Onan®

SERVICE MANUAL

FOR

Onan®

ELECTRIC GENERATING SETS

CCK
SERIES

SPEC A THROUGH K

SAFETY PRECAUTIONS

The following symbols are used in Onan manuals to alert users to the potentially dangerous conditions relating to maintenance of the equipment and replacement of parts. Please read and observe.

⚠DANGER ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

MODEL IDENTIFICATION

To avoid errors or delay in filling your parts order, always give the MODEL, SPEC NO., and SERIAL NO. from the Onan nameplate.

For handy reference, insert your nameplate information in the spaces below:

MODEL AND SPEC NO.

SERIAL NO.

PRODUCT SAFETY PRECAUTIONS

⚠WARNING

Contact with USED ENGINE OILS has been identified by a United States federal agency and some USA state agencies as causing CANCER or REPRODUCTIVE TOXICITY. When checking or changing engine oils take all necessary precautions not to ingest, breathe the fumes or contact the used oil.

⚠WARNING

Contact with ASBESTOS has been identified by a United States federal agency and some USA state agencies as causing CANCER or REPRODUCTIVE TOXICITY. When handling engine gaskets take all necessary precautions not to ingest, breathe or contact the dust from the gaskets! Use adequate ventilation and wear protective gloves, masks and clothing!

⚠WARNING

Contact with BENZINE and LEAD, found in gasoline, fuel additives and solvents has been identified by a United States federal agency and some USA agencies as causing CANCER or REPRODUCTIVE TOXICITY. When checking, draining or adding gasoline and fuel additives, or using solvents take all necessary precautions not to ingest, breathe the fumes, or contact the liquids. Use adequate ventilation and wear protective gloves, masks and clothing!

SPECIFICATIONS

M : manual start R : remote start (electric crank)	Model Series 4.0CCK M	4.0CCK R	5.0CCK M	5.0CCK R
Nominal dimension of plant (inches)				
Height	21	21	21	21
Width	21	21	21	21
Length (3- and 4-wire models, add 1-inch)	26-3/8	26-3/8	30	30
Number cylinders (horizontally opposed)	2	2	2	2
Displacement (cubic inch)	49.8	49.8	49.8	49.8
Cylinder bore	3-1/4	3-1/4	3-1/4	3-1/4
Piston stroke	3	3	3	3
RPM (for 60-hertz)	1800	1800	1800	1800
RPM (for 50-hertz)	1500	1500	1500	1500
Compression ratio, Standard	5.5:1	5.5:1	5.5:1	5.5:1
high compression	7:1	7:1	7:1	7:1
Compression Pressure (lbs) at cranking speed (app. 500 rpm)				
Standard heads	105-110			
High-Compression heads	130-135			
Ignition (type)				
Battery	No	Yes	No	Yes
Flywheel magneto	Yes	No	Yes	No
Battery voltage (ac plant)	None	12-V	None	12-V
Battery size (ac plant):				
SAE group 1H		two in series		two in series
Amp/hr. SAE rating - 20-hr (nominal)		105		105
Starting by pull rope (recoil) only	Yes	No	Yes	No
Starting by exciter cranking	No	Yes	No	Yes
Starting by starting motor ***	No	No	No	Yes
Battery charge rate amperes	6-Max.	6-Max.	6-Max.	6-Max.
Ventilation Required (cfm 1800 rpm)				
Engine (Pressure Cooling)	500	500	500	500
Engine (Vacu-Flo Cooling)	750	750	750	750
Generator	75	75	75	75
Combustion	32	32	32	32
Output rated at unity power factor load	All	All	All	All
Rating (output in watts)				
*50-hertz AC intermittent service	3500	3500	4250	4250
*50-hertz AC continuous service	3500	3500	4250	4250
**60-hertz AC intermittent service	4000	4000	5000	5000
**60-hertz AC continuous service	3500	3500	5000	5000
AC voltage regulation in ± %	4	4	5	5
AC frequency regulation in %	5	5	5	5
Revolving armature type generator	Yes	Yes	Yes	Yes
120/240-volt single phase model reconnectible	Yes	Yes	Yes	Yes
Rotating type exciter	Yes	Yes	Yes	Yes

* Basic 50-hertz model

** Basic 60-hertz model

*** Remote model 5CCK-150R only (Magnet Service DC Plant)

ASSEMBLY TORQUES

The assembly torques given here will assure proper tightness without danger of stripping threads. If a torque wrench isn't available, estimate the degree of tightness necessary for the stud, nut, or screw. Be careful not to strip threads. Use reasonable force only, with a wrench of normal length.

Check all studs, nuts and screws often and tighten as needed to keep them from working loose.

TORQUE SPECIFICATIONS (FOOT POUNDS)

Rear Bearing Plate Nuts	20-25
Connecting Rod Bolts	24-26
Oil Pump Mounting Screws	7-9
Oil Base Screws	43-48
Generator Adapter Screws	20-25
Timing Gear Cover Screws	15-20
Cylinder Head Screws	29-31
Fuel Pump Mounting Screws	10-15
Flywheel Mounting Screws	35-40
Intake Manifold Screws	15-20
Exhaust Manifold Screws	15-20
Spark Plugs	25-30
Blower Housing Screws	10-15

DIMENSIONS AND CLEARANCES

Refer to the Trouble Shooting 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. Maintain factory limits and clearances as shown below, replacing worn parts when necessary.

CLEARANCES

All clearances given at room temperature of 70°F.

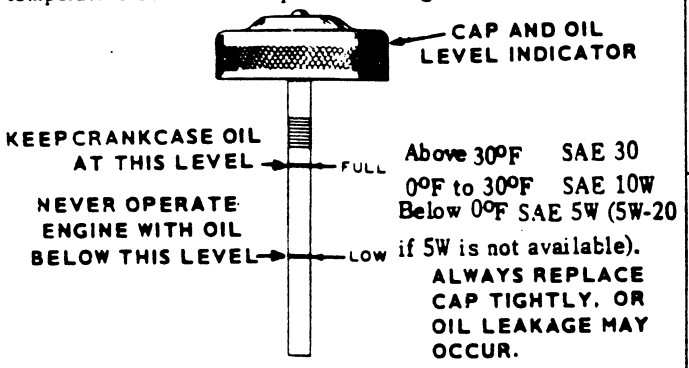
	Minimum	Maximum
Valve Tappets		
Intake	.006"	.008"
Exhaust	.015"	.017"
Valve Stem in Guide – Intake	0.0010"	0.0025"
Valve Stem in Guide – Exhaust	0.0025"	0.0040"
Valve Seat Interference Width	1/32"	3/64"
Valve Face Angle	44°	
Valve Seat Angle	45°	
Crankshaft Main Bearing		
Bronze Faced, Aluminium Alloy Faced, Solid Aluminium	0.0025"	0.0038"
Crankshaft End Play	0.006"	0.012"
Camshaft Bearing	0.0015"	0.003"
Camshaft End Play	0.003"	
Rod Bearing (Aluminum Rod)	0.0020	0.0033
Rod Bearing (Forged Rod)	0.0005"	0.0023
Connecting Rod End Play (Aluminum Rod)	0.002"	0.016"
Timing Gear Backlash	0.002"	0.003"
Oil Pump Gear Backlash	0.002"	0.005"
Piston to Cylinder, Conformatic Type (Measured at Bottom of Skirt)		
Clearance	0.0015"	0.0035"
Piston Pin in Piston	Thumb Push Fit	
Piston Pin in Rod	0.0001"	0.0006"
Piston Ring Gap in Cylinder	0.010"	0.023"
Breaker Point Gap (Full Separation)	0.020"	
Spark Plug Gap – For Gasoline Fuel	0.025"	
Crankshaft Main Bearing Journal – Std. Size	1.9992"	2.000"
Crankshaft Rod Bearing Journal – Std. Size	1.6252"	1.6260"
Cylinder Bore – Standard Size	3.2490"	3.2500"
Ignition Timing Advance		
1,500 to 2,400-rpm (without Automatic Spark Advance)	19°BTC	
2,500 and up (without Automatic Spark Advance)	25°BTC	

SERVICE AND MAINTENANCE

PERFORM ALL MAINTENANCE DETAILS AS SPECIFIED IN THE MAINTENANCE SCHEDULE

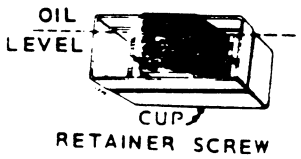
CRANKCASE OIL

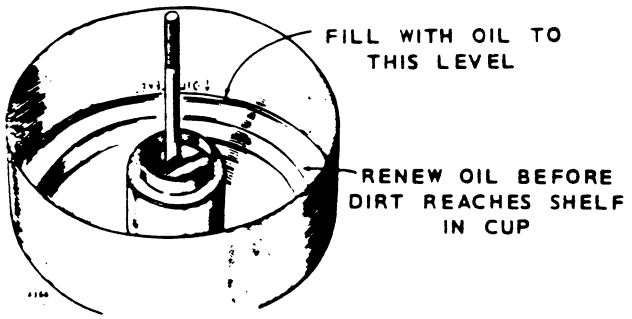
Oil capacity is four U.S. quarts. Fill to the *full* mark on oil indicator. Use a good quality detergent oil classified for service SE or SE/CC. Do not use service DS oil at any time. Use a single viscosity oil; oil consumption is usually higher with multi-viscosity *all weather* oil. Use the proper SAE number of oil for the expected temperature conditions. Do not mix brands or grades. Extremely dusty or low temperature conditions require oil change at 50 hrs.



Above 30°F SAE 30
0°F to 30°F SAE 10W
Below 0°F SAE 5W (5W-20 if 5W is not available).

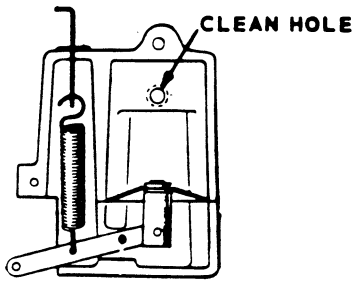
ALWAYS REPLACE CAP TIGHTLY, OR OIL LEAKAGE MAY OCCUR.





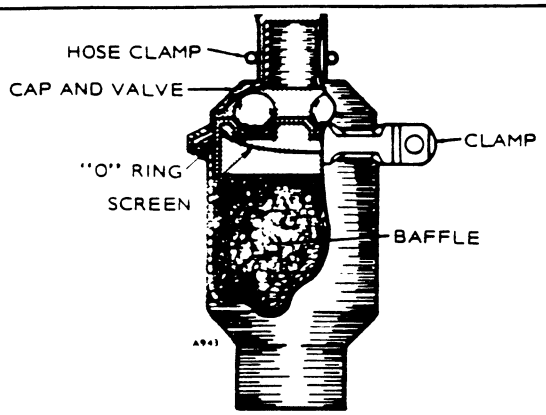
AIR CLEANER

Fill to level indicated on cup. Use the same type of oil as used in crankcase. On contractors model, remove cartridge and shake out accumulated dirt. Do not wash. Install new cartridge every 500 hours.

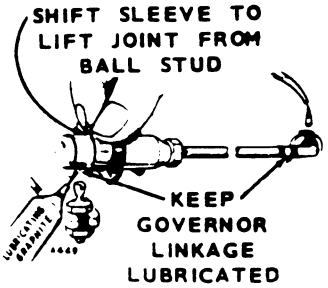


SPEED BOOSTER

Use 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.



Remove hose clamp, breather hose, breather cap clamp and insulator halves to release breather cap and valve assembly. Wash cap and valve assembly and the baffle in a suitable solvent and reinstall.



GOVERNOR LINKAGE

SPARK PLUG GAP
0.025" Gasoline
0.018" Gaseous Fuel

FUEL SEDIMENT

Empty carburetor and fuel filter (strainer) bowls of any accumulated sediment. Clean filter screen thoroughly. Reassemble and check for leaks.

GASOLINE FUEL

Use *regular* grade automobile gasoline.

WARNING *Never fill the tank when the engine is running. Leave some tank space for fuel expansion.*

MAINTENANCE SCHEDULE

Use this factory recommended maintenance schedule (based on favorable operating conditions) to serve as a guide to get long and efficient plant life. Neglecting routine maintenance can result in failure or permanent damage to the plant. Maintenance is divided into two categories: (1) *operator maintenance* – performed by the operator and (2) *critical maintenance* performed by qualified service personnel (*Onan* dealer).

OPERATOR MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS			
	8	50	100	200
Inspect Plant	x			
Check Fuel	x			
Check Oil Level	x			
Check Air Cleaner		x1		
Clean Governor Linkage		x1		
Check Spark Plug			x	
Change Crankcase Oil			x1	
Clean Crankcase Breather				x
Clean Fuel System				x
Check Battery				x
x1 - Perform more often in extremely dusty conditions.				

For any abnormalities in operation, unusual noises from engine or generator, loss of power, overheating, etc., contact your ONAN dealer.

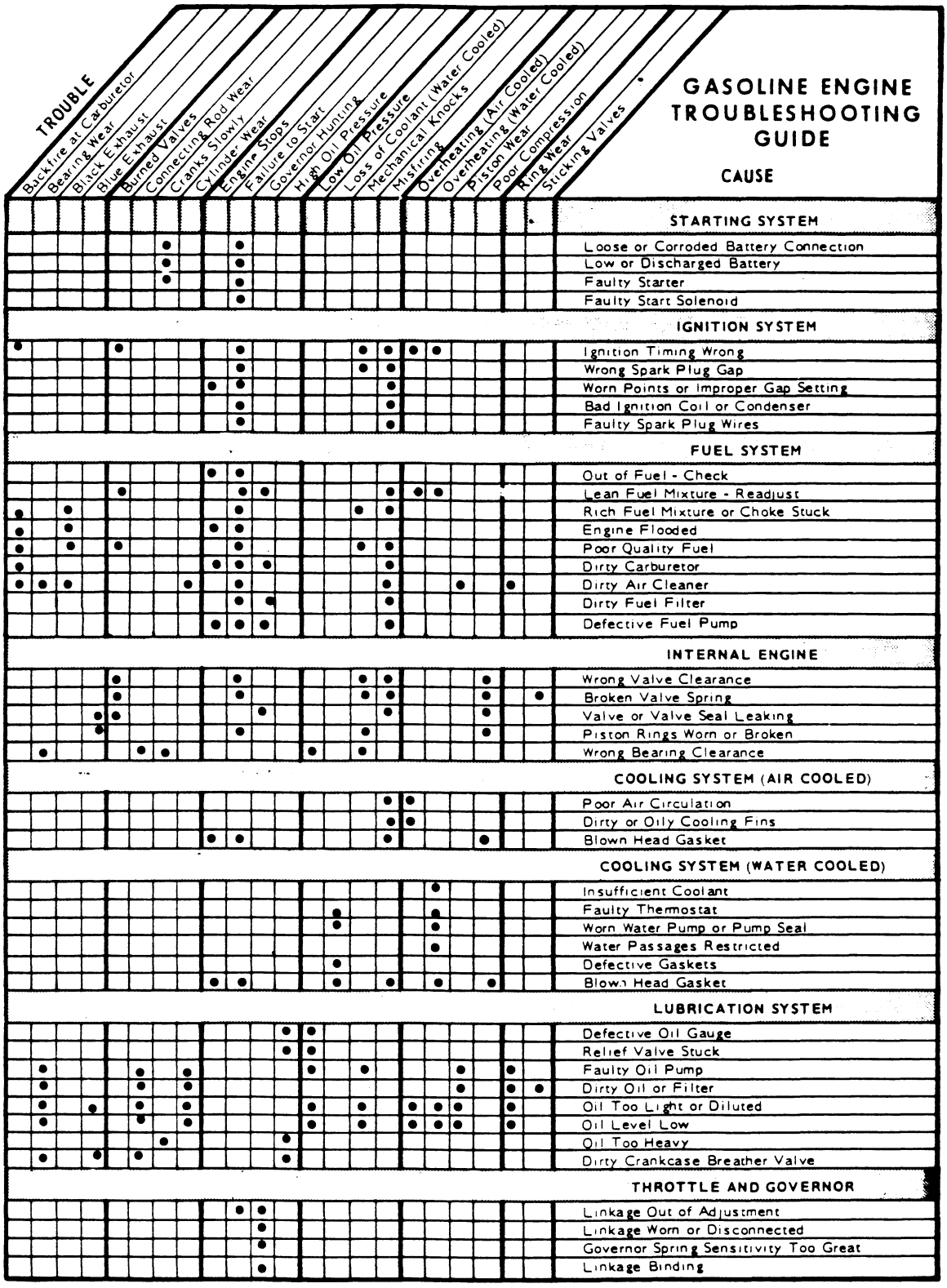
CRITICAL MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS			
	200	500	1000	5000
Check Breaker Points	x			
Clean Commutator and Collector Rings	x1			
Check Brushes	x2			
Remove Carbon & Lead		x		
Check Valve Clearance		x		
Clean Carburetor		x		
Clean Generator			x	
Remove & Clean Oil Base			x	
Grind Valves			x	
General Overhaul				x

x1 - Perform more often in extremely dusty conditions.

x2 - Replace all brushes when worn to 5/8" or less.

TROUBLESHOOTING



ADJUSTMENTS

CHECK BREAKER POINTS

Replace burned or faulty points. If only slightly burned, dress smooth with file or fine stone. Measure gap with thickness gage, gap points at .020".

Ignition breaker points, Fig. 1, must be correctly gapped. Crank engine to fully open breaker points (1/4 turn after top center). Loosen and move stationary contact to correct the gap at full point separation. Secure points and check for correct gap.

Ignition points should break contact just when the timing mark aligns with the flywheel timing mark (19° for 1500 to 2400 rpm, 25° for 2500-rpm sets). Final timing is corrected by properly shifting the breaker point box on its mounting and using a timing light. If specified timing cannot be obtained by positioning the breaker box, check to be sure the timing marks on gears are aligned.

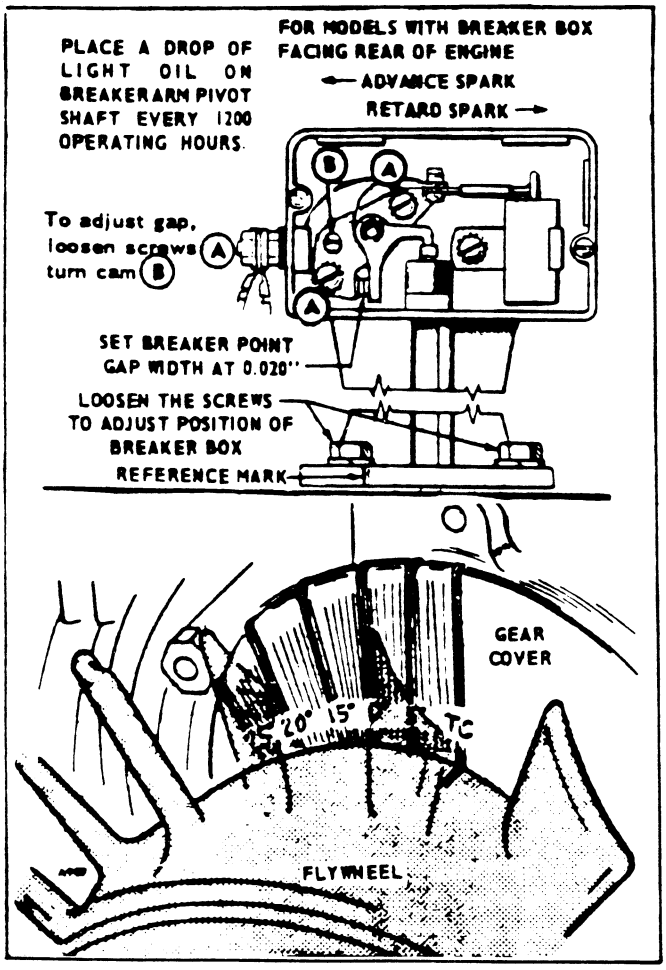


Figure 1. Ignition Timing

CARBURETOR

The carburetor has an adjustable idling jet. It is simple in construction and normally requires little attention other than a periodic cleaning. If the engine runs unevenly at half or full load due to faulty carburetion, the main adjusting needle (early models only) needs adjusting. Make the adjustment while the engine is running at normal operating temperature and with almost a full load connected to the engine. See Fig. 2.

Turn the main adjusting needle (early models only) out about two full turns. Then turn it slowly in until the engine begins to lose power and speed. Then turn it out very slowly until

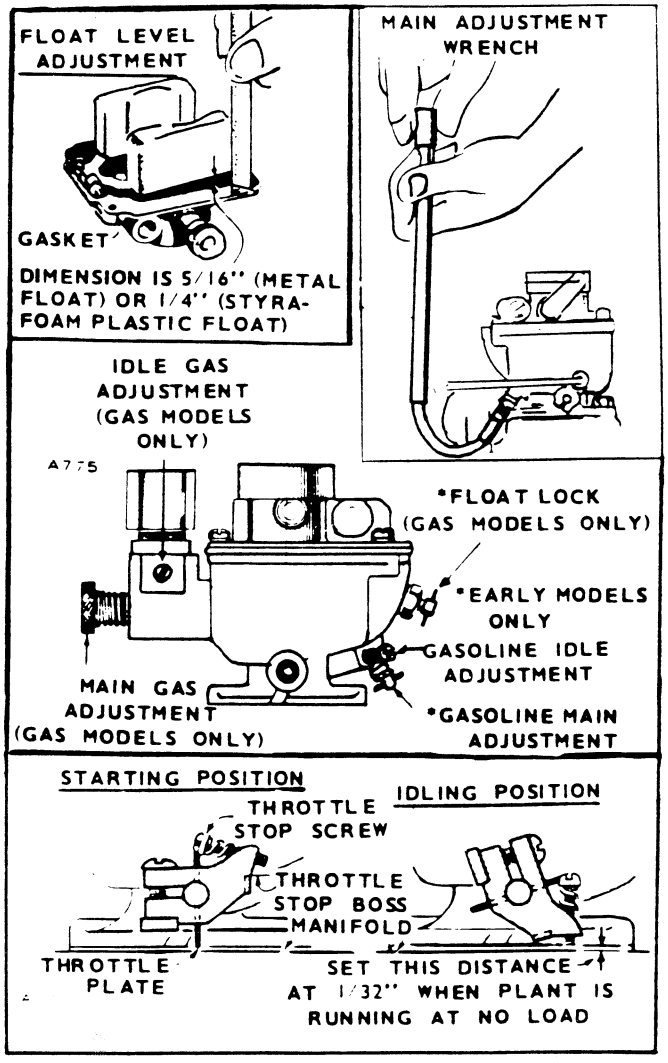


Figure 2. Carburetor Adjustments

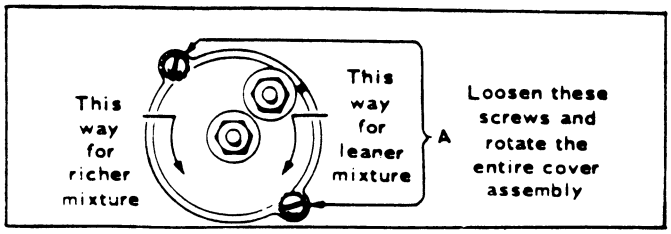


Figure 3. Electric Choke Adjustment

the engine runs smoothly at full power and speed. Onan carburetor wrench (420B169) can be purchased from your Onan dealer for easier adjustment of the carburetor engine adjusting needle.

When adjusting the idle jet needle, the engine should be running at normal operating temperature and without a load connected. Turn the idle adjusting needle in until the engine loses considerable speed. Then turn it out until the engine runs smoothly. A hunting condition at no load can sometimes be corrected by an idle adjustment.

To adjust the carburetor float level, bend the float near the shaft to obtain the correct level.

If the engine develops a hunting condition (alternate increase and decrease of engine speed) try correcting by opening the main adjusting needle (early models only) a little more. Do not open more than 1/2 turn beyond the maximum point of power. If this does not correct the condition, the sensitivity adjustment of the governor should be adjusted.

