HANDBOOK
OPERATION AND MAINTENANCE
INSTRUCTIONS

for

MODEL PFS 200 PNB

"NO BREAK"

ELECTRIC POWER SYSTEM

Manufactured by

TMC POWER DISTRIBUTION, INC.
ALEXANDRIA, VIRGINIA

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SECTION I

GENERAL DESCRIPTION

1-1 PURPOSE OF THE SYSTEM

The Model PFS 200 PNB "NO BREAK" Power System provides a continuous and precise electric power supply for priority equipment and systems. The power is continuous because, in the transition from normal to emergency operation, there is no break in the power output. The power is precise because the voltage and frequency are regulated within close limits.

The source of this power is the generator end of the system's motor-generator unit. In normal operation primary power to the motor end drives the unit. During emergency operation a diesel engine drives the unit. The term primary power, as used in this manual, means power intended for general use. Except for a few seconds when the system is being placed in operation, the primary power and equipment load are isolated from each other.

Ordinarily, fluctuations in a power line would affect the speed of the equipment operating on that line. If the equipment were a motor-generator unit, the generator output would fluctuate in relation to the line power. In a "No Break" Electric Power System, the momentum of an inertia flywheel eliminates speed variations caused by a fluctuating line power. By its momentum, the inertia flywheel ensures a smooth precise power supply for equipment and systems. It ensures this type of power in normal operation, during emergency operation, and during transition from one method of operation to another. An additional function of the inertia flywheel is to start the diesel engine if the primary automatic starting equipment should malfunction.

Under normal equipment-load fluctuations the voltage is maintained within plus or minus 0.5 percent. With a surge from no-load to full-load on the generator the voltage will dip no more than 7.5 percent. The voltage will recover to normal in 0.39 of a second. With a sudden decrease from full-load to no-load on the generator the voltage will rise no more than 9 percent. The voltage will recover to normal in 0.29 of a second.

Under normal equipment-load fluctuations the frequency is maintained within plus or minus 0.5 percent. With a full-load on the generator, the frequency will decrease no more than 0.6 of a cycle if the primary power fails suddenly and completely. With a full-load on the generator, the frequency will decrease no more than 0.2 of a cycle if the primary power fails gradually.

1-2 SYSTEM DESCRIPTION

For descriptive purposes the "No Break" Power System has been divided into the generator set and the control system.

a. Generator Set. - The generator set consists of four units of equipment and associated accessories. The equipment units are: a motor-generator, an inertia flywheel, a clutch, and a diesel engine. The units are mounted in-line on a sturdily-constructed steel frame. See figure 1-1.

(1) Motor-Generator. - The alternating current motor and generator that make up the motor-generator unit are brushless. By being brushless a source of radio frequency interference found in brush type motor-generators is eliminated.

The motor and generator are coupled together by a solid coupling flange on the motor shaft and a driving disc made of laminated steel plates on the generator shaft. The motor shaft is supported at both ends by ball bearings. The generator shaft is supported at one end by a ball bearing and at the other end by being coupled to the motor shaft.

The two principal components of the generator are the alternator and the exciter. See figure 1-2.

The alternator consists of a rotating field (rotor) and the stationary armature (stator). The rotating field consists of four coil and pole piece assemblies bolted to the shaft. These coils are connected in series and leads are brought out to probe plates. Rectifier assemblies convert the exciters ac output to dc, the rotating coils are then energized by this output. Embedded in the face of the pole pieces are cast aluminum or copper conductors which form damper windings. These damper windings help prevent hunting of the generators when operated in parallel. The armature consists of coil groups embedded in semi-enclosed slots of a laminated steel core. This stator and coil assembly is shrink-fitted and pegged to the main frame.

The exciter is constructed of a stack-up of slotted steel laminations mounted on a steel sleeve. This assembly, with conventional coil groups, slips onto the generator shaft. The resistor and rectifier plate assembly is secured to the armature sleeve. A locknut secures these assemblies on the generator shaft.

The generator is ventilated by the fan which is a part of the fan and driving assembly.

The motor is of the same basic design as the generator, modified to operate as a synchronous motor. It will perform satisfactorily on a voltage variation of plus or minus 10 percent, and a frequency variation of plus or minus 5 percent.

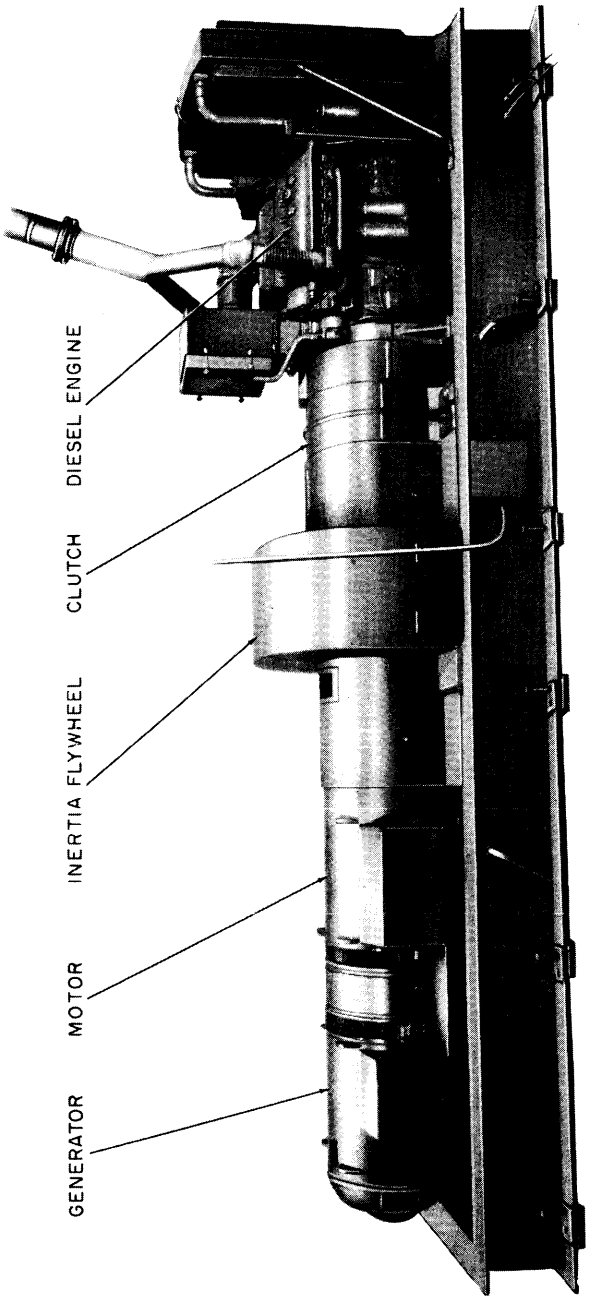
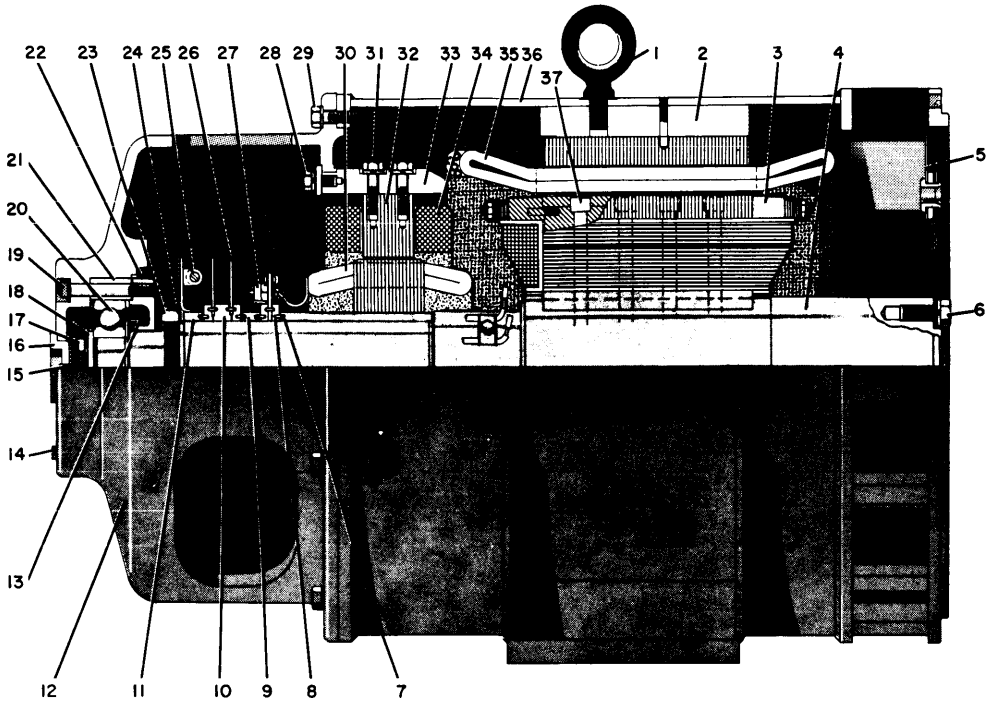


Figure 1-1. Model PFS 200 PNB "No Break" Electric Power System Generator Set



1. Eyebolt
2. Stationary Armature (Stator)
3. Rotating Coil
4. Rotating Field and Shaft Assembly (Rotor)
5. Fan and Driving Disc Assembly
6. Bolt-Fan and Disc Mounting
7. Pin-Plate Interlocking
8. Disc-Rectifier Plate Retaining (2 also used on probe plate)
9. Sleeve-Rectifier Plate and Probe Plate Spacing (Inner)
10. Spacer-Probe Plates Spacing
11. Sleeve-Resistor Plate and Probe Plate Spacing (Outer)
12. End Frame
13. Bearing Collar
14. Grease Plug-Lower
15. Grease Plug-Upper
16. Plug-End Frame Center
17. Bolt-Bearing Retaining
18. Washer-Bearing Retaining
19. Bolt-Bearing Cap Retaining
20. Ball Bearing
21. Bearing Sleeve
22. Bearing Cap
23. Locknut-Resistor Plate, Probe Plate, Rectifier Plate Retaining
24. Lockwasher-Plates Retaining
25. Resistor Plate Assembly
26. Probe Plate Assembly
27. Rectifier Plate Assembly
28. Bolt-Exciter Frame Mounting
29. Bolt-End Frame Mounting
30. Exciter Armature
31. Bolt-Shunt Coil Mounting
32. Pole Piece-Shunt Coil
33. Frame and Field Coil Assembly
34. Shunt Coil
35. Stator Coil
36. Frame, Stator and Coil Assembly
37. Bolt-Rotating Coil Mounting

Figure 1-2. Cutaway View of Generator

(2) Inertia Flywheel. - The forged-steel inertia flywheel is dynamically and electrostically balanced. Two oversized roller bearing pillow blocks provide support for the flywheel. See figure 1-3. The bearings are designed for 300, 000 hours of operation. A bearing sensing circuit provides early warning of any overheating of the bearings.

(3) Clutch. - A Liquid-Cooled Stationary Field Coupling is employed as a clutch between the diesel engine and the flywheel. The clutch utilizes the eddy-current principle to transmit rotary motion. The clutch consists of three assemblies: See figure 1-4.

(a) Field Assembly. - The field assembly is composed of a multilayered field coil and the two housings in which it is contained. This assembly together with two end-bells form the stator or housing of the unit. The stator encloses the drum and the rotor. The field housings are separated on the inner surface to form the north and south polar rings of the field assembly. Because the field coil is stationary, current may be conducted to the coil directly through the field coil leads. A commutator, slip rings, or brushes are not required.

(b) Drum Assembly. - The drum assembly is composed of a drum, drum shaft, and drum supports. This assembly revolves within the field assembly.

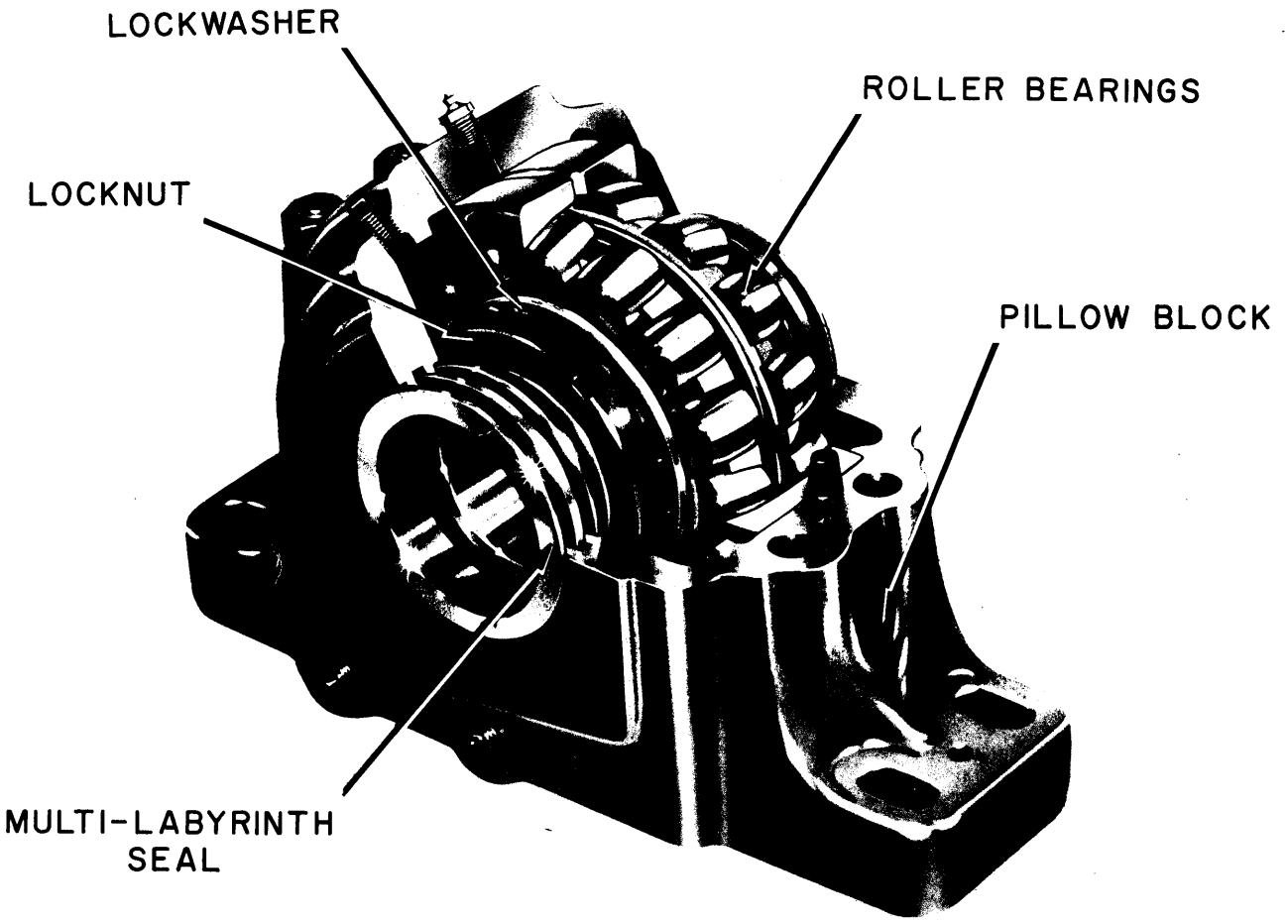


Figure 1-3. Roller Bearing Pillow Block, Cutaway View

The outer surface of the drum is separated from the polar rings of the field assembly by an air gap. A magnetic barrier divides the cylindrical portion of the drum into two sections. At the rotor end of the unit the drum assembly is supported by a ball bearing on the hub of the drum support. The other end of the assembly is supported by a ball bearing pressed onto the drum shaft. The drum assembly is driven by the prime mover and is the constant speed member of the clutch.

(c) Rotor Assembly. - The rotor assembly is composed of the rotor and the rotor shaft. It is enclosed by the drum assembly. At the drum end of the unit the rotor assembly is supported by a ball bearing pressed onto the rotor shaft. This bearing is housed in the drum support. The rotor shaft is supported at the other end by a ball bearing housed in the rotor end-bell. The outside diameter of the rotor consists of poles similiar in construction to the teeth of a spur gear. There is an air gap between the tips of the poles and the inner surface of the drum. The rotor assembly is the variable speed member of the clutch.

When the clutch is energized, torque is transmitted from the rotor to the drum. This torque is derived by a magnetic attraction between the eddy-current field in the drum and the poles of the rotor.

An air-cooled radiator and a water circulating pump are employed in the clutch cooling system.

(4) Diesel Engine. - The two-cycle diesel engine is equipped with the following accessories.

(a) Hydrostarter System. - The hydrostarter system is a complete hydraulic system for starting the diesel engine. See figure 1-5. The hydraulic fluid used in the system is 75 percent diesel fuel and 25 percent lubricating oil. An electric-driven charging pump takes a suction from the system reservoir and discharges to the accumulators. The charging pump is a single piston, positive displacement pump. The pump runs intermittently during engine operation maintaining a pressure of 2900 to 3000 PSI in the accumulators. When the accumulators are up to pressure, a pressure unloading valve by-passes the accumulators and the pump discharge is returned to the reservoir. The unloading valve is a part of the pump.

The piston-type accumulator is precharged with nitrogen. A seal ring between the piston and cylinder prevents the loss of gas into the hydraulic system. Opening of a control valve admits hydraulic fluid under pressure to the starter motor. As hydraulic fluid leaves the accumulator, the compressed nitrogen

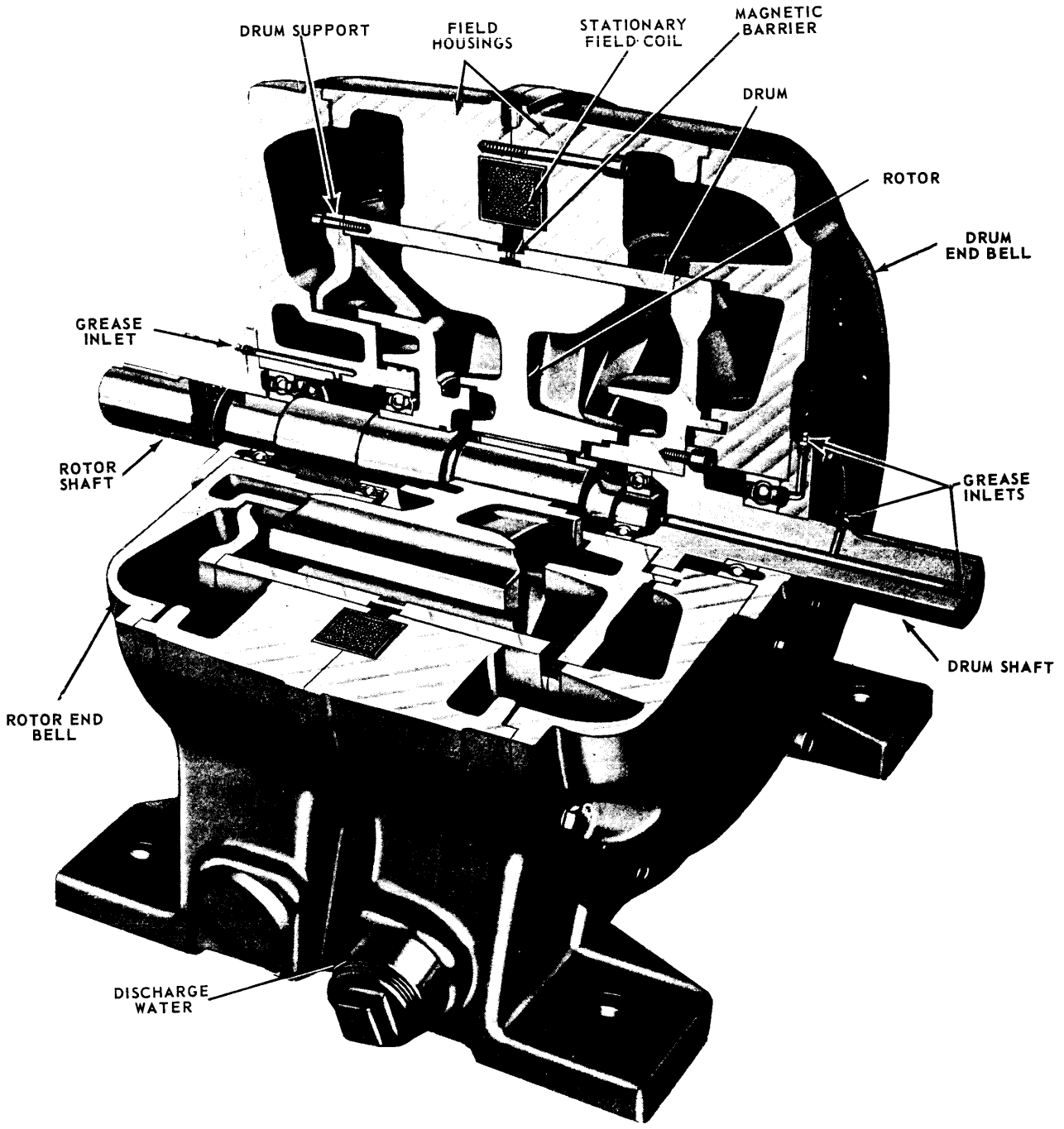


Figure 1-4. Cutaway View, Water Cooled Clutch

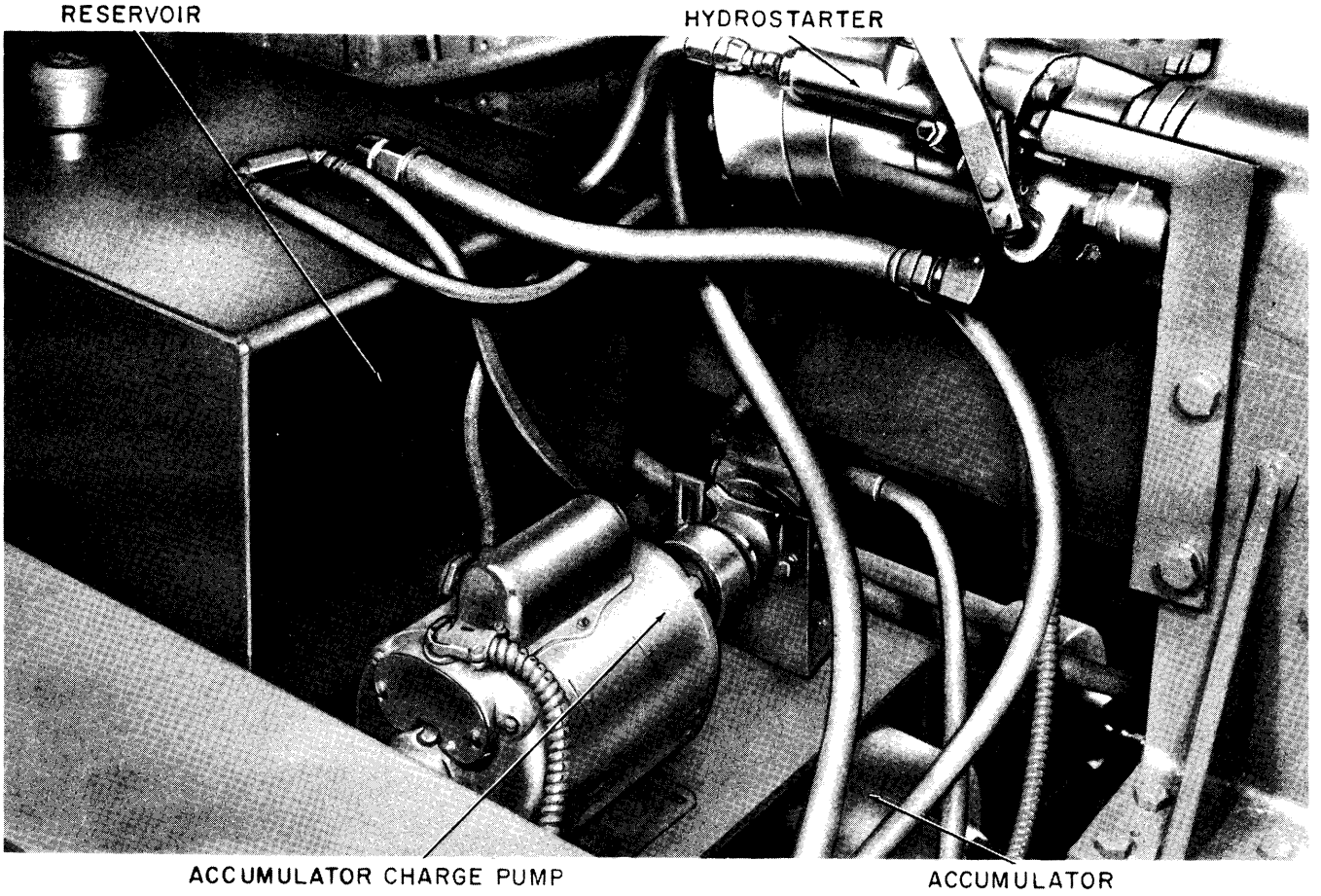


Figure 1-5. Hydrostarter System

moves the piston forcing more fluid out of the accumulator. By this action fluid to the starter motor is maintained at proper pressure. The accumulators are capable of starting the engine six times without recharging.

