

508A POWER PLANT CONTINUOUS 230-VOLT AC POWER OPERATING METHODS

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1. GENERAL

1.01 This section describes the operation of the 508A power plant (J86476) for use in the TH radio relay system. This plant supplies 230 volts ± 1 per cent, 60 cycles when operated on 200 to 250 volts, 60 cycles, 3-phase ac, or 230 volts ± 2 per cent, 60 cycles ± 2 per cent when operated on 125 to 145 volts dc.

1.02 This section is reissued to add information for the KS-15949, L1 alternator set and to add several paragraphs on running spare adjustments. Information for panel voltmeter calibration has also been added.

1.03 The power plant consists of continuously operated 2-motor alternator sets mounted on frameworks, together with the necessary switching and control equipment. The plant normally operates from service voltage, but continuous output is assured through the operation of an automatically connected dc motor during ac service failure.

Caution: *As this plant involves automatic equipment and higher voltages than those ordinarily used in telephone offices, care*

should be taken to be sure any parts of the plant on which maintenance work is to be done are properly disconnected, and then restored to normal when the work is completed.

1.04 It is necessary to insure that power be available at all times, and since the loads for the TH radio relay system may be such that a single set will not suffice, the 508A power plant is, therefore, arranged so that two to five regular 2-motor alternator sets, feeding separate load buses, are available.

1.05 Each alternator set is normally driven by a 3-phase, ac synchronous motor, and during ac service voltage and/or frequency failure, a 130-volt dc motor, operating from a 125- to 145-volt storage battery, automatically takes over. This transfer will also take place upon failure of an ac motor. In addition, there is a continuously running spare set which automatically carries the load should any one of the regular alternator sets fail or be out of service for maintenance. A nonrunning spare set is provided. This set is to be connected manually on a plug-in basis to substitute for any of the normally running sets if one is removed from service for an extended period.

1.06 Routine checks are intended to detect defects, particularly on infrequently operated parts of the equipment, and insofar as possible, to guard against circuit failures likely to interfere with service. Checks and adjustments other than those required by trouble conditions should be made during a period when they will not interfere with service.

1.07 Keeping the cabinet ventilating grills clean is especially important to prevent excessive heating. Care should be taken when doing any soldering to prevent solder splashes from causing shorts on other apparatus.

1.08 These instructions are based on drawing SD-81350-01. For a detailed description of the operation, see the corresponding circuit description.

1.09 For more detailed information on the operation and maintenance of individual equipment or apparatus, refer to the appropriate Bell System Practice.

1.10 The abbreviations cw and ccw, used herein, refer to clockwise and counter-clockwise rotations, respectively.

1.11 Use extreme caution in trouble shooting which involves access to equipment behind covers. It is advisable to locate defective elements, with all power turned off and fuses removed, using an ohmmeter to detect opens or shorts, and the SD drawings as a guide.

1.12 Early models of these units were furnished with the SR rheostats ("W" option) located on the rear shelf adjacent to the motor starters. Later units have had these rheostats replaced by two potentiometers (SRX and SRY) and a fixed resistor (SRZ) in approximately the same location ("T" option).

1.13 The early units did not have provision for the -10 per cent quick load transfer ("V" option).

1.14 The early power plants were equipped with KS-15823, L1 2-motor alternator sets. A KS-15844, L1 2-motor alternator set which operates in a similar manner is also

available. However, the KS-15844, L1 alternator set has a voltage regulator to maintain a closely regulated output voltage. An additional set, KS-15949, L1 is also available. This set is similar in operation to the KS-15844, L1 set except that a manual field flash for build up of alternator voltage is provided. See 3.54.

1.15 Since VOLTS OUT on the KS-15823, L1 sets was dependent on a permanent magnet type alternator, the output voltages were a function of the speed. With the KS-15844, L1 and KS-15949, L1 alternator sets, however, the VOLTS OUT is not an indication of the speed. For this reason, a tachometer is required when adjusting power plants with these alternators. The corresponding rpm reading is given in parentheses () for the VOLTS OUT reading where required.

2. LIST OF TOOLS AND GAUGES

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
265C	Contact Burnisher
—	3-inch "C" screwdriver
GAUGES	
KS-3008	Stop Watch (or equivalent)
KS-14510, L1	Volt-Ohm-Milliammeter
—	Tachometer, No. 5, Boulin Instrument Corp.
—	Weston Model 622 Rectifier Type Voltmeter, Scale 300/150/30 (Silicon Type Rectifier)