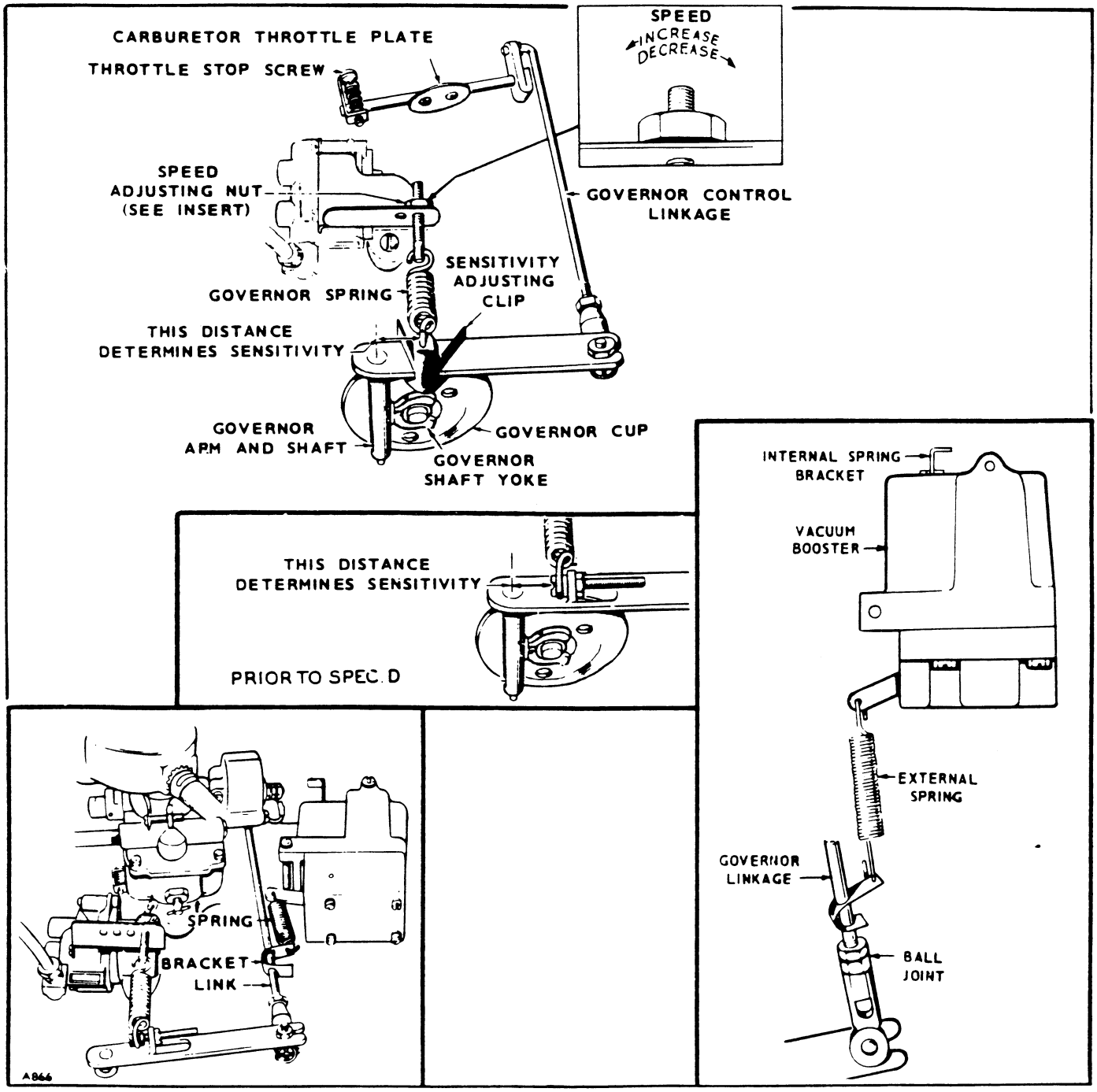


Figure 4. Governor and Speed-Booster Adjustments

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

If extremes in starting temperatures require a re-adjustment of the choke, loosen slightly the two cover retaining screws. For less choking action, turn the cover assembly a few degrees in a clockwise direction. For more choking action, turn counterclockwise. Retighten the cover screws.For more information see Fuel System Section.

GOVERNOR AND BOOSTER

The governor and booster control the speed of the engine. A speed adjustment includes adjusting both devices (Fig. 4).

GOVERNOR

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

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 or frequency meter (preferable both) should be connected to the generator output in order to correctly adjust the governor of the ac plant. A small speed drop not noticeable without instruments will result in an objectionable voltage drop. The engine speed can be checked with a tachometer.

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.

1. Adjust the carburetor main jet for the best fuel mixture while operating the plant with a full rated load connected.
2. Adjust the carburetor idle needle with no load connected.
3. Adjust the length of the governor linkage and check
3. linkage and throttle shaft for binding or excessive looseness.
4. Adjust the governor spring tension for rated speed at no load operation with booster disconnected (or held inoperative).
5. Adjust the governor sensitivity.
6. Recheck the speed adjustment.
7. Set the carburetor throttle stop screw.
8. Set the vacuum speed-booster.

VOLTAGE CHART FOR CHECKING GOVERNOR REGULATION

ALTERNATING CURRENT TYPES OF PLANTS NOTE: Output rating is at UNITY power factor load.	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
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	122-118	244-236
Preferred Voltage Spread	5	9

SPEED CHART FOR CHECKING GOVERNOR REGULATION

ALTERNATING CURRENT TYPES OF PLANTS	FOR ALL 60 HERTZ PLANTS	FOR ALL 50 HERTZ PLANTS
Maximum No Load Speed		
RPM	1920	1620
Hertz (Current Frequency)	64	54
Minimum Full Load Speed Without Booster		
RPM	1710	1500
Hertz	57	50
Maximum Speed Drop from No Load Operation to Full Load Operation		
RPM	90	90
Hertz	3	3
Preferred Speed Regulation, No Load to Full Load Operation		
RPM	1830-1770	1590-1530
Hertz	61-59	53-51
Preferred Speed Spread		
RPM	60	60
Hertz	2	2

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	1800*	1800**
Maximum Speed Drop from No Load Operation to Full Load Operation RPM	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.

LINKAGE

The engine starts at full 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 lever just contacts the underside of the carburetor bowl. This setting allows immediate control by the governor after starting. It also synchronizes travel of the governor arm and the throttle shaft.

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 to 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.

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 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 diffesence in speed between no load and full load conditions.

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

SPEED-BOOSTER

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 (Fig.4).

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 internal 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 maximum spread of 3 cycles.

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

ENGINE DISASSEMBLY

GENERAL

When engine disassembly is necessary - remove complete assemblies (tear down individual components like fuel pump, breaker mechanism, etc., as bench jobs). *Use special tools available.*

DISASSEMBLY

A. *Common sense* will dictate proper order of disassembly. As disassembly progresses, the order may be changed, as will become self-evident.
B. A suggested procedure would be as follows:
   1. Housings, shrouds, blower housing, air cleaner
   2. Flywheel - using puller or pry-bar method
   3. Gear Cover - protect oil seal from keyway damage.
   4. Crank Gear - use puller and gear puller ring.
   5. Loosen accessories such as fuel pumps, oil filter, starter, and generator.
   6. Control box and generator (lift all generator brushes) tag all wires for identification.
   7. Drain oil - discard oil removed.
   8. Cylinder head
   9. Valves, springs, rocker arms
   10. Camshaft and gear, rear bearing plate, oil pump
   11. Piston, connecting rod bearings
   12. Crankshaft
   13. Try to analyze reasons for any parts failure and necessity of the repair.
   14. Cleanliness and neat orderly work area makes the job easier to do.
   15. Use proper meters and gauges. Observe if cylinder requires boring, crankshaft needs grinding, or other major shop work necessary.
   16. Check generator and static exciter (if used). Use growler, test light (*buzzer*), or ohmmeter for armature or field coil shorts, grounds, or opens. Determine if commutator or slip rings need turning by lathe to true them up. Under-cut mica if necessary.

ASSEMBLY (USE GENUINE ONAN PARTS)

A. Engine assembling procedure is normally the reverse of disassembly - observing proper clearances of bearings, connecting rod, proper fitting and sizing of piston, rings, etc.
B. Follow proper recommended procedure for fit of valves, adjusting clearances, and torque of all special items. Use a torque wrench to assure proper tightness without danger of stripping threads.
C. As each internal engine part is assembled, use crank (or wrench) and turn over engine, making certain it turns freely. If tightness is noted after any operation you then know your last step is responsible.
D. As each internal engine part is assembled, coat it heavily with oil (the same grade to be used in the crankcase). During the first few critical moments of operation the engine will depend on this lubrication.
E. After you have the internal engine parts reassembled, the engine should turn over freely when cranked. If reasonable care and attention has been given, the engine will operate efficiently.
F. At this point, it is a matter of mechanically adding the outside accessory items to the block assembly. *Order of assembly is reverse of disassembly.*
G. When engine is complete, install generator and plant control. Check the tagged wires. Use wiring diagram to connect generator leads to control, and, from control to engine leads. All wires are marked for correct identification. If plant is to work properly, *wires must be connected correctly.*
H. The engine-generator is now ready for testing. Follow suggestions given in Adjustments Section. Before final test and adjustments, run the plant about 15 minutes under light load to reach normal operating temperature.

ASSEMBLY SUGGESTIONS (Things to keep in mind during engine assembly)

A. *See Onan Tool Catalog (900-19)* - many items require a *special tool* for correct installation. Some of these tools are:
   1. Oil seal driver and guide, bearing driver
   2. Valve spring compressor, valve lock replacer, valve guide driver, and valve seat remover.
   3. Gear puller and gear puller rings
   4. Piston ring spreader and compressor
   5. Flywheel puller, pry bar, armature puller
   6. Torque wrench, Plastigauge (for correct bearing clearance)
   7. Load test panel, armature growler, gas pressure gauge (or manometer)
B. Wet holes in crankcase (holes through crankcase) always use copper (gasket) washers.
C. Nuts, bolts and screws that do not require exact torque should be tightened snugly, then 1/4 extra turn.
D. Select proper length of any screw or bolt and position in hole. Make sure they do not *bottom.*

E. Gasket kits sometimes cover more than (1) engine. Therefore, select gasket of correct size and shape for part being used. Always use new gaskets.

F. When disassembling engine, *mike* bearing plate gasket thickness. Then select proper gasket thickness for correct end play.

G. When assembling crankshaft, make sure bearing thrust washers are in proper position supported by bearing stop pins. Use cup grease to hold in place.

H. When installing gearcase cover, put a dab of grease on roll pin so governor cup can be aligned.

I. Crank gears are easier to remove and install if heated.

J. Service manual (for any specific model) should be read carefully for correct timing.

K. Allow some gear lash (approximately .005 in. in oil pump. *Do not install gears tightly against each other!*

TESTING AND ADJUSTING SETS

Preparation.

Check the following:

1. Put proper oil in crankcase.
2. Service the air cleaner
3. Connect the fuel line.
4. Connect the load.
5. Connect fully-charged battery.
6. Check ventilation for proper cooling.

OPERATION

1. Start engine.
2. Check oil pressure, adjust brush rig.
3. Run set 15 minutes to bring up to operating temperature.
4. Check for oil leaks, loose electrical connections, tight fuel lines and tight exhaust connections.

ADJUSTMENTS

1. Adjust governor for speed and sensitivity.
2. Make sure meters are connected.
3. Check the output; volts, amps, watts, frequency.

IMPORTANT: For complete customer satisfaction repaint unit (Onan Green, spray can 525P137, or Onan White, spray can 525P216) and apply instructions from Kit 98-1100C or Marine Kit 98-1807.

FUEL SYSTEM

CARBURETOR

Carburetor maintenance should consist of regular cleaning. Some types of gasoline have a tendency toward formation of gum deposits inside the carburetor which 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 screwdriver to bend the lip of the float. With the carburetor casting inverted and the float resting lightly against the needle in its seat, there should be 5/16" (1/4" with styrafoam plastic float) clearance between the bowl cover gasket and the free end of the float (side opposite needle seat). See Fig. 2. Remove fuel inlet valve and inspect for wear or damage (Fig. 5).

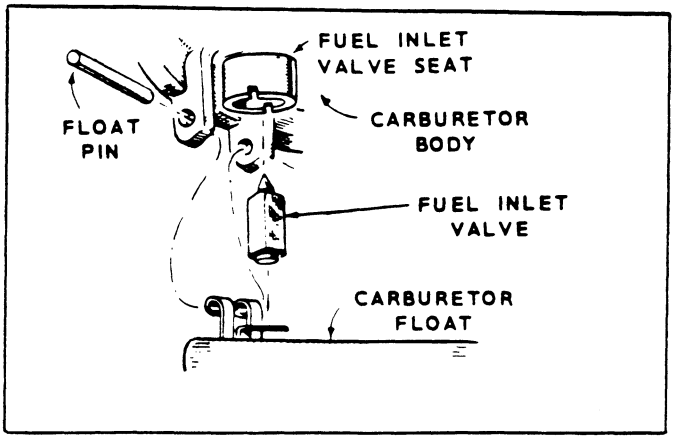


Figure 5. Fuel Inlet Valve

CHOKE

Remote starting plants use an automatic electric choke (Fig. 7), manual starting plants use a hand choke. An electric element controls the automatic electric choke. Before the plant starts, the choke is partially closed. When the plant has started, the generator supplies current to the heating element which heats the bi-metal coil, opening the choke plate.

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.

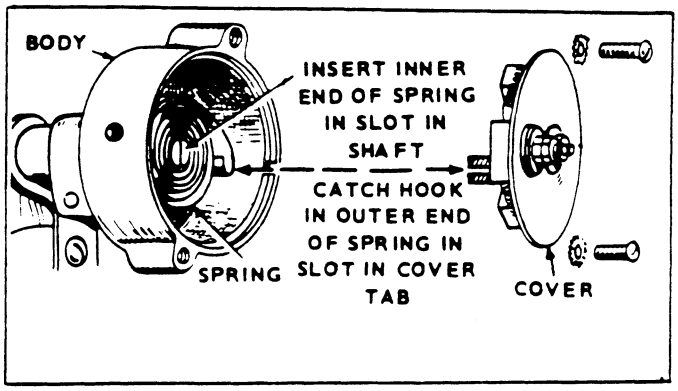


Figure 7. Automatic Electric Choke

AVERAGE AMBIENT TEMP (F°)	CHOKE SETTING CHOKE OPENING
58	closed
66	1/4 open
72	1/2 open
76	3/4 open
82	open

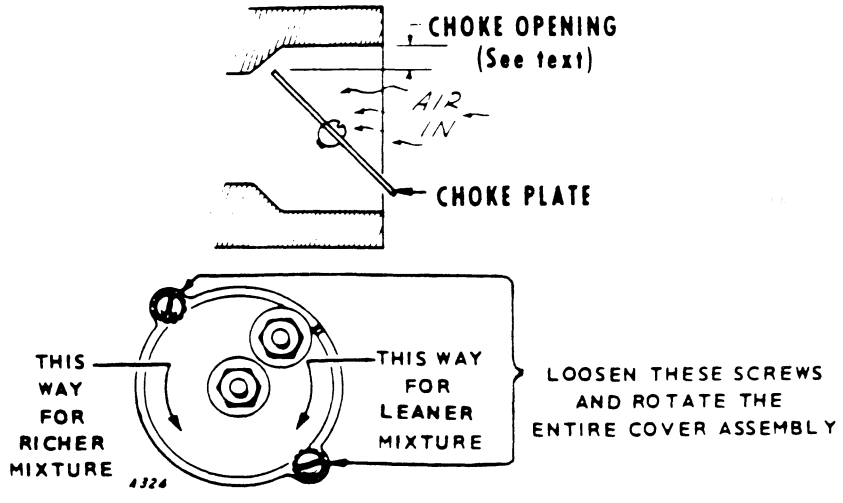


Figure 6. Adjusting Automatic Choke

Adjustment, Electric Choke: Under normal operation, adjust the choke so the distance measured between the choke plate and carburetor throat (Fig. 6) is as shown in the table with the engine cold. Use the straight shank end of a drill bit to measure the gap. The air cleaner must be removed for choke adjustment. To adjust the choke, loosen the 2 screws on the endplate and rotate the cover assembly.

Extreme temperature may require a slight re-adjustment 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 Figure 6.

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 in the 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, the choke is set too lean.

Disassembly and Repair: If the choke does not operate, or will not maintain its adjustment, disassemble it for repair. If it will not close, check for binding, incorrect assembly. If it will not open after plant starts, check for heating. The choke should be warm to the touch within a minute or two of plant starting. To disassemble choke, refer to Fig. 7.

If the choke will not heat properly, check for a broken heating coil or high resistance electrical connections. Check the coil resistance with an ohmmeter. With the element at room temperature, resistance should be about 5 - 6 ohms for 12-volt models. If the coil is defective, replace the thermostat cover.

Assembly (Fig. 7): When assembling electric choke, be sure the fork in the plate straddles and holds the outer end of the coil and that the spring winds in a clockwise direction from center.

FUEL SEDIMENT

Empty carburetor and fuel filter (strainer) bowls of any accumulated sediment. Clean filter screen thoroughly. Reassemble and check for leaks.

IGNITION SYSTEM

MAGNETO STATOR INSTALLATION

The magneto stator assembly is mounted on the gear cover and the flywheel must be removed to expose it. On engines *without* spark advance mechanism the stator has two 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 2,500-rpm and above. Connect the smaller (ground) coil lead to the stator mounting screw. Engines *with* spark advance mechanism have one set of mounting holes only. Connect the stator larger lead to the breaker box insulated terminal which also connects to the ignition coil (engines without spark advance mechanism) and breaker points. Be sure the larger lead is held in place to prevent rubbing on the flywheel. Beginning Spec G, install two washers between the gear cover and the magneto stator on both mounting screws (Fig. 8).

On engines *with* spark advance mechanism, the stator coil includes both the primary and secondary windings. There is no separate automotive type coil used.

IGNITION COIL INSTALLATION (Engines without Spark Advance Mechanism)

Coil connections differ between magneto ignition engines and battery ignition engines. Refer to the illustration which applies. The ignition coil is grounded on magneto ignition engines, but not grounded with battery ignition.

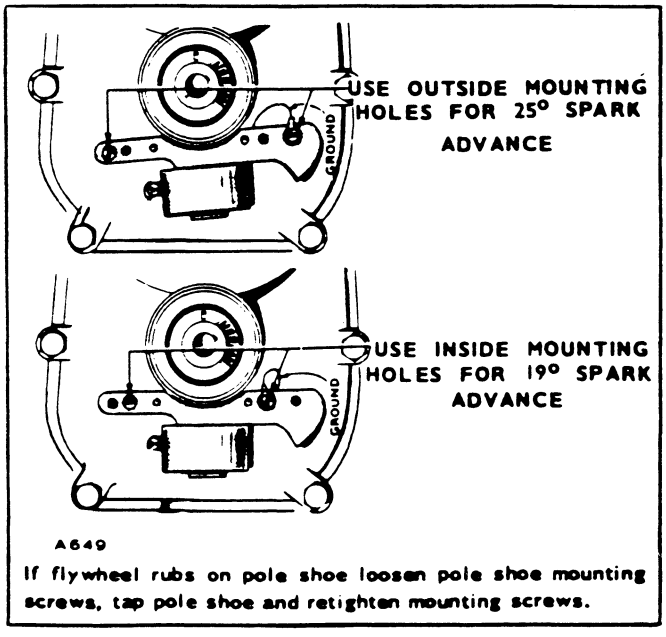


Figure 8. Magneto Stator Assembly

TIMING IGNITION (Engines without Spark Advance Mechanism)

Ignition timing procedure is the same for manual-start type engines with magneto ignition as for electric-start type engines with 12-volt battery ignition.

The spark advance is 19° 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° spark advance. The correct timing is stamped on the cylinder block near the breaker box. On engines having Vacu-flo cooling gain access to timing marks by removing the sheet metal plug from the top of the engine air housing. Through the plug opening, note the timing marks 19° and 25° stamped on gear cover. 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 (Fig. 11).
3. Adjust the ignition breaker point gap width to .020" at full separation.
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 #1 cylinder to retard the timing (points breaking too soon), or shift it slightly away from the #1 cylinder to advance the timing (points not breaking soon enough). Tighten the breaker box mounting screws securely after making an adjustment (Fig. 11).

To accurately check the time at which the spark occurs,

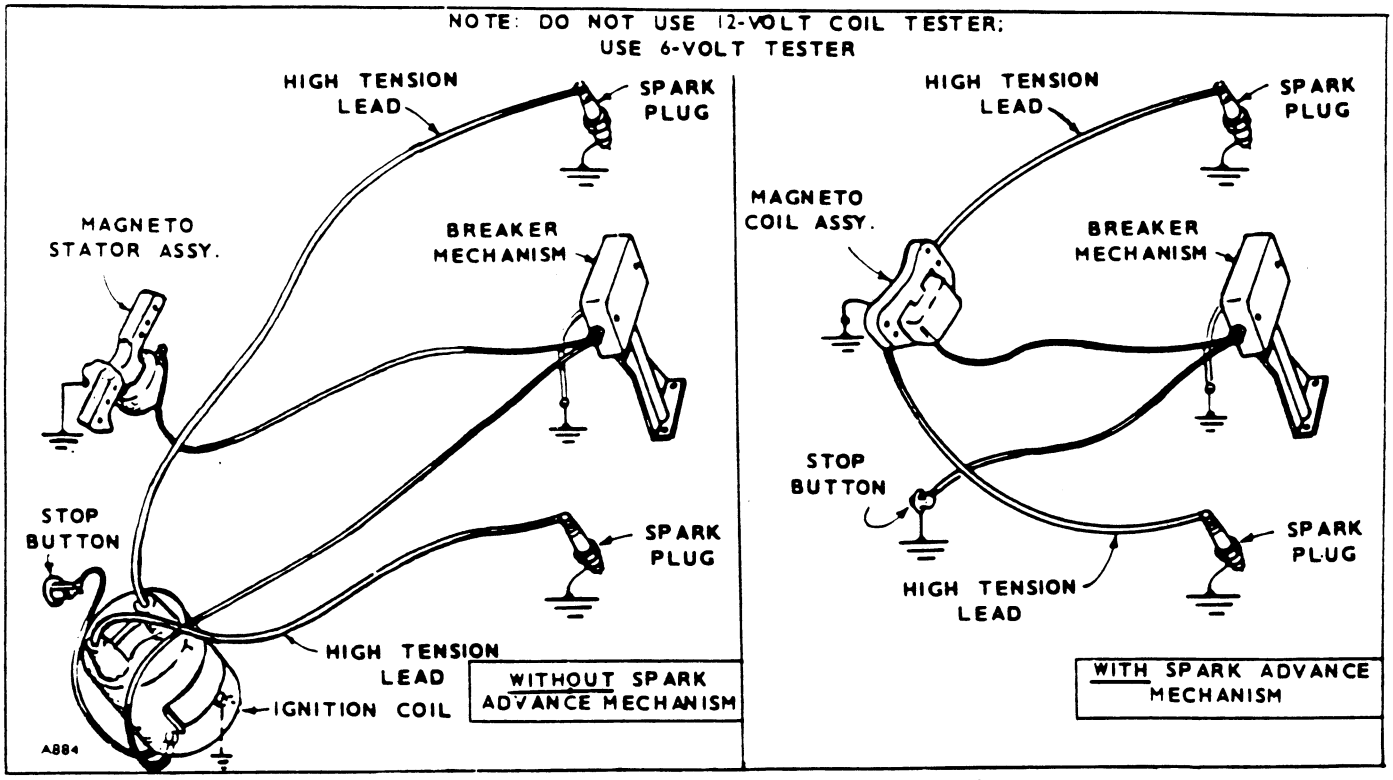


Figure 9. Coil Installation And Electrical Installation for Magneto

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.

TIMING IGNITION (Engines with Spark Advance Mechanism)

The correct timing (5° stopped or at idle speed; 24° running at 1100 rpm or over) is stamped on the crankcase near the breaker box. If the breaker points separate when the timing marks align, (engine stopped),timing is correct. Timing is best adjusted with an automotive type timing light while the engine is running.

Timing Marks on Flywheel: Align the correct timing mark on the flywheel with the TC mark on the gear cover.

Timing Marks on Gear Cover: Align the correct timing mark on the gear cover with the TC mark on the flywheel.

Timing Marks on Both Gear Cover and Flywheel: Align either the TC flywheel mark with the correct timing mark on the gear cover or the correct timing mark on the flywheel with the TC mark on the gear cover.