The starter motor is a multi-piston, swash plate motor. It is mounted on the flywheel housing. The starter motor has a pinion gear with an over-running clutch for engaging to the flywheel ring gear. Movement of the starter motor lever engages the pinion and opens the control valve in proper sequence. The starter motor rotates slowly until the pinion gear teeth and flywheel ring gear teeth are in position to mesh. The pinion gear then engages with the flywheel ring gear. When the engine has started, the hydraulic operated control valve closes and the pinion gear disengages.

(b) Governor. - The governor controls the speed of the engine. The governor is an electric governor with a flyweight head assembly. The flyweight head assembly is a mechanical backup if the governor should fail electrically. The governor consists of four assemblies: an electric control box, a resistor box, a speed adjusting potentiometer, and a hydraulic actuator. The hydraulic actuator is mounted on the engine. See figure 1-6. The other three assemblies are mounted in the control cabinet.

(c) Fuel System. - The fuel system includes: day tank, fuel transfer pump, fuel pump, fuel strainer, fuel filter, fuel lines, and fuel injectors.

The gear type fuel pump takes a suction from the day tank. The fuel strainer is located on the suction side and the fuel filter on the discharge side of the fuel pump. The fuel pump discharges through the fuel filter to the upper fuel manifold. From the upper manifold the fuel flows to the inlet side of the injectors. The fuel injectors meter, atomize, and inject the fuel into the cylinders. Surplus fuel from the outlet side of the injectors returns to the day tank by way of the return manifold. The fuel return piping is restricted to maintain fuel pressure at the inlet side of the injectors.

The 275 gallon day tank is replenished as required from the fuel oil storage tanks. The fuel transfer pump used for this purpose is a 60 gallon per hour, motor driven pump.

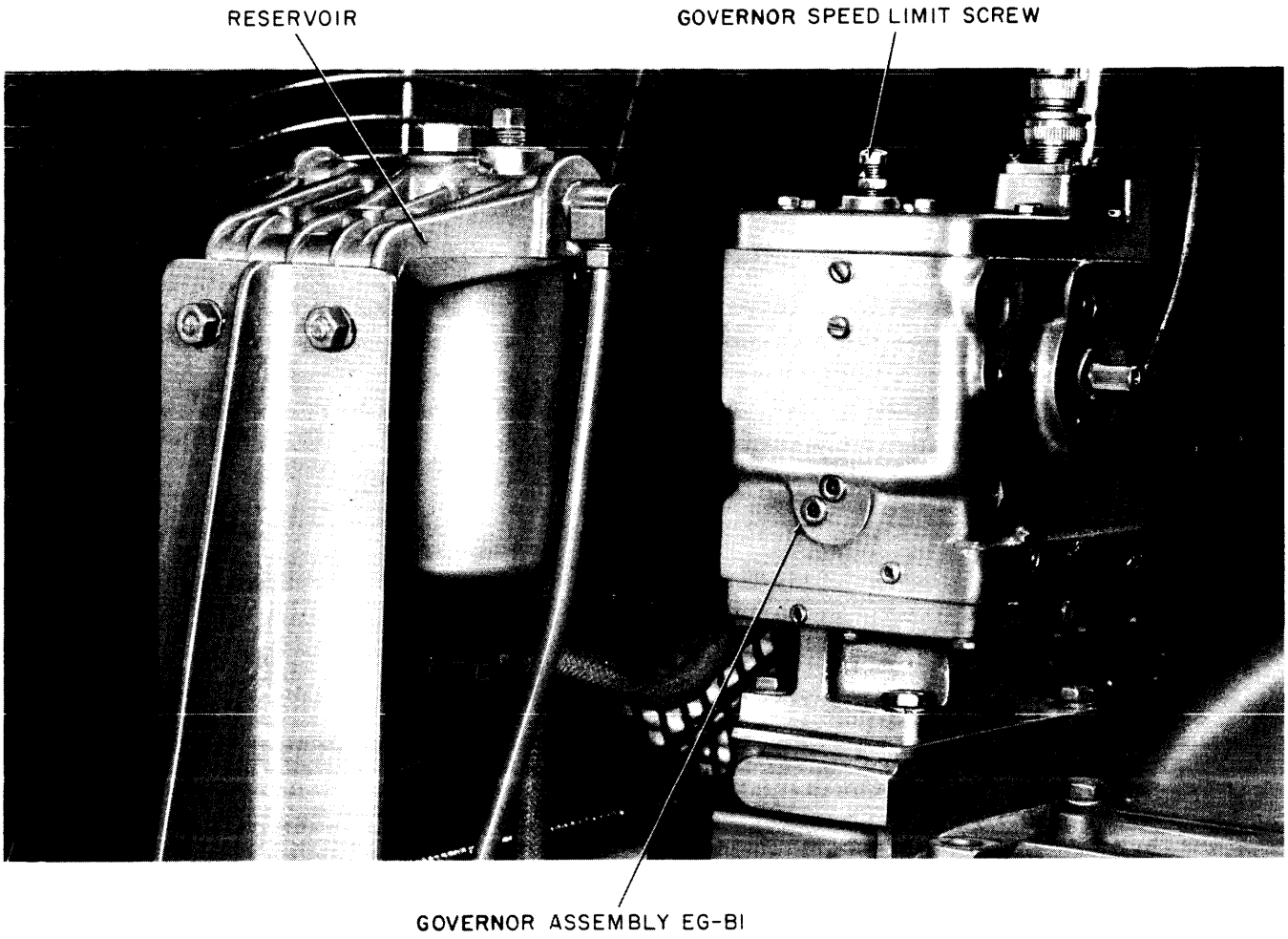


Figure 1-6. Engine Governor

(d) Lubrication System. - The oil pump is a gear type pump and is driven by the crankshaft. The oil scavenger pump takes a suction from the oil pan at the end opposite the oil pump suction and it returns this oil to the vicinity of the oil pump suction.

A pressure relief valve returns oil to the crankcase if the pump pressure rises too high. A regulator valve maintains the oil at a steady pressure at all speeds, regardless of oil temperature.

The oil pump discharge passes through two oil filters. It then flows through the oil cooler to the main oil gallery. From the main oil gallery the oil flows through drilled passages and grooves to the various engine parts.

The oil filters and coolers are equipped with by-pass valves. These spring-loaded valves ensure an oil supply to the engine should the filters or coolers become clogged.

(e) Cooling System. - The water pump takes a suction from the lower portion of an air-cooled radiator. The water pump discharge flows through the oil cooler into the cylinder block and through the cylinder heads. Upon starting a cold engine or when the cooling water is below operating temperature, the radiator is by-passed until the cooling water is up to operating temperature. A fan provides the cooling air for the radiator.

NOTE

Heaters are provided to keep the lubricating oil and cooling water heated during normal operation (diesel engine stopped).

(f) Exhaust Silencer. - An exhaust silencer is provided to quiet engine exhaust noise.

(g) Flexible Couplings. - The generator set units are aligned within 0.003". As an insurance factor, flexible couplings are also used. The flexible couplings are located between the generator and the flywheel, the flywheel and the clutch, the clutch and the diesel engine. See figure 1-7.

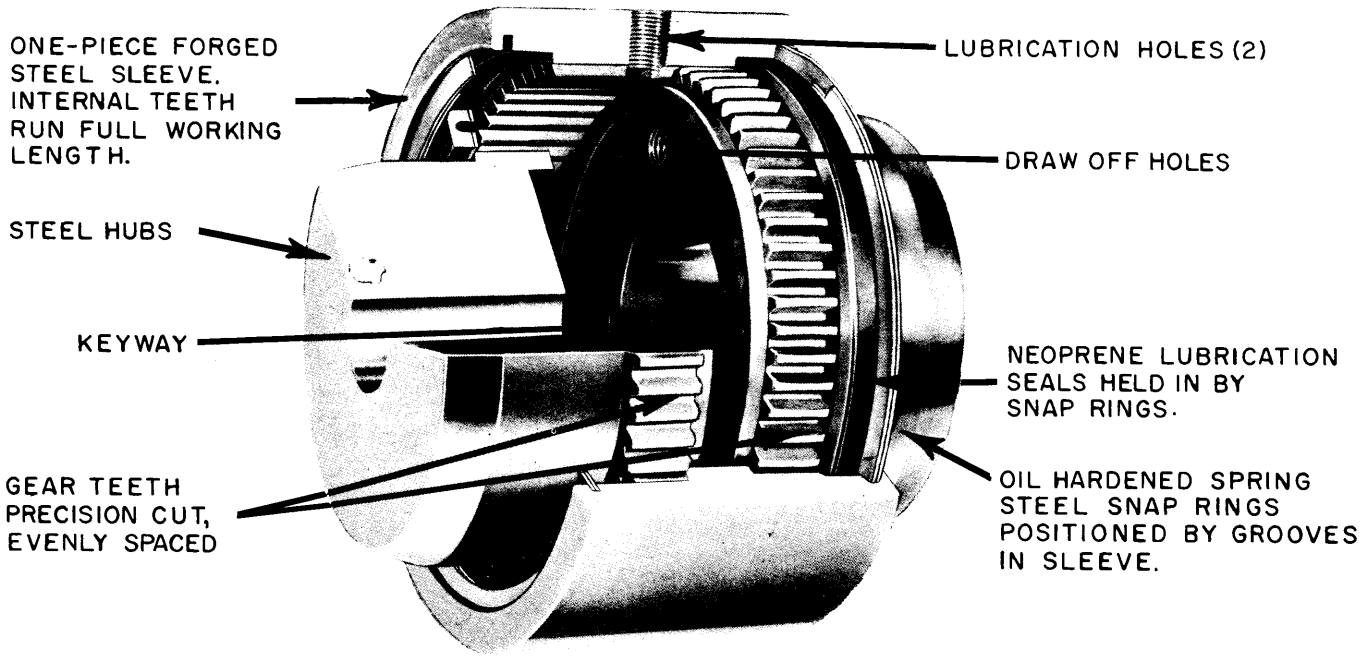


Figure 1-7. Flexible Gear Coupling, Cutaway View

b. Control System. - The control system consists of the control cabinet and the circuit breaker cabinet. The cabinets may be installed near the generator set or at a remote location - See figure 1-8.

(1) Control Cabinet. - The power systems control knobs, meters, and indicator lights are located on the front panel of the control cabinet. The interior of the cabinet contains; governor and clutch control equipment, voltage and frequency sensing devices, timing relays, synchronizers, bearing and water over-temperature relays. It is the equipment in this cabinet that regulates the generator set, providing a precise, no break electric power output.

(2) Circuit Breaker Cabinet. - The circuit breaker cabinet contains; a generator to load circuit breaker and a primary power to load circuit breaker. These circuit breakers are motor operated. It also contains a primary power to motor contactor with associated rectifier system.

c. Equipment Characteristics. - The equipment comprising the generator is listed in table 1-1, dimensions and weights are shown in table 1-2, motor-generator characteristics in table 1-3, and diesel engine characteristics in table 1-4.

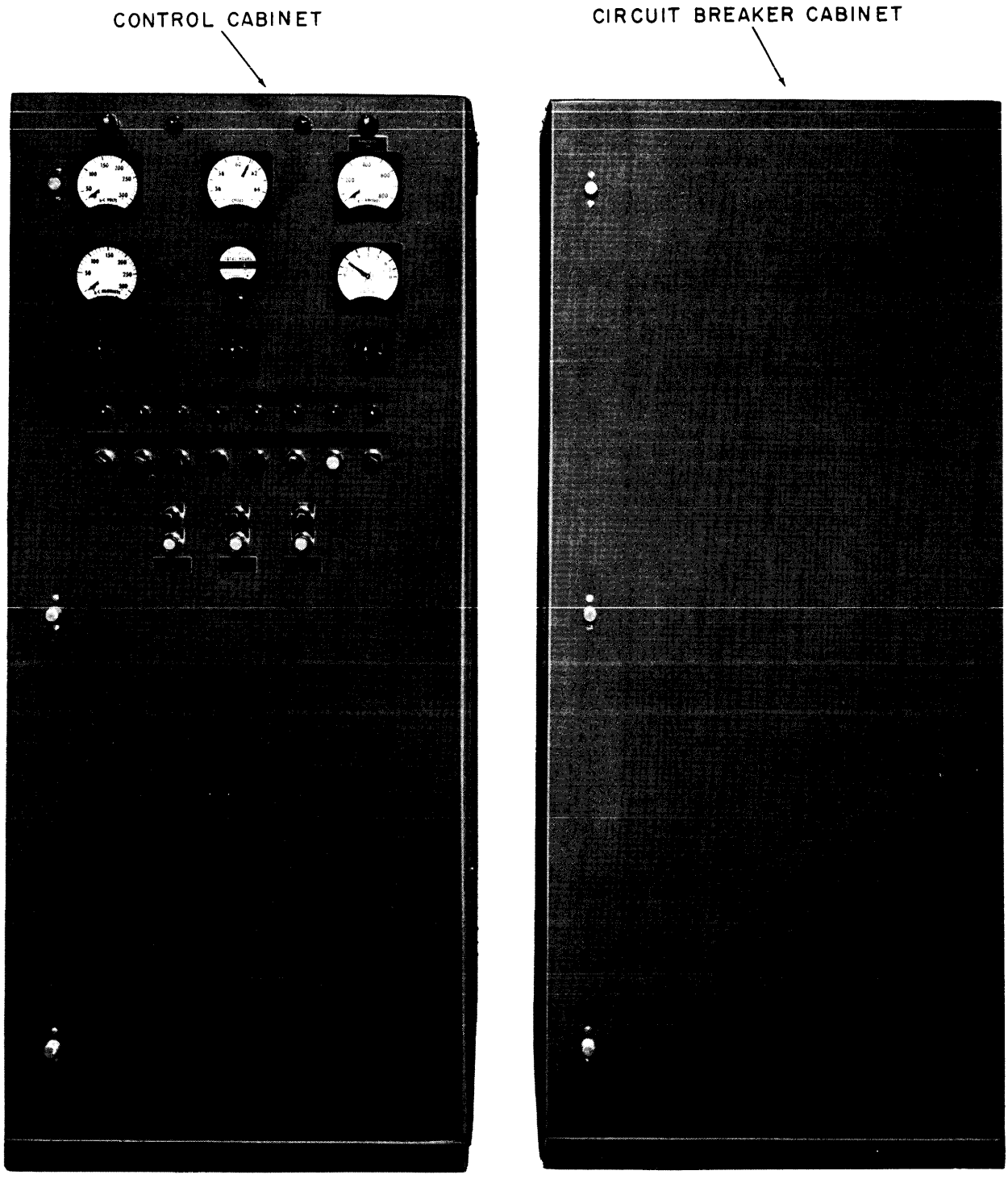


Figure 1-8. Control and Circuit Breaker Cabinets

TABLE 1-1. EQUIPMENT LIST

Equipment	Qty	Manufacturer	Model No.
Engine	1	General Motors	7123-7200-12V71
Clutch	1	Eaton	WCS-218
Flexible Gear Coupling	1	Sier-Bath	Special Size #3
Flexible Gear Coupling	2	Sier-Bath	Standard Size #4
Roller Bearing Pillow Block	2	Link-Belt	Series 7800
Inertia Flywheel	1	T. M. C.	
Synchronous Motor	1	Delco	TE-4864
Generator	1	Delco	TI-4821
Engine Governor	1	Woodward	EG-B1

TABLE 1-2. EQUIPMENT DIMENSIONS AND WEIGHT

Equipment	Dimensions (Inches)			
	Height	Width	Length	Weight (lbs)
Diesel Engine	65.375	48.375	68.75	5,100
Flexible Gear Coupling special size #3	6.625	6.625	2.75	45
Flexible Gear Coupling standard size #4	6.5	6.5	8.75	71
Roller Bearing Pillow Block	13.375	8.5	22	186
Inertia Flywheel	56.0 dia	24.0	56.0 dia	14,000
Motor	26.5	43.0	63.875	3,550
Generator	26.5	43.0	44.5	2,750
Clutch	33.5	32.5	34.0	2,750
Control Cabinet	70.0	28.0	28.0	500
Circuit Breaker Cabinet	70.0	28.0	28.0	600
Total Weight of Power System Complete with frame and associated accessories 38,500 lbs				

TABLE 1—3. MOTOR-GENERATOR CHARACTERISTICS

Unit	Characteristic
MOTOR-GENERATOR	
Voltage Input	208 Volts (198 Volts 50 cycle systems), 3 Phase, 60 Cycles
Voltage Output	208 Volts (198 Volts 50 cycle systems), 3 Phase, 60 Cycles
Voltage Regulation	Maintained within plus or minus 1/2 percent under steady load; 7.5 percent droop with rated output recovery in 0.39 second from no-load to full-load condition; 9 percent rise with 0.29-second recovery to rated output from full-load to no-load condition.
Frequency Regulation	50 or 60 cycles as applicable under steady state conditions, 0.6-cycle droop for complete incoming power failure and 0.2-cycle droop for gradual incoming power failure under rated load conditions.
SYNCHRONOUS MOTOR	208 Volts (198 Volts 50 cycle systems), 3 Phase, 60 Cycles
GENERATOR	250 KVA, 3 Phase, 50 or 60 Cycles, as applicable. 200 KW at 0.8 power factor.

TABLE 1—4. DIESEL ENGINE CHARACTERISTICS

Unit	Characteristics
Model Number	7123-7200-12V71
Number of Cylinders	12
Bore	4.25 Inches
Stroke	5 Inches
Compression Ratio (Nominal)	17 to 1
Total Displacement	851.2 Cubic Inches
Firing Order	1L-5L-3R-4R-3L-4L-2R 6R-2L-6L-1R-5R
Number of Main Bearings	Seven

SECTION 2

INITIAL PREPARATION FOR USE

2-1 SITE SELECTION

The power system should be installed in a location well protected from exposure to the weather, corrosive fumes, dust, and extreme high or low temperatures. Necessary heat dissipation when the motor is driving the generator is 91,000 BTU's. With the diesel engine in operation 171,000 BTU's must be dissipated. An opening capable of passing 3600 cubic feet of cooling air per minute is required during engine operation. Adequate ventilation facilities are also necessary.

2-2 UNCRATING AND HANDLING

a. Generator Set. - The generator set is shipped uncrated. Four eye pads are welded to the generator set frame for hoisting and handling. A 20-ton hoist is required to lift and maneuver the power system.
b. Control and Circuit Breaker Cabinets. - When handling, transporting, or uncrating the control and circuit breaker cabinets; make certain that the correct ends are up.

CAUTION

Use extreme care when handling the control and circuit breaker cabinets. Carelessness may result in extensive damage to the equipment in the cabinets.

Use nail pullers to remove the crating. When the crating has been removed, inspect both cabinets carefully for damage which may have occurred during transit.

2-3 FOUNDATION REQUIREMENTS

It is recommended that the generator set be installed on a steel-reinforced concrete slab. The concrete slab should be a minimum of 24 feet in length by 6.5 feet in width and be capable of supporting 20 tons. Housing dimensions for two power systems should be 36 feet in length by 24 feet in width by 10 feet in height.

2-4 INSTALLATION OF GENERATOR SET AND CABINETS

Install the generator set using the following procedures.
a. Using a 20-ton hoist and cable slings, or other suitable means, position the generator set on the concrete slab.
b. Level the generator set using the leveling bolts located at 12 points on either side of the generator set frame. See figure 2-1.
c. After leveling, reinforce the generator set frame with non-shrinking grout to prevent binding of the leveling bolts when the anchor bolts are tightened down. Drainage holes should be made in the grout to prevent accumulation of oil or water within the generator set frame.
d. After the grout becomes firm, secure the generator set frame to the concrete slab, using twelve 7/8 - inch anchor bolts.
e. The control and circuit breaker cabinets are provided with four 1/2 - inch holes in the bases for securing them.

2-5 CABLE ROUTING

Cabling between units should be well protected from possible damage. Insofar as practicable, the cabling should be routed through conduit or ducts, or supported overhead on hangers. The primary power cable must be a four-wire service, 1000 MCM minimum, capable of supplying 300 KVA to the power system. See figure 2-2 for cable entrance points to the cabinets.

2-6 FUEL SUPPLY

Fuel storage tanks and associated piping must be provided by the installing activity. The day tank and fuel transfer pump are provided by the manufacturer. The inlet and return fuel line connections are located in the side of the generator set frame near the diesel engine, and are identified by labels.

A recommended fuel system is illustrated in figure 2-3. The control box in this system is a float-operated electric limit switch. When fuel in the day tank drops to a predetermined level the switch operates the transfer pump, which in turn, replenishes the day tank. It is recommended that the plug in the bottom of the day tank be replaced with a valve and plug to facilitate draining water that accumulated from condensation.

2-7 ENGINE EXHAUST SYSTEM

The manufacturer provides the engine exhaust silencer and the piping between the silencer and the engine exhaust manifolds. See figures 2-4 and 2-5.

2-8 PREPARING THE POWER SYSTEM FOR USE

Before placing the generator in operation the following should be accomplished.
a. Remove the flywheel cover. Remove the four flywheel securing plates and bolts. See figure 2-6.
b. Fill the flywheel pillow block bearings to the mark on the sight glass, with SAE 60 lubricating oil.
c. Fill the motor and generator bearings to the mark on the sight glass, with SAE 30 heavy duty, mineral lubricating oil. See figure 2-7.
d. Fill the diesel engine radiator and the clutch reservoir with water.

e. Fill the diesel engine crankcase to operating level with SAE 30 heavy duty, additive lubricating oil.
f. Fill the hydrostarter system with hydraulic fluid. The hydraulic fluid should by 75 percent diesel fuel and 25 percent SAE 30 lubricating oil.
g. Align the flexible couplings between the motor and flywheel, flywheel and clutch, clutch and diesel engine. Spacing between coupling halves must be between 0.250 and 0.350 of an inch. Radial alignment of the coupling halves must be within 0.003 of an inch. Ensure that the couplings are lubricated. Use grease conforming to MIL-G-3278.
h. Make a thorough inspection of the generator set, and the control and circuit breaker cabinets; to ensure all units are ready for operation.

2-9 TEST PROCEDURES

When placing a power system in operation for the first time, and periodically or as operating conditions and performance indicate the need thereafter; perform the following tests.
a. With Power Off System
(1) Governor Circuit. - Disconnect leads 17 and 18 on the governor control box located in the control cabinet. At the engine, remove the connector plug from the engine governor. Connect an ohmmeter or continuity light across the governor leads in the control cabinet and short out the connector plug pins to test the circuit.

CAUTION

Do not leave the governor circuit disconnected. With the circuit disconnected the control box will build up voltage and burn out. This circuit can be very easily damaged if connected to the wrong voltage.

(2) Generator and Primary Power Continuity Test. - Test continuity between all phases of the generator and load, and primary power and load. The test can be made at the circuit breakers, using an ohmmeter. The minimum reading should be between 200 and 250 Ohms.
b. With Power on System. With power on the system (primary to load circuit breaker closed) perform the tests in accordance with the following procedure.

STEP NO. 1. - Disconnect the two wires from terminal No. 22 of the engine terminal board (ETB) located in the junction box attached to the side of the generator set frame. These wires are to the engine start valve and the fail start lamp.

STEP NO. 2. - Disconnect the wire at terminal No. 13 of the main terminal board located in the control cabinet. This wire is to the motor contactor relay MCR-1.

STEP NO. 3. - Interconnect terminals Nos. 8, 12, and 21 of the engine terminal board (ETB); using jumper wires. This will simulate an engine running condition.

STEP NO. 4. - Turn the circuit breaker switch to the manual position. Close the primary to load circuit breaker. This should start the hydrostarter charging pump.

STEP NO. 5. - Turn the control switch to the test position. Timer TM-1 should energize, time through its cycle and remain energized. Contacts 1-C of timer TM-1 should apply voltage to terminal No. 12 of the engine terminal board (ETB), energizing the clutch pump and starter circuit. Contacts 2-C should energize MCR-2. Under operating conditions relay MCR-2 initiates opening of the motor contactor.

STEP NO. 6. - Turn the clutch switch to the manual position. The Clutch Relay and Relay #1 MAN. should energize applying reduced voltage to the clutch. Turn the clutch switch to the automatic position, Relay #2 AUTO. should energize applying 220VDC to 230VDC to the clutch.

NOTE

Voltage readings may be obtained at terminals Nos. 6 and 7 of the engine terminal board (ETM).

