

## ENGINE ALTERNATORS — DIESEL

### STERLING

### STATIONARY

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#### 1. GENERAL

**1.01** This section describes the method of operating Sterling diesel engines, Models VDS-6-S and VDS-8-S.

**1.02** It is reissued to:

- Update the format to comply with Pacific Company (PAC) Standards.
- Include the appropriate legend on Page 1 in accordance with AT&T's "Guidelines and Procedures for Safeguarding Information" and PAC's System Instruction (SI) 178.

*Note:* Marginal arrows used to denote changes are omitted.

**1.03** The Sterling diesel engines are of the 4-cycle vertical type, operating at 1200 RPM. The engine is directly connected to its associated alternator by means of a flexible coupling. The engine, alternator and exciter are mounted on a common fabricated steel sub-base and the complete set is mounted on vibration dampening supports. (See Figs. 1 and 2.) For cooling, some sets have radiators and engine driven pusher-type fans, some have radiator and electrically driven fan units near the engine, and some have heat exchangers with remote radiator and electrically driven fan assemblies. The engine is equipped with starting motors, starting battery, and associated battery charging equipment. The electrical controls are mounted on a control panel adjacent to the engine unit. See Fig. 3 for typical installation.

**1.04** The Sterling Viking Diesel, Models VDS-6-S and VDS-8-S are, respectively, 6 and 8 cylinder supercharged engines and operate on a 4-stroke cycle. A cycle is described as a series of events which take place in a cylinder between two successive firing periods. The four strokes, which are completed in two crankshaft revolutions, are generally described in the following order:

(a) *Intake* — The two intake valves open just before the piston reaches top dead center. Upon the downward movement of the piston, a supply of fresh air enters the cylinder. When the piston has passed bottom dead center, the two intake valves close, completing the intake stroke.

(b) *Compression Stroke* — Both intake and exhaust valves are closed and as the piston moves upward the air is compressed. Sufficient heat (approximately 900 to 1000°F) is produced by the compression to ignite diesel fuel when the piston nearly reaches top dead center.

(c) *Power Stroke* — Actual injection of the fuel, at 3000 pounds per square inch, begins just before top dead center is reached and upon ignition forces the piston downward. Combustion of the fuel charge continues throughout the remainder of the power stroke.

(d) *Exhaust Stroke* — The two exhaust valves open just before bottom dead center and stay open throughout the upward movement of the piston, allowing the exhaust gases to be expelled from the cylinder. Near the end of the exhaust stroke, the intake valves open, allowing fresh air to enter and scavenge or clear out remaining exhaust gases from the combustion chamber.

**1.05** The fuel system consists essentially of a fuel tank with supply and return lines connected to the engine, fuel strainer, transfer pump, duplex fuel filters, air vent valve, a high pressure fuel injector pump and injector for each cylinder, a manual fuel primary pump, various valves, pressure