NOTE: *Use only one TC mark and one set of timing marks.*

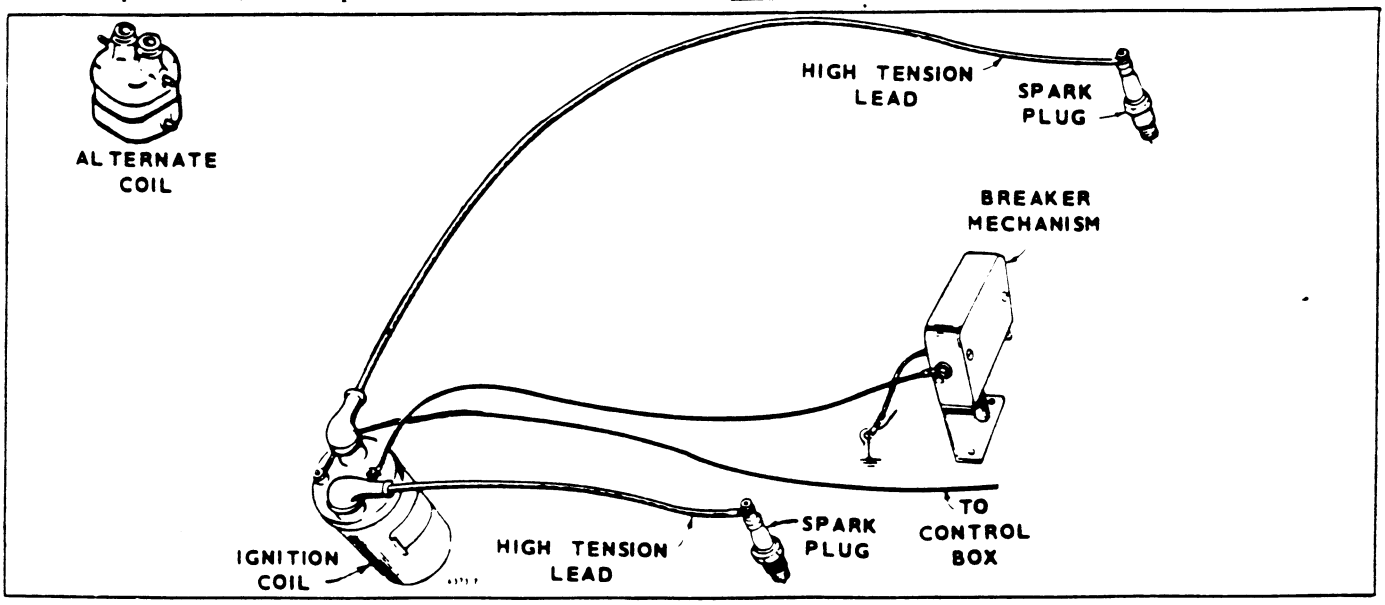


Figure 10. Coil Installation And Electrical Circuit For Battery Ignition.

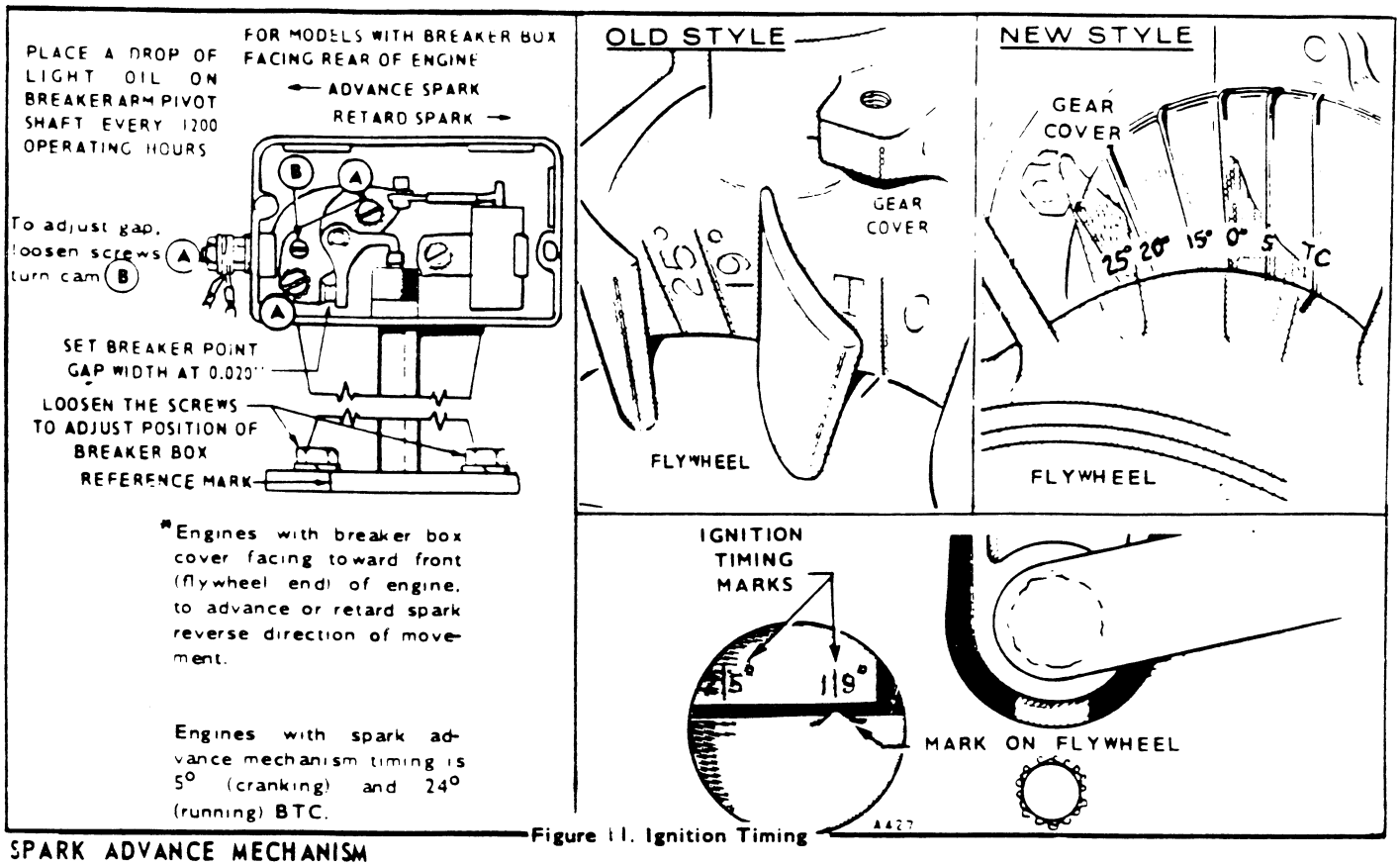


Figure 11. Ignition Timing

SPARK ADVANCE MECHANISM

The spark advance mechanism, located on the rear end of the camshaft, is operated by centrifugal force. As engine speed is increased, weights push the cam to advance the spark or release the cam, retarding the spark as engine speed is decreased.

If the spark advance mechanism should become dirty or gummy, causing the mechanism to stick closed (retarded), the engine will lack power. If the mechanism sticks open (advanced), the engine may possibly kick back on cranking. The spark advance mechanism can be reached for cleaning by either removing the cup shaped cover in crankcase rear camshaft opening (exposing the mechanism) or by removing camshaft from engine. Do not indent the cup shaped cover as it will interfere with the weight mechanism. To check the operation of the spark advance mechanism, follow Steps 2 and 3 as given under SPARK ADVANCE MECHANISM (Engines installed in vehicles).

TESTING IGNITION COIL

A 6-volt tester must 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.

TIMING IGNITION (Vacu-flo Units)

1. Remove the dot button from the top of the blower housing (Fig. 12).
2. Connect a timing light to either plug.
3. Start the engine and run it at 1400 to 1600 rpm.
4. Viewing the timing marks through the round hole in the blower housing, and using a timing light, the TC (top center) flywheel mark should align with the 24-25° mark on the gear cover (Fig. 12).
5. If the timing is incorrect, shift the breaker box until correct timing is achieved.
6. Replace the dot button.

SPARK ADVANCE MECHANISM (Vacu-Flo Units)

1. Follow Steps 1 through 4 under TIMING IGNITION (Vacuflo Units).
2. While watching the timing marks with the timing light, slow the engine to below 800 rpm. If the TC mark on the flywheel disappears and then re-appears when the engine is brought back to speed, the spark advance mechanism is operating properly.
3. If the spark advance mechanism does not react as outlined in Step 2, remove, clean and or replace as necessary.
4. Replace the dot button.

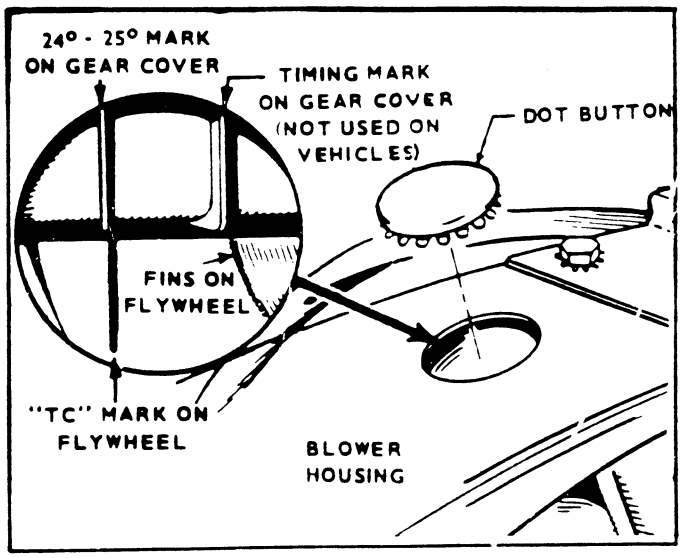


Figure 12. Vacu-Flo Ignition Timing

Condenser: A.3-mfd. condenser mounted in the breaker box aids primary field breakdown when the points open, and prolongs the life of the breaker points by reducing the arc across them. A defective condenser causes a weak spark and rapid breaker point wear. Use a standard commercial condenser tester to determine condenser leakage, opens or grounds. If no tester is available, check for shorts or defective leads. Replace the condenser if in doubt.

Coil: If spark is weak (or there is no spark) and the breaker points are clean and properly adjusted, test the coil for possible defects. As a general test of the coil, disconnect the spark plug leads, ground one, and hold the second lead 1/4" from the engine. Then crank the engine. A good spark indicates the coil is operating. Test the coil as follows:

Using an ohmmeter, check the resistance of the coil windings. Normal resistance readings range from .5 to 2 ohms for the primary winding and from 4,000 to 10,000 ohms for the secondary winding. Extremely low resistance usually indicates a shorted winding and extremely high resistance usually indicates an open in the winding.

WARNING *The 4 volt coils can be tested on a 6 volt tester. However, a 12 volt tester will destroy the coil in a few seconds.*

Spark Plugs: CCK generating sets use conventional spark plugs. Fouled spark plugs indicate they are too cold. Consult the plant parts catalog for the factory recommended plug. Remove, clean, and inspect the plugs at regular intervals. If they are in good shape, they can be cleaned on a commercial plug cleaner and regapped. The spark plug gap should be set at .025" for gasoline fuel, .018" for gas fuel.

When spark plug electrodes become excessively worn, or if the plugs are damaged, replace them.

When replacing or re-installing spark plugs, always install new gaskets.

GOVERNOR SYSTEM

GOVERNOR AND BOOSTER

The governor controls engine speed.

General: Before making governor adjustments, run the plant 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 attain a safe voltage operating range.)

Engine speed determines voltage and frequency. Increasing engine speed increases generator voltage and frequency. Decreasing engine speed decreases generator voltage and frequency. An accurate voltmeter or frequency meter (preferably both) should be connected to the generator output in order to correctly adjust the governor of the ac plant. A small speed drop not noticeable without instruments will result in an objectionable voltage drop. Check engine speed with a tachometer. Refer to Adjustment Section for all governor settings (Figure 4).

Use 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 (Fig. 13). 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

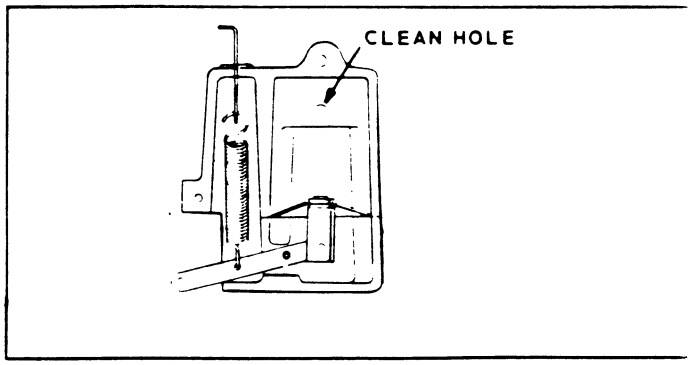


Figure 13. Cleaning Speed Booster

the booster diaphragm or gasket. If there is even a tiny crack or hole in the speed booster diaphragm it may keep the engine from firing on both cylinders. The problem may be very elusive, but is cured by replacing the diaphragm.

VALVES

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 a 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

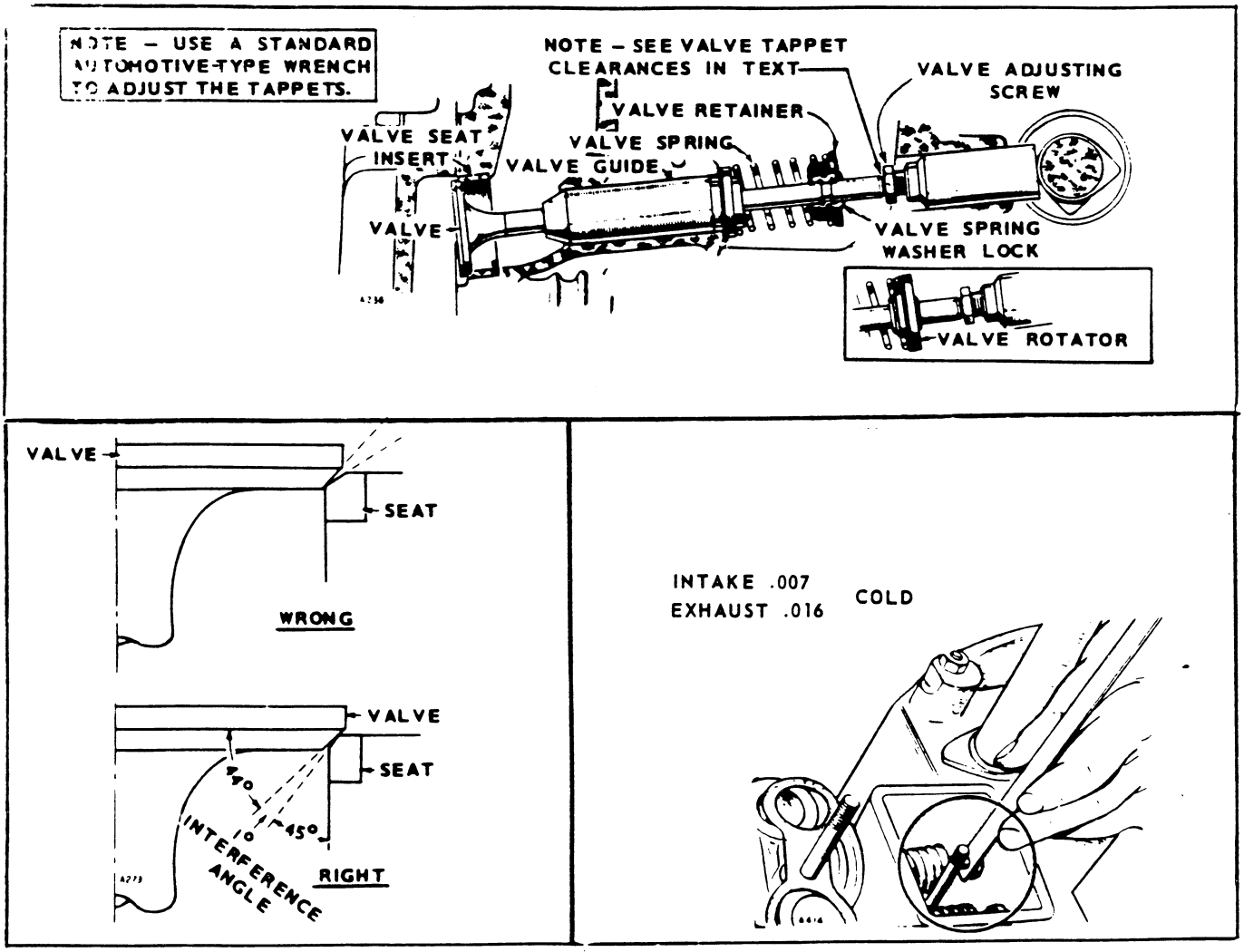


Figure 14. Valve Grinding and Adjusting

the seat band should be 1/32" to 3 64" wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure 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 assemble all parts removed.

The positive type valve rotocaps prolong valve life and decrease valve repairs. When functioning properly, the valve is rotated a fraction of a turn each time it opens. While at open position, the valve must rotate freely but in only one direction. If rotocaps are faulty, install new rotocaps.

TAPPET ADJUSTMENT

The engine is 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 Fig. 14 and the Table of Clearances. For each valve, the thinner gage (minimum) should pass freely between the valve stem and valve tappet but the thicker gage (maximum) should not (Fig. 14).

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.

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.

INTERNAL DISASSEMBLY

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 (smooth) hole in the governor cup. Turn the governor cup so that the metal-lined hole is at the three 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 3/4" from the cover 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 flyballs while sliding the cup off.

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

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 center pin.

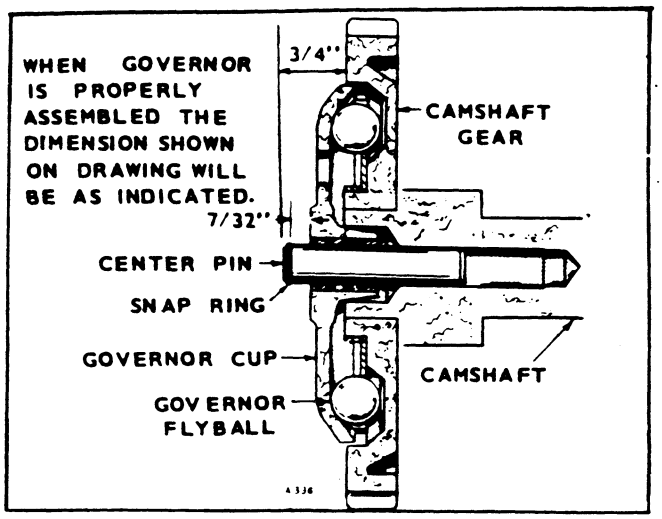


Figure 16. Governor Cup

The camshaft center pin extends out 3/4" from the end of the camshaft. This distance provides an in and out travel distance of 7/32" for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less, the engine will race, especially at no load. Remove the center pin and press in a new pin. Otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward or removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, always install both gears new.

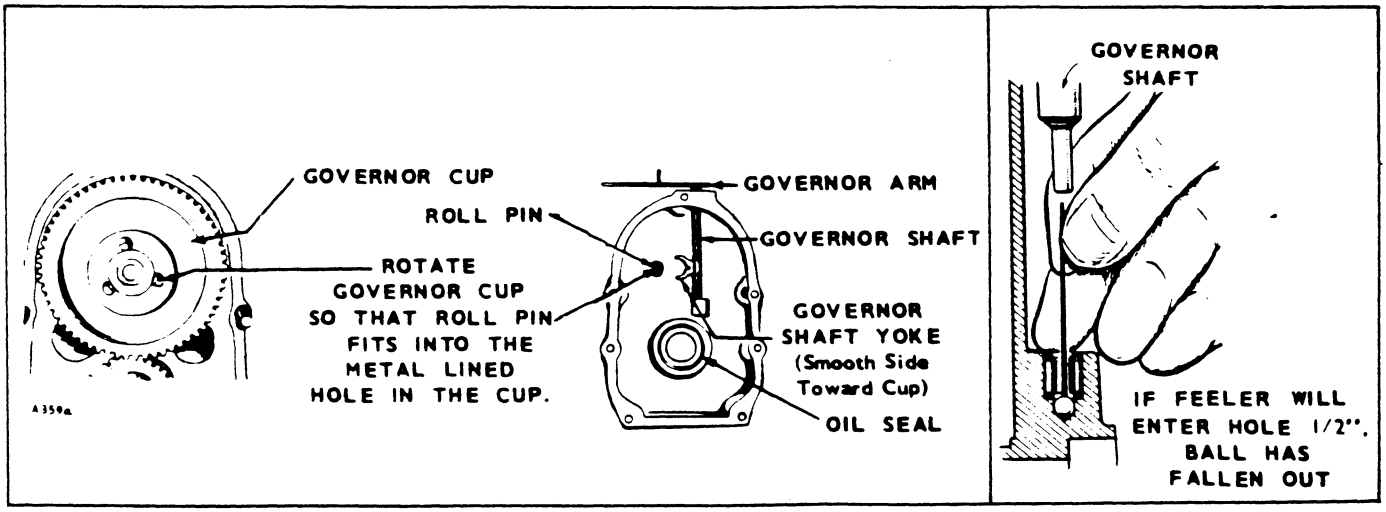


Figure 15. Gear Cover Assembly

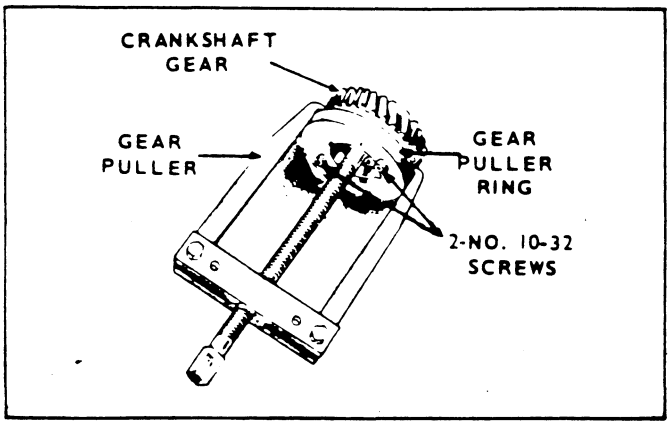


Figure 17. Removing Crankshaft Gear.

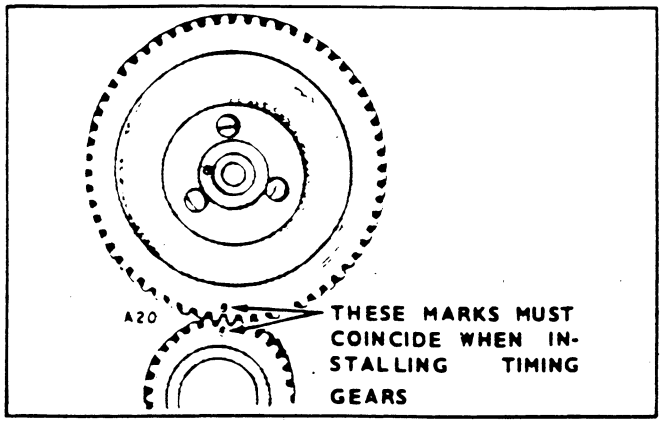


Figure 18. Timing Marks.

To remove the crankshaft gear, first remove the snap ring, then attach the gear pulling ring (*Onan* tool no. 420A248) using two #10-32 screws. Tighten the screws alternately until both are tight. Attach a gear puller to the puller ring and proceed to remove the gear, as shown in Fig. 17.

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. Then remove the operating plunger for the breaker points, the fuel pump and tappets. After removing the governor cup assembly from the gear, the camshaft may be pressed out of the gear by using 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 gear onto the camshaft, be sure it is started straight and the key is properly in place. When replacing the cam gear on units having automatic spark advance mechanism, remove the spark advance mechanism and put blocks beside the pins to avoid damage when pressing on cam gear. Install the governor cup assembly before installing the camshaft and gear.

Each timing gear is stamped with O near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine (Fig.18). When installing the camshaft gear and shaft assembly, be sure that the thrust washer is properly in place behind the camshaft gear. Then install the crankshaft retaining washer and lock ring.

PISTONS AND RINGS

The piston and connecting rod assemblies are removed from 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 cylinder, have badly worn ring grooves, or otherwise are not in good condition, install new pistons. Install new pistons if they are so loose on the piston pins that a 0.002" oversize pin will not correct it. Handle pistons carefully to avoid nicking the walls. Any raised surface of this type must be dressed down carefully.

Conformatic pistons are designed for a 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.

Inspect the rings carefully for fit in grooves, for tension, and for seating on cylinder walls. If in doubt, install new rings.

Before installing new rings, check the ring gap by placing each ring squarely in its cylinder at a position corresponding to the bottom of its travel (Fig.19). The gap between the ends of the ring should be as given in the Table of Clearances. Slightly oversize rings may be filed as necessary to obtain the correct gap, but do not use rings which require too much

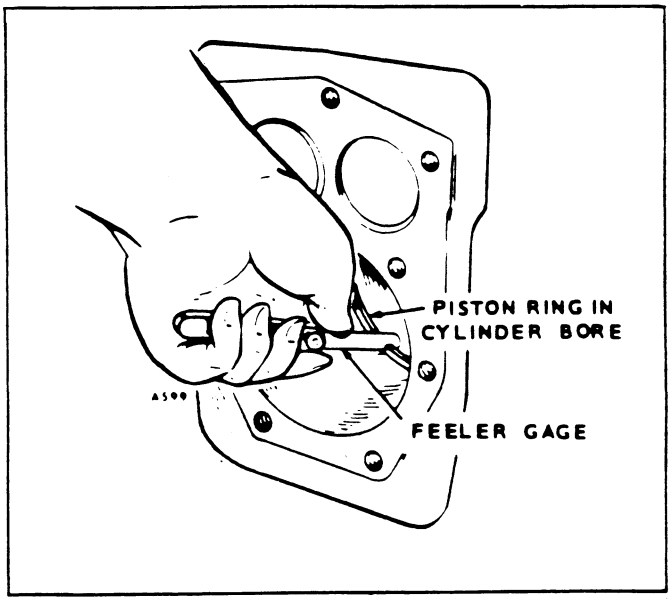


Figure 19. Fitting Piston Rings to the Cylinder

filing. Standard size rings may be used on .005" oversize pistons. 010", .020", .030" and .040" oversize rings are to be used on the corresponding size piston. Tapered rings are usually marked *top* on one side, or identified in some other manner. These rings must be installed with this mark toward the piston head. 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 positioned in their groove before installing the piston and connecting rod in the engine. Correct piston-to-cylinder clearance appears in the Table of Clearances.

