ENGINE-ALTERNATORS—DIESEL
KS-19583, 30 KW AND KS-19584, 45 KW
AUTOMATICALLY AND MANUALLY CONTROLLED
REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers the requirements and adjusting procedures for the KS-19583 and KS-19584 automatically and manually controlled diesel engine-alternators. It also covers the various options for the two sets.

1.02 This section is reissued to add governor filter element information, to add excessive vibration and noise information, to add radiator overpressurization caution, to revise battery information, and to add air box drain information. Figures 5 and 6 have been added. The Equipment Test is affected.

1.03 These sets are manufactured by the General Motors Corp and are rated at 30 kW for the KS-19583 set and 45 kW for the KS-19584 set and have a 0.8 lagging to 0.8 leading power factor. The sets are arranged for 208- to 240-volt, 60-Hz, 3-phase, 4-wire distribution. The engine and alternator sets are mounted on a common subbase in an inline arrangement (see Fig. 1, 2, 3, and 4). List numbers are used to identify sets as follows:

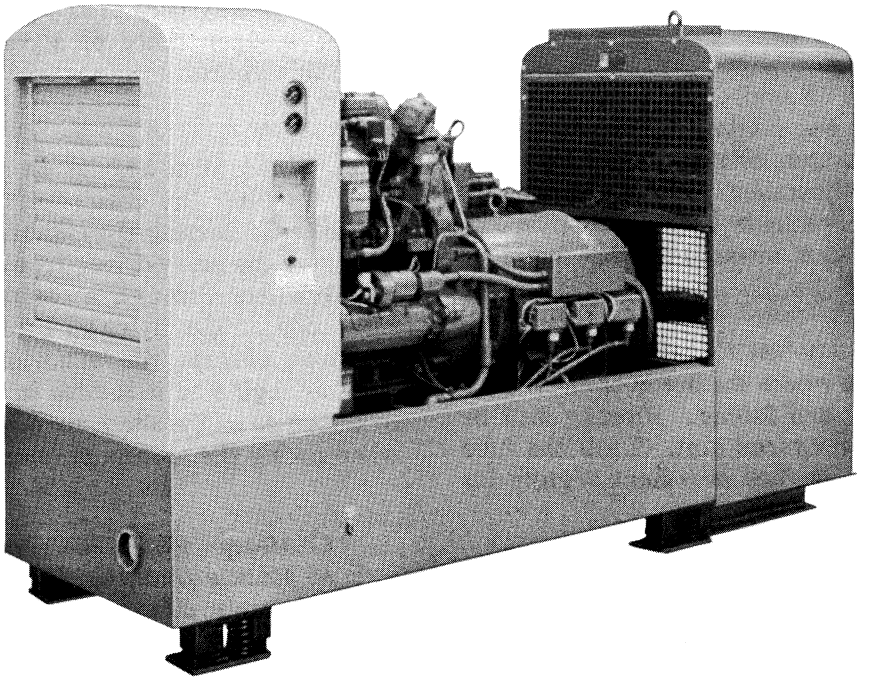


Fig. 1—Left Front View of KS-19583 Diesel Engine-Alternator

List Number

1. Engine-Alternator Set with Set-Mounted Radiator

Optional Equipment may be ordered by using the following list numbers:

2. Cold-Aid Starting Equipment
3. Shutters for Set-Mounted Radiators
4. Reserve Lube Oil Supply
5. Sound-Attenuated Enclosure
6. Set-Mounted Load Transfer Equipment

1.04 Additional information, necessary for the proper application of the requirements covered in this section, can be found in Section 020-010-711 which covers general requirements and definitions.

1.05 ***Dagger (†):*** Requirements marked with a dagger do not require a check prior to turnover.

1.06 ***Asterisk (*):*** Requirements marked with an asterisk necessitate dismantling or dismounting of apparatus, or affect the adjustment involved or other adjustment. No check need be made for these requirements unless the apparatus or part to be checked is made accessible for other reasons.

1.07 ***Hunting,*** as applied to engines, is defined as a condition where the speed of the engine is periodically rising and falling. Hunting may be either continuous or intermittent. Until the lube oil warms up, these engines may hunt slightly for several minutes.

1.08 The exciter and voltage regulator used on these engine-alternators are separate units. The exciter is of the brushless type, using a rotating rectifier bridge circuit. The voltage regulator is of the shunt-transistor type and provides regulation by comparing a portion of the alternator output voltage with a reference voltage. The difference in voltages is called an error voltage and is used to regulate the alternator output voltage.

1.09 Procedures included in this section for maintaining the requirements parallel, in part, the information contained in the manufacturer's maintenance manuals for diesel engines and supplementary instruction books for diesel generator set furnished with each set. These manuals cover, in detail, additional information which would be required for complete servicing or overhaul of the equipment rather than general everyday maintenance. Refer to Section 155-020-701 for requirements and adjustments for the J86634A Auto Solid State Control.

1.10 The information contained in this section shall take precedence over the manufacturer's manuals wherever differences occur. For example, certain cleaning fluids are prohibited in telephone buildings.

1.11 The engine shall always be stopped when making any adjustment unless otherwise specified.

1.12 When working on an engine, particularly near any part of the fuel system, avoid the use of an open flame or a portable lamp without a suitable guard.

1.13 When adjustments on the engine involve turning the crankshaft by hand, the tool provided for barring the engine shall be used. This tool is of the screwdriver type and is used to turn the flywheel through a removable plate on the right side of the flywheel housing. Before using this tool, observe the following caution. Always bar the engine so it rotates in the direction shown by the arrow on the alternator casing (counterclockwise when facing the alternator end).

Caution: Since the sets may be arranged to start automatically and because of the presence of commercial voltages within the main control cabinet, it is necessary before making any adjustments on either the set or its control equipment to render the automatic control and dc equipment inoperative. To render the automatic control and dc equipment inoperative, follow the instructions outlined in the paragraphs under the heading Working on a Set or Its Control Equipment in Section 155-191-301.

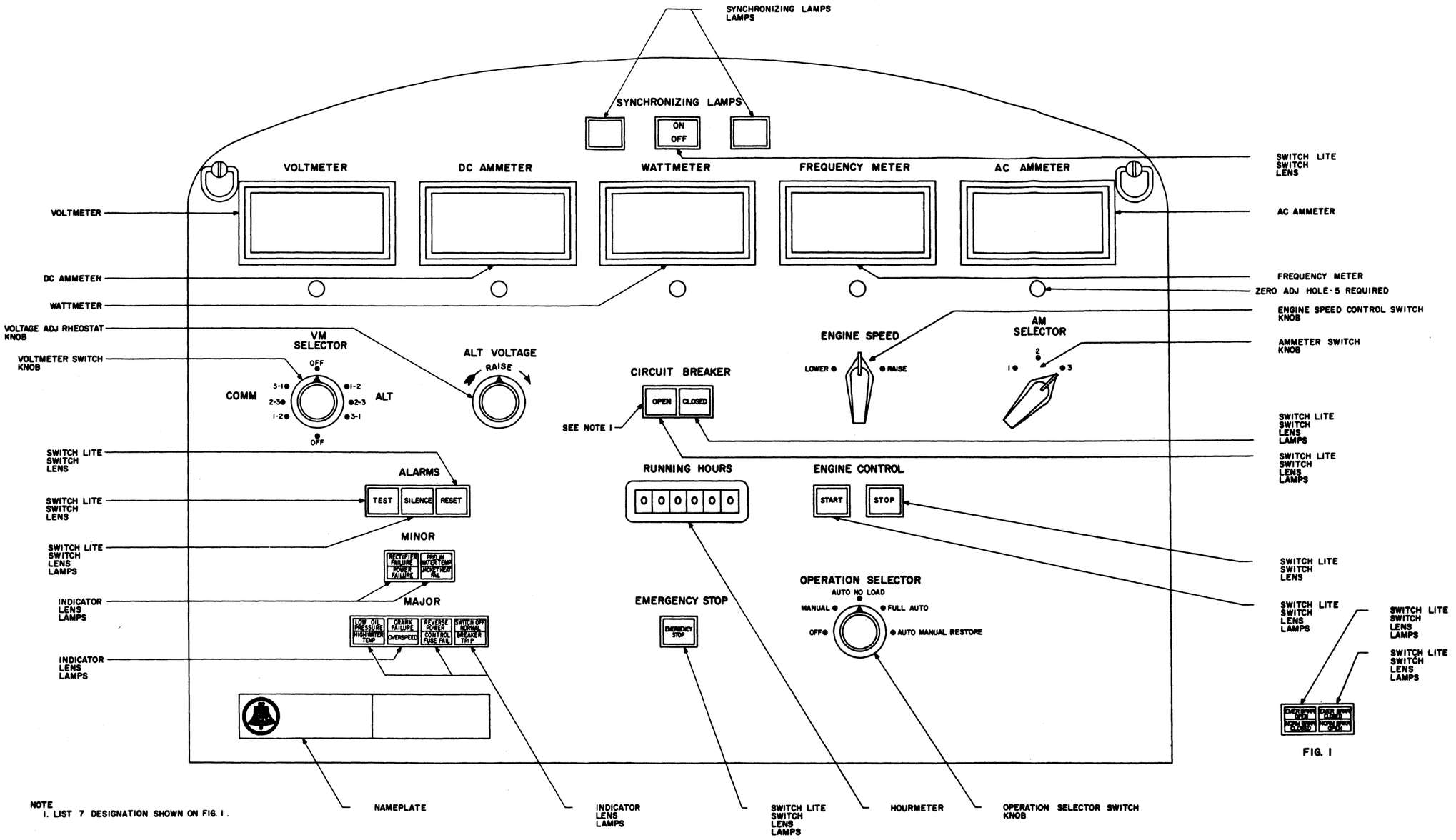
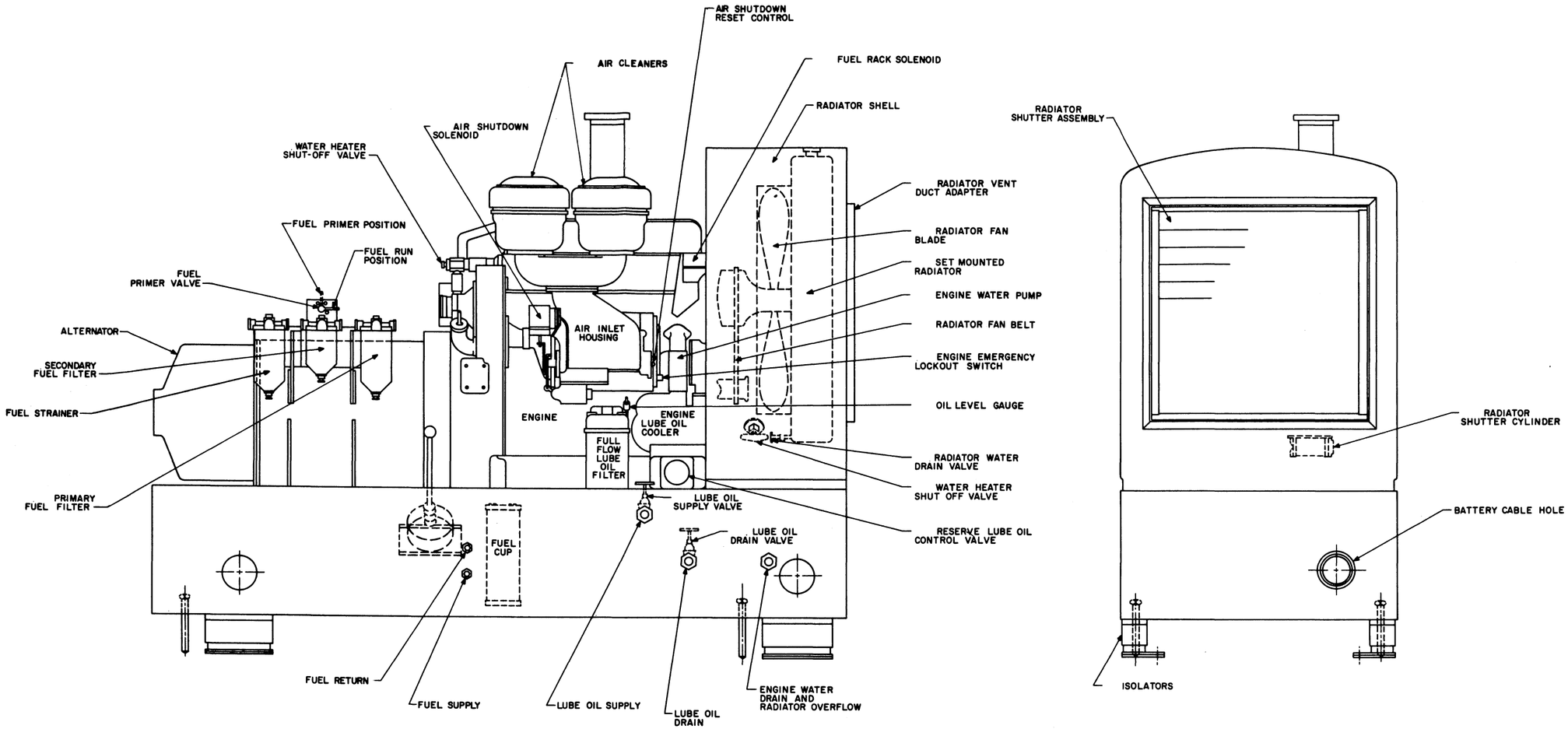


