

DISCHARGER-RECHARGER
KS-20142 L1 (LORAIN)
OPERATING METHODS

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1. GENERAL

1.01 The KS-20142 L1 discharger-recharger, manufactured by the Lorain Products Corporation of Lorain, Ohio, is used for in-service testing of a single lead-acid storage cell in determining the reserve capacity of that cell.

1.02 This section is reissued to add 1.09, to revise connect-disconnect procedures to battery to prevent possible sparks, to delete Table A and reletter Table B, to add new meters for testing, to revise Fig. 5, and to add a procedure for checking the VOLT LIM potentiometer. The Equipment Test List is affected.

1.03 The discharger-recharger is assembled in a handcart-type cabinet which permits movement to battery test locations (Fig. 1). Meters, indicating lamps, and most of the controls are easily accessible on the control panel when the hinged top cover is removed (Fig. 2). Those equipment or trim controls

not located on the control panel are located behind a removable side cover (Fig. 3). Two 12-foot, flexible cables, with provision for bolting to the cell terminal posts (Fig. 4), are provided for the discharge-charge current. Two 12-foot flexible leads are provided for external reference or sensing. A 23-foot, flexible, yellow, 3-wire cord (or two 12-foot cords) is provided for connection to a 120-volt, 60-Hz, 15-ampere, commercial outlet. The discharge-charge, external reference, and ac power input leads are connected to the discharger-recharger at the front (opposite the cart handle). A carrying case is provided for ease in carrying these leads between test locations (Fig. 1).

1.04 The discharger-recharger functions automatically to provide a 2-hour boost charge, a constant current discharge (at the cell's 5-hour rate), and then a recharge to restore the cell's capacity. This boost, discharge, and recharge cycle is normally completed during approximately 24 hours (Fig. 5). (See Section 157-601-701 for procedures in making discharge capacity tests and for cell replacement criteria.)

1.05 A dual-range ammeter (0-150A and 0-300A), indicating both the discharge and charge current, and a 1.5- to 3-volt dc recording voltmeter are mounted on the control panel of the discharger-recharger. Four lamps are mounted on the control panel. One of these lamps indicates when the unit is turned on. Two of these lamps indicate whether the discharge-charge leads are connected properly. The fourth lamp indicates when the unit overheats.

1.06 The unit is rated for a 117-volt, 60-Hz, 10-ampere, ac input. It will maintain a steady-state discharge-recharge current within ± 2 percent despite a ± 10 percent line voltage (ac input) variation and battery voltage variation with time.