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. Two materials have been used. Prior to Spec D models, rods are aluminum alloy with bearings integral. Begin with Spec D models, rods are forged steel with replaceable bushings and bearings. Rods are available in standard or .010", .020" or .030" undersize. Bearings are available in standard or .002", .010", .020" or .030" undersize.

For clearances refer to the *Table of Clearances.*

On aluminum alloy rods, proper clearance for rod to crankshaft is obtained by carefully dressing the ends of the connecting rod cap. Use a sheet of abrasive (320 grit or finer) 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 material from the cap before installing it. See Fig. 20.

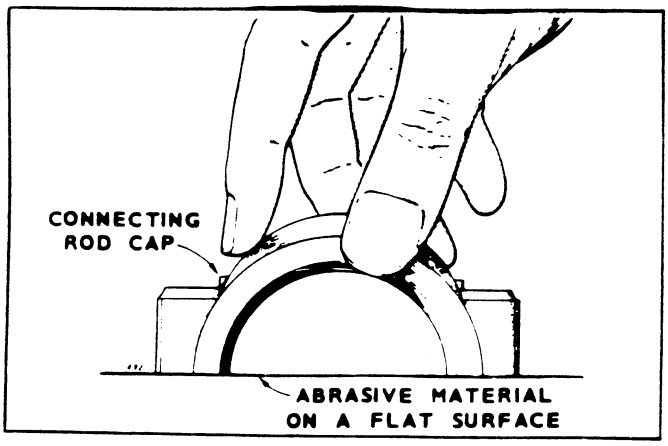


Figure 20. Dressing Connecting Rod Cap Ends

On *forged steel* rods proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

The connecting rod and piston assembly must be properly aligned before re-assembly to the engine. The aligning should be done on an accurate aligning gage 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 two fits on the crankshaft journal nearer the bearing plate. 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.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, the bearing journals should be refinished to use nearest available undersize bearings or a new crankshaft should be installed. If a worn main bearing journal cannot be fitted with an available precision type undersize bearing, then refinish it to the next undersize. If a worn rod journal cannot be fitted by dressing down the rod cap (Aluminum Rod) or by installing new bearing inserts (Forged Rod), then refinish it to take the corresponding undersize rod or bearing insert available.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

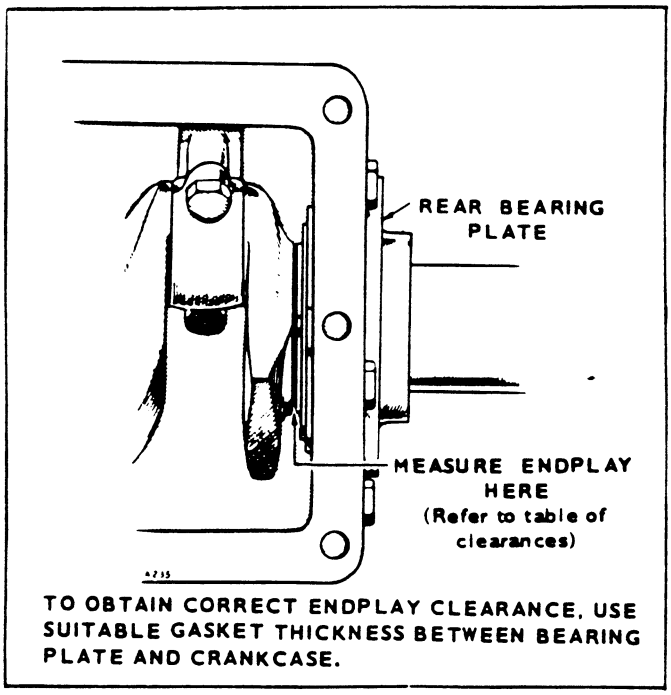


Figure 21. Crankshaft Endplay

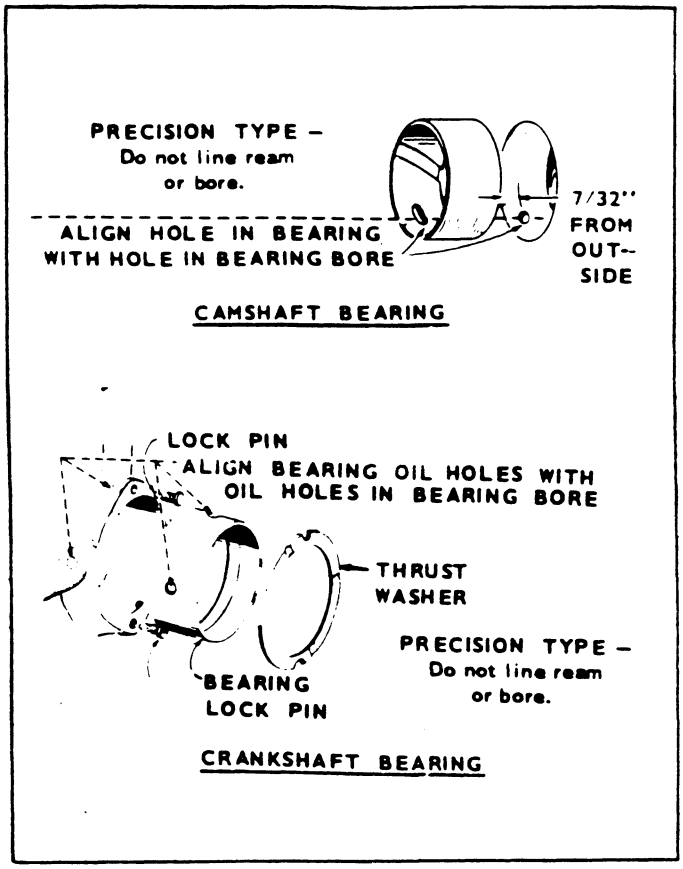


Figure 22. Camshaft And Crankshaft Bearings.

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 the bearings to reduce friction when installing and again lubricate with oil after installing. See Fig. 22.

New crankshaft main bearings are precision type which *do not* require line reaming or line boring after installation. They are available in standard size, .002", .010", .020" or .030" undersize. Expand the bearing bore by placing the casting in hot water or in an oven heated to 200°F.

Warning: *If a torch is used, apply only a little heat.* If practical, cool the precision bearing to shrink it. Align the oil hole(s) in the bearing with the oil hole(s) in the 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 the 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 the two washer notches must fit over two lock pins to prevent riding on crankshaft. Crankshafts with H stamped on the counter weight have induction hardened main bearing journals and should use steel backed aluminum bearings.

New camshaft bearings are a precision-type which *do not* require line reaming or line boring after installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the elongated hole in proper position and narrow section facing out (except bores without oil holes install with bearing groove at the top). Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in flush with the bottom of counterbore which receives the expansion plug.

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

Before installing the seals, fill the space between lips with a fibrous grease or stiff cup grease. This will improve sealing.

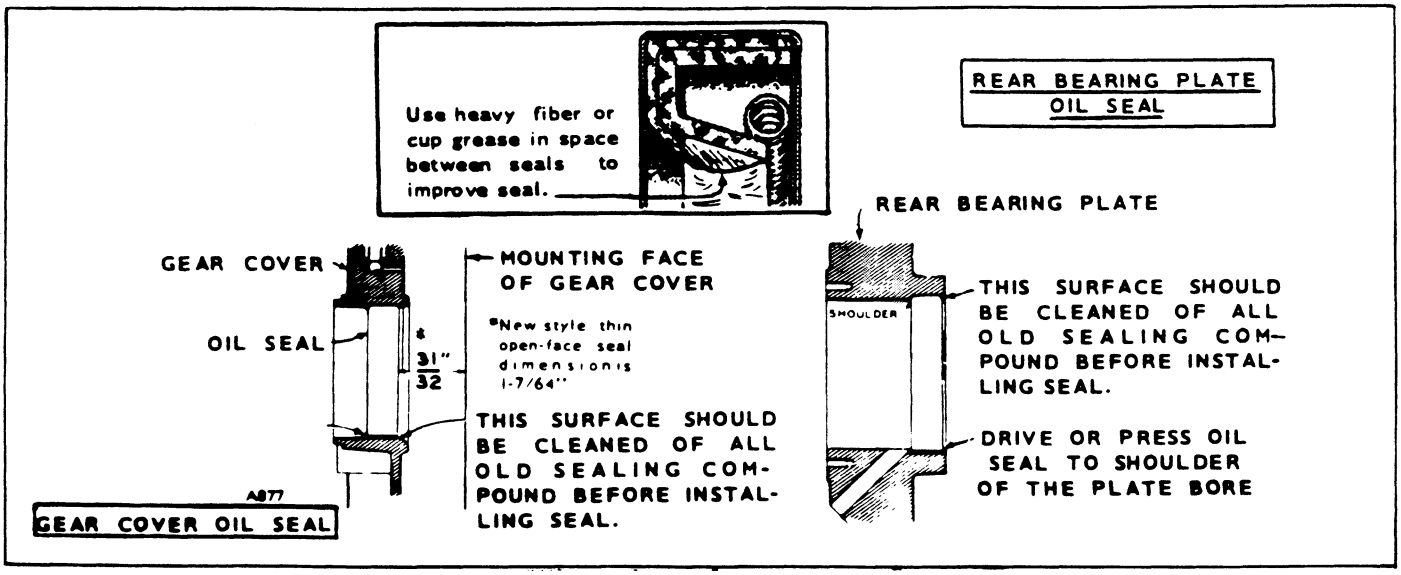


Figure 23. Gear Cover And Rear Bearing Plate Oil Seals

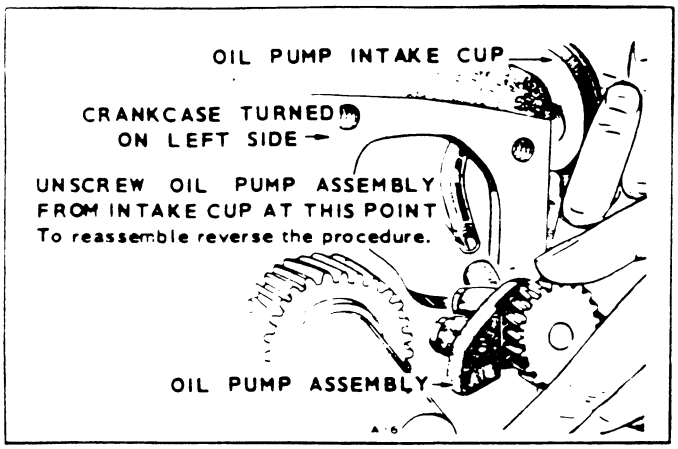


Figure 24. Oil Pump Assembly

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. Install new style, thin, open-face seal 1-7/64" from mounting face of 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. Use a seal expander (*Onan* Part #420A181) 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.

Engines equipped with some types of reduction gear assemblies, do not use the rear oil seal. The reduction gear assembly is oiled directly from the engine crankcase. Refer to the instructions screened on the case of the reduction gear assembly.

OIL PUMP

To remove the oil pump, it is necessary to detach the intake cup assembly, as illustrated in Fig. 24.

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.

OIL PRESSURE RELIEF VALVE ADJUSTMENT

Engine oil pressure is easily adjusted by means of the slotted stud and lock nut located near the breather tube. See Fig. 25 Oil pressure readings when the engine is thoroughly warmed up should be between 20 and 35 lbs. To increase oil pressure, loosen the locknut and turn the stud inward. To decrease oil pressure, loosen the locknut and turn the stud outward. Be sure to tighten the locknut securely after making an adjustment. The spring and plunger can easily be removed and cleaned.

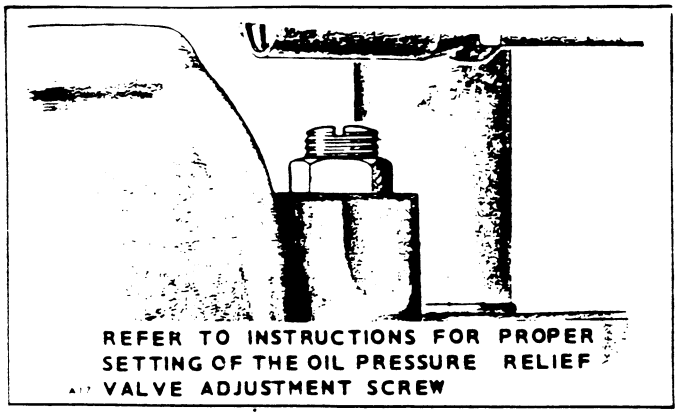


Figure 25. Oil Pressure Relief Valve Adjustment

Low oil pressure may point to worn main or connecting rod bearings, improper clearance at these points, a weak or broken by-pass spring, an improperly adjusted by-pass or a defective gage. Check the oil pressure gage before making any other test, it may be defective.

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 accomodate a new piston and rings of one of the available oversizes. Pistons are available in .010", .020", .030" and .040" oversize. Piston rings are available in .010", .020", .030" and .040" oversize. Use standard size rings on a .005" oversize piston. 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. Engine might be 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 cylinder block and on the unit nameplate. The standard cylinder bore size appears in the Table of Clearances.

CYLINDER HEADS

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. The cylinder head bolts should be tightened in the order designated in Figure 26 and to the torque specified at the time the engine is assembled or the cylinder head replaced. This should be at room temperature. At some later time, after the engine has been operated so it reached normal hot temperature and allowed to cool to room temperature, the cylinder head bolts should be re-torqued to the original specified torque. This retightening should be done before the engine has been run a total of fifty operating hours.

FLYWHEEL

To remove the flywheel, turn the flywheel mounting screw outward about two turns. Use a screwdriver behind the flywheel to take up the crankshaft end play. Then strike a sharp endwise blow on the head of the cap screw 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. Always use a steel key for mountung the flywheel.

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

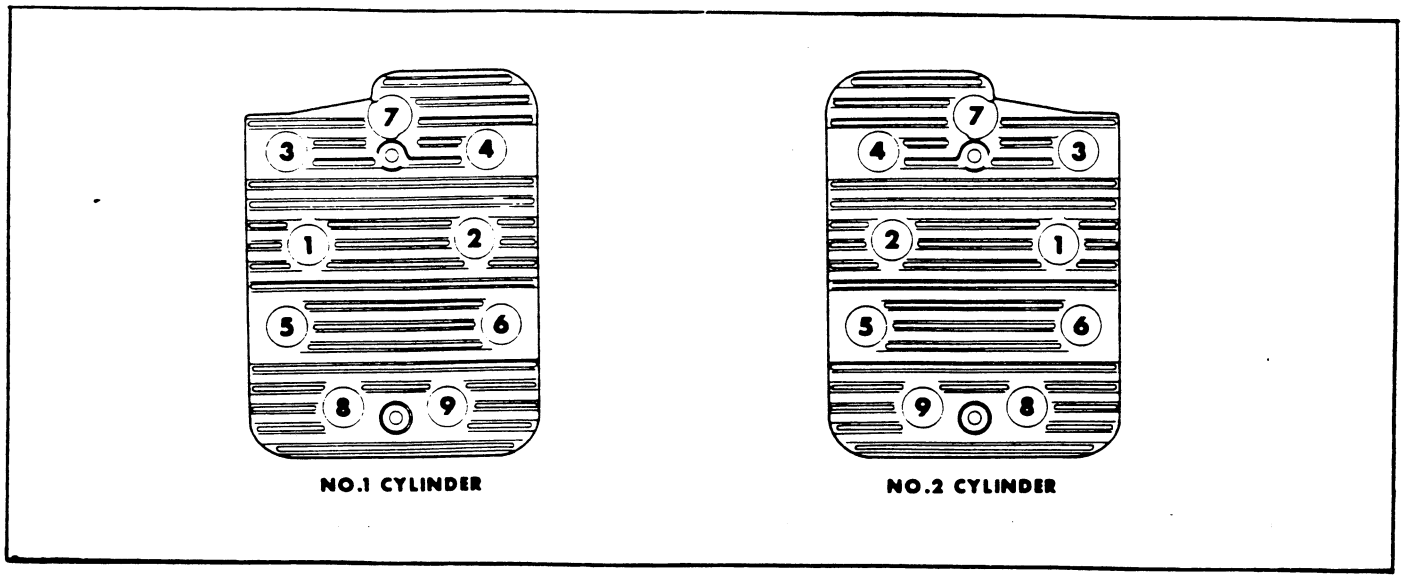


Figure 26. Head Bolt Tightening Order

MANUAL STARTER

READI-PULL STARTER

Refer to Fig. 32, showing the Readi-Pull manual starter disassembled.

Caution: ***The recoil spring may unwind and cause injury if allowed to let fly wildly when starter is disassembled or assembled.***

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 four 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. 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.

INSTALLING THE STARTER

Units Prior to Spec. D: Refer to Fig. 33. The blower housing on the engine must be as rigid as possible. Examine

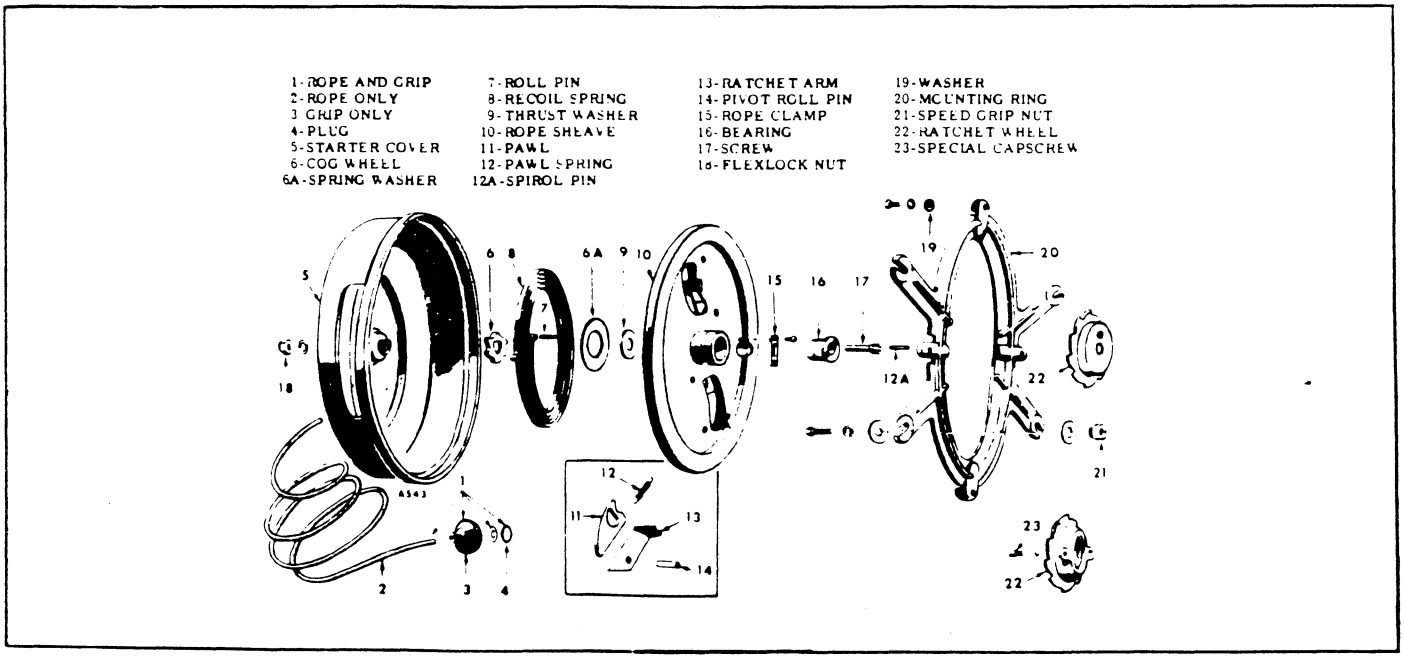


Figure 32. Readi-Pull Starter

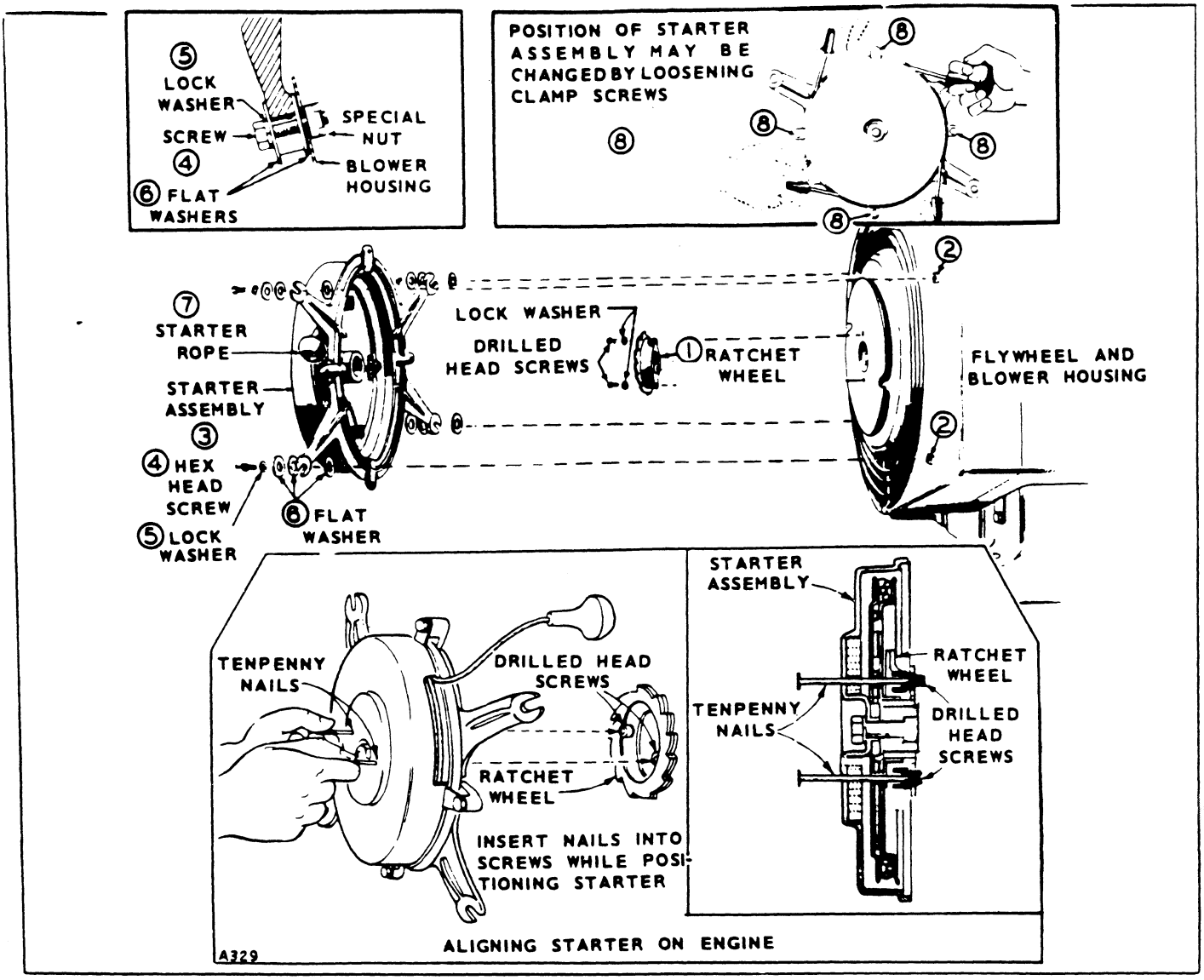


Figure 33. Installing Starter on Engine (Prior Spec D)

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" 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 tow 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).

