Onan®

MAJOR SERVICE MANUAL

ONAN

ELECTRIC GENERATING PLANTS

MCCK

SERIES

927-550

4 AC 69

W.D. # 611C697

[redacted]

ONAN DIVISION OF STUDEBAKER CORPORATION

AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432

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This manual contains information for the proper servicing of MCCK electric generating plants. For installation, preparation and operating instructions, refer to Operators Manual.

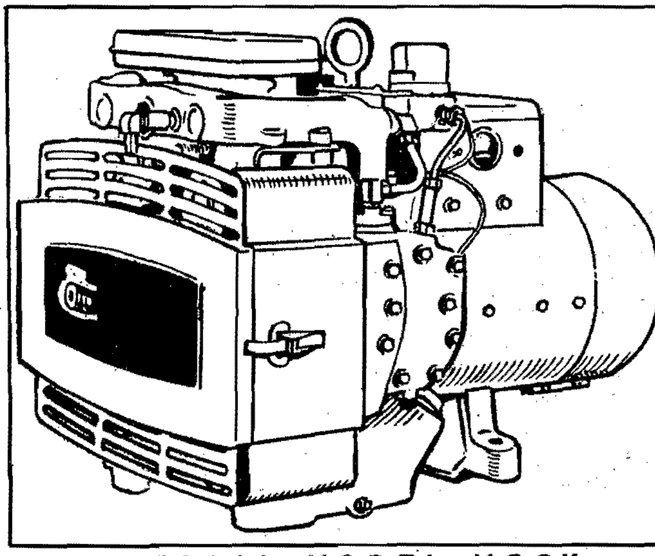
Instructions for 60-cycle, 1,800-rpm plants, also apply to 50-cycle, 1,500-rpm plants except for current, frequency and operating speed.

The engine end is designated as the *front end* of the plant. *Left side* and *right side* of the plant are determined by viewing from the front end.

IMPORTANT...RETURN WARRANTY CARD ATTACHED TO UNIT

MEMORANDUM

Instructions in this manual may refer to a specific model of generating plant. Identify the model by referring to the *MODEL AND SPEC (specification) NO.* as shown on the plant nameplate. Electrical characteristics are shown on the lower portion of the plant nameplate.



TYPICAL MODEL MCCK

How to read MODEL and SPEC NO.

605MCCK-3R /1A

1 — 605MCCK-3; 2 — R; 3 — 1; 4 — A

1. Factory code for general identification.
2. Specific type:
   A-AUTOMATIC type. *Automatic Demand Control series HA, is mounted on plant.
   E-ELECTRIC start type. Electric starting at the plant only.
   R-REMOTE type. Electric starting. For permanent installation, can be connected to optional accessory equipment for remote or automatic control of starting and stopping.
3. Factory code for optional equipment.
4. Specification (Spec) letter (advances when factory makes production modifications).

* For service information, refer to HA series Automatic Demand Control Manual number 907.8.

MANUFACTURER'S WARRANTY

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

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

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

Manufacturer shall not be liable for loss, damage or expense directly or indirectly from the use of its product or from any cause.

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

SPECIFICATIONS

	Model Series 4MCCK	605MCCK
Nominal dimension of plant (inches)		
Height	24	24
Width	22	22
Length	*28	33
Number cylinders	2	2
Displacement (cubic inch)	50	50
Cylinder bore	3-1/4	3-1/4
Piston stroke	3	3
RPM (for 60 cycle)	1800	1800
RPM (for 50 cycle)	1500	1500
Compression ratio	7:1	7:1
Battery voltage	12V	12V
Battery size		
SAE group 1H	two in series	two in series
Amp/hr. SAE rating - 20 hr. (nominal)	105	105
Battery charge rate amperes	2-3 Low 5-8 High	2-3 Low 5-8 High
Ventilation Required (cfm 1800 rpm)		
Generator	75	75
Combustion	32	32
Output rated at unity power factor load	1 phase	1 phase
Rating (output in watts)		
50 cycle AC Marine Service	3500	5500
60 cycle AC Marine Service	4000	6500
AC voltage regulation in ±%	3	3
AC frequency regulation in %	5	5
Revolving armature type generator	Yes	Yes
120/240 volt single phase model reconnectible	Yes	Yes
Rotating type exciter	Yes	Yes

* 29-9/16″ for 4MCCK-3.

TABLE OF CLEARANCES AND TORQUES

TABLE OF CLEARANCES

	Minimum		Maximum
Tappets - at 70°F	0.011″		0.013″
Valve Stem in Guide-intake	0.001″		0.0025″
Valve stem in Guide-exhaust	0.0025″		0.004″
Valve Seat Interference Width	1/32″		3/64″
Valve *Face* Angle		44°	
Valve *Seat* Angle		45°	
Valve Interference Angle		1°	
Crankshaft Main Bearings			
Steel-Backed Aluminum	0.0025″		0.0038″
Crankshaft End Play	0.006″		0.012″
Camshaft Bearings	0.0015″		0.0030″
Camshaft End Play	0.003″		
Connecting Rod Bearing	0.0005″		0.0023″
Connecting Rod End Play	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 below oil controlling ring, 90° from pin)	0.0015″		0.0035″
Piston Pin in Piston at 70°F		Thumb Push Fit	
Piston Pin in Rod at 70°F	0.0001″		0.0006″
Piston Ring Gap in Cylinder	0.010″		0.023″
Breaker Point Gap (Full Separation)		0.020″	
Spark Plug Gap - For Gaseous Fuel		0.018″	
Spark Plug Gap - For Gasoline Fuel		0.025″	
Crankshaft Main Bearing Journal - Standard Size	1.9992″		2.000″
Crankshaft Rod Bearing Journal - Standard Size	1.6252″		1.6260″
Cylinder Bore - Standard Size	3.249″		3.250″
Ignition Timing Advance		25°BTC	
Cooling System Capacity (Including Heat Exchanger)		7 Pints	

ASSEMBLY TORQUES

Assembly torques require the use of a torque wrench. These torques assure proper tightness without danger of stripping the threads.

TORQUE SPECIFICATIONS (FT. LBS.)

Rear Bearing Plate Nuts	20-25	Cylinder Head Bolts	29-31
Connecting Rod Bolts	27-29	Fuel Pump Mounting Screws (Approximately)	10-15
Oil Pump Mounting Screws	7-9	Flywheel Mounting Screws	35-40
Oil Base Screws	43-48	Intake Manifold Screws	15-20
Generator Adapter Screws	20-25	Exhaust Manifold Screws	15-20
Timing Gear Cover Screws	15-20	Spark Plugs	25-30

TROUBLE SHOOTING

POSSIBLE CAUSE	REMEDY
ENGINE CRANKS TOO STIFFLY	
Too heavy oil in crankcase.	Drain and fill with lighter oil.
Engine seized.	Disassemble and repair.
ENGINE CRANKS TOO SLOWLY WHEN CRANKED ELECTRICALLY	
Discharged or defective battery.	Charge or replace.
Faulty field rectifier.	Replace rectifier.
Corroded or loose battery terminals or connections.	Clean corroded terminals. Replace cable if necessary.
Brushes worn excessively or making poor contact.	Replace brushes and/or clean commutator.
Short circuit in generator or load circuit.	Repair or replace parts necessary. Disconnect load.
Dirty or corroded points in start solenoid switch.	Replace switch.
ENGINE WILL NOT START WHEN CRANKED	
Out of fuel.	Check fuel
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or time ignition.
Lack of fuel or faulty carburetion.	Check fuel system. Clean, adjust or replace parts as necessary.
Clogged fuel filter.	Replace.
Cylinders flooded.	Ground spark plug cables. Crank engine with plugs removed.
Poor fuel.	Drain. Fill with fresh fuel.
Poor compression.	Tighten cylinder head bolts and spark plugs. If still not corrected, grind valves and/or replace piston rings.
Wrong ignition timing.	Re-set breaker points or time ignition.

POSSIBLE CAUSE	REMEDY
ENGINE RUNS BUT VOLTAGE DOES NOT BUILD UP	
Poor brush contact.	Check: Brush seating on commutator and collector rings; free in holders and not worn too short and have good spring tension.
Open circuit, short circuit,	Refer to the *Generator* section of Maintenance
Residual magnetism lost.	Magnetize the field.
Direct short, or excessive load on AC circuit.	Disconnect A. C. load.
VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING	
Speed too low.	Adjust governor to correct speed.
Poor commutation or brush contact.	Refinish commutator or undercut mica if necessary. See that brushes seat well on commutator and collector rings, are free in holders, not worn too short, and have good spring tension.
Loose connections.	Tighten.
Fluctuating load.	Correct abnormal load condition causing trouble.
GENERATOR OVERHEATING	
Short in load circuit.	Correct short circuit.
Generator overloaded.	Reduce load.
Improper brush rig position.	Adjust.
ENGINE OVERHEATING	
Improper lubrication.	Change to proper oil.
Poor ventilation.	Provide ample ventilation at all times.
Insufficient water circulation. Clogged or restricted water cooling passages.	Clean cooling system. Check pump and lines.
Retarded ignition timing.	Time ignition.
Generator overloaded.	Reduce load.

POSSIBLE CAUSE	REMEDY
VOLTAGE DROPS UNDER HEAVY LOAD	
Engine lacks power.	See remedies under *Engine Misfires at Heavy Load.*
Poor compression.	Tighten cylinder head bolts and spark plugs. If still not corrected, grind the valves and/or replace piston rings.
Faulty carburetion.	Check fuel system. Clean, adjust or repair as needed.
Dirty flame arrester.	Clean.
Choke partially closed.	Choke plate must be wide open at operating temperature.
Carbon in cylinders or in carburetor venturi.	Remove carbon.
Restricted exhaust line.	Clean or increase size.
ENGINE MISFIRES AT LIGHT LOAD	
Carburetor idle jet clogged or improperly adjusted.	Clean.
Spark plug gaps too narrow.	Set gap.
Intake air leak.	Tighten. Replace gaskets if necessary.
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or time ignition.
ENGINE MISFIRES AT HEAVY LOAD	
Defective spark plug.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or time ignition.
Clogged carburetor.	Clean carburetor.
Clogged fuel screen.	Clean.
Defective spark plug cable.	Replace.
ENGINE MISFIRES AT ALL LOADS	
Fouled spark plug.	Clean and adjust.
Defective or wrong spark plug.	Replace.
Leaking valves.	Grind valves.
Broken valve spring.	Replace.
Defective or improperly adjusted breaker points.	Adjust or replace breaker points.

POSSIBLE CAUSE	REMEDY
LOW OIL PRESSURE	
Oil too light or diluted from leaking fuel pump diaphragm.	Drain, fill with proper oil. Repair or replace fuel pump.
Oil too low.	Add oil.
Oil relief valve not seating.	Remove and clean, or replace.
Badly worn bearings.	Replace.
Sludge on oil screen.	Remove and clean.
Badly worn oil pump.	Replace.
Defective oil pressure gage.	Replace.
HIGH OIL PRESSURE	
Oil too heavy.	Drain, fill with proper oil.
Clogged oil passage.	Clean all lines and passages.
Oil relief valve stuck.	Remove and clean.
Defective oil pressure gage.	Replace.
ENGINE BACKFIRES AT CARBURETOR	
Lean fuel mixture.	Clean carburetor. Adjust jets.
Clogged fuel filter.	Clean.
Air leak at intake manifold or carburetor flange.	Tighten mounting screws. Replace gaskets as necessary.
Poor fuel.	Fill with good, fresh fuel.
Spark advanced too far.	Re-set breaker points or time ignition.
Intake valve leaking.	Reface, seat or replace.
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE EXHAUST	
Poor compression. Usually due to worn pistons, rings, or cylinders.	Refinish cylinders. Install oversize pistons and rings.
Oil leaks from oil base or connections (does not cause smoky exhaust).	Replace gaskets. Tighten screws and connections. Check breather valve.
Oil too light or diluted.	Drain. Fill with proper oil.
Too large bearing clearance.	Replace bearings.
Engine misfires.	Refer to *Engine Misfires at All Speeds.*

POSSIBLE CAUSE	REMEDY
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or time ignition.
Too much oil.	Drain excess oil.

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

Fuel mixture too rich.	See that choke opens properly. Adjust jets and float level.
Choke not fully open.	See that choke opens properly.
Dirty flame arrester.	Clean.
Excessive crankcase pressure.	Clean breather valve.

LIGHT POUNDING KNOCK

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

ENGINE STOPS UNEXPECTEDLY

Empty fuel tank.	Fill.
Defective ignition system.	Check ignition system and repair or replace as needed.
Engine overheating.	High water temp. cut out stops engine.
Low oil pressure.	Low oil pressure switch stops engine.

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

Loose crankshaft bearing.	Replace unless one of the next two remedies permanently corrects the trouble.

SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE FIRST STARTED

Low oil supply.	Add oil.
Oil badly diluted.	Change oil.
Carbon in cylinders.	Remove the carbon.

POSSIBLE CAUSE	REMEDY
Spark advanced too far.	Set breaker points or time ignition.
Wrong spark plugs.	Install correct spark plugs.
Spark plug burned or carboned.	Clean. Install new plug if necessary.
Valves overheated.	Adjust tappet clearance.
Fuel stale or low octane.	Use fresh fuel.
Lean fuel mixture.	Clean fuel system. Adjust carburetor jets.
Engine overheated.	Check cooling system.

TAPPING SOUND

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

HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD

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

VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR PLANT

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

MOTORS RUN TOO SLOWLY AND OVERHEAT AT FAR END OF LINE BUT OK NEAR THE PLANT

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

NOISY BRUSHES

High mica between bars of commutator.	Undercut mica.

EXCESSIVE ARCING OF BRUSHES

Rough commutator or rings.	Turn down.
Dirty commutator or rings.	Clean.
Brushes not seating properly.	Sand to a good seat or reduce load until worn-in.
Open circuit in armature.	Install a new armature.
Brush rig out of position.	Line up properly.

The MCCK cooling system is a pressure-circulating, open type system that uses raw liquid coolant such as fresh water or sea water.

> **NOTE:** *Factory-installed heat exchangers for a closed-type system are available as an optional feature.*

In a raw water cooling system, water enters the pump located on the front right side of the engine. The pump delivers water to the cylinder jacket and it flows through the jacket and out openings in the cylinder heads controlled by thermostats. For engine warm-up, with thermostats closed, a by-pass from the cylinder block to the thermostat allows water flow. From the thermostat, water passes through the water cooled exhaust manifold and out the engine cooling system. Figure 1 shows the cooling system operation.

MAINTENANCE

Cooling system maintenance includes periodic inspection for leaks, inspection of the rubber pump impeller and flushing and cleaning.

The rubber impeller, because of continuous flexing, will, in time, need replacement. If the impeller fails after short service (usually under 500 hours), check for possible defects such as severe pitting, or abrasion caused by dirt in the cooling system.

The cooling system must be kept clean to function properly. Scale reduces heat transfer and restricts water flow. Flush the system at least once a year and more often if operation indicates clogged passages, pump wear, or overheating.

To flush the engine, remove the thermostats, Figure 2, and the water pump cover. Partially restrict the pump opening so the cylinder block fills with water. Attach the flushing gun nozzle to the thermostat opening and fill the block with water; then apply air pressure. Repeat the process until water coming from the block is clean.

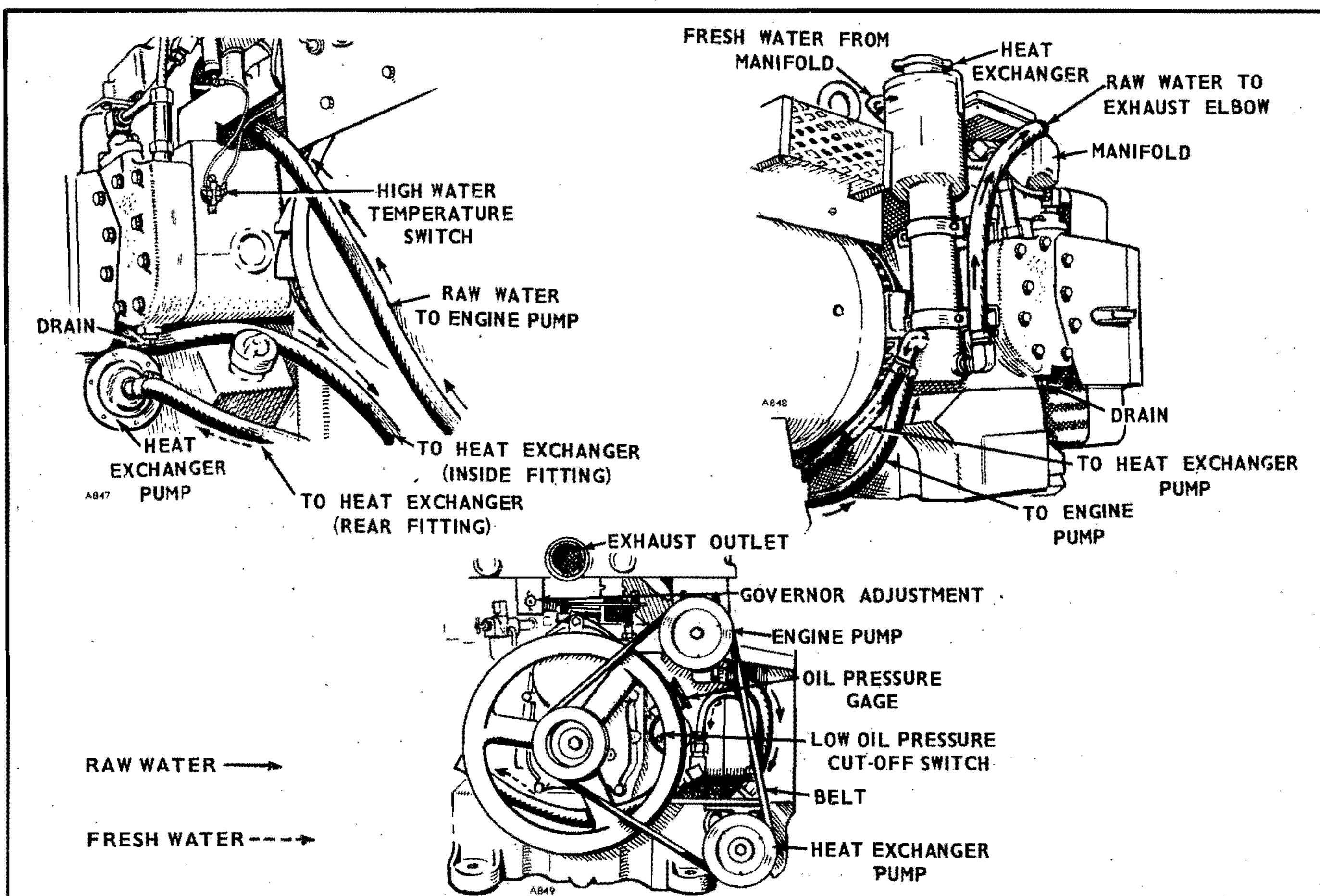


FIGURE 1. ENGINE COOLING SYSTEM (HEAT EXCHANGER MODELS)

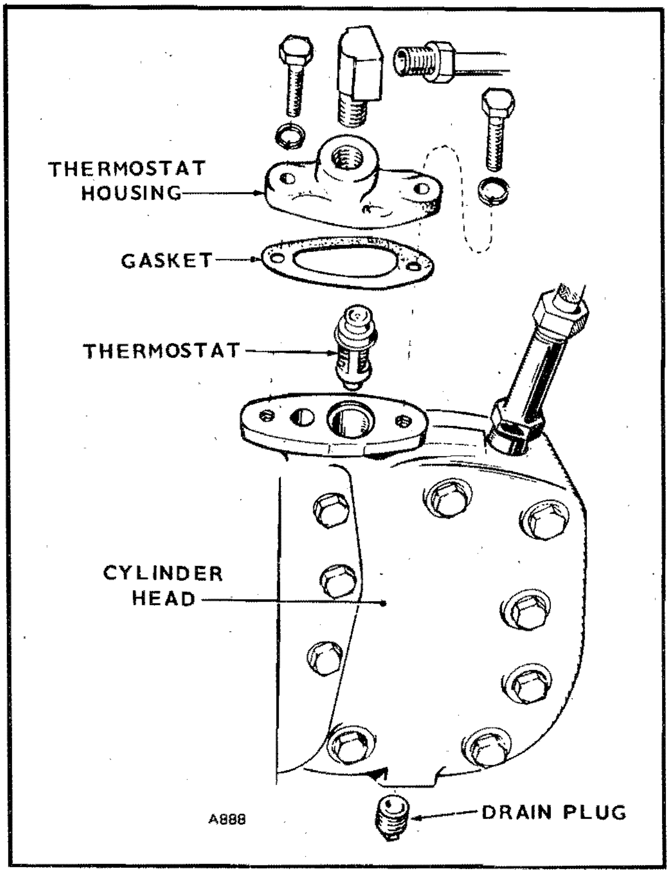


FIGURE 2. THERMOSTAT REMOVAL

TESTING

The cooling system can be tested for two abnormal conditions: (1) insufficient water flow and (2) air leaks.

