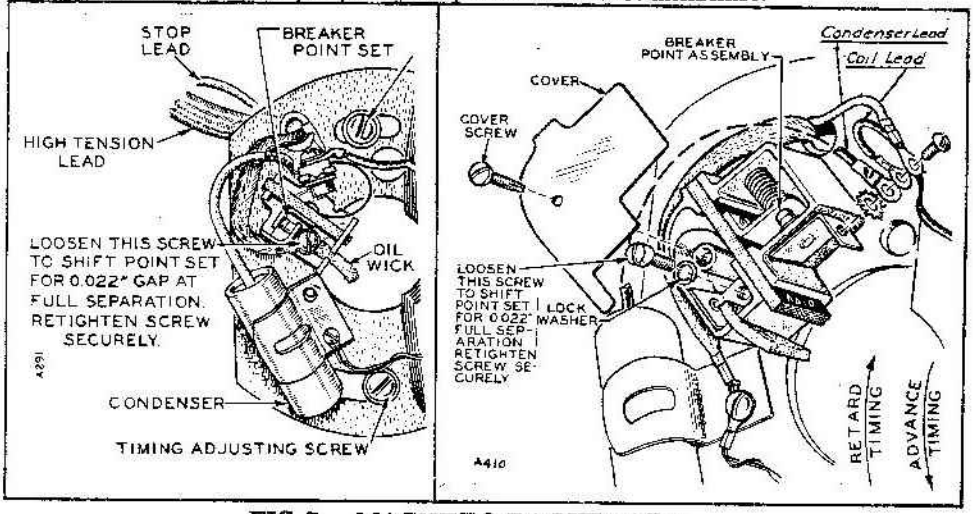


FIG 7 - MAGNETO BACKPLATE

VALVE SERVICE. - Properly seating 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. The intake valve guide must have a gasket under the shoulder. This gasket must contact tightly against the upper valve chamber surface. 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°. The valve SEAT angle is 45°. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life.

The valves should not be hand lapped, if at all avoidable, since the sharp

contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44°. Valve seats should be ground with a 45° stone, and the width of the seat band should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

Remove all grinding dust from engine parts and place 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 turn against the seat.

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

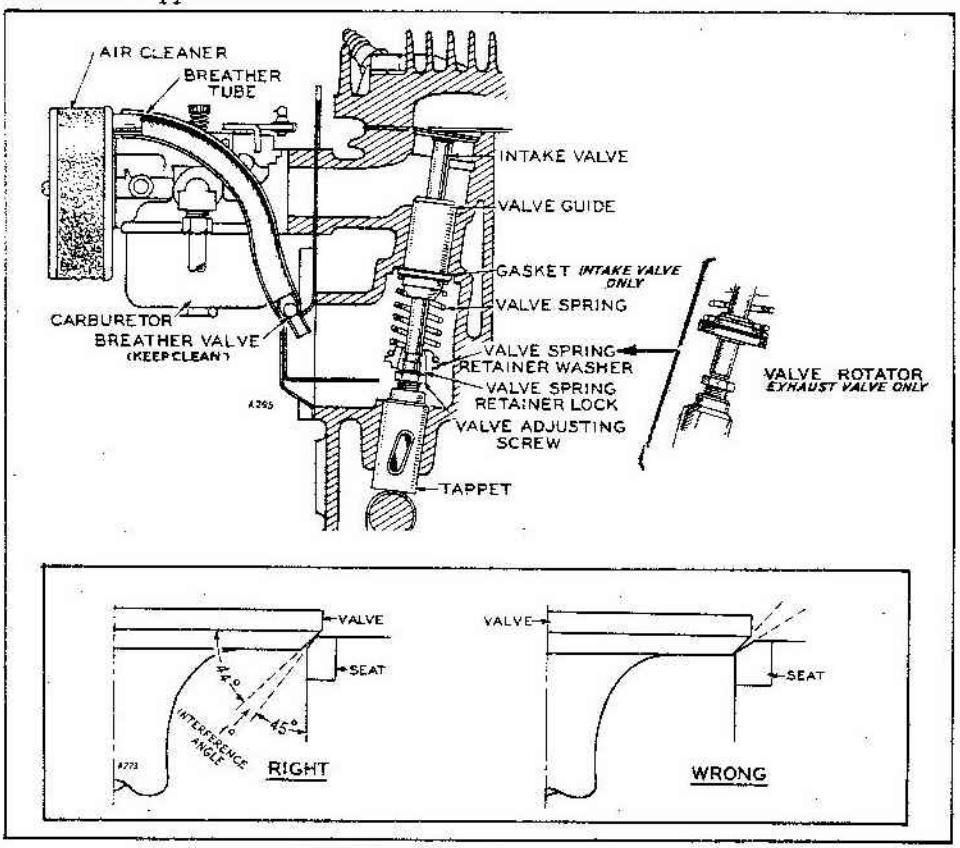


FIG 8 - VALVE SERVICE

TAPPET ADJUSTMENT. - The tappet clearance may be easily checked after first removing the valve compartment cover and the blower housing. Crank the engine over by hand until the intake valve (the one nearest the carburetor) opens and closes. Continue turning the flywheel slowly until the mark on the flywheel is in align-

ment with the TC mark on the gear cover. The correct tappet clearance for both the intake and exhaust valves appear in the Table of Clearance. Tappets are fitted with self locking adjusting screws. Use a 7/16" wrench for the screw, and a 9/16 wrench for the tappet when making any adjustment.

GEAR COVER. - When removing the gear cover, it is not necessary to remove the magneto assembly from the cover. Just disconnect the spark plug lead, at the spark plug, and the stop wire.

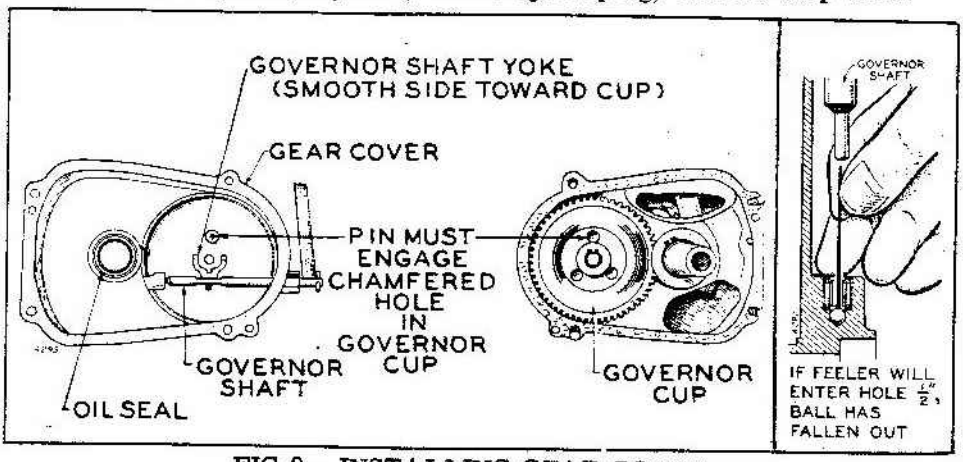


FIG 9 - INSTALLING GEAR COVER

When installing the gear cover, make sure that the pin in the gear cover engages in the one chamfered hole of the governor cup. Turn the governor cup so that hole is in an upward position where it corresponds to the 12 o'clock position on the face of a clock. 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.

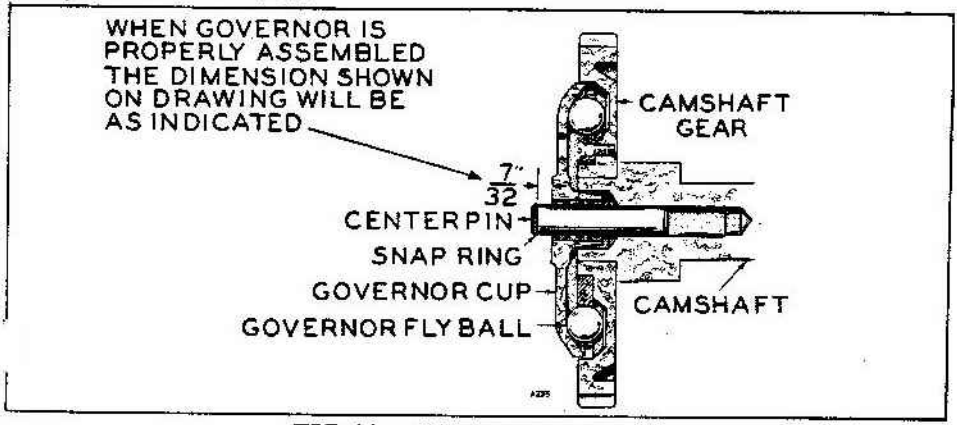


FIG 10 - GOVERNOR CUP

GOVERNOR CUP. - The governor cup may be removed from the cam gear and shaft after first removing the small lock ring from the camshaft center pin. Catch the governor flyballs in the hand as the cup assembly is removed. 3600 rpm units use only 5 flyballs while other models use 10 flyballs in the governor cup.

If a new governor cup is being installed, the distance from the small lock ring on the center pin to the face of the governor cup must be exactly 7/32" when the cup is pressed back against the flyballs as far as possible. If the distance is too small, carefully dress the face of the cup as required, being sure to remove any burr from the inside of the cup bore. If the distance is more than 7/32", carefully press the pin in the required amount. Be very careful not to damage the pin, as it is easier if the plant is tipped backward with the timing gears upward. Be sure that all flyballs are replaced and evenly spaced.