FIG. 1

CONTROL PANEL
KS-19584, LIST 2, 45KW ENGINE ALTERNATOR SHOWN

Fig. 2—Main Control Panel—KS-19584 Diesel Engine-Alternator

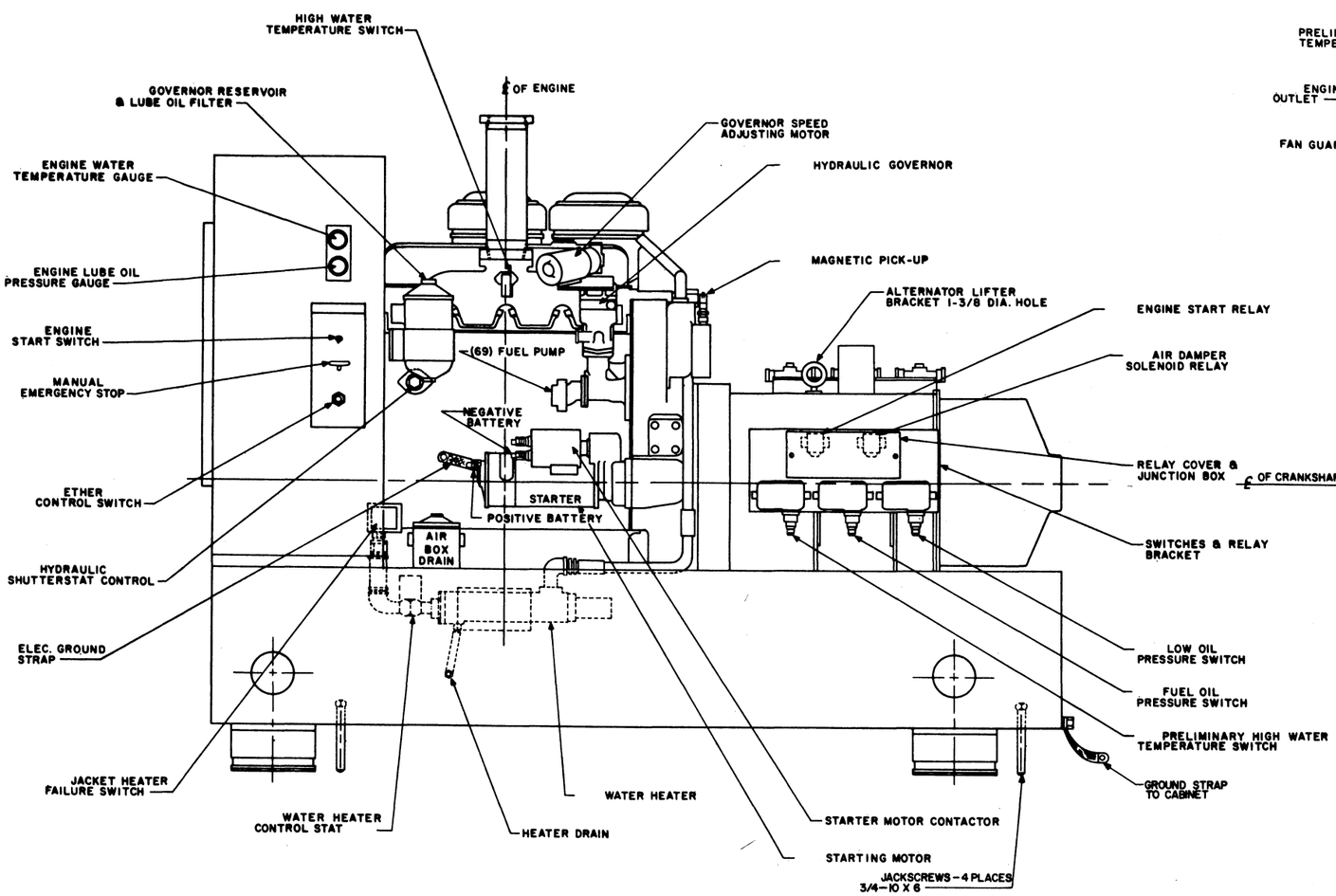


RIGHT SIDE VIEW

KS-19584 LIST 1, 45 KW ENGINE ALTERNATOR SHOWN

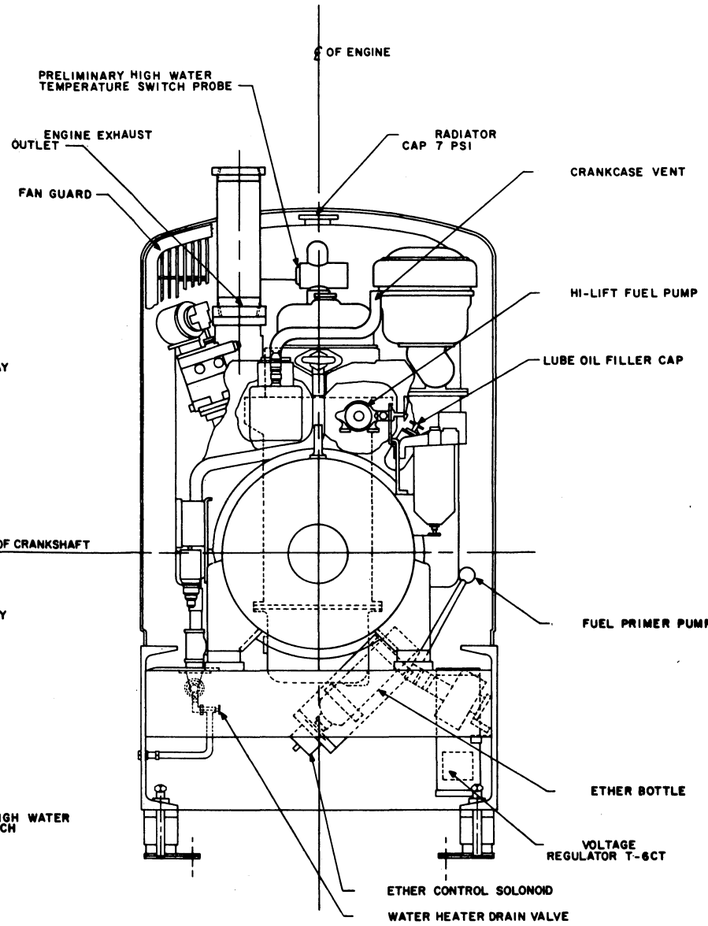
REAR VIEW

Fig. 3—Right Side View—KS-19584 Diesel Engine-Alternator



LEFT SIDE VIEW

KS-19584 LIST 1, 45KW ENGINE ALTERNATOR SHOWN



FRONT VIEW

(CONTROL CABINET REMOVED)

Fig. 4—Left Side View—KS-19584 Diesel Engine-Alternator

1.14 If the fuel tank or piping, including vent and fill pipes, is leaking, inform the supervisor. It may be desirable to have a new tank or piping provided or to acquire the services of a commercial tank specialist to repair the leak (see Section 065-320-301).