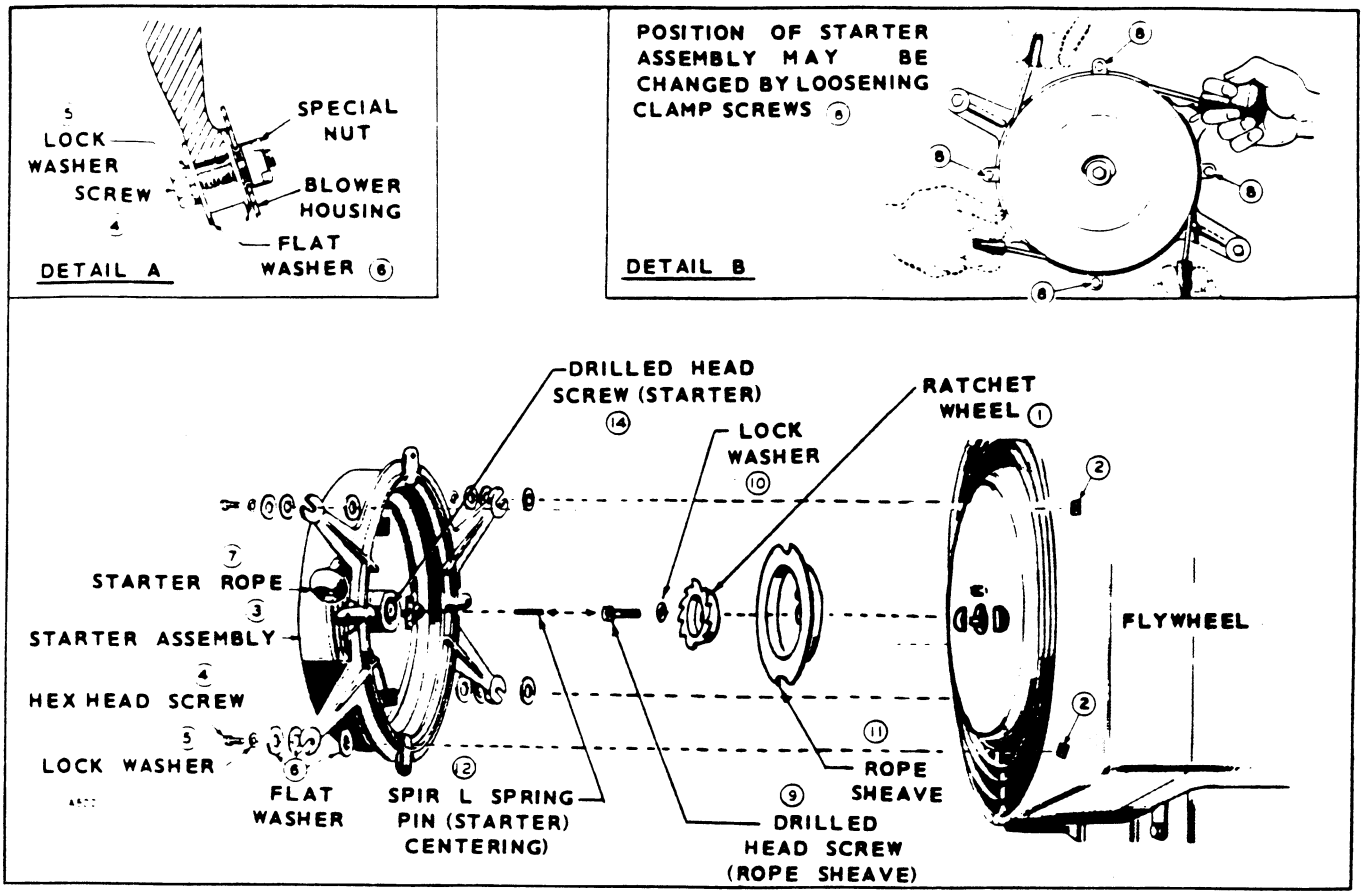


Figure 34. Installing Starter Kit (Spec D and Later)

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.

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. Refer to Figure 34.

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 re-installation adjust 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 the pull rope does not rub against the clamping screws.

GENERATOR MAINTENANCE

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.

BRUSHES AND SPRINGS

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

BRUSH RIG 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 rotated to the point of highest voltage (point of least arcing of the brushes) regardless of where the witness mark falls. After the brushes are seated and the generator is hot, readjust the brush rig. This is commonly known as the *neutral* brush position (See Figure 31).

COLLECTOR RINGS

If the collector rings become grooved or out-of-round, or the brush surface becomes pitted or rough so that good brush film cannot be maintained, remove the armature and refinish the collector rings in a lather. If the commutator appears to be rough or scored, refinish it at the same time. Remove or adequately shield the ball bearing during refinishing. There should be a maximum of .002" run-out of the collector ring when compared to the generator bearing.

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 hacksaw blade. (Fig. 28). 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.

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.

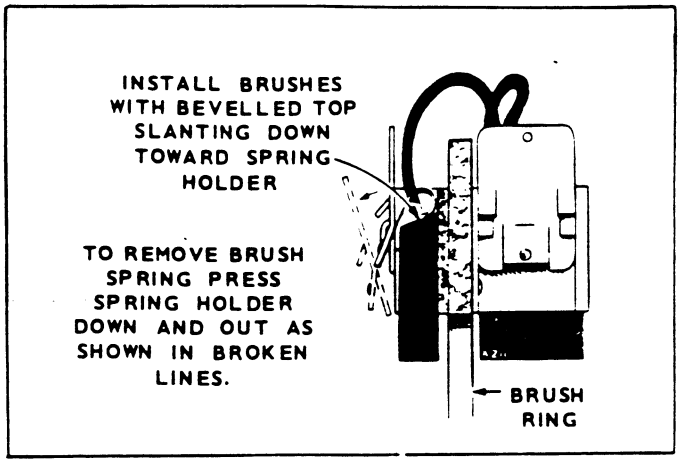


Figure 27. Brush Replacement

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 (Fig. 29). Place one test prod on the commutator, and the other test prod on a bare, clean part of the armature shaft. The test prods must make good electrical contact. The test lamp should not glow. If the test lamp does glow, the dc winding or the commutator is grounded. To test the ac winding, place one test prod on one of the collector rings and the other test prod on the armature shaft. If the test lamp glows, the ac winding or a collector ring is grounded. Replace a grounded armature with a new one.

ARMATURE OPEN CIRCUIT TEST

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

To test the ac winding, be sure all brushes are lifted or removed. Use a test lamp set. Place one test prod on each of the collector rings. If the test lamp does not glow, the ac winding is open circuited. See Figure 29.

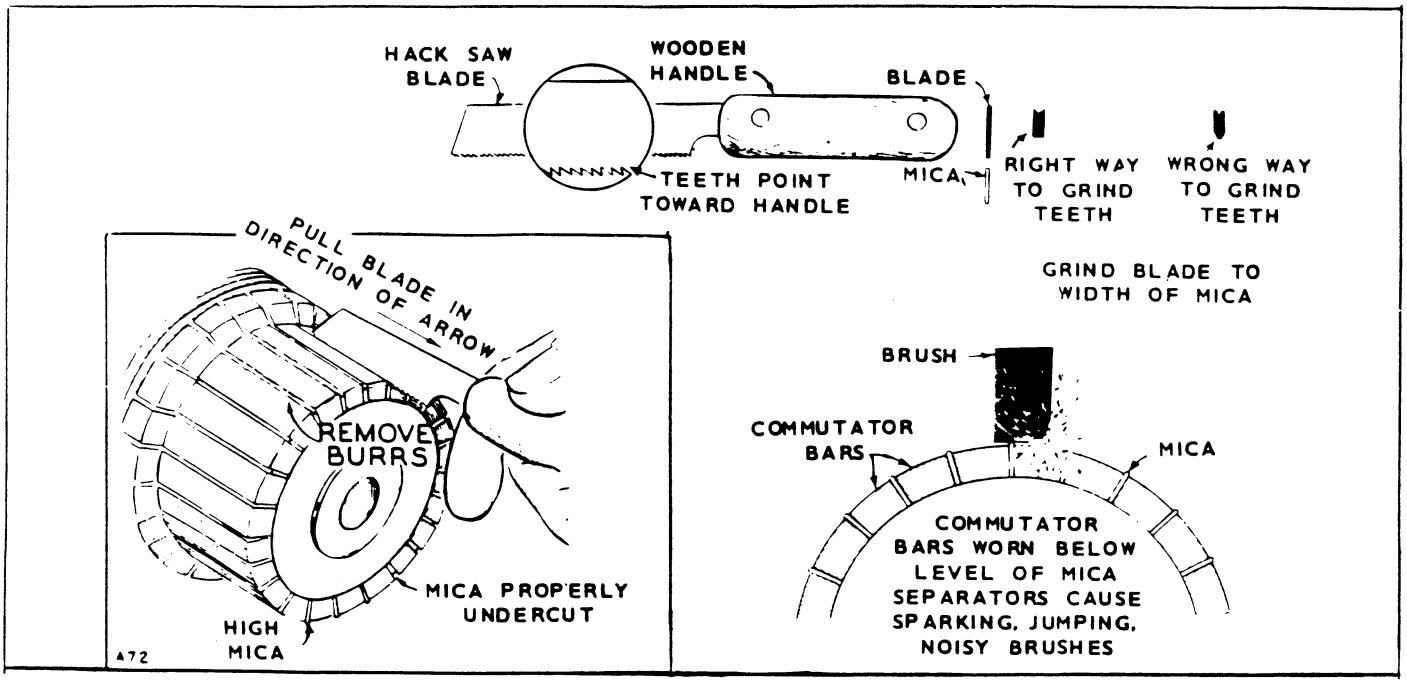


Figure 28. Undercutting Commutator Mica

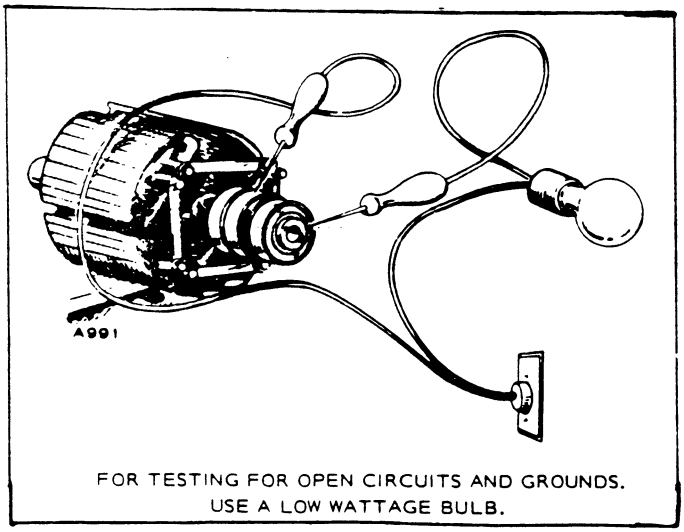


Figure 29. Test Circuit

(EXCEPTION – GENERATORS WITH 4 SLIP RINGS)

If the generator is a single phase model, test between the two slip rings nearest the commutator, and repeat the test between the two rings nearest the ball bearing. In each case the test lamp should glow. If the test is made between the two center rings the test lamp should not glow. If the test lamp does glow, a short circuit between the separate windings is indicated.

To test the dc winding, place the armature in a growler. With the growler current on, pass a smooth steel strip across the commutator segments. Repeat all around the commutator. At some point around the commutator, a spark should occur as the strip contacts two adjacent segments. Rotate the armature slightly and repeat the test. Continue until a spark is obtained between all adjacent segments. If no spark is obtained at some point, an open circuit is indicated.

NOTE:

A short circuit in the winding may 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.

GENERATOR DISASSEMBLY

The procedure is mostly self-evident. Remove the band and end cover. 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. Screwdriver 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.

ARMATURE SHORT CIRCUIT TEST

To test for a short circuit, place the armature in a growler. (Fig.30). With the growler current on, hold a steel strip about 1/2" 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.

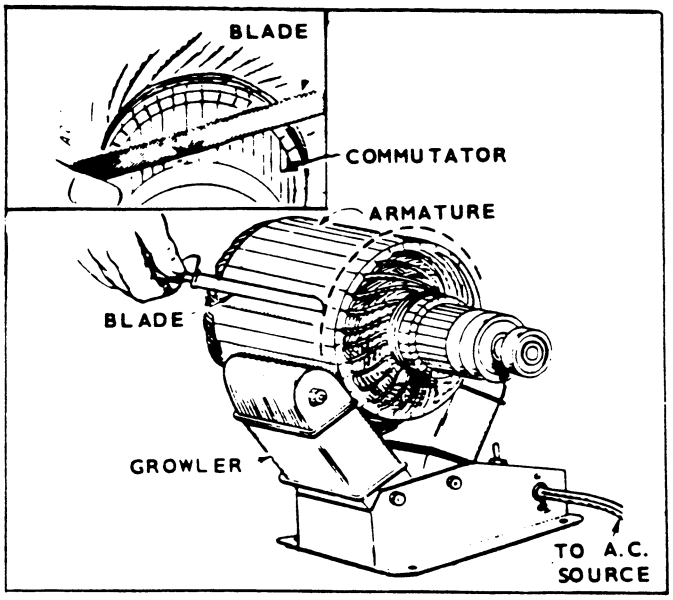


Figure 30. Testing With Growler

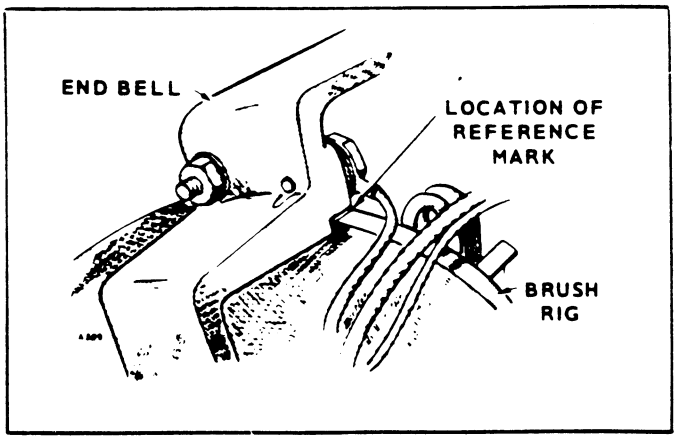


Figure 31. Brush Rig Alignment

TESTING FIELD WINDINGS

Use a test lamp set for all tests except short circuit tests. The field coils of all ac 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 WINDING 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 assembling 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. Assemble frame assembly and end bell. Tighten up both frame and through-stud nuts. Tap end bell with hammer in the horizontal and vertical plane to make sure the bearing is not binding. Tighten the armature-through-stud securely.

CONTROL SYSTEM

The plant control system regulates starting, stopping, battery charging and provides a means of emergency automatic stopping. Control system defects can best be analyzed with the proper wiring diagram.

When using *Onan* wiring diagrams, remember these points. The views shown are modified pictorially. Components are shown in their actual positions. Normally, the top view of each component is shown for terminal location. Dotted lines show the edges of the control box and indicate the direction from which it is being viewed, i.e. *Top View*.

All relays are shown in the de-energized position.

If any control part fails, replace the defective part with a part of identical manufacture. 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.

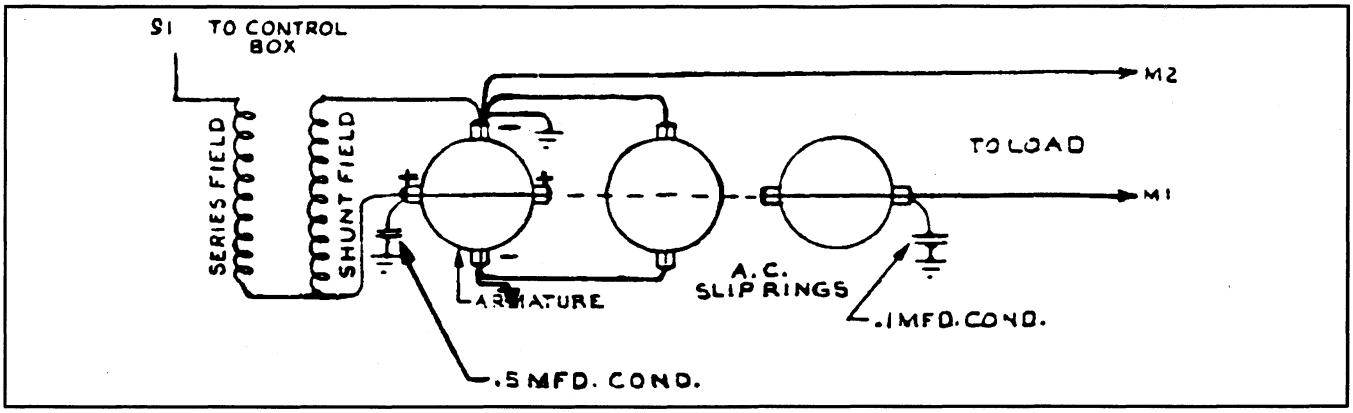
Always disconnect the battery to avoid accidentally starting the plant. When disassembling controls, tag each lead that has to be removed and mark the connection point of the lead (on the tag) to assure correct connections for assembly.

WIRING DIAGRAMS

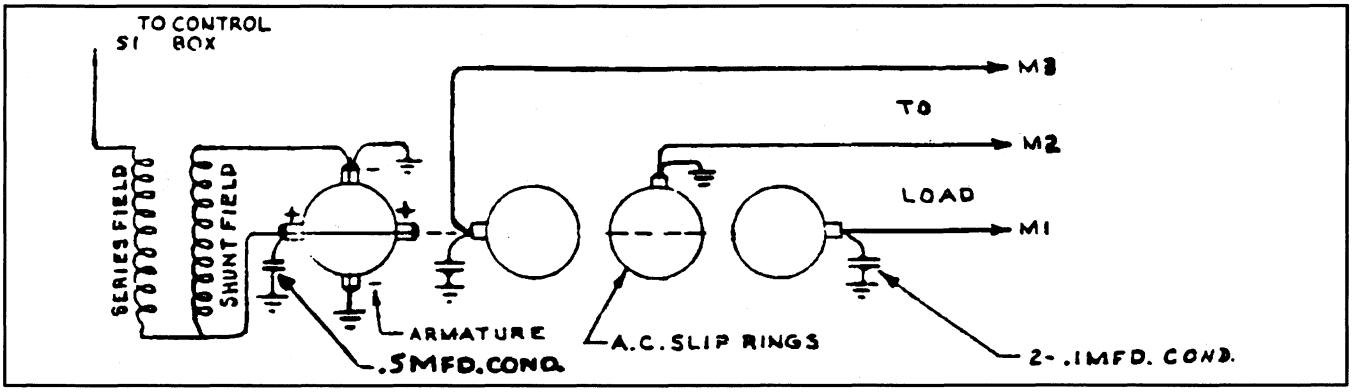
The wiring diagrams in this section are typical and apply only to standard generating plants. Wiring diagrams for special models are available on request from the factory; send generator model, spec, and serial numbers with the request.

ELECTRICAL DATA	TYPE OF PLANT				
	REMOTE START	PORTABLE MANUAL START	MANUAL START	MAGNET SERVICE	WIRING DIAGRAM NO.
120V, 2W, 1P	X				611C176
240V, 2W, 1P	X				611C176
120/240V, 3W, 1P	X				611C164
120/240VAC, 32VDC	X				611C235
120/240V,4W, 1P RECONNECTIBLE	X				611C236
120/208V, 4W, 3P	X				611C206
240V, 3W, 3P	X				611C178
120VAC, 32VDC	X				611C234
120V, 2W, 1P		X			602B144
240V, 2W, 1P		X			602B145
120/240V, 3W, 1P		X			602B146
120/208V, 4W, 3P		X			602B160
240V, 3W, 3P		X			602B147
115VDC		X			602B165
AC, 2 or 3 W, 1 or 3P			X		602B143
250VDC, Manual Start				X	602A166 602A174
250VDC, 6V Start				X	602B164
250VDC, 12V Start				X	611B244 611B276