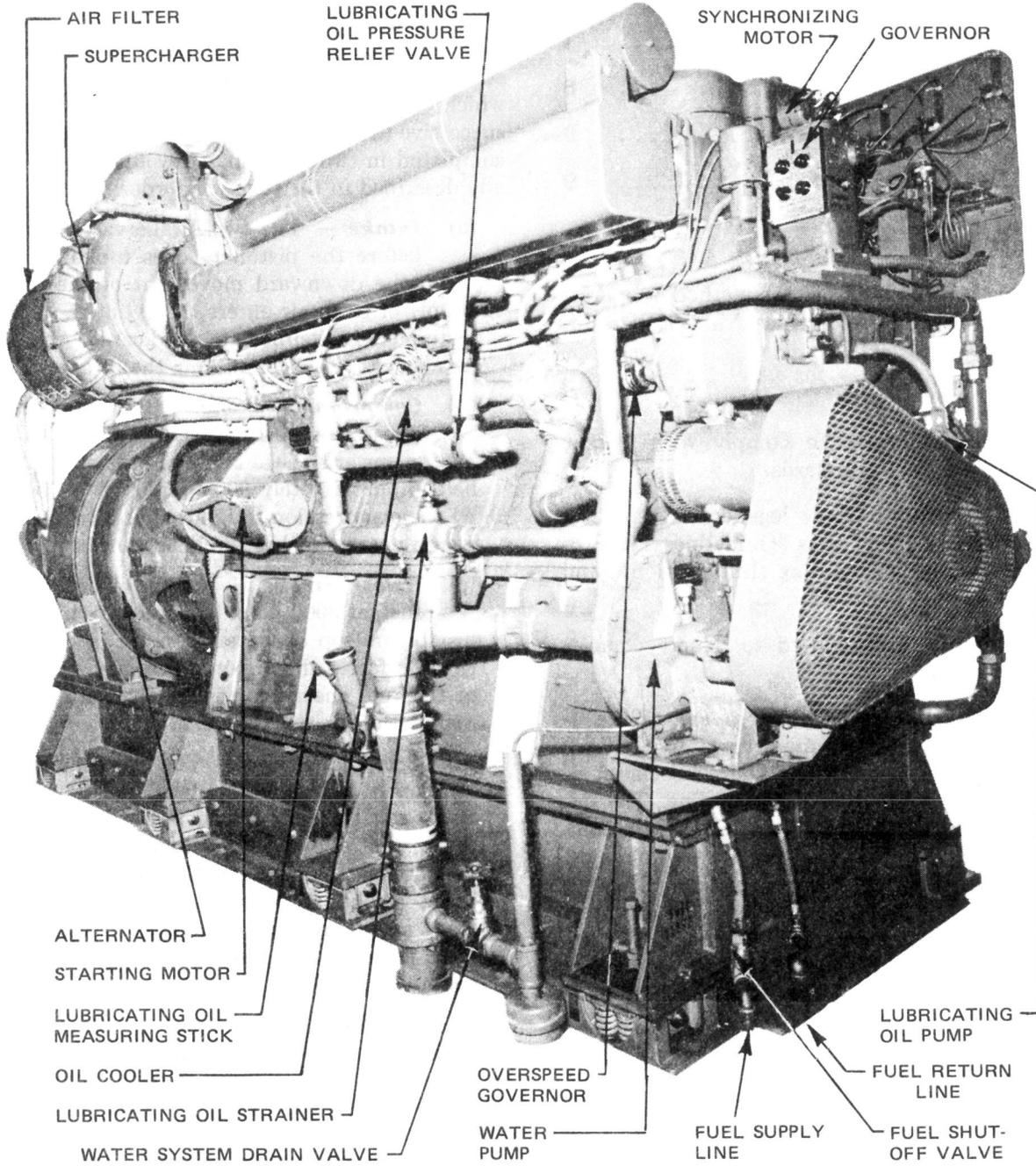
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gauge, etc, as indicated in Fig. 4. Fuel is drawn from the tank through the strainer by the transfer pump (or by the priming pump) and pumped through one unit or the other of the duplex filter to the high pressure injector pumps. The injector pumps are operated by the fuel cam of the engine crankshaft and pump fuel to their respective cylinders through a fuel injector in each cylinder head. The quantity of

fuel injected is determined by the position of a metering helix in the pump plunger, which position is in turn controlled by the fuel rack setting as adjusted by the engine controls and governor. The air vent valve is provided to vent off any air which may be introduced into the fuel system before it reaches the injector pumps.