1.15 Information is both Part 2, Requirements, and Part 3, Adjusting Procedures, has been arranged under the following headings:

HEADINGS	PART 2 PAR.	PART 3 PAR.
Lists of Tools, Gauges, Test Apparatus, and Materials	—	3.001
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Lubrication and Recommended Intervals	2.01	3.01
Record of Lubrication	2.02	3.02
Lube Oil Pressure	2.03	3.03
ENGINE		
Speed	2.04	3.04
Power	2.05	3.05
Back Pressure	2.06	3.06
Fuel Injectors	2.07	3.07
Fuel Oil Filters, Primary and Secondary, and Fuel Oil Strain	2.08	3.08
Governor Filter	2.09	3.09
Lube Oil Filter	2.10	3.10
Lube Oil Cooler	2.11	3.11
Air Cleaners	2.12	3.12
Air Box Drains and Tanks	2.13	3.13
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Low Lube Oil Pressure Switch	2.16	3.16
AUTOMATIC SHUTDOWN AND ALARM DEVICES (Cont)		
Preliminary High Water Temperature Switch	2.17	3.17
High Water Temperature Switch	2.18	3.18
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Solenoid Switch	2.33	3.33
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Routine Run	2.36	3.36

2. REQUIREMENTS

LUBRICATION

2.01 ***Lubrication and Recommended Intervals:***

Note: Unless otherwise specified, the following parts shall be lubricated with SAE 30W diesel engine lubricating oil for all ambient temperatures above 32°F. Use SAE 20W diesel engine lubricating oil for temperatures usually between 32 to 0°F. Below 0°F, use SAE 10W diesel engine lubricating oil.

Caution: Do not use any special flushing oils when draining the lubricating system.

(a) ***Crankcase, standard sets:***

(1) Before the start of each run, the lube oil level in the crankcase shall be within the expanded F mark (.← F → .) on the lube oil level gauge (dipstick).

(2) During any run, the lube oil level shall not fall below the L (low) mark on the dipstick. Check every 8 hours of continuous operation.

(3) The crankcase shall be drained and refilled with fresh lube oil after every 100 hours of engine operation or at least once a year.

Note: If commercial laboratory facilities are available, it may prove economical to have samples of lube oil from the crankcase analyzed at regular intervals to determine whether or not the crankcase should be drained. It will be possible to operate the engine for periods in excess of the 100-hour or 1-year interval for changing lube oil if the chemical tests indicate the lube oil is not contaminated. Also a complete chemical analysis can, by detecting metal traces, determine areas of excessive wear and possible engine failure.

(b) ***Crankcase, Sets Equipped with a Lube Oil Level Regulator:***

(1) List 5 sets are equipped with a lube oil level regulator which will automatically add and maintain the proper amount of lube oil in the crankcase.

Caution: Never use the visual bowl-type indicator on the lube oil level regulator to check the lube oil level. Always use the lube oil level gauge (dipstick).

(2) Before the start of each run, the lube oil level should be within the expanded F mark (.← F →.) on the dipstick.

(3) During any run, the lube oil level shall never fall below the L (low) mark on the dipstick.

(4) The crankcase shall be drained and refilled with fresh lube oil every 100 hours of engine operation or at least once a year.

Note: If commercial laboratory facilities are available, it may prove economical to have samples of lube oil from the crankcase analyzed at regular intervals to determine whether the crankcase should be drained. It would be possible to operate the engine for periods in excess of the 100-hour or 1-year interval for changing lube oil if the chemical tests indicate the lube oil is not contaminated. Also a complete chemical analysis can, by detecting metal traces, determine areas of excessive wear and possible engine failure.

(c) ***Governor:***

(1) The governor filter and reservoir combination shall be filled at all times with diesel engine lubricating oil. Check periodically.

(2) The governor filter and reservoir combination shall be drained, cleaned, filter replaced, and refilled after every 1000 hours of engine operation.

(d) ***Alternator:*** The alternator bearing grease reservoir should be lubricated whenever alternator is overhauled or whenever end frame is removed using BRB-2 (Standard Oil of California) grease or equivalent.

(e) ***Radiator Fan Bearings (Engine-Mounted):*** Lubricate the radiator fan grease fittings every 5 years or 20,000 hours of engine operation, using 260-300P grease.

(f) ***Starting Motor and Sprag Clutch:***

(1) The starting motor bearings shall be lubricated every 300 hours of engine operation or at least once a year.

(2) The Sprag clutch bearing shall be lubricated once every 2 years.

(3) The ***shaft on which the pinion slides*** shall be lubricated once every 2 years using SAE 10W lubricating oil.

(g) ***Governor Motor Bearings:*** The governor motor bearings shall be lubricated every 6 months with KS-16326 L1 oil.

(h) ***Governor, Fuel Control, and Air Shutdown Valve Shaft Linkage:***

(1) The governor linkage and fuel control joints shall be lubricated every 25 hours of operation or at least once a month.

(2) The air shutdown valve shaft bearing shall be lubricated at least twice a year.

2.02 ***Record of Lubrication:*** During the installation period, a record shall be kept by date of the lubrication of the engine and alternator and this record shall be turned over to the telephone company with the equipment.

2.03 ***Lube Oil Pressure:*** After the engine has started and the lube oil has warmed up, the lube oil pressure shall remain within the limits of 30 to 55 psi. Use the OIL PRESSURE gauge on the engine control panel located on the left side of the engine.

ENGINE

2.04 ***Speed:***

(a) The speed of the set at all loads between no load and full load shall remain within the following limits:

Min 1800 rpm

Max 1890 rpm

Use a tachometer.

To check this requirement, proceed as follows. With the governor droop set for 5.0 percent, start the engine. Allow it to run until the engine water and lube oil are at their normal temperatures. Apply full load to the set, and using the ENGINE SPEED control on the front of the main control panel, adjust the speed to 1800 rpm. Remove the load and check the speed. To check the speed at both full load and no load, insert a tachometer in the recess provided in the end of the pulse generator shaft.

Note: Although an indication of speed may be obtained from the FREQUENCY METER on the front of the main control panel (60 Hz corresponds to 1800 rpm and 63 Hz to 1890 rpm), it is not recommended for use in making initial speed adjustments.

(b) There shall be no bind in the throttle linkage, the governor operating linkage, injector racks, or their control tubes.

Gauge by feel.

(c) The engine shall not hunt except during the warmup period.

2.05** ***Power:

(a) When the set is installed at any altitude above mean sea level (not exceeding 1500 feet) and operated on an approved fuel in accordance with Section 065-320-301, the engine shall be capable of developing sufficient power at all times to drive the alternator to which it is connected at full-rated output with not more than 4 inches of mercury exhaust back pressure in an ambient temperature of 110°F (43°C).

Use the WATTMETER on the front of the main control panel and the R-3076 manometer.

(b) At altitudes higher than 1500 feet above mean sea level, the output requirement (a) shall be modified in accordance with the following table:

ALTITUDE IN FEET	KW OUTPUT 30 KW SET	KW OUTPUT 45 KW SET	AMBIENT TEMPERATURE
0-1500	30	45	110°F
3500	30	45	104°F
5000	30	44	99°F
6500	30	42	94°F
8000	29.5	40	90°F
10,000	28.0	37	84°F

Use the WATTMETER on the front of the main control panel.

Caution: Avoid the use of any fuel which contains any trace of acid, since its presence in the fuel oil will be injurious to numerous parts of the fuel injection equipment. Etching or corrosion of the nozzles, nozzle valves, bodies, pumps, etc, due to acid, will greatly impair their efficiency or destroy their function.

Note: The presence of acid in fuel oil may be detected by dipping one end of a piece of Fisher Alkacid Test Ribbon into the fuel oil for a few seconds. The test ribbon will turn yellow, orange, or red depending upon the degree of acidity. It will turn blue or green if no acid is present.

2.06 ***Back Pressure:*** The back pressure, measured approximately 1 foot from the exhaust outlet, shall not exceed 4 inches of mercury when the ambient temperature is as much as 110°F (43°C).

Use the R-3076 manometer.

2.07** ***Fuel Injectors: The fuel injectors shall be clean, free from dirt, acid, gum, or any other foreign matter.

†2.08 ***Fuel Oil Filters, Primary and Secondary, And Fuel Oil Strainer:*** The fuel oil filters, primary and secondary, and fuel oil strainer shall be drained and have their elements removed and replaced every 300 hours of engine operation or every six months.

†2.09 ***Governor Filter:*** The governor filter shall have its element replaced after every 1000 hours of engine operation.

†2.10 ***Lube Oil Filter:*** The full-flow lube oil filter shall have its element replaced with every lube oil change.

2.11 ***Lube Oil Cooler:*** The oil cooler core and water side of the lube oil cooler shall be cleaned when necessary.

Note: The need for cleaning can best be determined by experience.

†2.12 ***Air Cleaners:*** The requirements for new air filter cartridge installation is best accomplished by establishing renewal periods by daily inspection under actual service conditions.

2.13 ***Air Box Drains and Tanks:*** The air box drain tubes and tanks shall be cleaned every 300 hours or 1 year of engine operation.

2.14 ***Leaks:*** There shall be no leaks.