STEP NO. 7. - Turn the control switch to the automatic position. Timer TM-1 should deenergize and Timer TM-2 should energize. Contacts 1-C of timer TM-2 should energize relay MCR-1. Under operating conditions relay MCR-2 initiates opening of the motor contactor. Contacts 2-C of timer TM-2 should open sealing-relay Aux.-4 and the starter circuit. The engine start circuit and clutch circuits are now deenergized.

STEP NO. 8. - Test engine malfunction switches by jumpering the contacts, and observing the closing of the associated relays and the air box damper.

STEP NO. 9. - If the foregoing tests are satisfactory, turn all switches to the off position. Remove all jumper leads and reconnect those leads which were disconnected for the tests.

STEP NO. 10. - Open the primary to load circuit breaker.

STEP NO. 11. - Start the engine manually, check the operation of the low oil pressure switch and the idle speed governor (ISG).

STEP NO. 12. - Unlock the governor speed limiting screw and increase engine speed to test the overspeed governor (OSG). The overspeed governor should shut down the engine at 2100 RPM. Reset governor and restart the engine manually.

STEP NO. 13. - Bring generator set up to operating speed and voltage. Using a phase rotation meter ascertain that the generator and motor are in phase with primary power. The motor can be excited by applying primary voltage to terminal No. 12 of the main terminal board (MTB) in the control cabinet.

If all tests are satisfactory, the power system should be tested in accordance with the starting procedures in Section 3 of this manual, using a dummy load.

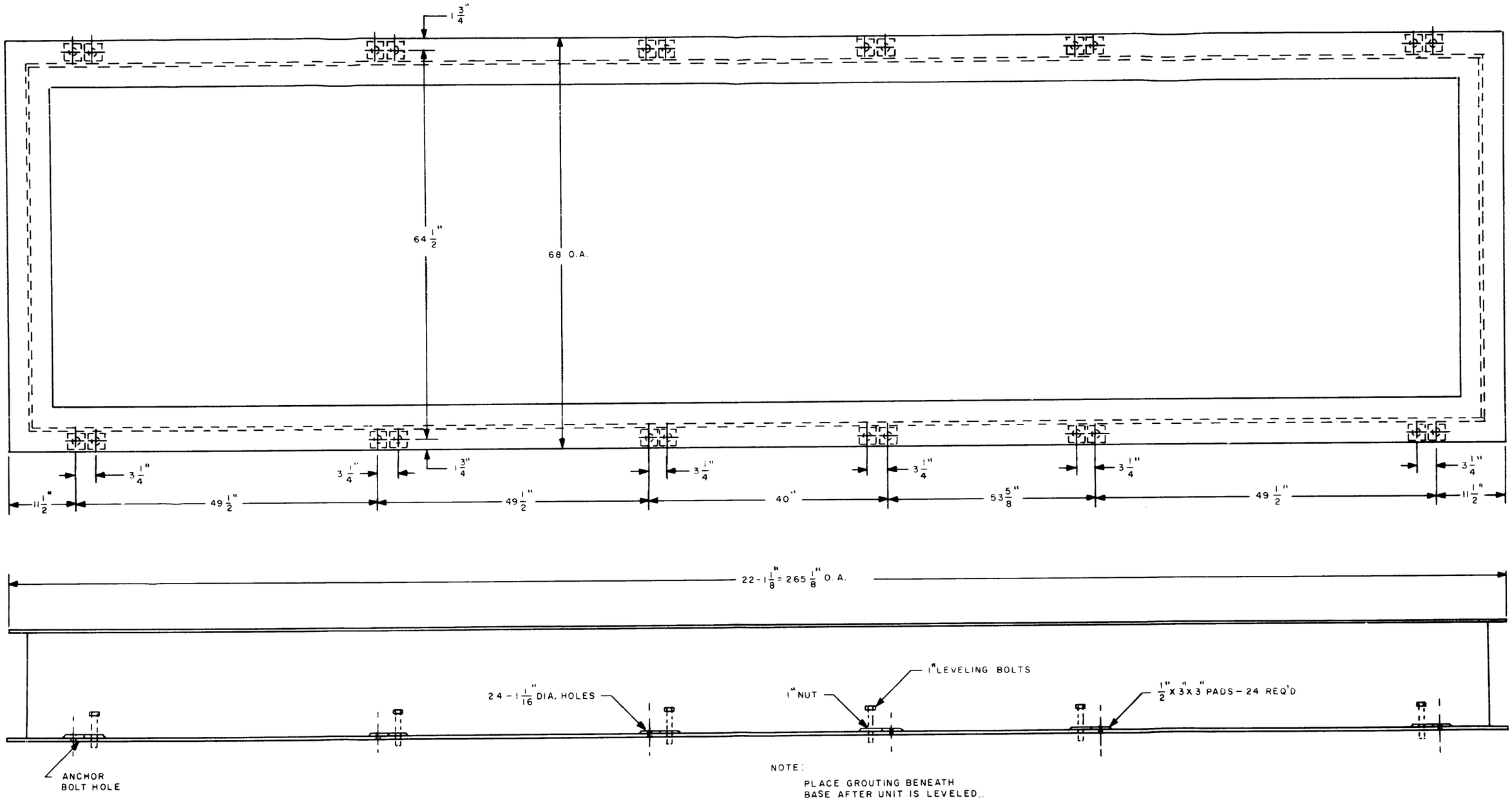


Figure 2-1. Generator Set Mounting Base, Showing Detailed Dimensions

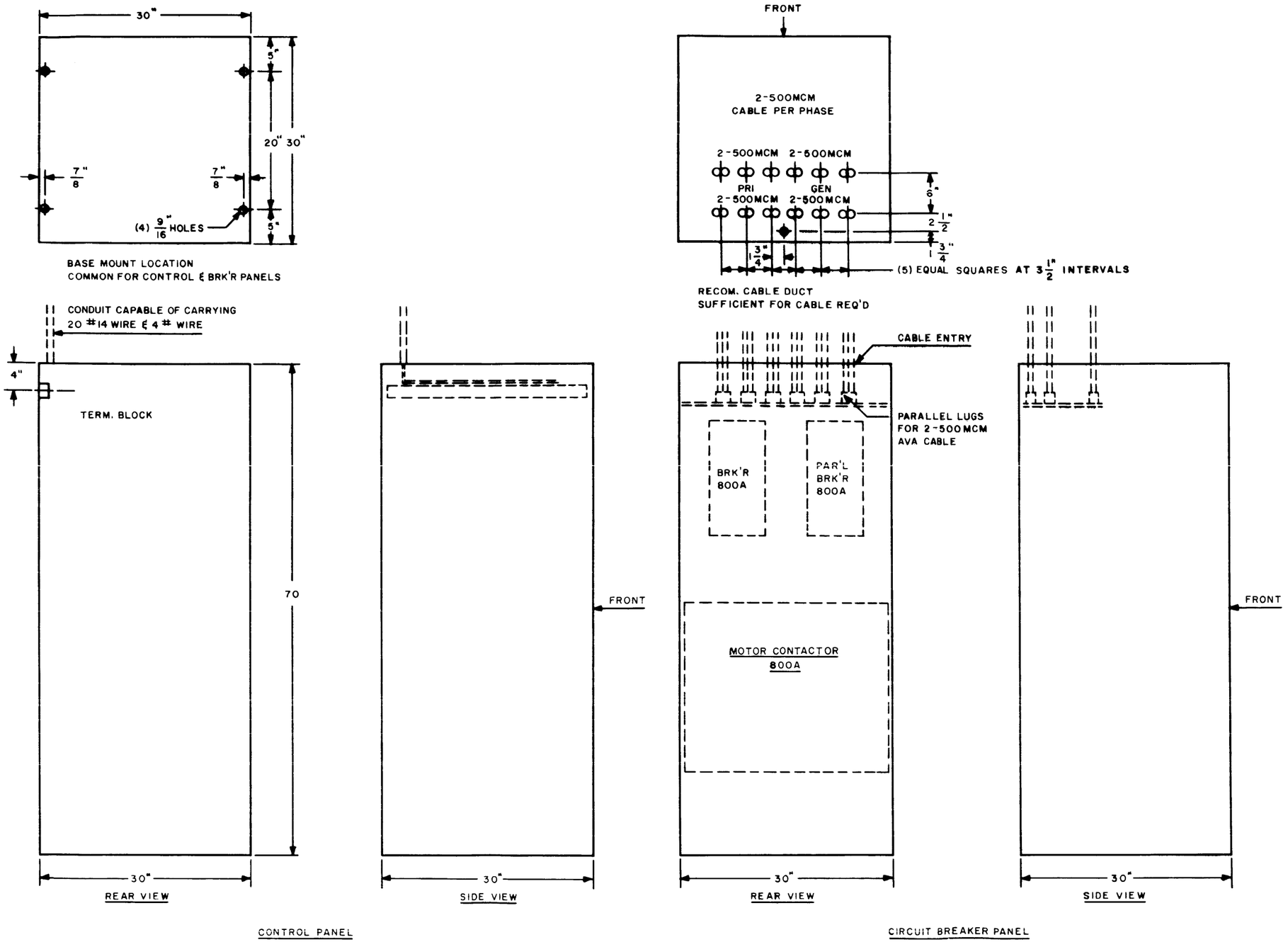


Figure 2-2. Control Cabinet and Circuit Breaker Cabinet, Cable Installation

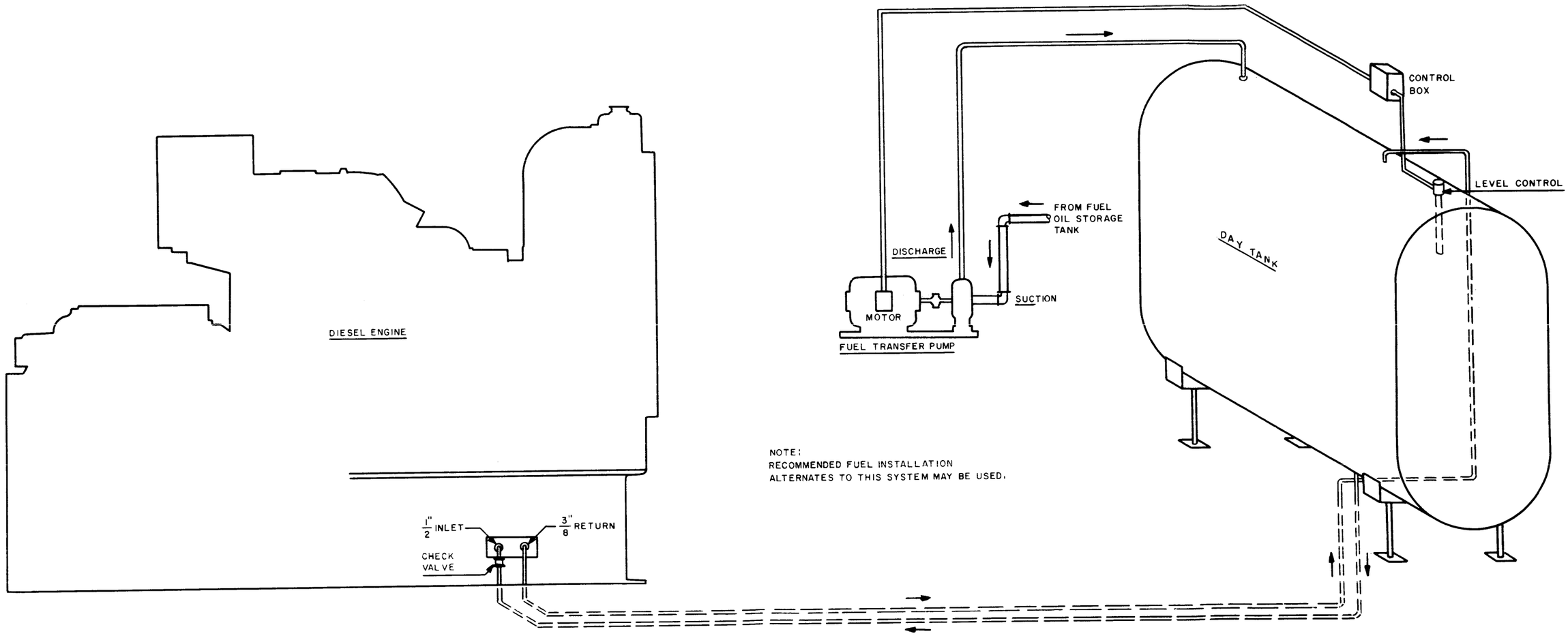


Figure 2-3. Diesel Engine Remote Fuel Supply

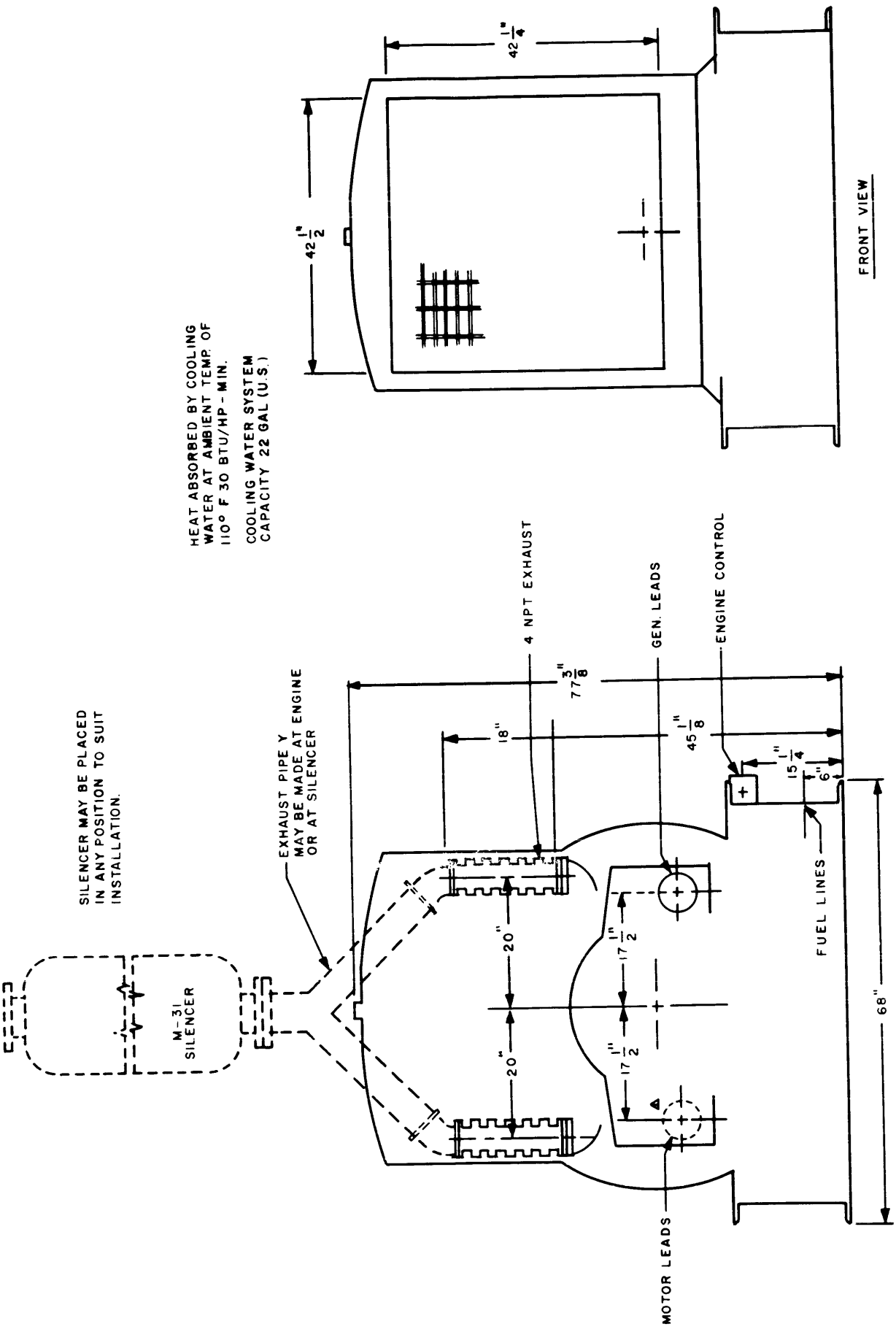


Figure 2-4. Power System, Front and Rear Views

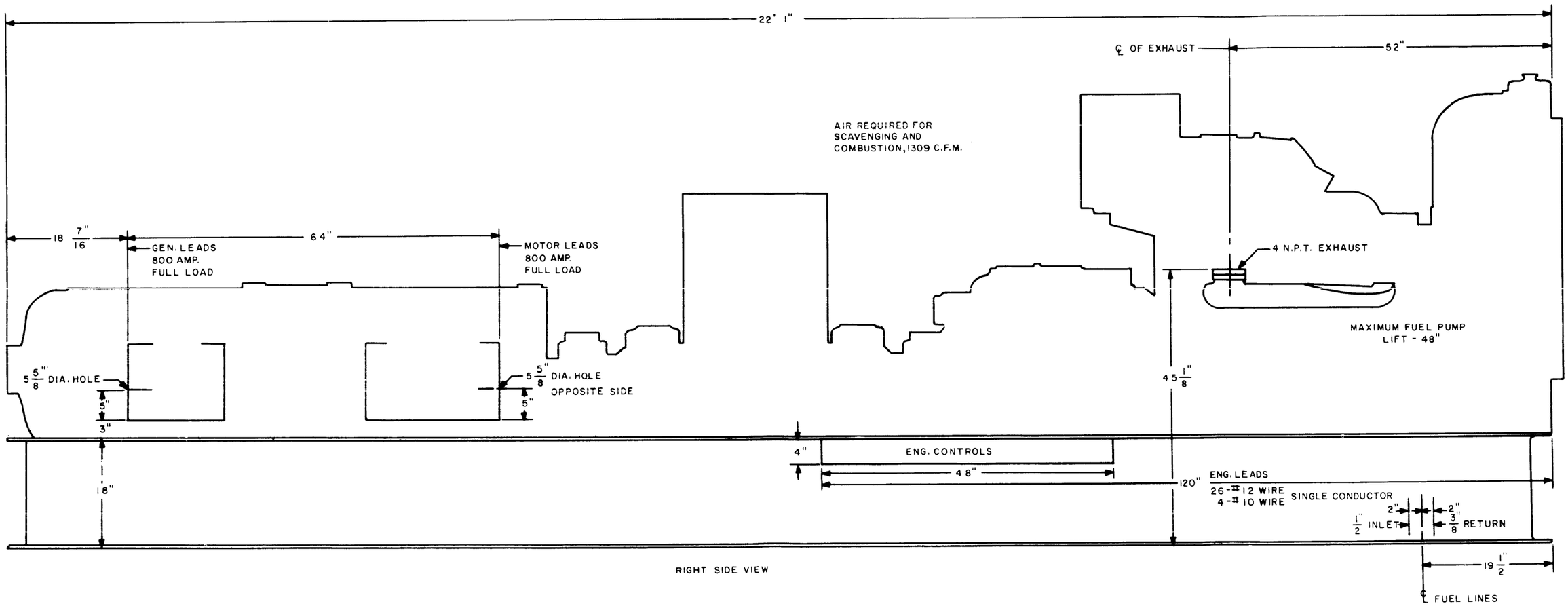


Figure 2-5. Generator Set, Right Side View

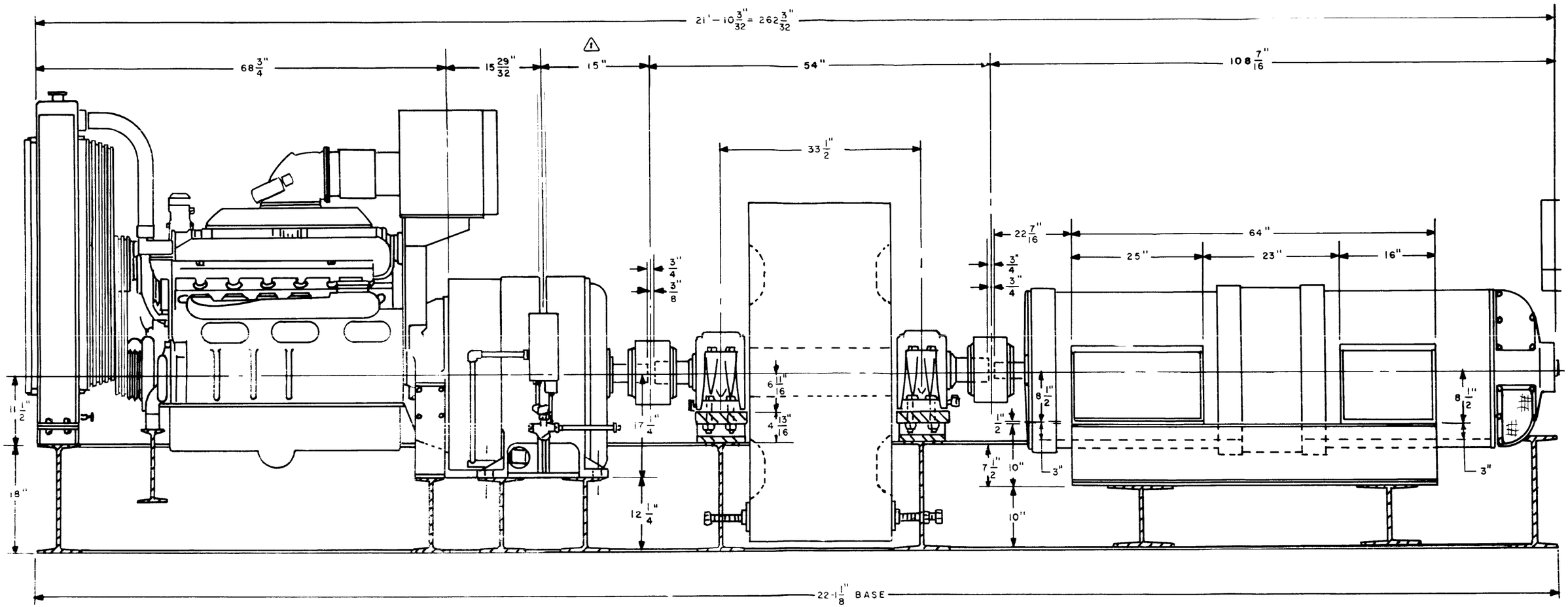
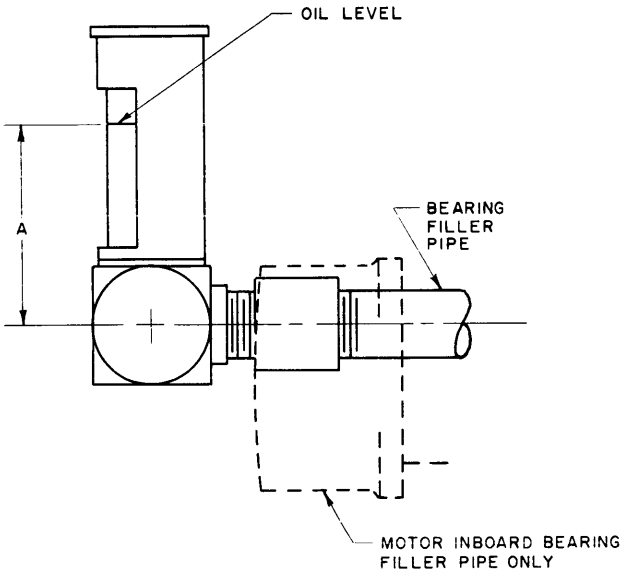


Figure 2-6. Generator Set, Left Side View

GENERATOR, MOTOR, AND FLYWHEEL BEARING OIL LEVELS



The lubricating oil level (dimension A) for generator and motor bearings is 1 3/8 inches.

The lubricating oil level (dimension A) for flywheel pillow block bearings is 13/16 inch.

Lubricating oil for generator and motor bearings: SAE 30 mineral oil.

Lubricating oil for flywheel pillow block bearings: SAE 60 mineral oil, non-detergent, conforming to MIL-15016A amendment 2, symbol 3120. Available in five gallon cans under Federal stock Number 9150-242-3188.

Figure 2-7. Generator, Motor, and Flywheel Bearing Oil Levels

SECTION 3

OPERATING INSTRUCTIONS

3-1 STARTING AND SECURING PROCEDURES

a. Pre-Starting Checks. - When placing a power system in operation that has been idle for several days or longer the following pre-start checks should be made.

(1) Motor-Generator

(a) Check the bearing oil level in the sight glasses. The oil level should be at the mark on the sight glass. If the oil level is below the mark add SAE 30 heavy duty additive lubricating oil. There are three bearings to check, one on the generator end and two on the motor end. See figure 2-7.

(b) Ensure that the unit and surrounding area are free of dirt and foreign matter which may be drawn into the unit by the ventilating fans.

(c) Check all covers and screens, make certain they are secure.

(2) Flywheel

(a) Check the bearing oil level in the sight glasses. The oil level should be at the mark on the sight glass. If the oil level is low add SAE 60 non-detergent mineral oil (FSN 9150-243-3188). There are two flywheel bearings to be checked.