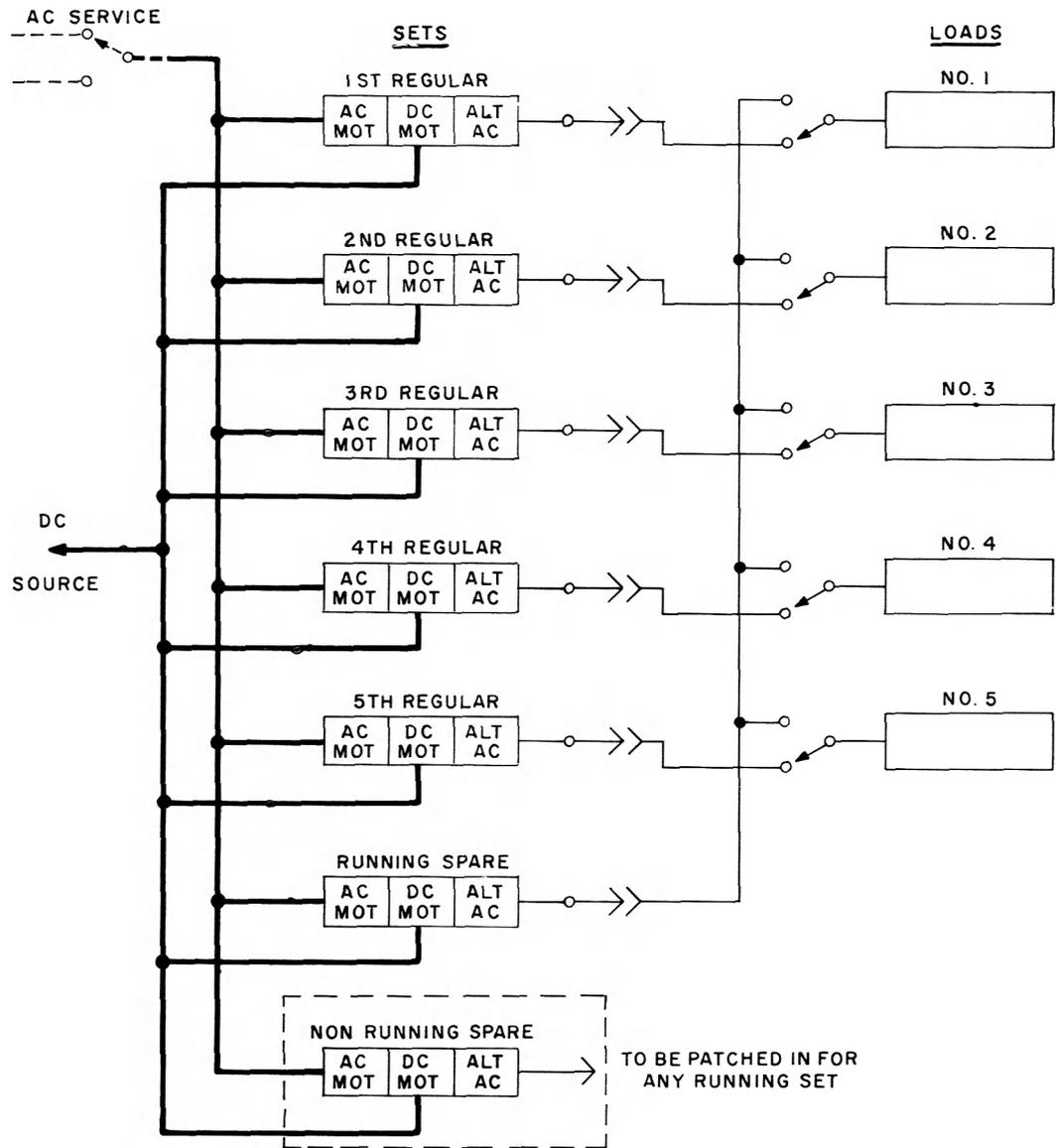
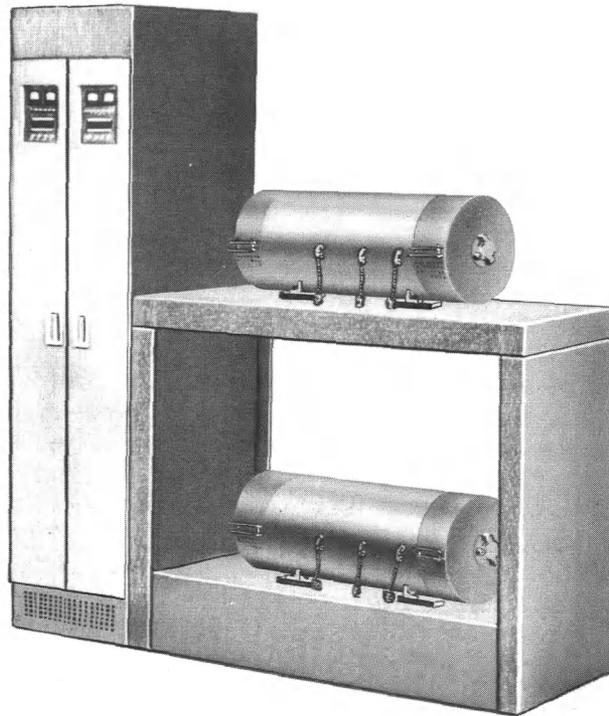
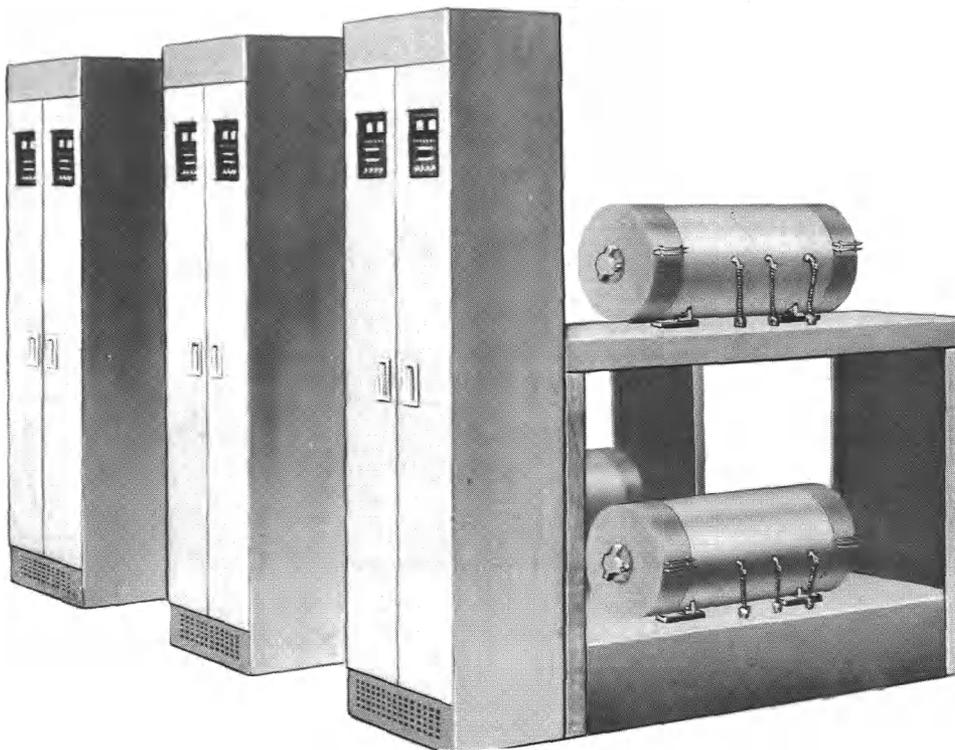


Fig. 1 - Plant Schematic



→
Fig. 2 – Bay Arrangement With Machine Table at Side of Cabinet
(Alternators Vary — Depending on KS number)



→
Fig. 3 – Plant Arrangement With Machine Tables Behind Cabinets
(Alternators Vary — Depending on KS number)