AUTOMATIC SHUTDOWN AND ALARM DEVICES

2.15 ***Overspeed, Locked Rotor, and Excessive Cranking Cycle:*** A magnetic (reluctance) pickup is incorporated in the set to provide shutdown protection for overspeed, locked rotor, and excessive cranking cycle.

(a) ***Overspeed:*** When engine speed exceeds 2150±100 rpm, pulses are sent to the J86634A Solid State Control Unit which then furnishes signals to de-energize the fuel-rack solenoid, actuate the air damper, de-energize the starting circuits, shunt-trip the circuit breaker (if closed), light the associated trouble lamps, and sound the horn alarm. A remote major alarm is also given. When shutdown occurs, the air damper must be manually reset before restarting.

(b) ***Locked Rotor (Mechanically Bound Engine):*** If the engine fails to attain 100 rpm within a period of 3 seconds, the events and set shutdown will occur as in (a).

(c) ***Excessive Cranking Cycle:*** If the engine fails to attain 650 rpm within 35 seconds, the events and set shutdown will occur as in (a).

2.16 ***Low Lube Oil Pressure Switch:***

(a) If the lube oil pressure drops to 25±5 psi the low lube oil pressure switch contacts open and events and set shutdown will occur as in 2.15(a). Use the lube oil pressure gauge on the engine control panel.

(b) Once a year, the pressure switch shall be removed from the engine and pressure checked with compressed air to determine whether it is meeting requirement (a). This should be done at the time of annual routining unless malfunction indicates the need for testing.

Use the 81A Test Set.

2.17 ***Preliminary High Water Temperature Switch:***

(a) The preliminary high water temperature switch contacts shall close when the engine cooling water reaches 194±3°F to send a signal to the J86634A Solid State Control Unit, to light the PRELIM. WATER TEMP. lamp, to sound a horn alarm, and to furnish a remote minor alarm. The set will ***not*** shut down. To check the cooling water temperature, use a thermometer or the WATER TEMPERATURE gauge on the engine control panel.

(b) To check the requirement in (a), raise the engine cooling water temperature using one of the following methods. For set-mounted radiators, partially block the radiator fan intake. For remote radiator sets, operate the LINE DISCONNECT switch to stop the fan. Start the engine and allow it to warm up. Note the temperature at which the PRELIM. WATER TEMP. lamp lights and the horn alarm sounds.

Caution: Stopping of the fan during engine operation for extended periods can result in serious damage to the engine.

2.18 ***High Water Temperature Switch:***

(a) The high water temperature switch contacts shall close when the engine cooling water temperature reaches 210±5°F. When this temperature is attained, events and set shutdown will occur as in 2.15(a).

Use the WATER TEMPERATURE gauge on the engine control panel.

(b) Once a year, the high water temperature switch and bulb shall be removed from the engine and checked to determine whether they are meeting requirement (a). This is done by connecting 81A Test Set across the switch terminals and placing the bulb controlling the switch in an open can of water and noting that the switch contacts close when the temperature rises to the value given in the requirement, as indicated on a suitable thermometer immersed in the water as near to the switch bulb as possible. This should be done at the time of annual routining unless malfunction indicates the need for earlier checking. If requirement is not met, replace the switch.

Note 1: To prevent engine coolant leakage, plug up the hole in the exhaust manifold where switch was removed with a suitable plug, rubber stopper, or pipe plug.

Note 2: If site elevation prevents the use of water because of low boiling point, substitute a can of lube oil taking precautions not to ignite the oil.

2.19 ***Reverse Power:*** If the set receives approximately 20 kW of reverse power when it is operating in parallel, it will shut down as in 2.15(a).

2.20 ***Control Fuse Failure:*** If the set loses the main dc fuse, shutdown will occur due to loss of battery to the fuel-rack solenoid which cuts off the fuel supply. The trouble lamp will light, the horn alarm will sound, and the set will shut down. A remote alarm is also given.

2.21 ***Circuit Breaker Shunt-Tripped:*** If the circuit breaker is shunt-tripped due to an overload or a short circuit condition, the set will shut down as in 2.15(a).

2.22 ***Battery Charging Rectifier:*** If the rectifier used for trickle charging the starting and control batteries should fail, a signal is sent to the J86634A Solid State Control Unit to light the RECT. FAIL. lamp, to sound a horn alarm, and to furnish a remote minor alarm. The set will not shut down.

2.23 ***Jacket Heater Failure:*** If the immersion heater (if provided) used to maintain cooling water temperature between 75 and 110°F should fall below 50±5°F, a signal is sent to the J86634A Solid State Control Unit to light the JACKET HEATER FAIL. lamp, to sound a horn alarm, and to furnish a remote minor alarm. The set will not shut down.

ENGINE COOLING SYSTEM

2.24 ***Cooling Water:***

(a) Water which will meet the following specification will be satisfactory for use in the cooling system of these engines:

pH Range	7 to 9
Total Solids	200 ppm max
Total Hardness	100 ppm max
Iron as Fe	25 ppm max
Chlorides as Cl	50 ppm max

(b) If the local water will not meet the specifications in (a), distilled water shall be used.

(c) The cooling solution in these engines shall be free of acid.

Use Fisher Alkacid Test Ribbon.

2.25 ***Radiator Pressure Caps:***

(a) The 7 psi pressure cap for the set-mounted radiator shall be tight and the valves shall operate under pressure and vacuum.

Gauge by eye and feel.

(b) The cap shall be replaced as necessary.

Caution: ***Do not plug or add a valve in the radiator overflow out side the engine base. The radiator overflow, which is also the vent for the pressure cap is piped to this drain. Blockage may result in overpressurization and cooling system failure. Add a decal to read "COOLANT DRAIN AND RADIATOR OVERFLOW—DO NOT RESTRICT."***

2.26 ***Radiator Fan Belt:*** The slack in the fan belts shall not be less than 1/2-inch nor more than 3/4-inch when depressed at a point midway between the engine pulley and the fan pulley, use a straight edge and a R-8550 steel scale.

2.27 ***Antifreeze Solution and Rust Inhibitor:*** When the set is not in operation and is installed in a location where the surrounding temperature may fall below freezing, the cooling system shall be drained or protected by addition of a suitable antifreeze as covered in Section 065-305-301. Where antifreeze is not required, a rust inhibitor, as covered in the same section, shall be used, except that dichromate-type inhibitor shall not be used.

2.28 ***Radiator Discharge Air Shutters:*** An option (List 4) is available to equip sets with discharge air radiator shutters. These shutters are driven open by lube oil pressure and are closed by spring action. The temperature-sensing controller for the shutters shall monitor the radiator jacket water temperature and shall be set to operate when the jacket water temperature reaches 145±15°F.

Use WATER TEMPERATURE gauge on engine control panel.

2.29 ***Cold-Aid Starting Equipment:*** List 3 options provide an immersion heater, a cold-weather governor motor, and an ether starting device.

(a) The immersion heater element is immersed in the cooling solution and a heater control switch maintains the jacket water temperature between 75 and 100°F.

Gauge the temperature by the feel of the water jacket. The immersion heater requires cleaning every 300 hours or 6 months.

Note: If it is necessary to remove the water heater or drain the water from the cooling system, disable the heater by removing its fuses at the distribution cabinet. Check that the valves on either side of the heater are closed to prevent loss of water.

(b) ***Ether Starting Device:*** The ether supply canister shall be replaced after every use.

Caution: When using the ether starting device, always adhere to the usual safety practices for handling and disposal of pressurized containers. Never use the ether starting device when ambient temperature is above 40°F or on a hot engine. Ether pressurized containers should be stored in a safe location and are to be mounted on engine only when needed.

(c) ***Cold-Weather Governor Motor:*** The cold-weather design governor motor operates in ambients of +40°F or below. It is larger and has less friction than the regular governor motor to facilitate operating in cold temperature.

ALTERNATOR, EXCITER, AND VOLTAGE REGULATOR

2.30 ***Voltage:*** With the engine-alternator operating within its rated speed of 1800 to 1890 rpm, the voltage regulator shall hold the output voltage within 2 percent anywhere within the rated voltage of the set under all operating conditions.

Use ac meters on main control panel.

BATTERY SYSTEM

2.31 ***Starting and Control Batteries (Lead-acid or nickel-cadmium type):*** Batteries are to be maintained in accordance with Sections 157-601-701 and 157-633-101 for lead-acid and 157-631-101 for nickel-cadmium.

Caution 1: Avoid creation of sparks, including those from static electricity or the use of an open flame near batteries, as the gas given off by the battery is highly explosive.

Caution 2: Do not add liquid to a nickel-cadmium battery until charging has been attempted. If the battery has been discharged or allowed to stand unused for a long period of time, the electrolyte is absorbed into the plates. Charging the battery will cause the liquid to rise to a point just above the tops of the plates.

STARTING SYSTEM

2.32 ***Starting Motor and Sprag Clutch:*** When battery is applied to the starting motor by means of the cranking control circuit, the motor shall start cranking the engine. When the engine starts, the Sprag clutch permits the pinion to overrun on its shaft until the starting solenoid is released causing the pinion to disengage from the flywheel.

2.33 ***Solenoid Switch:***

(a) The solenoid switch disc contact studs shall be dressed periodically. It is recommended that this be performed at 2-1/2 year intervals.

(b) The solenoid switch shall be checked periodically to determine whether cracking or deterioration of the insulators of the contact disc is present. It is recommended that this be performed at 2-1/2 year intervals.

2.34 ***Fuel Oil Pressure Switch:*** The fuel oil pressure switch contacts shall be closed while the engine is not running. The switch contacts shall open when the engine speed reaches 850±50 rpm, and shall remain open for any pressure above 850±50 rpm while the set is operating. The switch contacts shall close when the engine speed drops below 800 rpm and shall remain closed for any engine rpm below the opening engine rpm while the engine is running.