1. To measure water flow, install a tank of known capacity at the water outlet. Run the engine until the thermostat opens and then measure the length of time necessary to fill the tank. From this, obtain the flow in gallons per minute (GPM). If water flow is below 3.5 GPM, check pump operation and inspect the passages and water lines for clogging.
2. Air leaks will cause premature impeller failure. To test for air leaks, insert the cooling system outlet into a tank of water and watch for bubbles while the engine is operating. If bubbles appear, inspect the cooling system thoroughly to find the source.

REPAIR

When making cooling system repairs, use Permatex or thread-sealing compound on all threaded connections.

All water lines should be 1/2″ inside diameter or larger. Long runs of pipe or hose need a larger inside diameter to reduce resistance.

Thermostats: Thermostats are located on the top of each cylinder head. These thermostats are connected by tubing to the water-cooled manifold. Replace a thermostat if damaged by corrosion or other causes.

Check opening and closing by placing a thermostat and a thermometer in a water bath. The thermostat should start to open at 145°F and be fully open at 165°F. It should close immediately when removed from hot water. Replace the thermostat if it does not operate properly.

Water Pump: The water pump is a positive-displacement, rubber impeller type, located on the upper right corner of the engine. Disassemble pump and repair according to Figure 3 and the following instructions:

1. Remove the cover and gasket.
2. Remove the impeller with pliers or by prying with a screwdriver, avoiding damage to the pump body. To install a new impeller, align the driving flat surface with the shaft flat surface; bend blades nearest the cam and insert. (*Do not* remove the factory coating of high-analine oil from the impeller.)
3. Remove the retaining ring. Then pry the seal assembly through the drain slots. The factory uses Never Seez compound to install the bellows seal. This may remain in the pump body. An alternate sealer is suitable but not necessary. Install with faces *clean and oiled.*

IMPORTANT: *Use engine lubricating oil on the inside and outside diameter of the seat ring on the new seal before installation. The oil facilitates self-alignment.*

4. To remove the bearing and shaft assembly, drive out by striking the impeller end of the shaft, using a brass or wood dowel. Install by the same method, striking the drive end of the shaft. If the fit is tight, strike the outer race only. Lubricate the pump bore lightly for ease of assembly.

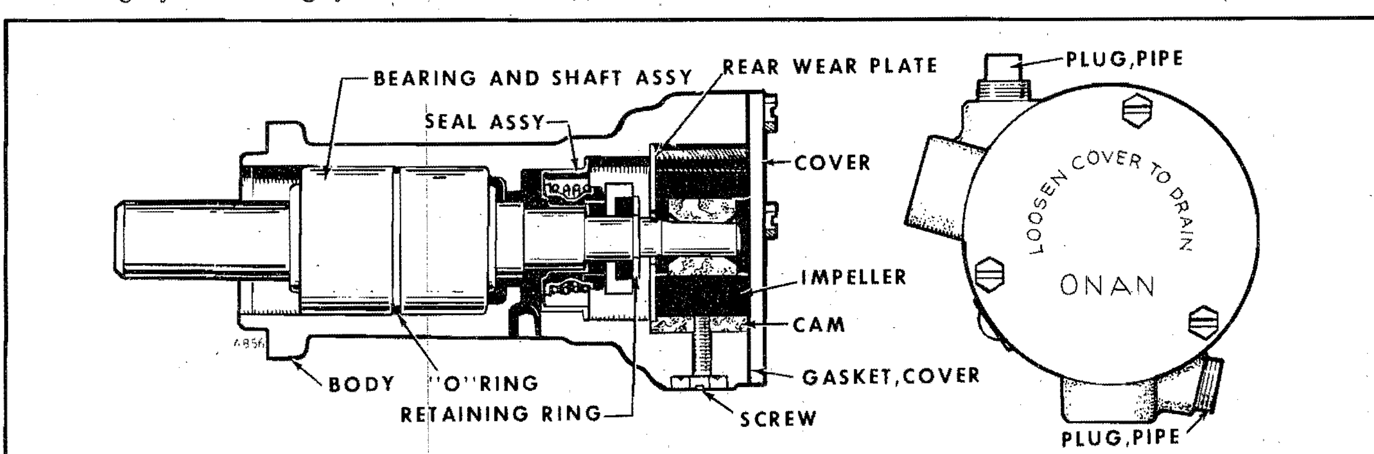


FIGURE 3. RUBBER IMPELLER WATER PUMP

5. Torque screws 15 to 17 in. lbs.

NOTE: *This pump is not to be used in a closed system (fresh water) such as keel cooling.*

High Water Temperature Cut-off Switch: This normally closed switch (Figure 1) senses water temperature in the engine cooling jacket. The switch opens, breaking the circuit to the coil primary when the water temperature reaches approximately 200°F and closes when the temperature drops below approximately 160°F.

HEAT EXCHANGER COOLING (Optional, Figure 4)

Onan heat exchanger cooling is available factory installed, or as a kit for customer installation. A complete heat exchanger installation contains two water systems; a fresh water system and a raw water system. The fresh water system continuously re-circulates fresh water through the water jacket, exhaust manifold, centrifugal pump, and one side of the heat exchanger. The raw water system uses the engine-mounted rubber-impeller pump to draw and circulate sea water through the heat exchanger, and then discharges it.

CAUTION When planning to install a heat exchanger other than Onan-approved, or any keel cooler, consult the factory or an Onan distributor. To ensure an adequate installation, the engine cooling system must be modified.

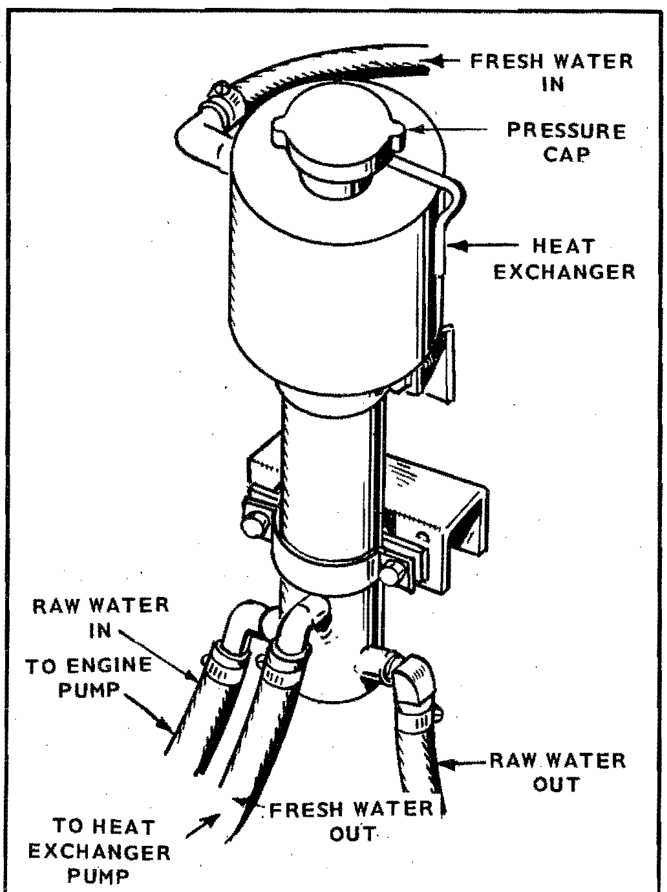


FIGURE 4. HEAT EXCHANGER

Maintenance: Maintain the fresh water system the same as an automotive radiator cooling system. Clean and flush once a year and use anti-freeze if there is danger of freezing. Use a rust inhibitor in the closed water system. For raw water systems, check periodically for air leaks, rubber impeller wear, damage or restricted lines.

Cleaning: To clean the fresh water system, drain and fill with radiator cleaner. When chemical cleaning is done, always flush the cooling system to wash out deposits loosened by the chemical cleaning.

Flush the engine water jacket as previously discussed. First remove the water outlet hose from the engine water jacket to the heat exchanger. Flush both the fresh water side and the raw water side of the heat exchanger. Remove the rubber impeller pump cover to flush the raw water side. Also flush the water-cooled exhaust manifold. When flushing is completed, check the system thoroughly for leaks.

Centrifugal Pump Repair: The centrifugal fresh water pump is mounted on the heat exchanger bracket. If it leaks, or the bearings require replacement, disassemble as follows and replace the worn components:

1. Remove the water inlet from the pump and the six screws holding the end cover to the pump.
2. Unscrew the impeller from the shaft (counterclockwise when facing the impeller).
3. Remove the pump body by unscrewing the single cap screw that clamps the pump body to the pedestal.
4. Remove the retaining ring and drive the bearing assembly from the pedestal.
5. To remove the water seal, drive it out of the pump body.

Replace the worn components. When replacing the water seal, check the wear plate pressed into the impeller and replace it if necessary. To assemble the pump, reverse the disassembly procedure. After assembly, rotate pump shaft to see that impeller does not rub on pump body.

FUEL SYSTEM

MCCK engines use a gasoline carburetor fuel system to deliver a fuel-air mixture to the combustion chamber.

FUEL

Use a *regular* grade of gasoline. One of the most important considerations is the fuel content of Tetra Ethyl Lead. Premium fuels contain more lead than regular, but the lead quantity also varies between brands of fuel. In constant-speed operation, typical of generating plants, deposit build-up in combustion chambers is proportional to the amount of lead in the gasoline. More lead means more deposits and the need for more frequent head removal for cleaning. The interval between these cleanings can often be increased by changing fuel.

If fuel is stored for any great length of time, it can oxidize and form gums; the fuel becomes stale. *Onan* recommends changing stored fuel as often as every three months, especially where there is a great variation in temperatures.

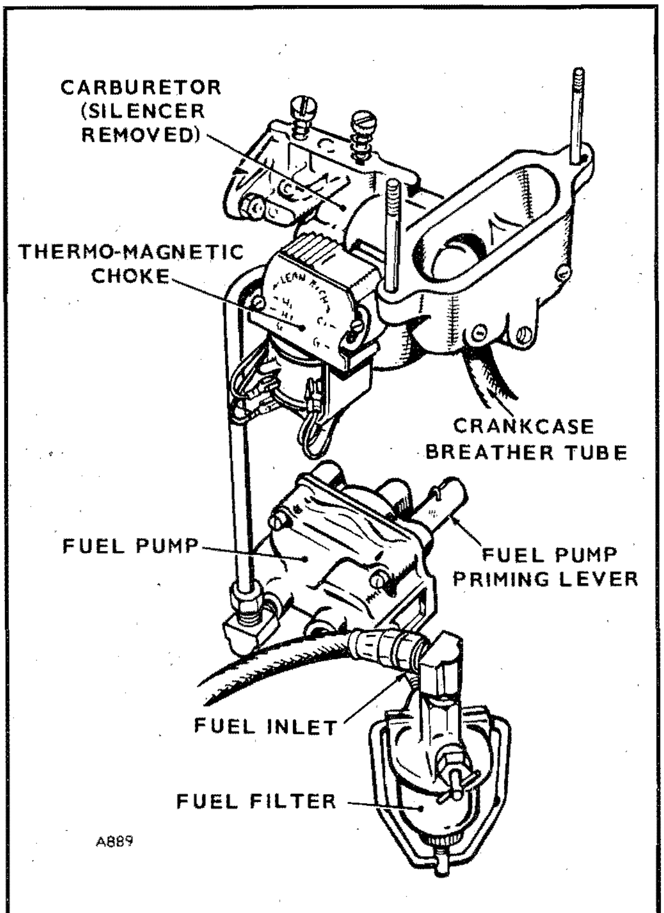


FIGURE 5. FUEL SYSTEM

MAINTENANCE

Periodic maintenance should consist of cleaning or replacing the fuel strainer, flame arrester, carburetor and complete carburetor adjustment.

To clean the fuel strainer, remove the fuel sediment bowl and screen (Figure 6) and thoroughly wash the screen. At the same time, remove the carburetor float bowl and clean it. Assemble and check for leaks.

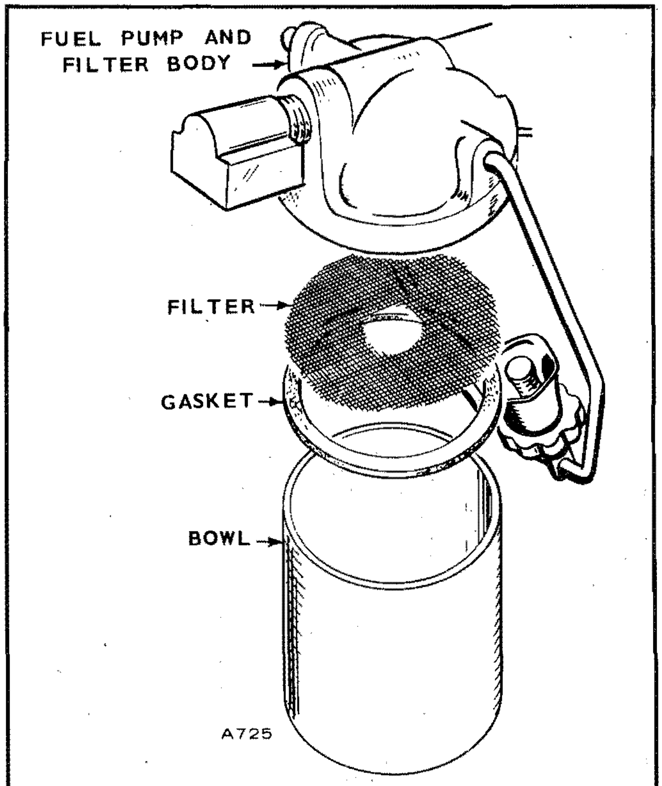


FIGURE 6. FUEL STRAINER

FUEL PUMP

The fuel pump is located on the top of the engine. If fuel does not reach the carburetor, make the following checks:

1. Check fuel level in tank.
2. Be sure shut-off valve is open.
3. Remove fuel line from pump outlet and crank the engine over several times. Fuel should spurt out of the pump. If not, remove the pump for repair or replacement.

Testing: If the fuel pump delivers fuel, test it with a pressure gauge or manometer. Perform these tests before removing the pump from the engine. Disconnect the pump outlet line and install the pressure gauge, Figure 7.

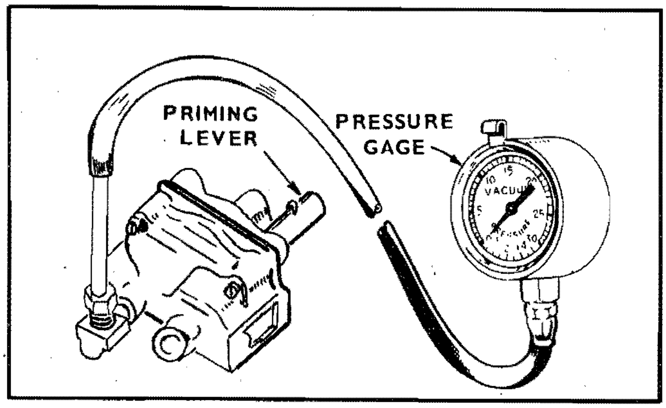


FIGURE 7. TESTING FUEL PUMP

Test the valves and diaphragm by operating the priming lever a few times while watching the pressure. It should not drop off rapidly after priming has stopped.

Run the engine at governed speed (on the fuel remaining in the carburetor) and measure the fuel pump pressure. Pressure should be between 2 and 3 psi with the gauge held 16″ above the fuel pump.

A low pressure reading indicates wear; overhaul or replace the pump. If the reading is above maximum, the diaphragm is probably too tight or the diaphragm spring too strong. Fuel seeping under the diaphragm retainer nut and between the diaphragm layers, causing a bulge in the diaphragm, may also cause high pressure. Overhaul the pump if this occurs.

Low pressure, with little or no pressure leak after pumping stops, indicates a weak or broken spring or worn linkage. In most cases the pump should be replaced.

Removal and Repair:

1. Remove the pump inlet, outlet and the two cap screws holding the pump to the engine. Lift the pump from the engine.
2. Notch the pump cover and body with a file so they can be assembled in the same relative position. Then remove the screws holding them together.
3. Tap the body with a screwdriver to separate the two parts. Do not pry them apart; it will damage the diaphragm.
4. Remove the screws holding the valve plate to the cover and lift out the valve and cage assemblies.
5. Drive out the rocker arm hinge pin.
6. Remove the rocker arm, spring and link.
7. Lift out the diaphragm assembly and spring.
8. Fuel pump failure is usually due to a leaking diaphragm, valve, or valve gasket. A kit is available for replacement of these parts. Because the extent of wear cannot be easily detected, replace all parts in the kit. If the diaphragm is broken, or leaks, check for diluted crankcase oil.

   Occasionally, failure is due to a broken or weak spring or wear in the linkage. In this case, replace the worn parts or install a new pump.

Pump Assembly:

1. Soak the diaphragm in fuel; then insert the diaphragm spring and soaked diaphragm into the pump body.
2. Insert the link and rocker arm into the body; hook it over the diaphragm pull rod. Align the rocker arm with the rocker arm pin hole; then drive in the pin.
3. Compress the rocker spring and install between the body and rocker arm.
4. Insert the valve cages, gaskets and valve cover plate. Position the inlet valve (with spring showing), and the outlet valve, with the spring in the cover recess.
5. Assemble the cover to the body with scribed marks aligned. Install screws but do not tighten.
6. Push the rocker arm to full stroke and hold in this position to flex the diaphragm.

IMPORTANT: *The diaphragm must be flexed, or it will deliver too much fuel pressure.*

   Tighten cover screws alternately and securely before releasing the rocker arm.
7. Install the pump and repeat pressure test.

THERMO-MAGNETIC CHOKE

This choke uses a strip heating element and a heat-sensitive bimetal spring to control the choke blade position. A solenoid, actuated during engine cranking, closes the choke all or part way, depending on ambient temperature. The bimetal is factory-calibrated to position the choke to the proper opening under any ambient condition.

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 adjustment, or incorrect assembly of the coil. If it will not open after the plant starts, check for heating. The choke should be warm to the touch within a minute or two of plant starting.

Adjustment must be made with the bimetal at ambient temperature. Do not attempt adjustments until the engine has been shut down for at least one hour. Remove the flame arrester and adapter to expose the carburetor throat. Loosen the screw which secures the choke body assembly. Refer to Figure 8 for correct choke setting, according to temperature. Use a drill or the shank of a drill bit to measure the choke opening. For a richer mixture, turn the choke body clockwise; to lean it, turn counterclockwise. Tighten the screw that secures the choke body.