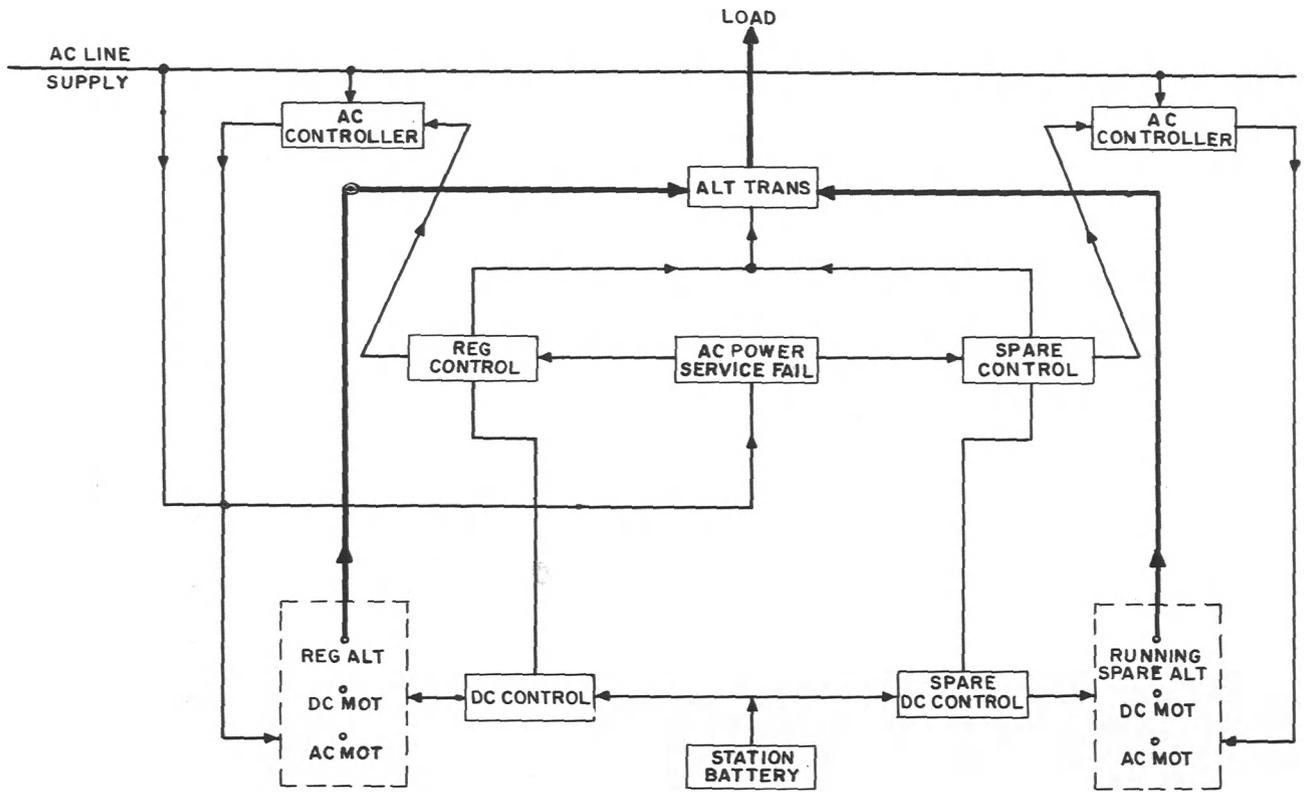


Fig. 4 - Block Diagram

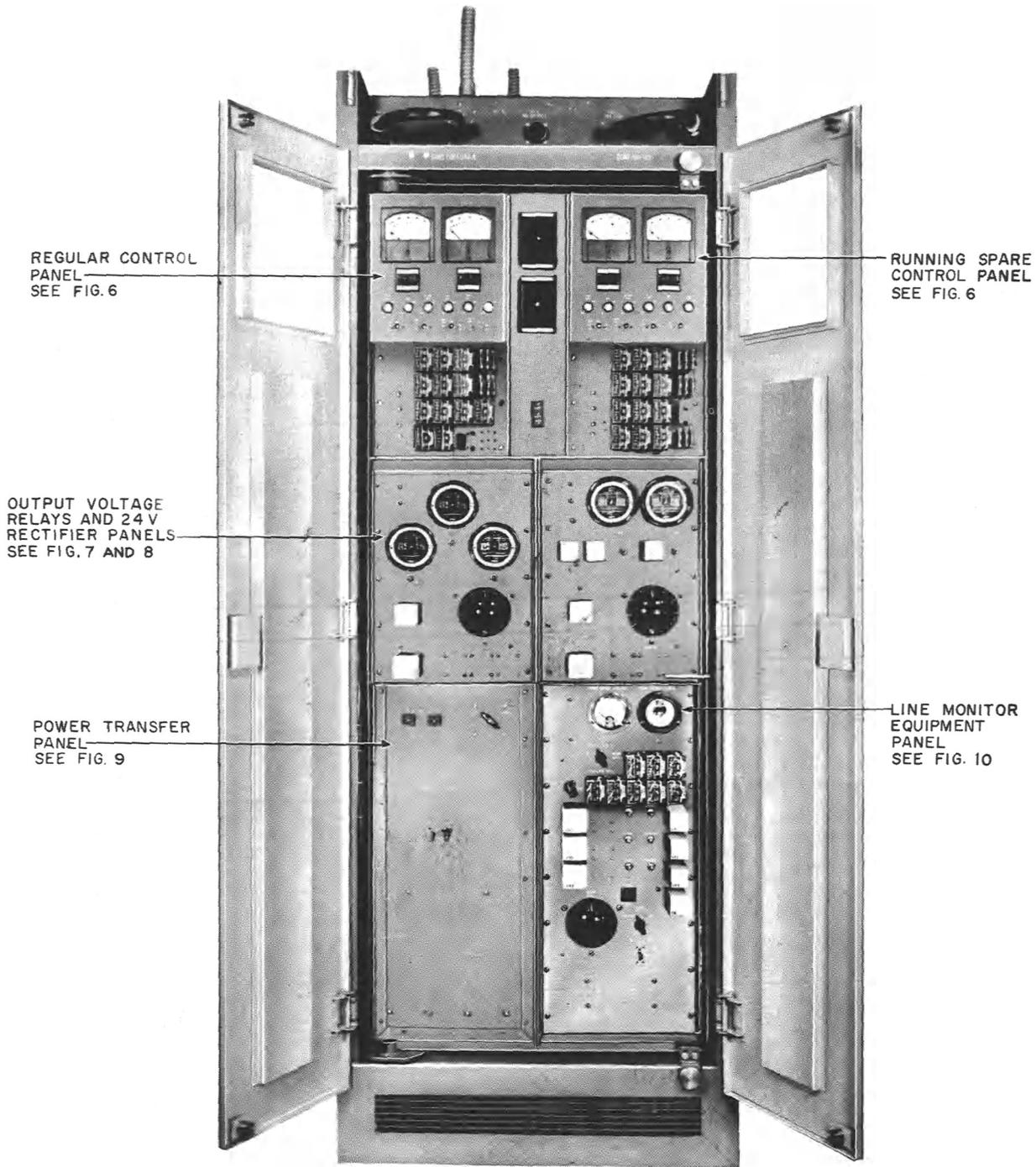


Fig. 5 - Control Cabinet — Front View — Doors Open

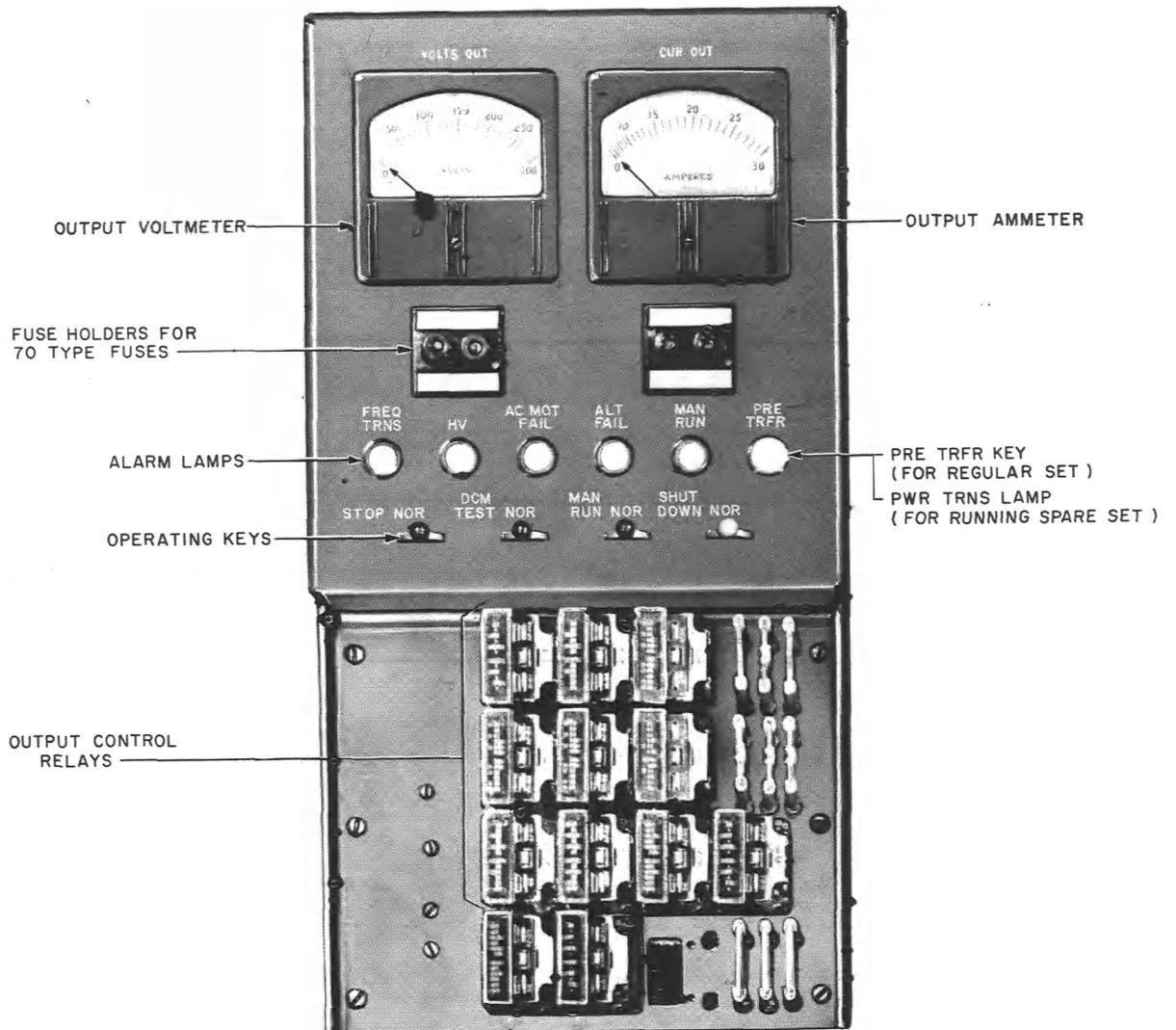


Fig. 6 - Main Control Panel - Regular and Running Spare

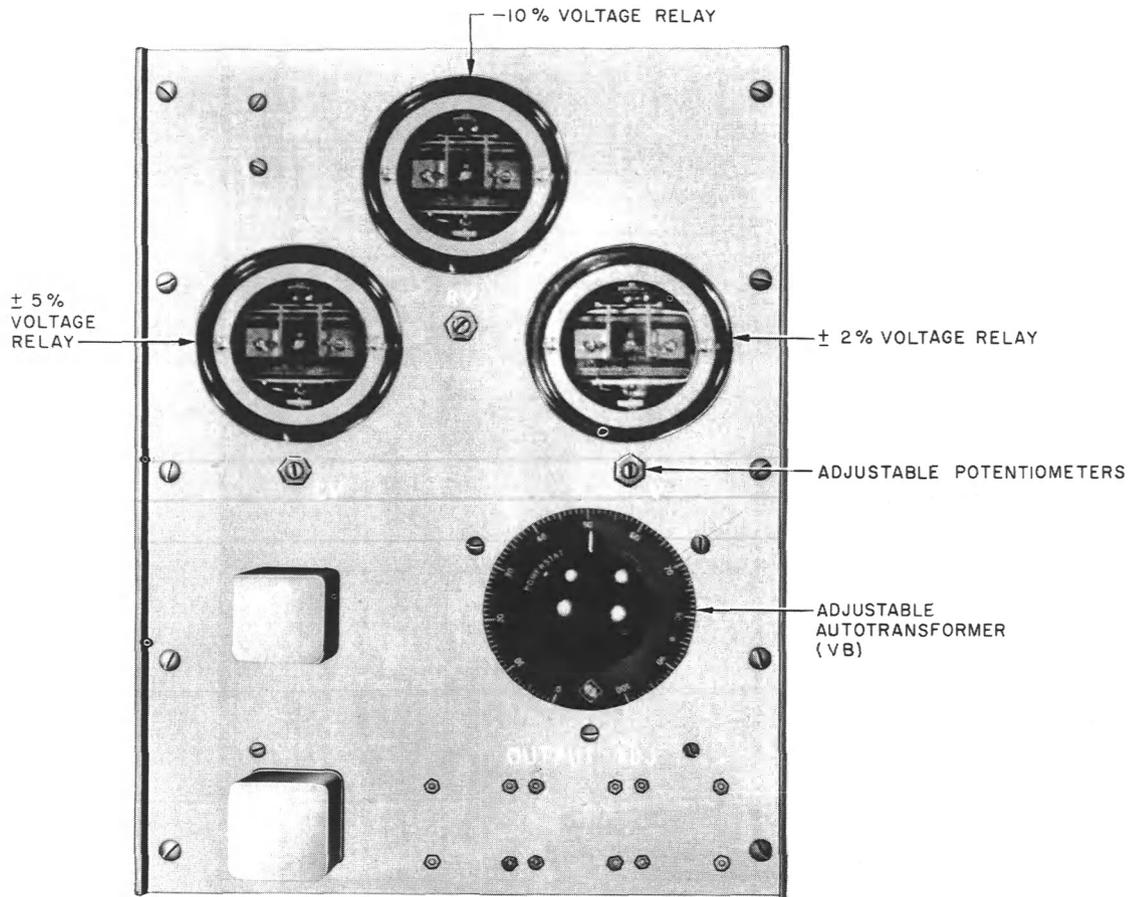


Fig. 7 - Voltage Relay and 24-Volt Rectifier Panel — Regular

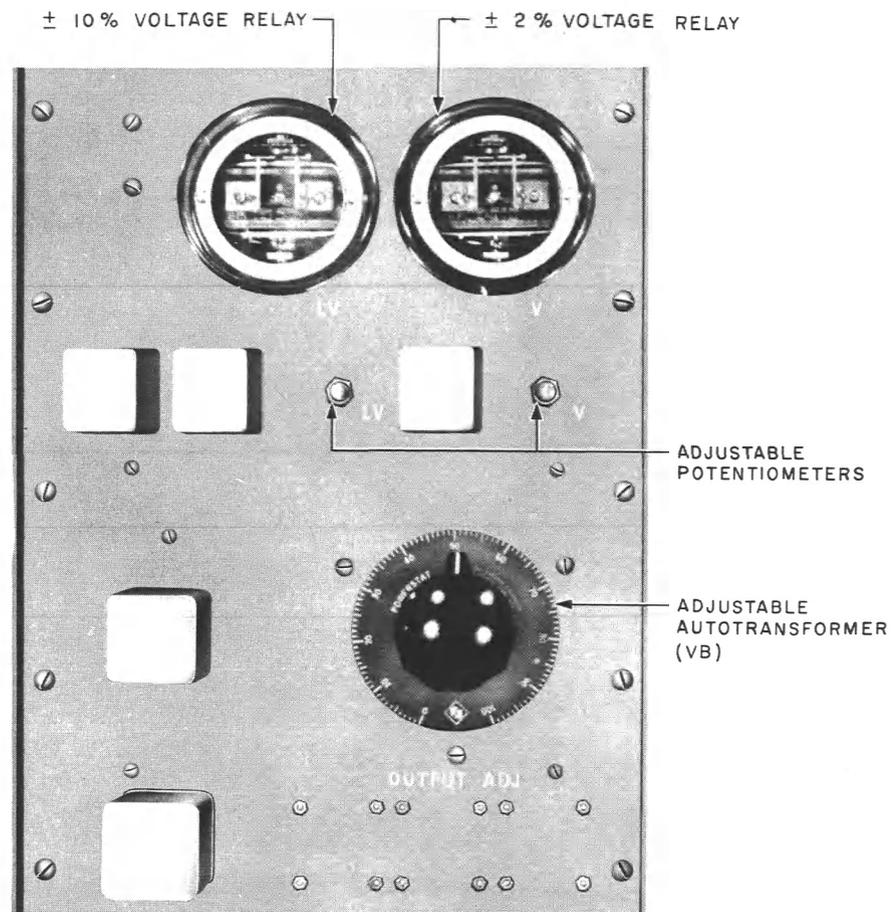


Fig. 8 - Voltage Relay and 24-Volt Rectifier Panel — Running Spare

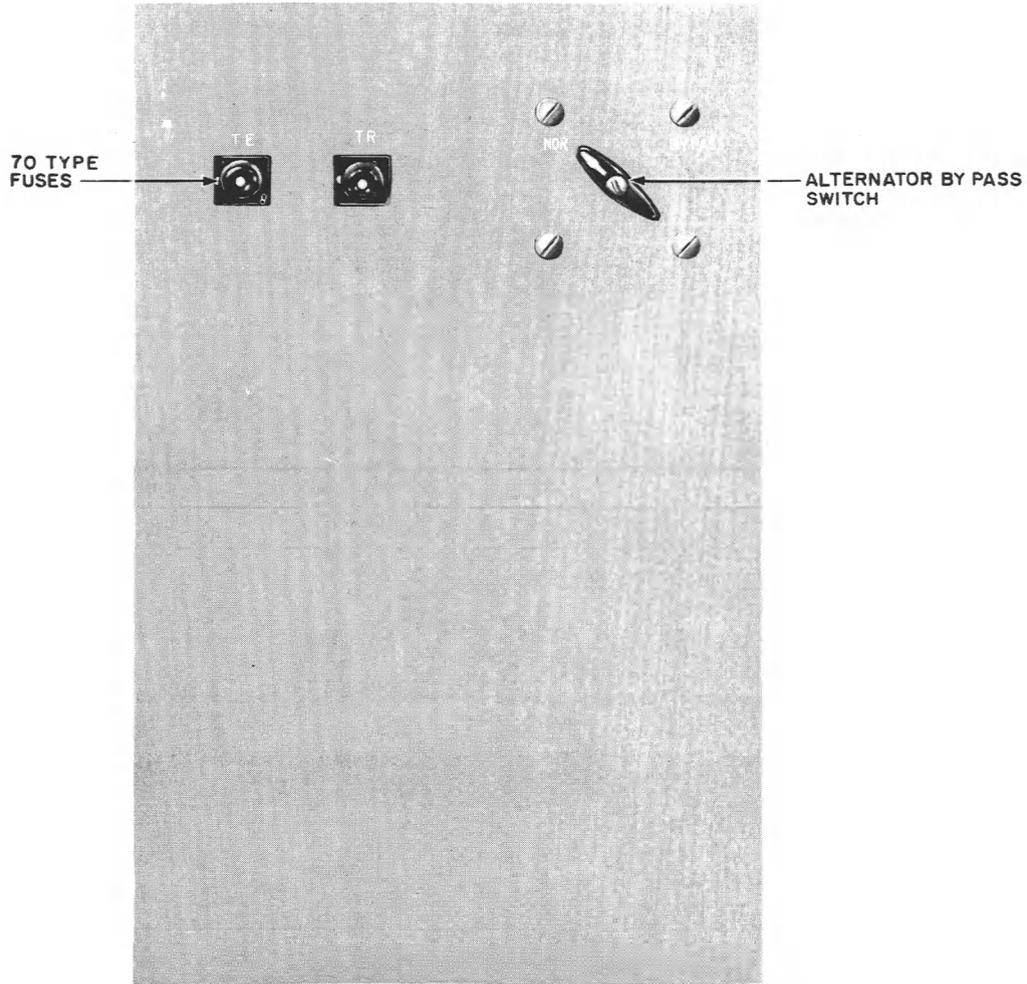


Fig. 9 – Power Transfer Panel

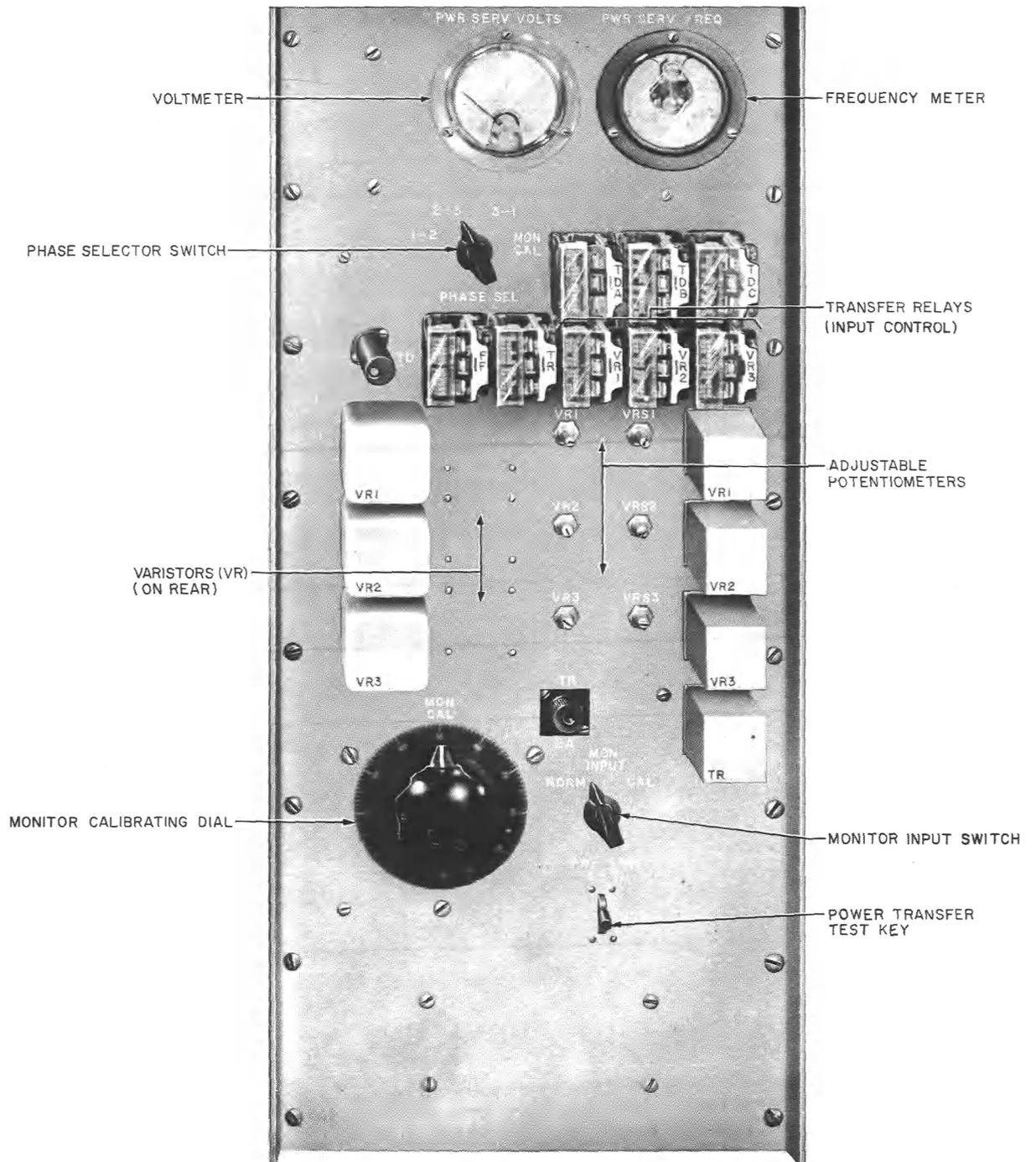


Fig. 10 - Line Monitor Panel

3. OPERATION

A. How the Power Plant Works

3.01 General: This power plant consists of a 2-motor driven alternator unit, a running spare operating at no load, and a nonrunning spare unit and associated controls and alarm circuits all mounted in cabinets. The circuitry is such that up to four additional regular units may be added to carry separate loads. Except during alternator transfer, the power plant is capable of supplying continuous 230-volt ac power for the TH radio relay system. The units are normally operated from commercial ac lines.

3.02 The ac synchronous motor and alternator are designed for brushless operation to reduce maintenance. The dc motor field circuit uses varistors to hold a nearly constant speed on the motor as the battery voltage decreases during discharge. In addition, the dc motor brushes are lifted off the commutator when running on ac.