TEST AND ROUTINE RUNS

2.35 ***Test Run:***

(a) At time of turnover, a one-hour preliminary run shall be made at various loads from no load to not exceeding full load of the alternator. At the satisfactory completion of the one-hour preliminary run, a two-hour, full-load, official test shall be made. Following this, the engine set shall then be operated for 30 minutes carrying the anticipated load if known, otherwise at full load. Test load information is covered in Section 171-123-101.

(b) During the test run described in (a), the requirements of this section shall be met.

†**2.36** ***Routine Run:***

Caution: When operating these sets on either the weekly or annual routine run for the periods listed, the set should always be loaded between 30 percent and full load (preferably as near full load as possible).

If the maximum available office load is less than 30 percent of the alternator full-load rating, supplement the office load with an artificial load to bring it up to at least 30 percent, but not exceeding full load. For information on test loads, refer to Section 171-123-101.

(a) To ensure proper lubrication, to avoid rusting of cylinder walls and valve stems, and to minimize the collection of sediment in the fuel supply system, the set must be routined on the basis given in (b) and (c).

Note: Short runs, such as demonstration starts or those where the engine water does not have time to warm up to 160°F or above, should be avoided as they are harmful to the engine.

(b) ***Weekly:*** Routine the set by running it at maximum available office load, not exceeding full load, for at least 1 hour in accordance with the operating instructions covered in Section 155-191-301.

Note: It is suggested that data of all runs and maintenance be recorded.

(c) ***Annually:*** At least once a year, the weekly run should be extended to approximately 7 hours, having the set carry as near possible the total load that it would be expected to carry under emergency conditions.

3. ADJUSTING PROCEDURES

3.001 ***List of Tools, Gauges, Test Apparatus, and Materials*** (Equivalents may be substituted):

(a) The following tools and instruction information listed are furnished with each engine by the manufacturer. The tools furnished are of a size and design recommended by the engine manufacturer for use with a particular engine, while the instruction information covers the maintenance and adjusting procedures for the apparatus involved (see 1.09).

Description of Parts

One instruction book

Two one-pint cans of touch-up paint (one of each color)

100 percent spares of synchronizing lamps

10 panel lamps

100 percent spares on all fuses

100 percent spares on fuel oil filters

100 percent spares on lube oil filters

One barring tool

One adjustment tool for fuel-rack solenoid

Note: Various sections of the manufacturer's maintenance manuals, furnished with each set, specify certain tools in addition to those listed above. However, as their use is intended primarily for overhaul rather than general maintenance of the set, they have not been included.

(b) In addition to the tools and instruction information furnished with the engine, it is desirable to have additional tools, gauges, test apparatus, and materials as follows.

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
KS-2663	File
KS-6320	Orange Stick
R-1051	Pillar File
R-2512	Adjustable Wrench
R-2739	90 Degree Offset Screwdriver
R-2959	1/16-Inch Hex. Allen Wrench
—	1/2- and 3/4-Inch Open Double-End Flat Wrench
—	Grease Gun, Lincoln Engineering Co., No. 5958
—	Hand Oiler
—	Combination Pliers
—	4-Inch E Screwdriver
—	15/16- and 1-Inch Open Double-End Flat Wrench, J. H. Williams Co., No. 33C
—	Hot Plate to Heat Water (for testing temperature switches)
GAUGES	
KS-6909	Thickness Gauge Nest
R-1032 Detail 1	Thermometer
—	4-Inch Manometer, Manning, Maxwell, and Moore, Inc., Model 1370
R-8550	6-Inch Steel Scale
—	Tachometer, No. 5, Boulin Instrument Corp
—	0° to 230°F Thermometer, No. 14-999, Fisher Scientific Co.
—	Voltmeter, DC Weston Model 931, Ranges 300/150/75/30
	Voltmeter, DC, Weston Model 1, Ranges 150/75/3

CODE OR SPEC NO.	DESCRIPTION
TEST APPARATUS	
81A	Test Set
—	Test Cords, D-79650 (red) 6 Foot, D-79651 (black) 6 Foot, and 168023 (red) 10 Foot, Weston Electrical Instrument Co.
MATERIALS	
KS-7860	Petroleum Spirits
KS-14666	Cleaning Cloth
KS-16326 L1	Medium Petroleum Oil
R-3266	NO-OX-ID A Compound
—	Boric Acid Solution
—	Abrasive Paper, Extra Fine, Garnet 4/0 or Flint
—	Grease, 260-300P
—	Red Lead
—	Diesel Engine Lubricating Oil, Lubricants Type A (Group 1) SAE 30, 20W, or 10W, as Required (see 065-330-110)
—	Asbestos Packing, 1/16-Inch Thick, Width and Length, as Required
—	Packing, Garlock No. 605, Garlock Packing Co., 1/16-Inch Thick, Width and Length, as Required
—	Pyroid Packing, Anchor Packing Co., 1/16-Inch Thick, Width and Length, as Required
—	Pail (for waste oil)
—	Shellac
—	Bicarbonate of Soda
—	Oakite No. 20 Cleaner, Oakite Products, Inc
—	Alkacid Tester, Fisher Scientific Co.

3.002 ***General:*** Care should be exercised when using petroleum spirits in power rooms where dc machines are located, since commutation may be adversely affected by the fumes softening the commutator film. To avoid the need for burnishing the commutators of the dc machines after performing any cleaning operations called for in this section, provide adequate ventilation, use the absolute minimum amount of petroleum spirits required for the cleaning operation, and keep the container closed when not in use.

LUBRICATION

3.01 ***Lubrication and Recommended Intervals*** (Reqt 2.01):

(a) ***Crankcase, Standard Sets:***

(1) If the lube oil level in the crankcase is below the specified limits, add lube oil through the oil filler tube located on the right side of the engine until the lube oil level, as indicated on the dipstick, is within the expanded F mark on the dipstick. The dipstick has an expanded scale using two full marks on either side of the F mark (.← F → .). The other marking is an L (low) mark. Approximately 13.5 quarts of lube oil are required for the 30 kW set and 19 quarts for the 45 kW set.

(2) To change lube oil in the crankcase, open the lube oil drain valve located on the right side of the engine, and drain the lube oil while it is hot into a suitable container using either the gravity method or a Bowser hand pump. In some installations, the drain line may be plumbed to an outside container. Also drain the lube oil cooler and filter by opening their respective drains. Close all drain valves that were opened.

(3) Add fresh lube oil of the proper viscosity through the lube oil filler tube located on the left side of the engine (13.5 quarts for the 30 kW set and 19 quarts for the 45 kW set). Start the engine and run it for approximately 10 minutes. Check the lube oil level again and add approximately 2 quarts of lube oil for the 30 kW set and 2 quarts for the 45 kW set, the amount taken during run-up to fill the lube oil filters. The lube oil should be at the proper level.

Note 1: Never mix lube oils of different manufacturers or viscosities.

Note 2: A record of crankcase lubrication should be kept to show additions and changes of lube oil.

Note 3: Check that any container used for adding lube oil is clean to avoid contamination of clean lube oil.

(4) At the time specified in the requirements for draining the old lube oil from the crankcase, a complete crankcase flush is advisable. To accomplish this, follow the prescribed method for lube oil change. Drain the old lube oil and refill the crankcase with SAE 10W viscosity lube oil to the L (low) mark on the dipstick while the engine is hot. Restart the engine and run it at no load for approximately 5 to 10 minutes. Shut the set down, drain the flushing oil, and refill the crankcase with lube oil of the proper viscosity.

Note: If commercial laboratory facilities are available it may prove economical to have samples of lube oil from the crankcase analyzed at regular intervals to determine whether or not the crankcase should be drained. It will be possible to operate the engine for periods in excess of the 100-hour or 1-year interval for changing lube oil if the chemical tests show the lube oil is not contaminated. Also, a complete chemical analysis can, by detecting metal traces, determine areas of excessive wear and possible failure.

(b) ***Crankcase—Sets Equipped with Lube Oil Level Regulator:***

(1) The lube oil level regulator will automatically add and maintain the proper amount of lube oil in the crankcase. The amount of lube oil normally contained in the system is 15.5 quarts for the 30 kW set and 21 quarts for the 45 kW set, including the oil used in the lube oil filter.

Caution: Never use the visual bowl-type indicator on the lube oil regulator to check the lube oil level. Always use the lube oil level gauge (dipstick). The dipstick is marked with an expanded scale, using an

F mark (.←F→.) and an L (low) mark. Never operate the engine with the lube oil level below the L (low) mark on the dipstick.

Note: Never mix lube oils of different manufacturers or viscosities.

(2) To change lube oil in the crankcase, close the lube oil level regulator valve, open the drain valve on the right side of the engine, and drain the old lube oil, while hot, into a suitable container, using either the gravity method or a Bowser hand pump. In some installations, the drain line may be plumbed to an outside container. Drain the lube oil filter and cooler by removing their respective drain plugs. Replace all drain plugs that were removed.

Note 1: Flush crankcase as given in (a)(4).

Note 2: If commercial laboratory facilities are available, it may prove economical to have samples of lube oil from the crankcase analyzed at regular intervals to determine whether or not the crankcase should be drained. It will be possible to operate the engine for periods in excess of the 100-hour or 1-year interval for changing lube oil if the chemical tests show the lube oil is not contaminated. Also, a complete chemical analysis can, by detecting metal traces, determine areas of excessive wear and possible engine failure.

(3) Open the lube oil level regulator valve and add lube oil of the proper viscosity through the lube oil filler tube until the lube oil level is within the expanded F mark on the dipstick. Start the engine and allow it to run for approximately 5 to 10 minutes. Shut the set down and recheck the lube oil level. The lube oil level regulator should have added the correct amount of lube oil to bring it to the proper level.

(c) ***Governor:*** To flush the oil in the governor and filter reservoir combination, open the oil drain on the housing remove the top, and drain the old oil into a suitable container. Remove the filter and clean the housing. Insert a new filter, close drain, and pour in oil until the filter is completely submerged, replace the filter reservoir top. See 3.09.

Note: The governor reservoir and filter are in the lubricating system of the engine. It is suggested that the filter be replaced after every 1000 hours of engine operation.