Repair of Choke Heating:

If the choke will not heat properly, check for a broken heater wire, high-resistance connections or broken lead wires to the bimetal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 30.6 to 37.4 ohms for a 12-volt system. If the heater is defective, install a new one. When the START button is engaged, the solenoid should cause the spring-loaded armature to contact the solenoid core. If this does not occur, check for broken lead wires or a defective solenoid coil. There must be slack in the lead wires between the choke body

AMBIENT TEMP. (°F)	60	65	70	75	80	85	90	95	100
CHOKE OPENING (Inches)	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4

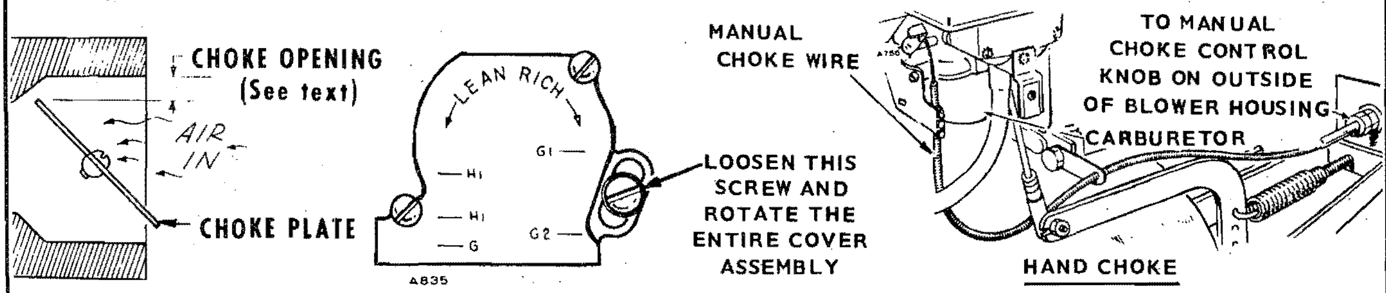


FIGURE 8. THERMO-MAGNETIC CHOKE SETTINGS AND ADJUSTMENTS

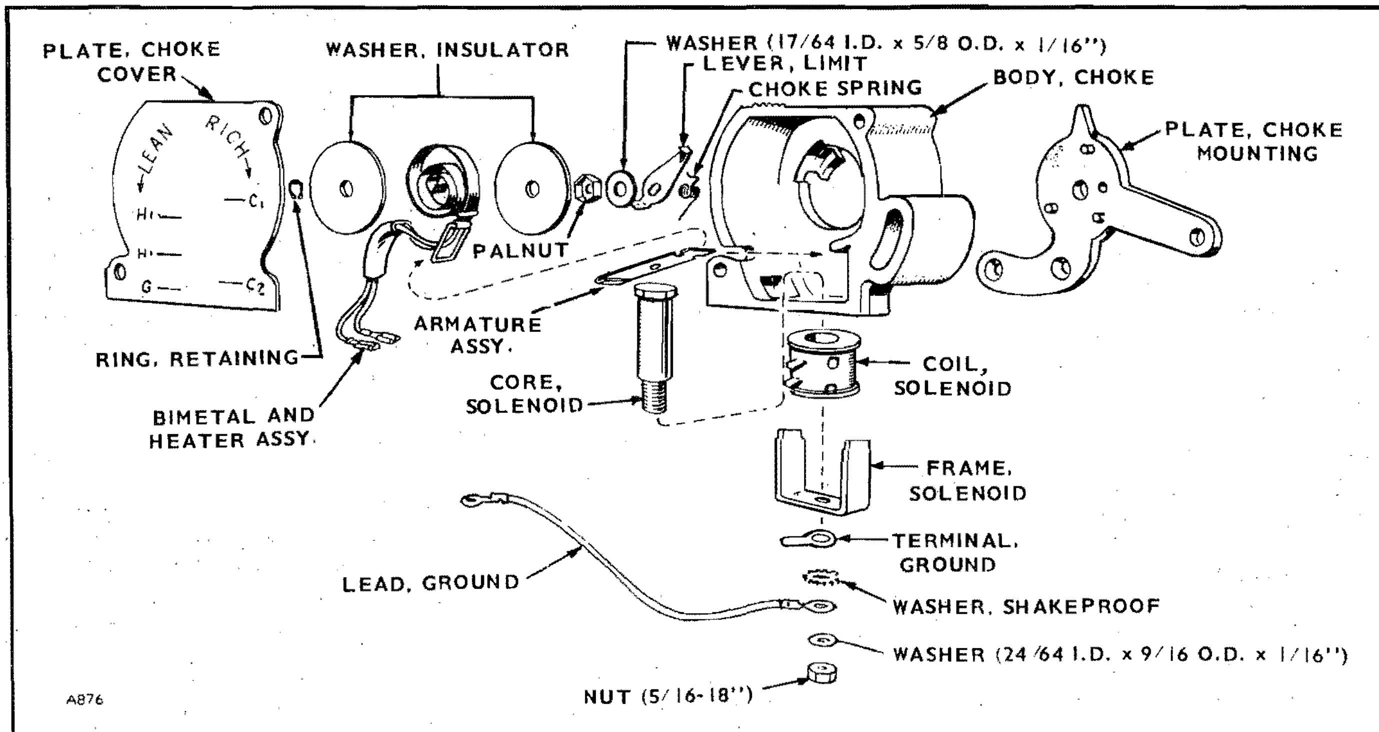


FIGURE 9. THERMO-MAGNETIC CHOKE ASSEMBLY

and the bimetal and heater assembly. The solenoid coil should have a resistance of 2.09 to 2.31 ohms in a 12-volt system.

Assembly:
Refer to Figure 9. When assembling the thermo-magnetic choke, connect the bimetal and heater assembly as follows:

1. The lead tagged G goes to the ground terminal on the coil solenoid.
2. The lead tagged H goes to either of the H_1 terminals on the solenoid core.

CARBURETOR, GASOLINE

The gasoline carburetor is a horizontal draft-type. It consists of three major sections: the bowl and float, idle circuit and load circuit.

Fuel enters the carburetor through the fuel inlet valve (Figure 10) and passes into the float chamber. The fuel level in the bowl is regulated by the float, which opens and closes the inlet valve.

The idle circuit (Figure 11) supplies fuel during no-load operation and for light loads. The throttle plate is nearly closed at no-load, creating high intake manifold vacuum. The pressure difference between the manifold and float chamber causes fuel to flow through the idle circuit. The pressure difference draws fuel up through the hollow center of the idle transfer tube and then through passages in the carburetor body to the idle port, and is controlled by the idle needle. As the throttle is opened to increase power, the idle transfer port is uncovered and additional fuel is added during the transfer from idle to main jet operation. Figure 12 shows the load circuit.

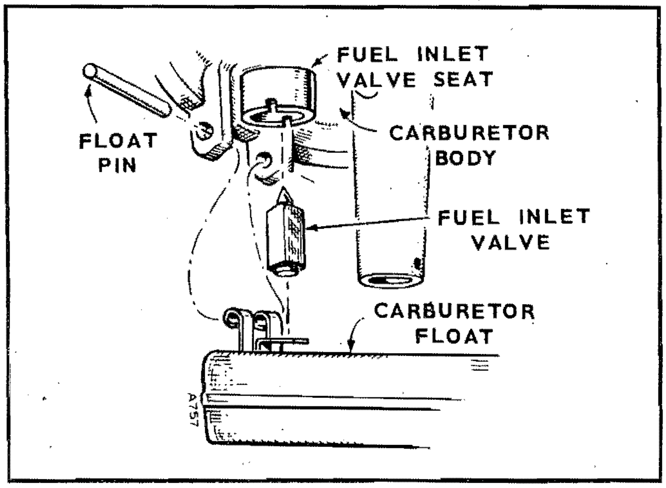


FIGURE 10. CARBURETOR INLET VALVE

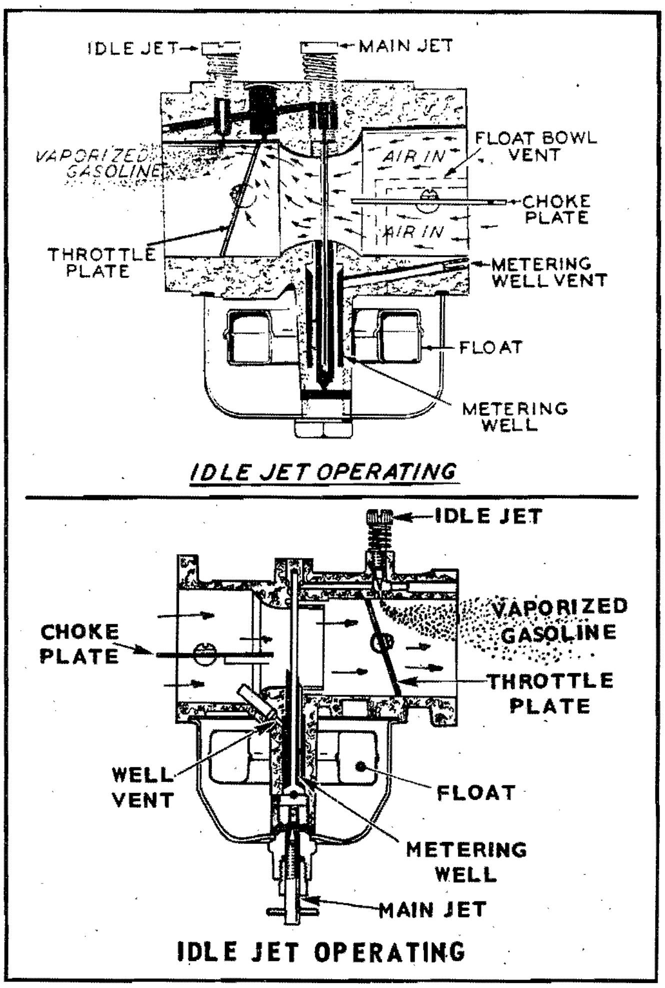


FIGURE 11. CARBURETOR IDLE CIRCUIT

When the load increases, the engine governor opens the throttle to maintain speed. With the throttle open, the manifold vacuum decreases and the idle circuit becomes less effective. As the air flow increases, a reduced pressure is created at the venturi (narrow section of the carburetor throat). The difference in pressure between the venturi and fuel bowl draws fuel up the main nozzle, where it mixes with air from nozzle bleed holes before entering the carburetor. The main adjusting needle controls fuel delivery.

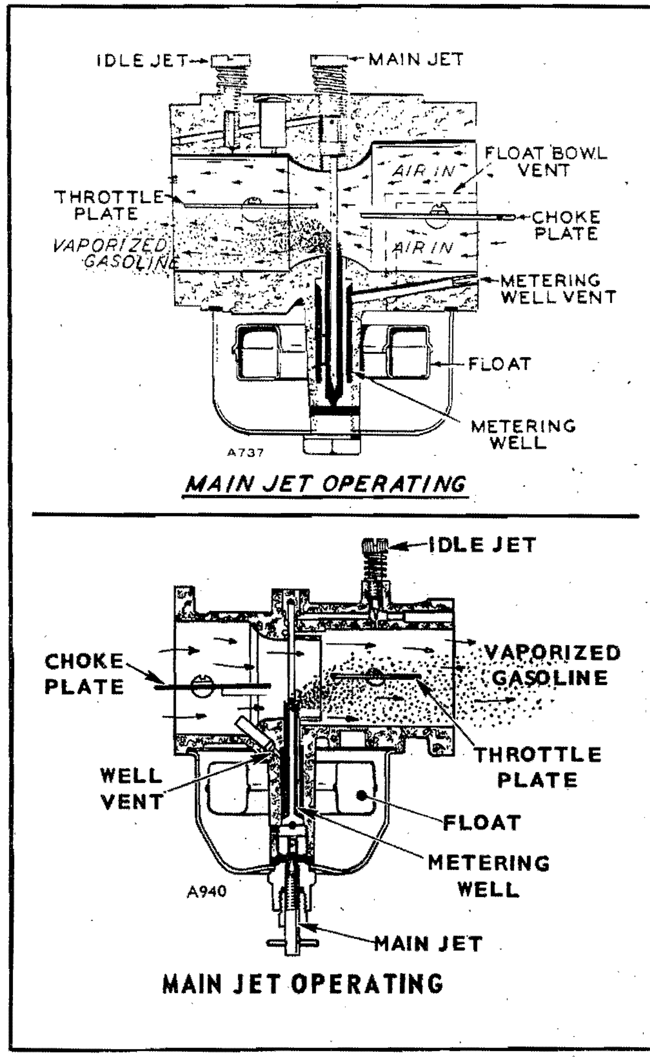


FIGURE 12. CARBURETOR LOAD CIRCUIT

During sudden increases in load, the main nozzle cannot immediately deliver the increased fuel because of restriction at the main adjusting needle. To prevent a lag when the load is suddenly increased, a by-pass around the outside of the nozzle delivers fuel until the main jet can catch up with the increased demand.

CHOKE (Gasoline Fuel System)

Electric starting engines use an automatic electric choke (Figure 5); manual-starting engines use a hand choke (Figure 8). An electric element controls the automatic electric choke. Before the engine starts, the choke is partially closed. When the engine has started, the charging generator supplies current to the heating element which heats the bimetal coil, opening the choke plate.

Adjustment, Electric Choke: Under normal operation, adjust the choke so the distance measured between the choke plate and carburetor throat (Figure 8) is as shown in the table with the engine cold. Use the straight shank end of a drill bit to measure the gap. The upturned silencer must be removed for choke adjustment. To adjust the choke, loosen the screw on the choke body and rotate the cover assembly.

Adjustment, Gasoline Carburetor: The carburetor should be adjusted in two steps—first the load adjustment and then the idle adjustment. See Figures 11 and 12.

> **NOTE:** *If the carburetor is completely out of adjustment so the engine won't run, open both needle valves 1 to 1-1/2 turns off their seats to permit starting. Don't force the needle valves against their seats. This will bend the needle.*

Before adjusting the carburetor, be sure the ignition system is working properly and the governor is adjusted. Then allow the engine to warm up.

1. Apply a full load to the engine. Carefully turn the main adjustment in until speed drops slightly below normal. Then turn the needle out until speed returns to normal.
2. With no engine load, turn the idle adjustment out until the engine speed drops slightly below normal. Then turn the needle in until speed returns to normal.

ALTERNATE METHOD; USE WHEN THERE IS NO LOAD ADJUSTMENT POSSIBLE

1. Start the engine and allow it to warm up. Push in on the governor mechanism to slow the engine down to about 400 to 500 rpm.
2. Set the idle adjustment screw for even operation (so the engine is firing on all cylinders and running smoothly).
3. Release the governor mechanism to allow the engine to accelerate. The engine should accelerate evenly and without a lag. If not, adjust the needle outward about 1/2 turn and again slow down the engine and release the mechanism. Continue until the engine accelerates evenly and without a lag after releasing the governor.

With the carburetor and governor adjusted, and the engine running with no load (Figure 13), allow 1/32″ clearance to the stop pin. This prevents excessive hunting when a large load is suddenly removed.

Removal and Disassembly:

1. Remove the fuel line, governor linkage and electric choke wire.
2. Remove the two carburetor mounting nuts; remove the carburetor.
3. Remove the silencer adapter and choke from the carburetor.
4. Remove the main fuel adjustment needle (begin Spec R) and the float bowl nut and pull off the bowl. Remove the float pin and float.
5. Lift out the float valve and unscrew its seat.
6. Remove the no-load adjusting needle, the load adjusting needle (Spec A only) and spring.

CAUTION Check for burrs on throttle shaft and choke shaft at screw attachment points. If rough, remove burrs before pulling shafts out.

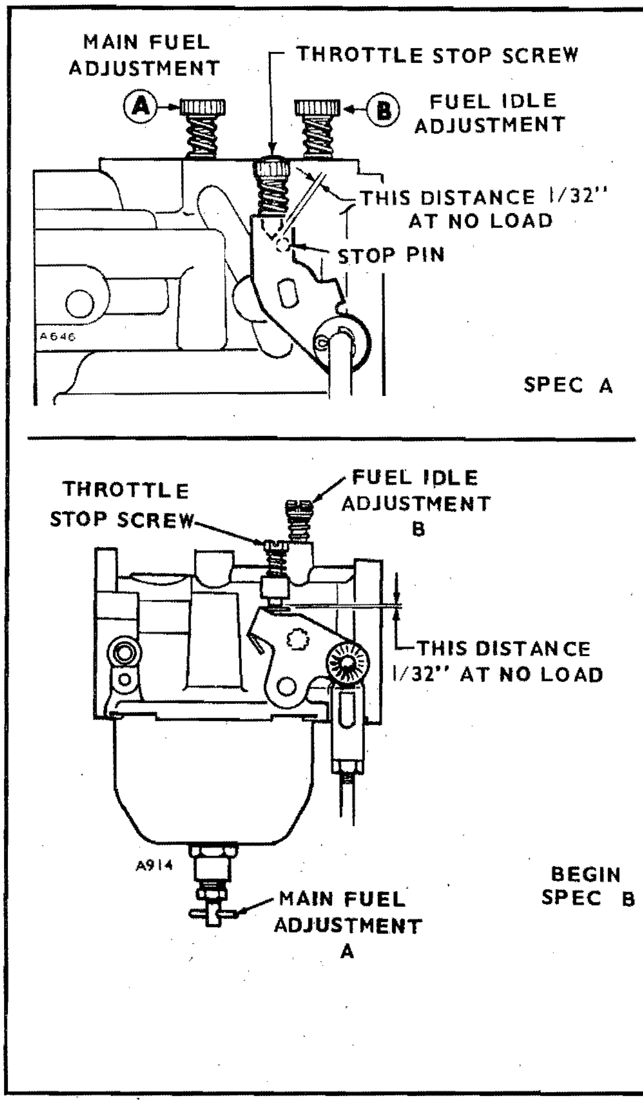


FIGURE 13. ADJUSTING GASOLINE CARBURETOR

7. Remove the throttle plate screws and the plate, and pull out the throttle shaft.
8. Remove the choke plate screws and plate and pull out the choke shaft.

Remove the main nozzle (Spec A only). The main nozzle is not removable, beginning with Spec B.

Cleaning and Repair: Soak all components thoroughly in a good carburetor cleaner, following the cleaner manufacturer's instructions. Clean all carbon from the carburetor bore, especially in the area of the throttle valve. Blow out the passages with compressed air. If possible, avoid using wire to clean out the passages.

Check the adjusting needles and nozzle for damage. If the float is loaded with fuel or damaged, replace. The float should fit freely on its pin without binding. Invert the carburetor body and measure the float level (Figure 14).

To adjust float level, bend the small lip that the fuel inlet valve rides on.

Check the choke and throttle shafts for excessive side play and replace if necessary. Don't remove the coating on the throttle shaft.

Assembly and Installation:

1. Install the throttle shaft and valve, using new screws. Install as shown in Figure 12 with the bevel mated to the carburetor body. On valve plates marked with the "C", install with mark on side toward idle port when viewed from flange end of carburetor. To center the valve, back off the stop screw, close the throttle lever and seat the valve by tapping it with a small screwdriver; then tighten the two screws.
2. Install choke shaft and valve. Center the valve in the same manner as the throttle valve (Step 1). Always use new screws.
3. Install the main nozzle (Spec A only), making sure it seats in the body casting.
4. Install the fuel inlet valve seat and valve.
5. Install the float and float pin. Center the pin so the float bowl doesn't ride against it.
6. Check the float level with the carburetor casting inverted. See Figure 14.
7. Install the bowl ring gasket, bowl and bowl nut (and main jet begin Spec B). Make sure that the bowl is centered in the gasket and tighten the nut securely.
8. Install the load adjusting needle with its spring. Turn in until it seats, and back out 1 to 1-1/2 turns.
9. Install the idle adjusting screw finger tight. Then back out 1 to 1-1/2 turns.
10. Reinstall the choke and adjust.
11. Install the silencer assembly and gasket.
12. Install the carburetor on the engine and connect the gasoline inlet, governor mechanism breather hose and choke.
13. Install the silencer.

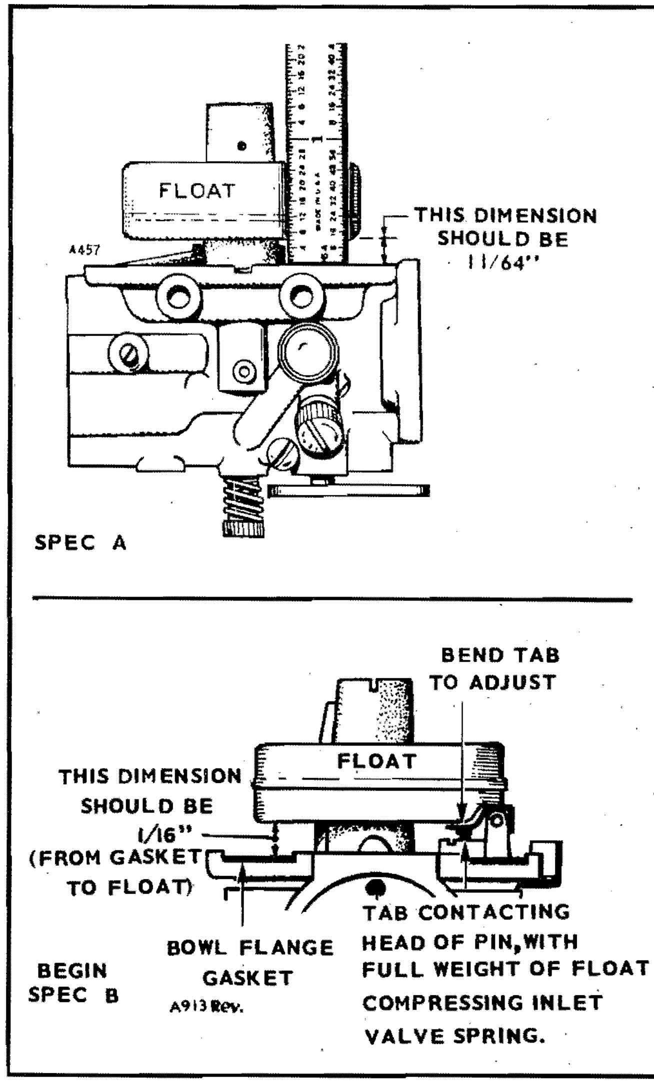


FIGURE 14. SETTING FLOAT LEVEL

IGNITION SYSTEM

The MCCK ignition system uses a 4-volt coil (battery ignition) to fire both spark plugs simultaneously. The ignition system is shielded to prevent radio interference. The ignition system is shown in Figure 15.

MAINTENANCE

Operating with a weak spark is detrimental to the generating plant. Periodic maintenance should include:

1. Checking ignition breaker point gap.
2. Gapping and cleaning spark plugs.
3. Inspecting low and high tension cables.
4. Checking the ignition timing.

Timing: Ignition timing procedure is the same for electric start and remote-start plants with 12 volt battery ignition.