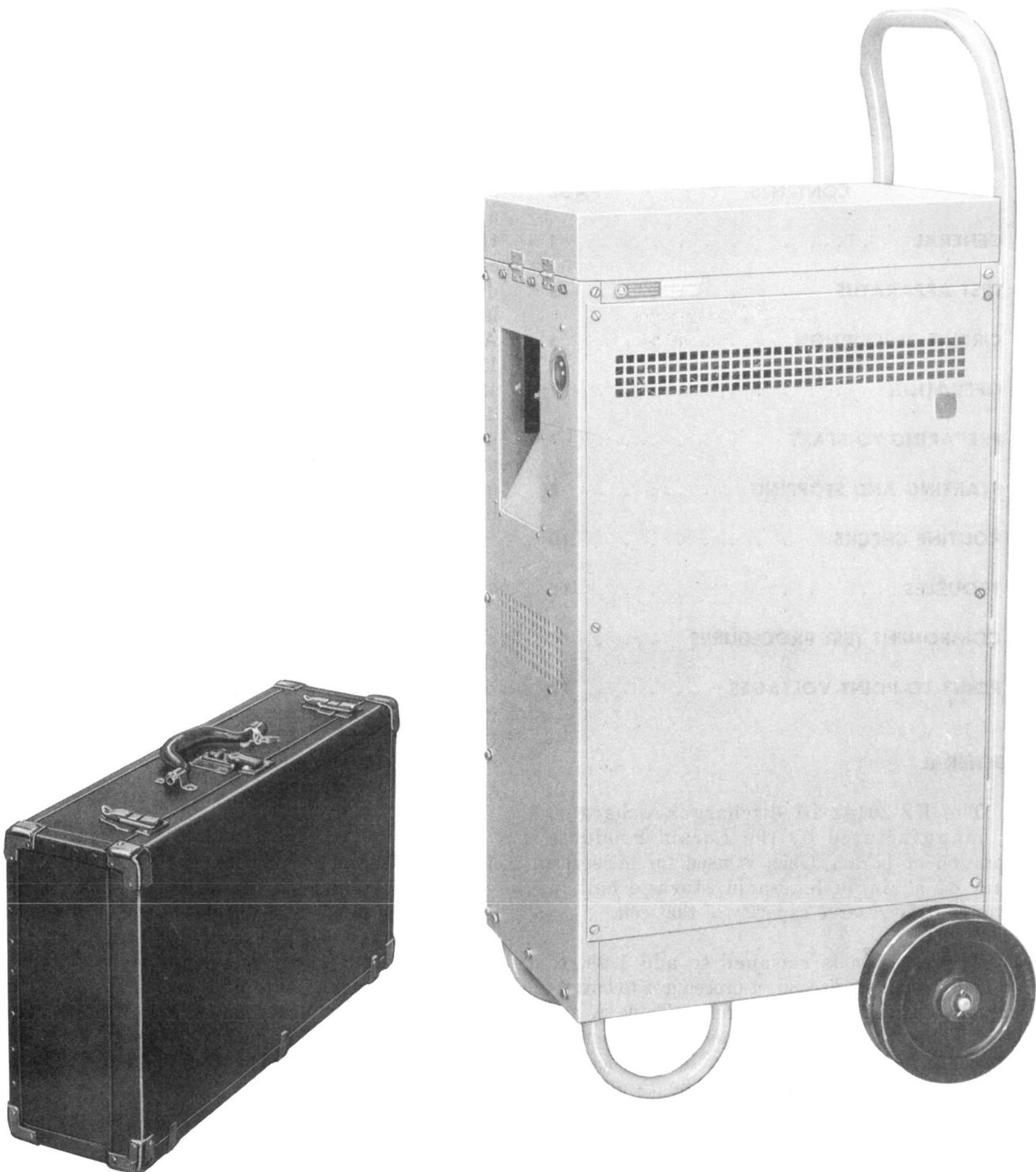


Fig. 1—KS-20142 L1 Discharger-Recharger and Cable Carrying Case

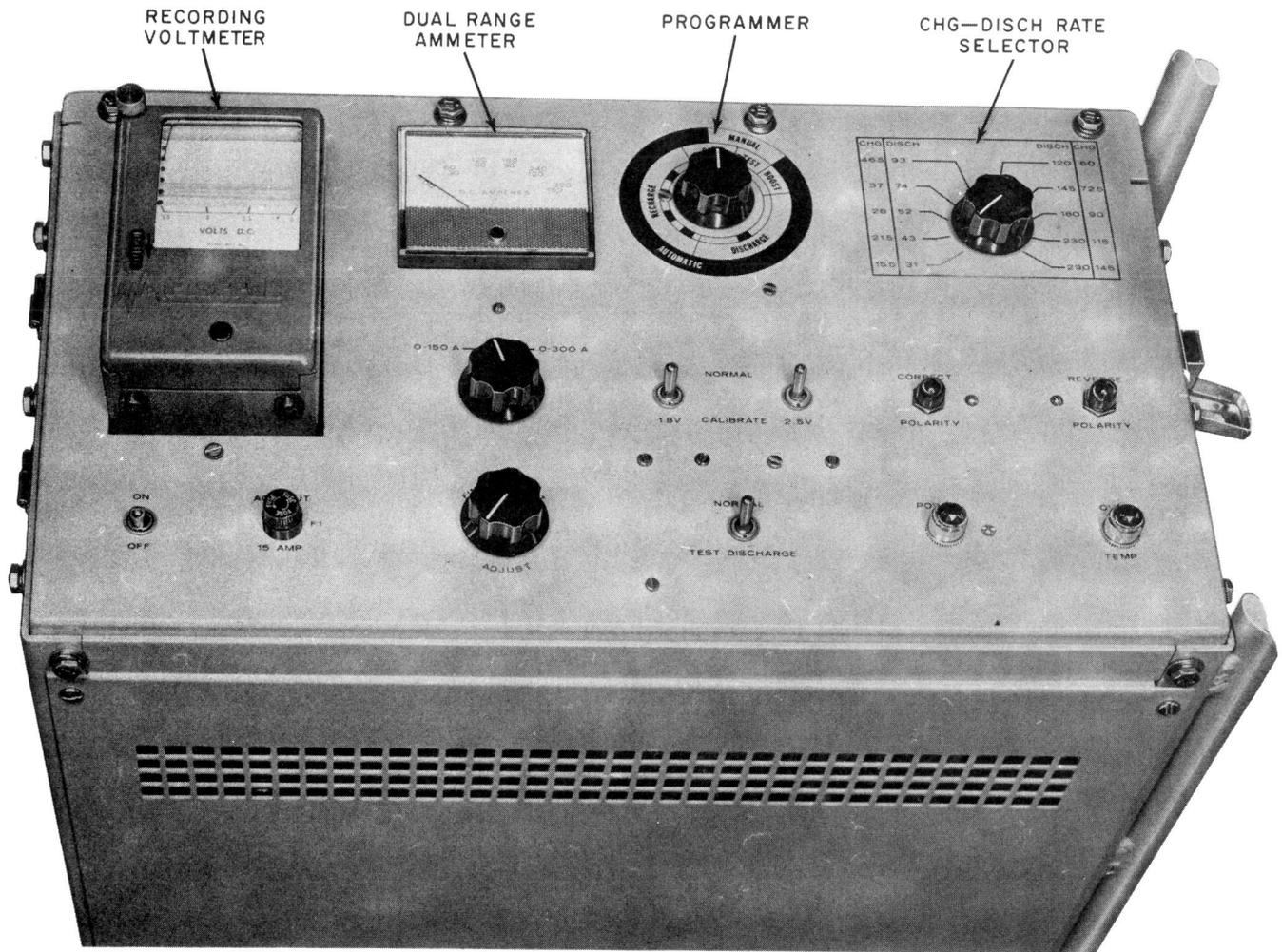


Fig. 2—KS-20142 L1 Discharger-Recharger—Control Panel

1.07 The discharger-recharger uses forced air ventilation. Ventilation openings of the cabinet should be unobstructed to facilitate cooling.

1.08 The following circuit cards and assemblies, with corresponding Lorain Products Corporation part numbers, are given to facilitate ordering of cards or assemblies which are to be replaced as a unit.

CIRCUIT CARD

A1—4338-093
 A2—4257-507
 A3—4248-501
 A4—4865-031
 A5—4862-301

A6—4862-302
 A12—4863-045

ASSEMBLIES

M1 (Ammeter)—2924-705
 *M2 (Recording Voltmeter)—2948-210
 M3 (Timer)—374KA
 M4 (Microswitch)—6NB

*Use Style I chart paper which, in this application, has 50 mV per vertical division and 15 minutes per horizontal division.

1.09 Refer to Section 157-601-701 for details on discharge capacity test including procedures and cell replacement criteria. Refer to Section