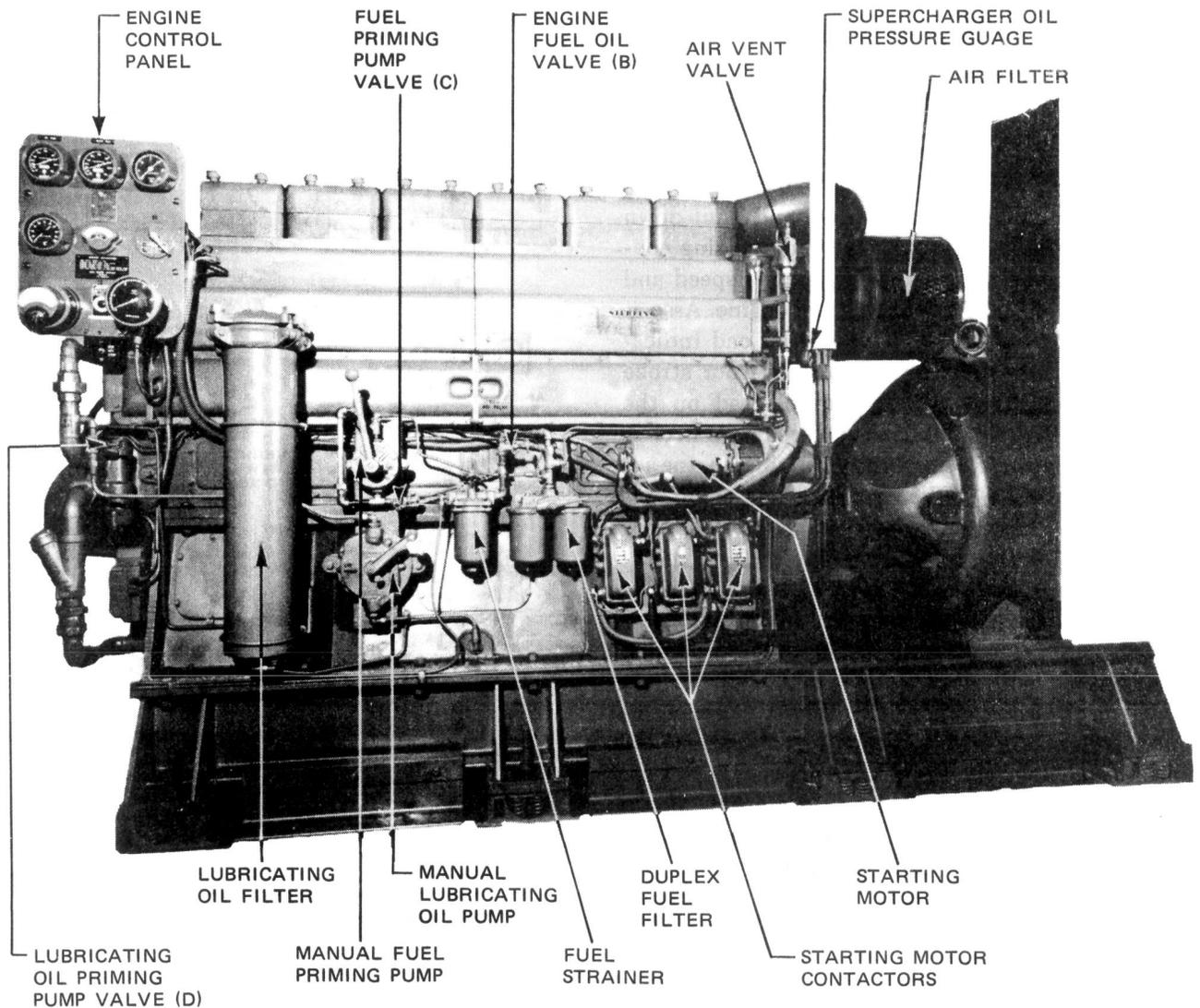


**Engine-Alternator Set — Model VDS-6-S — End View  
Fig. 1**

1.06 The supercharger is a Buchi Turbo-charger which, driven by exhaust gases, supplies additional air for combustion. The speed of the turbocharger blower and therefore the pressure of the supercharging air automatically adjust themselves to the existing engine load due to variation of exhaust pressure with the load.

positive displacement oil pump and oil lines and drilled passages in various parts of the engine. An oil cooler, oil strainer, and oil filter are provided, and a pressure regulating valve maintains correct engine lubricating oil pressure. The turbocharger is lubricated by oil from the engine lubricating oil header, with a pressure regulating valve provided in the connection for the purpose of maintaining a lower operating oil pressure in the turbocharger. A manual lubricating oil priming pump is provided for the purpose of building up oil pressure prior to starting the engine.

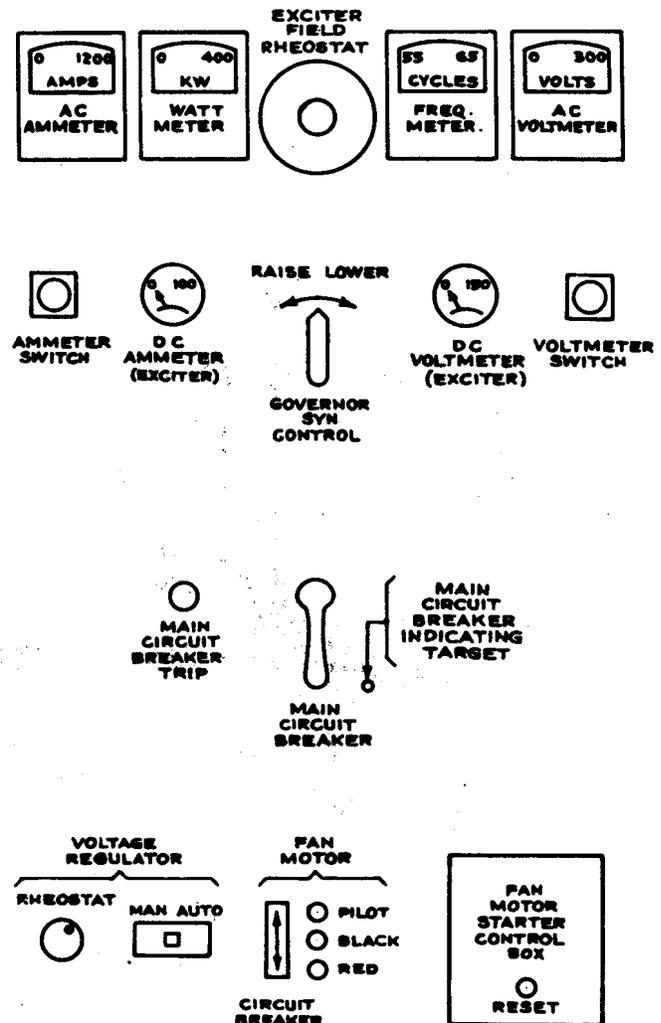
1.07 The engine lubricating system illustrated in Fig. 5 supplies oil under pressure to all parts of the engine by means of a rotor type, gear driven,