Caution: When installing a new engine and running it for the first time, add lube oil to the crankcase and governor reservoir. The engine is shipped dry.

(d) ***Alternator:*** The alternator ball bearing grease level is checked by removing plug in center of end frame. Grease level must be up to bottom of shaft. Add grease, when required, through central hole on end frame.

(e) ***Radiator Fan Bearings (Engine-Mounted):*** The radiator fan bearings do not require periodic lubrication, as the bearings are prepacked with grease at the time they are installed in the fan hub. Further lubrication is seldom required unless fan and hub require overhaul, at which time the assembly must be dismantled and the bearings repacked with 260-300P grease.

(f) ***Starting Motor and Sprag Clutch:***

(1) Add 5 drops of oil to each oil cup by using a hand oiler. Some starting motors are provided with a plugged hole. In such case, remove the plug and add the required amount of oil and replace plug. Some starter motors may be life-time lubricated so no lubrication is required.

(2) To lubricate the Sprag drive bearing or shaft on which the pinion moves, the motor must be removed from the engine. Clean the shaft with petroleum spirits and lubricate it sparingly with specified oil.

Caution: Do not dip the clutch body of the Sprag drive in cleaning fluids and do not lubricate this portion.

(g) ***Governor Motor Bearings:*** Add oil, by using a hand oiler, through the oiler on top of the motor housing and also through the small hole provided in the top, above the rear bearing hub, until the felt wicks are thoroughly dampened.

(h) ***Governor, Fuel Control, and Air Damper Shutdown Shaft Linkage:***

(1) To lubricate the governor linkage and fuel control joints, apply several drops of oil to joints by using the hand oiler.

(2) To lubricate the air shutdown valve shaft linkage, apply several drops of oil at the bearing by using a hand oiler.

3.02 ***Record of Lubrication*** (Reqt 2.02) (No Procedure)

3.03 ***Lubricating Oil Pressure*** (Reqt 2.03):

(a) If, during test conditions, the lube oil pressure gauge located on the engine control panel, indicates below 30 psi while operating, shut the engine down immediately. Check that there is ample lube oil in the crankcase and examine oil piping for leaks. Correct any malfunction that may be contributing to low lube oil pressure before starting the engine again.

(b) During power failure operation, observe the lube oil pressure gauge on the engine control panel. If the indication is less than 30 psi, perform a quick check of the lube oil supply in the crankcase and check the lube oil lines for leaks. Add lube oil, if necessary, and repair oil lines temporarily to avoid shutdown during an emergency.

ENGINE

3.04 ***Speed*** (Reqt 2.04): The speed of the set at all loads between no load and full load shall remain within the following limits:

Min 1800 rpm

Max 1890 rpm

Use a tachometer.

To check this requirement, proceed as follows. With the governor droop set for 5.0 percent (droop position), start the engine. Allow it to run until the engine water and lube oil are at their normal temperatures. Apply full load to the set and using ENGINE SPEED control on the main control panel, adjust the speed to 1800 rpm. Remove the load and check the speed. To check the speed at both full load and no load, insert a tachometer in the hole provided in the end of the pulse generator shaft.

Note: Although an indication of speed may be obtained from the FREQUENCY METER on the front of the main control panel (60 Hz corresponds to 1800 rpm and 63 Hz to 1890 rpm), it is not recommended for use in making speed adjustments.

3.05 ***Power*** (Reqt 2.05):

(1) Each engine-alternator set is provided with a nameplate on which is stamped the output capacity of the alternator. Loads on the alternator should not be such that volts, amperes, or kilowatts are exceeded for more than a few minutes.

(2) Loss of power is generally due to one or more of the following causes:

Injector racks not properly positioned

Faulty injector timing

One cylinder cutting out

Air cleaner clogged

Insufficient fuel supply

Clogged fuel oil filter

Air leaks on suction side of fuel pump

Faulty injector

Improper governor adjustment

Loss of compression

Fuel tank air vent plugged

Engine in a closed room with inadequate air inlet.

3.06 ***Back Pressure*** (Reqt 2.06): To determine the back pressure, connect the manometer as closely as possible to the engine exhaust manifold. Fill manometer with water to approximately the zero mark and then shift zero mark to indicate zero. The indications of the manometer is the

sum of the indications of the water above and below the zero mark. If the back pressure does not meet the requirements, the trouble is probably due to worn or defective piston rings or pistons. If the back pressure exceeds the specified amount, it may be due to an accumulation of scale, dust, and carbon in the exhaust line or silencer. As these malfunctions require complete disassembly, inform the supervisor. The services of a representative of the engine manufacturer should be obtained.

3.07 ***Fuel Injectors*** (Reqt 2.07): Fuel injectors should not be disturbed. If it is determined that they are malfunctioning, the supervisor should be informed and the services of a representative of the engine manufacturer should be obtained.

3.08 ***Fuel Oil Filters, Primary and Secondary, and Fuel Oil Strainer*** (Reqt 2.08): Fuel oil filter and strainer elements are replaced as follows.

(1) With the engine shut down, place a container under the filter and open the fuel oil drain. Loosen the cover nut or bolt just enough to allow the fuel oil to drain freely.

(2) Support the shell, unscrew the cover nut or bolt, and remove the shell and the element.

(3) Remove and discard the element, the shell gasket, and the cover nut or bolt gasket.

Caution: Only filter and strainer elements designed for fuel oil filtration should be used to filter the fuel.

(4) Wash the shell thoroughly with fuel oil and dry with compressed air.

(5) Examine the element seat and the retaining ring to ensure they have not slipped out of place. Check the spring by pressing on the element seat. When released, the seat must return against the retaining ring.

Note: The element seat, spring, washer, and seal cannot be removed from the strainer shell. If necessary, the shell assembly must be replaced. However, the components of the filter shell are serviced. Examine the filter retainer seal for hardening or cracking. If necessary, replace the seal.

(6) Place a new element over the stud and down against the seat. Check that the fuel drain is closed and fill the shell approximately two-thirds full of clean fuel oil.

Note: Thoroughly soak the density-type strainer element in clean fuel oil before installing it. This will expel any air entrapped in the element and is conducive to a faster initial start.

(7) Install a new gasket in the recess of the shell.

(8) Place the shell and element in position under the cover. Then, with a new gasket over the cover bolt, thread the bolt (or nut) into the stud.

(9) With the shell and gasket properly positioned, tighten the cover bolt or nut just enough to prevent fuel leakage.

(10) Remove the filler plug in the cover and complete filling the shell with fuel oil.

(11) Start the engine and check the fuel system for leaks.

3.09 ***Governor and Filter Reservoir*** (Reqt 2.09): The governor Filters element is changed as follows:

The filter element should be changed every 1000 hours. Replace the element as outlined below:

(1) Remove the drain plug from the bottom of the filter shell and drain the oil.

(2) Disconnect the oil by-pass line from the top of the filter cover.

(3) Loosen the filter cover bolt counterclockwise until the bolt and the filter cover assembly can be removed. Discard the cover gasket.

(4) Remove and discard the filter element.

(5) Wipe out the filter shell and cover. Install a new filter element over the center stud.

(6) Using a new cover gasket, place the cover assembly on the shell.

(7) Install the drain plug at the bottom of the filter shell.

(8) Fill shell approximately 3/4 full of engine lube oil.

(9) Tighten the cover bolt carefully to prevent damage to the gasket.

(10) Connect the oil by-pass line to the cover bolt.

(11) Start the engine and check all connections for oil leaks. If leaks occur, tighten as necessary. See Fig. 5.

3.10 ***Lube Oil Filter*** (Reqt 2.10): The full-flow lube oil filter element is changed as follows.

(1) Remove the drain plug from the shell or adapter and drain and lube oil from the filter into a suitable container.

(2) Back out the center stud and withdraw the shell, element, and stud as an assembly. Remove and discard the filter element.

(3) Remove the center stud. Also, remove the thin nut or snap ring from the center stud, slide the stud out of the shell, and discard the stud gasket. Examine the retainer seal for hardening or cracking. If necessary, replace the seal.

(4) Clean the filter shell and the adapter.

(5) Install the washer on the center stud and slide the stud through the filter shell. Replace the spring, new center stud gasket seal, and retainer and secure with the thin nut or snap ring.

(6) Install a new shell gasket in the filter adapter.

(7) Install a new filter element over the center stud in the shell. Place the shell, element, and stud assembly in position on the filter adapter and tighten the center stud to 40 to 50 lbs/ft torque.

(8) Install the drain plug.

(9) Start and run the engine and check for lube oil leaks. After any leaks have been

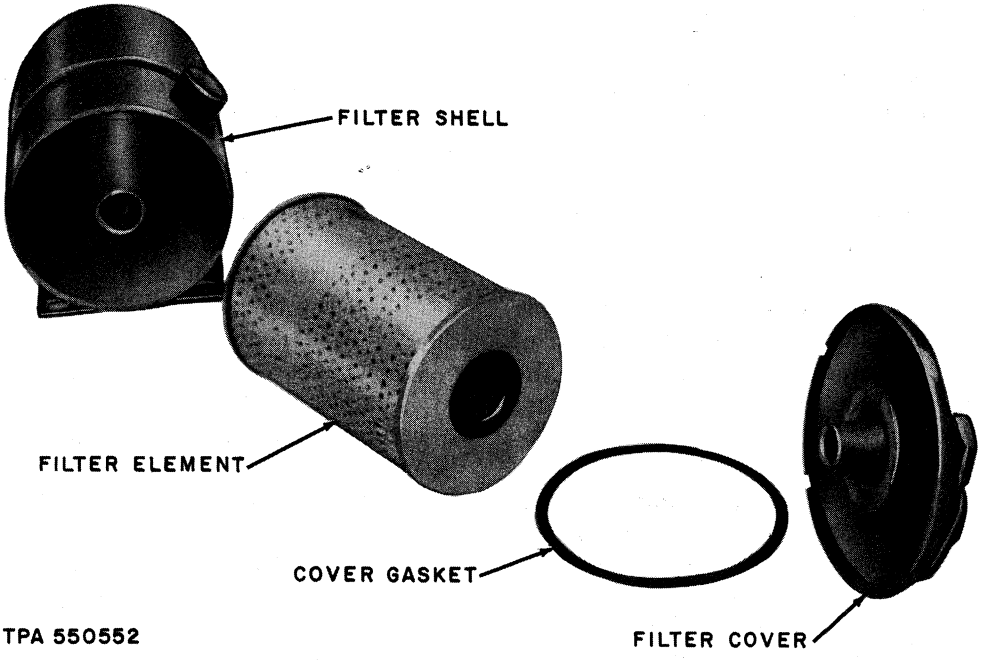

Fig. 5—Governor Filter Lube Oil Reservoir

corrected and the engine stopped long enough for the lube oil from the various places to drain back into the crankcase, add lube oil, if necessary, to bring it to the proper level on the dipstick.