The spark advance is 25° before top center. Timing is stamped on the cylinder block near the breaker box. Set timing as follows:

1. Remove the cover from the breaker box. If timing is out of adjustment, attain an approximate setting by loosening the mounting screws and shifting the breaker box to align the witness marks on the cylinder block and breaker box.
2. Crank the engine over slowly by hand in the direction of crankshaft rotation until the witness mark on the flywheel and the TC mark on the gear cover are exactly in line (see Figure 16).
3. Adjust the ignition breaker point gap width to 0.020" at full separation.
4. Turn 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 flywheel slowly to the right and note if the ignition points just separate when the mark on the flywheel aligns with the correct degree mark (25°) on the gear cover. If 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 to the right to retard the timing (points breaking too soon), or shift it slightly to the left to advance the timing (points not breaking soon enough). Tighten the breaker box mounting screws securely after making an adjustment (see Figure 16).

To accurately check timing, a timing light may be used when the engine is running.

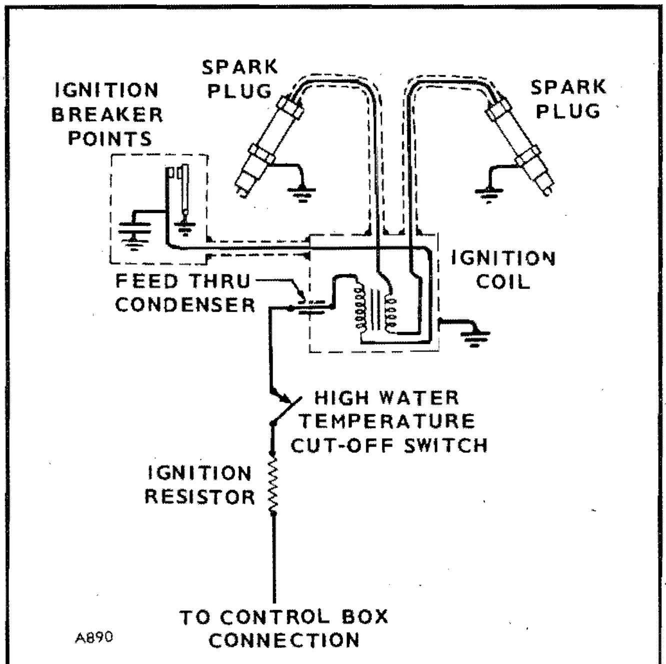


FIGURE 15. IGNITION SYSTEM

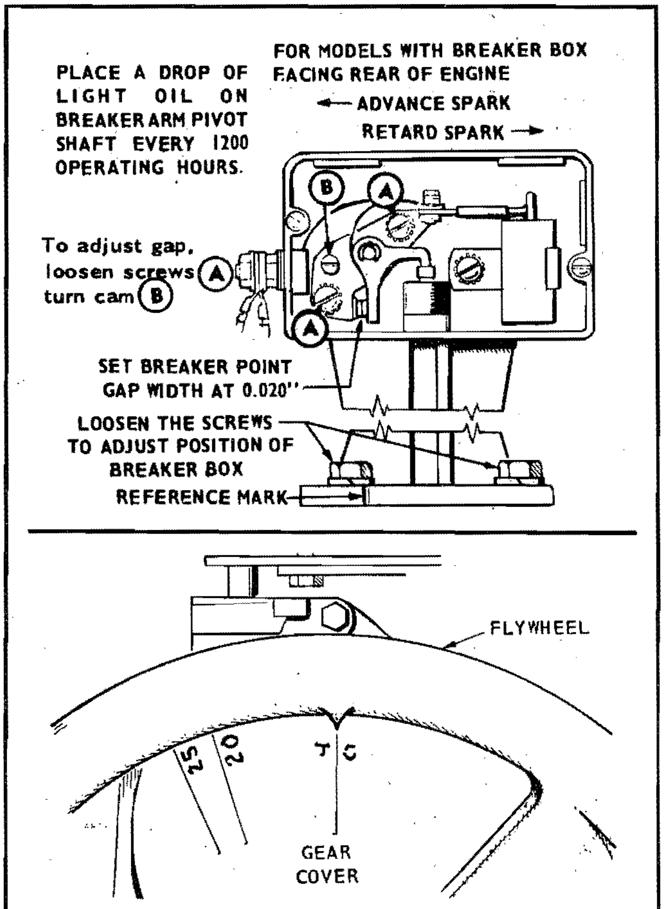


FIGURE 16. IGNITION TIMING

To accurately check timing when not running the engine, connect a continuity test lamp across the ignition breaker points. Touch one test prod to the breaker box terminal (to which the coil lead 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. Install the breaker box cover.

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.

CAUTION 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: MCCK generating plants use aviation-type spark plugs equipped to accept suppressed ignition leads. 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.

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

When replacing or reinstalling spark plugs, always install new gaskets.

GOVERNOR SYSTEM

GOVERNOR AND BOOSTER

The governor and booster control engine speed. A speed adjustment requires adjusting both devices.

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 the engine speed increases the generator voltage and frequency. Decreasing the engine speed lowers the 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.

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

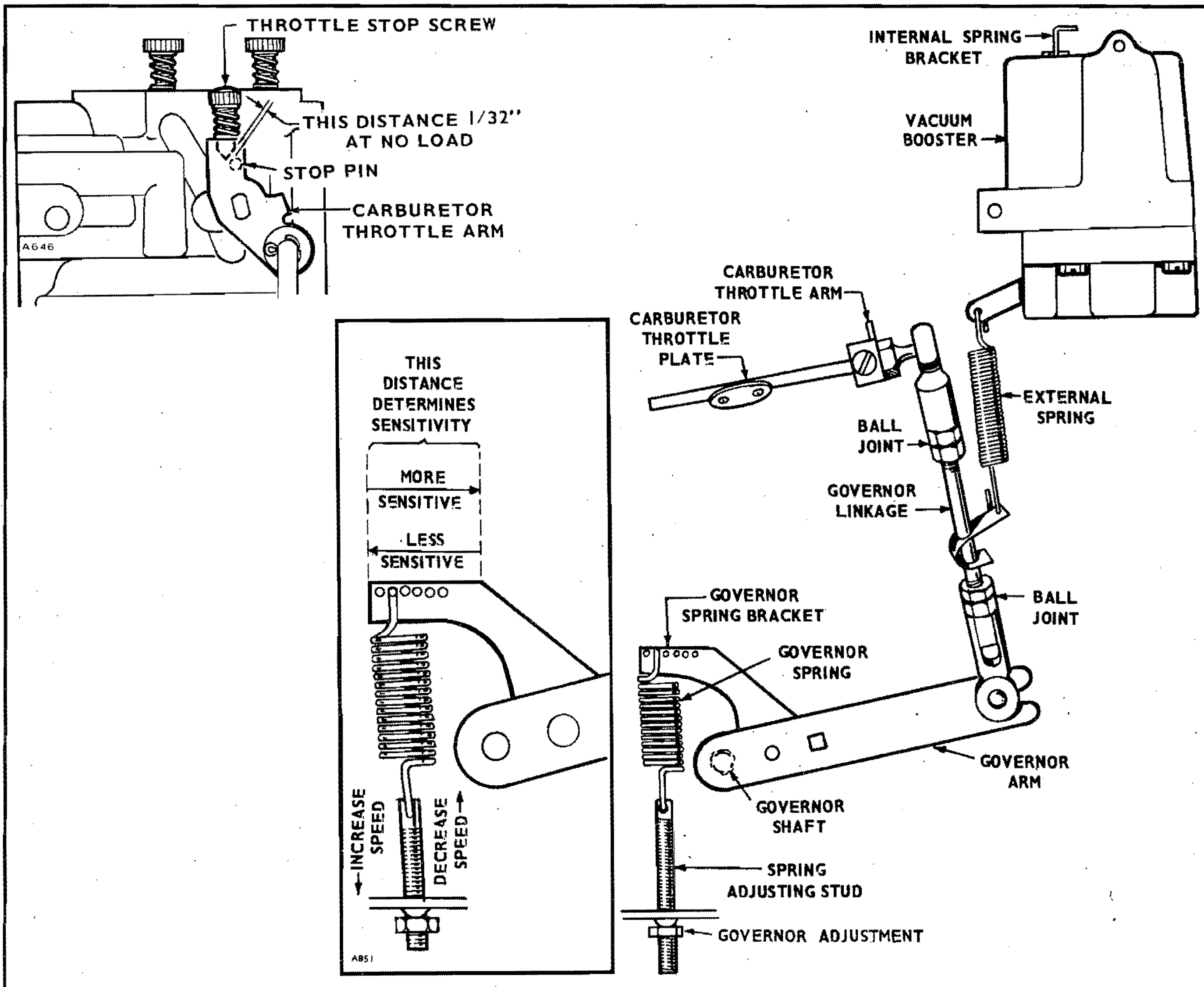


FIGURE 17. GOVERNOR AND GOVERNOR ADJUSTMENTS

The vacuum booster is a separate auxiliary device which supplements the governor. The vacuum booster is adjusted to increase governor action which increases engine speed as the generator load is increased. This results in nearly-constant voltage output.

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

As the plant load increases, engine vacuum decreases and the booster internal spring tension overcomes the pull of the diaphragm and tension is put on the booster external spring. This tension *helps* the regular governor spring in its function by causing a slight increase in engine speed as the load is increased.

A binding in the governor shaft bearings, ball joint or 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 governor action is still erratic, install a new spring and adjust.

ADJUSTMENT:

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

GOVERNOR

The governor and speed-booster control engine speed (Figure 17). Rated speed and voltage appear on the nameplate. The engine speed on a 4-pole generating plant equals the frequency times 30. This means a 60-cycle plant must turn at 1800 rpm. The governor should not allow more than 2-1/2 cycles change from no-load to full-load.

Linkage: The length of the linkage connecting the governor arm of the throttle arm is adjusted by rotating the ball joint. Adjust length so that with the engine stopped and the governor arm held in the closed throttle position, the stop screw on the carburetor throttle lever is 1/32″ from the stop pin. This setting allows immediate control by the governor after starting and synchronizes travel of the governor arm and throttle shaft.

Speed Adjustment: With the warmed-up plant operating at no-load, and with the booster external spring disconnected, adjust the governor spring tension. Turn the speed adjusting nut to obtain a voltage and speed reading within the limits shown.

Sensitivity Adjustment: Check the voltage and speed with no load connected and then 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), move the governor spring toward the governor shaft. Adjusting for too much sensitivity will cause hunting.

To decrease sensitivity, move the governor spring toward the outer end of the governor arm. Too little sensitivity will result in too much difference in speed between no-load and full-load conditions.

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

NOTE: *Make all final governor adjustments with the flame arrestor and resonator mounted on the carburetor.*

VALVE SERVICE

Properly-seated valves are essential to good engine performance. The 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. A conventional-type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. Valve locks are the split, tapered-type, the smaller diameter facing toward the valve head. Tappets are replaceable from the valve chamber after the valve assemblies are removed. See Figure 18 for valve details.

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 seat. This interference angle minimizes face deposits and lengthens valve life. Valve seat face should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

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

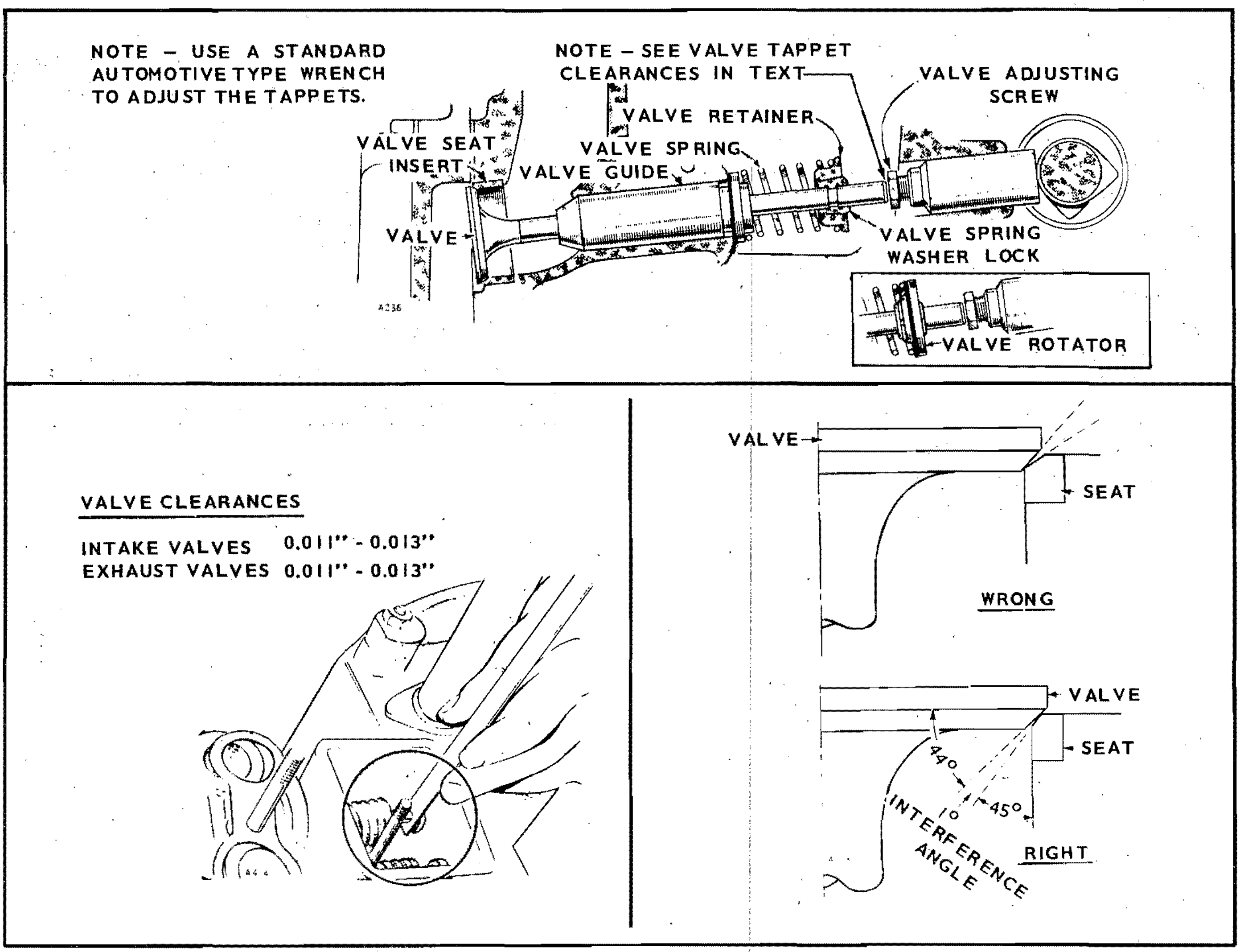


FIGURE 18. VALVE DETAILS AND CLEARANCES

rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and assemble. Adjust the valve clearance.

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

TAPPET ADJUSTMENT

These plants are equipped with adjustable tappets. To make a valve adjustment, remove the valve covers. Facing the flywheel, crank the engine over slowly by hand until the left intake valve 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 piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left cylinder. Clearances are shown in Figure 18. For each valve, the thinner gauge (minimum) should pass freely between the valve stem and valve tappet but the thicker gauge (maximum) should not.

To adjust valve clearance, turn adjusting screw as needed to obtain the right clearance. The screw is self-locking.

To adjust the valves on the right 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 cylinder.

GEAR COVER

After removing the mounting screws, tap the gear cover gently with a soft-faced hammer to loosen it. When installing the gear cover, make sure the pin in the gear cover engages the metal-lined (smoothest) hole in the governor cup. Turn the governor cup so the metal-lined hole is at 3 o'clock (Figure 19). The smooth side of the governor yoke must ride against the governor cup. Check that the bearing ball is in position (Figure 19). 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 flyballs having a grooved or flat spot, the ball spacer, if its arms are worn or 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 without too much 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 camshaft center pin.

The camshaft center pin extends out 3/4″ from the camshaft end. This provides an in-and-out travel of 7/32″ for the governor cup (Figure 20). Hold the cup against the flyballs when measuring. If the distance is less, 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.

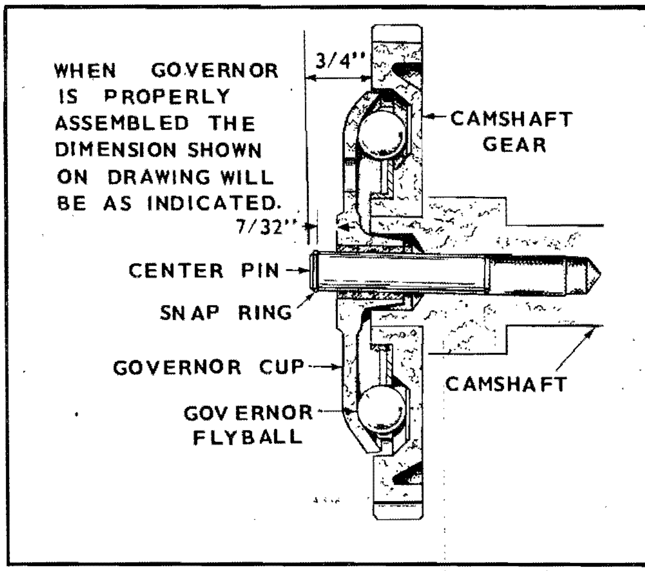
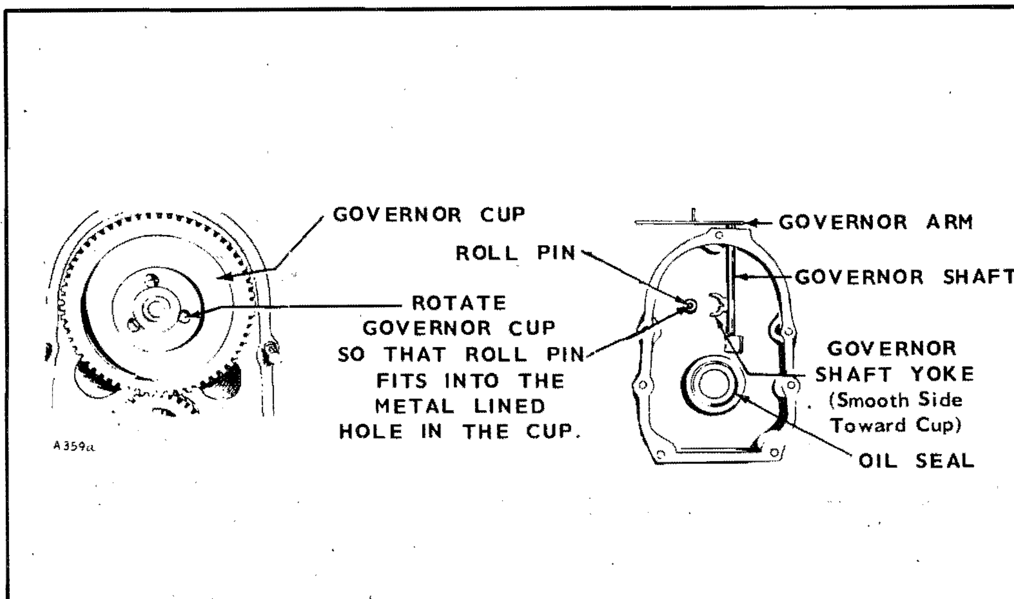


FIGURE 20. GOVERNOR CUP



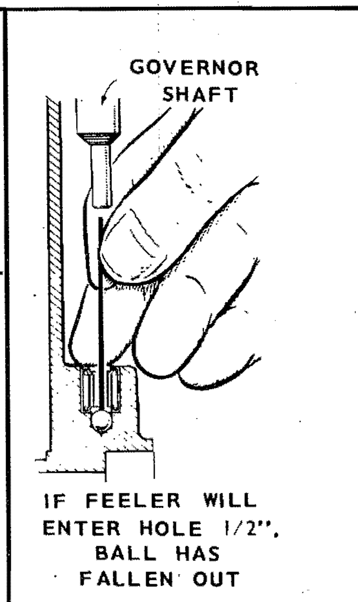


FIGURE 19. GEAR COVER ASSEMBLY

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, always install two new gears. 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 (Figure 21).

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, valve assemblies and breaker point plunger. Remove the fuel pump and tappets. After removing the governor cup assembly from the gear, the camshaft may be pressed out of the gear by use of a hollow tool or pipe which will fit over the camshaft center pin. *Do not press on the center pin.* The governor ball spacer is a press fit to the camshaft gear.

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

Each timing gear is stamped with an O-mark near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. 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

Piston and connecting rod assemblies are removed from the top. The pistons have two compression rings and one oil control ring (with expander). Inspect each piston. Piston ring grooves should be cleaned of any carbon deposits, and the oil return slots in the lower groove must be open.

If pistons are badly scored, loose in the cylinders, have badly worn ring grooves and are loose on the piston pins so that .002″ oversize piston pins will not correct it, install new pistons. Handle pistons carefully.