3.03 During power failure, the alternators are transferred to dc drive running on the station batteries, thereby maintaining a continuous ac supply to the equipment.

3.04 In addition, the ac input voltage and the ac output voltage are monitored as follows.

(a) If the ac input voltage fails, the dc motor drives the alternator. The sets will automatically transfer back to ac drive on restoration of ac input voltage.

(b) A marginal voltage control transfers the sets from ac to dc drive whenever power service voltage drops to about 165 volts. When ac voltage returns to 195 volts, and when frequency is normal, the transfer from dc to ac drive is made after a delay of about 100 to 150 seconds. The running spare set transfers first, and then each regular set transfers at 10- to 15-second intervals.

(c) If the ac output voltage changes about ± 5 per cent due to the frequency being outside the limits of 59.2 to 62.6 cycles for the voltage input, an automatic control circuit will operate to transfer the motors from ac to dc operation.

(1) The unit will automatically transfer back to ac drive after the frequency deviation is corrected with the same sequence as in (b).

(2) If the ac output voltage drops below 218.5 volts or rises above 241.5 volts (± 5 per cent), automatic transfer to dc drive is made. If the voltage remains outside the limits, the load is transferred to the running spare set. After correction of the trouble, the regular alternator must be manually started on the dc motor and transferred to the ac supply.

(3) On later units, if the ac output voltage suddenly drops 10 per cent ("V" option), there is quick transfer of the load to the running spare set. The regular alternator shuts down and must be manually started in the normal manner.

3.05 A running spare set, normally driven by its ac motor, is run continuously at no load. This set is a common set for a maximum of five regular sets for supplying the TH radio system. The spare is arranged to replace automatically any regular set that fails or goes high or low in voltage, or that is removed from service for maintenance. The loads are picked up in order of priority. Regular set 1 has first load priority, regular set 2 has second, etc. As a result of this priority, if the running spare set is carrying the load of the second regular set and the first regular set fails, the running spare set will automatically drop the load of the second regular set and pick up the load of the first regular set. The load of the second regular set is disconnected.

3.06 Suitable alarms are provided to indicate high or low alternator voltage, alternator failure, ac motor failure, and faulty power service voltage and frequency. Transfer of any load to the running spare is signaled by alarm lamps on the regular panel, and ammeter reading on the spare panel.

3.07 Manual controls are included with each alternator set and its associated control equipment to permit testing and maintenance work.