3.11 ***Lube Oil Cooler*** (Reqt 2.11): The lube oil cooler requires very little maintenance when soft water and antifreeze are used. If, after long use, cleaning is required, the manufacturer's maintenance manual should be consulted.

3.12 ***Air Cleaners*** (Reqt 2.12): The air filter (air cleaner) supplied with each engine is a heavy-duty, oil-bath type and serves as silencer as well as a cleaner. It is mounted on the air intake manifold. The air drawn through the cleaner by the blower passes over the oil bath where a major portion of any dirt in the air is trapped, then up through the filter element where the finer dirt particles are removed, and down the central duct to the blower. To clean the filter, remove the wing-type through bolt at the top and lift the entire assembly free of the air intake manifold, keeping it in an upright position. Wash the filter element thoroughly in fuel oil or petroleum spirits to remove all dirt. Drain the dirty oil from the oil reservoir and clean the sludge from the bottom of the reservoir. Refill the reservoir with oil to the level indicated on the inside of the reservoir. Approximately two pints of oil are required. Reassemble, after the filter element has thoroughly drained, and place the assembled unit in position on the air intake manifold.

3.13 ***Air Box Drains and Tanks*** (Reqt 2.13): The drain tubes should be open at all times since a clogged or plugged tube will prevent the discharge of water vapor and oil fumes. To clean the tubes, disconnect them from the tanks and cylinder block and blow them out with compressed air. The tanks should also be cleaned using a KS-14666 cloth. Reconnect tubes, making sure all joints are tight. ▶If the set is equipped with an immersion heater, air box draining may be facilitated by using a small, flexible, plastic cup or allowing the drippings to drain into a cloth which must be removed after each draining. See Fig. 6.◀

3.14 ***Leaks*** (Reqt 2.14):

(a) To stop leaks in the cooling system, tighten connections, replace packing or gaskets, and replace rubber hose as required.

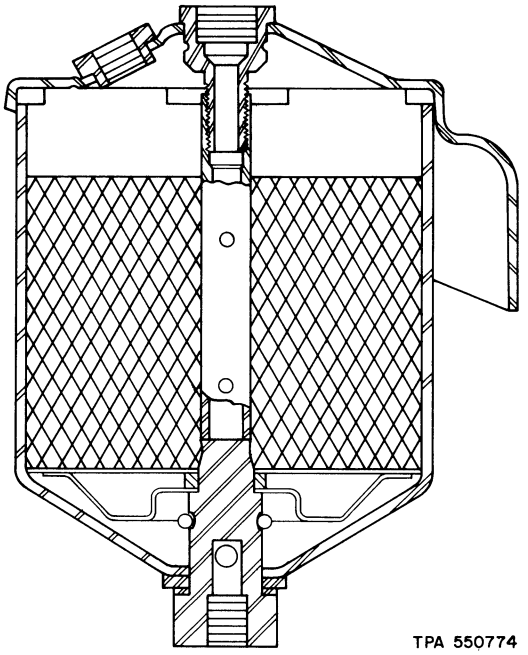

Fig. 6—Air Box Drain Tank Cutaway View

(b) Air leaks in the fuel system, especially in the suction side of the fuel pump, will be indicated by a loss of power. To check for a leak in the fuel system, remove the fuel return line at the base. Insert length of tubing. Insert the opposite end of the tube into a large container, such as a gallon glass bottle or equivalent. Start the engine with no load and allow fuel to collect in bottle. Observe during this check if air is being pumped through the fuel system. It will be indicated by air bubbles appearing as foam on the fuel in the container (occasional bubbles are permitted). If air is present, correct the condition by tightening any loose fuel line and filter connections. Check the fuel flow again to determine that all air leaks have been stopped. Replace any packing or gaskets, as required, at other points in the system. Replace the return fuel line to its original connection after completing this test, checking that the connection is tight and does not leak.

(c) To stop cylinder head gasket leaks, install a new cylinder head compression gasket and a set of cylinder head oil gaskets.

(d) Generally, there are no dangerous quantities of carbon monoxide in the exhaust from diesel engines and, therefore, no tests are needed

to check for this gas. However, leaks in the exhaust system are usually indicated by smarting or watering of the eyes, or by observance of a bluish haze in the engine room air. To stop exhaust system leaks, replace gaskets, as required, or relead or tighten the joints in the exhaust piping. When gasket replacement is necessary, use standard engine gaskets when available. Sheet asbestos packing or equivalent, 1/16-inch thick, may be substituted between the manifold and the cylinders and Garlock No. 605 packing or Pyroid packing or eqivalent, 1/16-inch thick, may be substituted between the flanged joint of the exhaust pipe section and the engine manifold. Red lead should be used in making up all screw joints in the exhaust system, coating the male threads at the time.

(e) If required, the lube oil cooler may be removed from the cooler housing or the entire cooler assembly may be removed from the cylinder block. Since the element through which the lube oil passes, while being cooled, is surrounded by water in a cast iron housing, the cooling element MUST be well sealed against water getting into the lube oil or lube oil getting into the water. When the oil cooler is disassembled, special care must be taken at assembly to have the proper gaskets in place and the retaining cap screws tight.

(f) To stop a leak in the lube oil system, tighten bolts and all other lube oil connections and replace gaskets as required.

(g) To stop an air leak around the air box handhole covers, remove the handhole cover and examine the gasket for rupture. If it is found to be defective, replace with a new gasket. If the existing gasket is satisfactory, replace the cover and ensure that it is properly tightened to avoid further leaks.

AUTOMATIC SHUTDOWN AND ALARM DEVICES

3.15 ***Overspeed, Locked Rotor, and Excessive Cranking Cycle*** (Reqt 2.15): A magnetic pickup is provided for and mounted on the engine. This pickup is mounted in a vertical position and at right angles to the tooth surface of the pulse generator. The pickup provides an output of 8 volts at 1800 rpm with an air gap of 0.005 inch between the pickup and the highest point of the pulse generator. The allowable tolerance for the air gap is 0.004 to 0.006.

(a) ***Overspeed:*** (See Section 155-020-701)

(b) ***Locked Rotor (Mechanically Bound Engine):*** (See Section 155-020-701)

(c) ***Excessive Cranking Cycle:*** (See Section 155-020-701)

3.16 ***Low Oil Pressure Switch*** (Reqt 2.16): (See 3.17)

3.17 ***Preliminary High Water Temperature Switch*** (Reqt 2.17):

(a) The preliminary high water temperature switch, the low (lube) oil pressure switch, and the fuel oil pressure switch are the same as far as adjustment is concerned. The switches are bracket mounted and each is marked HIGHER on the right-hand end with an arrow to indicate direction. They are adjusted using a 90 degree off-set screwdriver.

(b) To set the switch, turn the differential screw (located inside switch cover) counterclockwise against the stop for minimum differential. Bring pressure or temperature to a point where circuit closes. If contacts are open, turn range adjustment screw slowly counterclockwise until contacts just close. If contacts are already closed, turn range adjustment screw clockwise until contacts open and then turn slowly counterclockwise until contacts just close. This fixes the closing point. The differential screw which governs the point at which the contacts open may be turned clockwise to widen the differential slightly.

Note: When adjusting these switches, check the adjustment by observing an operating cycle.

(c) The above procedure is for a complete setting of the switches. If only a minor adjustment in pressure is to be made, increase or decrease the pressure setting by a slight adjustment of the range adjustment screw.

3.18 ***High Water Temperature Switch*** (Reqt 2.18): The high water temperature switch is nonadjustable and must be replaced if malfunction occurs.

3.19 ***Reverse Power*** (Reqt 2.19): (See Section 155-020-701)

3.20 ***Control Fuse Failure*** (Reqt 2.20):

3.21 ***Circuit Breaker Shunt-Tripped*** (Reqt 2.21):

3.22 ***Battery Charging Rectifier*** (Reqt 2.22):

3.23 ***Jacket Heater Failure*** (Reqt 2.23):

ENGINE COOLING SYSTEM

3.24 ***Cooling Water*** (Reqt 2.24):

(a) Since the presence of acid in the water can be injurious to the cooling system, tests of the water should be made at various intervals. To detect acid, immerse one end of a small piece of Fisher Alkacid Test Ribbon in the cooling solution for approximately one minute and note the color change in the ribbon as a result of its immersion. A comparison of the color obtained with the following tabulations will indicate the degree of acidity or alkalinity of the water.

COLOR	pH	CONDITION
Red	2	Very acidic
Orange	4	Strongly acidic
Yellow	6	Weakly acidic
Green	8	Weakly basic
Blue	10	Strongly basic

(b) If the Alkacid Ribbon Test of the water shows by its color that its pH is within the 7 to 9 (neutral to weakly basic) range recommended, it will be satisfactory to continue its use until such time as it is replaced for normal reasons. If the test indicates a tendency to be acid, it must be replaced with neutral water. This applies to the water in the cooling system regardless of its content of antifreeze or rust inhibitor additive.