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

Inspect rings carefully for fit in grooves, tension, and seating on cylinder walls. Install new rings where there is any doubt about the condition of the old rings. Figure 22 shows following step.

Before installing new rings, check the ring gap by placing each ring squarely in its cylinder at a position corresponding to the bottom travel. The gap 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 requiring too much filing. Standard size rings may be used on a .005″ oversize piston. .010″, .020″, .030″ and .040″ oversize rings are to be used on .010″, .020″, .030″ and .040″ oversize pistons, respectively. Tapered rings are usually marked *top* on one side, or identified in some other manner. Rings must be installed with this mark toward the closed end of the piston. Space each ring gap 90° from the preceding one, with no gap in line with the piston pin. The bottom piston ring groove should be fitted with an oil control ring plus expander, and the two upper grooves fitted with compression rings.

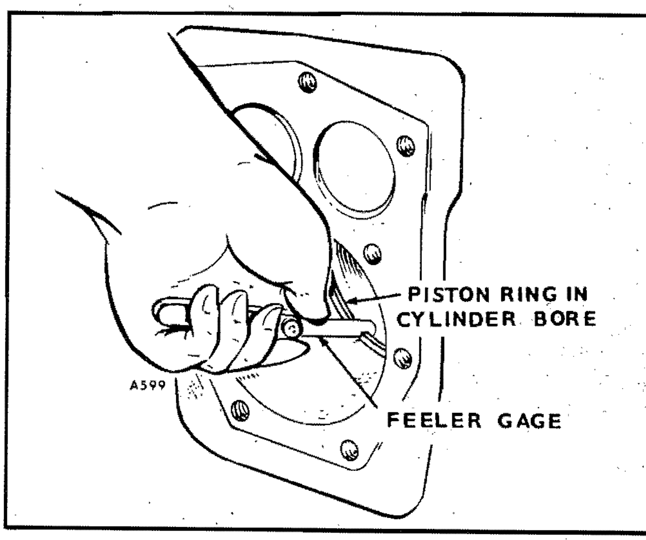


FIGURE 22. FITTING PISTON RINGS

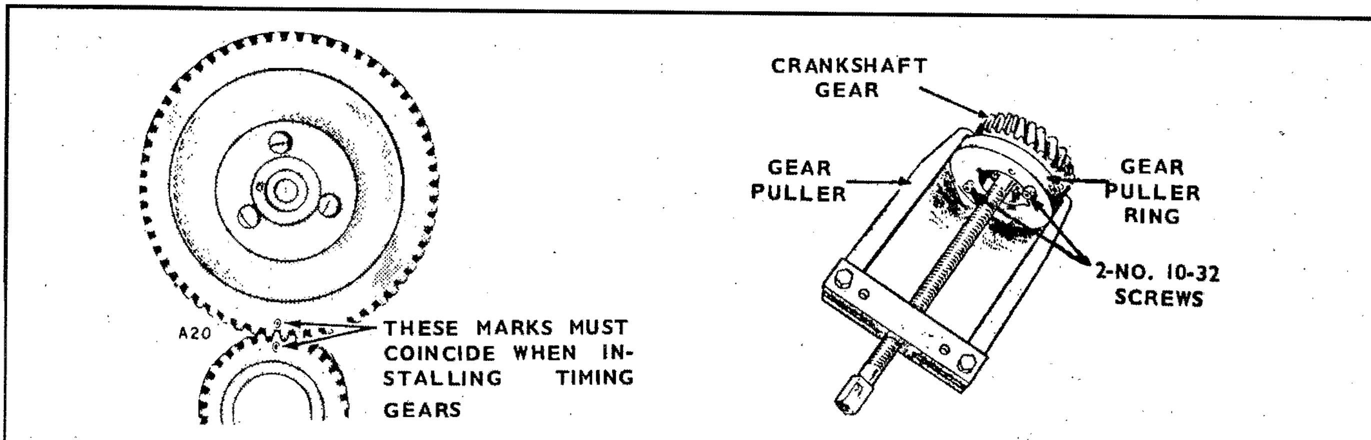


FIGURE 21. TIMING GEARS AND GEAR PULLER

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.

Pistons are fitted with full-floating piston pins. The pin is retained by two circlips in each boss. Be sure these lock rings are properly in place before installing the piston assembly. Correct piston-to-cylinder clearance appears in the Table of Clearances.

CONNECTING RODS

Connecting rods should be serviced at the same time pistons or rings are serviced. Rods must be removed with the piston. Rods are forged steel with replaceable bushings and bearings. They are available in standard or .002″, .010″, .020″ or .030″ undersize.

For clearances, refer to the Repair section.

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 piston assembly must be properly aligned before installation. Aligning should be done on an accurate gauge by a competent operator. Misalignment causes rapid wear of piston, pin, cylinder and connecting rod.

Install connecting rods and caps with raised lines (witness marks) aligned, and with the caps facing toward the oil base. The rod and cap numbered 2 fits on the crankshaft journal nearer the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing rods. Crank engine by hand to see that 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 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, refinish it to the next undersize. If a worn rod journal cannot be fitted by installing new bearing inserts (forged rod), then refinish it to take the corresponding undersize rod or bearing insert available.

Whenever making major engine repairs, always inspect the drilled crankshaft passages. Clean out any foreign material to assure proper connecting rod lubrication.

BEARINGS

Camshaft or crankshaft bearing removal requires complete engine disassembly. Use a press or suitable drive plug to remove the bearings. Support the casting to avoid distortion or bearing bore damage during removal and installation. Oil the bearings to reduce friction before and after installation. See Figure 24.

New crankshaft main bearings are a 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. 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 bearing flush with the inside end of the bore. If the head of the lock pin is damaged, use side cutters or an *easy out* tool to remove; then install new pin. Apply oil to thrust washer to hold it in place while installing the crankshaft. Oil grooves in thrust washers must face the crankshaft. Washers must be flat (not bent) with the two notches fitting over two lock pins to prevent riding on crankshaft.

New camshaft bearings are a precision-type and *do not* require line reaming or boring. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the elongated hole in the proper position and narrow section facing

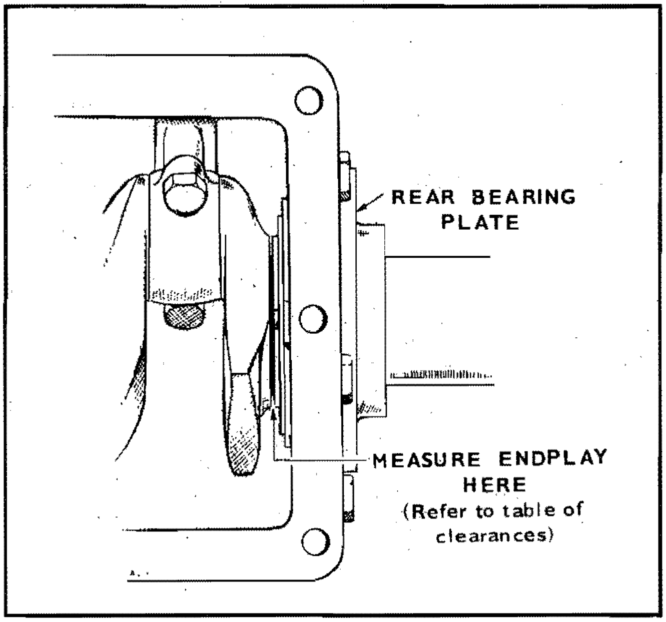


FIGURE 23. CRANKSHAFT ENDPLAY

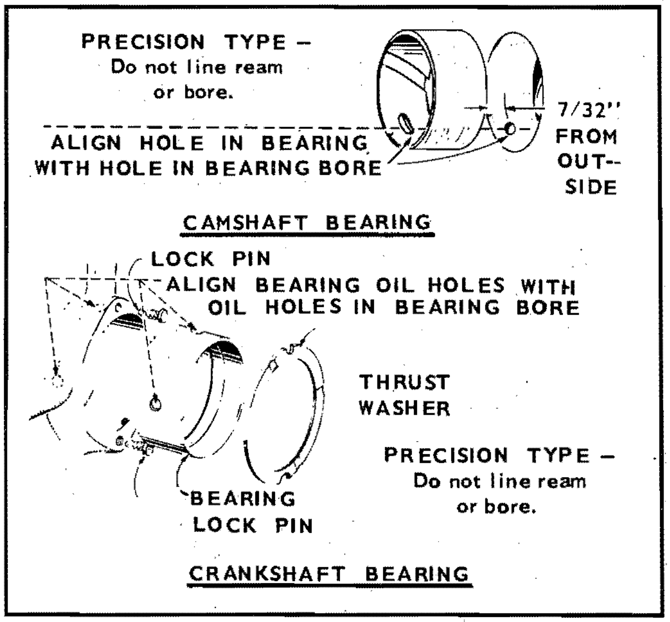


FIGURE 24. CAMSHAFT AND CRANKSHAFT

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 the counterbore which receives the expansion plug.

OIL SEALS (FIGURE 25)

The gear cover must be removed to replace oil seals. Drive out the oil seal from inside the gear cover.

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

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

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 the thin, open-face seal 1-7/64 inch from the mounting face of the cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft when replacing the bearing plate to avoid seal damage. Remove the shim stock as soon as the plate is in place.

OIL PUMP

To remove the oil pump, it is necessary to detach the intake cup assembly, as shown in Figure 26. Inspect the pump thoroughly for worn parts and always prime it before installing. Except for gaskets, component parts are not available individually (suction cup is available). Install a new pump assembly if required.

OIL PRESSURE RELIEF VALVE ADJUSTMENT

Oil pressure can be easily adjusted by means of the slotted stud and lock nut located just below the governor linkage.

Oil pressure at operating temperature should be between 25 and 40 pounds. To increase oil pressure, loosen the

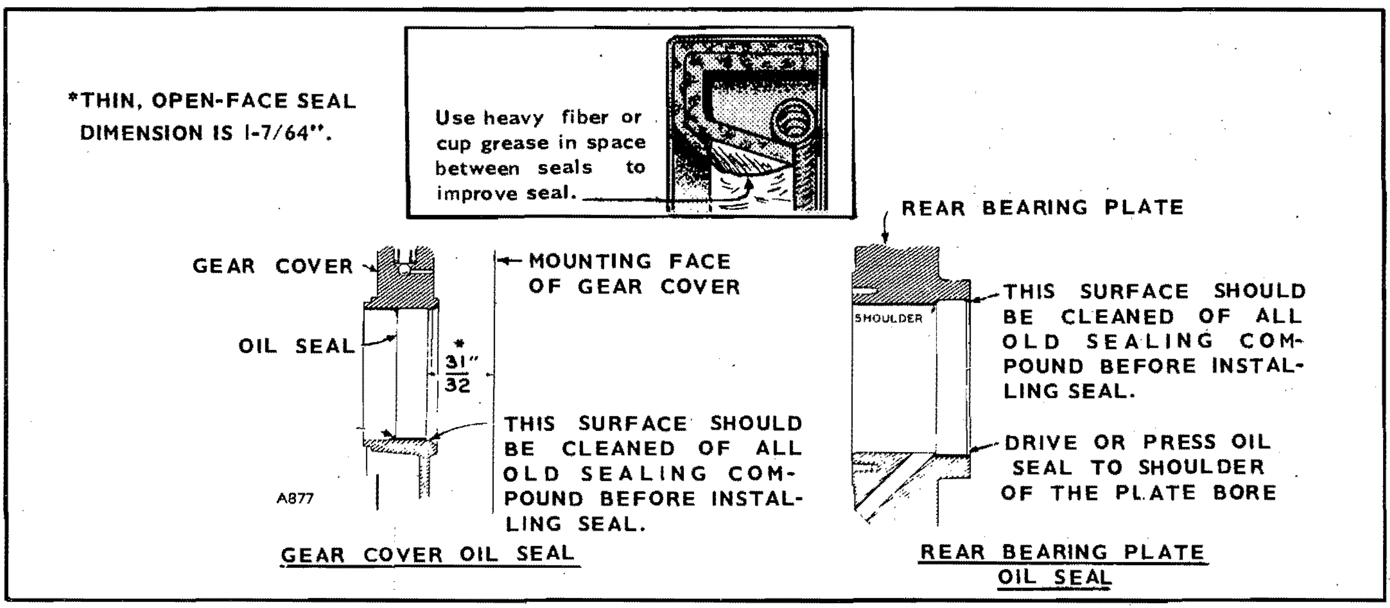


FIGURE 25. GEAR COVER AND REAR BEARING PLATE OIL SEALS

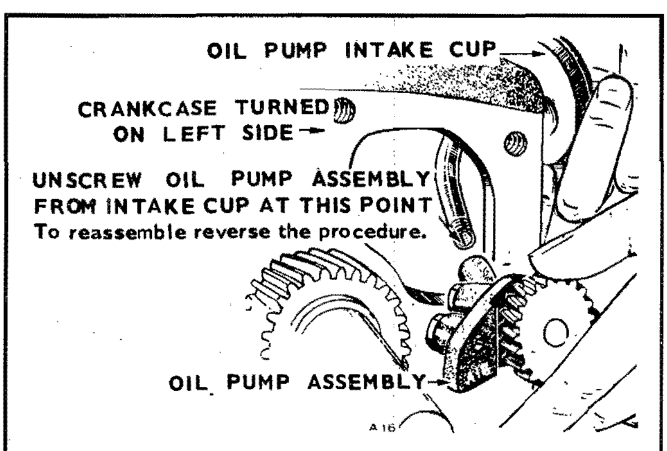


FIGURE 26. OIL PUMP ASSEMBLY

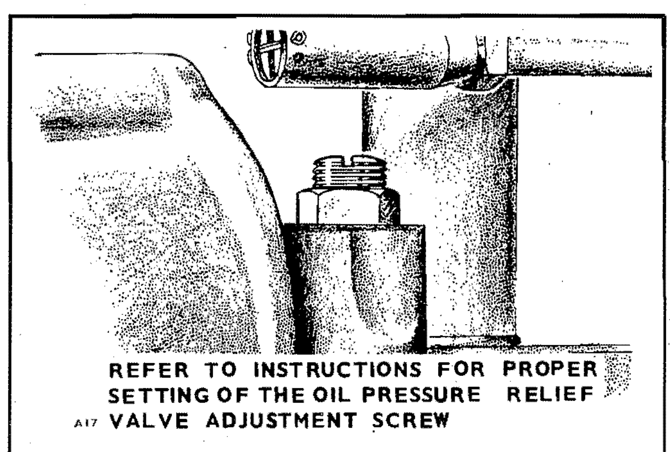


FIGURE 27. OIL PRESSURE RELIEF VALVE ADJUSTMENT

lock nut and turn the stud in; decrease pressure by loosening the lock nut and turning the stud out. Always tighten the lock nut after making an adjustment.

Low oil pressure may point to worn or poorly adjusted main or connecting rod bearings, weak or broken by-pass spring, defective gauge or a poor adjustment. Always check the oil pressure gauge before making other tests.

CYLINDER

The cylinder wears very little in normal service. If, through improper lubrication or accident the cylinder wall is scored or worn badly, the cylinder may be rebored and honed to accommodate an oversize piston and rings. Pistons are available in .010″, .020″, .030″ and .040″ P/S. Piston rings are available in .010″, .020″, .030″ and .040″ O/S. Use standard 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. An engine may be fitted at the factory with .005″ oversize pistons, and is 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.

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. Always use a steel key for mounting the flywheel.

CYLINDER HEADS

Torque cylinder heads at room temperature according to Figure 28. At some later time, after the engine has been operated so it reaches normal hot temperature and cooled to room temperature, the cylinder head bolts should be retorqued to the original specified torque. This retightening should be done before the engine has been run fifty operating hours.

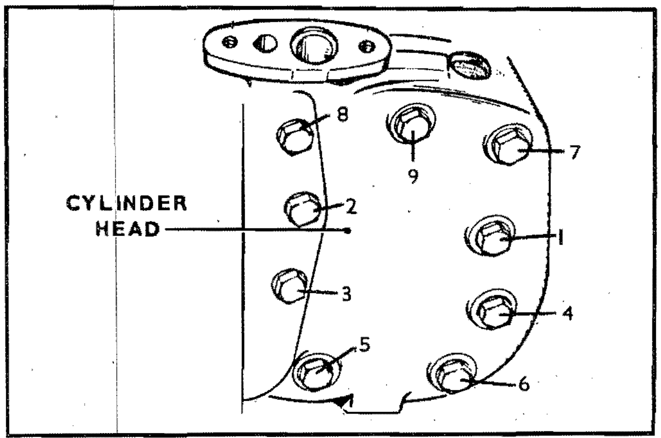


FIGURE 28. CYLINDER HEAD BOLT TORQUE SEQUENCE

A revolving-armature generator is used in MCCK generating plants. It is a 4 pole, self-excited generator with inherent regulation. The generator serves as a starting motor and furnishes DC current to recharge the batteries during operation.

The generator field contains shunt windings and series windings (a few turns of heavy wire wound on the same forms as the shunt windings). The series windings act as the starting motor field. The shunt windings are the working field, which produce the magnetic field in which the armature turns to produce useful output. A rectifier in series with the shunt field, mounted on the generator frame, provides increased engine cranking torque during plant starting.

The generator armature contains both AC output windings and DC windings to supply the field and battery charging circuit.

The generator is mounted to the engine through the engine-to-generator adapter and the armature is directly connected (a tapered fit) to the crankshaft. The outboard end of the generator rides on a ball bearing housed in the end bell. Because of its construction, the generator cannot be removed as a unit.

Generator leads are marked with metal tags for identification. Lead and terminal marking codes are noted on the plant wiring diagrams.

Generators need little care other than a periodic check of brushes, commutator and collector rings. If a major generator repair becomes necessary, have the equipment checked by a competent electrician thoroughly familiar with its operation. Continuity tests may be performed without disassembly of the generator.

DISASSEMBLY

1. The first step is to remove generator band and end bell cover. Remove all brush springs and lift the brushes from their holders.
2. Remove generator through-stud-nuts. Hold both the end bell and 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.
3. Remove baffle ring from adapter. Turn armature through-stud nut out to the end of the through stud. While pulling the armature outward with one hand, strike a sharp endwise blow on the nut with a heavy soft-faced hammer to loosen the armature. If the armature does not come loose, strike the armature with a sharp downward blow in the center of the lamination stack with a lead or plastic hammer. Rotate the armature and repeat. Be careful not to hit the collector rings, commutator, bearing or windings.
4. Upon disassembly, all parts should be wiped clean and visually inspected.

BRUSHES AND SPRINGS

Inspect brushes periodically. Replace if worn to 5/8″. 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. See Figure 29.

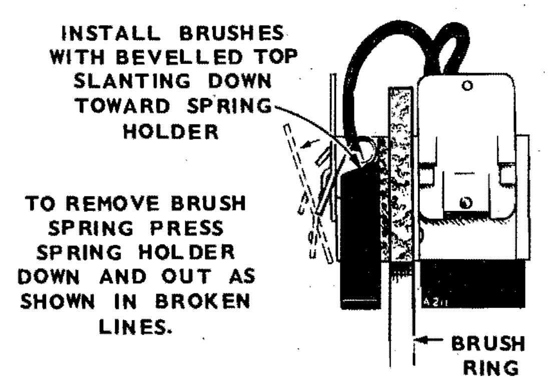


FIGURE 29. BRUSH REPLACEMENT

BRUSH RIG ALIGNMENT

The brush rig must be aligned in the neutral position. If it is not, sparking occurs. Normally, the neutral position is identified by a chisel mark on the brush rig (Figure 30). If the mark is lost or a new brush rig installed, follow these instructions to find the neutral position:

1. With the generator end cover and band removed to allow access to the rig, connect a voltmeter across the DC terminals and start the unit and apply full rated load.
2. Loosen the brush rig mounting screws and rotate the rig to get the highest voltage.
3. Rotate the rig in one direction until the voltmeter reading starts to decrease. Mark this point.
4. Repeat Step 3 in the other direction.
5. Half the distance between the two marked points is the neutral position.

IMPORTANT: *If a voltmeter is not available, use the above procedure, but mark the point where arcing begins.*

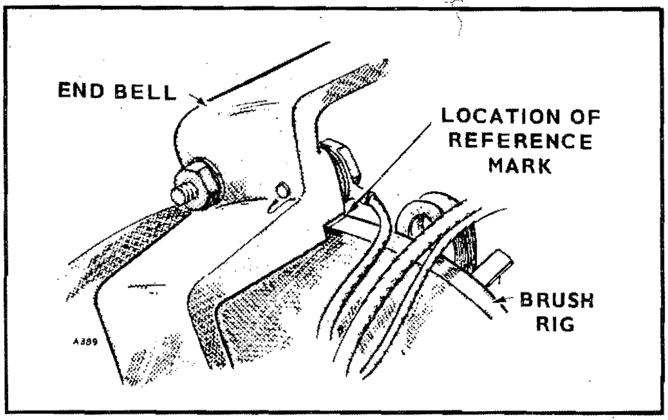


FIGURE 30. BRUSH RIG ALIGNMENT

COLLECTOR RINGS

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

COMMUTATOR

Commutator bars wear with usage so that the mica between them must be undercut. This should be done as soon as the mica on any part of the commutator touches the brushes. A suitable undercutting tool can be made from a hack saw blade. Avoid injury to the surfaces of the copper bars. Leave no burrs along the edges of the bars. Undercut mica whenever the commutator is refinished. See Figure 31.