(b) Ensure that the flywheel cover is secure.

(3) Clutch

(a) Check the water level in the reservoir of the cooling system.

(b) The cooling water pressure should be maintained at 7.5 PSI nominal. The temperature should be maintained between 162 degrees F and 168 F.

(4) Diesel Engine

(a) Check the crankcase oil level using the dip stick. If the oil level is low add SAE 30 lubricating oil.

(b) Check water level in cooling system radiator. Add water as necessary.

(c) Check hydraulic fluid reservoir level. If necessary add hydraulic fluid (75 percent diesel fuel, 25 percent SAE 30 lubricating oil). The proper level is two inches from the bottom of the reservoir.

(d) Check air-box damper.

(5) Cabinets

(a) Inspect the interior of the control and circuit breaker cabinets. Ensure that the cabinets are clean and that tools or materials have not been left in the cabinets.

NOTE

In removing dust and dirt from the cabinets, vacuum cleaning is preferable to blowing out with compressed air.

(b) Inspect for loose connections, loose nuts and bolts, and any other conditions which must be corrected before the power system is placed in operation.

b. Starting. - The power system is started by the following procedure.

STEP NO. 1. - Check the circuit breaker cabinet to ensure that the generator to load circuit breaker is open.

STEP NO. 2. - Turn the voltmeter, power factor meter, and ammeter switches to No. 1 position. See figure 3-1.

STEP NO. 3. - Turn all other switches to the off position.

STEP NO. 4. - Unlock the governor speed limiting screw and unscrew it approximately five turns. See figure 1-6. This will limit the speed of the diesel engine when started, to a speed of 600 to 1200 RPM (800 RPM for 50 cycle system).

STEP NO. 5. - Turn the CONTROL SWITCH to TEST. In ten seconds the starter circuit will be energized starting the diesel engine. When the water temperature is above 140° F, increase the engine speed to 1500 RPM (1200 RPM for 50 cycle system) by screwing down on the governor speed limiting screw. Engine speed and cooling water temperature may be noted at the instrument panel on the side of the engine.

NOTE

If for any reason the engine must be secured at this point (before the generator is putting out voltage), it will be necessary to turn the CONTROL SWITCH to the OFF position and stop the engine manually.

STEP NO. 6. - Turn the CLUTCH SWITCH to MAN. The speed of the engine will be decreased when the clutch is first energized and a minute later when full voltage is applied to the clutch automatically.

STEP NO. 7. - Turn the CLUTCH SWITCH to AUTO.

NOTE

While performing STEPS NO. 6 and NO. 7, the engine speed should not be permitted to drop below 600 RPM. If the engine speed does drop below 600 RPM, turn the CONTROL SWITCH to OFF to prevent engaging of the engine starter.

STEP NO. 8. - Increase engine speed from 1500 RPM (1200 RPM for 50 cycle system) to approximately 1850 RPM (or such speed as will give a generator output of 50 or 60 cycles as applicable) by screwing down on the governor speed limiting screw. Lock the governor speed limiting screw at this setting.

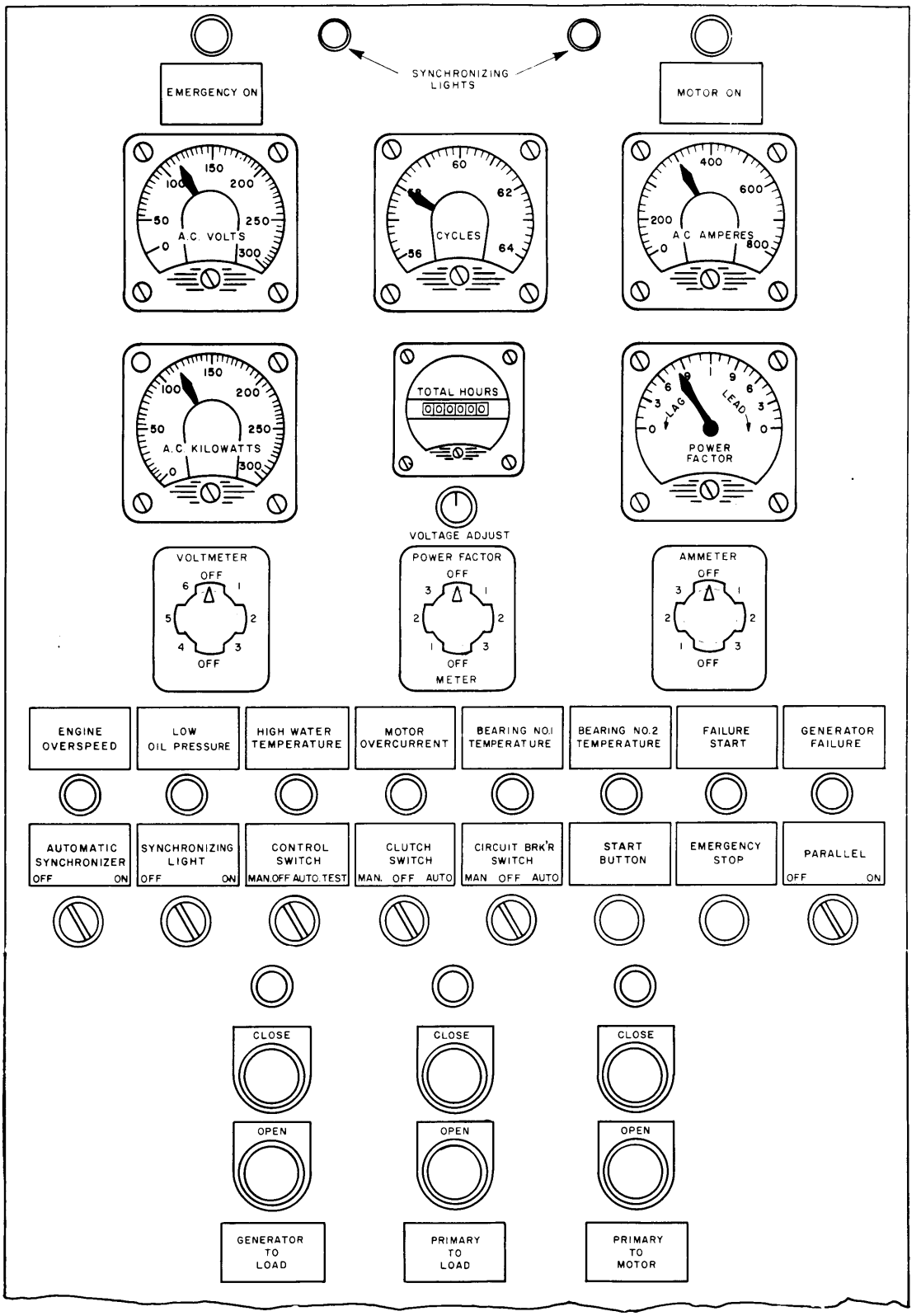


Figure 3-1. Control Panel

STEP NO. 9. - With the generator output at 60 cycles (or 50 cycles), turn the SYNCHRONIZING LIGHT switch to ON. The lights should come on and go off, slowly and together; if not, adjust the governor speed rheostat. The governor speed rheostat is located in the control cabinet, on the top shelf at the extreme right.

STEP NO. 10. - With the CIRCUIT BRK'R SWITCH in MAN., push the CLOSE button of the GENERATOR TO LOAD circuit breaker when the synchronizing lights are completely out.

OR

With the CIRCUIT BRK'R SWITCH in the AUTO. position, turn the AUTOMATIC SYNCHRONIZER switch to ON. When the lights go out, the GENERATOR TO LOAD circuit will close and the PRIMARY TO LOAD circuit breaker will open, paralleling the generator and the primary voltage for a period of approximately 1/3 of a second.

NOTE

When paralleling generator with primary power, or primary power with generator; be sure the close button of the circuit breaker being closed is held in for at least one second, so that voltage is available to open the other circuit breaker.

STEP NO. 11. - Turn the CIRCUIT BRK'R SWITCH to AUTO.

STEP NO. 12. - Turn the CONTROL SWITCH to AUTO.

NOTE

With the completion of STEP NO. 12, the motor contactor will close automatically after a preset time interval. The yellow MOTOR ON light illuminates when the motor contactor closes. The red EMERGENCY ON light illuminates when the diesel is engine driving the motor-generator.

c. Securing. - The power system is secured by the following procedure.

STEP NO. 1. - Turn the CONTROL SWITCH to TEST.

STEP NO. 2. - Turn SYNCHRONIZING LIGHT to ON.

STEP NO. 3. - Adjust the governor speed control rheostat, if necessary, to maintain a slow coming on and going off of the synchronizing lights.

STEP NO. 4. - Turn the CIRCUIT BRK'R SWITCH to MAN.

STEP NO. 5. - When the synchronizing lights are completely out, push CLOSE button of PRIMARY TO LOAD circuit breaker and hold it in at least one second to allow the GENERATOR TO LOAD circuit breaker to open. Primary power is now feeding the equipment load.

STEP NO. 6. - Turn all switches to OFF. The No-Break Electric Power System is now secured. The flywheel and motor-generator will stop rotating within two hours.

d. Function of Switches and Controls

(1) Automatic Synchronizer Switch. - When in the on position completes a circuit from Aux-6 to the automatic synchronizer. The automatic synchronizer will then transfer the electrical load from primary power to the generator output when they are in phase.

(2) Automatic Synchronizing Lights Switch. - When in the off position, phase 1 and phase 3 voltages of the primary power are applied to the synchronizing lights; phase 1 to one of the lights and phase 3 to the other light. These voltages are applied through a 1500 ohm resistor in each circuit. When the switch is turned to the on position, voltage from the corresponding generator phases are applied to the lights, the lights will then illuminate and extinguish indicating when primary power and generator output are in phase.

(3) Control Switch. - When in either the manual or automatic positions, voltage is supplied to the Hi-Lo phase sentinel and automatic starting system.

When the switch is in test position the function is the same as in the manual or automatic positions and in addition, timer TM-1 is energized. Timer TM-1 will initiate starting of the diesel engine after a three second time delay.

When the control switch is turned to the off position it applies voltage through the governor speed adjusting potentiometer to the engine governor causing the engine to shut down. With the switch in off position all engine starting relays are deenergized.

(4) Clutch Switch. - When in the manual position energizes Relay #1 MAN. and the Clutch Relay. After a one minute time delay the clutch timer energizes the clutch relay. The Clutch Relay shunts out the dropping resistors in series with the secondary of the clutch transformer. The purpose of the resistors is to reduce the voltage and current applied to the clutch when the system is first started.

NOTE

Two 100 ohm resistors for 120 volt clutches and three 500 ohm resistors for 220 volt clutches.

In the automatic position the switch energizes Relay #2 AUTO. and the Clutch Relay. Relay #2 AUTO. applies full voltage to the secondary of the clutch transformer. The Clutch Relay by shunting out the resistors applies full voltage to the clutch.

(5) Circuit Breaker Switch. - When the CIRCUIT BKR'R SWITCH is placed in MAN. position, voltage is applied to the following switches under the conditions stated.

(a) To the open and close buttons of the generator to load circuit breaker when the generator is putting out voltage.

(b) To the open and close buttons of the primary to load circuit breaker when primary power voltage is supplied to the control cabinet.

(c) To the open and close buttons of the motor contactor when the generator to load circuit breaker is closed and the generator is supplying the load.

When the CIRCUIT BRK'R SWITCH is placed in the OFF position, there is no voltage to the push buttons of the circuit breakers or the motor contactor.

When the CIRCUIT BRK'R SWITCH is placed in the AUTO. position voltage is supplied to the system sentinel shelf allowing the failure relay circuits to operate when needed.

(6) Start Button. - When pushed will energize the overcurrent relay Aux-1. The overcurrent relay when energized applies voltage to the engine starter.

(7) Emergency Stop. - Pushing the EMERGENCY STOP button will energize the engine overspeed relay OSR and air box damper solenoid ABD. This will shut off the air supply to the engine, causing the engine to shutdown. The air box damper must be reset manually before the diesel engine can be restarted. When the overspeed relay is tripped voltage is removed from the engine starter and the clutch, and will remain so as long as the switches are in an on position and there is load voltage to keep the relays locked in.

SECTION 4

OPERATING PRINCIPLES

4-1 SCOPE

Section 1 included a brief description of the units comprising the generator set. The manufacturers manuals which are referenced in the bibliography and accompany this manual describe the operating principles of those units. For this reason this section is confined to the operation principles of the No-Break Electric Power System control system.

4-2 MONITORING OF PRIMARY POWER AND TRANSFER TO EMERGENCY OPERATION

During normal operation of the No-Break Power System, primary power to the motor end of the motor-generator set drives that unit and the inertia flywheel. The diesel engine is at rest and the electric clutch is deenergized.

Each phase of the primary power is monitored by a Hi-Lo phase sentinel and a voltage relay. See figure 7-1.

a. Hi-Lo Phase Sentinel. - Should the voltage in a phase of the primary power drop below 110 volts (99 volts for 50 cycle system) or rise above 130 volts (119 volts for 50 cycle system), the Hi-Lo phase sentinel monitoring that particular phase will initiate a series of electrical operations which will transfer the power system to emergency operation.

When a Hi-Lo phase sentinel is actuated by a drop or rise in voltage it energizes timer TM-1 and relay Aux - 3. After a three second time delay, the 1C contacts of TM-1 close energizing relay Aux -2 and Timer - 5. Should the primary power voltage return during the 3 second time delay, timer TM-1 resets and Aux - 3 deenergizes. If the primary power voltage does not return to normal the series of electrical operations continues. Aux - 2 then energizes the engine start circuit. The start valve solenoid is energized and opens the start valve. The start valve when opened permits hydraulic pressure to open the hydrostarter control valve. With the control valve open, hydraulic pressure from the accumulators operates the starting motor, starting the engine.

Timer - 5 when energized opens the instant start circuit from relay Aux - 1. Timer - 5 starts timing upon deenergization.

When the diesel engine reaches a speed of 600 RPM the ISG (idle speed governor) cuts out the engine starter.

The C-2 contacts in timer TM-1 close 5 seconds after the timer has been energized. The closing of these contacts opens the holding relay on the motor contactor and the motor contactor opens.

Relay Aux - 3 opens the coil circuit to timer TM-2 to prevent it from being energized. Timer TM-2 times the closing of the motor contactor when primary power voltage returns to normal.

b. Voltage Relays. - The function of the voltage relays (V1, V2, and V3) is to initiate a transfer from normal operation to emergency operation with instant starting of the diesel engine. These relays operate in the event of a sudden and complete primary power failure. They are set to operate when the primary power voltage drops below 70 volts. When such a drop in voltage occurs, the voltage relays energize relay Aux - 6. A second function of relay V3 is to cause the motor contactor to open instantly. Relay Aux - 6 has two sets of normally open contacts. One set energize timer TM-1 and relay Aux - 3. The other set of contacts energize relay Aux - 2 and Timer - 5. Relay Aux - 2 energizes the engine start circuit. The start valve solenoid is energized and initiates starting of the diesel engine.

From this point on the relays and timers perform the same functions as when the transfer to emergency power is initiated by the Hi-Lo phase sentinel. The prime difference in the sequence of relay and timer operation in the transfer to emergency operation by Hi-Lo phase sentinels and voltage relays is the energizing of Aux - 2 by Aux - 6 rather than through timer TM-1 with a 3 second time delay in starting the diesel engine.

4-3 TRANSFER FROM EMERGENCY OPERATION TO NORMAL OPERATION

When primary power voltage returns to normal, the Hi-Lo phase sentinels deenergize timer TM-1 and relay Aux - 3. Deenergizing of timer TM-1 deenergizes Timer - 5 which then starts timing. When relay Aux - 3 is deenergized it energizes a circuit to the coil of timer TM-2. Timer TM-2 has two sets of contacts. Contacts 1-C of timer TM-2 cause the motor contactor to close after a 30 second time delay. Contacts 2-C of timer TM-2 energize relay Aux - 4. Relay Aux - 4 opens the holding circuit to relay Aux - 2. After a 35 second time delay, timer TM-2 opens the engine start circuit and removes voltage from the clutch. Timer-5 after a 45 second time delay from the time it was deenergized shuts the engine down at the governor.

4-4 MONITORING PRIMARY POWER FREQUENCY

CY. - The primary power frequency is monitored by CF-1 under-frequency and over-frequency relays. See figure 7-6. The over-frequency relay is energized at 61 cycles (51 cps for 50 cycle system) and the under-frequency relay at 59 cycles (49 cps for 50 cycle system). When either of these relays is energized it will energize timer TM-1 and relay Aux-3 initiating a transfer to emergency operation as described in paragraph 4-2 a.

4-5 MOTOR OVER-CURRENT T. - A CO-5 relay monitors each of the three phases of primary power. See figure 7-6. If the motor current should exceed 960 amperes on any one of the phases, the CO-5 relay detecting the over-current will energize and in turn will energize relay Aux-1. Relay Aux-1 energizes the engine start circuit directly, providing for an instant start of the diesel engine and energization of the clutch. Relay Aux-1 is electrically held closed and will not deenergize unless the Control Switch at the control cabinet is turned to the off position. Relay Aux-1 is also energized when the Control Switch is turned to the manual position.

4-6 SYSTEM PHASE SENTINEL

The system phase sentinels monitor each phase of the generator output. The phase sentinels are set to energize if the generator voltage should drop below 110 volts (99 volts for 50 cycle system) or rise above 130 volts (119 volts for 50 cycle system). See figure 7-3.

When the phase sentinels are energized they energize relays Aux-4, Aux-6, and Aux-7. They also illuminate the Generator Failure indicator light.

A set of normally closed contacts in relay Aux-4 opens the engine start circuit. A second set of normally closed contacts opens the circuit to relay Aux-3, through the motor contactor. A set of normally open contacts energizes the overspeed relay and the air box damper solenoid.

Relay Aux-6 has two sets of normally closed contacts and two sets of normally open contacts. The normally closed contacts function when the generator is synchronized with primary power in transferring the equipment load from primary power to generator output. The normally open contacts function when the generator is synchronized with primary power in transferring the equipment load from generator output to primary power.

Relay Aux-7 provides a holding circuit for Aux-4, Aux-6, and for itself. Aux-7 also supplies voltage to auxiliary switch No. 2, in the Primary to Load circuit breaker, which opens the motor contactor.

4-7 SYNCHRONOUS RELAY

The synchronous relay is energized by the synchronous governor when the engine reaches a speed of approximately 1700 RPM. The synchronous relay applies voltage to the synchronizing circuit through relay Aux-6, and to the failure relays HWR, LOR, and OSR.

4-8 RELAY AUX-8

Relay Aux-8 is energized by a circuit to the auxiliary contacts of the Generator to Load circuit breaker. Relay Aux-8 supplies voltage to the system phase sentinels and to the 1-C contacts of timer TM-2. Relay Aux-8 also supplies voltage to a set of normally closed contacts in relay Aux-4 providing a circuit through the motor contactor to TM-1 and relay Aux-3.

4-9 POWER SYSTEM SAFETY FEATURES

Safety devices and emergency indicator lamps are provided to prevent damage to the power system in event of certain malfunctions and to alert operating personnel if these malfunctions occur. See figures 7-3, 7-5 and 7-6.

a. Generator Failure. - In event of a generator failure the system phase sentinels energize relays Aux-4, Aux-6, Aux-7, and illuminates the generator failure lamp. Relay Aux-4 energizes the OSR relay, opening the engine start circuit. Relay Aux-6 transfers the electrical load to primary power, through the automatic synchronizer. Relay Aux-7 opens the motor contactor.

b. Flywheel Bearing Over-Temperature. - A temperature-sensitive electric switch is located at each of the two flywheel bearing housings. The switch when closed by a temperature rise above 240° F energizes the bearing relay. The bearing relay energizes relays Aux-4, Aux-6, Aux-7, illuminates the bearing temperature lamp and rings an alarm. Relay Aux-4 energizes the OSR relay, opening the engine start circuit. Relay Aux-6 transfers the electric load to primary power, through the automatic synchronizer. Relay Aux-7 opens the motor contactor. The equipment load is transferred to primary power automatically, through the automatic transfer and automatic synchronizer switch, and the power system is automatically secured.

c. Engine Overspeed. - To ensure against damage caused by overspeeding of the engine, an overspeed device is provided. Should the engine reach a speed over 2100 RPM (1800 RPM for 50 cycle system), the overspeed governor will energize the OSR relay, which in turn energizes the air box damper solenoid and illuminates the engine overspeed lamp. The air box damper solenoid shuts the engine down by closing the air box damper. The clutch and automatic starting system are deenergized.

d. Low Oil Pressure. - Should the lubricating oil pressure drop below 20 pounds, a pressure-operated electric switch closes energizing the LOR relay. The LOR relay energizes the air box damper solenoid and illuminates the low oil pressure lamp. The air box damper solenoid shuts the engine down by closing the air box damper. The clutch and automatic starting system are deenergized.

e. High Water Temperature. - Should the engine cooling water temperature rise above 208° F, a temperature-sensitive switch closes energizing the HWR relay. The HWR relay energizes the air box damper solenoid and illuminates the high water temperature lamp. The air box damper solenoid shuts the engine down by closing the air box damper. The clutch and automatic starting system are deenergized.

f. Motor Overcurrent. - In event of an overcurrent condition on the motor, the CO-5 relays provide an instant starting of the diesel engine through relay Aux-1. The clutch is automatically energized and the motor overcurrent lamp is illuminated.

g. Fail Start. - If for any reason the engine should fail to start the fail start lamp will illuminate.

NOTE

Automatic transfer to primary power and engine shutdown, alarm bells, and similar features pertaining to power system malfunctions are provided as desired by the individual facility. Operating personnel should acquaint themselves with the failure features of the power system installed at their facility.

4-10 TIMING RELAY AND SWITCH SETTINGS

a. TK Timing Relay (TM-1 and TM-2) - The type TK timing relay is set for the desired time delays by two adjustments:

Remove the cover strip at the top of the gear train assembly and shift the gears to the desired time scale. Factory recommended settings on the time scale are:

TM-1 - 30 second scale
TM-2 - 5 minute scale

Loosen the thumb nut locking the two trip discs. Rotating the trip discs clockwise increases the time delay, counterclockwise decreases the time delay.

In timer TM-1 the front trip disc sets the time delay for engine starting, the rear disc sets the time delay for opening of the motor contactor when the power system shifts from motor to diesel engine operation.

Factory recommended settings on timer TM-1 are:

Engine starting - 3 seconds
Motor contactor opening - 5 seconds

In timer TM-2 the rear tripping disc sets the time delay for closing the motor contactor when the power system shifts from diesel engine to motor. The rear disc sets the time delay for opening the starter circuit after the power system has transferred from diesel engine to motor operation.

Factory recommended settings on timer TM-2 are:

Motor contactor closing - 30 seconds
Starter circuit opening - 35 seconds

b. Agastat Time Delay Relay (Clutch Timer) - The time dial is lettered from A through E with 0 as the zero mark. To increase the time delay period, turn the dial clockwise, to shorten the time delay turn the dial counterclockwise.

Factory recommended setting is one minute.

c. AM Timing Relay (Timer-5). - Time delay adjustment is made solely by turning the dial. Factory recommended setting is 45 seconds.

d. CF-1 Relays (Over-Frequency and Under-Frequency). - The frequency settings are made by adjusting the frequency setting rheostat. The time delay setting is made by adjusting the time setting dial. Factory recommended settings are:

OVER-FREQUENCY RELAY

Frequency Setting	61 cycles (51 cps for 50 cycle system)
Time Delay	5 seconds

UNDER-FREQUENCY RELAY

Frequency Setting	59 cycles (49 cps for 50 cycle system)
Time Delay	5 seconds

e. Fuel Pressure Switch - The adjustment is factory set and fixed to operate at 20 pounds pressure.

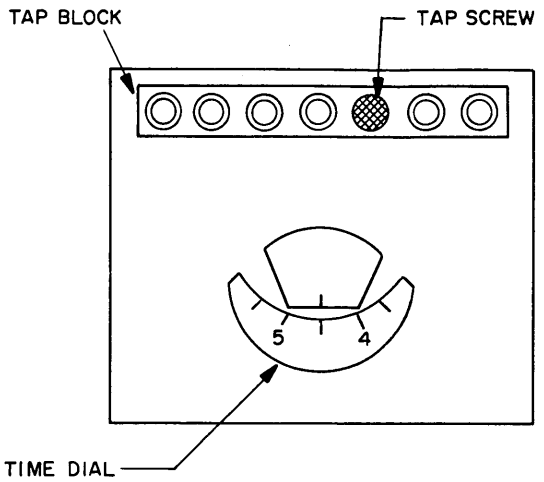
f. Flywheel Bearing Temperature Switch. - By turning the adjusting screw clockwise the temperature setting at which the switch will close is raised. Turning the adjusting screw counterclockwise lowers the temperature setting. Factory recommended setting is 240°F.

g. High Water Temperature Switch. - Adjustment of this switch is the same as for the flywheel bearing temperature switch. Factory recommended setting is 208°F.

h. Low Oil Pressure Switch. - By turning the adjusting screw clockwise the pressure at which the switch will close is raised. Turning the adjusting screw counterclockwise lowers the pressure setting. Factory recommended setting is 20 pounds.

i. Co-5 Relays, Phase Sentinels, Overspeed Governor, Synchronous Governor and Idle Speed Governor. - Adjustment and settings are shown in figures 4-1 through 4-4 respectively.