Caution: If the engine water is to be replaced, remove the heater fuses before draining water to protect heater elements. After water has been installed, replace the heater fuses.

3.25 ***Radiator Pressure Caps*** (Reqt 2.25):

(a) Turn the radiator cap and, if loose, replace gasket in cap.

Note: Always remove the radiator cap slowly and carefully to avoid overflow of hot cooling liquid and possible personal injury.

(b) Remove the radiator cap and if the valves are inoperative, replace the cap.

3.26 ***Radiator Fan Belt*** (Reqt 2.26): Maximum life of the fan hub bearings of the engine mounted radiator will be ensured with a properly adjusted fan belt. It should be neither too tight nor too loose. Too much tension will impose unnecessary loading on the bearings, and too little tension causes slipping, excessive belt wear, and leads to overheating of the cooling system. (For best results, the belt should have enough slack so it can be depressed approximately the dimensions at the midpoint of a straight line running between the rim of the pulleys.) This straight line can be determined by placing a straight edge across the rim of the pulleys and measuring the amount of slack from the straight edge. An adjusting bracket is provided behind the fan for belt adjustment. To adjust the belt, loosen the bracket retaining bolts and turn the adjusting bracket to tighten the belt or down to loosen it. When the proper adjustment has been obtained, securely tighten the bracket retaining bolts. A worn, frayed, cracked, or oil soaked fan belt should be replaced.

3.27 ***Antifreeze Solution and Rust Inhibitor*** (Reqt 2.27):

3.28 ***Radiator Discharge Air Shutters*** (Reqt 2.28):

3.29 ***Immersion Heater Cold-Aid Starting Equipment*** (Reqt 2.29):

(a) Clean the immersion heater every 300 hours or 6 months as follows.

(1) Close valves to the heater.

(2) Open heater drain cock located in bottom of heater body.

(3) Remove element from heater body and clean.

(4) Inspect swing check valve in the heater to ensure that it is free to operate.

(5) Remove any sludge accumulation in the heater.

(6) Reassemble heater, close drain cocks, and open heater valves.

(7) Start and run engine to check coolant and add coolant, if required.

(b) If the immersion heater switch malfunctions, it should be replaced.

(c) ***Ether Starting Device:*** The ether starting device is a closed pressure primer system. The pressurized cylinder and discharger valve assembly are bracket mounted on the left rear side of the engine. The ether starting device pushbutton is mounted on the engine control panel for accessibility to the operator during engine starting.

Caution 1: Fuel cylinder contents are under pressure and are extremely flammable. Keep contents away from heat, sparks, or open flame. Avoid contact with the skin and avoid breathing of fumes. Observe the precautions printed on the cylinder.

Caution 2: Never use the ether starting device when the ambient temperature is above 40°F or on a hot engine. Pressurized ether containers should be stored in a safe location and are only to be installed on the engine when needed.

ALTERNATOR, EXCITER, AND VOLTAGE REGULATOR

3.30 ***Voltage*** (Reqt 2.30):

(a) The voltage regulator furnished is of the shunt-transistor type. It is designed to regulate the terminal voltage within the regulation limits of ± 1 percent at either 208 or 240 volts ac for any combination of steady-state load variations from no load to full load and from 0.8 lagging to 0.8 leading power factor conditions. In addition, the voltage regulator is designed to sustain any symmetrical or unsymmetrical short circuit on the output terminals of the alternator and furnish during these conditions current values of 3 per unit.

(b) Voltage adjustments of the alternator output are provided using a rheostat located on the front of the main control panel. This rheostat provides alternator output control within a range of ± 10 percent.

(c) Resistor R4 is adjusted to prevent regulator oscillation (hunting). This is accomplished by using a feedback circuit consisting of an antihunt transformer with resistors R4 and R5. This feedback signal is added to the dc sampling voltage.

(d) For cross-current compensation, adjustment of the Droop Adjust Resistor R1 minimizes the circulating current between alternators, when they are operating in parallel. The droop transformer produces a voltage proportionate to the current in Line 2 which is added to the sensing and current voltages. Since these voltages are in quadrature at unity power factor, the reactive portion of current directly affects the sensed voltage causing generated voltage of the alternator to be adjusted in a manner to reduce the cross current. During single operation the Unit-Par. switch should be in the closed position.

BATTERY SYSTEM

3.31 ***Starting and Control Batteries (Lead-acid or nickel-cadmium type)*** (Reqt 2.31):

(a) ***Starting Battery:*** The following procedures assume that lead-acid starting batteries are the KS-15577 L15, 24-volt, 12-cell storage battery. These batteries have a nominal specific gravity of 1.210 and a capacity of 207- to 217-ampere hours at the 8-hour rate for the KS-15577 L15. The nickel-cadmium starting battery used is assumed to be KS-15578 List 13W, 24-volt, 20-cell storage battery with float voltage limits of 28.0 to 28.6 volts.

(b) ***Control Battery:*** The following procedures assume that the control battery is the KS-5361 L116C, 24-volt, 12-cell lead-acid storage battery recommended for all temperature ranges. It has a nominal specific gravity of 1.210 at a capacity of 10 ampere-hours at the 8-hour rate. The nickel-cadmium control battery is assumed to be a KB1 24-volt, 20-cell storage battery with voltage limits of 28.0 to 28.6 volts. ▶The batteries are to be maintained in accordance with procedures contained in Sections 157-601-701 and 157-633-101 for lead-acid and 157-631-101 for nickel-cadmium.◀

(1) To give the lead-acid battery an initial charge, follow the instructions in Section 157-601-201. This may be done (but it is not

recommended) by a garage or battery service station charge, but the attendant should be instructed that the battery is of low specific gravity type.

Note: The J87249B battery charging rectifier is ***not*** to be used for boost charging of batteries.

(2) ***During life,*** the 24-volt start and control batteries should be checked periodically to determine that their float voltage is being maintained between 25.8 and 26.4 (for lead-acid) and 28.0 and 28.6 (for nickel-cadmium). Checking of total battery voltage should be made using a Weston Model 931 dc voltmeter and 6-foot test cords. If the 6-foot test cords are not long enough for proper voltage measurements, the 10-foot Weston No. 168023 test cord should be used in conjunction with the black 6-foot test cord and Weston voltmeter. The normal charging source is the J87249B battery charging rectifier. Reference to Section 169-649-301 should be made for operating information on these rectifiers. Sections 020-010-711 and 157-601-301 may be consulted for further information on the lead-acid battery.

3.32 ***Starting Motor and Sprag Clutch*** (Reqt 2.32):

(1) The starting motor operates a Sprag clutch pinion to engage a ring gear on the flywheel of the engine, and turns the engine over as long as battery is supplied to it by the cranking circuit. When the engine starts, the Sprag over-running clutch disengages its pinion from the flywheel, due to the loss of the starting voltage.

(2) After the starting motor has been in service for 2 years or if it needs repair, it should be removed from the engine, dismantled, and cleaned. Clean the drive thoroughly with petroleum spirits and lubricate it sparingly with a light oil.

Note: If the starting motor is to be used in temperatures which are likely to fall below 0°F, always apply Casite to the drive components to ensure free operation at low operating temperatures.

(3) Examine all wiring for loose or corroded connections and for broken leads. Tape any wiring that has become frayed. Examine the brushes to ensure that they move freely and replace those that are broken or worn. Clean the commutator with a clean KS-14666 cloth. Follow the procedure for commutator maintenance outlined in Section 171-110-701.

(4) If the starting motor should fail to operate when the cranking circuit is energized, check the starting system wiring between the battery and the motor for open or loose connections and examine the starting control devices to ensure that they operate and make good contact. If required, clean contacts with petroleum spirits, smooth with a KS-2663 file to ensure good contact is made, and again clean with petroleum spirits. Wipe the contacts with a clean KS-14666 cloth after cleaning.

3.33 ***Solenoid Switch*** (Reqt 2.33):

(1) Remove the cranking motor cable leads and the wires from the switch terminals. Tag these for identification. Remove the mounting bolts, washers, lockwashers, and nuts. Remove the four nuts on the bottom of the switch. Remove the contact stud assembly. Abrade the contact studs and contact disc, using Garnet 4/0 or Flint extra-fine abrasive or a fine file. Replace switch and wiring in reverse order.

(2) Remove the switch as covered in (1). If the contact disc or insulators are found to be badly cracked or deteriorated, replace the contact disc assembly. This is done by removing the cotter pin and nut and installing a new contact disc assembly. Replace the nut and cotter pin. Replace the other parts and the switch as covered in (1).

3.34 ***Fuel Oil Pressure Switch*** (Reqt 2.34): The fuel oil pressure switch is located beside the lube oil pressure switch and the preliminary high water temperature switch, and is adjusted as in 3.17.

TEST AND ROUTINE RUNS

3.35 ***Test Run*** (Reqt 2.35):

(1) During the test run, different loads for the engine-alternator set may be obtained by varying the amount of load connected to the alternator load terminals. The speed of the engine shall be taken with an accurate indicator or tachometer placed against the end of the pulse generator shaft. Discuss loading arrangements with the supervisor. When sufficient office or building load is not available or service reactions are involved in its use, artificial loads may be necessary.

Caution: When sufficient office load is not available for a partial load test, always augment the available office load with an artificial load. Do not perform a partial load test using less than 30 percent full load (see Section 171-123-101).

(2) Any malfunctions which may develop will probably be noticed during a test run and may be corrected before the set is needed at a time of actual power failure.

3.36 ***Routine Run*** (Reqt 2.36): On these standby sets, with weekly operations for short periods, all working surfaces requiring lubrication will be lubricated frequently enough so sufficient oil will remain on them to protect them and to provide partial lubrication immediately upon starting.

Caution: When sufficient office load is not available for a partial load test, always augment the available office load with an artificial load. Do not perform a partial load test using less than 30 percent full load (see Section 171-123-101).