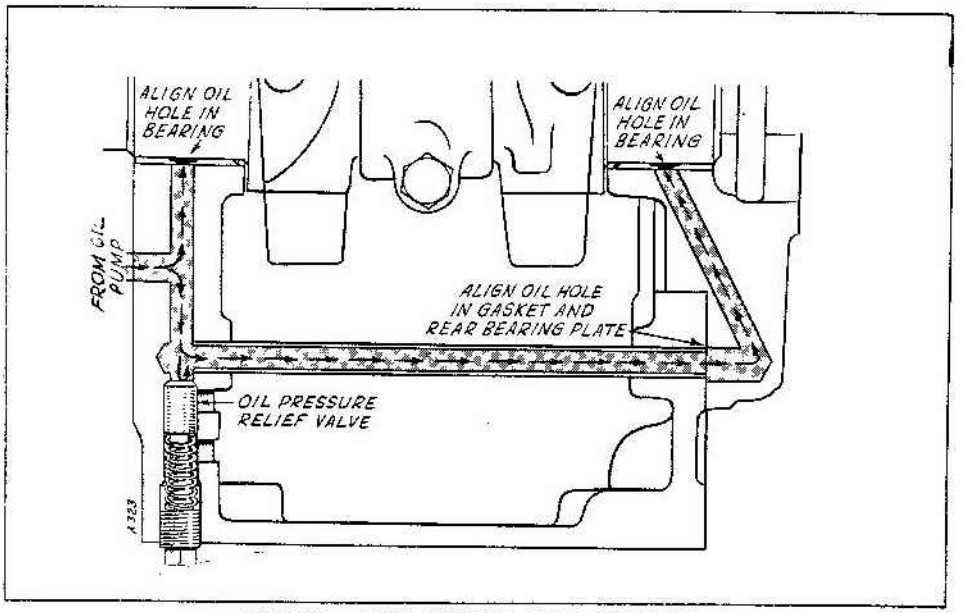


FIG 11 - PRESSURE LUBRICATION

PRESSURE LUBRICATION. - Pressure lubrication does not apply to all models. Pressure lubricated plants have a gear type oil pump, an oil intake cup, a non-adjustable relief valve, and necessary machining. If the oil pump is to be removed, it must be turned off the intake pipe. If the oil pump fails, install a complete new pump. The relief valve can be removed for cleaning. The internal oil line, if accidentally damaged, is replaceable. When installing the oil pump, be sure the pump mounting gasket is in good condition. Install the intake pipe and cup tightly and at the correct angle to have the cup parallel to the oil base. BE SURE THE PUMP IS PRIMED WITH OIL.

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, 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.

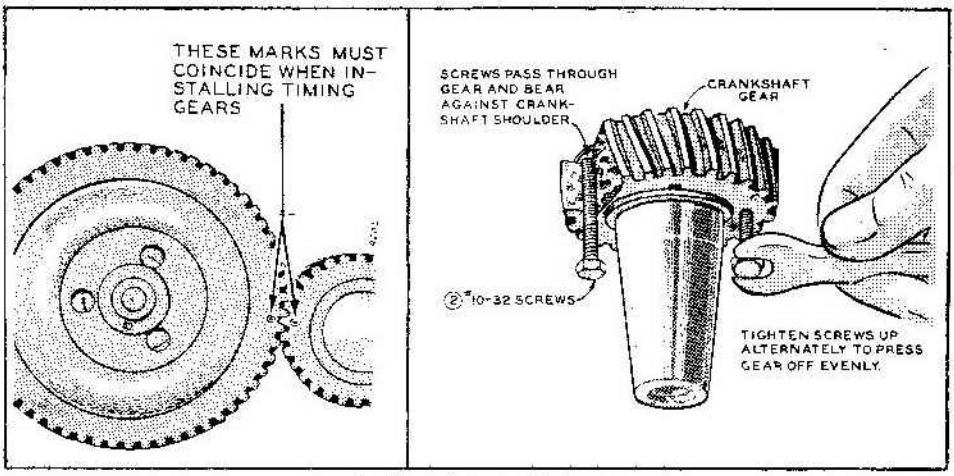


FIG 12 - TIMING GEARS

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 anti-flicker breaker plunger (where used). 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.

If either the crankshaft gear or camshaft gear becomes damaged or worn, replace both gears, never only one. 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", .030" and .040" oversizes. Some engines were fitted at the factory with a .005" oversize piston, and are so indicated by a letter "E" following the engine serial number stamped on the side of the crankcase, and on the nameplate. If the cylinder is 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. Use standard size rings on a .005" oversize piston.

PISTON AND RINGS. - The piston and connecting rod assembly are removed through the top of the cylinder. The piston is fitted with two compression rings and one oil control ring. The piston ring grooves should be cleaned of any carbon deposits, and the oil return holes in the lower groove must be open. Before installing new rings on the piston, check the ring gap by placing each ring squarely in the 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", .030", and .040" oversize rings are to be used on .010", .020", .030", and .040" 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 oil control ring and the two upper grooves fitted with compression rings.

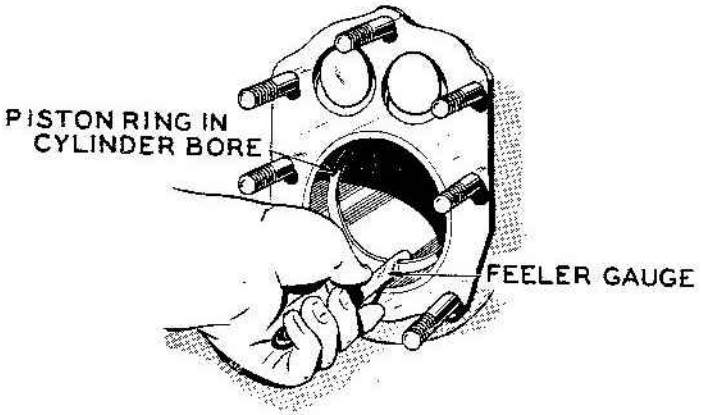


FIG 13 - FITTING PISTON RINGS

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 connecting rod in the engine. Correct piston to cylinder clearance appears in the Table of Clearance.

CONNECTING ROD. - Mark the connecting rod before removing it to assure reassembling with the same side facing the camshaft. Notice that the oil dipper is installed to splash oil toward the camshaft side of the engine.

Connecting Rods are available in standard size or 0.010",0.020", and 0.030" undersize.

The connecting rod bearing clearance to the crankshaft journal may be reduced as necessary by carefully dressing the cap on a sheet of abrasive cloth (#320 grit or finer) placed flat on a surface plate or piece of plate glass.

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.

Be sure the connecting rod oil dipper is properly installed, as it is vital to proper splash type lubrication.

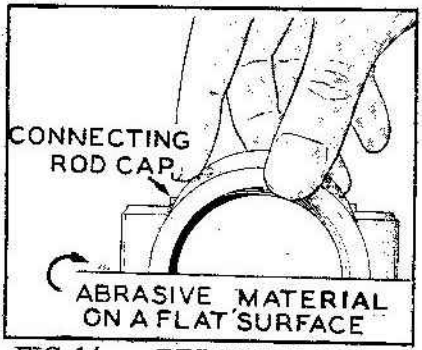


FIG 14 - REDUCING CONNECTING ROD CLEARANCE

MAIN BEARINGS. - The main bearings are the sleeve type babbitt faced, steel backed and are not flanged. Crankshaft main bearings are precision type and are available in standard size, 0.002", 0.010", 0.020", and 0.030" undersize. Precision type bearings DO NOT require line reaming.

Use a press or a suitable drive plug to remove bearings. Have the cylinder block supported to avoid distortion. Be careful to not damage the bearing bore, especially if a punch tool is used.

Warm the bearing plate and cylinder block slightly with hot water or by placing in an oven heated to 200°F. In an emergency, a blow torch may be used, but only a little heat is required. Avoid overheating.

Align the oil hole in the bearing and the oil passage hole in the bearing bore. On splash lubricated units, the oil hole will be upward. On pres-

sure lubricated units, the oil hole will be opposite the camshaft. Install the cold precision bearing so the inside end of the main bearing is 1/16" to 3/32" back from the inside end of the bore to allow clearance for the machined radius of the crankshaft.

Adjust the crankshaft end play as shown in the Table of Clearances by using the correct thickness of gaskets between the rear bearing plate and the cylinder block. These gaskets must not block the oil passage on pressure lubricated units.

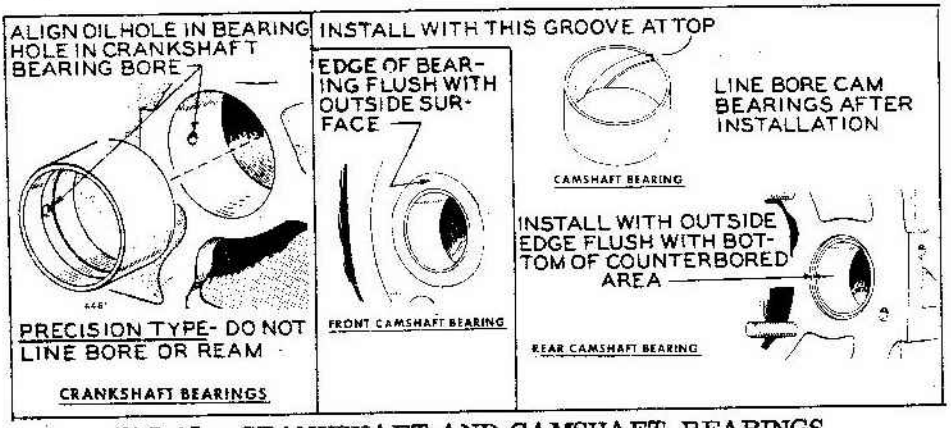


FIG 15 - CRANKSHAFT AND CAMSHAFT BEARINGS

CAMSHAFT BEARINGS. - The steel backed, babbitt lined camshaft bearings are not flanged. These bearings must be line bored after being pressed into the cylinder block. Replacement of the camshaft bearings is not practicable without proper equipment.

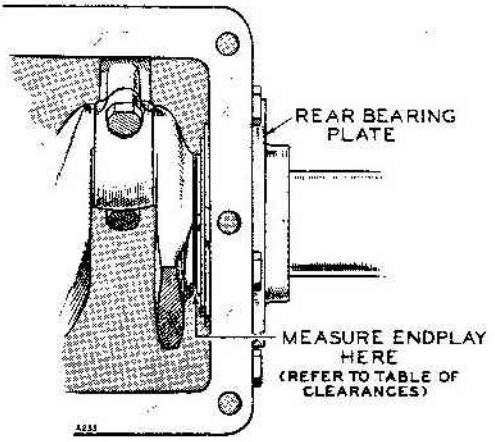


FIG 16 - CRANKSHAFT END-PLAY

Press the front camshaft bearing in flush with the outside surface of the cylinder block. Press the rear camshaft bearing in flush with the bottom of the counterbore which receives the expansion plug.

VALVE COMPARTMENT OIL DRAIN. - A drain hole from the valve compartment enters the crankcase. This hole must be unobstructed to provide for proper drainage of oil from the valve compartment.

OIL SEALS. - When replacing either crankshaft oil seal, be sure the open side faces toward the inside of the engine. Use care not to turn back the edge of the oil seal or damage it in any way. The rear bearing plate must be removed to replace the rear oil seal. Remove the gear cover to replace the front oil seal. Seal expanding and driving tools are available through the dealer.