CO-5 MOTOR OVER-CURRENT RELAY ADJUSTMENT AND FACTORY RECOMMENDED SETTINGS



Adjustment

Location of the tap screw in the tap block governs the minimum current required to close the relay contacts.

The time delay in closing of contacts is set by adjusting the time dial. Time dial indicates position of the moving contact over a 270° range. Time dial indexes from 1/2 (Minimum time) to 11 (maximum time).

Factory Recommended Settings

Closing Current - 6 amperes (corresponding to 960 amperes on the motor)

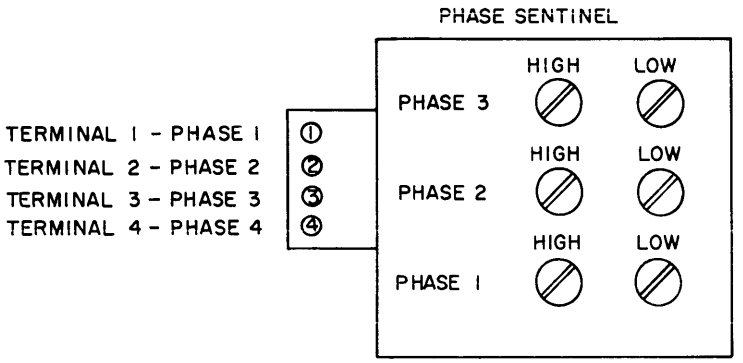
Tap screw in position No. 6 of tap block.

Time Delay - 4.5 seconds time delay.

Adjustment made by turning time dial.

Figure 4-1. CO-5 Relay Adjustment

HI-LO PHASE SENTINELS AND SYSTEM PHASE SENTINELS ADJUSTMENT AND FACTORY RECOMMENDED SETTINGS



Adjustment

With the control cabinet deenergized, connect one lead of a variable voltage transformer to the terminal of the phase sentinel to be adjusted and the other lead to the neutral terminal.

Apply a voltage of the same value as that at which the phase sentinel relay being adjusted is to operate. The adjusting screws at the left set the over-voltage at which the phase sentinel operates, those on the right the under-voltage operation. Clockwise movement of the screws decrease the setting, counterclockwise increase the setting. The high settings operate on energization, the low settings on deenergization.

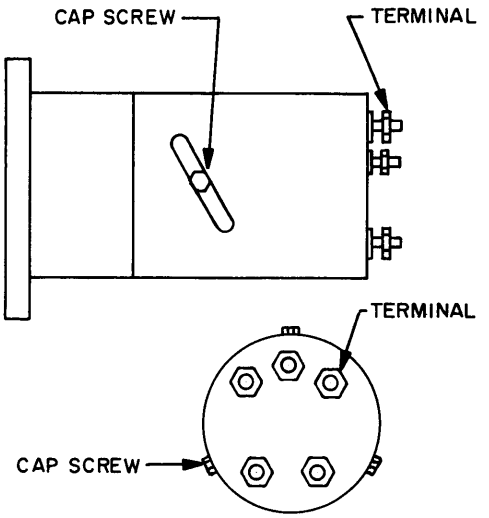
Factory Recommended Settings

Hi-Lo Phase Sentinel	High - 130 (119 for 50 cycles) volts Low - 110 (99 for 50 cycles) volts
System Phase Sentinel	High - 130 (119 for 50 cycles) volts Low - 110 (99 for 50 cycles) volts

Time delay - None

Figure 4-2. Phase Sentinel Adjustment

OVERSPEED GOVERNOR ADJUSTMENT AND FACTORY RECOMMENDED SETTING



Adjustment

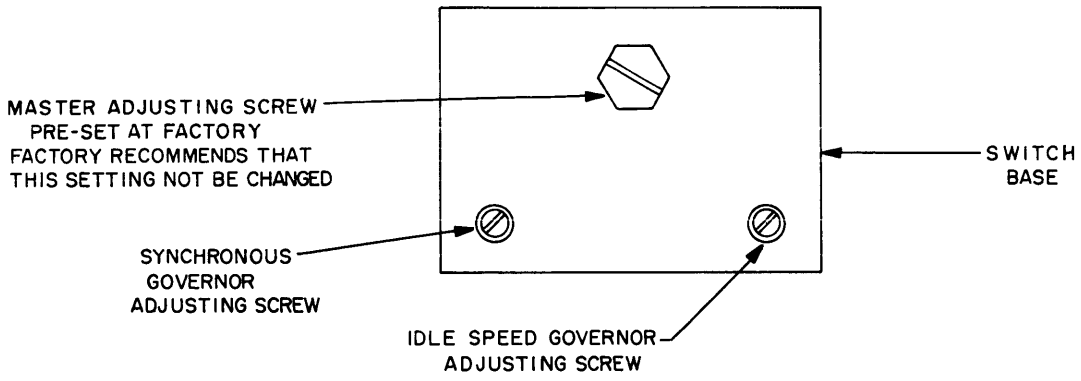
Loosen the three cap screws in the switch case. Turn the case clockwise to increase setting, counter-clockwise to decrease the setting.

Factory Recommended Setting

Engine tripping speed - 2100 RPM (1800 RPM for 50 cycle systems)

Figure 4-3. Overspeed Governor Adjustment

SYNCHRONOUS GOVERNOR AND IDLE SPEED GOVERNOR ADJUSTMENT AND FACTORY RECOMMENDED SETTINGS



Adjustment

Turning the adjusting screws clockwise increases the setting, counter-clockwise decreases the setting.

Factory Recommended Settings

Synchronous Governor - 1750 RPM (1450 RPM for 50 cycle systems)
Idle Speed Governor - 600 RPM

Figure 4-4. Synchronous Governor and Idle Speed Governor Adjustments

SECTION 5

PREVENTIVE MAINTENANCE

5-1 INTRODUCTION

The preventive maintenance required by the "No Break" Electric Power System is much the same as that required by any power system employing similar electrical and mechanical units. The items listed in this section are recommended for inclusion in a preventive maintenance program. Some of these items are general in nature, others are characteristic of the "No Break" Electric Power System. They are not intended to serve as a complete preventive maintenance program, and should not be considered as such, local conditions and engineering practices will in all probability require additional items.

Before attempting any maintenance or repair work on the "No Break" Electric Power System, be sure that all safety precautions required by departmental instructions are carried out.

5-2 DIESEL ENGINE

a. Check the oil level daily with the engine stopped. If below the FULL mark on the dipstick add oil. Use an SAE 30 heavy duty, additive oil.

b. It is recommended that new engines be started with 100 hour oil change periods. The interval may be increased, based on the analysis of the drained engine oil, until the most practical oil change interval has been established.

c. Renew the oil filter elements and gaskets everytime the engine oil is changed. When the engine is started check the filter for oil leaks.

d. Check the engine oil temperature at 1000 hour intervals or when over heating is suspected. The temperature should be taken immediately after the hot, loaded engine has been stopped. The temperature may be taken by inserting a steel jacket thermometer in the dipstick opening. The oil temperature should not exceed the normal cooling water temperature (160 degrees F - 185 degrees F) by more than 60 degrees.

e. Check the cooling water level in the radiator daily. Maintain the water level near the top of the radiator. Clean the cooling system every 1000 hours using radiator cleaning compound. After cleaning, thoroughly rinse and fill the system with fresh water. Add rust inhibitor.

f. Inspect the cooling water system hoses every 500 hours. Renew hoses as necessary.

g. Inspect the outside of the radiator core every 200 hours. Clean the radiator core as necessary using fuel oil and compressed air.

h. Open the fuel oil day tank drain every 500 hours to drain off any water or sediment accumulation. Keeping the day tank filled will reduce condensation in the day tank to a minimum.

i. Daily, drain approximately a 1/4 of a pint of fuel and sediment from the strainer and filter. Install new elements every 300 hours. Check for leaks with the engine running.

j. Clean the blower screen every 1000 hours by washing in fuel oil and using a stiff brush. Blow out with compressed air.

k. Check the air filters every 400 hours, more often if conditions require. Clean or change the filter when the flag in the Service Indicator locks at the top.

l. Every 100 hours check the air flow from the air box drain tubes with the engine running. Clean the air box drain tubes every 500 hours or more often if required.

m. Clean the crankcase breather every 1000 hours. The 1000 hour interval may be reduced or extended as conditions require. Clean the breather by washing in fuel oil and blowing out with compressed air.

n. Check tension of fan belts every 500 hours and adjust as necessary.

o. Every 500 hours remove and clean the hydrostarter system hydraulic fluid filter. Clean both the filter and the bowl by washing in diesel fuel and blowing out with compressed air.

p. Drain and clean the hydrostarter system reservoir every 2000 hours or as conditions warrant.

q. Remove the hydrostarter from the engine every 2000 hours and apply a good quality, lightweight grease on the drive clutch pinion to ensure the clutch will slide freely while compressing the spring. Apply grease on the fingers of the clutch fork and on the spool of the clutch yoke engaged by the fork. This lubrication period may be reduced or lengthened as conditions warrant.

CAUTION

The oil pressure in the hydrostarter system must be released before servicing the hydrostarter motor or other parts to prevent possible injury to personnel or damage to equipment. This may be accomplished by cranking (without starting) the diesel engine.

5-3 CLUTCH

a. The initial lubrication is sufficient for approximately 3000 hours, if operated under reasonably normal conditions, free of deteriorating fumes, excessive humidity, dust, dirt, or any foreign matter harmful to the bearings and lubrication. Local operating conditions and climate must be considered when determining how often lubrication is necessary.

The clutch has three bearing lubrication fittings. Two fittings are located at the input end of the clutch, one of these at the top of the bearing cap and the other in the shaft. The grease fitting at the output end of the clutch is located at the top of the bearing cap. Grease drain plugs are installed at the bottom of both bearing caps, remove these drain plugs before greasing.

Using grease conforming to MIL-G-3278, pump grease into the two bearing cap fittings until clean grease is visible at the drain hole. Pump approximately one ounce of grease into the shaft fitting.

CAUTION

The grease drain plugs should always be removed before pumping grease into the bearing cap fittings. Do not over-grease the bearings, doing so will cause overheating and damage. It is recommended that the clutch be operated for approximately 15 minutes before replacing the grease drain plugs, to expel excess grease.

b. Though a number of chemical cleaning methods may be used to de-scale the clutch, it is recommended that the clutch be descaled manually. By using a soft water (preferably distilled water if readily available), it should not become necessary to de-scale the clutch until normal bearing replacement is required.
c. Inspect the outside of the radiator core every 200 hours. Clean the radiator core as necessary using fuel oil and compressed air.

5-4 MOTOR-GENERATOR

The motor-generator unit is so designed and constructed that it requires a minimum of maintenance. The most important requirement in proper maintenance of the unit is cleanliness.
a. Keep the area swept down. Keep the unit wiped clean on the outside.
b. Periodically as conditions warrant, blow out all loose dirt and dust from the windings with dry, low pressure air (25 pounds maximum). By using a suction blower attached to the unit, and the unit suitably masked, a more thorough cleaning may be accomplished.
c. Keep the unit moisture free.
d. When practicable, measure the insulation resistance of the motor and generator monthly.
e. Change oil in the bearings periodically as operating conditions warrant. Use SAE 30 mineral oil.

5-5 PILLOW BLOCK BEARING

a. Change the oil in the pillow block bearings every 300 hours, or as operating conditions warrant. Use SAE 60 mineral oil, non-detergent, conforming to MIL-15016A Amendment 2, Symbol 3120. It is available in five gallon pails under Federal Stock Number 9150-243-3188. Fill the pillow block bearings to the mark on the sight glass with the generator set at rest, they should be rechecked with the generator set operating at normal running speed. The oil level mark indicates the proper oil level with the generator set in operation. Oil may be added through sight glass cap. Wipe the sight glass clean with a cloth before unscrewing the cap to add oil.

CAUTION

Too high or too low an oil level will cause over-heating and bearing failure. The oil must be kept at the level indicated. The use of incorrect types of oils and the introduction of dirt or foreign particles into the bearing when adding or changing oil, will also cause a bearing failure.

5-6 FLEXIBLE COUPLING

With a new Power System, the flexible couplings should be inspected and lubricated as necessary at 2000 hour intervals. The intervals may be extended or reduced as operating conditions and experience warrant. Use grease conforming to MIL-G-3278.

The flexible couplings may be relubricated by either of the two following methods.
a. The preferred method of re-lubrication is: remove one snap ring, slide the sleeve to one side, clean the teeth and re-lubricate with fresh grease. It is important that there is a quantity of grease between the two hubs to provide a reservoir of lubricant. As the coupling rotates, centrifugal action will force the grease between the gear teeth, and the reservoir of grease between the hubs will keep the coupling sufficiently lubricated.
b. An alternate method is; remove the two lubrication plugs and rotate the sleeve so the holes are 45 degrees off the horizontal. Pump grease in one hole until grease is expelled from the other hole. Wipe off excess grease with a cloth and replace the plugs.

5-7 CONTROL AND CIRCUIT BREAKER CABINETS

a. Keep the outside of the cabinets clean at all times. Keep the area around the cabinets swept down.
b. Monthly, clean the interior of the cabinets by vacuuming or wiping with a clean lintless cloth. Inspect for loose screws, nuts, bolts, connections, or any other conditions that may require corrective measures.

5-8 CONTROL SYSTEM

The control system has been engineered for long, dependable, trouble-free operation. It will perform indefinitely if reasonable care is exercised in its operation and maintenance.

No attempt should be made to repair resistors, control transformers, meter movements, sealed units, or the like. Faulty components should be replaced with approved replacement parts. Current transformers of the bar type are utilized in the control system. These transformers isolate the measuring instruments from the line potential and operate at comparatively low values of secondary current. Thus, the measurement of heavy current is made possible by meters of standard design.

WARNING

Current transformer secondaries should never be open-circuited when the primary circuit is energized. An open secondary results in excessive secondary voltage which is lethal.

Cleanliness is of prime importance. The cabinets should be kept clean and dust free both inside and outside. The cleanliness and smoothness of contacts on switches, relays, and the like are essential for proper operation of these devices. The moving parts of these devices should operate freely. As a general rule, the circuit breaker mechanisms require little lubrication. Excess oil on the parts of a circuit

breaker collects dirt and dust. The occasional application of a few drops of a good grade of light machine oil at bearing points is sufficient.

Whenever the control system is completely shutdown, a thorough inspection of the control system should be performed:

a. Check all electrical and mechanical connections for tightness.
b. Examine insulation for wear or frayed spots.
c. Clean the control and circuit breaker cabinets using a vacuum cleaner, air pressure regulated to 15 pounds maximum pressure, or a brush.
d. Check moving parts of electrical devices for smoothness of operation.
e. Check contact surfaces of electrical devices for smoothness, surface wear, pitting, and corrosion.
f. Investigate any evidence of dampness.

5-9 TROUBLE SHOOTING

Table 5-1 is a trouble shooting chart giving the trouble, the operating condition at the time of occurrence, switch position, and probable cause of the trouble.

Figures 5-1 through 5-8 show the location of equipment in the control cabinet.

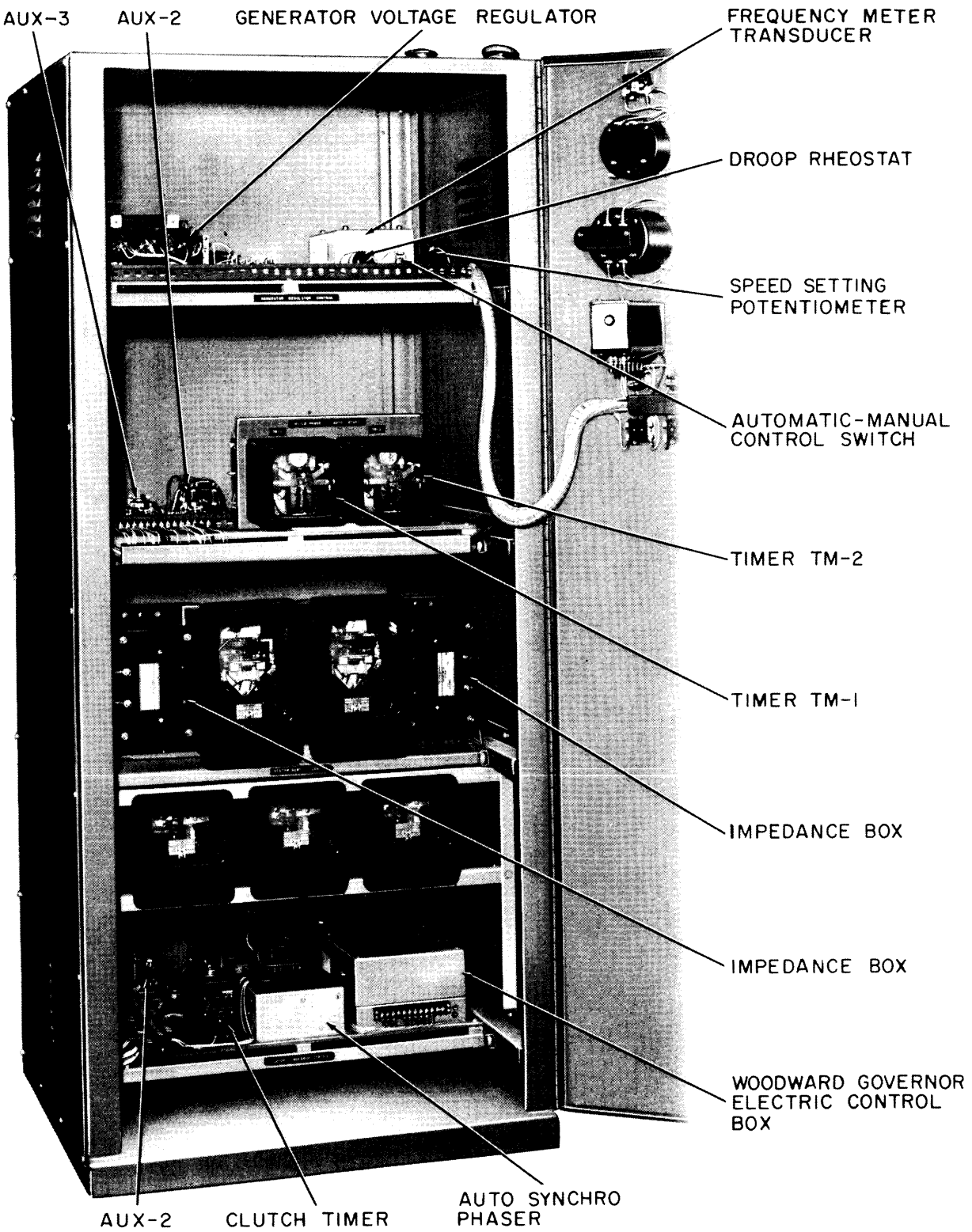


Figure 5-1. Control Cabinet, Internal View

TABLE 5—1. TROUBLE SHOOTING

ON-ROL SW.	CLUTCH SW.	CKT. BKR. SW.	GEN. CKT. BKR.	PRI. CKT. BKR.	MOTOR CON-TACTOR	PROBABLE CAUSE											
AN.	OFF	MAN	OPEN	CLOSE	OPEN	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	NC CONTACTS IN TM-5 OPEN	AUX - 1 NOT ENERGIZED	MANUAL START PUSHBUTTON			CONTROL SWITCH OPEN	OPEN CIRCUIT
EST	OFF	MAN	OPEN	CLOSE	OPEN	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	Aux-2 not Energized	TM-1 Not Energized	Test Switch Open			CONTROL SWITCH OPEN	OPEN CIRCUIT
UTO	AUTO	AUTO	CLOSED	OPEN	CLOSED	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	NC Contacts in TM-5 Open	Aux-1 not Energized	CO-5's not Energized			CONTROL SWITCH OPEN	OPEN CIRCUIT
UTO	AUTO	AUTO	CLOSED	OPEN	CLOSED	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	Aux-2 not Energized	TM-1 not Energized	Phase Sentinel not Functioning	AUX-8 not Energized	Aux-1 Switch in Gen. C-B not closed	CONTROL SWITCH OPEN	OPEN CIRCUIT
UTO	AUTO	AUTO	CLOSED	OPEN	CLOSED	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	Aux-2 not Energized	Aux-6 Not Energized	Relays V1, V2, V3 Contacts not closed			CONTROL SWITCH OPEN	OPEN CIRCUIT
EST	AUTO	MAN.	OPEN	CLOSE	OPEN	Generator C-B Motor not energized	Generator Pushbutton Open	CRT. BKR Switch Open								CONTROL SWITCH OPEN	OPEN CIRCUIT
EST	AUTO	AUTO	OPEN	CLOSE	OPEN	Generator C-B Motor not energized	NC Contacts Open on Aux-6	Auto Synchronizer not operating	Auto Syn. Sw. Open	Synchronous Relay not Energized	Synchronous Governor Contacts Open					CONTROL SWITCH OPEN	OPEN CIRCUIT
EST	AUTO	AUTO	CLOSED	OPEN	OPEN	Air Box Damper not Energized	HWR, LOR, OSR Relays not energized	HW, LO, OS Switches Open								CONTROL SWITCH OPEN	OPEN CIRCUIT
EST	MAN	MAN	OPEN	CLOSED	OPEN	Clutch over Heating	Clutch Water Pressure Low	Clutch Pressure SW. Opening	Clutch Relays Open	Clutch SW Open						CONTROL SWITCH OPEN	OPEN CIRCUIT
EST	AUTO	AUTO	CLOSED	OPEN	OPEN	Air Box Damper not energized	Overspeed Relay not Energized	Aux-4, Aux-6 & Aux-7 not energized	Bearing Relay not Energized	Bearing Temperature Switch Open						CONTROL SWITCH OPEN	OPEN CIRCUIT

TROUBLE	OPERATING CONDITION	AUTO SYN SW.	SYN LIGHT SW.	CON-TROL SW.	CLUTCH SW.	CKT. BKR. SW.	GEN. CKT. BKR.	PRI. CKT. BKR.	MOTOR CON-TACTOR	PROBABLE CA						
Engine fails to start immediately or not at all	Start in Manual	OFF	OFF	MAN.	OFF	MAN	OPEN	CLOSE	OPEN	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	NC CONTACTS IN TM-5 OPEN	AUX NOT ENER
Engine fails to start immediately or not at all	Start in Test	OFF	OFF	TEST	OFF	MAN	OPEN	CLOSE	OPEN	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	Aux-2 not Energized	TM-1 Not Ener
Engine fails to start immediately or not at all	Start in Auto due to motor over-current	ON	ON or OFF	AUTO	AUTO	AUTO	CLOSED	OPEN	CLOSED	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	NC Contacts in TM-5 Open	Aux- Ener
Engine fails to start immediately or not at all	Start in Auto due to Primary Low Voltage	ON	ON or OFF	AUTO	AUTO	AUTO	CLOSED	OPEN	CLOSED	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	Aux-2 not Energized	TM-1 Ener
Engine fails to start immediately or not at all	No immediate Start due to Primary Voltage Failure	ON	ON or OFF	AUTO	AUTO	AUTO	CLOSED	OPEN	CLOSED	LOW ACCUMULATOR PRESSURE	OPEN PRESSURE SWITCH	TIME DELAY RELAY NOT ENERGIZED	STARTER SOLENOID NOT ENERGIZED	ISG SWITCH OPEN	Aux-2 not Energized	Aux- Not Ener
Unit will not Transfer to Gen Power manually	Transferring to Generator from Primary	OFF	ON	TEST	AUTO	MAN.	OPEN	CLOSE	OPEN	Generator C-B Motor not energized	Generator Pushbutton Open	CRT. BKR Switch Open				
Unit will not Transfer to Gen Power Automatically	Transferring to Generator from Primary	ON	ON	TEST	AUTO	AUTO	OPEN	CLOSE	OPEN	Generator C-B Motor not energized	NC Contacts Open on Aux-6	Auto Synchronizer not operating	Auto Syn. Sw. Open	Synchronous Relay not Energized	Synchronous Governor Contacts Open	
Engine not Shutting under abnormal conditions	Engine Driving Generator	ON or OFF	ON or OFF	TEST	AUTO	AUTO	CLOSED	OPEN	OPEN	Air Box Damper not Energized	HWR, LOR, OSR Relays not energized	HW, LO, OS Switches Open				
CLUTCH will energize or will not stay energized	Bringing Unit Up to Speed	OFF	ON or OFF	TEST	MAN	MAN	OPEN	CLOSED	OPEN	Clutch over Heating	Clutch Water Pressure Low	Clutch Pressure SW. Opening	Clutch Relays Open	Clutch SW Open		
Bearings over heating System fails to transfer to primary power	Engine or Motor Driving Generator	ON	ON or OFF	TEST	AUTO	AUTO	CLOSED	OPEN	OPEN	Air Box Damper not energized	Overspeed Relay not Energized	Aux-4, Aux-6 & Aux-7 not energized	Bearing Relay not Energized	Bearing Temperature Switch Open		