Engine-Alternator Set — Model VDS-6-S — Control Side  
Fig. 2

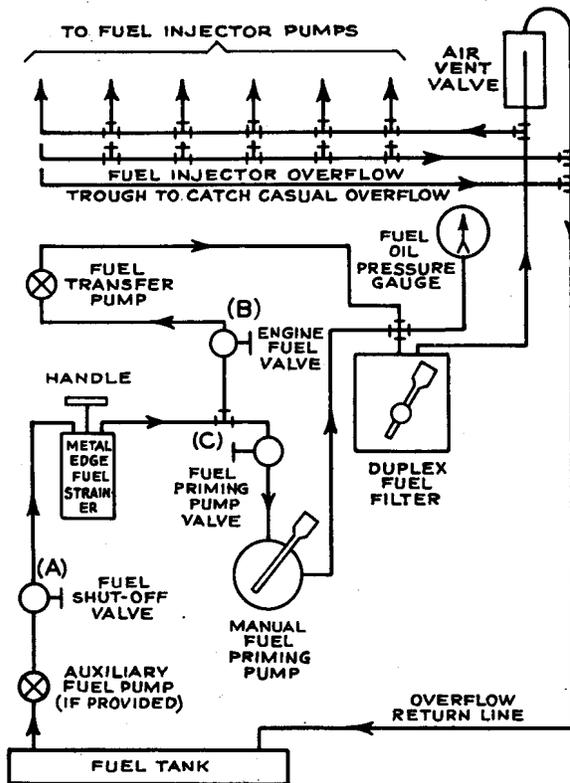
**1.08** The Woodward UG8 Dial Control governor is of the hydraulic type and is normally adjusted so that it will maintain same engine speed regardless of engine load. The Synchronizer, or speed adjusting control, is used to change the engine speed when running alone or to change the engine output load when the engine has been paralleled with other units. The Synchronizer Indicator located directly below the synchronizer control merely indicates the number of revolutions of the latter control knob. A Synchronizing Motor may be mounted on the governor cover to provide remote speed control. Its use enables an operator to adjust the frequency of an engine driven alternator from a remote control board prior to synchronizing with other units, or to change load distribution after synchronizing. The Load Limit Control limits the load that can be put on the engine by restricting the movement of the shaft which control the amount of fuel supplied to the engine. It can be used to restrict engine speed during the warm-up and shut-down periods. Generally, the governor synchronizing controls should be used for adjusting engine speed and the stop switch used for stopping the engine. Associated with the Load Limit Control is a Load Indicator which indicates the amount of governor stroke being used and thus the amount of load on the engine. (See Fig. 6.) The Speed Droop Control is provided primarily for use when running engine alternators in parallel. When running one engine alternator alone the control is normally set for zero droop, which setting allows the governor to maintain constant speed regardless of load within the limits of no load and the load for which the Load Limit Control is set. When running units in parallel the speed droop controls can be set to divide and balance the load automatically between the paralleled sets. Under this method of operation the speed droop controls should be set at the lowest point that will give satisfactory load division. If one unit in the plant has enough capacity, its governor may be set on zero droop and it will regulate the frequency of the combined units. This unit will take all the load changes within the limits of its capacity and will control frequency if its capacity is not exceeded. Under this method of operation the frequency of the combined units is adjusted by operating the synchronizer of the governor having zero droop. Redistribution of load between units is accomplished by operating the synchronizers of the governors having speed droop.

**1.09** The Overspeed Governor is electrically connected to a solenoid control which, when the circuit is closed, shuts off the fuel supply by closing the fuel rack on the fuel pumps, or shuts off the fuel supply in the main fuel header, depending on the installation. The governor is set to operate the solenoid control when the engine reaches 6 to 7 percent above rated speed. This circuit is closed by a microswitch which is operated by the governor flyballs through a pressure pin. When the flyball pressure is released from the microswitch, the governor is automatically reset, or is manually reset by pressing a button located on top of the overspeed governor, depending on which type of governor is used.



Typical Electrical and Engine Control Panel  
Fig. 3

**1.10** The Lubricating Oil Pressure Safety Switch is electrically connected to a solenoid control which, when the circuit is closed, shuts off the fuel supply in a manner similar to that of the overspeed governor. This switch operates the solenoid when the lubricating oil pressure goes below 20 to 25 pounds and thus requires that it be made inoperative while starting and until the oil pressure has built up sufficiently to keep the contacts open. This is accomplished by means of a Lubricating Oil Safety Control By-Pass Switch mounted on the engine control panel.