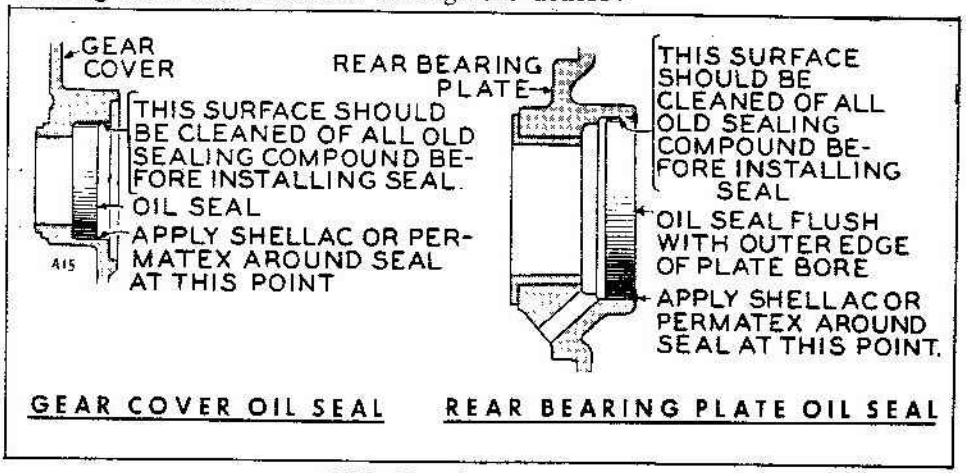


FIG 17 - OIL SEALS

GENERATOR

Two types of generator construction are used in this series of plants. The 3600 rpm plants have a 2 pole generator. All other plants have a 4 pole generator and differ according to the model.

BRUSH REPLACEMENT. - Install new commutator brushes and other rectangular brushes when the old ones are worn to 5/8" or less in length. The cylindrical type or nearly square (1/4 x 3/8) type collector ring brush with spring attached may be used until worn to 5/16" in length. It is not necessary to remove the brush rig to install new brushes. Remove the end cover to expose the brush rig. Brushes and leads are then easily accessible. New brushes are

shaped to fit and seldom need sanding to seat properly. Always use the correct brush as listed in the parts list. Never substitute a brush which appears to be the same, for they may have different electrical characteristics. Be sure to retighten the brush lead terminal nuts tightly. If some brush sparking occurs after replacing brushes, run the plant at a light load until the brushes wear to a good seat.

BRUSH RIG POSITION. - The position of the brush rig is important. The correct setting results in the least sparking at the commutator brushes at average load operation.

On standard models, the neutral brush rig position is determined and permanently fixed at the factory. It cannot shift from neutral position.

Special models may have a brush rig of the adjustable design, and neutral position is identified by a "witness" mark at the point of mounting. As long as the original brush rig and armature are continued in service, these reference marks must be observed. If a new brush rig or armature is installed, the original alignment marks may have to be disregarded in order to find the proper neutral position.

COMMUTATOR. - The commutator, and collector rings on AC plants, acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright, newly machined appearing surface. Ordinary cleaning with a dry, lint free cloth is usually sufficient. Very fine sandpaper (#00) may be used to remove slight roughness. Use only light pressure on the sandpaper while the plant is operating. Do not use emery or carborundum paper or cloth. Clean out all carbon dust from the generator.

After long service, the surface of the commutator may become worn down to the level of the mica insulation between the commutator bars. This condition would lead to noisy brush action, excessive brush sparking and wear and pitting of the commutator bars.

Undercut the mica between the bars to 1/32" below the surface of the bars. If it is not convenient to take the armature to an electric shop, the operation may be done with a tool fashioned from a hack saw blade.

Grind the blade to a thickness equal to the thickness of the mica between the bars. Do not scratch the surface of any bar. Use sandpaper to remove any burrs left along the edges of the bars. See that spaces between the bars are perfectly clean before reassembling the generator.

If the commutator becomes damaged or wears unevenly so that it is grooved or out of round, turn it smooth on a lathe. After turning, the mica must be undercut as described above.

GENERATOR DISASSEMBLY. - To disassemble the generator, first remove the end cover. Lift each brush high in its guide, so that the brush is held by spring pressure against its side. It is not necessary to remove the brush rig from its support. Tag leads which are disconnected, to assure correct replacement. Mark the position of other parts by scratching them to aid correct reassembling. After removing the two frame stud nuts, the brush rig and frame may be removed as a unit, the armature bearing remaining on the armature.

To remove the armature, loosen the armature center nut just enough to avoid damaging the threads. While pulling outward on the armature, strike the nut a sharp endwise blow with a heavy soft faced hammer, to loosen the armature. The armature has an external taper which fits into the internal taper of the engine crankshaft. When the armature is loose, remove the stud nut and slide the armature carefully off the through stud.

GENERATOR REASSEMBLY. - Upon reinstalling the armature, be sure the run-out at the commutator end is not more than .012". Excessive run-out may be due to a nick or dirt on the taper of either the armature or crankshaft. Remove any foreign material, install the armature, then correct excessive run-out by striking the high side of the shaft near the ball bearing. Never strike the commutator.

On armatures not having a ball bearing, strike against a board held flat to the side of the lamination, to correct excessive run-out.

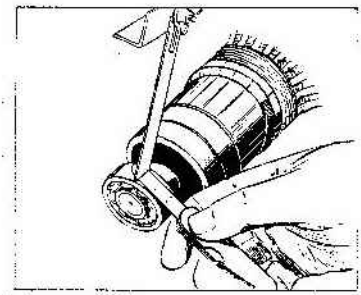


FIG 18 - ARMATURE RUN- OUT

The frame will mount only in the correct side upward. If the brush rig has been removed, it must be installed in the original position. Avoid accidentally damaging brushes during assembly. Check for good brush contact and for good spring tension.

FIELD WINDINGS. - A ground or open circuit in the field coils may be determined by the use of a continuity type test lamp. Disconnect (and tag) all field leads. Refer to the proper wiring diagram. Test the field winding for an open circuit by placing one test prod on each of the two terminal ends of the winding. If the test lamp does not light, the field winding is open. If the open circuit can be located in one of the external leads, the break can be easily repaired. An internal break usually requires replacement of the coil set. A

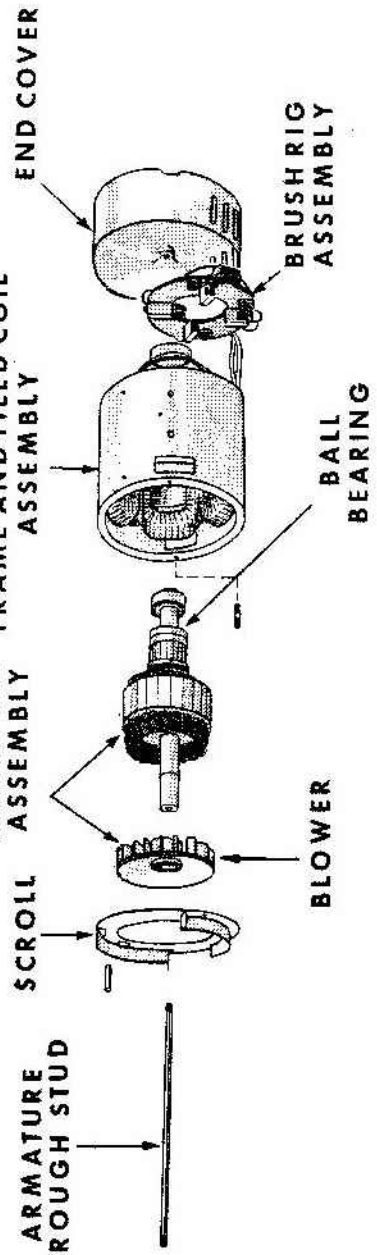


FIG 19 - GENERATOR ASSEMBLY

grounded condition can be determined by placing one test prod on a terminal end of the winding and the other test prod on a bare metal part of the generator frame. If the test lamp lights, a ground is indicated. Find the point where the ground occurs and repair as necessary.

An internal short circuit is best located by the use of a sensitive ohmmeter. Compare the resistance of each individual coil winding. A short circuit is indicated by a lower resistance reading. Replace the entire coil set assembly if a short circuit is indicated.

ARMATURE. - The armature may be tested for a ground by placing one test prod of a continuity type test lamp on the center shaft and the other test prod first on the commutator, then on one of the collector rings. If the test lamp lights, the armature is grounded. Place a test prod on each of the two collector rings. If the test lamp does not light, the ac winding has an open circuit. The use of an armature growler is required to test the dc winding for an open circuit, and to test for a short circuit. Follow the directions of the growler manufacturer.

CONTROLS

CONTROL BOX EQUIPMENT. - Always disconnect the battery from the plant whenever servicing any control box equipment. Keep all connections tight and clean, and inspect leads occasionally for worn insulation. If any of the control box equipment does not function properly, replace the defective part with a corresponding new unit. It is seldom practicable to repair relays, switches, etc.

STARTER INSTALLATION. - Follow each step in proper sequence. Refer to the illustrations for part reference numbers.

1. Remove the flywheel screw. Leave the existing rope sheave in place. The washers and screw are also reused. The sheave provides easier emergency cranking than the starter cup.

2. Secure cup #2 by placing lockwasher #26 and flatwasher #24 between cup and capscrew #23. See Figure 20b.

3. Assemble the mounting ring #3 (sometimes called bracket) to the starter (if not already so attached) using the four screws #4. Select the correct one of four possible positions to give the desired direction of rope pull.

4. Place three "U" shaped speed nuts #22 on the engine housing with the longer end of the "U" nut toward the inside.

5. Failure to center the starter properly will damage the starter!! Incorrect alignment may be caused by distortion or shifting of the blower housing on the engine.