GENERATOR TESTING

Windings: Before making any tests, lift all brushes from their holders and disconnect the load circuit wires from the plant. If the armature tests defective, the practical repair is to replace it. If a field coil tests defective, replace the entire coil assembly unless the trouble is in one of the external leads. Then it can be repaired as the nature of the trouble requires.

Armature Ground: Lift or remove brushes so that none contact the commutator or collector rings. Use a continuity test lamp set (Figure 32). Place one test prod on the commutator, and the other test prod on a clean part of the armature shaft. The test prods must make good electrical contact. The test lamp should not glow. If the test lamp glows, the DC winding or the commutator is grounded. To test AC windings, place one test prod on one of the collector rings and the other test prod on the armature shaft. If the test lamp glows, AC windings or a collector ring is grounded. Replace grounded armatures.

Armature Open: Armature AC windings may be tested for an open circuit without removing the armature. Testing the DC winding requires removal and the use of an armature growler (Figure 32).

To test AC windings, lift or remove all brushes. Use a test lamp set. Place one test prod on each of the collector rings. If the lamp does not glow, AC windings are open circuited.

To test the DC windings, place the armature in a growler. Then 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

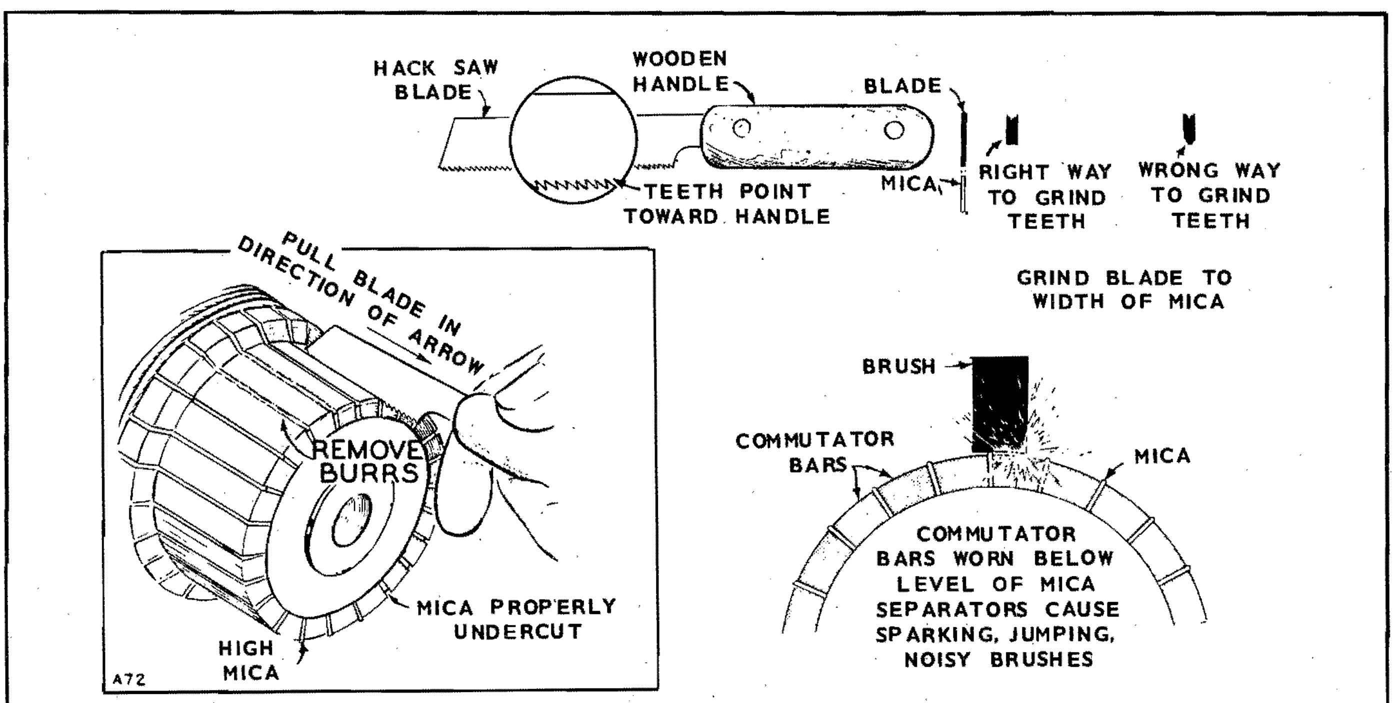


FIGURE 31. UNDERCUTTING COMMUTATOR MICA

obtained between all adjacent segments. If no spark is obtained at some point, an open circuit is indicated.

> **IMPORTANT:** *A short circuit in the winding might prevent sparking. This condition may also be indicated by the short circuit test.*

Replace an open circuited armature with a new one.

Armature Short: To test for a short circuit, place the armature in a growler and 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 armature revolution in the growler has been made. Replace a short circuited armature with a new one.

Field Windings: Use a test lamp set for all tests except a short circuit. The field coils are saturated shunt wound, having a series field winding for cranking. When testing a field coil assembly, disconnect all of its external leads from their terminals. Tag and mark each lead to assure proper connections for assembling.

Testing Field Windings for Grounds: To test a coil assembly for 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 the armature ball bearing needs replacement, pull the bearing from the shaft with a suitable bearing puller. Do not damage the armature shaft – it must remain true to serve as a turning center when refinishing the commutator or collector rings. Drive the bearing onto the shaft shoulder. Use a double-sealed prelubricated ball bearing.

Shunt Field Rectifier: Using a multimeter, check the rectifier for an open circuit in one direction and a closed circuit in the other direction. If the rectifier is defective in either direction, replace it.

Assembly:

1. Clean and inspect all mating surfaces. Surfaces should be free of nicks and dirt.
2. Coat mating area between the generator shaft and the engine crankshaft with a thin film of lubricating oil, Molycoat or equal.
3. Assemble the armature through stud to the engine crankshaft with required torque.
4. Check to see that the key is in the crankshaft.

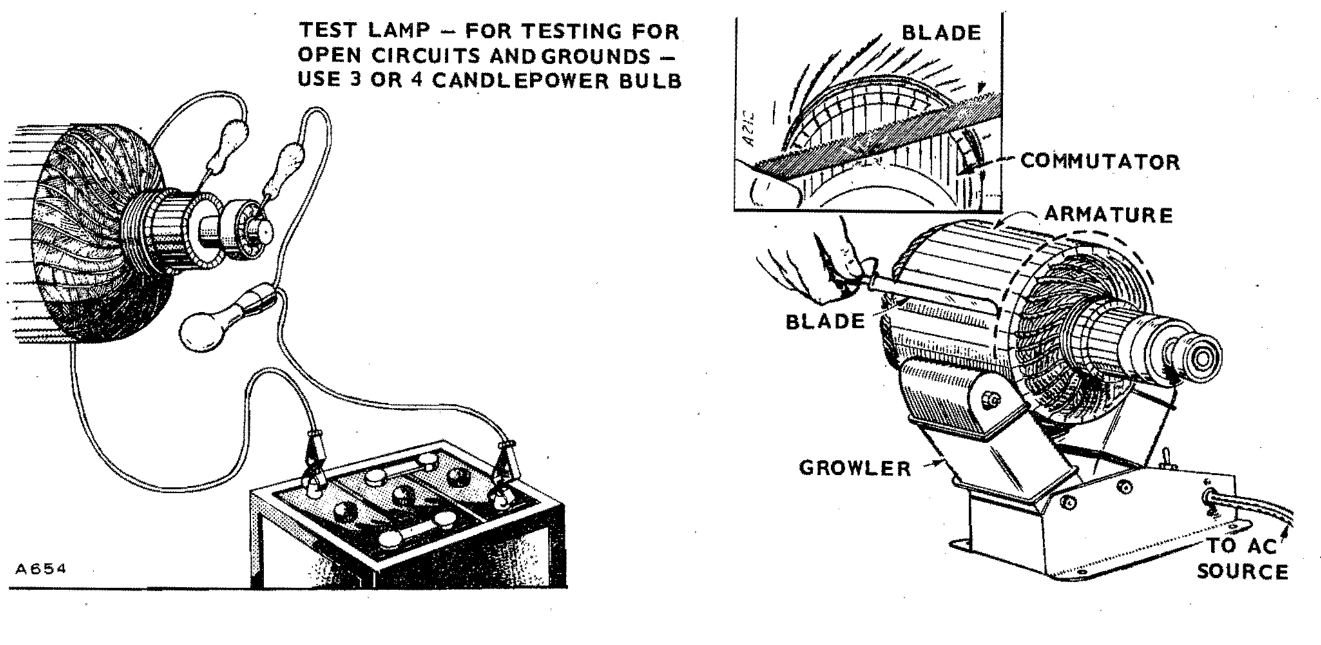


FIGURE 32. ARMATURE TESTING

5. Slide armature over the through stud and onto the crankshaft, being careful not to let the weight of the armature rest on the through stud.
6. Install baffle ring, when used.
7. Assemble generator through studs to the adapter with required torque.

CAUTION DO NOT tighten the armature or rotor through stud before mounting the frame and bearing support. If this procedure is not followed, misalignment may occur, shortening the life of the rear main and outboard bearings. Also, cranking torque requirements could be doubled, resulting in damage to the commutator and DC brushes.

8. Install the frame and bearing support. Tighten frame to required torque.
9. NOW torque down the armature through-stud nut. Because you have tightened the frame and bearing support before tightening the armature, you have the armature and frame in alignment.
10. Tap the bearing support in the horizontal and vertical plane with a lead hammer to relieve stresses on the components and then recheck the torque.

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.*

> **NOTE:** *For servicing information on optional automatic demand controls for older MCCK plants, refer to HA series Automatic Control manual number 907.8.*

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.

CAUTION 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.

CONTROL-O-MATIC

GENERAL DESCRIPTION

The Control-O-Matic, standard on newer model MCCK plants, is an engine-control, an automatic-demand control and a bilge-blower control, all combined into one top-mounted control box.

The Control-O-Matic, with its switch in AUTOMATIC position, will monitor the AC load circuit to:

a. Sense a load on the AC line.
b. Close the bilge blower circuit (when used).
c. Open the bilge blower circuit.
d. Start the electric plant.
e. Sense when all load is removed.
f. Stop the electric plant.

A sheet metal enclosure approximately 12-5/8″ wide, 7-5/8″ deep, and 6″ high houses the Control-O-Matic. The Control-O-Matic mounts on top of the electric plant with its front panel facing the generator end of the plant. The front panel holds the charge ammeter, emergency relay, and toggle switch. A unique hinge arrangement holds the front panel, cover and chassis together. The control box may be opened in a very limited space to expose all the relays for servicing.

HOW CONTROL-O-MATIC WORKS

A three position toggle switch on the front panel selects one of three modes of operation; RUN; OFF; and AUTOMATIC.

The Bilge-Blower Control circuit in the Control-O-Matic delays cranking while it closes a 12-volt, 5-amp circuit to operate the bilge blower.

When the three position toggle switch is moved to the RUN position, the Bilge-Blower Control goes through its control cycle before the electric plant cranks and runs.

The electric plant stops when the three-position switch is moved to the OFF position.

If the operator places the three-position switch in the AUTOMATIC position, the electric plant will crank and run on load demand after the Bilge-Blower Control cycles. The electric plant stops when all the load is removed from the AC line.

OPERATION OF CONTROL-O-MATIC

Control-O-Matic operation is explained on the following pages. Accompanying the description of each function is a schematic drawing, with current flow shown as bold lines on the drawing. A pictorial wiring diagram appears as Figure 33 on the next page. Throughout the text are references to various components (electrical devices), terminal positions, and current flow. When reading through the text, follow current flow on the schematics and locate relative positions of electrical devices and terminal positions on Figure 33. This will provide a more comprehensive understanding of the operation of the Control-O-Matic.

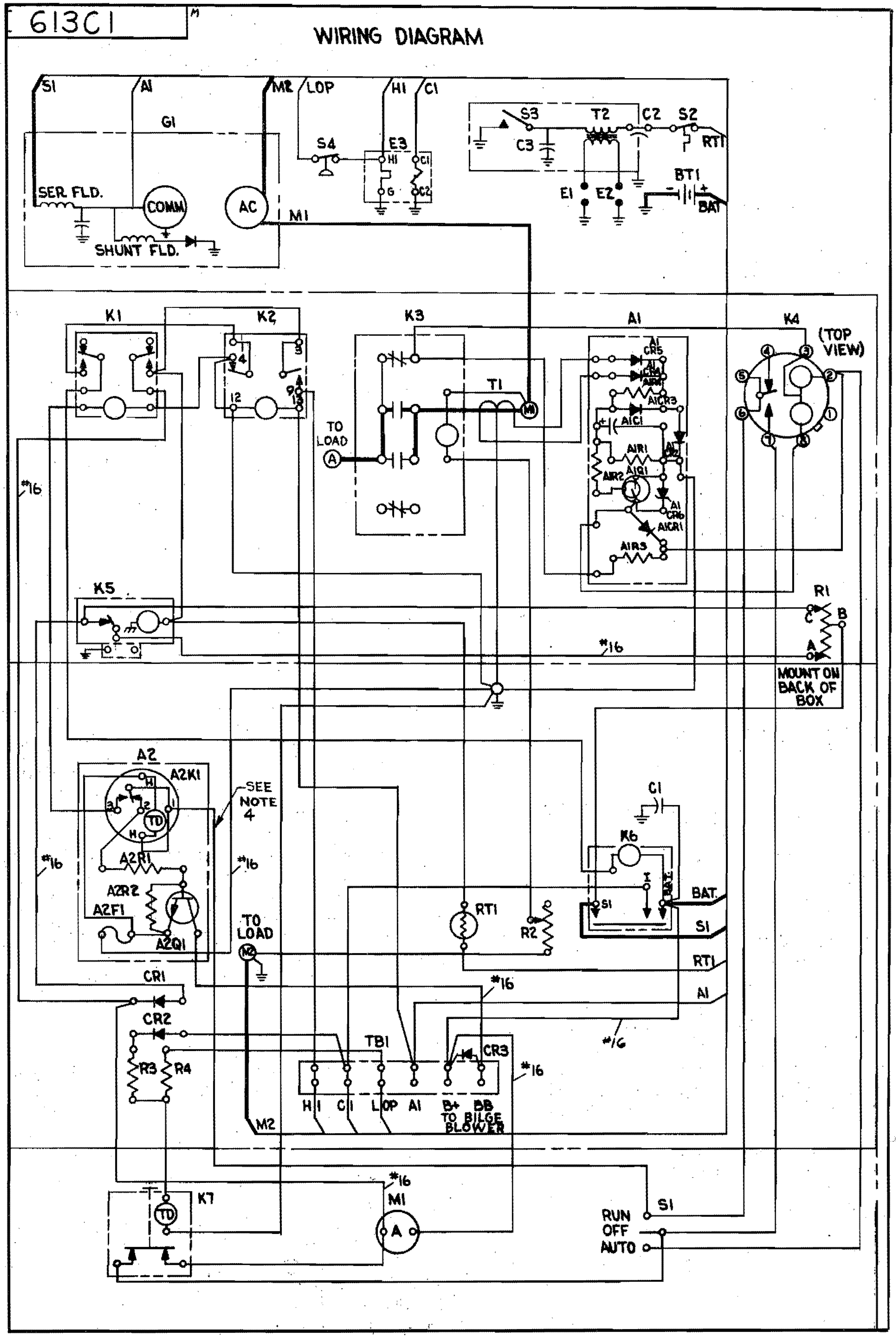

613C1
WIRING DIAGRAM
S1
A1
M2
LOP
H1
C1
G1
SER FLD.
COMM
AC
M1
SHUNT FLD.
S4
E3
S3
T2
C2
S2
C3
RT1
BT1
E1
E2
BAT
K1
K2
K3
T1
TO LOAD
K4
(TOP VIEW)
K5
R1
MOUNT ON BACK OF BOX
A2
A2K1
TD
A2R1
A2R2
A2F1
A2Q1
SEE NOTE 4
C1
K6
BAT.
RT1
R2
CR1
CR2
R3
R4
TB1
CR3
TO BILGE BLOWER
K7
M1
RUN
OFF
AUTO

FIGURE 33.

The control must operate with a negative ground. Connect battery with correct polarity.

Switch S_1 is a three-position switch. Center position is OFF. Moving the switch handle to the RUN position bypasses Relay K_4 contact (7-6) to energize the Bilge Blower Control which goes through its control cycle before the electric plant cranks and runs. By moving the S_1 switch handle to AUTO, the Control-O-Matic starts the plant, which will run as long as a load demand prevails. In this case, the load must be at least a 40-watt incandescent lamp.

LOAD DEMAND

When the plant is in AUTOMATIC Mode and a 40-watt lamp (or larger) is turned on, a load demand exists. Battery current flows through Switch S_1, Relay Coil K_4 (2-3), K_3 contacts, Load Terminal A, through the load to ground, and back to the battery to energize Relay K_4.

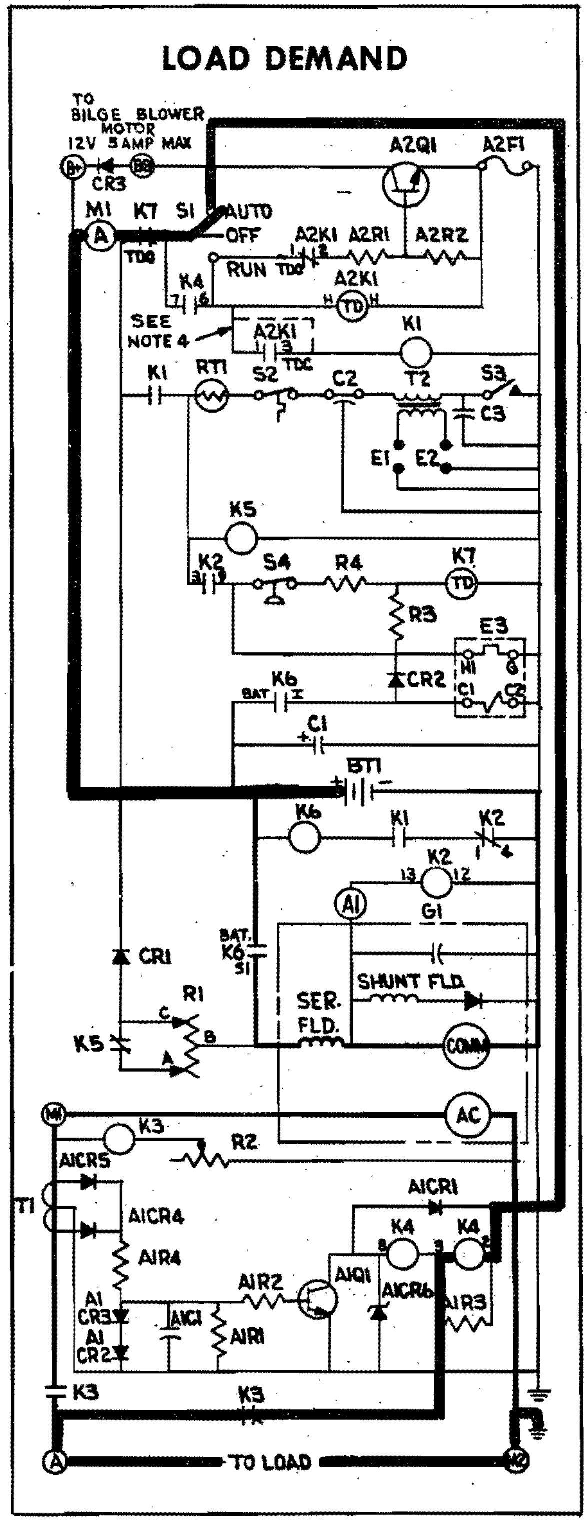


FIGURE 34.

CLYMAR INC.
N55 W13787 Oak Lane
Menomonee Falls, Wisc. 53051
(414) 781-0700

TRANSISTOR "ON" AND TIME DELAY

When Relay K_4 energizes, contacts (6-7) close the circuit from B+ to the run terminal on Switch S_1 and to Terminal 1 on Relay A_2K_1 (Bilge Blower Control). Current flows through the heater of Relay A_2K_1 to the 6-1/4 ampere fuse, to ground and back to the battery. The heater on the five-minute time delay begins its cycle. Simultaneously, as current flows through the heater on Time Delay A_2K_1, it also flows through the closed A_2K_1 contacts (1-2) through Resistor A_2R_1 to the base of the transistor, through Resistor A_2R_2, and through the fuse to ground. This switches Transistor A_2Q_1 on.