3.08 A BY-PASS switch is furnished with each regular set to permit maintenance of the load transfer contactor with the voltage re-

moved. When in the NOR position, the load is connected to the regular alternator output through this switch. When in the BY-PASS position, the load is connected to the running spare alternator.

B. Preparing to Start

Initial Adjustments

3.09 When preparing the power plant for initial service, check that the following conditions have been met.

- (a) The ST switch on the motor starter is OFF.
- (b) The BY-PASS switch is in the NOR position.
- (c) The correct transformer taps have been connected for the power service rated voltage at the VR 1, 2, 3 transformers. (See the associated SD drawing.)
- (d) All keys are in the NOR position.
- (e) All 70-type fuses have been installed.
- (f) All VR 1, 2, 3 potentiometers are maximum ccw.
- (g) All V, LV, and RV potentiometers are maximum ccw.
- (h) All VRS 1, 2, 3 potentiometers are maximum cw.
- (i) The OUTPUT ADJ control is at approximate midrange position. (50 on dial)
- (j) The MAN RUN-NOR key is operated to MAN RUN.

3.10 All sets are started on dc drive, and until ready to start, the STOP-NOR key must be operated to STOP. On early units, check to see that the front band on the SR rheostat ("W" option) is near the center of the tube, and that the rear band is at the rear of the tube. On later units, the SRX and SRY potentiometers ("T" option) should be fully ccw (see 1.11). Temporarily connect the "L" lead to terminal 7 on the VB autotransformer.

Caution: Do not loosen or move the bands on the SR rheostat unless the set is at a standstill. Avoid any contact with exposed equipment on the dc starter when fuses are installed in the dc motor supply circuit.

DC Motor — Direction of Rotation and Preliminary Speed Adjustment

3.11 Install fuses in the dc motor supply circuit and B battery. **Do not** install fuses in the ac motor supply. Operate the MAN RUN-NOR and DCM TST-NOR keys to MAN RUN and DCM TST. Operate ST toggle switch on the motor starter to ON and restore the STOP-NOR key to the NOR position. The set should start in the direction indicated and accelerate until the last accelerating contact of the starter closes. Output voltage should build up as indicated by the VOLTS OUT voltmeter.

3.12 With the OUTPUT ADJ control in full ccw position, read VOLTS OUT or the speed, depending on the alternator equipment. If this reading is 210 volts (1700 rpm) or more, the speed is adequate for transfer to ac drive. If the reading is less than 210 volts (1700 rpm) operate the STOP-NOR key to STOP to stop the set. Allow the set to coast to a standstill and move the front band on the SR rheostat 1/2 inch forward and tighten it. Restart the set by restoring the STOP-NOR key to NOR and read the voltage. Repeat this procedure until the voltage is 210 volts (1700 rpm) or more. This procedure is for earlier units having the SR rheostat. For later units, the above adjustment is made by turning the SRX potentiometer cw until the voltmeter reads 210 volts (1700 rpm). This may be done while the set is running.

AC Motor — Direction of Rotation — No Load

3.13 To check the direction of rotation of the ac drive, operate the STOP-NOR key to STOP. Insert 35-ampere fuses (not Fusetrans) in the ac motor supply circuit. Leave the associated fuse unit switch in the ac service cabinet OFF. Block the MR starter operated. Operate the fuse unit switch to ON. The set should start to turn until current in-rush blows the 35-ampere fuses. Note the direction of rotation. Restore the fuse unit switch to OFF. If the set rotates in the wrong direction, interchange the L1 and L2 leads at the fuse unit switch. Remove the block on the MR starter. Replace the 35-ampere fuses with 45-ampere Fusetrans in the motor supply circuit.

3.14 Install 3-ampere fuses to the ac supply for the line monitor.

C. Initial Adjustments**Line Monitor Circuit**

- 3.15** Operate all DCM TST-NOR keys to DCM TST.
- 3.16** Operate the monitor input (MI) switch to CAL and the phase selector (PH) switch to MON CAL to permit adjustment of the monitor circuit voltages.
- 3.17** Adjust the VR 1, 2, 3 potentiometers so that the associated VR 1, 2, 3 relays release at 165 volts when the ac input voltage is reduced from 210 volts. Check that the VR relays reoperate at 195 volts after this release. The VRS 1, 2, 3 potentiometers are used to adjust the ratio of operate to release voltage, but the adjustments of these controls are interdependent. Turning these potentiometers ccw gives a wider separation of operate and release voltages. For initial adjustment, they should be fully cw, and they should be adjusted so as to obtain the above release and reoperate voltages.

3.18 Operate the monitor input (MI) switch and DCM TST keys to NOR, and the phase selector switch (PH) to the 1-2 position, thus allowing the sequence relays to return the sets to ac drive.

Note: In the event that the set does not transfer to ac drive, perform steps 3.19 to 3.23, which will correct misadjustment of voltage relays.

3.19 Operate the PWR TRNS TST-NOR key to PWR TRNS TST to check the transfer of the set to dc drive. Restore the key to NOR and check the 100- to 150-second delay in operation of the TR relay and the approximate 10- to 15-second intervals between the return of subsequent sets to ac drive.

Alternator Voltage Check — AC and DC Drives

→ **Note:** See 3.56 for voltmeter calibration
→ which should be made at this time.

- 3.20** Check that the MA relay is operated.
- 3.21** With the DCM TST-NOR, MAN RUN-NOR, and STOP-NOR keys operated, restore the STOP-NOR key to NOR. Allow the set to accelerate to full speed.

3.22 Adjust the LV potentiometer until either the AF or HT relay releases. The MS relay should operate. Operate the DCM TST-NOR key to NOR, and the set should transfer to ac drive.

3.23 Return the set to dc drive by operating the DCM TST-NOR key to DCM TST and take the reading on the output voltmeter or speed reading. Stop the set by operating the STOP-NOR key to STOP. If the reading is less than 230 volts (1800 rpm), move the front band on the SR rheostat forward; move it toward the rear if the output reading was more than 230 volts (1800 rpm). Tighten the band and start the set by operating the DCM TST-NOR key to NOR and then releasing the STOP-NOR key to NOR. Check the output voltage or speed and repeat the above steps until the output voltage or speed is between 225 and 235 volts (1760 and 1840 rpm). This applies to early units with "W" option. On units with the "T" option, turn the SRX potentiometer cw to raise the voltage or speed, and turn it ccw to lower the voltage or speed. Adjust the output voltage or speed so that it is between 225 and 235 volts (1760 and 1840 rpm). The set should transfer to ac drive. The KS-15844, L1 and KS-15949, L1 sets have a VOLTS ADJ potentiometer on the voltage regulator. Adjust this potentiometer to give 230 volts on the VOLTS OUT meter at no load and with the OUTPUT ADJ control set at 50. For the KS-15823, L1 sets adjust the OUTPUT ADJ control so that the VOLTS OUT meter reads 230 volts at no load. Adjust the V and LV potentiometers until the movable contacts on the V and LV relays are centered between the fixed contacts. The AF, HT, AV, and HV relays should all be released. Also adjust the RV potentiometer ("V" option) until the movable contact in the RV relay contacts the H terminal. The QT relay should be released.

Speed Control

3.24 The speed of the set on dc drive should closely match the speed on ac drive to effect a smooth transfer. The dc motor speed varies with load changes and the final adjustment of the motor shunt field control circuit must be made with a load equivalent to the operating load.

3.25 The SRD varistors are connected across part of the SR field rheostat on early units ("W" option). On later units, the varistors are connected across part of the SRY potentiometer and the fixed SRZ resistor ("T" option). They act to control the speed of the dc motor by conducting only a small amount of current at low battery voltage (125 volts), and more current for higher battery voltages. Voltage across that portion of the SR rheostat or the SRY potentiometer and SRZ resistor shunted by the varistors remains practically constant with variations in battery voltage. This causes more field current to flow at high battery than would flow without the varistors, and tends to keep the speed constant.

3.26 Provision must be made to provide a source of variable dc power at 120 to 155 volts, 100 amperes for the motor input voltage.