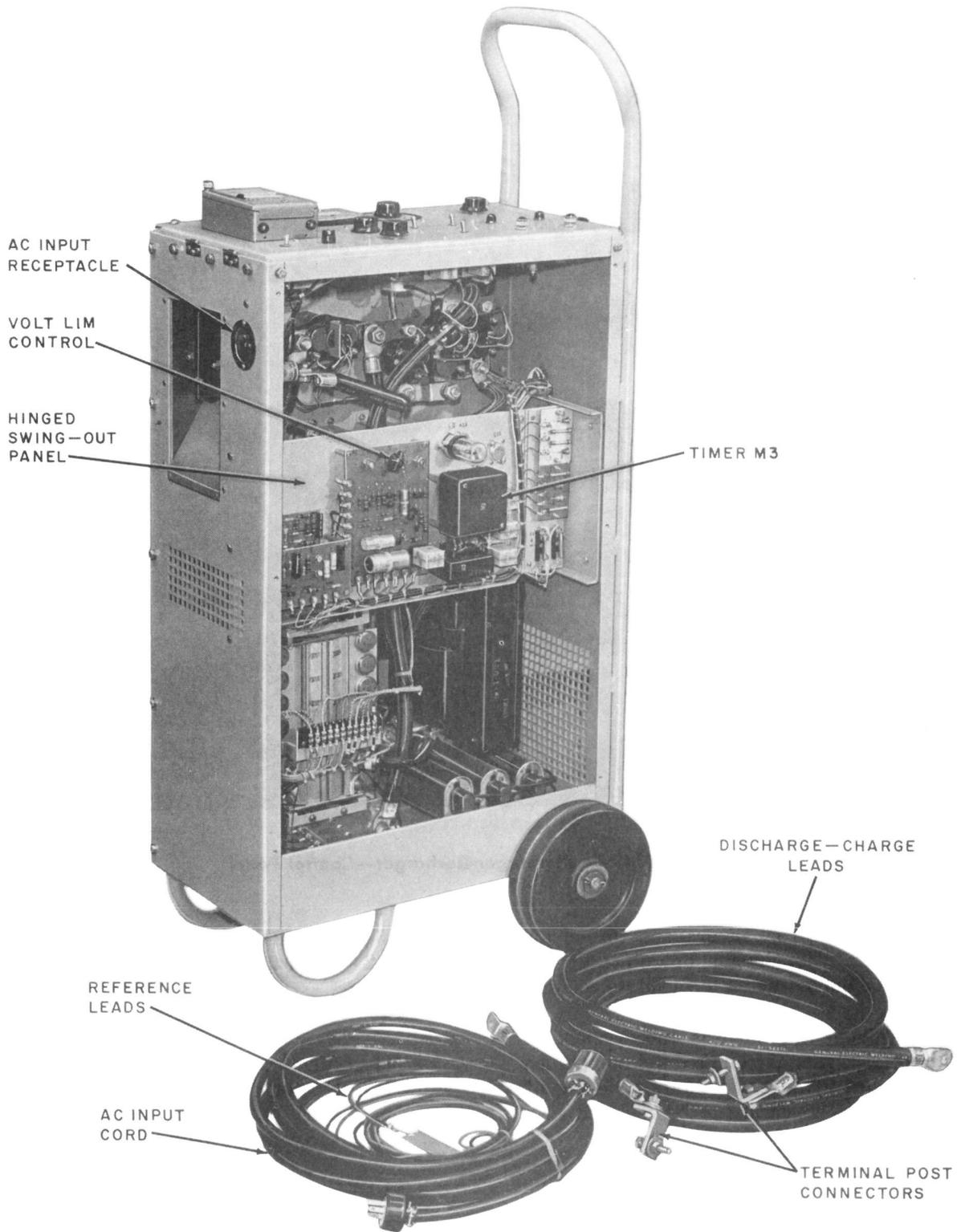


Fig. 3—KS-20142 L1 Discharger-Recharger—Top and Side Covers Removed

157-601-505 for operating methods of the KS-20142 L1 Fan-Tron discharger-recharger. When the KS-20142 L1 (Lorain) discharger-recharger is used to perform a discharge capacity test, the BOOST charge must be bypassed, as covered in 4.04.◀

2. TEST APPARATUS

2.01 ▶The only test apparatus required is the KS-16979 Volt-Ohm-Milliameter.

Note: The KS-14510 volt-ohm-milliameter or the Weston Model 1240 Multimeter are acceptable substitutes. In some ohmmeter applications of the KS-14510 with diodes, it is necessary to keep in mind that the lead polarity of this meter is opposite to its polarity as a voltmeter.◀

3. CIRCUIT DESCRIPTION

3.01 General: Functional circuits of the discharger-recharger are shown in block form in Fig. 6. The schematic diagram (Fig. 7) shows the electrical circuit of the unit.

3.02 Input Circuit: With switch S1 in the ON position and the programmer advanced to the TEST position, contacts 1 and 2 of programmer microswitch M4-1 make, supplying ac power to the primary of transformer T1 and to the blower motor. The POWER ON lamp, connected across the T1 primary, lights.