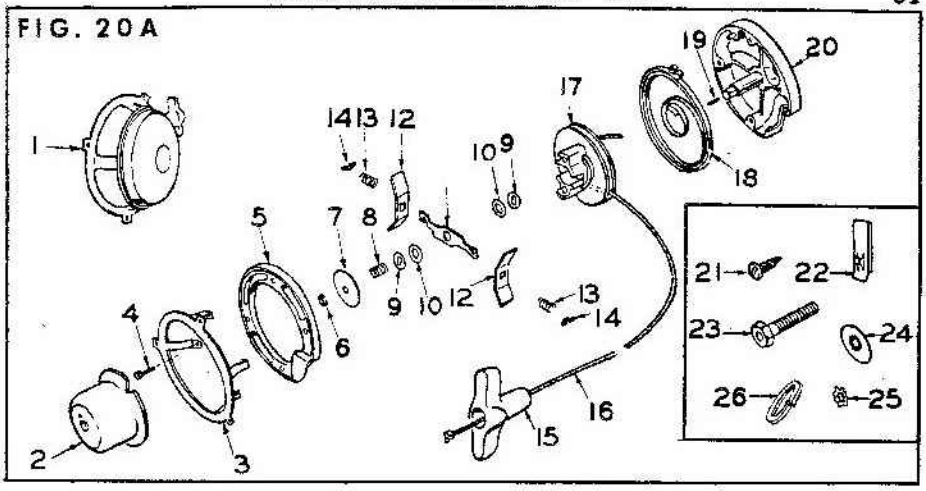
   Place the starter against the engine blower housing and check to see that the centering pin #19 engages the center hole of the cup-and-flywheel-mounting capscrew while the starter mounting holes align. (NOTE: If the centering pin does not extend far enough to engage the center hole of the capscrew, a pair of pliers can be used to pull the pin out farther.) Use the three sheet metal screws #21 to mount the starter securely to the blower housing.

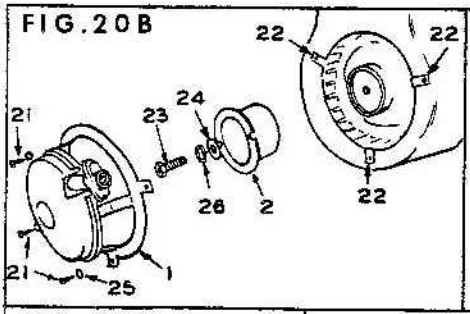
6. Operate the starter to see that the installation is satisfactory. After the starter is mounted on the engine, there should be clearance of about 1/8 inch between cup #2 and rotor face # 17. A minimum clearance of 3/32 inch between capscrew #23 and starter shaft must also be maintained.

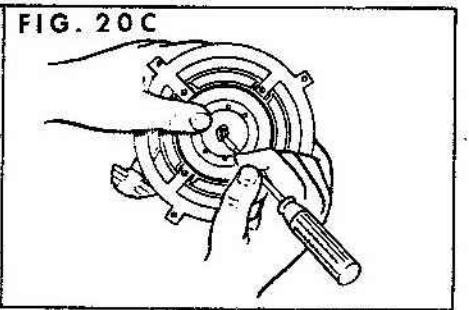
7. During operation, the starter friction shoe plates will roughen the cup. This condition is normal.

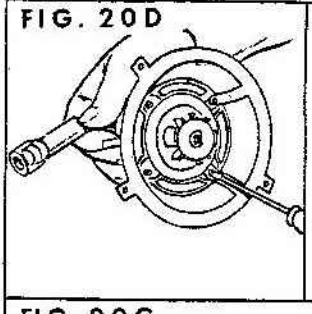
8. When operating the starter, slowly pull out at least six inches of cord, then give a fast steady pull. By this method, cord breakage is less apt to occur due to a false start and engine backfiring.

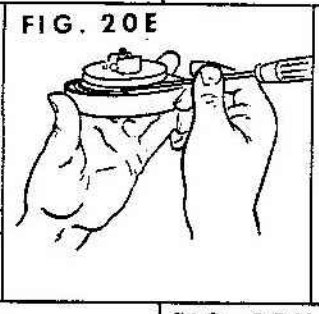
STARTER DISASSEMBLY. - CAUTION: Improper disassembly may allow rewind spring to release wildly and cause personal injury.

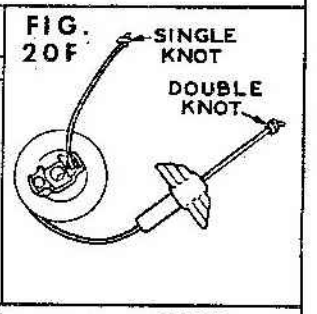


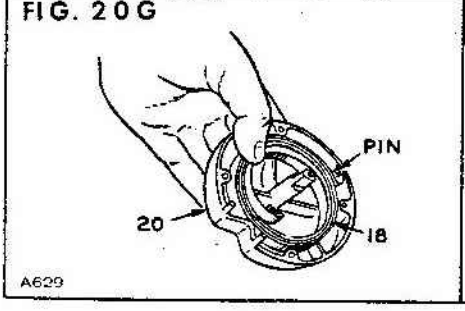












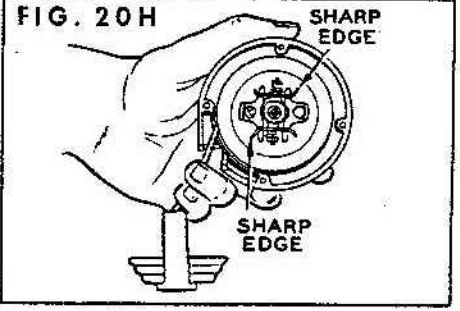


FIG. 20 - ROPE-RECOIL STARTER

1. Loss of spring #8 can be avoided by holding washer #7 in position with hand while removing truarc retainer ring #6 with a screw driver. See Figure 20c.

2. Remove the following parts and assembly:

   Large washer #7; Brake Spring #8; Washers #9 and 10; Friction Shoe Assembly - (Including parts #11, 12, 13 and 14); Washers #10 and 9.

3. To prevent spring rotation of rotor (rope sheave) #17, cord can be held as shown in Figure 20d, while removing four screws. Continue to hold rotor and cover as shown and remove mounting ring #3 and middle flange #5. Now the tension of the re-wind spring can be relieved by slowly releasing hold, and allowing spring to unwind.

4. Prevent re-wind spring #18 from escaping from cover (and causing personal injury) by carefully lifting rotor #17 only 1/4 inch away from the cover and detach inside spring loop from rotor as shown in Figure 20e. (NOTE: If spring should escape, it can be replaced in cover easily by coiling in turns).

5. Clean the starter parts. Gummy grease and dirt may cause sluggish performance.

CORD REPLACEMENT.

1. First perform procedure given for starter disassembly.

2. Tie single knot in end of new cord. See Figure 20f.

3. Thread cord through rotor hole and out through rotor cord groove, pulling knot into cavity, then wind rope on rotor. Replace handle, tying a double knot.

4. Perform procedure given for starter assembly.

RE-WIND SPRING REPLACEMENT.

1. First perform procedure given for starter disassembly.

2. Starting with the inside loop, remove re-wind spring #18 carefully from cover #20 by pulling out one loop at a time, holding back rest of turns. NOTE that starting from the outermost coil of the spring, the spring must be wound in crankshaft rotation direction.

3. Spring holders furnished with replacement springs simplify the assembly procedure. Place spring in proper position as shown in Figure 20g, with the outside loop engaged around the pin. Then press spring into cover cavity thus releasing the spring holder.

4. Lubricate the shaft with a film of light grease. Lubricate the re-wind spring with a few drops of SAE 20 or SAE 30 oil. Under extremely dusty operating conditions, if performance indicates a dirty condition, then use only powdered lubricating graphite on the spring or do not lubricate it at all. Avoid lubrication of the brake washers.

5. Perform procedure given for starter assembly.

STARTER ASSEMBLY.

1. First complete installation of re-wind spring and cord.

2. Place rotor #17 (complete with handle and cord wound in proper direction) into cover #20 and hook the inside loop of spring #18 to rotor with the aid of a screw driver or other slender tool. Prevent the unhooking of the rewind spring from the rotor by keeping a slight tension on the spring until later when the middle flange is installed.

3. Install the following parts and assembly:

   Washers #9 and 10; Friction shoe assembly (See Figure 20h for positions.) (Including parts #11, 12, 13 and 14); Washers #10 and 9; Spring #8; Larger Washer #7; and Truarc retainer ring #6.

4. Wind the cord in the proper direction onto the rotor, then add two additional turns of the rotor and cord for pre-tension. A fatigued spring condition may require more additional turns to attain desired pre-tension of the re-wind spring.

5. With tension held on the cord, place middle flange #5 against cover #20, then install mounting ring #3 in position for desired direction of pull and continue as instructed under starter installation.

TROUBLE SHOOTING. - If friction shoe fails to function and engage with the cup, check for failure of brake spring #8, check for lubrication getting onto brake washers #10, and check for proper position of friction shoe sharp edge and friction shoe lever.

Periodically observe if starter assembly has shifted away from centering with crankshaft.

A broken re-wind spring should be replaced with a new one.

The life of a fatigued re-wind spring can be extended by adding turns of the rotor to increase pre-tension and then reinstalling the middle flange. Or, try forming new loops and coiling spring inside-out.

POSSIBLE CAUSE	REMEDY
GENERATOR WILL NOT CRANK ENGINE (ELECTRIC CRANKING MODELS ONLY)	
Battery discharged.	Recharge.
Loose connections.	Tighten connections.
Defective starting circuit.	Repair or replace as necessary.
Defective switch.	Replace.
ENGINE CRANKS TOO STIFFLY	
Too heavy oil in crankcase.	Drain, refill with lighter oil.
Engine stuck.	Disassemble and repair.
ENGINE WILL NOT START WHEN CRANKED	
Faulty ignition.	Clean, adjust, or replace breaker points, plug, condenser, etc., or retime magneto.
Lack of fuel or faulty carburetion.	Refill the tank. Check the fuel system. Clean, adjust or replace parts necessary.
Clogged fuel screen.	Clean.
Cylinder flooded.	Crank few times with spark plug removed.
Poor fuel.	Drain, refill with good fuel.
Poor compression.	Tighten cylinder head and spark plug. If still not corrected, grind the valves, replace piston rings, if necessary.
Wrong timing.	Reset breaker points or retime magneto.