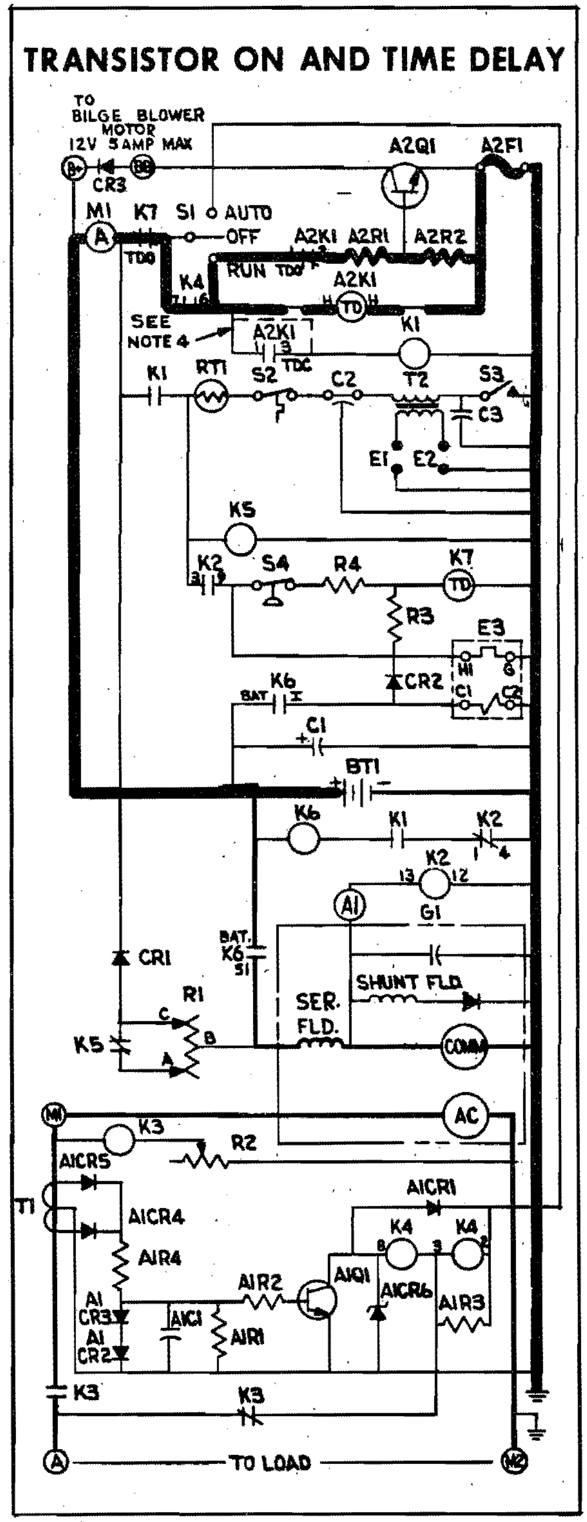


FIGURE 35.

BILGE BLOWER ON

When Transistor A_2Q_1 turns on, current flows from the B+ Terminal through the bilge blower, to Terminal BB on Terminal Block TB_1, through the transistor and through the fuse to ground. The bilge blower operates for five minutes to evacuate explosive vapors from the boat bilge. At the end of the five minute period, Time Delay A_2K_1 operates to close contacts (1-3) and open contacts (1-2). Transistor A_2Q_1 turns off to interrupt the power to the bilge blower.

Diode (CR_3) between B+ and BB is a discharge diode to protect other components in the control from inductive voltage when the bilge blower is turned off.

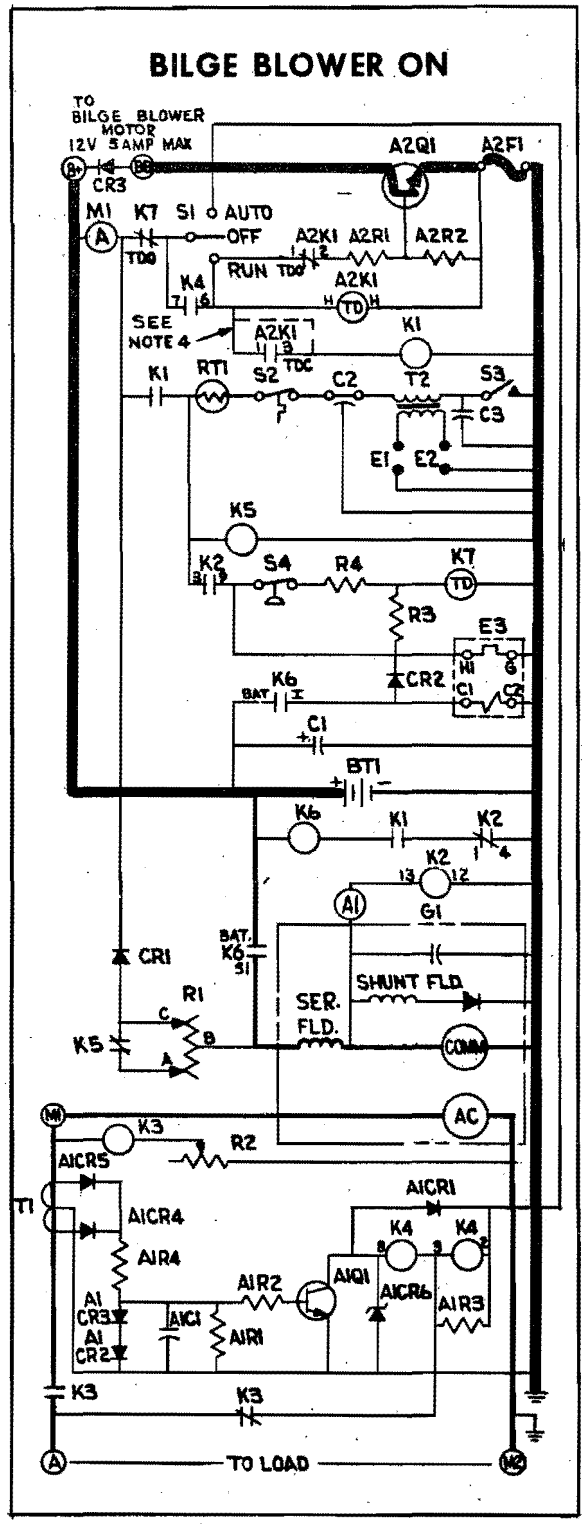


FIGURE 36.

ENGINE CRANK CIRCUIT

When Time Delay A_2K_1 contacts (1-3) close, Current flows to energize the Start-Stop Relay (K_1). The K_1 contacts close the circuit through K_2 contacts (1-4) to energize Start Solenoid Relay K_6. The main contact of K_6 closes to supply battery power to the cranking windings on the generator.

CHOKE

The auxiliary contact (BAT-I) of Start Solenoid K_6 closes the circuit to the Solenoid (C_1-C_2) on the thermo-magnetic choke mounted on the carburetor.

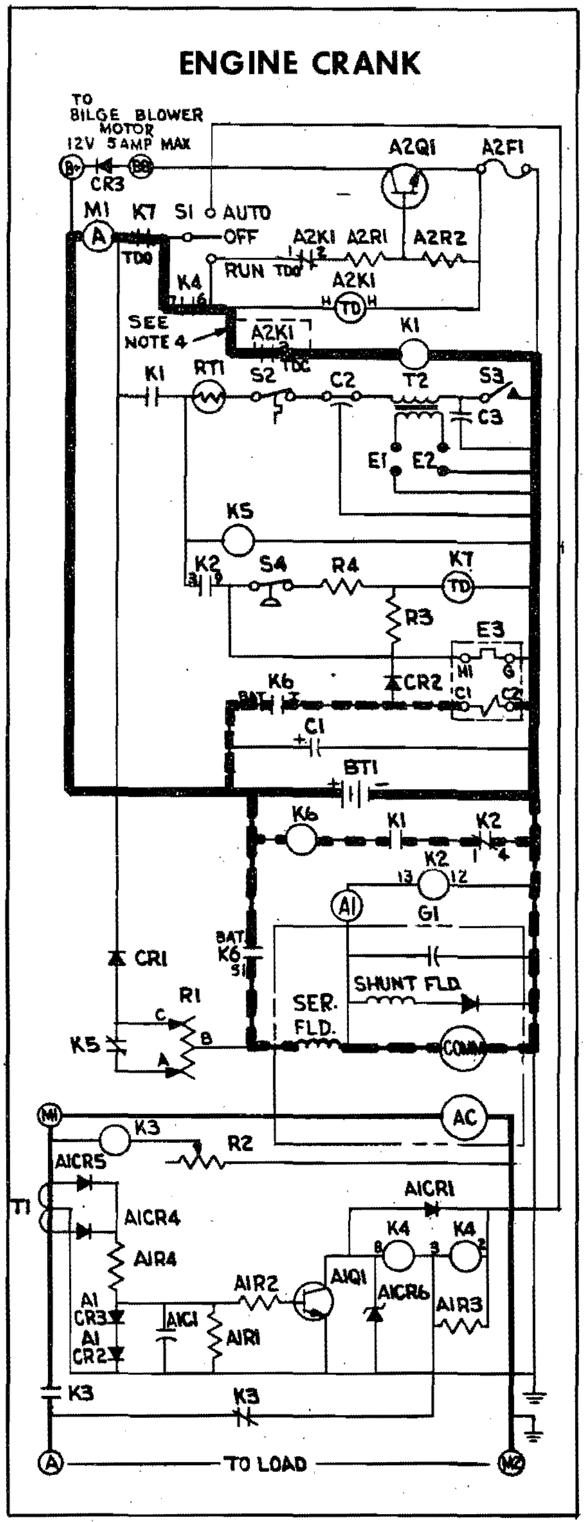


FIGURE 37.

CRANKING LIMITER

When the Start Solenoid Relay K_6 picks up, contact I closes to supply battery power through Diode CR_2 through the Resistor R_3, to the heater on the Time Delay Relay K_7 (320B104 Emergency Relay). If the electric plant does not start within approximately 45 seconds, this relay opens its contacts to the control circuit and shuts the unit down.

Diode CR_2 serves as a blocking diode to prevent current flow to the choke control during a low oil-pressure condition.

IGNITION

When Relay K_1 energizes, its contacts close to supply battery power to Relay K_5 and the ignition circuits. Current flows through the Ignition Resistor (RT_1), the High-Water-Temperature Switch (S_2), the primary of the ignition coil and through the breaker points (S_3) to ground. This supplies ignition power to spark plugs E_1 and E_2.

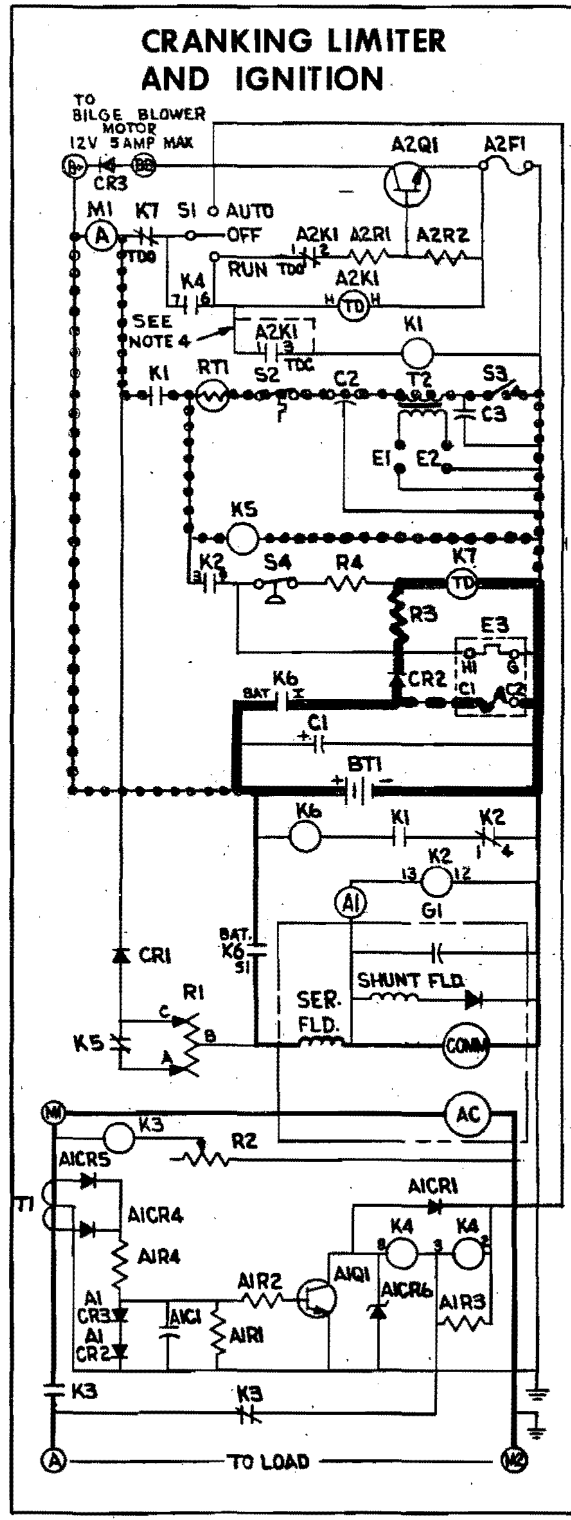


FIGURE 38.

START DISCONNECT, CHOKE HEATER AND BATTERY CHARGE

When the electric plant starts, power from the armature, supplied through Lead A_1, energizes Relay K_2, which is the Start Disconnect Relay (307B642). Relay K_2 contacts (1-4) open the Start Relay (K_6) coil circuit. Relay K_6 de-energizes, opening its contacts to disconnect the cranking circuit and Choke Solenoid circuit.

Relay K_2 contacts (3-9) close the circuit to the Bi-metal Heater (H_1-G) of the thermo-magnetic choke. The Bi-metal heats to open the choke for normal running as the engine warms up.

Relay K_2 contacts (3-9) also close the circuit to Time Delay Relay K_7 through Low Oil Pressure Switch S_4 and Resistor R_4. If oil pressure switch S_4 does not open, Time Delay Relay K_7 operates to open the normally-closed contact to shut down the plant. Wait one minute; then push to reset.

BATTERY CHARGE

When the generator comes up to speed it supplies battery charge current through Lead S_1 to Start Solenoid Relay K_6, and Terminal S_1 to Resistor R_1 (charge resistor). The resistor is divided with the upper Terminal C and the lower Terminal A connected to the contact on the Voltage Regulator K_5. This supplies the high charge rate for fast battery charging.

Current flows from the terminal of Relay K_5 through the Reverse Current Diode (CR_1), through the ammeter back to the battery for charging. When the battery reaches a preset charge level, the coil on Relay K_5 is energized, opening the contacts and dropping the charge to a low rate.

Resistor R_1 is set at the factory for correct two rate charging.

START DISCONNECT CHOKE HEATER AND BATTERY CHARGE

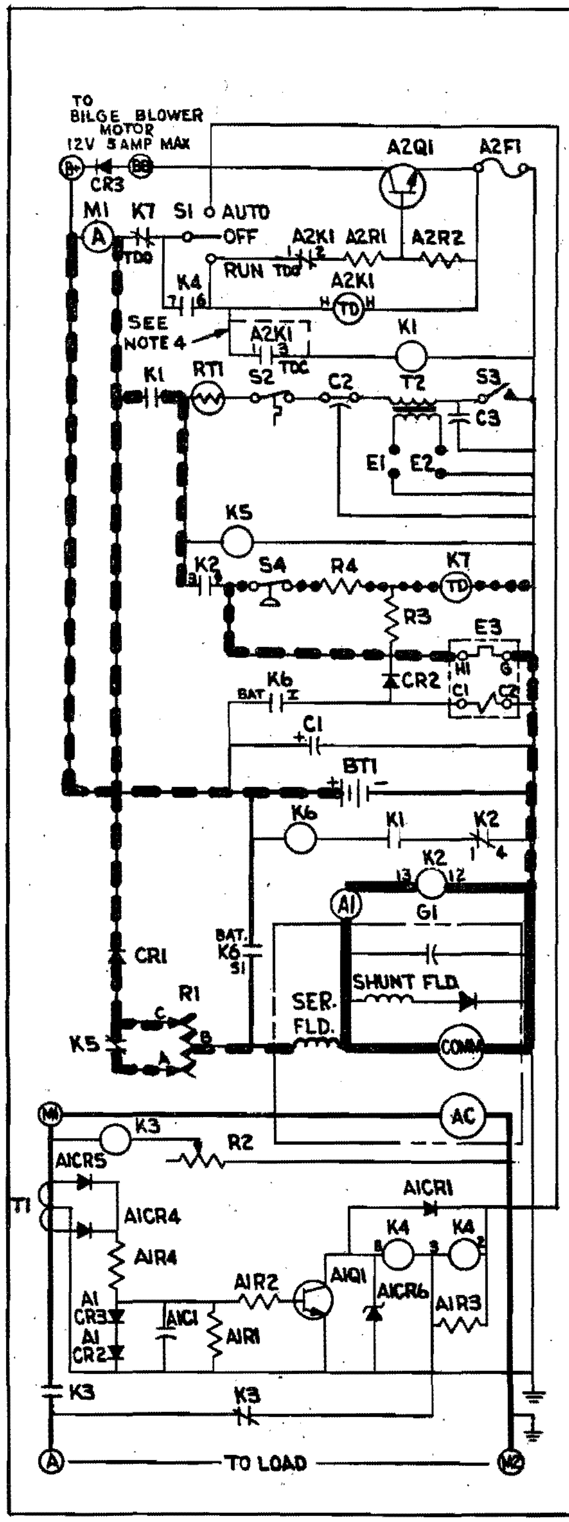


FIGURE 39.

GENERATOR SUPPLYING POWER

When the generator AC voltage reaches approximately 105 volts on 115-volt units or 210 volts on 240-volt units, the coil on the Line Contactor K_3 energizes to open the auxiliary contacts and close the main contacts. The generator is now supplying power to the load.

With the generator supplying power to the load, current through the primary winding of Transformer T_1 produces current in the secondary and supplies power to the Load Sensor Amplifier A_1. This power is rectified by Diodes A_1CR_5 and A_1CR_4. This power is applied to the base of the Transistor A_1Q_1. The transistor switches on and passes current through both coils on Relay K_4, keeping it energized. This relay remains energized as long as a minimum 40 watt incandescent lighting load is across the output terminals of Relay K_3.

STOP

When the load is removed, the flow of current through the power leads and the current produced in the secondary of Transformer T_1 drops to zero. This switches the transistor off to de-energize Relay K_4. The contacts open to break the ignition circuit and stop the engine.

MISCELLANEOUS

To eliminate the five minute bilge blower time delay, disconnect the lead from Terminal 1 on Time Delay A_2K_1 and connect it to Terminal 3.

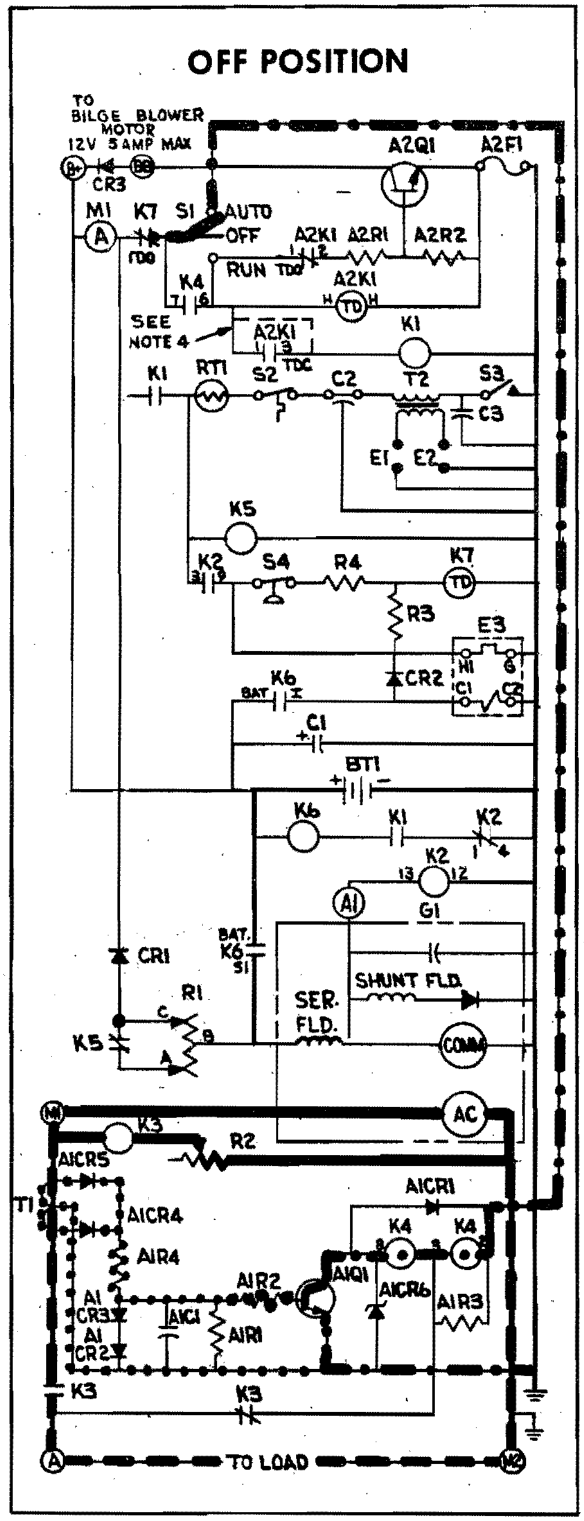


FIGURE 40.