3.03 Saturable Transformer: Power transformer T1 is a saturable transformer having two core sections: a nonsaturable primary core section on which the ac input winding 1-2 is wound and a saturable secondary core section on which secondary windings 5-7 and 8-10 and a ferroresonant circuit winding 3-4 are wound. Magnetic shunts separate the two T1 core sections to reduce coupling between the primary and secondary windings. The T1 primary winding flux induces alternating current in the secondary core windings. The voltage developed across the saturating winding 3-4, when applied across capacitors C3, C4, and C5, alternately charges and discharges the capacitors. The capacitor current in the saturating winding causes saturation of the secondary core section. Once the core is operating in the saturated condition, changes in the input voltage have little effect upon the voltage developed across the saturating winding.

3.04 Power Rectifier: Transformer T1 windings 8-10 supply ac power to rectifying diodes CR201 and CR202 (part of A2) which change this alternating current to direct current to charge the battery cell when the discharger-recharger is operating in the charge mode. Choke L1 and capacitors C1 and C2 filter the output of CR201 and CR202.

3.05 Auxiliary Power Supplies: Transformer T1 windings 5-7 supply ac power to the transistor supply rectifier consisting of rectifier diodes CR204 and CR205, filter capacitor C6, and choke L3. The input to this rectifier is fused by F7 and F8; the output is fused by F3. This rectified output voltage is applied to the driver-amplifier and regulator circuits. Primary winding 1-2 of transformer T2 is connected across secondary windings 8-10 of transformer T1. Transformer T2 windings 6-8 perform two functions: alternating current is supplied to the rectifier bridge circuit in the low voltage detector and to diodes CR501 and CR502, which rectify the alternating current and supply dc power to operate the discharge-recharge control relay circuitry. T2 windings 3-5 supply alternating current to diodes CR601 and CR602 which rectify this current to supply direct current to the error detector and driver amplifier circuitry.

3.06 Current Sensing Circuit: Load current is sensed by saturable reactor L2. Load current, flowing in the control winding of L2, controls the current through the gate windings. Current for the gate windings is supplied by winding 9-10 of transformer T2 and rectified by diode CR8. This rectified current, which is proportional to the load current, flows through the ammeter (M1) and selected resistors in the resistor string to the error detector circuit. The voltage developed across the selected resistors is compared to another voltage in the error detector circuit. A difference in voltage causes an error signal to flow to the driver amplifier.

3.07 Driver Amplifier and Regulator Circuit: The error signal in 3.06 is amplified by the driver amplifier to control the conduction of the regulator circuit. When operating in the discharge mode, the amount of conduction of the regulator circuit determines the constant discharge current of the battery cell. In the charge mode, the conduction of the regulator circuit maintains constant charge current to the cell until the constant voltage level is reached.

3.08 Discharge-Recharge Relay Control:

(a) When the programmer is advanced to the BOOST position, contacts 1-2 of both M4-3 and M4-4 microswitches make contact. The programmer then remains stationary. With contacts 1-2 of microswitches M4-3 and M4-4 making, relays K6 and K7 operate and relays K8 and K9 release. With relays K6 and K7 operated, the current and voltage regulator is connected between the power rectifier and battery cell for the charging mode.

(b) When the regulated charge voltage begins, relay K102 operates, starting timer M3. When the timer setting runs out, auxiliary contacts 3-4 of M3 make to operate relay K12, advancing the programmer toward the discharge position. At the same time, contacts 1-3 of microswitch M4-5 close, operating relay K15. Contacts of relay K15 (parallel-connected 5 to 9, 6 to 10, 7 to 11, and 8 to 12) close, causing the voltage calibration circuit to inject a 2.5-volt calibrate signal (of approximately 10 seconds duration) on the recording voltmeter.

Note: The voltmeter is removed from the reference circuit while the calibration signal is injected.

(c) When the DISCHARGE position is reached, contacts 1-3 of programmer microswitch M4-3 and contacts 1-2 of M4-4 make, causing relays K6 and K7 to release and relays K8 and K9 to operate. At this time, contacts 1-2 of microswitch M4-2 make to stop the advance of the programmer. Closing of the auxiliary contacts of relays K8 and K9 inserts additional voltage dropping resistors in parallel with the proportional voltage circuit. The programmer remains in this position until the low voltage detector circuit (circuit card A12) senses that the battery cell voltage has decreased to 1.70 ± 0.02 volts (turnaround voltage).