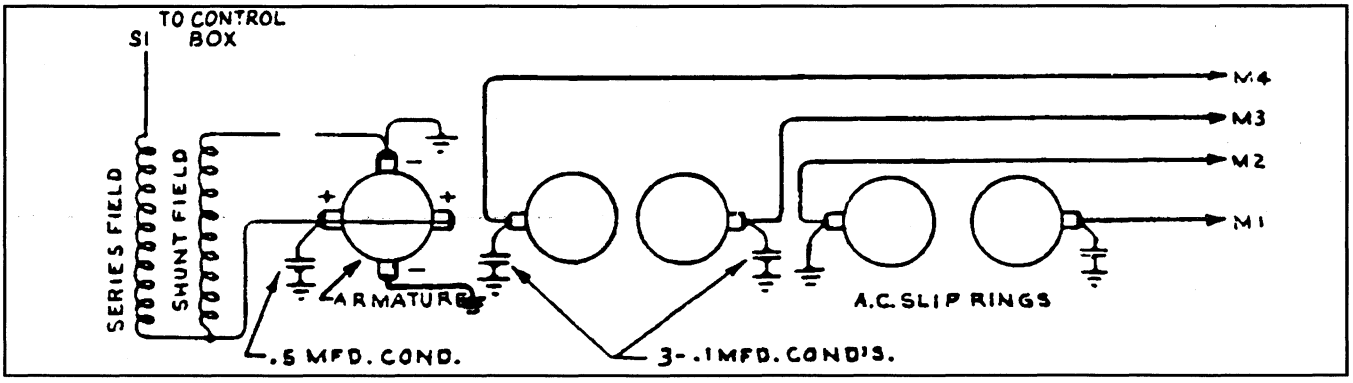
GENERATOR WIRING DIAGRAMS



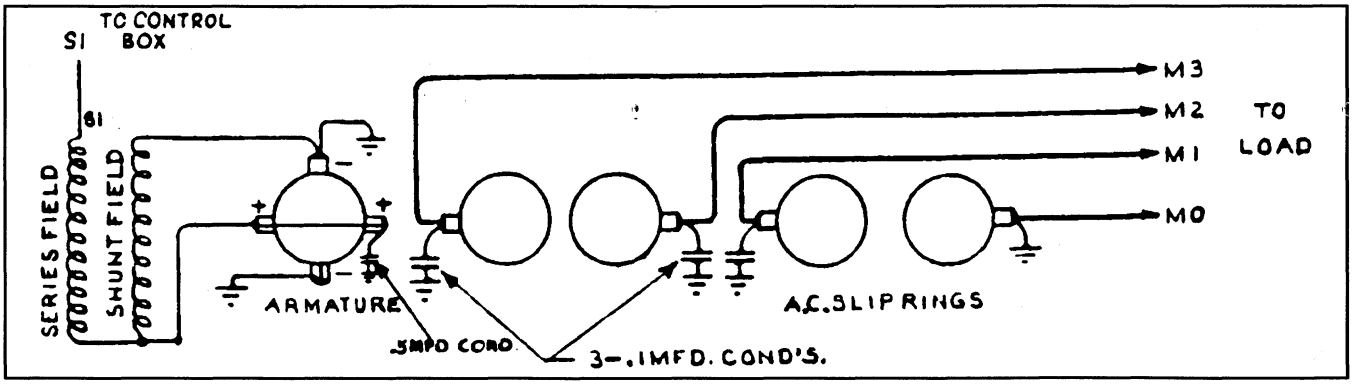
Revolving Armature 2-Wire, Single Phase



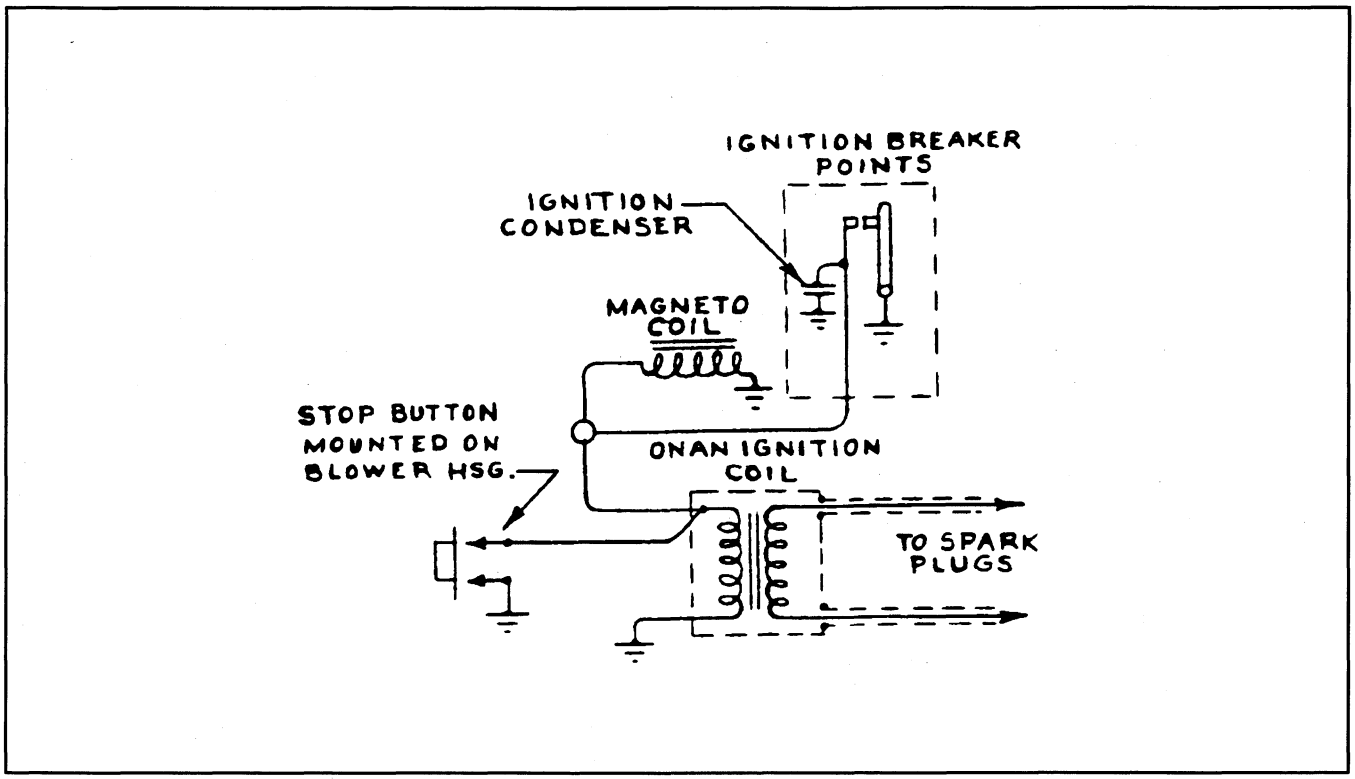
Revolving Armature 3-Wire, Single Phase



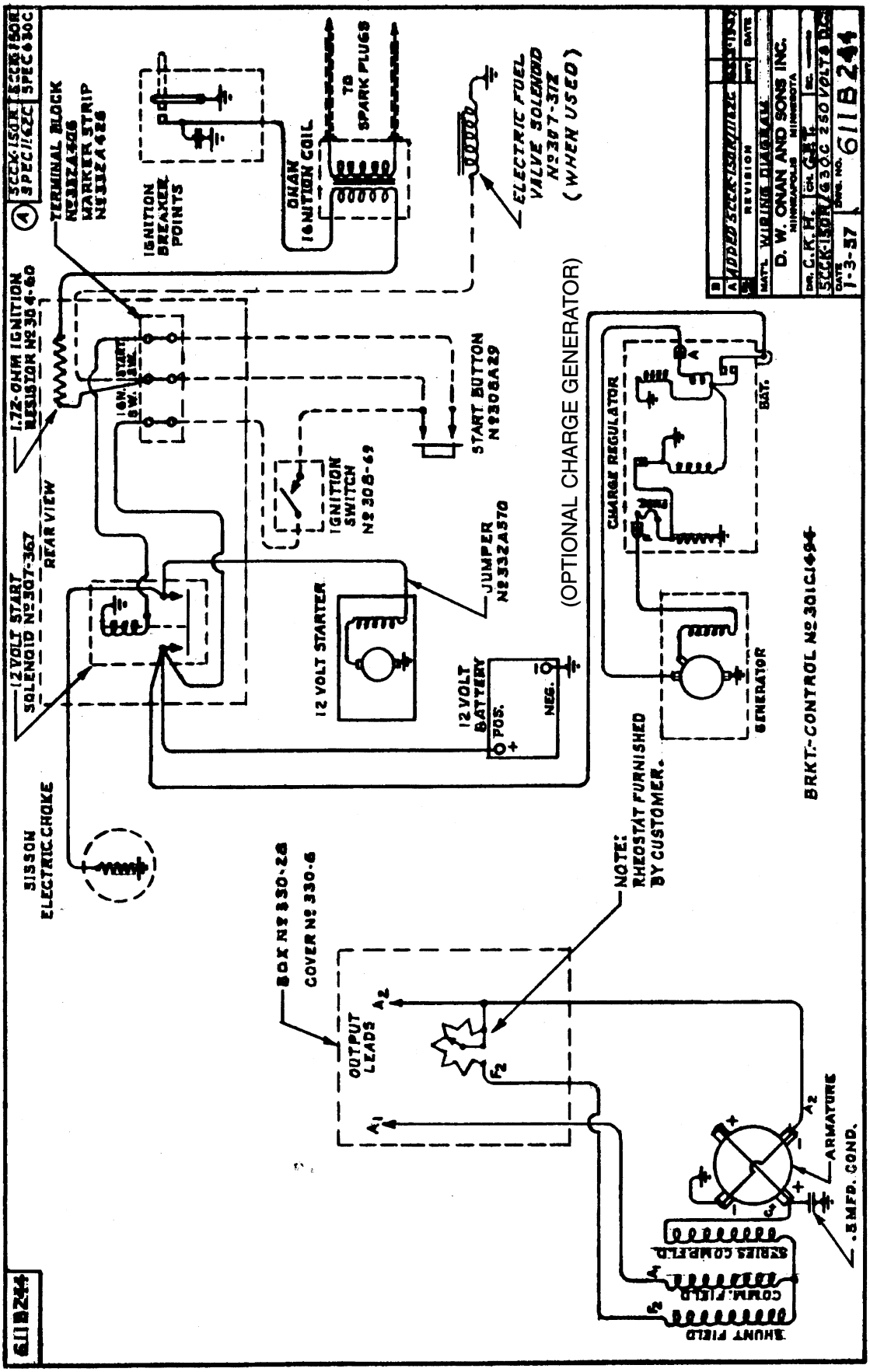
Revolving Armature Reconnectible for 120, 240, or 120–240 Volts, Single Phase (CCK-3CR)



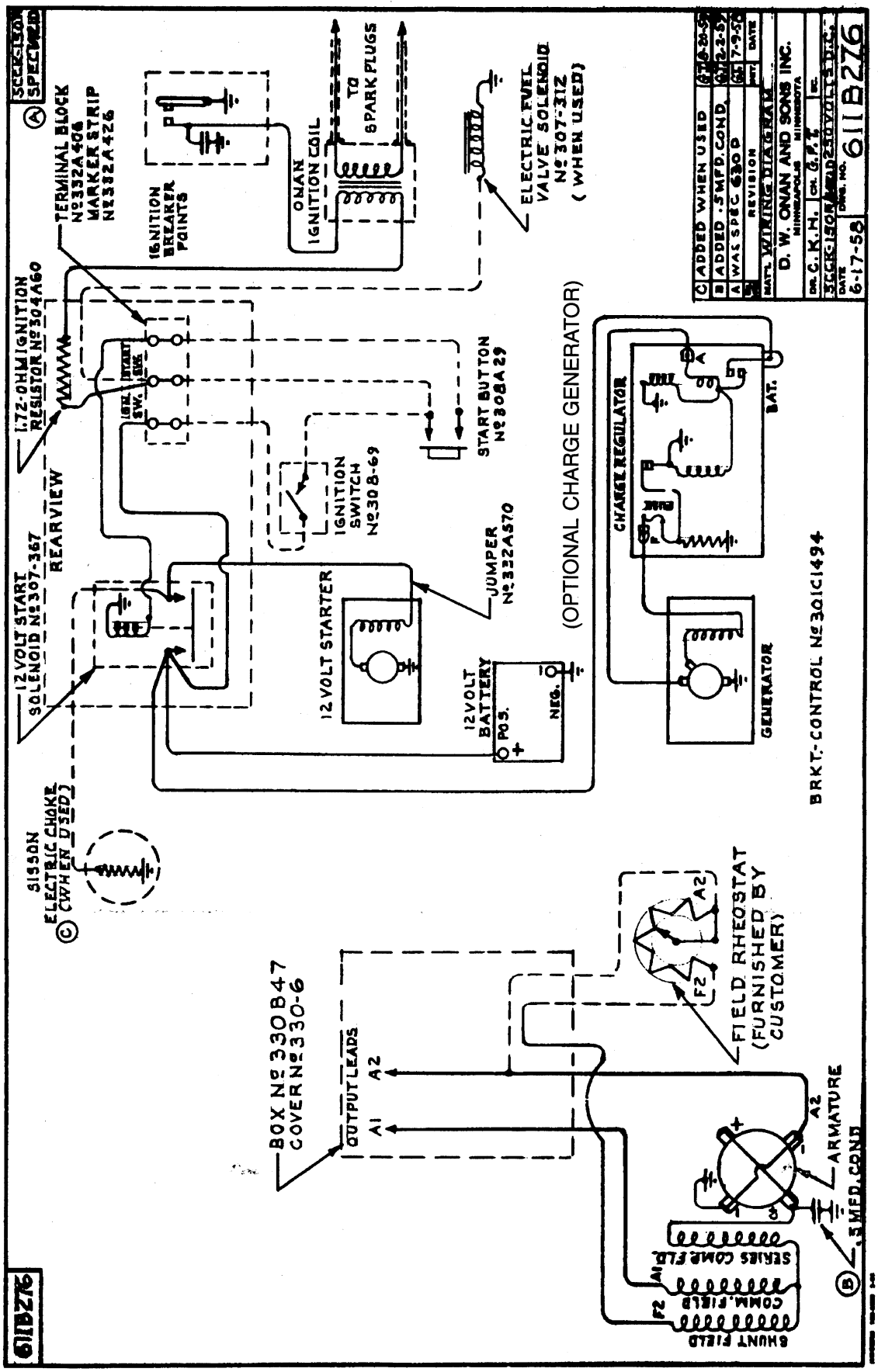
Revolving Armature 4-Wire, Three Phase



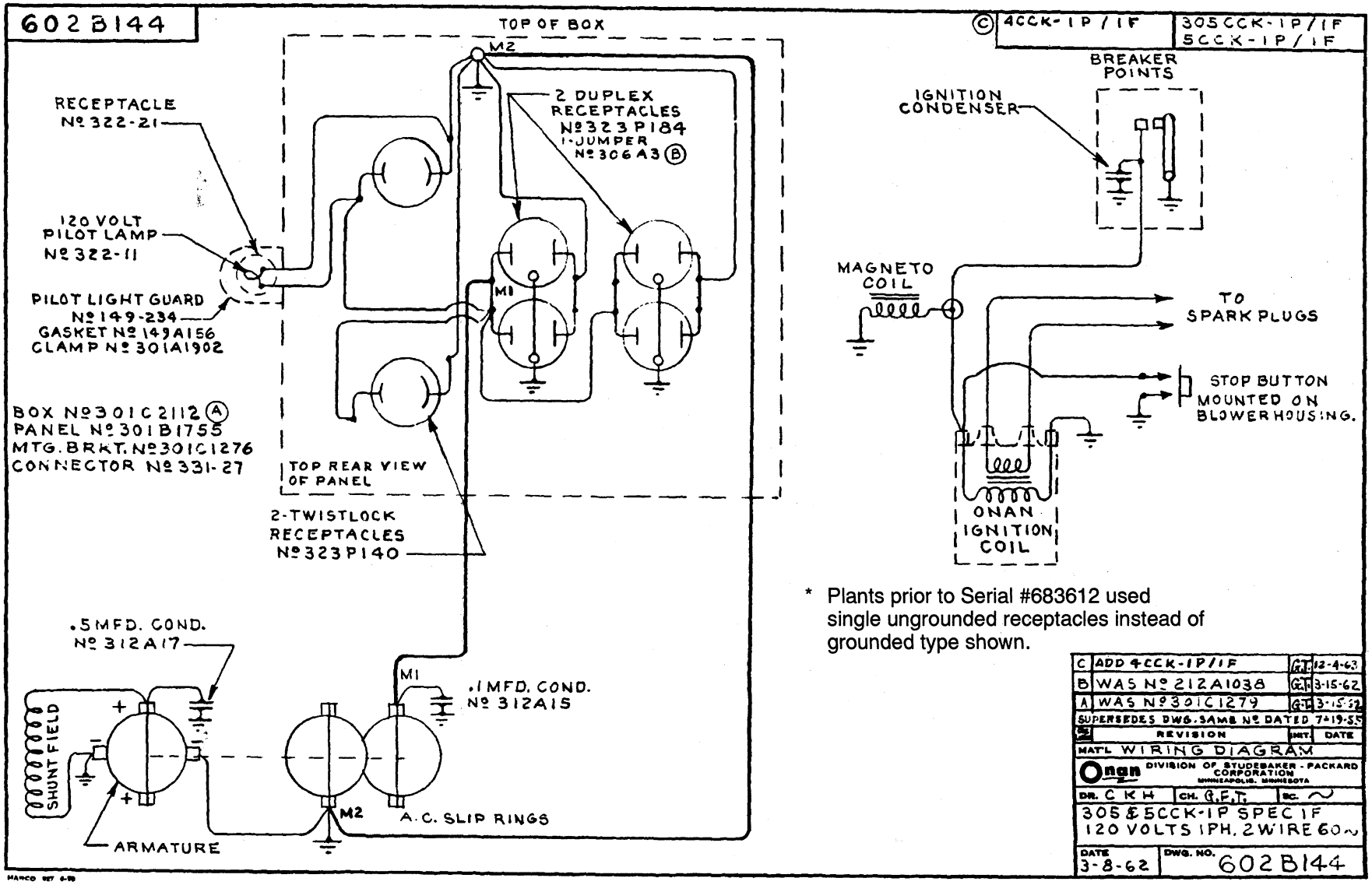
Typical Wiring Diagram of Magneto Ignition Used On Manual and Portable Type Plants



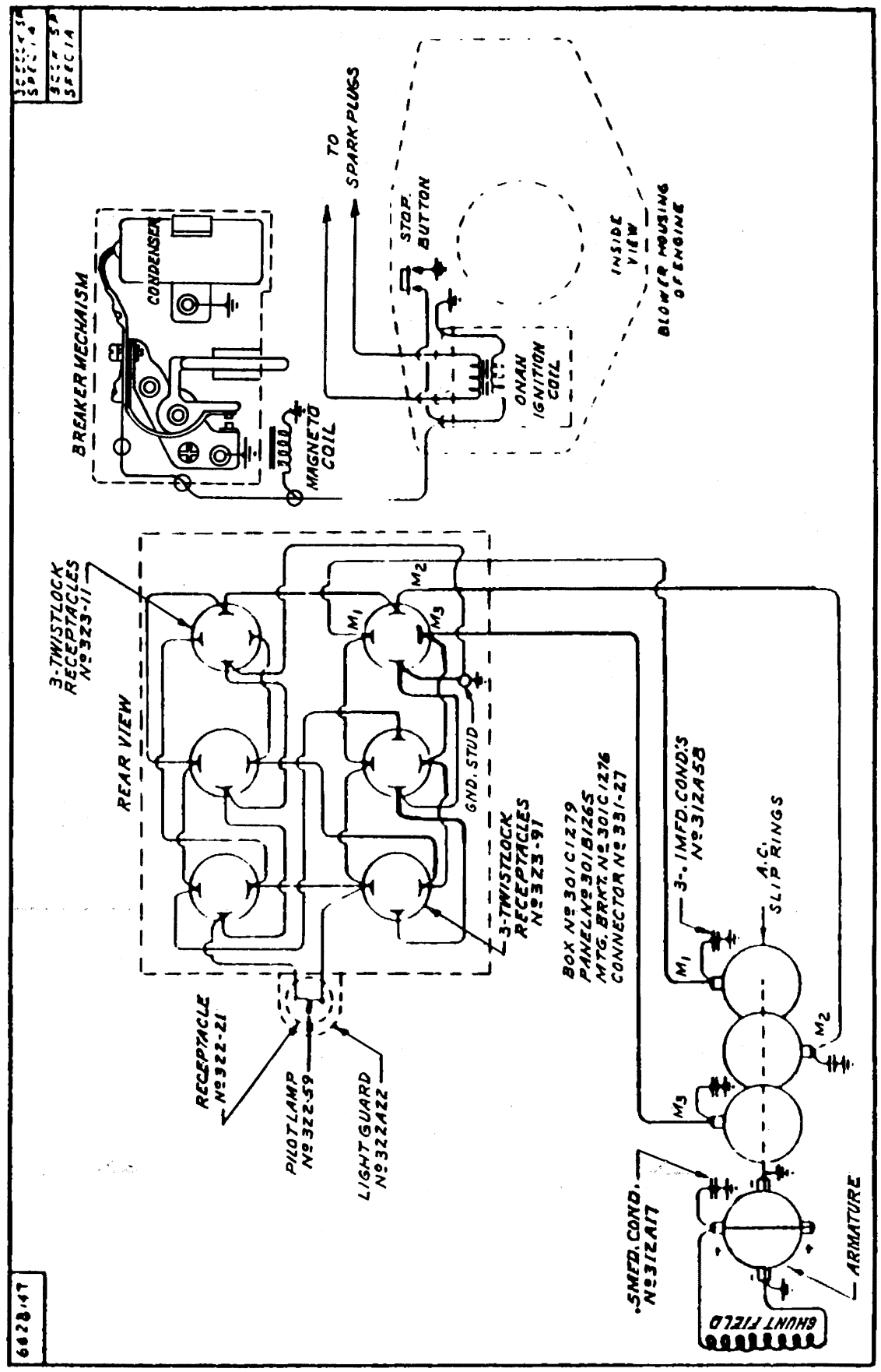
Wiring Diagram #611B244 – 250 Volt – DC Magnet Service, 12 Volt Starter



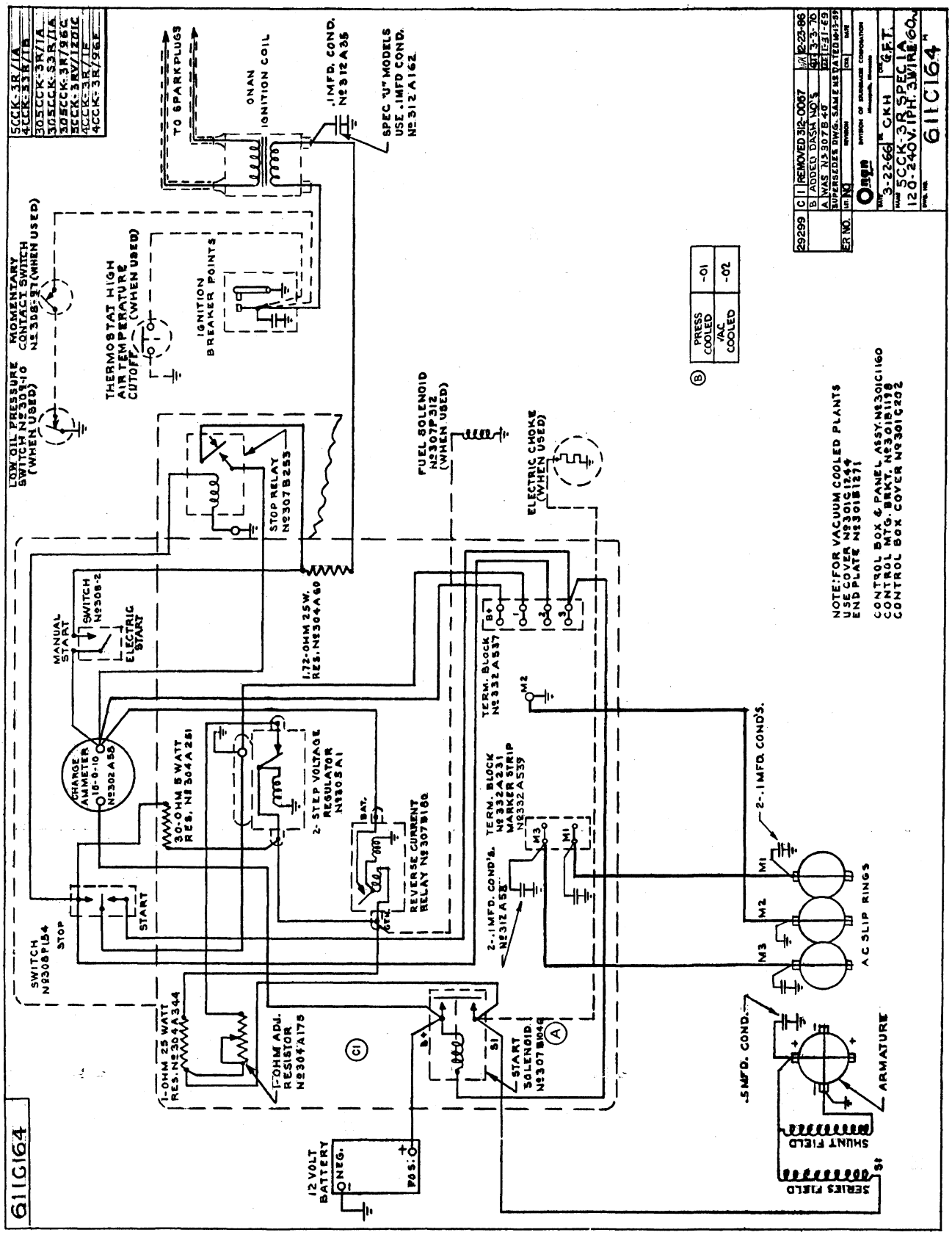
Wiring Diagram #611B276 – 250 Volt – DC Magnet Service, 12 Volt Starter



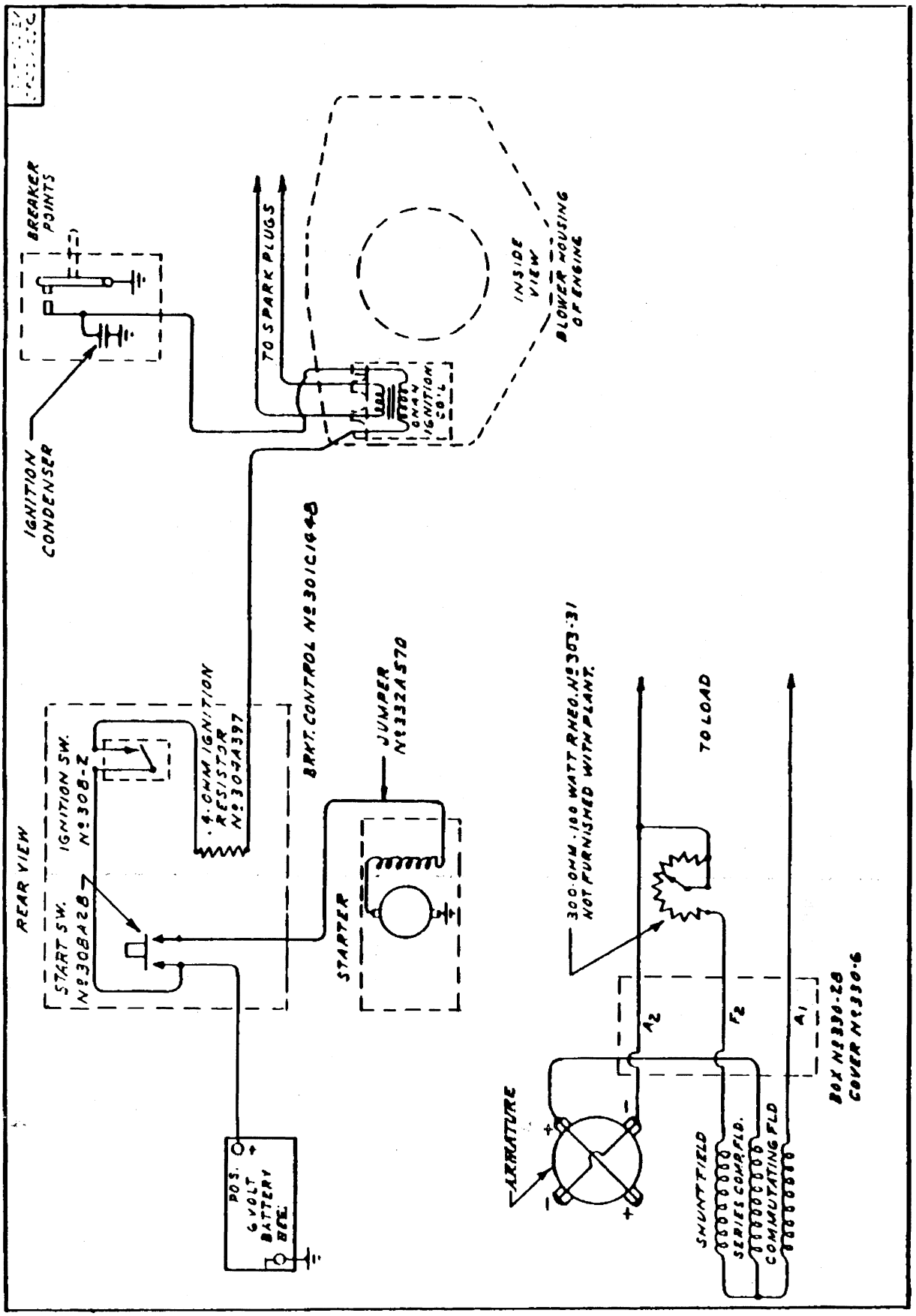
Wiring Diagram #602B144 – Portable Type Plant With Carrying Frame – 120 Volt AC, 1-Phase, 3-Wire