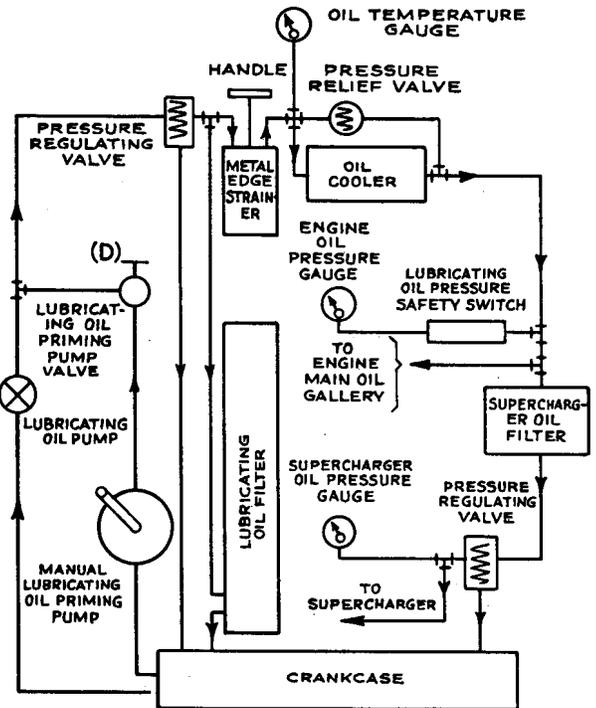


**Typical Fuel Supply Arrangement  
Fig. 4**

**1.11** The Water High Temperature Safety control switch is electrically connected to a solenoid control which, when the circuit is closed, shuts off the fuel supply in a manner similar to that of the overspeed governor. This switch operates the solenoid when the water temperature rises above approximately 190°F.

**1.12** Care must be used to prevent dirt entering a fuel oil storage tank. See that the supplier or attendant cleans all equipment used in filling the tank before placing fuel oil in the tank. Always allow new fuel to settle for at least 6 hours before using, if

it is at all practicable. Ordinary fuel oil that has been stored for more than 6 months in a storage tank or engine base has a tendency to form gum. After 6 months, it is desirable to remove the fuel from the storage tank and dispose of it, but this may be avoided to a large extent by limiting the quantities of fuel oil to such amounts that they will be used up within this time. Stabilized or compounded fuel oils may have a longer storage rating, however. Use Standard Diesel Fuel.



**Typical Lubrication Arrangement  
Fig. 5**

**1.13** Keep the engine clean and well lubricated as dirt and lack of lubrication cause undue wear. Care should be taken to remove dirt from all points of lubrication before lubricant is applied.

**1.14** Routine checks on emergency power plant equipment should be made during a period when they will cause the least service reaction.

**1.15** Additional information on the control of these sets, which involves the equipment for engine and alternator control and voltage regulation, may be found in the drawings and manuals furnished by the manufacturer.

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1.16 More detailed information on the operation and maintenance of individual pieces of apparatus, including information which would be useful when an overhaul of the set is required, is to be found in the instruction manuals which are furnished by the manufacturer with each set.

1.17 The cooling water capacity of engine water jacket circulation systems is approximately as follows:

ENGINE	LOCATION	Approx. Cap. Gallons
Sterling VDS-6-S	San Jose Main	45
Sterling VDS-6-S	San Francisco Mission	45
Sterling VDS-6-S	Fresno Main	35
Sterling VDS-8-S	East Bay Franklin	60

**CAUTION:** Avoid the use of an open flame or a portable lamp without a protecting guard while working around the engine, particularly near any part of its fuel system. While Diesel oil is not normally explosive, it will ignite and burn if sufficient heat is applied through the medium of an open flame.

2. OPERATION

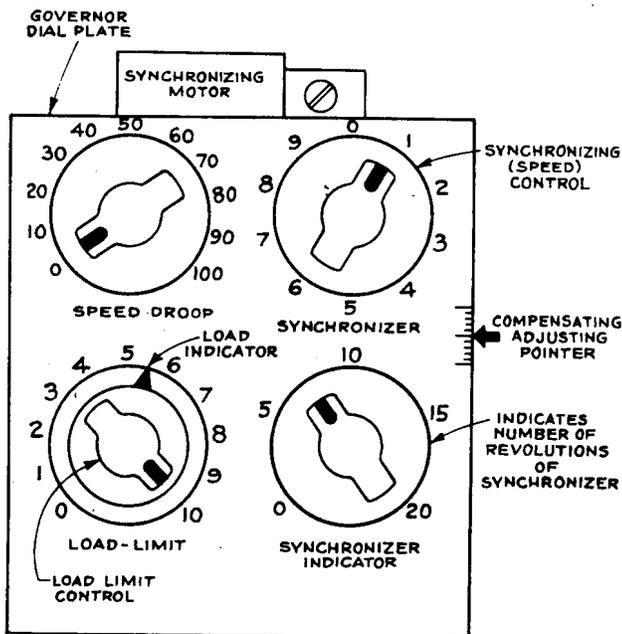
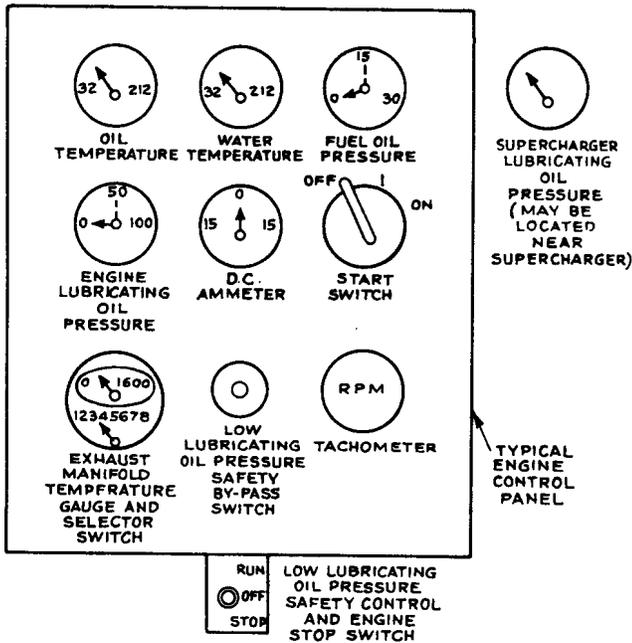
Preparation for Starting