3.09 Voltage Sensing Circuit:

(a) The low voltage detector circuit senses the reference voltage through the extended reference leads. When the battery cell voltage decreases to the turnaround voltage setting of potentiometer R1205 on A12 (1.7 volts factory setting), the low voltage detector circuit releases relay K10 and, in turn, operates relay K12 causing the programmer to advance toward the RECHARGE

position. As the programmer advances, contacts 1-3 of microswitch M4-6 close, operating relay K14. Contacts of relay K14 (parallel connected 5 to 9, 6 to 10, 7 to 11, and 8 to 12) close, causing the voltage calibration circuit to inject a 1.8-volt calibrate signal (approximately 10 seconds in duration) on the recording voltmeter.

Note: The voltmeter is removed from the reference circuit while the calibration signal is injected.

(b) The programmer continues to advance toward the RECHARGE position, but before this position is reached, contacts 1-2 of microswitch M4-2 make. When the RECHARGE position is reached, relays K6 and K7 operate and relays K8 and K9 release. An increase in battery voltage, sensed by the low voltage detector circuit, operates relay K10 which, in turn, causes relay K12 to release. (Contacts 1-2 of microswitch M4-2 are in parallel with relay K12 contacts 8-12 so that the programmer continues to advance.) Shortly after the programmer reaches the RECHARGE position, contacts 1-2 of microswitch M4-2 open, causing the programmer to stop.

(c) After the battery cell voltage reaches the regulated charge voltage level determined by the setting of potentiometer R123 on card A1, relay K102 operates, starting timer M3. The timer sets the length of time the battery cell will be held at this regulated voltage level. At the expiration of the timer period (normally 2 hours), auxiliary contacts 3-4 of M3 make to operate relay K12 which, in turn, causes the programmer to advance to the second cycle of the recharge mode. The programmer stops and the M3 timer resets and again times out a 2-hour regulated voltage charge period. This process of resetting and timing out the preset regulated voltage level is repeated twice more (normally a total of four 2-hour cycles). At the end of the last timing cycle, auxiliary contacts 3-4 of timer M3 cause relay K12 to remain operated until the programmer advances to the OFF position which automatically shuts down the unit.

3.10 Over Temperature Detection Circuit: A thermal actuated switch (S201) senses the heat sink temperature. When the temperature exceeds $175 \pm 5^\circ\text{F}$, S201 opens lighting the OVERTEMP lamp. Relay K11 is now placed in series with either relays K6 and K7 or relays K8 and K9,

depending upon the operational mode at the time (K8 and K9—discharge, K6 and K7—recharge). Relay K11 takes most of the voltage drop, causing whichever relays are in series with it to drop out. This terminates the operational mode but does not turn off the unit. Relay K11 remains operated through holding contacts 8-12 and is now independent of switch S201. When the temperature of S201 drops to $160 \pm 5^\circ\text{F}$, the switch will close, extinguishing the OVERTEMP lamp. Normal operation may now be resumed by operating the input ON-OFF switch momentarily to OFF and then to ON, or the programmer may be restarted manually.

4. OPERATION

PREPARING TO START

4.01 Connections: Check that the ON-OFF switch and the program selector on the control panel are in the OFF position, and that the ac line cord is disconnected. Prepare the discharger-recharger for operation by making the following connections.

Warning: **Do not connect or disconnect leads at the battery at any time gassing of any consequence is taking place because of the danger of explosion or fire.**

Caution 1: Care should be exercised in connecting the leads to the cell to be tested. After connecting a discharge-charge cable, accidentally grounding one of the other test leads may cause cell-to-ground voltages to be applied to circuitry causing equipment damage. Contact between the leads and the battery rack or the wrong cell may cause excessive sparking with resultant explosion and fire hazard if gas is in the vicinity of the battery. Refer to "Exposure and Fire Protection" and "Battery Connections" covered in Section 157-601-701 for connection procedures to be followed, with the possible use of a temporary connection switch to remove arc hazard.