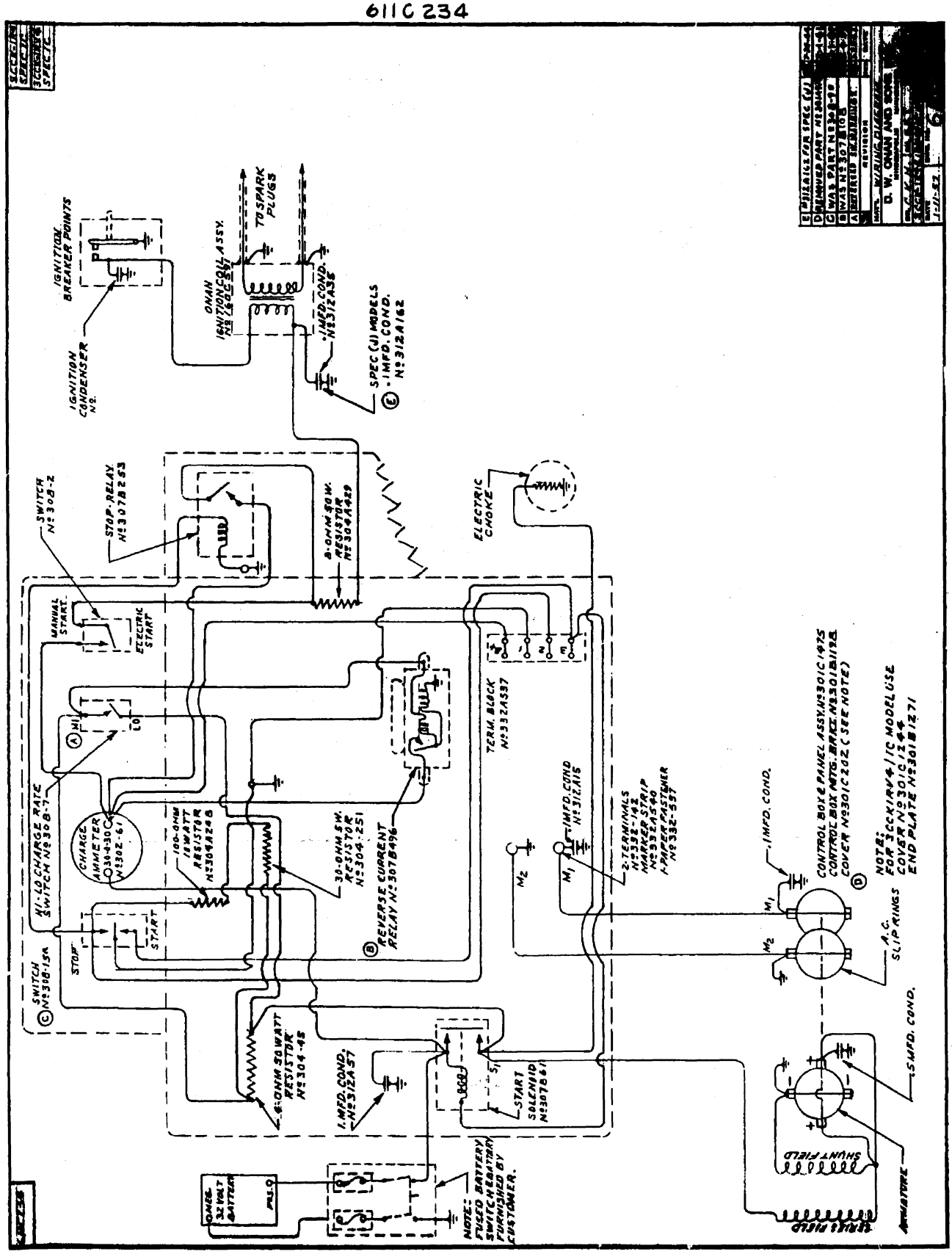
Wiring Diagram #602B147 – Portable Type Plant with Carrying Frame, Alternating Current, 240 Volt, 3-Phase, 3-Wire



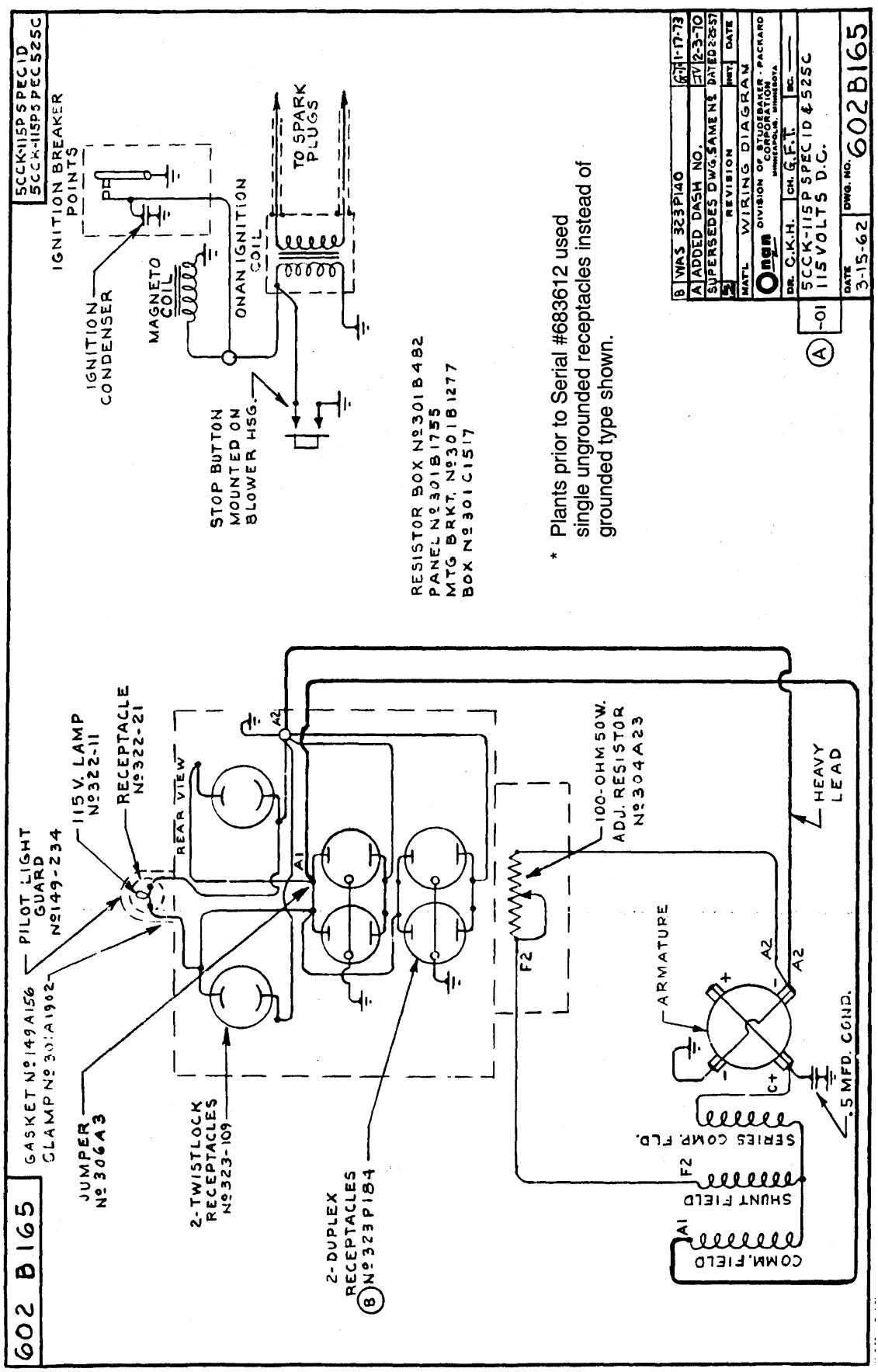
Wiring Diagram #611C164 – Remote Type Plant, Alternating Current, 120/240 Volt, 3-Wire, 1-Phase



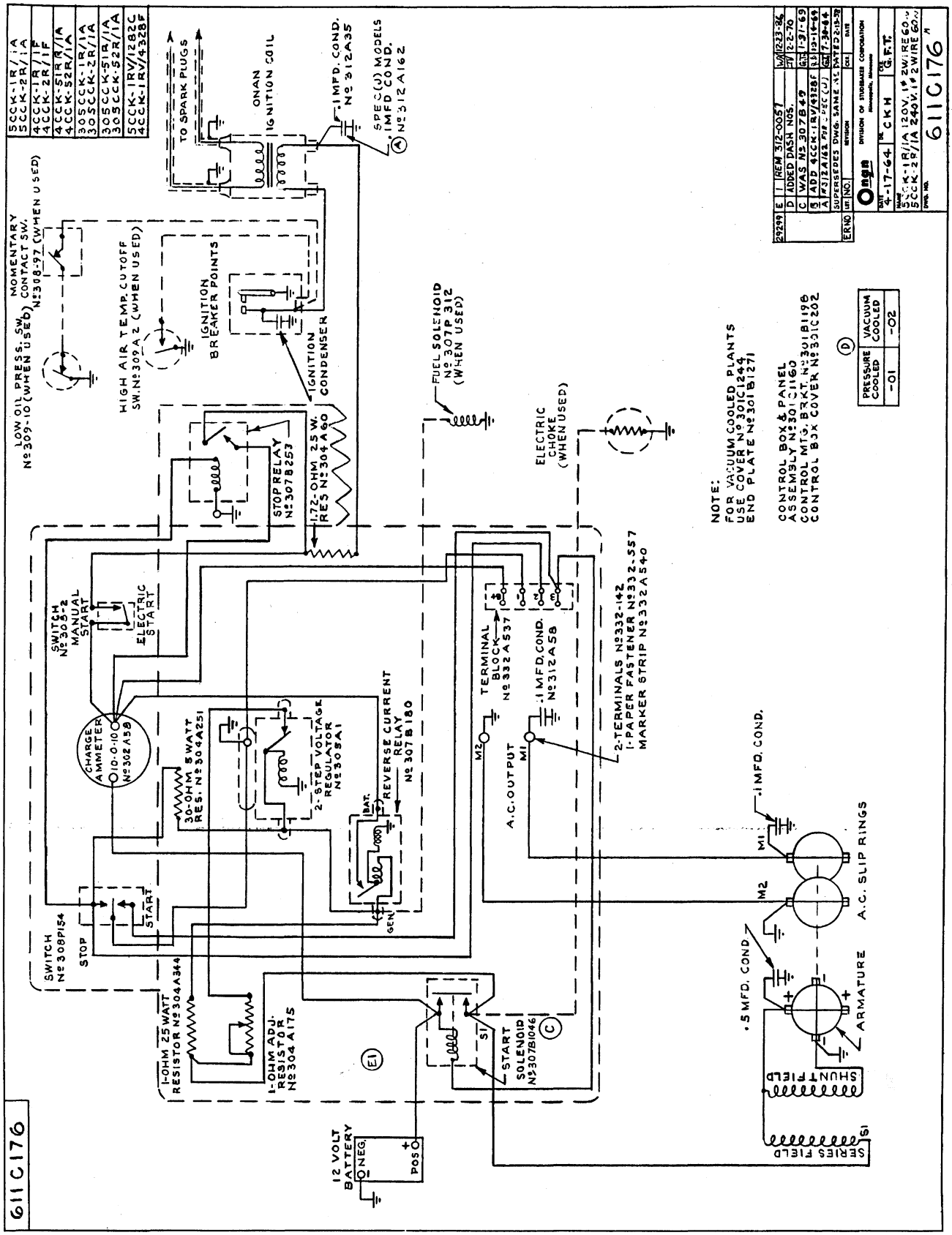
Wiring Diagram #602B164 – 250 Volt, Direct Current, 6 Volt Starter, Vacu Flo Magnet Service



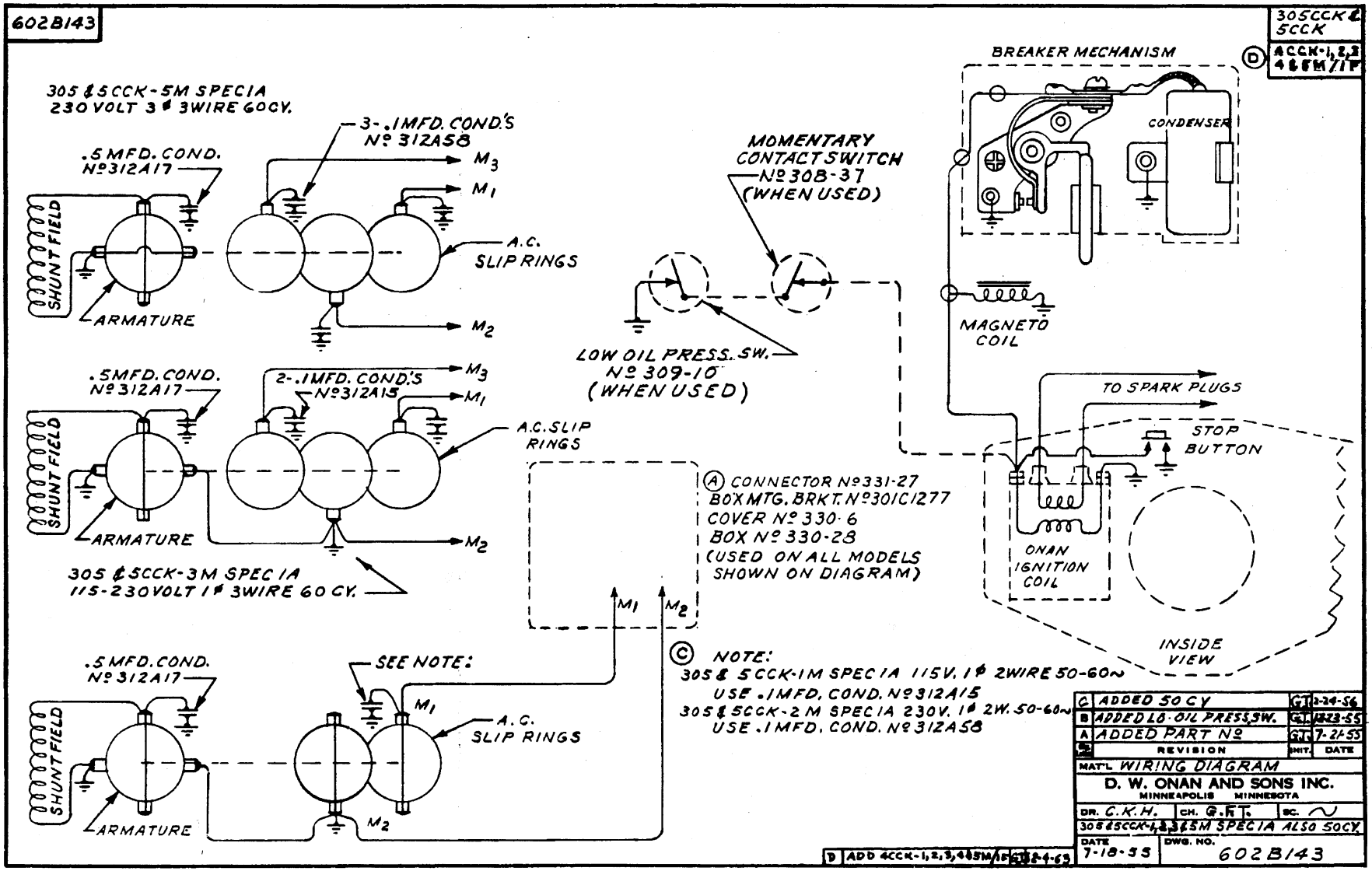
Wiring Diagram #611C234 – Dual Purpose Type Plant, 120 Volt AC, 32 Volt DC



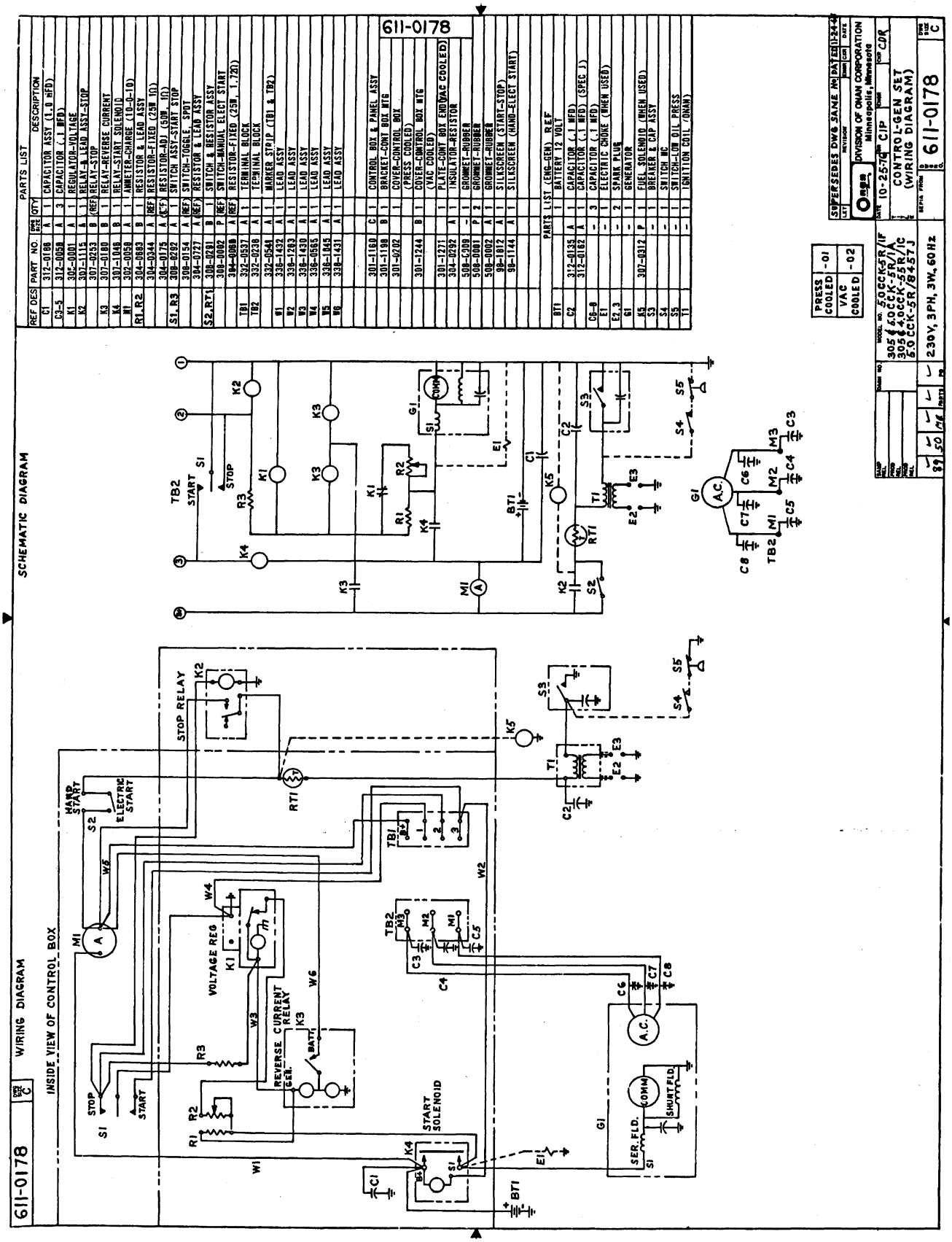
Wiring Diagram #602B165 – Portable Type Plant, 115 Volt DC



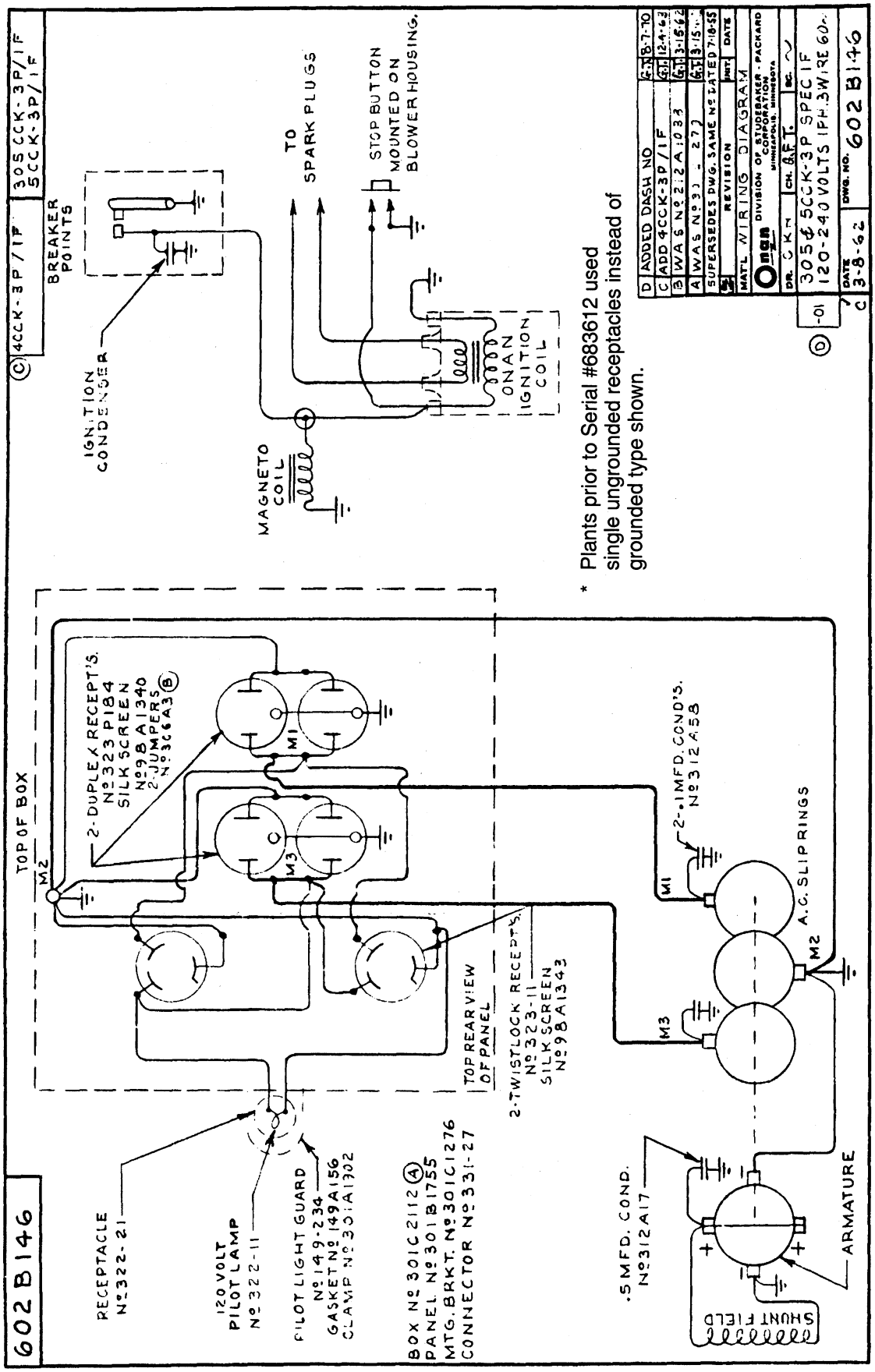
Wiring Diagram 611C176 – Remote Type Plant, Alternating Current, 120 Volt 2–Wire, and 240 Volt 2-Wire, 1-Phase



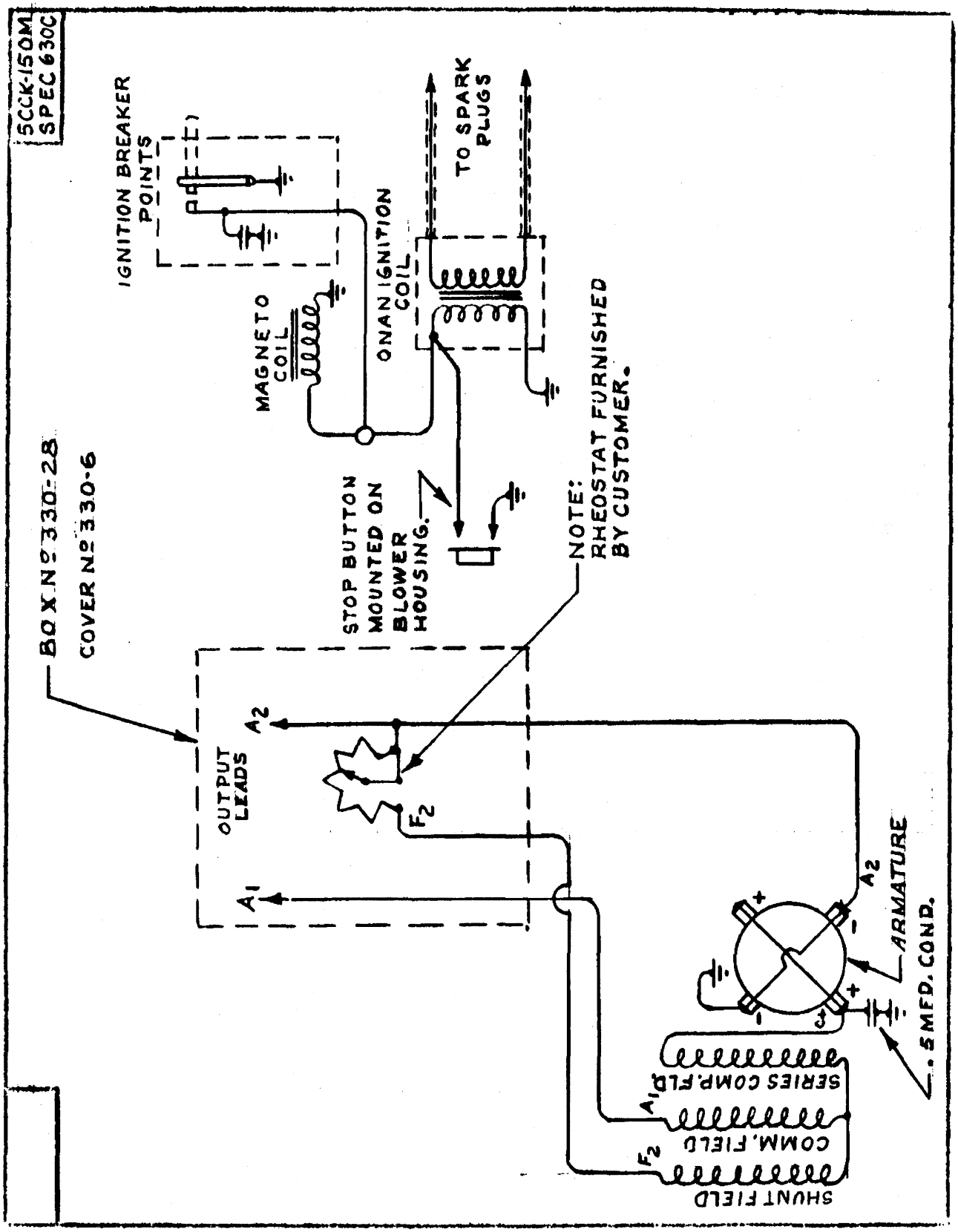
Wiring Diagram #602B143 – Manual Type Plant, Not In Carrying Frame, Alternating Current, 1- or 3-Phase, 2- or 3-Wire