2.01 Before starting, go over the engine carefully to see that there are no tools or other objects on it which could interfere with its operation.

2.02 Make certain that there is fuel in the fuel tank sufficient for the expected run.

2.03 Make certain that the oil in the crankcase is at the proper level as indicated by the marks on the gauge. Also check the governor oil level. The oil level in the crankcase should never be permitted to fall below the "LOW" mark on the gauge while the engine is operating. Should oil in the crankcase show a higher level than previous reading, examine the odor of the lubricating oil for a trace of fuel oil. If fuel oil is present, tighten all fuel line connections, drain crankcase and refill with fresh lubricating oil. If the appearance of emulsion or water in the crankcase is noted, steps should be taken to reseal the head gasket and then change the oil.

**Note:** On engines equipped with forced feed lubrication, the FULL mark on the gauge is designed to assure an adequate supply of lubricating oil for long runs. However, experience with oil consumption of a particular engine may indicate that it is preferable to replenish the oil in the crankcase to a level slightly below this mark.



Typical Engine and Governor Controls  
Fig. 6

- 2.04** Lubricate parts requiring lubrication. (See Chart A.)
- 2.05** Close drain valves in exhaust line and silencer. If the engine is equipped with an air exhaust duct extending from the engine radiator to the outside see that any louvers, etc, provided in this duct are properly operated.
- 2.06** Open valves in fuel lines and start auxiliary fuel pump if one is provided in the line from the main storage tank to the engine. See Fig. 4.
- 2.07** On engines equipped with radiator and engine-driven fans or electrically driven fans near the engine:
- Check all water jacket and radiator drains and close any that may be found open.
  - Open the water supply valve to radiator until water flows from the overflow drain, then close valve.
  - Do not allow excessive amounts of water to drain, as this will reduce the rust inhibitor concentration.
- 2.08** On engines equipped with heat exchangers and remote radiators:
- Check all water jacket and radiator drains and close any that may be found open.
  - Check water gauge on expansion tank for engine water jacket circulation system. If necessary, open water supply valve to bring water level up to mark indicated on gauge, then close valve.
  - Be sure that sufficient water is in the remote radiator system.
- Note:** At Fresno add water as follows, if necessary. Open water supply valve which connects roof water supply tank to remote radiator located on roof and allow radiator to fill as much as possible by static head pressure. Then close valve and open two valves associated with manual water pump. Manually pump water to radiator until a continuous flow from overflow drain indicates that radiator is full, then close manual pump valves.
- 2.09** Operate DUPLEX FUEL FILTER SELECTOR HANDLE to cut-in opposite filter.
- 2.10** Close ENGINE FUEL VALVE (B) and open FUEL PRIMING PUMP VALVE (C), Fig. 4.
- 2.11** Operate MANUAL FUEL PRIMING PUMP until a pressure of 10 to 15 pounds is indicated on the fuel pressure gauge.
- 2.12** Close FUEL PRIMING PUMP VALVE (C) and open ENGINE FUEL VALVE (B), Fig. 4.
- 2.13** Open LUBRICATING OIL PRIMING PUMP VALVE (D), Fig. 5.
- 2.14** Operate the LUBRICATING OIL PRIMING PUMP until a pressure of 20 pounds is indicated on the oil pressure gauge.
- 2.15** Close LUBRICATING OIL PRIMING PUMP VALVE (D), Fig. 5.
- 2.16** Note that the governor LOAD LIMIT CONTROL is in position 10.
- 2.17** Note that the SYNCHRONIZING INDICATOR on the governor is in the minimum speed position. (This setting restricts the engine speed to approximately 600 RPM, and should be so set from the previous shutdown. If not, manually retard the SYNCHRONIZING CONTROL DIAL to the minimum setting.)
- 2.18** Operate the LOW LUBE OIL PRESSURE SAFETY CONTROL AND ENGINE STOP SWITCH to the RUN position.
- 2.19** **Starting:** Press the LOW LUBRICATING OIL PRESSURE SAFETY BY-PASS SWITCH and operate the START switch to position No. 1. Allow a short interval (approximately 1/2 second) to permit the starting gears to engage, then advance the START switch to the RUN position. If the engine does not start in 15 to 20 seconds, release the START switch and allow a 15 second interval before attempting to start the engine again.
- Note:** When advancing the START switch to the No. 1 position the operator may be able to note audibly the relay operation and gear engagement.