POSSIBLE CAUSE	REMEDY
ENGINE RUNS BUT VOLTAGE DOES NOT BUILD UP	
Poor commutation.	See that brushes seat well on commutator, are free in their holders, are not worn too short, and have good tension.
Open circuit, short circuit, or ground in generator.	See Generator Repair, Replace part necessary.
Residual magnetism lost.	Consult your dealer.
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST	
Poor compression, usually due to worn piston, rings, or cylinder.	Refinish cylinder. Replace piston 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 correct oil.
Worn engine.	Repair as necessary.
Worn intake valve guide or valve stem.	Replace.
Engine misfiring.	Refer to symptoms of engine misfiring.
Faulty ignition.	Clean, adjust, or replace breaker points, plug, condenser, etc., or retime magneto.
Too much oil.	Drain excess oil.
BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION, FOULING OF SPARK PLUG WITH BLACK SOOT, POSSIBLE LACK OF POWER HEAVY LOAD	
Fuel mixture too rich.	Adjust carburetor or choke. Install needed carburetor parts.
Choke not open	See that choke opens properly.

POSSIBLE CAUSE	REMEDY
BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION, FOULING OF SPARK PLUG WITH BLACK SOOT, POSSIBLE LACK OF POWER UNDER HEAVY LOAD (cont.)	
Dirty air cleaner.	Clean.
Excessive crankcase pressure, causing excessive fuel pump pressure.	Clean breather valve.
LIGHT POUNDING KNOCK	
Loose connecting rod bearing.	Adjust or replace.
Low oil supply.	Add oil.
Oil badly diluted.	Change oil.
ENGINE STOPS UNEXPECTEDLY	
Fuel tank empty.	Refill.
Defective ignition.	Check the ignition system. Repair or replace parts necessary.
DULL METALLIC THUD. IF NOT BAD, MAY DISAPPEAR AFTER FEW MINUTES OPERATION. IF BAD, INCREASES WITH LOAD.	
Loose crankshaft bearing.	Replace unless one of the next two remedies permanently corrects the trouble.
SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE FIRST STARTED	
Low oil supply.	Add oil.
Oil badly diluted.	Change oil.
PINGING SOUND WHEN ENGINE IS SUDDENLY OR HEAVILY LOADED	
Carbon in cylinder.	Remove carbon.
Spark too early.	Adjust breaker points or retime magneto.

PINGING SOUND WHEN ENGINE IS SUDDENLY OR HEAVILY LOADED (Cont.)

Wrong spark plug.	Install correct spark plug.
Spark plug burned or carboned.	Install new plug.
Valves hot.	Adjust tappet clearance.
Fuel stale or low octane.	Use good fresh fuel.
Lean fuel mixture.	Clean and adjust carburetor.
Engine hot.	Check air circulation.

TAPPING SOUND

Tappet clearance too great.	Adjust or replace tappets.
Broken valve spring.	Install new spring.

HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD

Loose piston.	If noise only slight and disappears when engine warms up, no immediate attention needed. Otherwise replace worn parts.

VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR POWER PLANT

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

ELECTRIC MOTOR RUNS TOO SLOWLY AND OVERHEATS AT FAR END OF LINE BUT OK IF USED NEAR POWER UNIT

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

VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING

Speed too low.	Adjust governor to correct speed.
Poor commutation of brush contact.	See that brushes seat well on commutator, are free in their holders, are not worn too short, and have good spring tension.

POSSIBLE CAUSE	REMEDY
VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING (Cont.)	
Loose connections.	Tighten connections.
Fluctuating load.	Correct any abnormal load condition causing trouble.
ENGINE BACKFIRES AT CARBURETOR	
Lean fuel mixture.	Clean or adjust carburetor.
Clogged fuel screen.	Clean screen.
Poor fuel.	Refill with good, fresh fuel.
Spark too late.	Adjust breaker points or retime magneto.
Intake valve leaking.	Grind or replace.
NOISY BRUSHES	
High mica between bars of commutator.	Undercut mica.
EXCESSIVE ARCING OF BRUSHES	
Rough commutator.	Turn down.
Dirty commutator.	Clean.
Brushes not seating properly.	Sand to a good seat.
Open circuit in armature.	Replace.
Brush rig out of position.	Line up properly.
GENERATOR OVERHEATING	
Brush rig out of position.	Adjust.
Overloaded.	Reduce load.
VOLTAGE DROPS UNDER HEAVY LOAD	
Engine lacks power.	See remedies for engine misfires under heavy load.

POSSIBLE CAUSE	REMEDY
VOLTAGE DROPS UNDER HEAVY LOAD (Cont.)	
Poor compression.	Tighten cylinder head and spark plug. If still not corrected, grind the valves. Replace piston rings, if necessary.
Faulty carburetion.	Check the fuel system. Clean, adjust or replace parts necessary.
Dirty air cleaner.	Clean.
Choke partially closed.	See that it opens wide.
Carbon in cylinders.	Remove carbon.
Restricted exhaust line.	Clean or increase the size.
ENGINE MISFIRES AT LIGHT LOAD	
Spark plug gap too narrow.	Adjust to correct gap.
Intake air leak.	Tighten or replace gaskets.
Faulty ignition.	Clean, adjust or replace breaker points, plug, condenser, etc., or retime ignition.
Low compression.	Tighten cylinder head and spark plug. If still not corrected, grind valves. Replace piston rings, if necessary.
ENGINE MISFIRES AT HEAVY LOAD	
Spark plug gap too wide.	Adjust gap.
Faulty ignition.	Clean, adjust or replace breaker points, plug, condenser, etc., or retime magneto.
Clogged carburetor.	Clean jet.
Clogged fuel screen.	Clean.

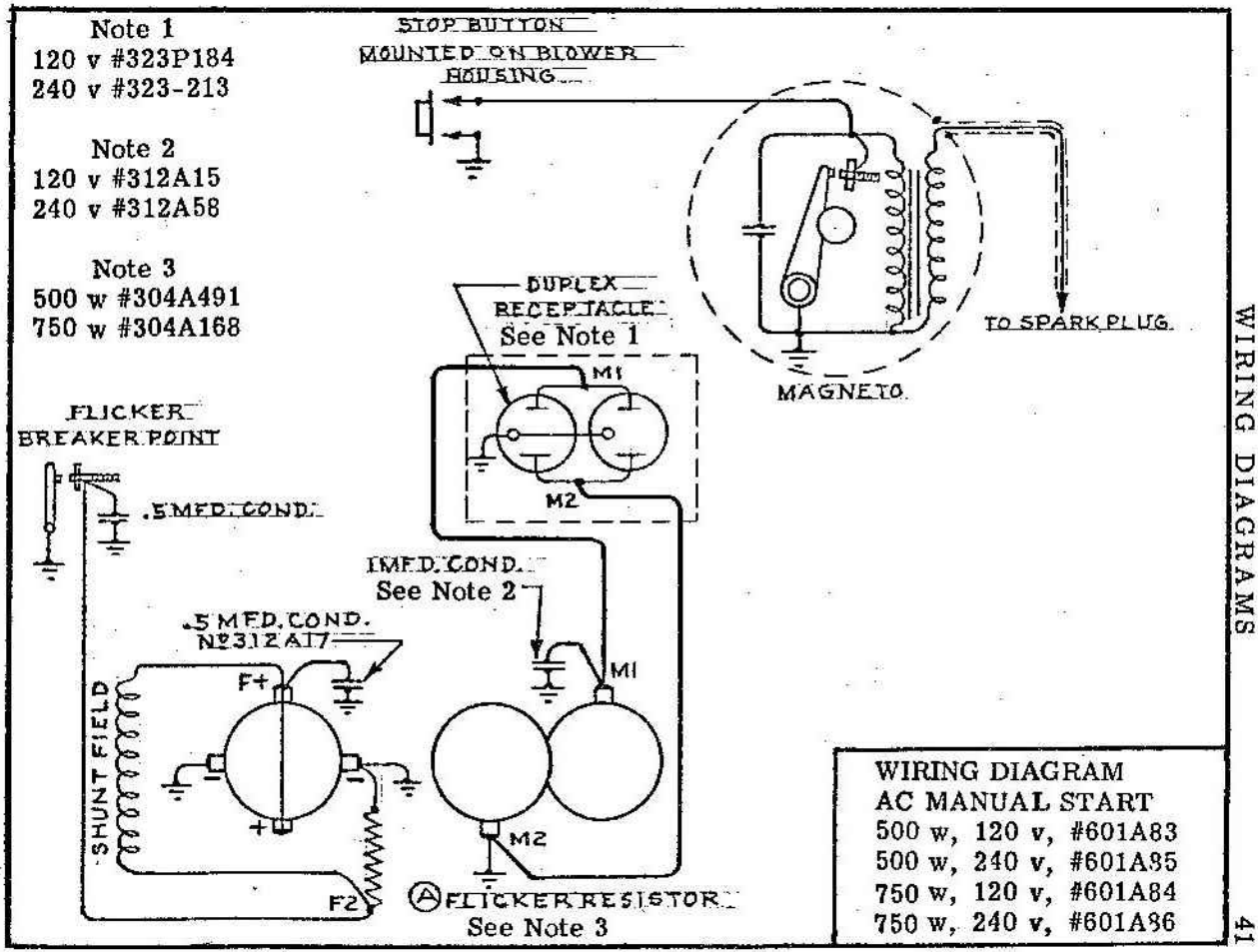
WIRING DIAGRAMS

DIAGRAMS ARE SHOWN FOR PLANTS BEGINNING WITH SPEC. LETTER H. DIAGRAMS FOR PLANTS WITH SPEC. LETTERS PRIOR TO H ARE AVAILABLE. GIVE COMPLETE MODEL AND SPEC. AS SHOWN ON THE PLANT NAMEPLATE.