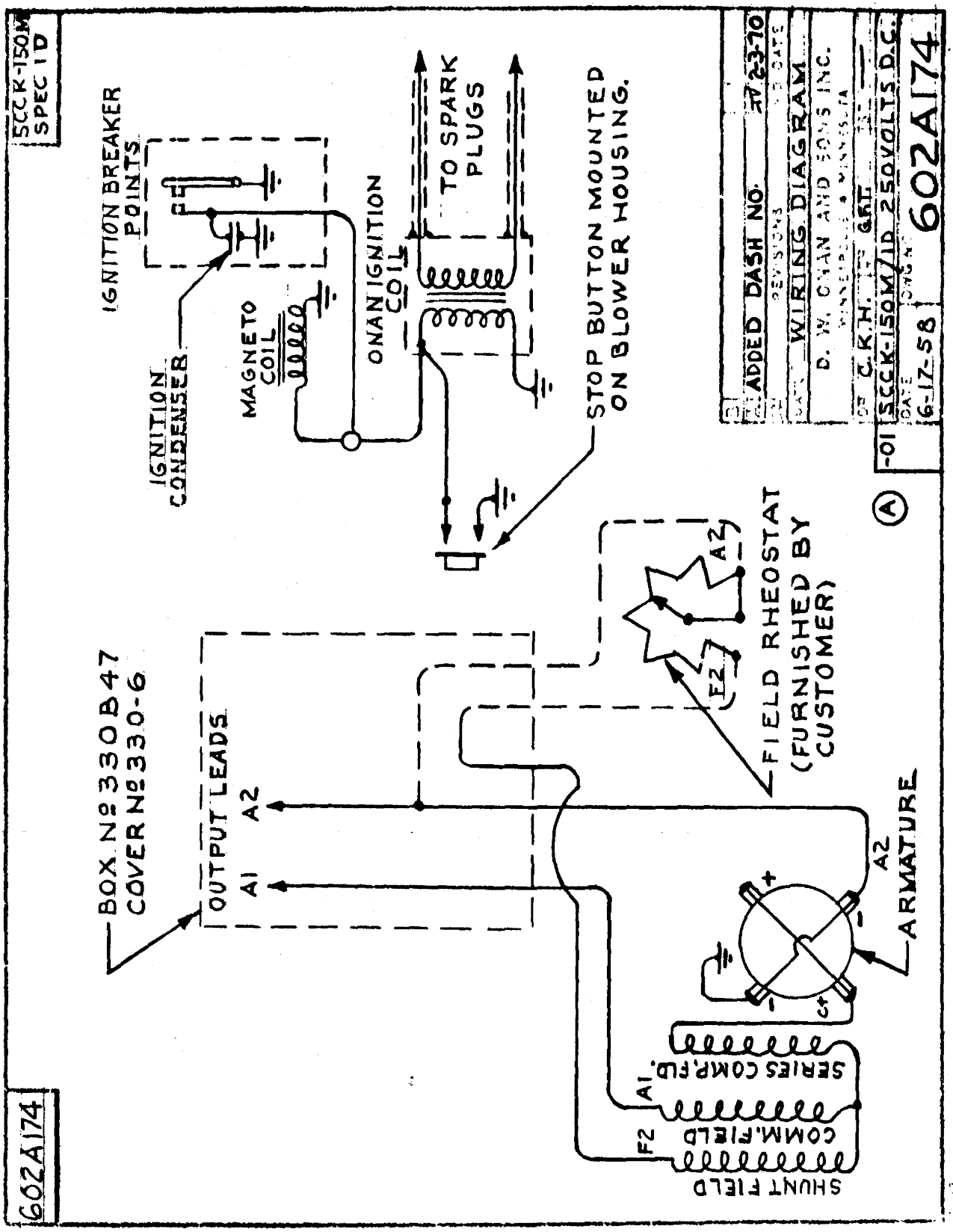
Wiring Diagram #611C178 – Remote Type Plant, Alternating Current, 240 Volt, 3-Wire, 3-Phase



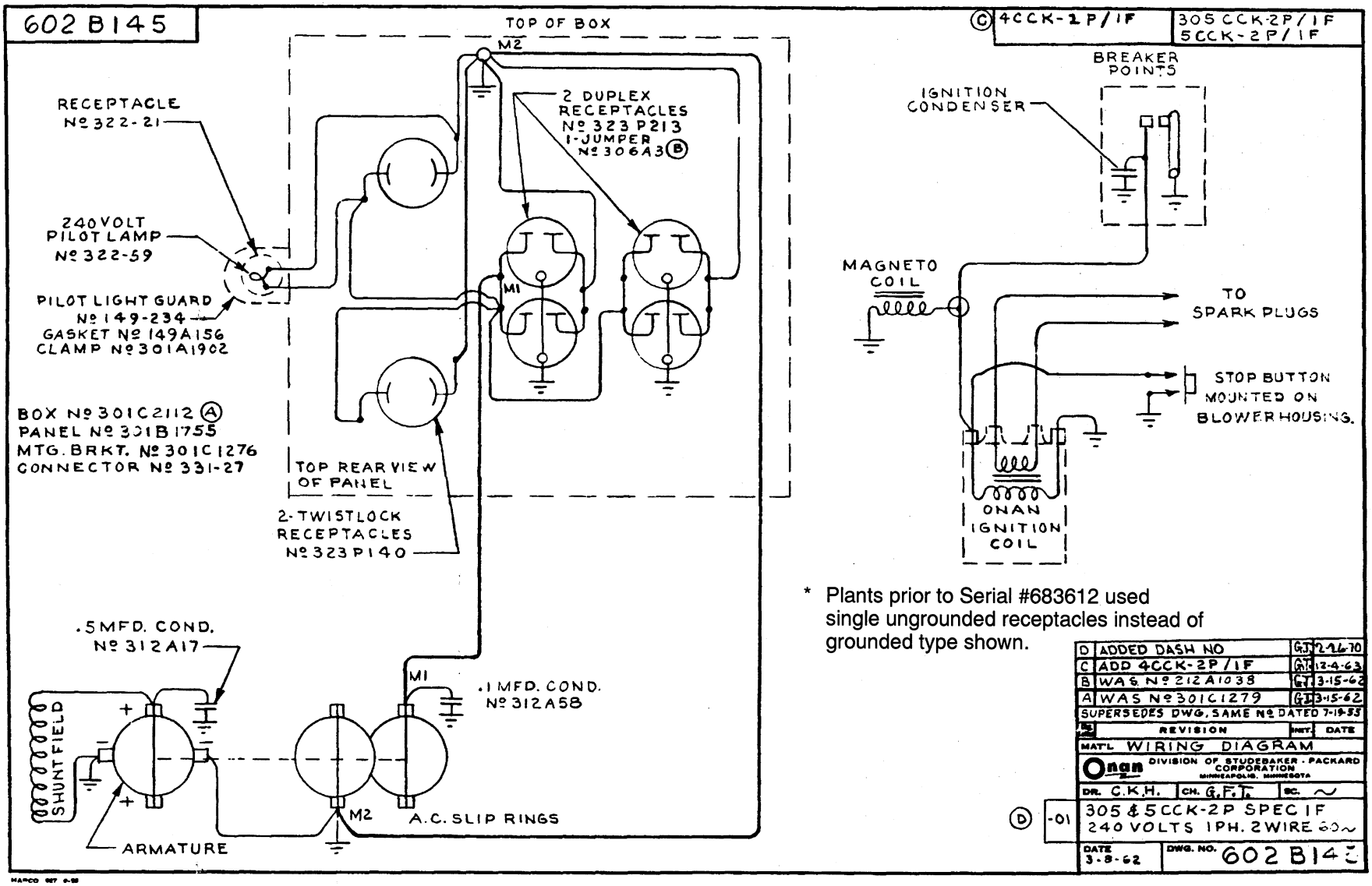
Wiring Diagram #602B146 – Portable Type Plant with Carrying Frame – 120/240 Volt AC, 1-Phase, 3-Wire



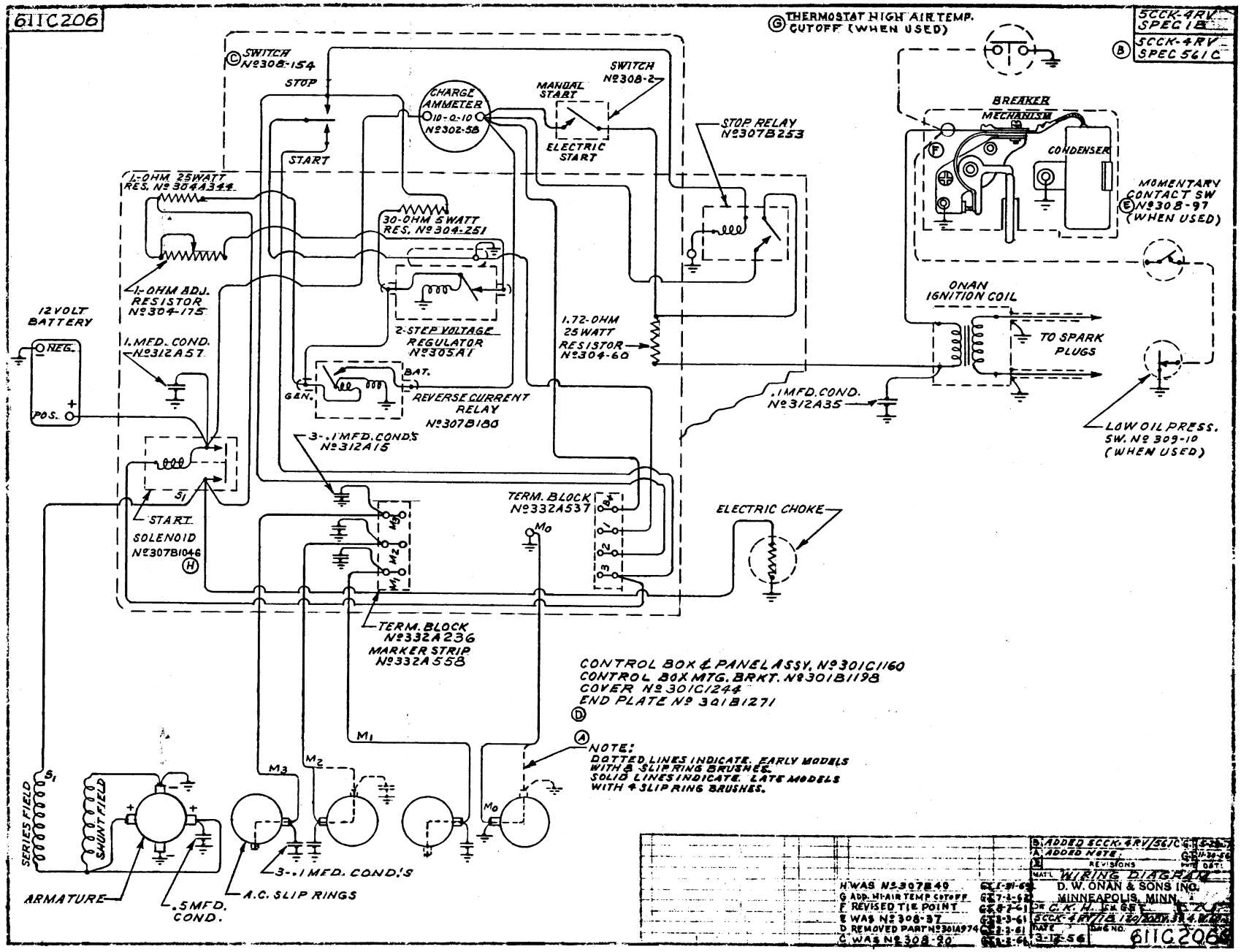
Wiring Diagram #602A166 – 250 Volt, DC Magnet Service, Manual Start



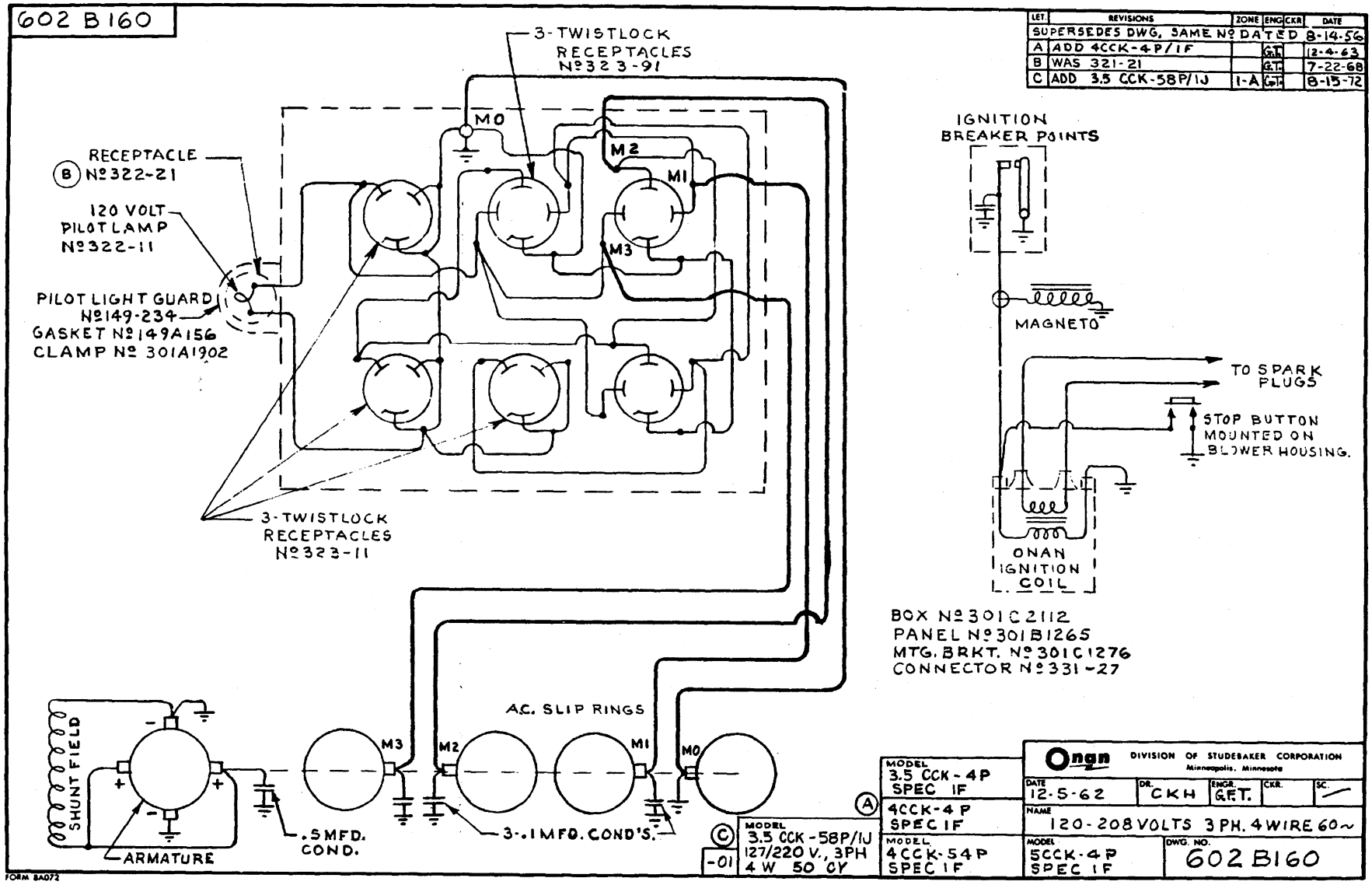
Wiring Diagram #602A174 – 250 Volt, DC Magnet Service, Manual Start



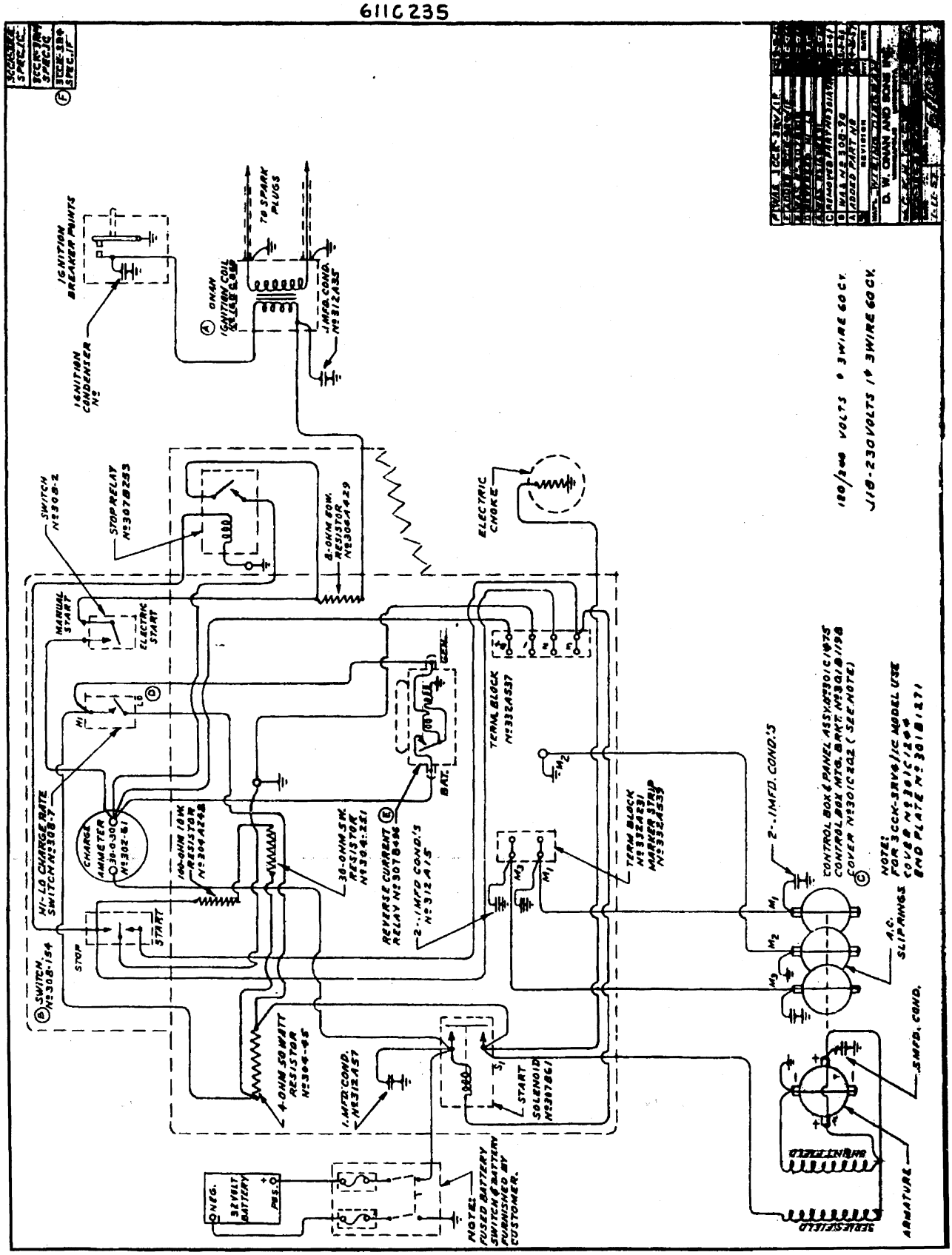
Wiring Diagram #602B145 – Portable Type Plant With Carrying Frame – 240 Volt AC, 1-Phase, 2-Wire



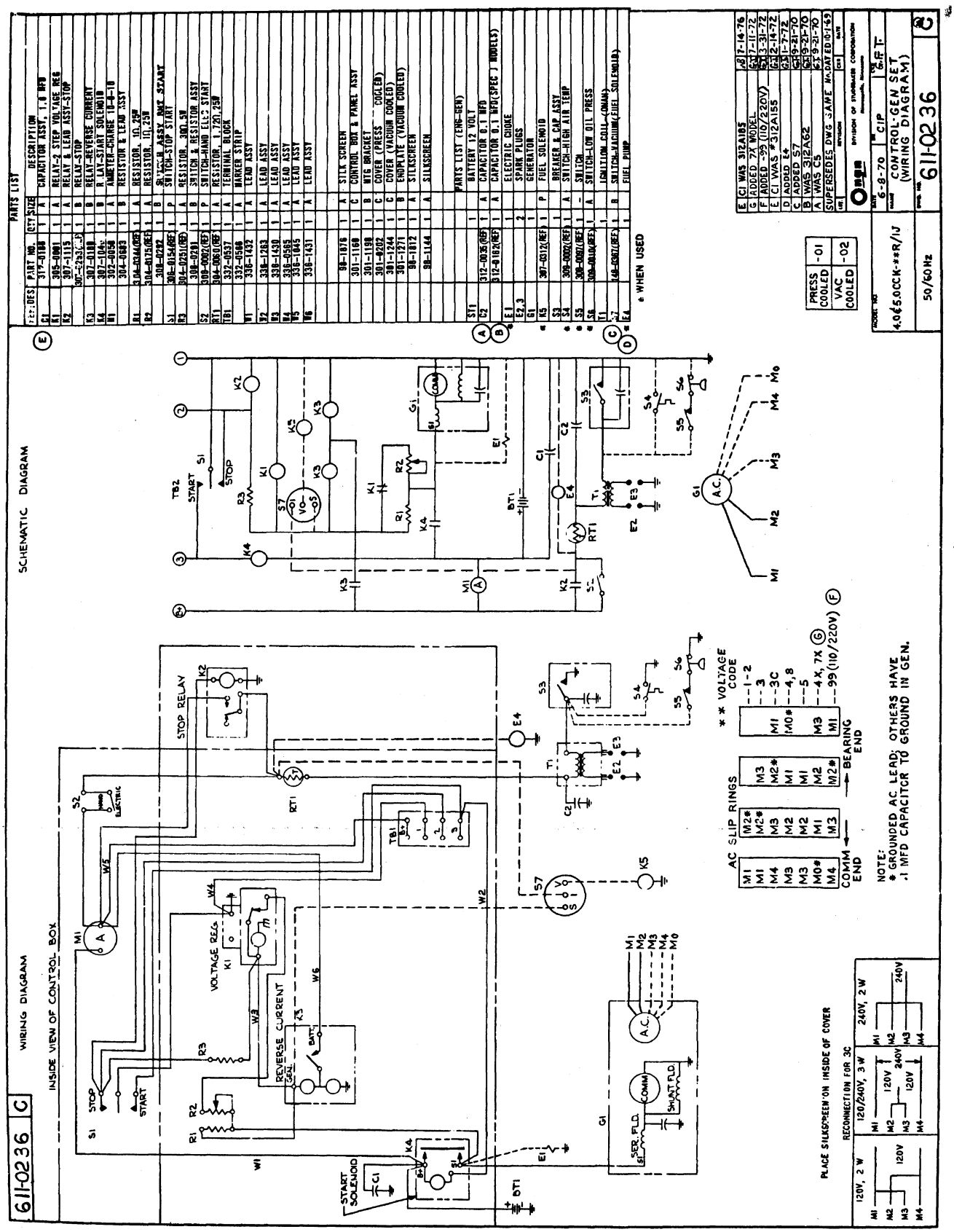
Wiring Diagram #611C206 – Remote Type Plant, Alternating Current – 120/208 Volt, 4-Wire, 3-Phase



Wiring Diagram #602B160 – 120/208 Volt AC, 3-Phase, 4-Wire



Wiring Diagram #611C235 – 32 Volt Remote Start – 120/240 Volt AC, 750 Watt



Wiring Diagram – #611C236 Reconnectible, 120/240 Volt AC, 4-Wire