CLYMAR INC.
N55 W13787 Oak Lane
Menomonee Falls, Wisc. 53051
(414) 781-0700

CONNECTING AUXILIARY RELAY TO CONTROL-O-MATIC

This circuit allows a separate battery or power source to operate the bilge blower. It also permits use of larger blowers with running currents in excess of 5 amperes. The auxiliary relay should have a 12 VDC coil and contacts heavy enough to carry the current required by the bilge blower.

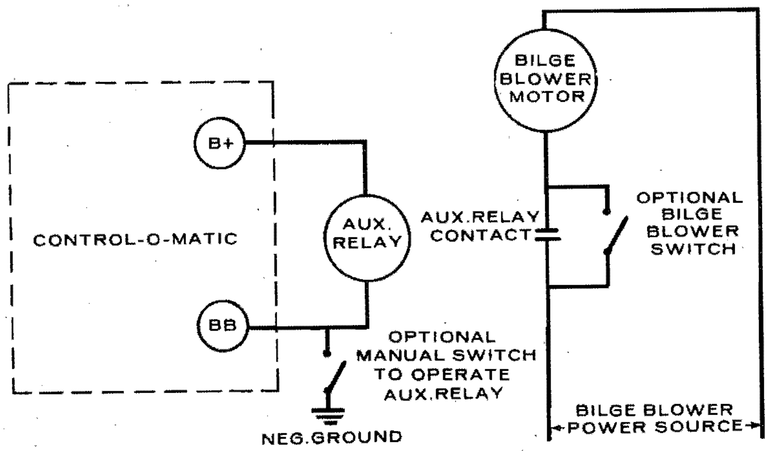


FIGURE 41.

CONNECTING BILGE BLOWER TO CONTROL-O-MATIC

The bilge blower operates on power from the electric plant cranking battery. The optional switch will run the bilge blower as long as the switch is closed. The bilge blower running current must not exceed 5 amperes.

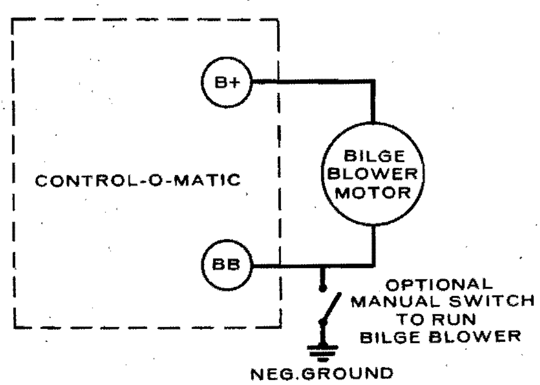


FIGURE 42.

TROUBLE SHOOTING PROCEDURE FOR 120VOLT SINGLE PHASE, 12VOLT DC CONTROL-O-MATIC

A 20,000 Ohm/Volt VOM is needed for some of the following tests. The symptoms are listed by number and followed by test procedures.

1. Control switch is in RUN position, but electric plant does not crank after the usual 5 minute delay period.
   a. Check battery connections and battery voltage.
   b. Disable the bilge blower control Relay A_2K_1 by moving the lead wire from Terminal 1 to Terminal 3, Figure 33. If plant cranks with the bilge blower control disabled, the problem is in the bilge blower control circuit. Refer to Paragraph 5.
   c. Check to see if the Start Solenoid K_6 picks up. If it doesn't, check for a faulty solenoid by connecting a jumper from the S terminal to ground. This bypasses contact K_1 and K_2. The start solenoid should pick up. If it picks up, check for proper operation of relay K_1 and K_2.
2. Electric plant will not start on load demand.
   a. Move the toggle switch to RUN position. Plant should crank after approximately a five minute delay.
   b. Apply some load (at least 100 watts) to load the circuit. Move toggle switch to AUTO position. Plant should continue running.
   c. If plant stops with 100W load, move toggle switch to OFF position. Connect a jumper wire from terminal 8 of Relay K_4 to the ground terminal in the Control-O-Matic. Move toggle switch to AUTO. Plant should start and run. If it does not, remove relay to check continuity of relay coil terminals 2-3 and 8 of 307A62. Resistance 2-3 equals approximately 100 ohms; 2-8 equals approximately 1000 ohms.

      Apply 6 to 12 volts to terminals 2-8 to see if relay operates. When relay operates, contacts 4-6 open and contacts 6-7 close.
   d. If relay is good, check voltages as follows. The voltage measured from the chassis ground terminal to:
      - the B+ terminal on the Start Solenoid should equal battery voltage.
      - terminal 2 of relay socket should equal battery voltage.
      - terminal 3 of Start-Run relay should be near zero if K_3 contact is closed properly and sufficient load is connected to the Load circuit.
   e. Check voltages of load sensor amplifier with plant running under a minimum load of 100 watts. Start electric plant in AUTO position for this test by jumpering the outside terminals of Switch S_1.
      - Measure AC output voltage of Transformer T_1 at terminals on load sensor amplifier. The voltage should read 2 to 3 VAC.

        Use a 20,000 ohm Voltmeter to minimize error.
      - Voltage from ground to the transistor side of Resistor A_1R_2 should measure 0.6 to 0.7 VDC.
      - Voltage across A_1CR_1 should read 5 to 14 VDC.
      - Remove jumper from Switch S_1.
3. Control-O-Matic starts plant automatically under load, but slows down or stops as soon as contactor picks up.
   a. Recheck size and type of load. Minimum requirements are a 40 watt incandescent lamp load or a 425 watt heater load.
   b. Recheck adjustment of contactor Pick-Up Resistor R_2.
      - Apply a load and help contactor pick up and hold in as the plant starts. If this corrects the problem, reduce the resistance of R_2.
      - Apply a load and hold the contactor to delay pickup. If this helps, increase the resistance setting of Resistor R_2.
   c. Move toggle switch to the OFF position. Connect a jumper from Terminal 8 of Relay K_4 to ground terminal. Move toggle switch to the AUTO position. The plant should start and run.
   d. Apply a load, such as a 100W lamp; then remove the jumper while the plant is running with the switch in the AUTO position. If the plant stops, place the toggle switch to OFF, jumper the two outside terminals of the toggle switch, and place in AUTO position to restart. While the plant is running with a 100 watt minimum load, measure the voltage on the load sensor amplifier as follows:
      - AC output voltage of Transformer T_1, measured at terminals on load sensor amplifier should be 2 to 3 VAC.
      - Voltage from ground to the transistor side of Resistor A_1R_2 should measure 0.6 to 0.7 VDC.
      - Voltage across A_1CR_6 should read less than 5 VDC.
      - Voltage across Diode A_1CR_1 should read 5 to 14 VDC.
4. Plant won't stop with load removed.
   a. Move the toggle switch to the OFF position to stop the plant. If the plant does not stop, remove the battery lead and check for a faulty Start Solenoid. The contacts may have stuck closed.
   b. Remove the load from the load side of the contactor in the Control-O-Matic and reconnect battery.
   c. Put toggle switch in AUTO position.
      - If the plant does not crank, place the toggle switch in the RUN position to start the plant. Put the switch in AUTO position; the plant should stop. If the plant stops with the load lead removed from the load side of the contactor, it indicates that there was sufficient load on the AC line to keep the Control-O-Matic energized. Recheck the load circuit.
      - If the plant cranks with the toggle switch in the AUTO position and the load lead disconnected, the Start-Run relay or Load Amplifier are malfunctioning. Remove the ground lead from battery. Remove the Start-Run relay. Check continuity from Terminal 6 to 7 of Relay 307A62. This circuit should be open. Check continuity with 1-1/2 volts or less from tube socket Pin 8 to ground. The circuit should

show a high resistance (approximately 20,000 ohms), with positive on Pin 8 and will show a low resistance (approximately 20 ohms) with negative to Pin 8.

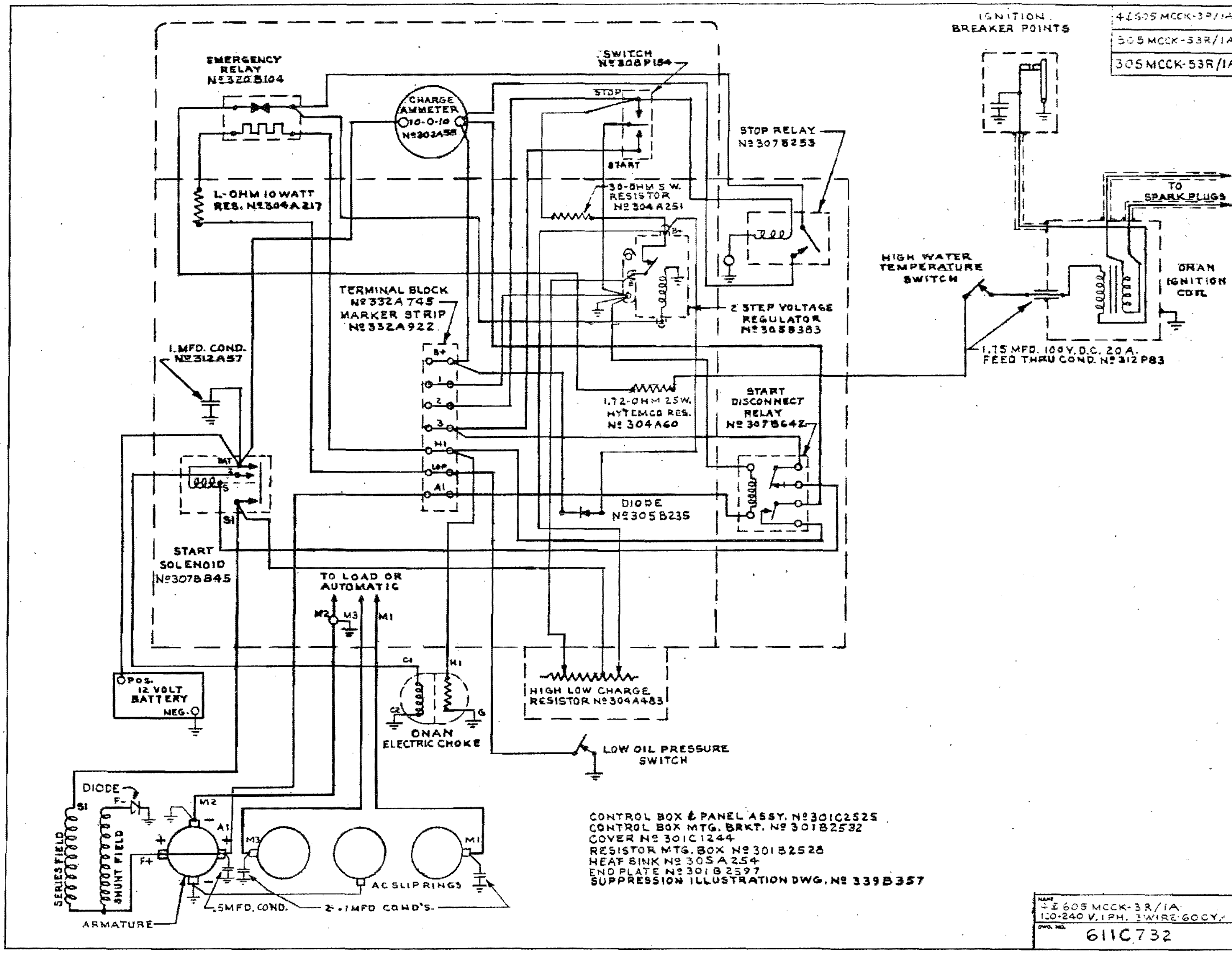
If this check indicates continuity in both directions, unsolder one end of Zener Diode A_1CR_6 and repeat same test. If resistance increases to the expected values, the zener diode has shorted. To verify this, check continuity in both directions on the zener diode itself.

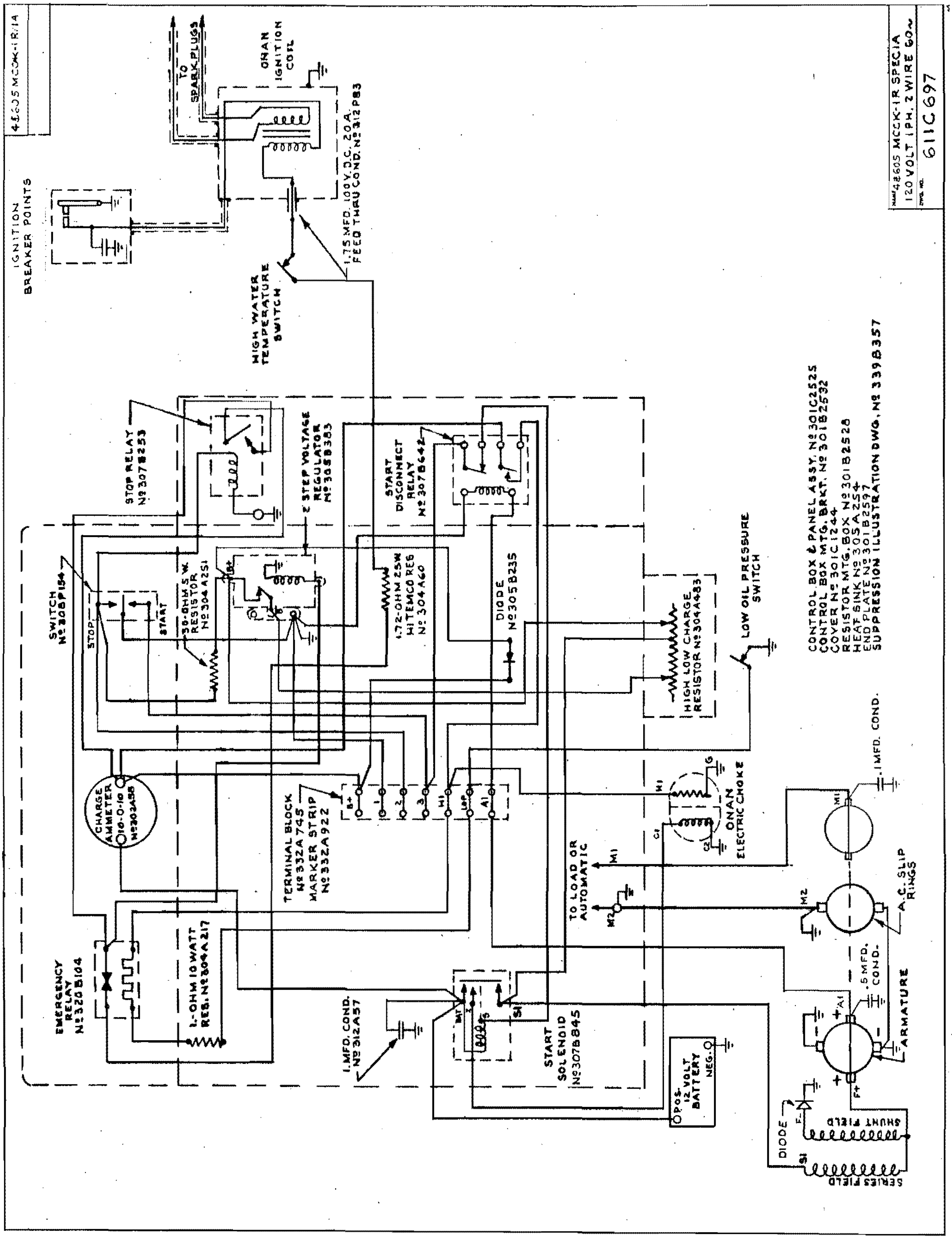
If resistance does not increase with the zener diode disconnected, check the transistor for a short from the collector to the emitter.

5. Bilge Blower Control circuit does not function at all.
   a. Check the 6-1/4 amp fuse A_2F_1.
6. Blower circuit is energized continuously and electric plant won't crank.
   a. Check heater element of thermal relay for an open circuit or a poor connection which may prevent relay from heating up enough to switch.
7. Blower circuit is not energized, but plant starts after a 2- to 6-minute delay.
   a. Check the blower operation by placing a jumper from Terminal BB to ground. Check the transistor Turn-On circuit. Measure the voltage across Terminals (1-2) of A_2K_1 to ground. This voltage should be 0.7V or less while the bilge blower is energized. Measure the voltage from Terminal 2 of A_2K_1 to ground. This voltage should be equal to the battery voltage. Check the voltage across Resistor A_2R_2. This voltage should be 0.7 to 1.5 volts. If these tests are satisfactory, the transistor if defective. Replace it.

WIRING DIAGRAMS

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


EMERGENCY RELAY Nº 320B104
CHARGE AMMETER 10-0-10 Nº 302A55
SWITCH Nº 308P154
STOP
START
STOP RELAY Nº 307B253
L-OHM 10 WATT RES. Nº 304A217
30-OHM 5 W. RESISTOR Nº 304A251
IGNITION BREAKER POINTS
TO SPARK PLUGS
ONAN IGNITION COIL
HIGH WATER TEMPERATURE SWITCH
1.75 MFD. 100V. D.C. 20A. FEED THRU COND. Nº 312P83
2 STEP VOLTAGE REGULATOR Nº 305B383
TERMINAL BLOCK Nº 332A745
MARKER STRIP Nº 332A922
1.MFD. COND. Nº 312A57
1.72-OHM 25W. HYTEMCO RES. Nº 304A60
START DISCONNECT RELAY Nº 307B642
DIODE Nº 305B235
START SOLENOID Nº 307B845
BAT
S
S1
TO LOAD OR AUTOMATIC
M1
M2
M3
POS. 12 VOLT BATTERY NEG.
ONAN ELECTRIC CHOKE
C1
C2
G
HIGH LOW CHARGE RESISTOR Nº 304A483
LOW OIL PRESSURE SWITCH
DIODE
F-
F+
A1
SERIES FIELD
SHUNT FIELD
ARMATURE
.5MFD. COND.
2-.1MFD. COND'S.
AC SLIP RINGS
CONTROL BOX & PANEL ASSY. Nº 301C2525
CONTROL BOX MTG. BRKT. Nº 301B2532
COVER Nº 301C1244
RESISTOR MTG. BOX Nº 301B2528
HEAT SINK Nº 305A254
END PLATE Nº 301B2597
SUPPRESSION ILLUSTRATION DWG. Nº 339B357
4E605 MCCK-3R/1A
305 MCCK-53R/1A
305 MCCK-53R/1A
4E605 MCCK-3R/1A
120-240 V. 1 PH. 3 WIRE 60 CY.
DWG. NO.
611C732


4B605 MCCK-1R/1A
IGNITION BREAKER POINTS
TO SPARK PLUGS
ONAN IGNITION COIL
1.75 MFD. 100V. D.C. 20A. FEED THRU COND. Nº 312P83
HIGH WATER TEMPERATURE SWITCH
STOP RELAY Nº 307B253
2 STEP VOLTAGE REGULATOR Nº 305B383
START DISCONNECT RELAY Nº 307B642
SWITCH Nº 308P154
STOP
START
30-OHM 5 W. RESISTOR Nº 304A251
1.72-OHM 25W HITEMCO REG Nº 304A60
DIODE Nº 305B235
HIGH LOW CHARGE RESISTOR Nº 304A483
LOW OIL PRESSURE SWITCH
CONTROL BOX & PANEL ASSY. Nº 301C2525
CONTROL BOX MTG. BRKT. Nº 301B2532
COVER Nº 301C1244
RESISTOR MTG. BOX Nº 301B2528
HEAT SINK Nº 305A254
END PLATE Nº 301B2597
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CHARGE AMMETER 10-0-10 Nº 203A58
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MARKER STRIP Nº 332A922
ONAN ELECTRIC CHOKE
.1 MFD. COND.
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1.-OHM 10 WATT RES. Nº 304A217
1. MFD. COND. Nº 312A57
START SOLENOID Nº 307B845
POS. 12 VOLT BATTERY NEG.
DIODE
SHUNT FIELD
SERIES FIELD
4B605 MCCK-1R SPECIA
120 VOLT 1PH. 2 WIRE 60~
611C697