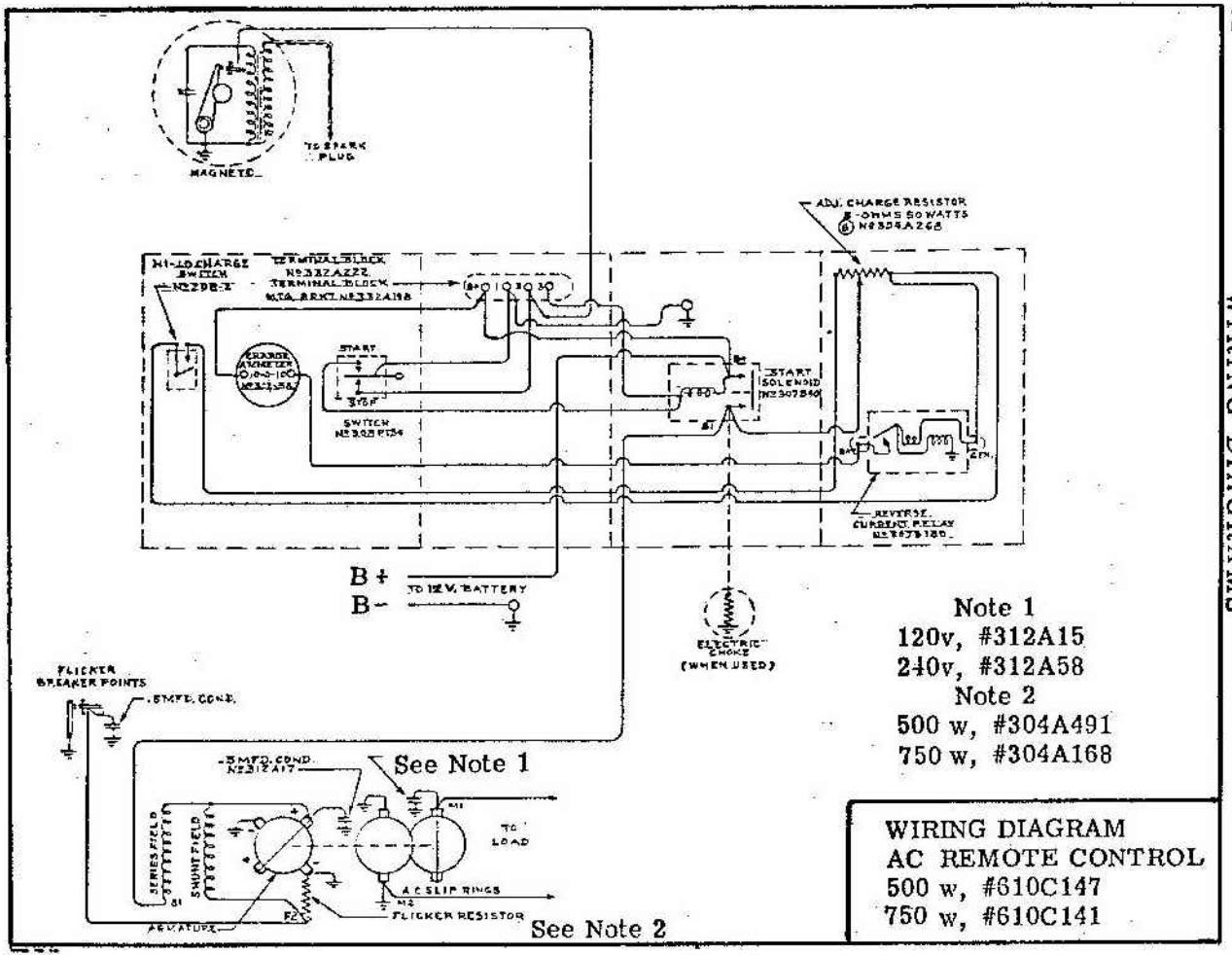
Note 1
120 v #323P184
240 v #323-213

Note 2
120 v #312A15
240 v #312A58

Note 3
500 w #304A491
750 w #304A168

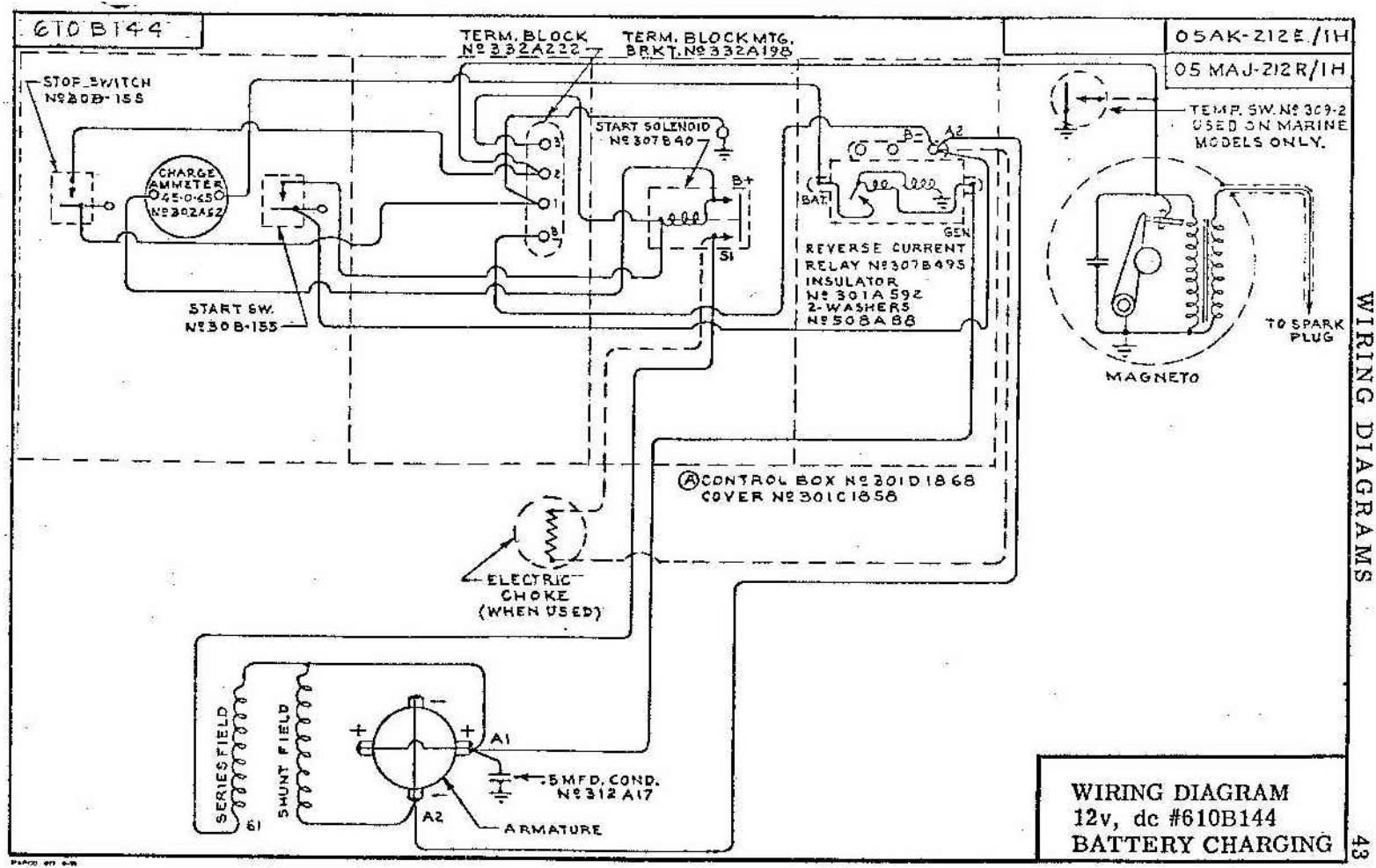


WIRING DIAGRAM
AC MANUAL START
500 w, 120 v, #601A83
500 w, 240 v, #601A85
750 w, 120 v, #601A84
750 w, 240 v, #601A86