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**2.20** After the engine starts, observe that the lubricating oil pressure gauges (engine and turbocharger) show a positive registration, indicating that oil is being supplied to the moving parts. The LOW LUBRICATING OIL PRESSURE SAFETY BY-PASS SWITCH may be released as soon as it is noted that engine oil pressure has built up to approximately 25 pounds. If after 10 or 15 seconds, no pressure is indicated on either or both gauges, stop the engine immediately. Turbocharger oil pressure should indicate at least 10 pounds. If pressure is indicated, allow the engine to warm up at idling speed for an approximate period of 10 minutes.

**2.21** After engine has warmed up, operate the GOVERNOR SYNCHRONIZER CONTROL SWITCH to bring engine up to operating speed. Note that the frequency meter reads the value, between 60 and 63 cycles, that experience indicates the proper no-load frequency.

**2.22** Note that the AC voltage rises to the proper value (208 to 210 volts). Adjust voltage, if necessary, using the VOLTAGE REGULATOR RHEOSTAT. On installations equipped with a voltage regulator AUTOMATIC MANUAL switch, this may be left in the AUTOMATIC position at all times unless the voltage regulator gives an indication of failure. Should it become necessary to remove the voltage regulator from service, remove load, adjust EXCITER FIELD RHEOSTAT to minimum voltage position, operate voltage regulator switch to MANUAL position, and adjust voltage by means of EXCITER FIELD RHEOSTAT. With voltage at proper value, load may then be applied and voltage adjusted as required by use of EXCITER FIELD RHEOSTAT.

**2.23** Start the room ventilating fan, if one is provided, or open windows as much as local conditions permit.

**2.24** If a heat exchanger is provided, start remote radiator fan and water pump motor. If unit is provided with electrically driven fan near engine instead of engine-driven fan, start fan motor.

**2.25** Note that the CIRCUIT BREAKER for the fan motor, if provided, is in the ON position. Start fan motor by pressing black START button. If fan motor does not start, check fan motor overload control switch and reset by means of RESET switch if necessary.

**2.26** When it has been determined that the load can be connected, close the MAIN LINE CIRCUIT BREAKER. Load can then be applied. Gradual application of the load is desirable.

**2.27 *Running:*** After the load has been applied, adjust speed by means of the GOVERNOR SYNCHRONIZER CONTROL SWITCH to maintain frequency of 60 cycles, as indicated on FREQUENCY METER.

**2.28** During a prolonged run, try to keep the oil in the fuel oil tank above the 1/4 full level mark.

**2.29** See that the oil pressure, as indicated by the pressure gauges, does not fall below 40 pounds for the engine or 10 pounds for the turbocharger. Normal oil pressure are as follows: 60 to 70 pounds for engines at operating speeds, 20 to 30 pounds at idling speeds, and 12 to 17 pounds for turbochargers.

**2.30** The normal OUT temperatures of the lubricating oil is 165°F to 175°F with a maximum of 195°F.

**2.31** The maximum temperature of the cooling water, as indicated on the water temperature gauge, should not exceed 185°F for an installation where the surrounding air temperature is below 110°F. Where the surrounding air temperature is above 110°F, the temperature of the cooling water should not be permitted to exceed 195°F.

**2.32** The maximum difference between the highest and lowest cylinder exhaust temperature, as indicated by the EXHAUST MANIFOLD TEMPERATURE GAUGE, should not exceed 100°F after the engine has thoroughly warmed up. Variations greater than 100°F should be referred to the Power Maintenance Engineer for corrective action.

**2.33** Under prolonged operation, the crankcase oil level should be checked every 8 hours, or more often if required to meet the instructions outlined in 2.03. Feel the cover on top of the lubricating oil filter occasionally to see that it is warm. If cold, it indicates the filter is clogged. Correct as necessary.

**2.34 *Stopping:*** Remove the load. Gradual removal is preferable. Ventilating fans, water pumps, and remote radiator fans which may be part of the load should be stopped last.