3.27 The method of obtaining this voltage depends upon the particular battery charging equipment in use. The polarity of the voltage supply must be positive with negative ground. Making this speed control test will require that the battery be disconnected from the charging unit in order to permit wide variations of the output voltage of the charging unit.

3.28 When a motor generator set is used as the charging source, open the battery switch on the generator control bay and connect a No. 4 wire from the EM cell terminal of the battery switch to the load side of the dc motor supply ALT- fuse for the machine under test. Include means for fuse protection in this lead. Start the alternator set in the normal way and transfer to ac drive. Start the auxiliary charging generator and adjust the output voltage to match the discharge bus voltage. Remove the dc motor supply ALT- fuse. Install a temporary 80-ampere fuse in the No. 4 temporary lead. Close the battery switch to the EM cell position. Transfer the set to dc drive. The input voltage to the dc motor may now be adjusted on the generator control bay.

3.29 If the charging unit is a rectifier, remove the CHG and CHG alarm fuses from the rectifier and connect a No. 4 wire from the rectifier side of the charge fuse of the rectifier to the load side of the dc motor supply fuse for the machine under test. Include an 80-ampere fuse in this lead. Start the alternator set in the nor-

mal way and transfer to ac drive. Start the rectifier and manually raise the output voltage until the output ammeter indicates 10 amperes. Quickly remove the dc motor supply ALT- fuse at the fuse panel and transfer the set to dc drive. The input voltage to the dc motor may now be manually adjusted at the rectifier.

3.30 Run the alternator set for approximately 1 hour on dc drive with the equivalent anticipated alternator load prior to making adjustments. Block the QT, HT, and AF relays released. Connect a KS-14510, L1 dc high-resistance voltmeter across terminals 1 and 3 of the SRA potentiometer. If the SRA potentiometer is fully cw, then full-scale deflection of the meter indicates 300 milliamperes of SRD varistor current.

3.31 Proceed as follows.

- (a) Adjust the SRA potentiometer fully cw and the SRY potentiometer fully cw.
- (b) Do not readjust the SRX potentiometer.
- (c) Transfer the set to ac drive and connect the equivalent anticipated load.
- (d) Adjust the alternator output voltage to 230 volts by means of the OUTPUT ADJ control. With no further changes in the control or load, the alternator output of 230 volts for the KS-15823, L1 set may be used to indicate an alternator speed of 1800 rpm (60 cycles). For the KS-15844, L1 and KS-15949, L1 sets, a tachometer must be used to measure the speed.
- (e) Increase the dc bus voltage to 145 volts.
- (f) Transfer the set to dc drive by operating the DCM TST key.
- (g) Reduce the dc bus voltage to 125 volts and operate the set for 1 minute.
- (h) Adjust the SRX potentiometer cw until the VOLTS OUT meter reads 234 volts (1830 rpm).
- (i) Adjust the SRY potentiometer cw until the varistor current increases to 15 milliamperes.
- (j) Readjust the SRX potentiometer cw until the alternator output is 230 volts (1800 rpm).
- (k) Repeat steps (i) and (j) if necessary.

(l) Raise the dc bus voltage to 145 volts. The varistor current should not exceed 150 milliamperes.

(m) Increase the dc bus voltage to 152 volts and check that the varistor current is less than 250 milliamperes. If the current exceeds 250 milliamperes, stop the set and check the SRD varistors.

(n) Reduce the dc bus voltage to 145 volts.

(o) Transfer the set to ac drive.

(p) Transfer the set to dc drive and observe the VOLTS OUT meter or speed change.

(q) Reduce the dc bus voltage gradually to 125 volts and observe the VOLTS OUT meter or speed change. The alternator voltage should remain between limits of 226 and 234 volts (1770 and 1830 rpm). If the voltage exceeds 234 volts, adjust the SRA potentiometer ccw until the voltage is within limits.

(r) Remove the block on the QT, HT, and AF relays.

(s) Return all keys to NOR.

Note: The above procedure applies to sets having potentiometers ("T" option). For sets having rheostats ("W" option), the same procedure should be followed, except that for any adjustment of the SRX potentiometer, adjust the band nearest the front of the bay on the SR rheostat. Any adjustment of the SRY potentiometer will correspond to an adjustment of the band toward the rear of the bay on the SR rheostat.

Alternator $\pm 2\%$ Voltage Alarms

3.32 Adjust the OUTPUT ADJ control to obtain an output voltage of 234.5 volts. Adjust the V potentiometer to close the H contact of the V voltage relay at this value.

3.33 Adjust the OUTPUT ADJ control to reduce the output until the L contact of the V voltage relay closes. This contact should close at 225.5 volts.

Regular Alternator $\pm 5\%$ Voltage Relay

3.34 Depress and hold the PRE TRFR key, and then operate the MAN RUN-NOR key to MAN RUN to transfer the load to the

running spare. Then release the PRE TRFR key and operate the DCM TST-NOR key to DCM TST to transfer the regulax set to dc drive.

3.35 Adjust the OUTPUT ADJ control to an output voltage of 241.5 volts. Adjust the LV potentiometer to close the H contact of the LV voltage relay at this value.

3.36 Adjust the OUTPUT ADJ control to reduce the output until the L contact of the LV voltage relay closes. This contact should close at 218.5 volts.

3.37 After adjustment of the V and LV potentiometers, adjust the OUTPUT ADJ control to 235 volts output.

3.38 Restore the DCM TST key to NOR; depress and hold the PRE TRFR key, and then operate the MAN RUN key to NOR which returns the load to the regular set. Release the PRE TRFR key. Connect the "L" lead permanently to either terminal 6 or 7 of the VB transformer so that a 230-volt alternator output at normal loads may be obtained by using the OUTPUT ADJ control. The VOLTS ADJ potentiometers on the KS-15844, L1 and KS-15949, L1 alternators should be readjusted if necessary to give a 230-volt output at normal load with the OUTPUT ADJ control set at 50.

Regular Alternator - 10% Voltage Relay

3.39 Operate the DCM TST-NOR key to DCM TST, transferring the set to dc drive.

3.40 Adjust the OUTPUT ADJ control to give 230 volts, and then adjust the RV potentiometer to just close the H contact on the RV relay at this value. The L contact of the relay should make at 10 per cent less or 207 volts.

3.41 Depress and hold the PRE TRFR key, and then operate the MAN RUN-NOR key to MAN RUN, transferring the load to the running spare. Release the PRE TRFR key.

3.42 To check operation of the L contact, shut the set down at no load and observe the output voltage. The QT relay should operate at approximately 207 volts.

3.43 Return the load to the regular set.

Running Spare Alternator $\pm 10\%$ Voltage Relay

- 3.44 Operate the running spare set at no load on dc drive. Operate the MAN RUN-NOR key to MAN RUN.
- 3.45 Adjust the OUTPUT ADJ control to give 253 volts at no load.
- 3.46 Adjust the LV potentiometer of the running spare set so that the H contact of the LV voltage relay just makes as indicated by the operation of the HT relay.
- 3.47 Restore the DCM TST and MAN RUN keys to NOR.

RUNNING SPARE ADJUSTMENTS

3.48 For power plants *using KS-15823, L1* alternator sets as the running spare:

(a) **Condition 1 — Regular Sets Equally Loaded**

- (1) Adjust OUTPUT ADJ control of the running spare to give 230 volts on ac drive and connected to a regular load.
- (2) Adjust dc motor field circuit in accordance with Speed Control (3.24 through 3.31 inclusive).

(b) **Condition 2 — Regular Sets Unequally Loaded**

- (1) Transfer the *maximum load* of the plant to the running spare, with the spare on ac drive.
- (2) Adjust OUTPUT ADJ control of the spare to give an alternator output voltage of 225 volts.
- (3) Transfer load back to regular set. **Do not alter** OUTPUT ADJ control.
- (4) Transfer *minimum load* of the plant to the spare and note output voltage difference from 225 volts.
- (5) Readjust OUTPUT ADJ control on spare for an output voltage of 230 volts **plus one half** of the observed difference.
- (6) Transfer load back to regular set.
- (7) Adjust dc motor field circuit in accordance with Speed Control (3.24 through 3.31 inclusive) using the *maximum load* of the plant.