Caution 2: Damage to the unit may result if it is operated with the discharge-charge leads connected with reverse polarity.

(a) **Discharge-Charge Leads:** Observing the above precautions, connect the discharge-charge leads (Fig. 3) first to the terminal studs designated POS and NEG on the front of the unit and then to the appropriate terminals of the cell to be

tested. If the cell has two terminal posts for each polarity, connect the leads to the posts which are diagonally opposite each other. (Refer to Fig. 4 for cell post termination details.) Observe terminal post polarity. If connection polarity is correct, the green CORRECT POLARITY lamp on the control panel will light. If the leads are incorrectly connected, the red INCORRECT POLARITY lamp will light (see Caution 2). Care should be taken in connecting the leads to prevent excessive strain from being applied to the cell termination posts. A battery lead clamp assembly (WECO P-33A984 not furnished by Lorain) may be used to relieve strain on the posts. Do not disconnect the cell under test from the battery string.

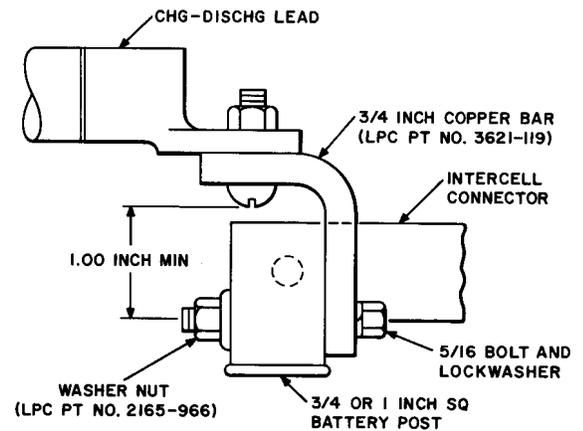


Fig. 4—Battery Post Termination

(b) **Reference Leads:** Observing the same precautions as in (a), connect the external reference leads first to the terminal studs designated EXT REF + and - on the front of the unit and then to the cell to be tested. Observe terminal post polarity. If the cell to be tested has two terminal posts for each polarity, connect the reference leads to the posts which do not have the discharge-charge leads connected to them while observing correct polarity. If the cell has only two terminal posts, connect the reference leads **directly** to the posts to which the discharge-charge leads are connected and **not** to the lugs of the discharge-charge leads.

(c) **AC Input:** Connect the 3-conductor input cord to the male receptacle adjacent to the discharge-charge terminal studs (POS and NEG)

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on the unit (Fig. 3) and then to a source of 120-volt, 60-Hz, single-phase ac power.

4.02 Adjustments: The adjustments in (a), (b), and (c) need only be made if requirements differ from factory settings.

(a) **Voltage Limiting:** The VOLT LIM (R123) potentiometer, accessible when the side cover is removed (Fig. 3)(on later or modified units this adjustment is accessible at the side cover), is factory set at 2.55 volts regulated charge voltage. If other than 2.55 volts is desired, the adjustment can be made in the range from 2.3 to 2.7 volts. For KS-5553 (lead-antimony) cells the regulated charge voltage must be set at 2.35 volts.

(b) **Timer M3:** The timer is adjusted for a regulated charge voltage period of 2 hours boost and 8 hours recharge (four 2-hour timer cycles). If a different charge voltage period is desired, the timer must be readjusted. The timer is adjustable from 36 minutes to 5 hours. To change the timing cycle, remove the timer cover, loosen the locknut securing the calibrated dial, and rotate the dial until the desired time interval is aligned opposite the index marker. Make sure that the relay clapper can move freely, then tighten the locknut to ensure the desired setting. Replace the timer cover.

(c) **Turnaround Voltage:** Potentiometer R1205 on circuit card A12 sets the turnaround voltage. This voltage is factory set at 1.7 volts, but is adjustable between 1.5 and 1.9 volts. The value of 1.7 volts was selected instead of the standard discharge end voltage of 1.75 volts (see Section 157-601-101) because of the lack of precision of the adjustment on the discharger-recharger. This ensures that the value of 1.75 volts will be reached.