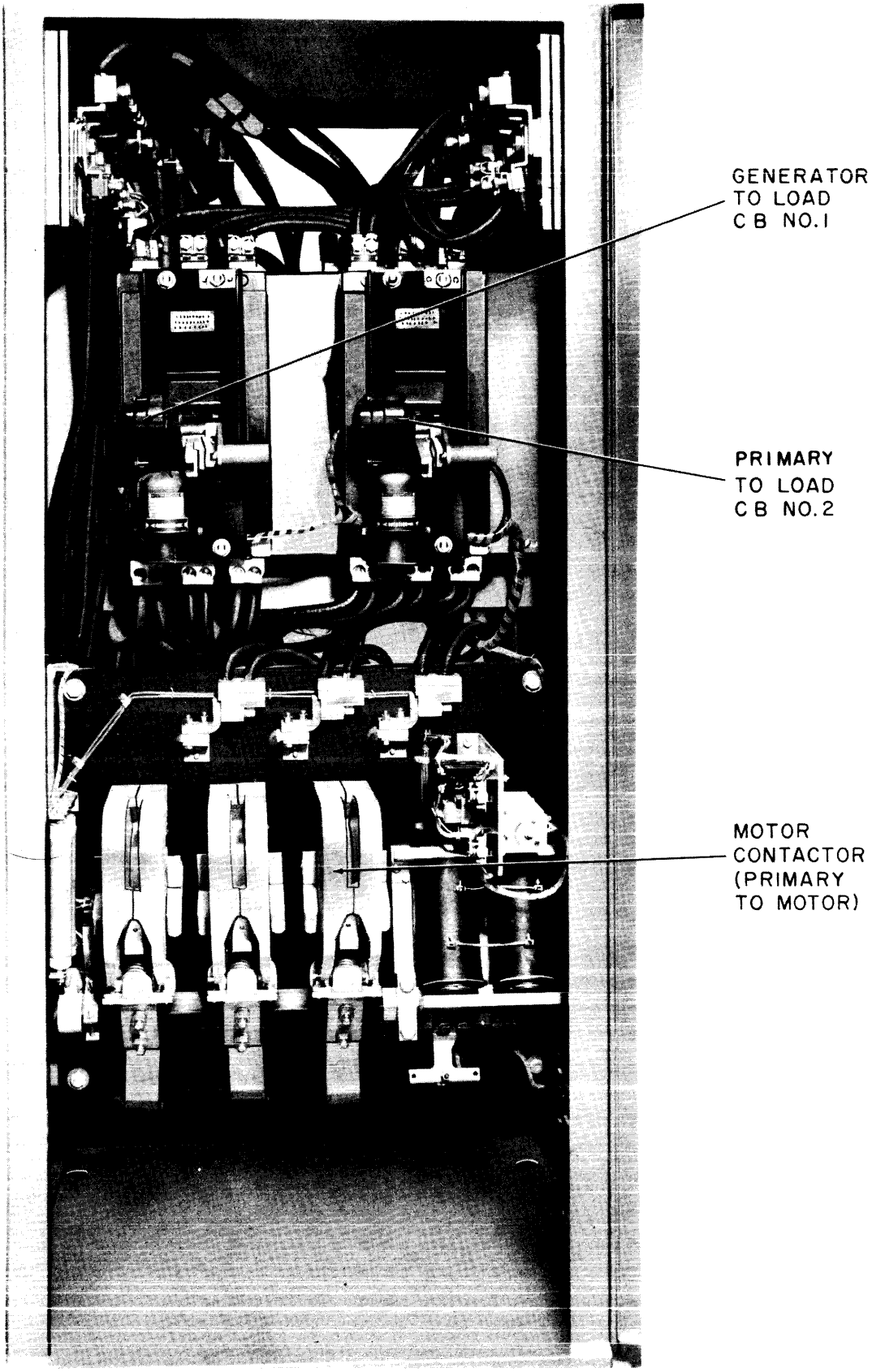


Figure 5-2. Circuit Breaker Cabinet, Internal View

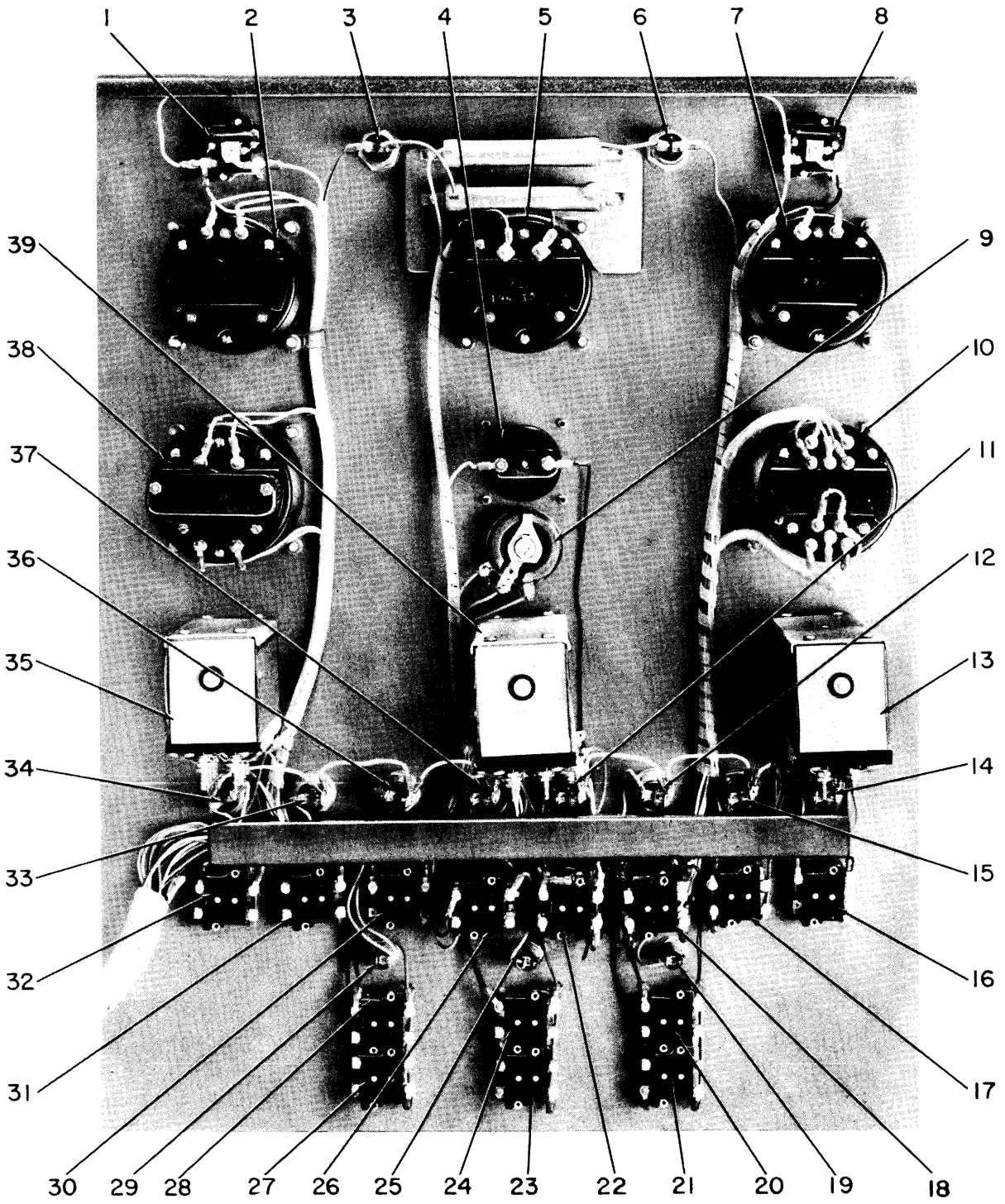


Figure 5-3. Rear View of Control Panel

LEGEND FOR FIGURE 5-3

1. Motor ON Lamp
2. AC Ammeter
3. Synchronizing Lamp
4. Elapsed Time Indicator
5. Frequency Meter
6. Synchronizing Lamp
7. AC Voltmeter
8. Emergency ON Lamp
9. Voltage Adjust
10. AC Kilowatt Meter
11. Motor Overcurrent Lamp
12. High Water Temperature Lamp
13. Voltmeter Switch
14. Engine Overspeed Lamp
15. Low Oil Pressure Lamp
16. Automatic Synchronizer Switch
17. Synchronzing Light Switch
18. Control Switch
19. Generator to Load Closed Lamp
20. Generator to Load Close Button
21. Generator to Load Open Button
22. Clutch Switch
23. Primary to Load Open Button
24. Primary to Load Close Button
25. Primary to Load Closed Lamp
26. Circuit Breaker Switch
27. Primary to Motor Close Button
28. Primary to Motor Open Button
29. Primary to Load Closed Lamp
30. Start Button
31. Emergency Stop Button
32. Gov. Parallel Switch
33. Failure Start Lamp
34. Generator Failure Lamp
35. Ammeter Switch
36. Bearing No. 1 Temperature Lamp
37. Bearing No. 2 Temperature Lamp
38. Power Factor Meter
39. Power Factor Meter Switch