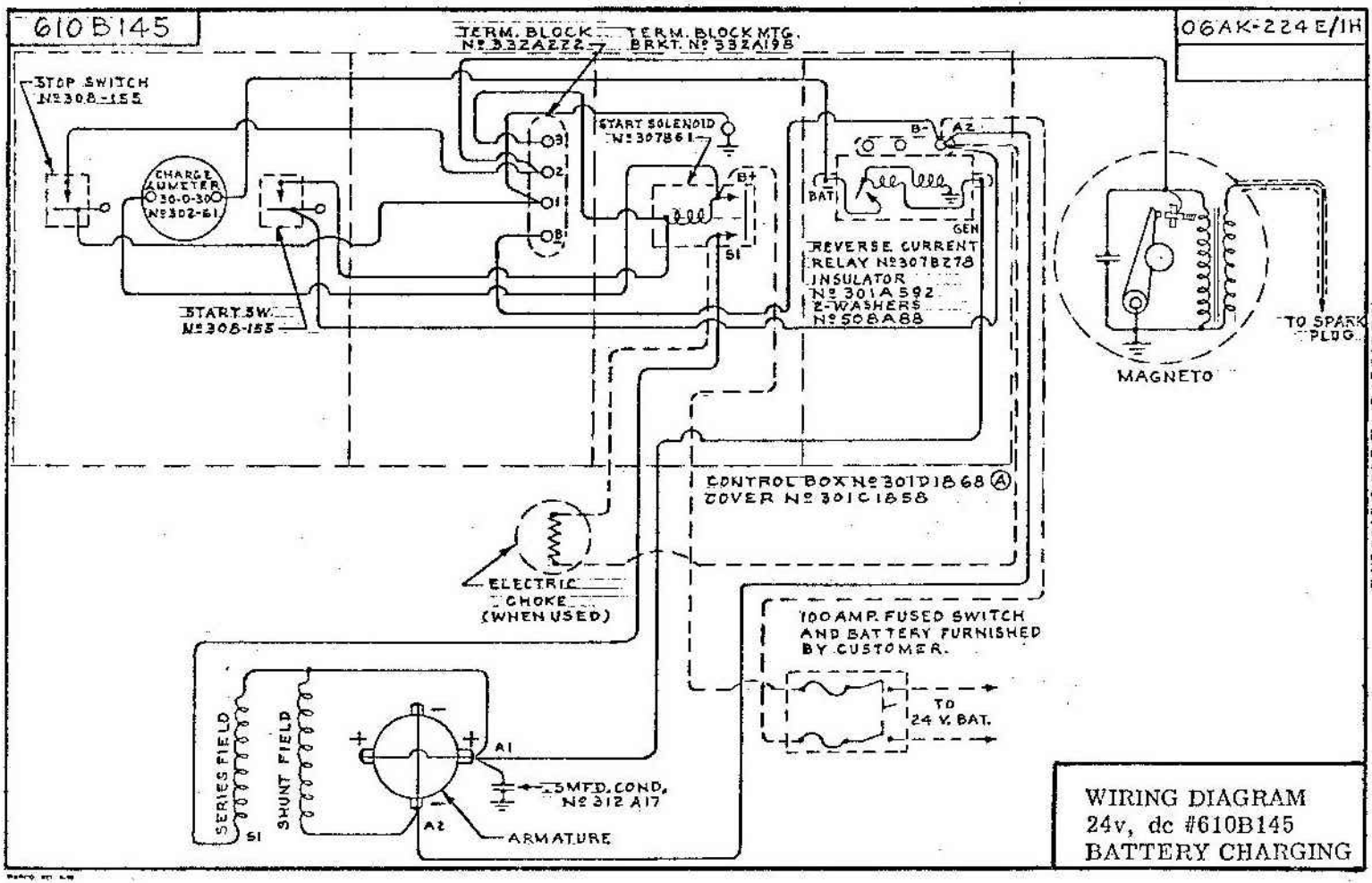


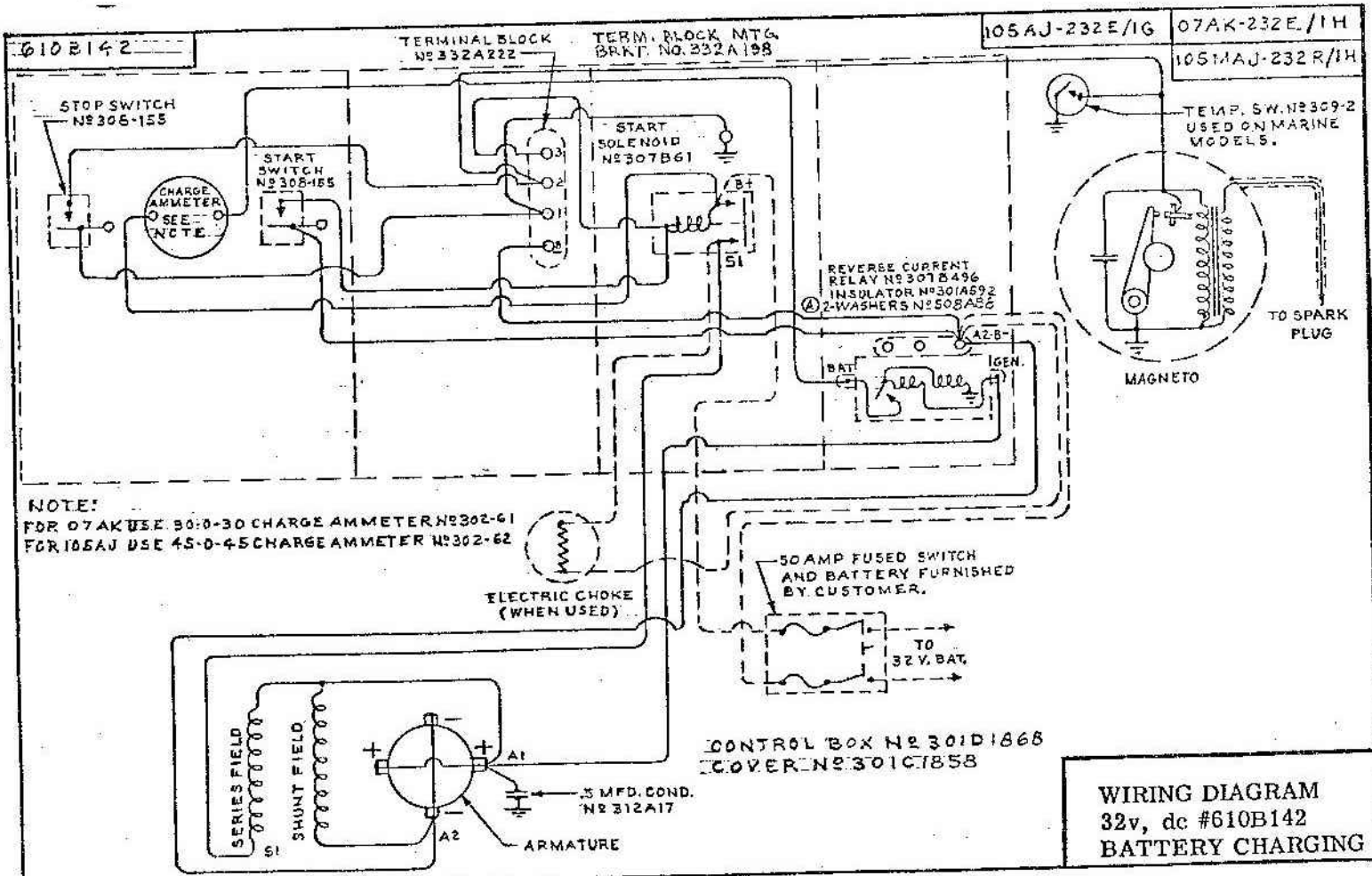
Note 1
120v, #312A15
240v, #312A58
Note 2
500 w, #304A491
750 w, #304A168

WIRING DIAGRAM
AC REMOTE CONTROL
500 w, #610C147
750 w, #610C141



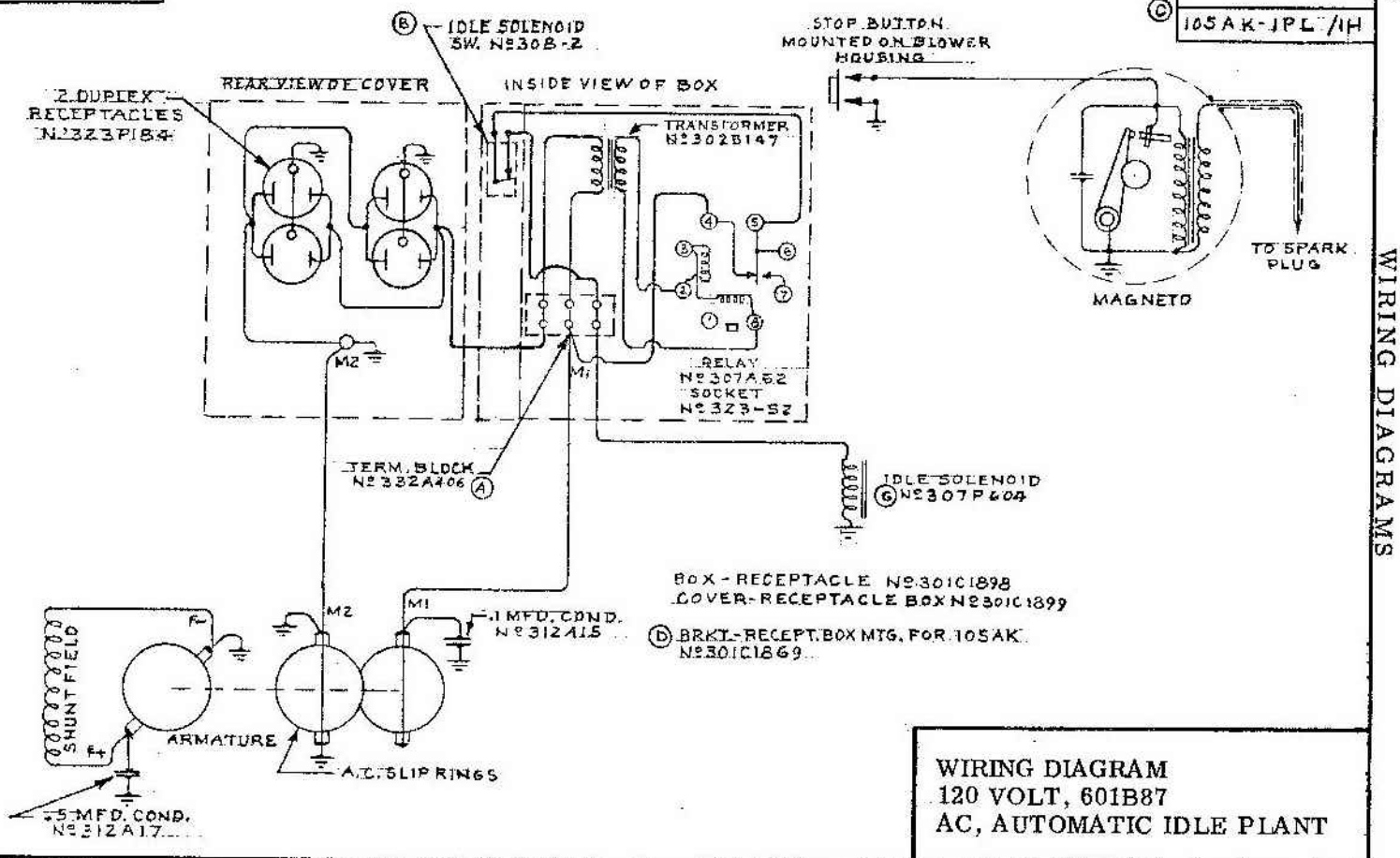
WIRING DIAGRAM
12v, dc #610B144
BATTERY CHARGING


610B145
06AK-224E/1H
TERM. BLOCK Nº 332A222-7
TERM. BLOCK MTG. BRKT. Nº 332A198
STOP SWITCH Nº308-155
CHARGE AMMETER 30-0-30 Nº302-61
START SOLENOID Nº307861
START SW. Nº308-155
REVERSE CURRENT RELAY Nº307BZ78
INSULATOR Nº301A592
2-WASHERS Nº506A88
MAGNETO
TO SPARK PLUG
CONTROL BOX Nº301D1868 (A)
COVER Nº301C1858
ELECTRIC CHOKE (WHEN USED)
100 AMP. FUSED SWITCH AND BATTERY FURNISHED BY CUSTOMER.
TO 24 V. BAT.
SERIES FIELD
SHUNT FIELD
.5MFD. COND. Nº312A17
ARMATURE
WIRING DIAGRAM
24v, dc #610B145
BATTERY CHARGING