- 2.35** Open the MAIN LINE CIRCUIT BREAKER.
- 2.36** Gradually reduce speed to idling by means of the GOVERNOR SYNCHRONIZING CONTROL SWITCH. Note that the SYNCHRONIZING CONTROL DIAL is in the minimum or idling speed position. Allow engine to idle for 2 to 3 minutes to allow more uniform cooling of engine parts.
- 2.37** Stop engine by operating the LOW LUBRICATING OIL SAFETY CONTROL and STOP switch to the STOP position. Hold in this position until engine is completely stopped, then release.
- 2.38** Close valves in fuel lines, and stop auxiliary fuel line pump, if provided.
- 2.39** Stop the room ventilating fan, if provided and operating from another power source, and close windows if opened.
- 2.40** Open valve or drain in exhaust line and silencer. If an air exhaust duct is provided between the engine radiator and the outside, see that any louvers, etc, are properly closed.
- 2.41** If there is any danger of water freezing in the water jackets or other parts of the cooling system and an anti-freeze is not used, drain cooling system and leave drains open. Draining of the cooling system should preferably be done only as an emergency means, since the loss of rust inhibitor would be uneconomical as a general practice.
- 2.42** Replenish the oil in the crankcase as necessary.
- 2.43** Clean the engine thoroughly and be sure it is in proper shape for the next run.
- 2.44** Check the amount of fuel in the tank and replenish as required to ensure that ample supply of fuel is available for the next run.
- 2.45** *Routine Runs and Checks:* Routine runs should be made in accordance with Sections for particular type of engine.
- 2.46** On installations equipped with starting batteries and trickle chargers, frequent checks should be made wherever practicable, to ensure that

the charger is functioning and that the battery is fully charged. If possible, use the same maintenance procedures as are used for other batteries in the power plant.

**2.47** *Reports:* Record each run as per items on Engine Run Log Form E 5697-PAC. Readings should be taken at the start and end of each run and at one-half hour intervals during the run. When changes are made in the load during a run, readings should be taken as soon as practicable after changes have been made.

**2.48** A copy of Form E 5697-PAC covering each run should be retained in the central office file.

### 3. LUBRICATION

**3.01** All main bearings of the engine and certain accessories such as supercharger, water pump, fuel pump, etc, are provided with automatic lubrication and do not require manual lubrication. (See Chart A for parts requiring lubrication.)

**3.02** Sudden failure of the oil pressure would indicate failure of the oil system, whereas a normal pressure when starting with the oil cold, then a gradual drop in pressure below normal as the engine warms up may indicate a low oil supply, oil dilution, wear on crankshaft bearings, or sticking oil pump relief valve. *Should the oil pressure fall below the minimum specified in 2.29, stop the engine, determine cause and apply remedy before restarting the engine.*

### 4. GENERAL TROUBLES

**4.01** Any trouble, with the exception of minor mechanical difficulties, is usually traceable to air in the fuel lines, weak compression, improper mixture of fuel and air, poor combustion, lack of proper lubrication, or improper cooling.

**4.02** For a list of the possible troubles which may be encountered in the operation of the engine and suggested means for correcting these troubles refer to the manufacturer's maintenance manual. (See 1.15.)

## CHART A

## LUBRICATION CHART

INTERVAL	LUBRICANT (SEE SECTION 065-330-101)	PART	AMOUNT
Beginning of each run	(See Note)	Crankcase	Where oil level has fallen more than 1/3 distance from FULL mark to LOW mark on oil level gauge, fill to FULL mark on gauge.
		Governor	Check oil level. Add oil, if required, to maintain level at mark on sight glass.
		Alternator and Exciter Bearings	Check oil level. Add oil, if necessary, to bring up to indicated level.
Every 8 hours of continuous operation	In Lubrication and Fuel System	Crankcase	Add oil as required to bring level up to FULL mark on gauge. Never let the oil level go below LOW mark.
		Fuel and Lube Oil Strainers	Rotate strainer handles several times to remove sediment from metal edge element.
		Water Pump	Screw down on grease cup one half turn while engine is running.
100 hours	Oil 58-65 S-210	Starting Motor and Drive Bearings	2 or 3 drops. <b>CAUTION: Do not over-lubricate.</b>
Every 200 hours operation or at least once every year	(See Note)	Crankcase	Drain old oil and refill with fresh lubricant until level shows FULL on gauge, and start engine. After 5 minutes, re-check level and add oil as required to bring the level up to FULL mark. The approximate amounts of oil required to fill the crankcase for each type engine are shown below. These amounts include the oil normally carried in the oil cooler, filters, strainers, lubricating passages, etc, which, depending upon their state of fullness may sometimes vary the amounts shown. ENGINE                      APPROX. GALLONS STERLING VDS-6-S                      40 STERLING VDS-8-S                      50
200 hours	(See Note)	Turbocharger Filter Silencer	Remove filter, clean by washing with fuel oil or petroleum spirits. Dip in oil and drain before replacing.
		Governor	Drain and refill to mark on sight glass.
	Oil 56-210 S-210	Governor Throttle Linkage	Clean and oil lightly.
500 hours	Grease 200-250P	Fan Hub	Fill with grease through fitting or through hole from which grease plug has been removed. <b>Do not</b> force excessive amounts of grease through fitting. Replace plug, if provided.
	Grease Water Pump 70-200P	Water Pump	Fill cup with grease. <b>Do not</b> force excessive amounts of grease into cup.
	In Lubricating System	Lubricating Oil Filter and Strainer	Remove element and replace with new element. Remove strainer, clean by washing with fuel oil or petroleum spirits, dry and replace.

**Note:** Use Standard "Delo" or Associated SAE 30 diesel engine lubricating oil.