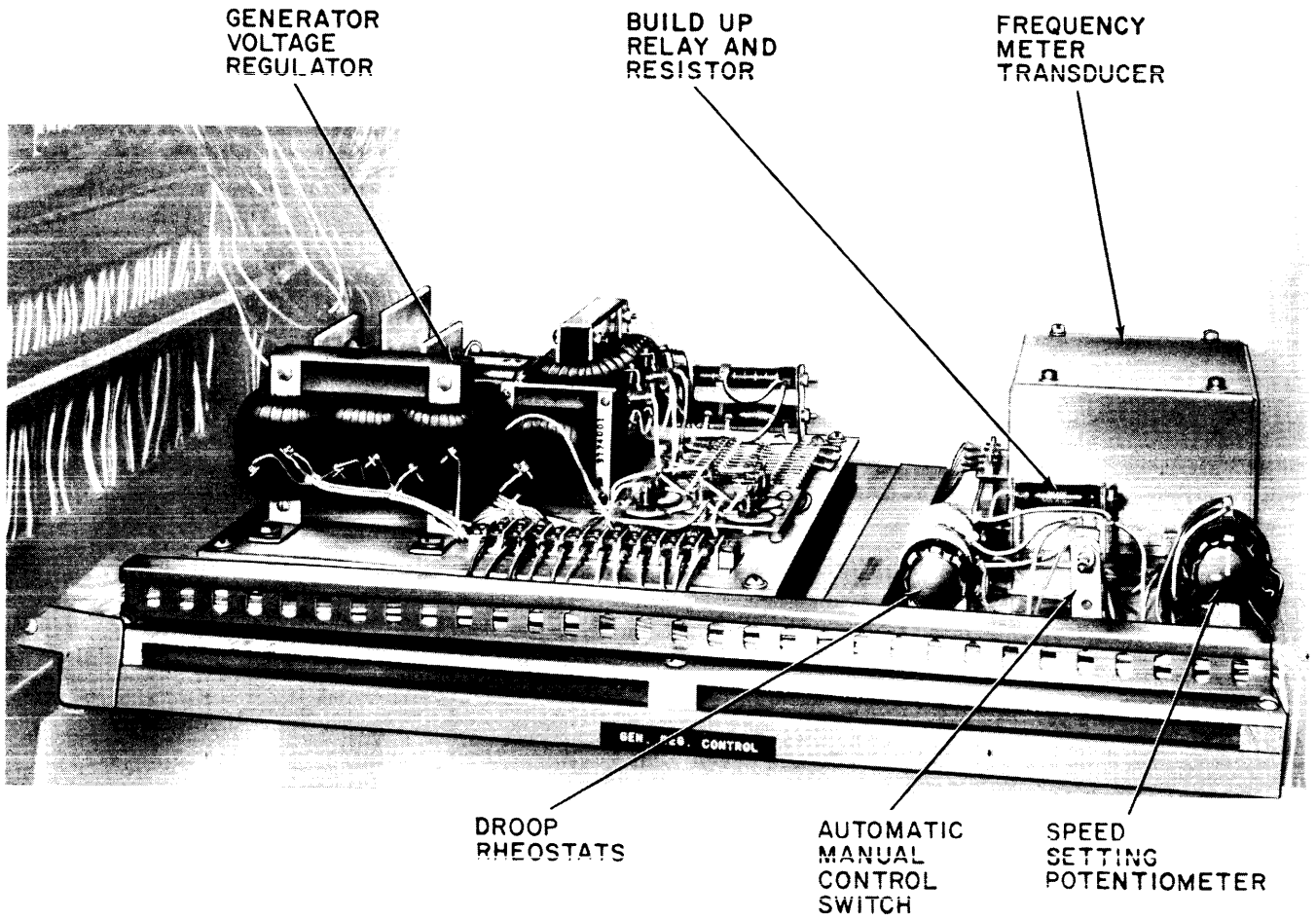


Figure 5-4. Generator Regulator Control Shelf, Front View

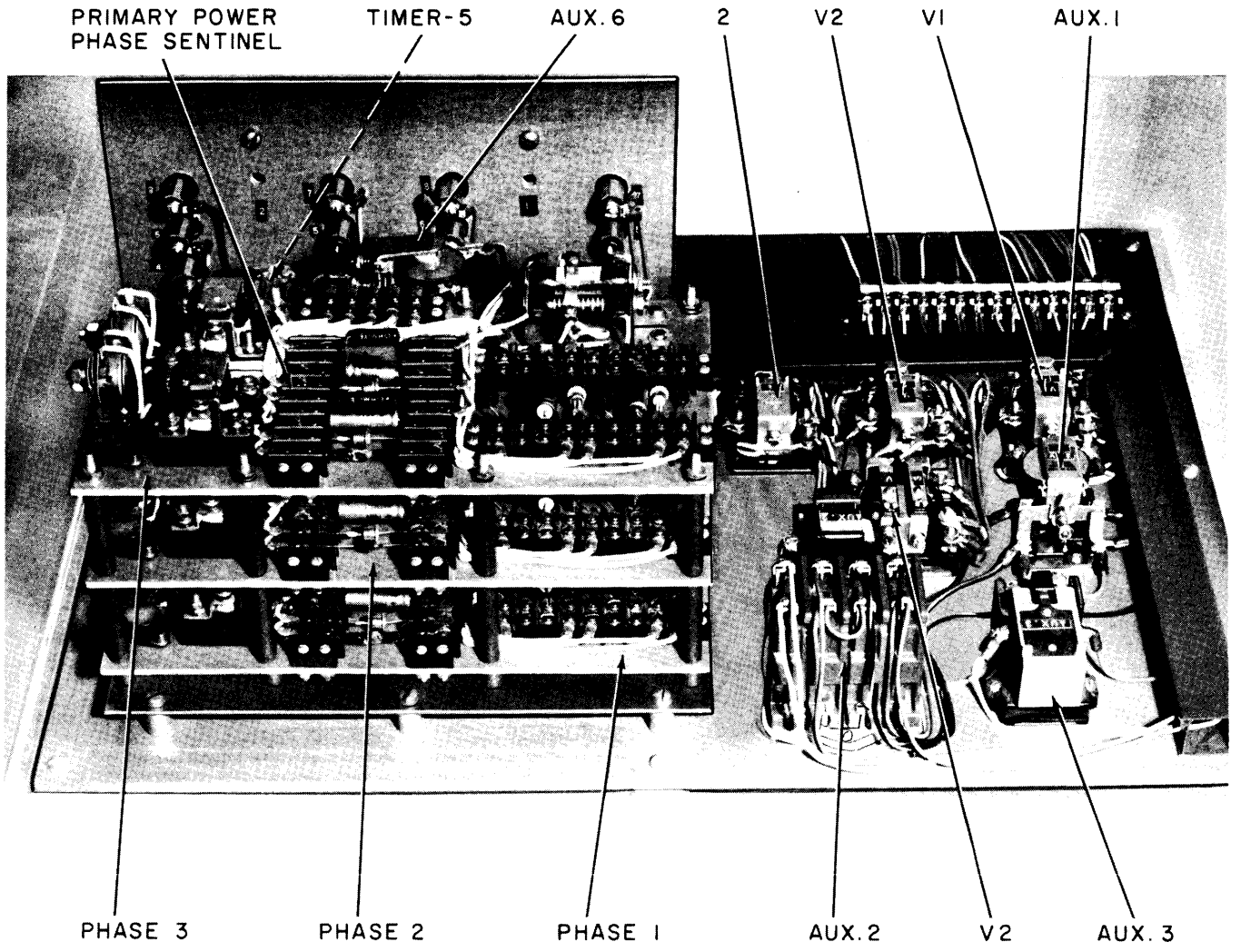


Figure 5-5. Hi-Lo Phase Sentinel Shelf

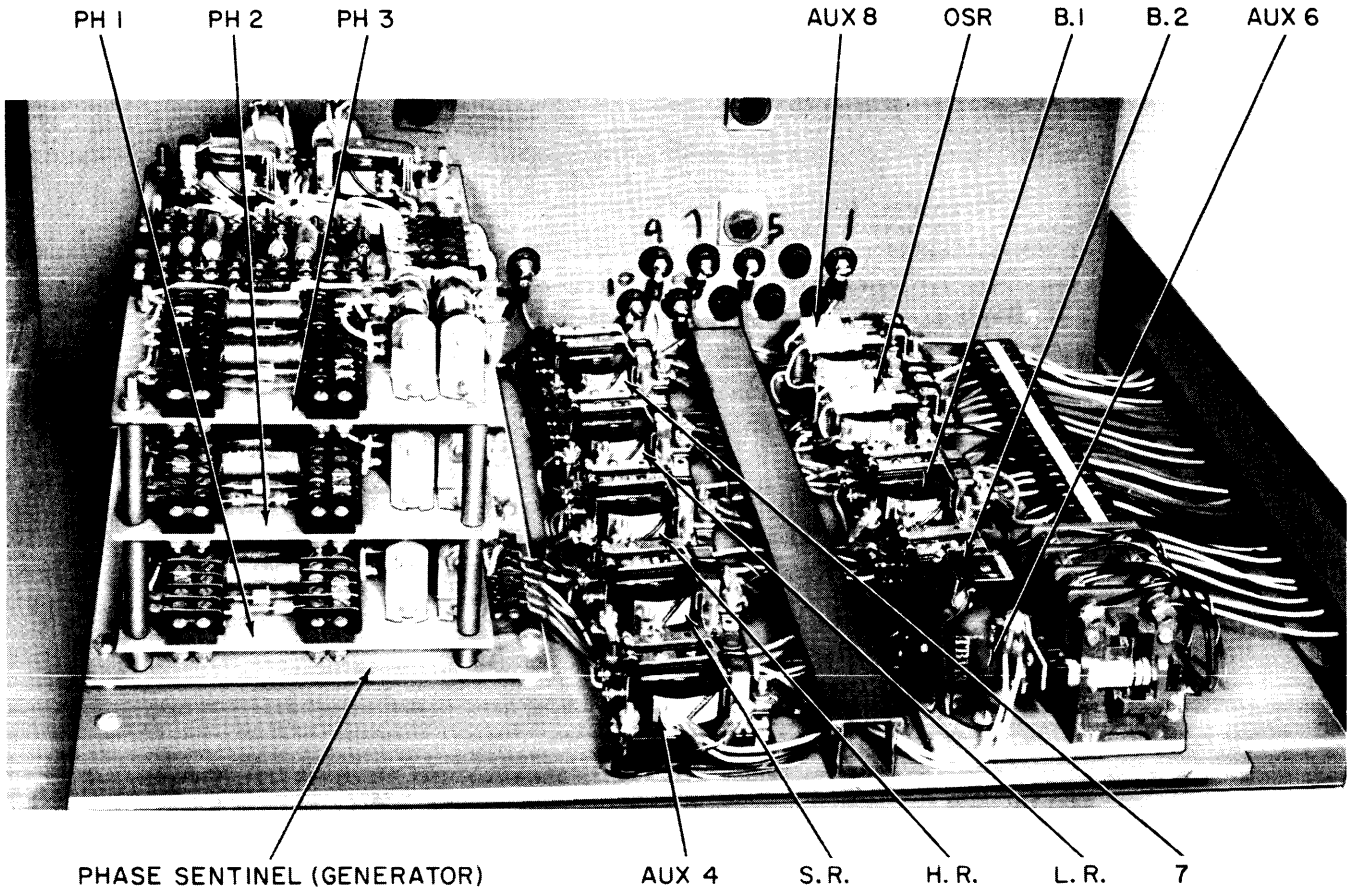


Figure 5-6. System Sentinel and Control Shelf

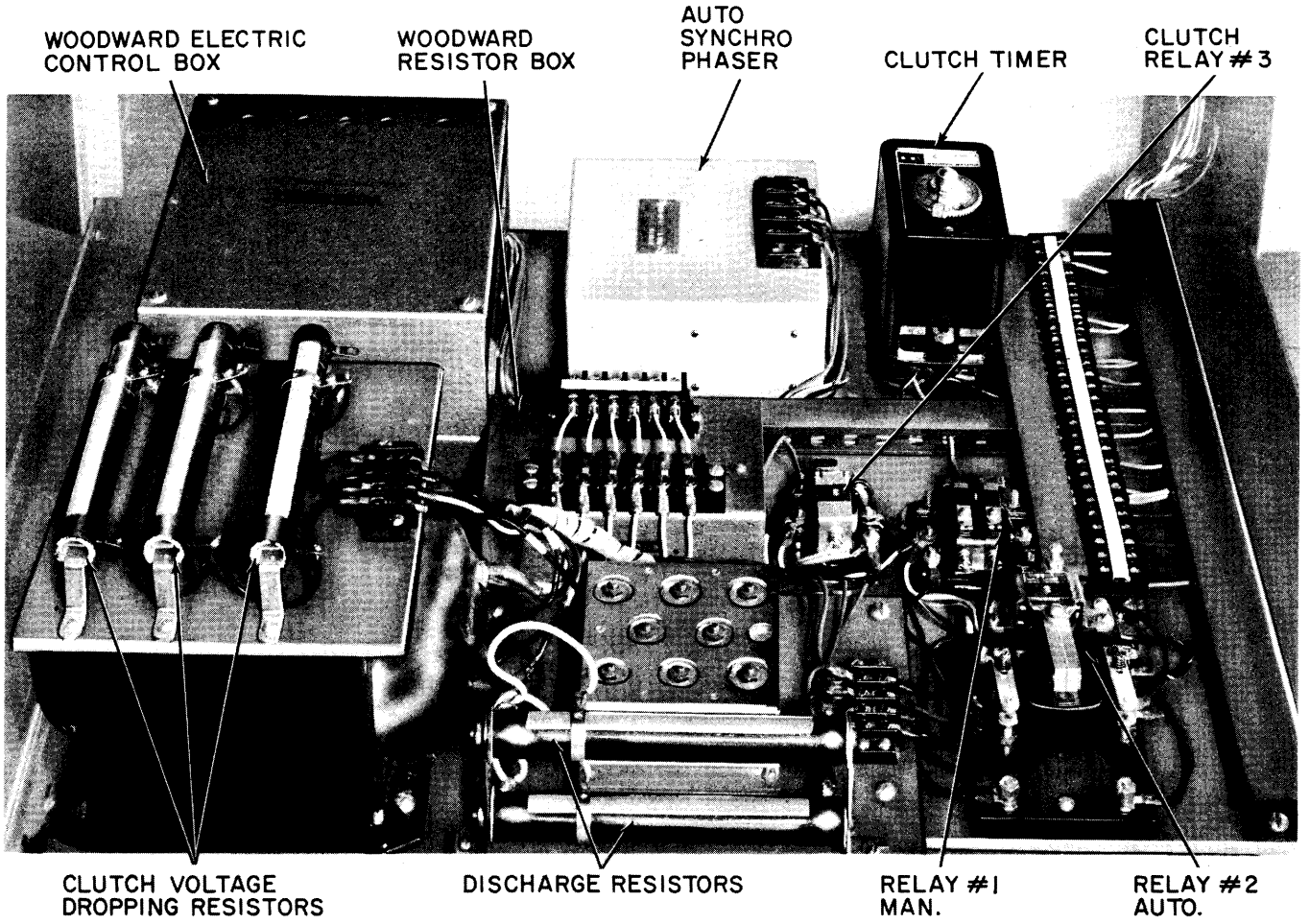


Figure 5-7. Clutch-Governor Control Shelf

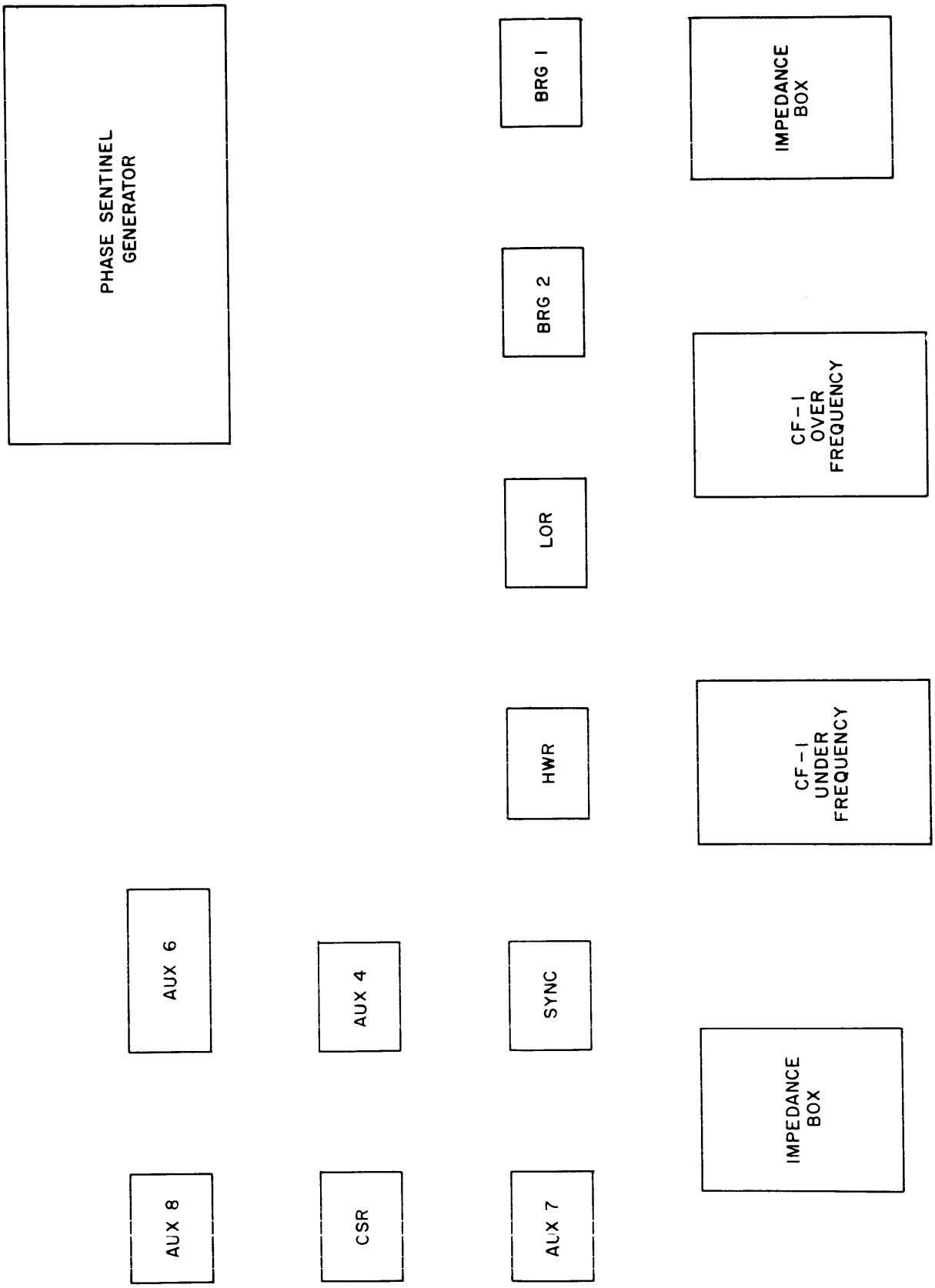


Figure 5-8. System Sentinel and Control Shelf Layout

SECTION 6

REPAIR PARTS LIST

NOTE

This section contains a complete repair parts list for the entire "No Break" power system. Also included is a tabular listing of manufacturers codes.

TABLE 6-1. REPAIR PARTS LIST, MODEL PFS 200 PNB "NO BREAK" ELECTRIC POWER SYSTEM

Mfgr.	Mfgr. Part No.	TMC Part No.	Description
GM	5196375	TE-52201	Gasket Kit, Engine Overhaul
GM	5117016	TE-52202	Gasket, Hand Hole Cover
GM	5196382	TE-52203	Gasket Kit, Cylinder Head Overhaul
GM	5183329	TE-52204	Stud, Cylinder Head
GM	5150013	TE-52205	Nut, Cylinder Head Stud
GM	5115454	TE-51934	Seal, Crankshaft, Oil Front
GM	5114335	TE-51936	Seal, Crankshaft, Oil, Rear, Single Lip
GM	5196319	TE-52206	Shell Set, Crankshaft Main Bearing, (Std.)
GM	5117005	TE-52207	Washer, Crankshaft Main Brg., Thrust
GM	5116353	TE-52208	Bolt, Main Brg., Cap
GM	5117982	TE-51944	Key, Crankshaft Pulley 3/8" x 1-1/4"
GM	5117028	TE-52210	Rod Assembly, Connecting
GM	5117023	TE-52211	Bolt, Connecting Rod
GM	5117629	TE-52212	Nut, Connecting Rod
GM	5150140	TE-51950	Nozzle, Connecting Rod Spray
GM	5125248	TE-52213	Bushing, C/R Piston Pin
GM	5196320	TE-52214	Shell Set, Connecting Rod Bearing (Std.)
GM	5197026	TE-52215	Piston Assy (Std.)
GM	5197037	TE-52216	Ring Set Piston (Std.)
GM	5188406	TE-52217	Pin, Piston
GM	5188405	TE-52218	Retainer, Piston Pin
GM	5113953	TE-52219	Liner, Cylinder (Std.)
GM	5197025	TE-52220	Cylinder Kit, Replacement
GM	5184474	TE-52221	Insert, Cylinder Liner
GM	5111422	TE-51953	Bearing, C/S, Rear End
GM	5117984	TE-52222	Bearing, C/S, Front End
GM	5111424	TE-51954	Washer, Camshaft End Bearing Thrust
GM	5196026	TE-52223	Bearing Set, Camshaft Inter.
GM	5115572	TE-51956	Ring, Camshaft Inter. Bearing Lock
GM	5117649	TE-52224	Bolt, Camshaft Inter. Bearing Lock
GM	5116476	TE-52225	Seal, Cam Shaft Oil, Front, Left Bank
GM	5111340	TE-51959	Arm Assy, Exhaust Valve Rocker, Left
GM	5111343	TE-51960	Arm Assy, Exhaust Valve Rocker, Right
GM	5179954	TE-51961	Arm Assy, Injector RKR
GM	5150322	TE-51962	Shaft Assy, Rocker
GM	5150324	TE-52226	Bracket, Rocker Shaft
GM	5150325	TE-51963	Bolt, RKR Shaft Bracket
GM	5128640	TE-51964	Rod, Push
GM	5151601	TE 51965	Locknut, Push Rod
GM	5186858	TE-51966	Spring, Push Rod
GM	5150302	TE-52227	Seat, Push Rod Spring, Upper
GM	5123250	TE-52228	Seat, Push Rod Spring, Lower
GM	5150303	TE-51967	Retainer, Push Rod
GM	5115087	TE-51968	Follower Assy, Cam Shaft

TABLE 6-1. REPAIR PARTS LIST, MODEL PFS 200 PNB "NO BREAK" ELECTRIC POWER SYSTEM (Cont.)

Mfgr	Mfgr. Part No.	TMC Part No.	Description
GM	5195167	TE-51969	Valve, Exhaust W/Locks
GM	5117561	TE-51970	Spring, Exhaust Valve
GM	5129101	TE-51972	Screw, Bridge Adjusting
GM	5150329	TE-52229	Gasket, Rocker Cover
GM	5228523	TE-52043	Injector, Assy S-70
GM	5193221	TE-51975	Overhaul Kit, Injector
GM	5195078	TE-51977	Overhaul Kit, Fuel Pump
GM	5150198	TE-51978	Gasket, Fuel Pump to Blower
AC	TP-539	TE-52254	Element, Fuel Filter
GM	5230007	TE-51979	Seal, Fuel Oil Pump
GM	5117369	TE-51986	Connector, Fuel Pipe, Manifold
GM	5125108	TE-51987	Washer, Fuel Pipe Connector, Manifold
GM	4223773	TE-51988	Gasket, Gov. Cover
GM	5176228	TE-51989	Screw, Injector Control Lever
GM	5150265	TE-51990	Pin, Inj. Cont. Tube to Gov. Ling
GM	5122692	TE-52230	Gasket, Air Inlet Housing
GM	5196386	TE-52231	Gasket Kit, Blower Installation
GM	5196383	TE-52232	Repair Kit, Blower
GM	5124519	TE-52077	Seal Ring, Blower Housing End Cover
GM	5154637	TE-51999	Ring Snap, Blower Drive Shaft
GM	5153286	TE-52234	Screen, Oil Pump Inlet
GM	5153284	TE-52235	Retainer, Oil Pump Inlet Screen
GM	5126327	TE-52236	Spring, Oil Pressure Regulator
GM	5126326	TE-52237	Spring, Relief Valve
GM	5117269	TE-52238	Gasket, Pressure Regulator
GM	5573014	TE-52004	Element, L/O Full Flow Filter
GM	5109915	TE-52240	Gasket Set, Oil Pan to Block
GM	5129604	TE-52241	Pad, Breather
GM	5197158	TE-52242	Reconditioning Kit, Water Pump
GM	5117976	TE-52243	Gasket, Water Pump Body Cover
GM	5123622	TE-52244	Impeller Assy, Water Pump, 1/2" - 20 Hex
GM	5128476	TE-52245	Nut, Water Pump Impeller
GM	5121751	TE-52246	Seal Assy, Water Pump
GM	5119826	TE-52247	Thermostat Assy
GM	5118265	TE-52248	Seal, Thermostat
GM	5126967	TE-52249	Water Pump Assy
GM	5122230	TE-52250	Pump Assy, Oil
GM	5184531	TE-52251	Pump Assy, Fuel
GM	8524267	TE-52253	Core Assy, Oil Cooler, Twin 12 Plate
GM	5125121	TE-52255	Starter Assy, Hydraulic
		TE-52038	Pump Assy, Hydraulic
GM	5125522	TE-52036	Accumulator, Hydrostarter
WG	379138	TI-40029	Control Box, Governor
ND	901312	TG-901312	Bearing, Ball
ND	3226XRIA	TM-80002	Bearing ND 3226XRIA
DP	5514417	TG-90000	Gauge, Oil
DP	5386281	TM-80007	Rectifier
DP	A-8867	TC-600013	3/4 HP Motor 56 Frame
DP	5386280	TM-80006	Rectifier
DP	5543845	TM-80008	Nut
DP	4153-D	TM-80003	Diode, Regulator
		TE-52041	Hose Set, Hydrostarter
MS	4RV4A28	TC-60001	Switch, Micro
LB	222321B	TF-70004	Bearing
LB	7811603HLB	TF-70001	Seal, 7"
LB	781603HLB	TF-70000	Seal 6-1/16"
SB		TC-60014	Coupling, Nyflex 5/8 Bore
WP	I. T. C. O.	TC-60000	Impeller, Pump (D)
DP		TI-40009	Phase Sentinel

TABLE 6-1. REPAIR PARTS LIST, MODEL PFS 200 PNB "NO BREAK" ELECTRIC POWER SYSTEM (C nt.)

Mfgr.	Mfgr. Part No.	TMC Part No.	Description
FC	T-64	TE-52078	Cartridge, Pamic, Air Cleaner
CC	5U4-2-16	TI-40001	Relay, Magnetic, 60 cy, 110V, Type P.M.
WL	105-6510	TI-40034	Relay
CH	10250T406	TI-40055	Switch, No. 7 Cam
CH	10250T131	TI-40053	Switch, No. 1 Cam
CH	10250T1	TI-40022	Contact Block - NO - NC
CH	10250T132	TI-40054	Switch, No. 4 Cam
CH	10250T3	TI-40044	Contact Block - 2 NC
CH	10250T132	TI-40054	Switch, No. 5 Cam
		TI-40052	Circuit Breaker, Motor Operated
		*TI-40037	Transformer
		*TI-40038	Rectifier
ND	309SF	TC-60003	Bearing
ND	47616ND	TC-60012	Bearing
LB	122RF/MRC	TC-60002	Bearing
LB	43316L1A/NO	TC-60011	Bearing
		†TI-40060	Transformer - Rectifier Power Pack Unit

* Applicable to Power Systems Numbers 103, 104, 105, and 106 only.
† Applicable to all Power Systems except Numbers 103, 104, 105, and 106.

TABLE 6-2. MANUFACTURERS CODES

Manufacturer Code	Manufacturers Name
GM	General Motors, Detroit Diesel Engine Division
WG	Woodward Governor Co.
ND	New Departure, Division of General Motors Corp.
DP	Delco Products Co., Division of General Motors Corp.
TMC	Technical Materiel Corp.
MS	Micro Switch, Division of Minneapolis Honeywell Corp.
LB	Link Belt Co.
SB	The Sier-Bath Gear and Pump Co., Inc.
WP	Worthington Pump Co.
FC	The Farr Company
CC	Clark Control Company
WL	Ward Leonard Electric Company
CH	Cutler Hammer Company
WH	Westinghouse Electric Corp.
GE	General Electric Company

SECTION 7
DRAWINGS

7-1. GENERAL.

7-2. This section contains schematic and wiring diagrams of the entire 200 KW "No-Break" system.

7-3. LEGEND OF ABBREVIATIONS.

7-4. Table 7-1 lists the abbreviations used on all power system electrical drawings along with their appropriate meanings.

TABLE 7-1. LEGEND OF ABBREVIATIONS, POWER SYSTEM ELECTRICAL SCHEMATICS

Abbreviation	Meaning
ABD	Air Box Damper
ALT	Alternator
A M	Ammeter
ARM	Armature
AUTO	Automatic
AUTO SYNC	Automatic Synchrophaser
AUX	Auxiliary Relay
BRG L	Bearing Over-Temperature Indicator Light
BRG R	Bearing Over-Temperature Relay
CB	Circuit Breaker
CF	Frequency Sensing Relay
CF+ and CF-	Exciter Field Compensator Terminal Lugs
CIRC BRK'R SWITCH	Circuit Breaker Switch
CL R	Clutch Relay
CL RELAY	Clutch Relay
CL PUMP	Clutch Pump
CL TRANS	Clutch Transformer
CO-5	Current Sensing Relay
C S	Control Switch
CT	Current Transformer
Current TRANSF	Current Transformer
EMER ON	Emergency Power On
EXC , EXCT , or EXT	Exciter

TABLE 7-1. LEGEND OF ABBREVIATIONS, POWER SYSTEM ELECTRICAL SCHEMATICS (Cont.)

Abbreviation	Meaning
F+ and F-	Excitor Field Terminal Lugs
FREQ M	Frequency Meter
GEN FAIL	Generator Failure
GOV CONT	Governor Control
HI-LO PHASE SENTINEL	High Voltage-Low Voltage Phase Sentinel
HR M	Hour Meter
HWL	Water High-Temperature Indicating Light
HWR	Water High-Temperature Relay
HWS	Water High-Temperature Switch
HYD R	Hydraulically Operated Relay
HYDRO PUMP	Hydrostarter Pump
ISG	Idle Speed Governor
K.W.M.	Kilowatt Meter
LOL	Low Oil Pressure Indicating Light
LOS	Low Oil Pressure Switch
LOR	Low Oil Pressure Relay
MAN	Manual
MTB	Master Terminal Board
M C	Motor Contactor
MOTOR CONT	Motor Contactor
MOT ON CURR	Motor On Primary Power
M S	Motor Starter
N	Neutral
N C	Normally Closed
N O	Normally Open
O F	Over Frequency
OSG	Over Speed Governor
OSR	Over Speed Relay
P1, P2, P3	Primary Power Legs
P F M	Power Factor Meter

TABLE 7-1. LEGEND OF ABBREVIATIONS, POWER SYSTEM ELECTRICAL SCHEMATICS (Cont.)

Abbreviation	Meaning
PH SENT	Phase Sentinel
PRESS	Pressure
SEC	Secondary
SPEED SETTING POT	Speed Setting Potentiometer
STABIL	Stabilizer
START FAIL	Engine Starting Failure
SW	Switch
SYNC	Synchronizer
SYNC GOV	Synchronizing Governor
SYNC R	Synchronizing Relay
SYST	System
T1, T2, T3	Generator Legs 1, 2, and 3
T-1, T-2	Timer NO. 1, Timer NO. 2, etc.
TB	Terminal Board
T-ENERG.	Timer, Energizing
TM, T-M	Timer
TRANSD	Transducer
TRANSFMR	Transformer
U F	Under Frequency
V-1, V-2, V-3	Voltage Sensing Relays NO. 1, NO. 2, NO. 3, etc.
V M	Voltmeter

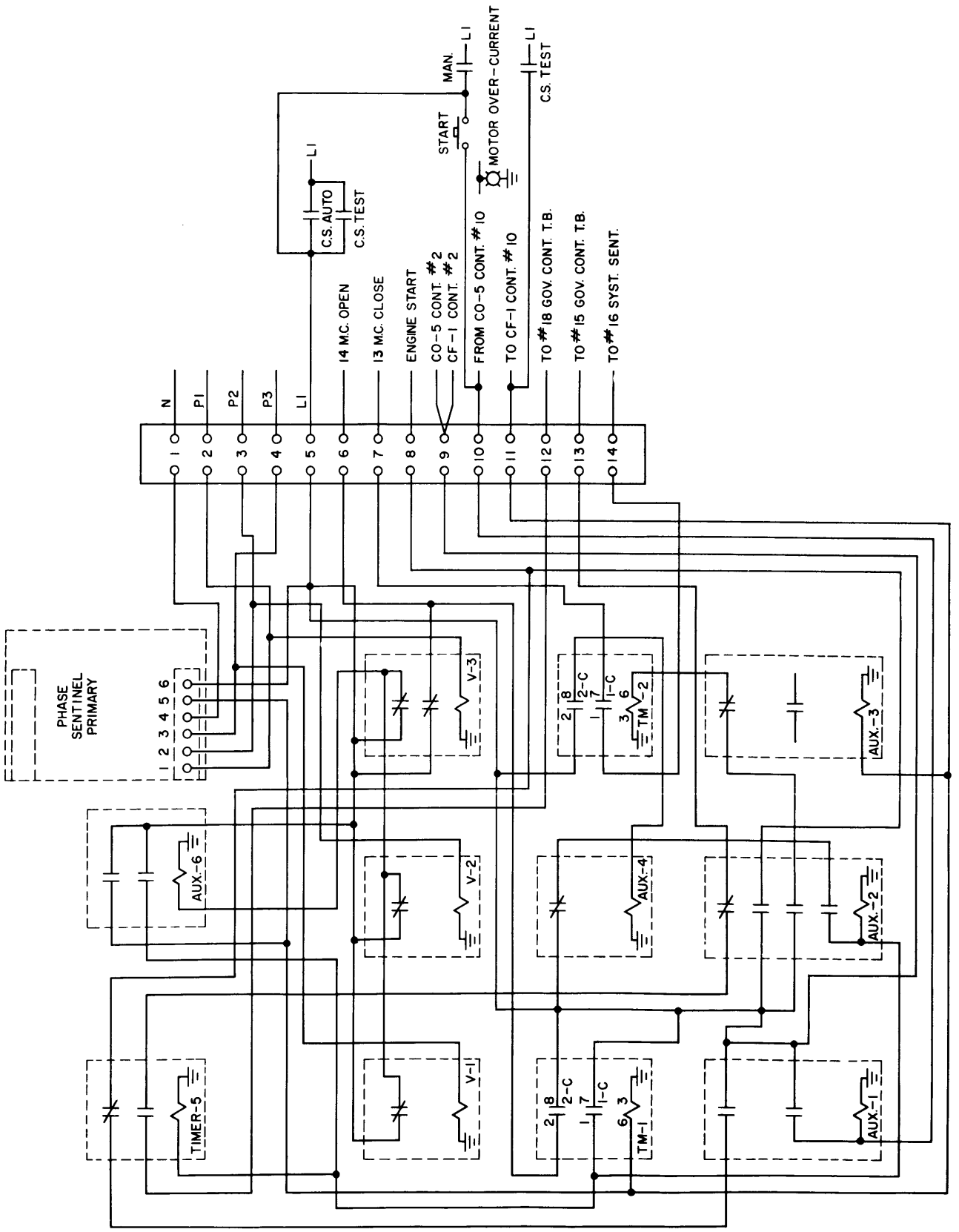
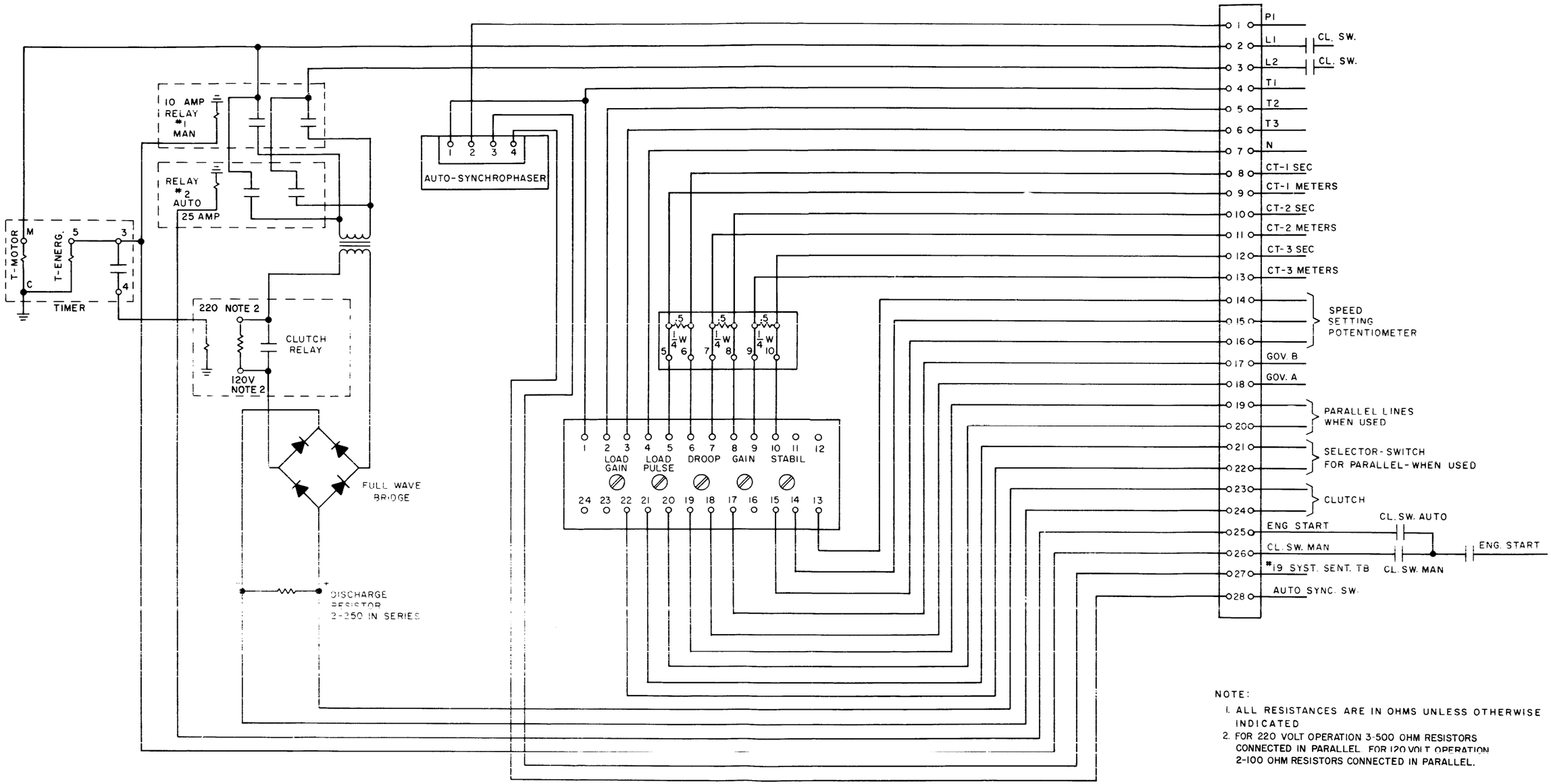


Figure 7-1. Hi-Lo Phase Sentinel and Auto Start System, Schematic Diagram



NOTE:

1. ALL RESISTANCES ARE IN OHMS UNLESS OTHERWISE INDICATED
2. FOR 220 VOLT OPERATION 3-500 OHM RESISTORS CONNECTED IN PARALLEL FOR 120 VOLT OPERATION 2-100 OHM RESISTORS CONNECTED IN PARALLEL.