3.49 For power plants *using KS-15844, L1* and *KS-15949, L1* alternator sets as the running spare, the following adjustments should be made.

- (1) The VOLTS ADJ potentiometer on the voltage regulator of the running spare should be adjusted for an alternator output of 230 volts on ac drive with the load of any regular set connected to the spare and with the OUTPUT ADJ control set at 50.

3.50 For power plants *using KS-15823, L1* alternator sets as the running or nonrunning spare and the load on any regular set is expected **to exceed 16 amperes**, the following applies.

- (1) When the load on any regular set exceeds 16 amperes, the LV relay range ($\pm 10\%$) of the spare must be raised 7% at no load to allow for the higher alternator output voltages at no load. This is accomplished by removing the strap between terminals 15 and 16 of the TS(U) terminal strip. The RX resistor then shifts the LV ($\pm 10\%$) relay range up 7% at no load. When a load is transferred to the running spare set, the EP relay releases to short out the RX resistor and returns the LV relay to the normal range of $\pm 10\%$.

Removal of a Set From Service

3.51 If a normally running set is to be removed from service for an extended period, a nonrunning spare set may be substituted. This set has its own ac and dc starters as well as other control equipment. The motor supply circuits are connected in the same manner as the running sets. The control leads are multiplied to proper sockets on the switching panel at the top front of each bay. The control leads for the running set are also connected through a plug associated with the control circuit and a socket associated with the set.

3.52 To place a nonrunning spare set in service, proceed as follows. Operate the STOP key of the set to be replaced, disconnect the plug from the socket and connect it to the socket of the nonrunning spare. **Since the nonrunning spare socket is in each bay, it is essential that not more than one control plug be connected to the nonrunning spare socket at any time.** The

warning sign should be reversed and relocated on the switching panel of the bay in which the change was made. During installation, the non-running spare set should be started to check rotation and speed control by making this substitution. Restore the plant to normal operation in the same manner. Only one set at a time may be replaced by a nonrunning spare. It is recommended that this substitution be made for the running spare at least once a year. This is desirable for lubrication purposes as well as to prevent commutator flattening due to continuous brush pressure.

Alternator Shutdown

3.53 Manual control keys are provided to start and stop any motor alternator set so that it may be removed from service for maintenance purposes.

Caution: Before stopping a motor-alternator carrying load, transfer load to the running spare set.

(a) Transfer load to the running spare by operating the BY-PASS switch to BY-PASS, or by depressing and holding the PRE TRFR key and then operating the MAN RUN-NOR key to MAN RUN. Release the PRE TRFR key.

(b) To stop the alternator, operate the STOP-NOR key to STOP.

(c) To restart the alternator, operate the keys listed in the following order.

STOP-NOR to STOP

DCM TST-NOR to DCM TST

MAN RUN-NOR to MAN RUN

STOP-NOR to NOR (alternator should attain normal speed on dc drive)

DCM TST-NOR to NOR (transfers to ac drive)

MAN RUN-NOR to NOR (load transfers from running spare set)

MANUAL FIELD FLASH (KS-15949, L1 sets only)

3.54 These sets as furnished have a continuous drain on the battery of approximately 0.25 ampere per machine. This provides automatic positive buildup of alternator voltage.

This drain may be eliminated by removing the strap between the minus (-) and PB terminals of the TB1 terminal strip in the voltage regulator of the alternator.

Note: Removal of this strap is required only when it is desirable to defer the need for additional rectifier equipment as additional machines are added to the plant.

3.55 When this strap is removed, automatic buildup of alternator output voltage will not occur upon starting. To build up alternator output voltage it is necessary to operate the MANUAL FIELD FLASH BUTTON momentarily after the set has been started and has reached normal speed. This button is located on the voltage regulator.

PANEL VOLTMETER CALIBRATION

3.56 To calibrate the panel voltmeter, connect a Weston Model 622 rectifier type voltmeter across the terminals of the VOLTS OUT output voltmeter. Adjust the output voltmeter, using the zero adjusting screw, so as to agree with the Weston meter reading. Disconnect the Weston meter after making the adjustment. This calibration should be made on a semi-annual basis.

4. CHECKS

Routine Checks

4.01 The following routine checks of the voltage transfer equipment, emergency facilities, and alarms should be made semi-annually unless operating experience indicates otherwise. These checks degrade service on working lines. It is suggested, therefore, that these checks be made at a time when service interruptions can be tolerated.

Alternator Control Bays

4.02 Check the following items.

(a) Power Failure

(1) Operate the PWR TRNS TST-NOR key to PWR TRNS TST to simulate a power failure or out of limits low supply voltage.

(2) All alternator sets should automatically transfer from ac to dc motor drive. The PWR TRNS lamp should light. Operate the ACO key to silence the alarms.

(3) Check that the alternator voltage on the VOLTS OUT meter has not changed more than 5 volts with the battery supply within limits of 125 to 150 volts.

(4) Operate the PWR TRNS TST-NOR key to NOR.

(5) After an interval of 100 to 150 seconds, the alternator sets should transfer back to ac motor drive at 10-second intervals and the PWR TRNS light should extinguish.

(b) **Alternator Failure**

(1) Note the position of the OUTPUT ADJ control for 230-volt alternator output, and simulate a failure of the alternator by gradually lowering the alternator output to about 218 volts with a ccw rotation of the control. The HLV lamp should light at 225 volts.

(2) The regular alternator should transfer to dc drive at about 219 volts after a 1-second delay. The AC MOT FAIL lamp should light.

(3) The load transfers to the running spare at about 219 volts after another 1-second delay.

(4) The regular alternator stops. The ALT FAIL lamp lights and the ALT FAIL alarm is given, which may or may not be in a distant location. The AC MOT FAIL lamp should go out.

(c) **Transfer back to the regular motor alternator set as follows.**

(1) Operate the regular alternator control keys to the following positions.

STOP-NOR to STOP

DCM TST-NOR to DCM TST

MAN RUN-NOR to MAN RUN

(2) Return the OUTPUT ADJ control to the position noted in (b)(1).

(3) Operate the STOP-NOR key to NOR and the set should attain normal speed on dc drive.

(4) Operate the DCM TST-NOR key to NOR. The set transfers to ac drive.

(5) Depress and hold the PRE TRFR key, and then operate the MAN RUN-NOR key to NOR and observe that the load transfer contactor has transferred the load to the regular alternator set. Release the PRE TRFR key. Adjust the control to 230 volts with normal load connected.

(6) Restore the lines to service.

(d) **Tests for Other Regular Alternators**

(1) Repeat (b) and (c) for any other regular alternator, if provided.

(e) **Test for Emergency (Nonrunning Spare) Alternators**

(1) With the load supplied by one of the regular alternators, repeat (b) for the emergency alternator, except that since this set is running at no load, the load transfer will not occur and the HLV alarm will not be given.

5. GENERAL TROUBLES

Alarms

5.01 In general, troubles which may occur in this equipment will be indicated by various alarms. Listed below are the alarms and possible troubles which caused them.

ALARMS

POSSIBLE TROUBLES

PWR TRNS

Major ac power service voltage change, unbalance or failure.

VR relays out of adjustment.

HLV

Faulty alternator.

Change in OUTPUT ADJ control.

Change in resistance of V potentiometers.

Shorted V capacitors.

Defective V varistors.

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ALARMS	POSSIBLE TROUBLES
AC MOT FAIL (Regular)	Faulty alternator.
AC MOT FAIL (Emerg)	Change in OUTPUT ADJ control.
	DC brush lifters failed to operate.*
	LV relay out of adjustment.
	LV potentiometers out of adjustment.

ALARMS	POSSIBLE TROUBLES
	LV varistors defective.
	Blown fuse.
FREQ TRAN	Output voltage and service frequency outside limits.

* With the set on ac drive, failure of both the SRD varistors and the brush lifters will result in the dc motor acting as a generator. This voltage operates the BF relay, causing the set to transfer to dc drive with eventual shutdown due to low speed and output voltage.