WIRING DIAGRAM
32v, dc #610B142
BATTERY CHARGING

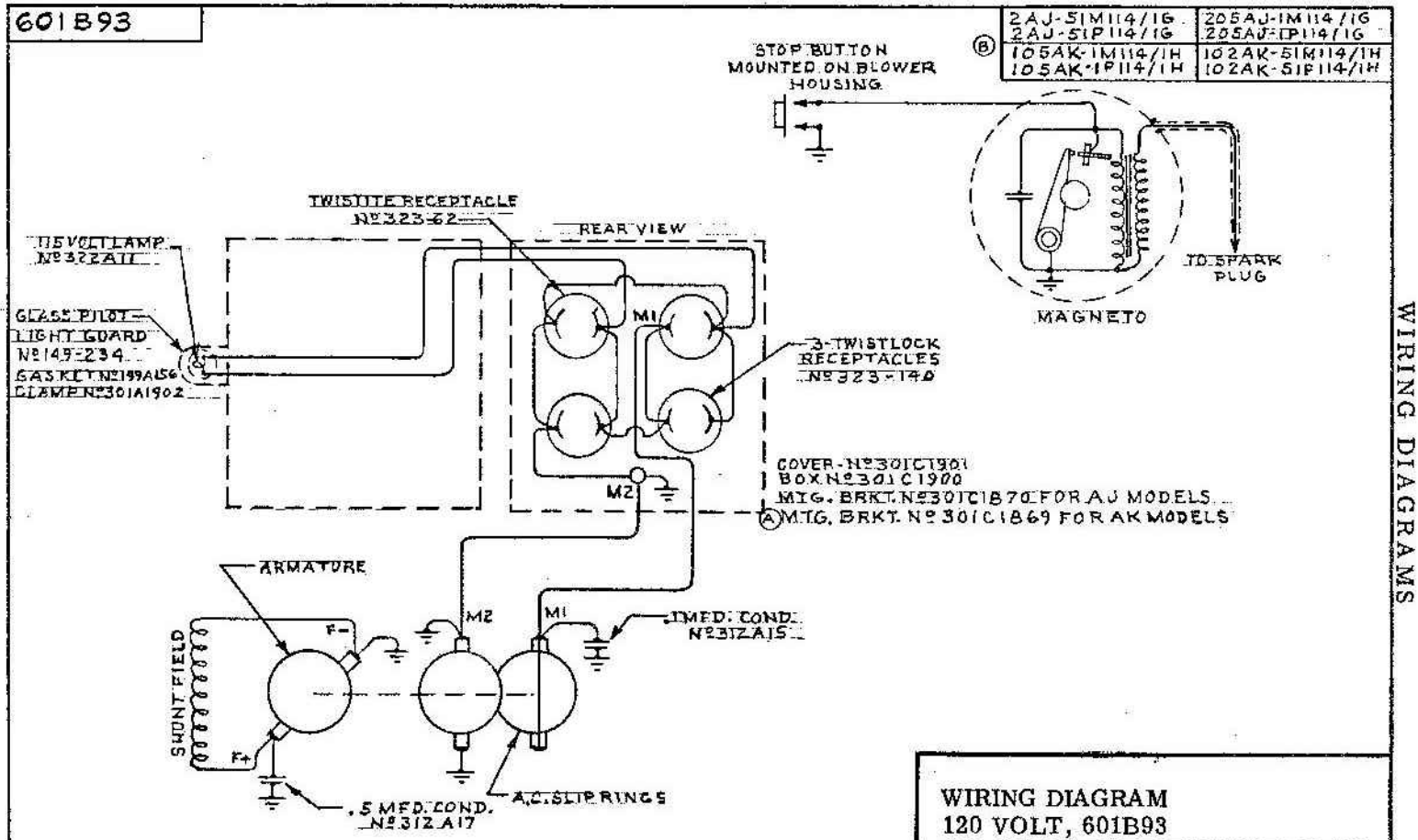
601B87



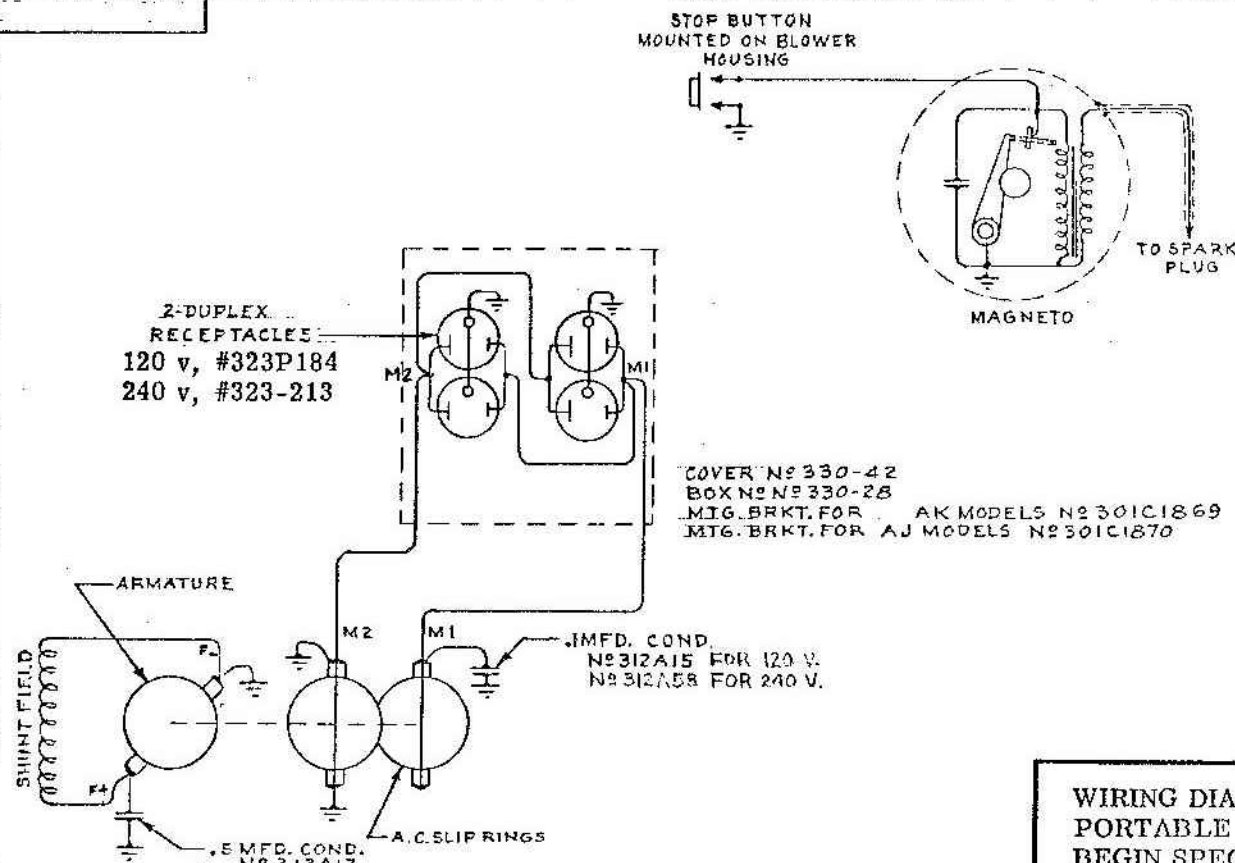
WIRING DIAGRAM
120 VOLT, 601B87
AC, AUTOMATIC IDLE PLANT

601B93

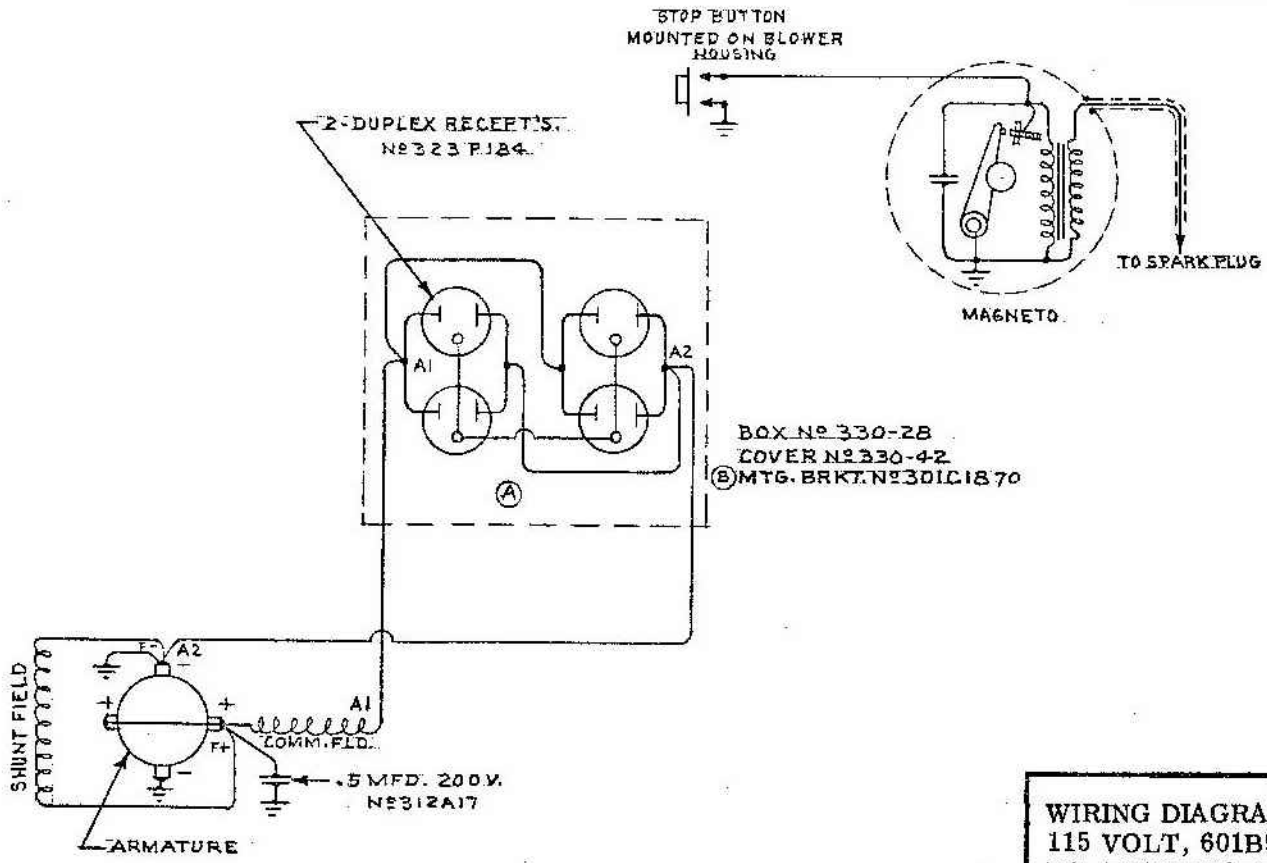
Ⓑ	2AJ-5IM114/1G 2AJ-5IP114/1G	205AJ-1M114/1G 205AJ-1P114/1G
	105AK-1M114/1H 105AK-1P114/1H	102AK-5IM114/1H 102AK-5IP114/1H



WIRING DIAGRAM
120 VOLT, 601B93
AC, 4 SEPARATE RECEPTACLES



WIRING DIAGRAM
PORTABLE OR MANUAL
BEGIN SPEC. H.
1200 or 1500 w, 120 v, #601B89
1200 or 1500 w, 240 v, #601B90



WIRING DIAGRAM
115 VOLT, 601B92
DC, TURF MODEL