Figure 7-2. Governor and Clutch Control

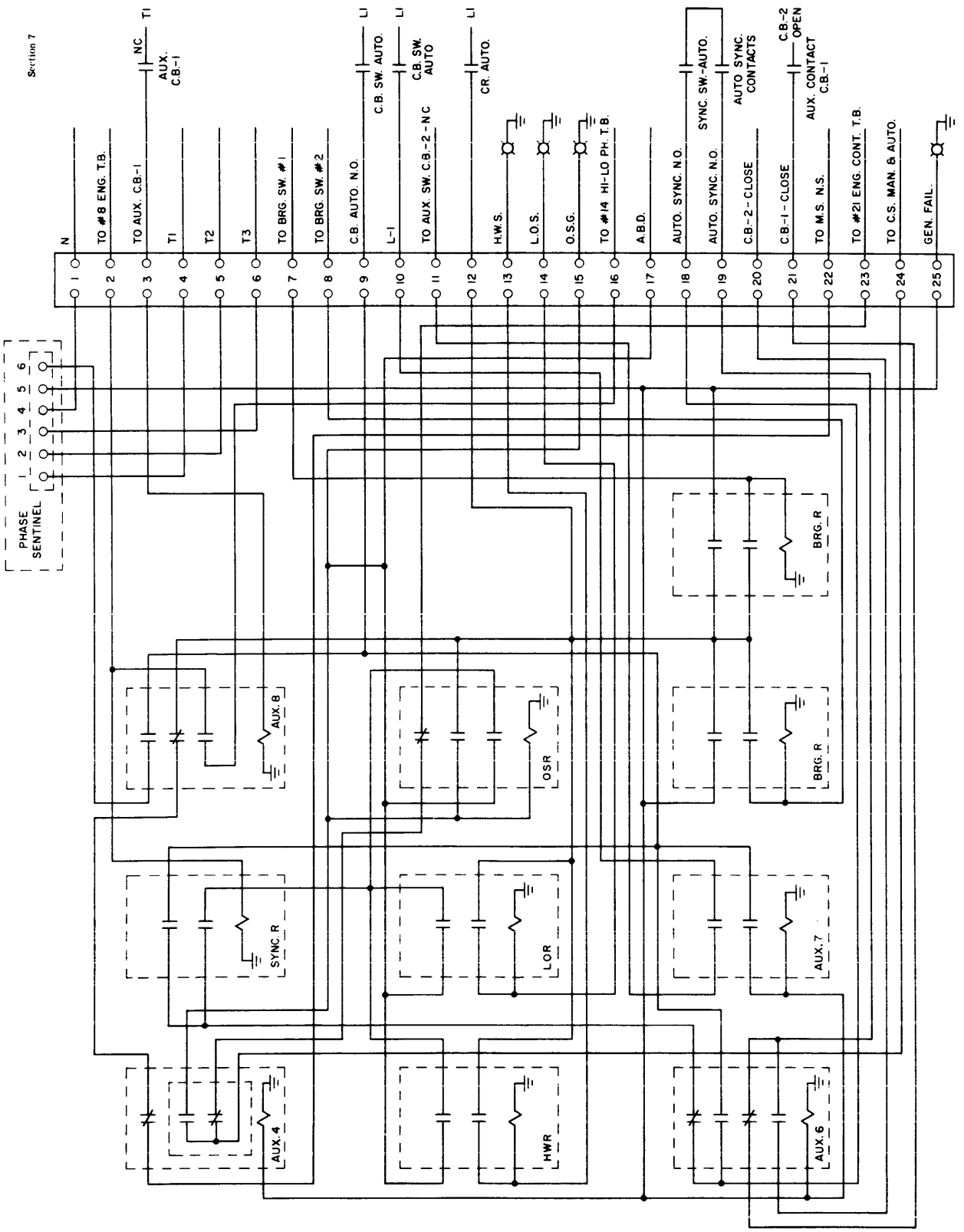


Figure 7-3. System Control Circuit, Schematic Diagram

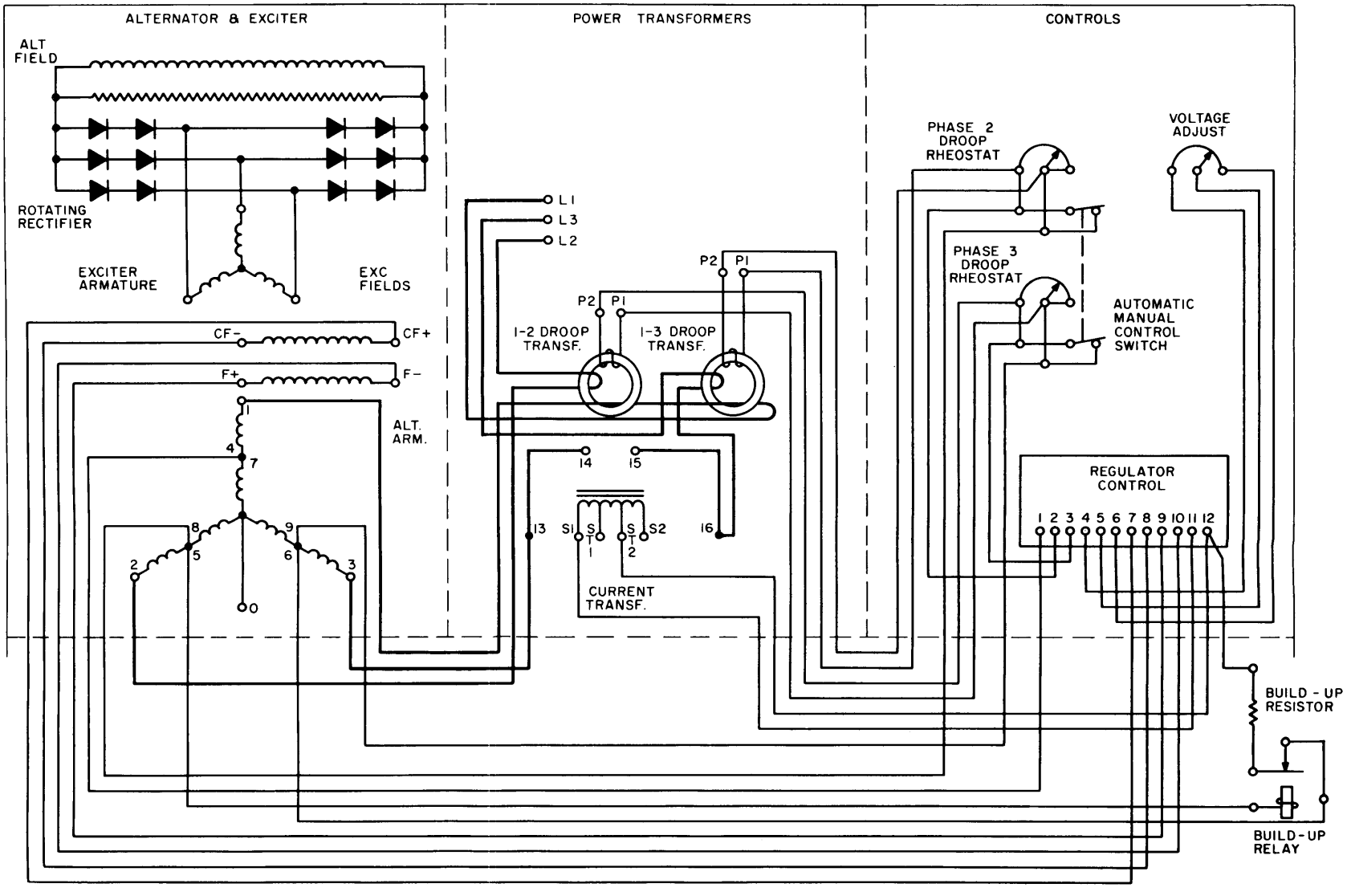


Figure 7-4. Regulator Schematic Diagram

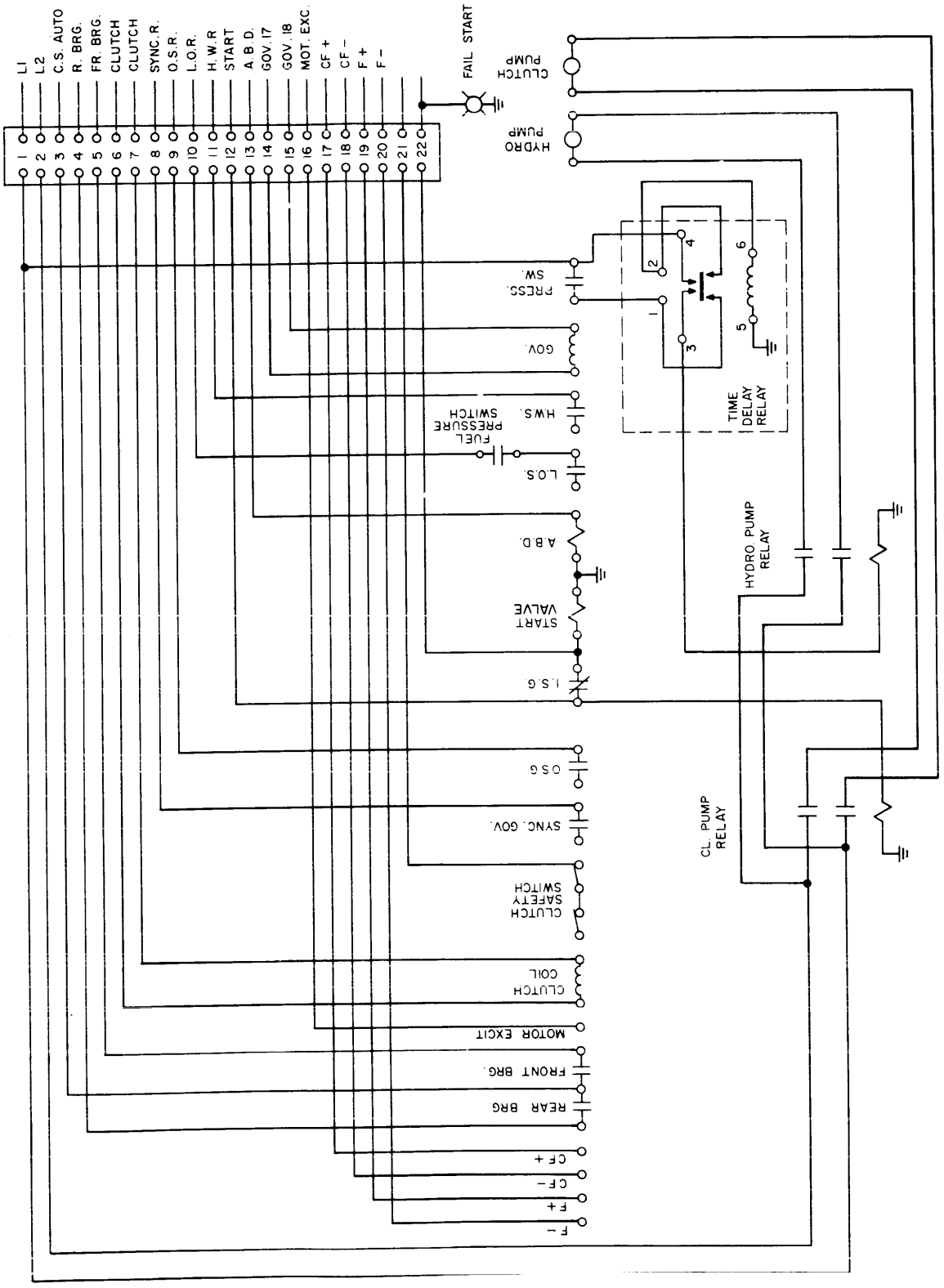


Figure 7-5. Engine Control, Schematic Diagram

	MAN.	OFF	AUTO.
1-2	X		X
3-4	X		X
5-6			X
7-8	X		

CLUTCH SWITCH

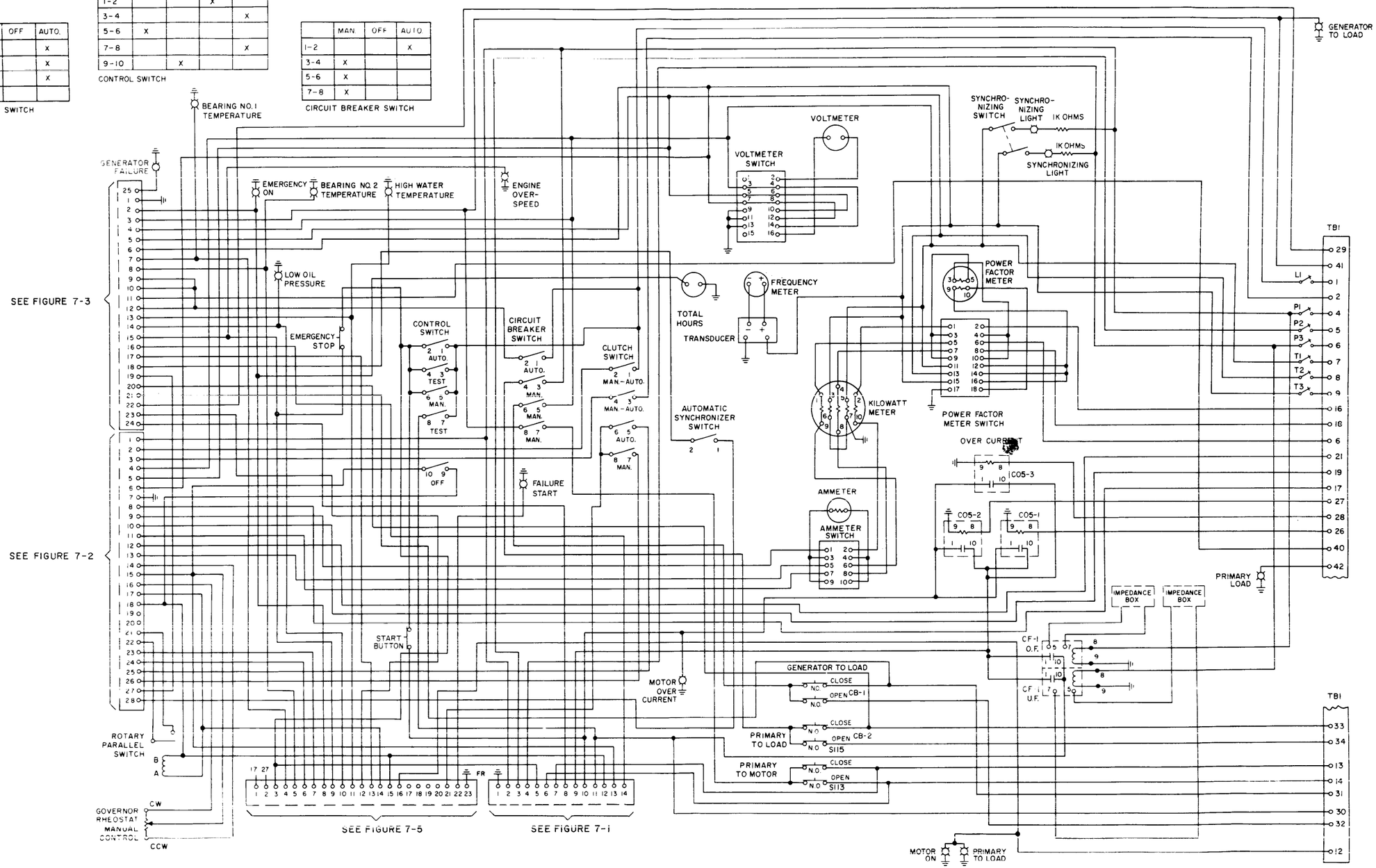
SWITCH LEGEND

	MAN.	OFF	AUTO	TEST
1-2			X	
3-4				X
5-6	X			
7-8				X
9-10		X		

CONTROL SWITCH

	MAN.	OFF	AUTO
1-2			X
3-4	X		
5-6	X		
7-8	X		

CIRCUIT BREAKER SWITCH



SWITCH LEGEND

VOLTMETER SWITCH

CONT	POSITION							
	OFF	1	2	3	OFF	4	5	6
2-3		X						
2-5			X					
2-7				X				
2-4						X		
2-6							X	
2-8								X
16-9		X						
16-11			X					
16-13				X				
16-10						X		
16-12							X	
16-14								X

AMMETER SWITCH

CONT	POSITION			
	OFF	1	2	3
1-2	X		X	X
1-3		X		
2-4		X		
5-6	X	X	X	
4-6				X
3-5				X
7-8	X	X		X
8-10			X	
7-9			X	

POWER FACTOR METER SWITCH

CONT	POSITION			
	OFF	1	2	3
1-2	X		X	X
1-3		X		
2-4		X		
5-6	X	X	X	
4-6				X
3-5				X
7-8	X	X		X
8-10			X	
11-12		X		
13-14			X	
15-16				X
17-18		X	X	X

Figure 7-6. Control Cabinet Schematic Diagram

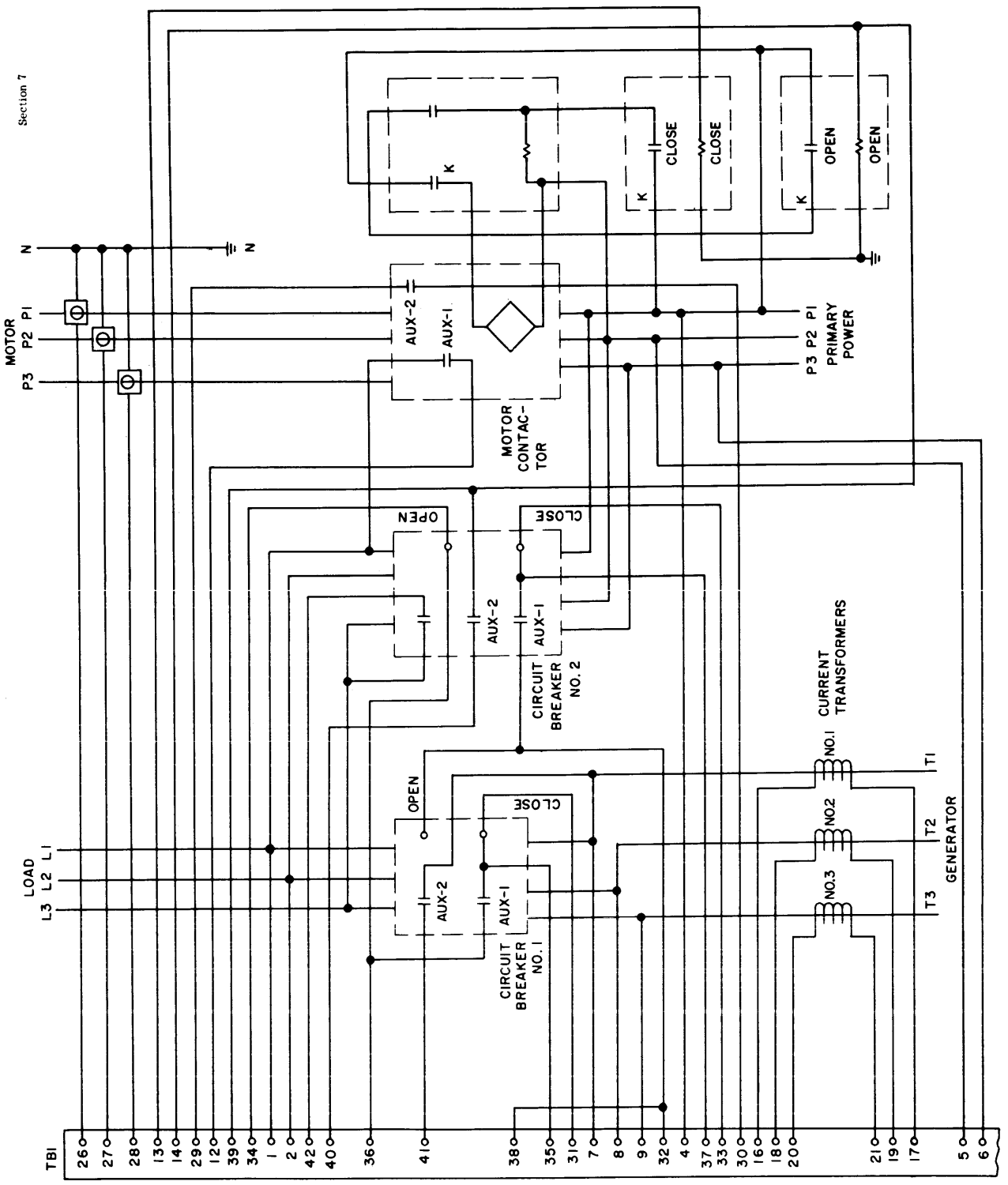


Figure 7-7. Circuit Breaker Cabinet Schematic Diagram

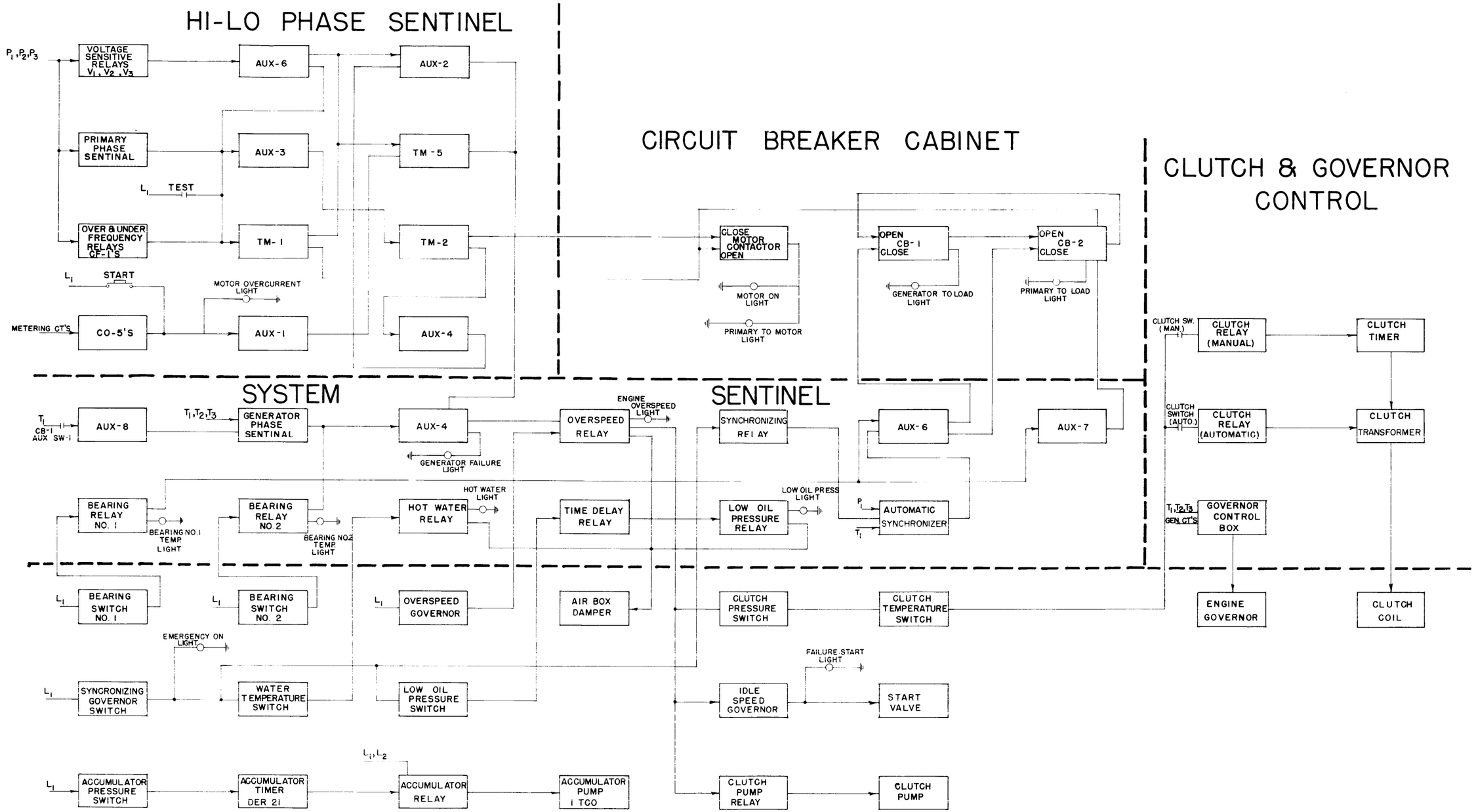


Figure 7-8. Block Diagram of Control System