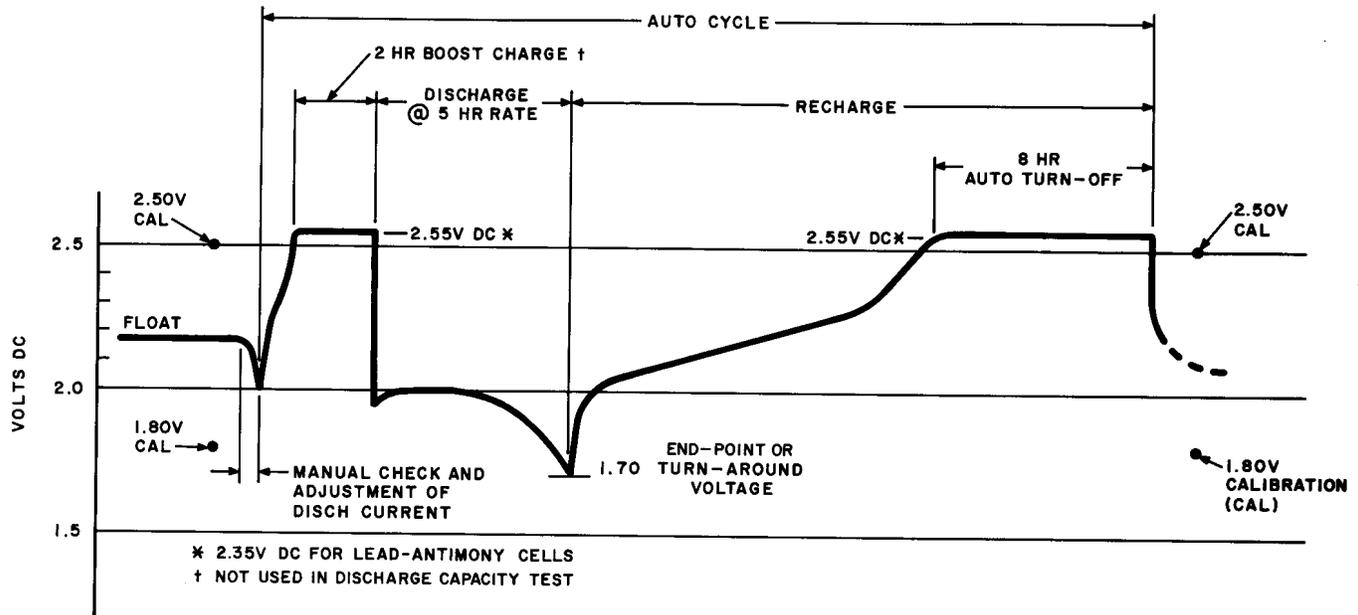
(d) **Discharge-Charge Rate:** Using the CHG-DISCH selector knob (coarse adjustment), select the applicable discharge rate for the cell being tested. (See Section 157-601-701.)

Note: This adjustment sets both the discharge and charge rates.

STARTING AND STOPPING

4.03 After performing 4.01 and 4.02, start the discharger-recharger as follows.

- (a) Operate the input ON-OFF switch to ON.
- (b) Rotate the programmer to the TEST position and observe that the POWER ON lamp lights.
- (c) Hold the NORMAL-TEST DISCHARGE switch in TEST DISCHARGE and rotate the FINE CURRENT ADJUST knob to set the precise discharge rate. When the desired current has been obtained, release the NORMAL-TEST DISCHARGE switch.
- (d) Advance the programmer to the BOOST position to begin the automatic test cycle. The programmer will remain in this position until the cell voltage is brought up to the regulated charge voltage at which point a timer starts the 2-hour period. **Operating personnel shall be present during the initial phase of the boost charge.** Refer to 3.08 and 3.09 for a detailed description of automatic operation and to Fig. 5 for a typical diagram of the boost-discharge-recharge cycle.
- (e) At the beginning of the boost charge, observe that the charge rate is equal to one-half the discharge rate and the voltage is increasing toward the regulated charge voltage.
- (f) Adjust the VOLT LIM potentiometer to 2.55 volts per cell for lead calcium cells or to 2.35 volts per cell for lead antimony cells, as required, then:
 1. Hold the CALIBRATE 2.5V switch in the CALIBRATE position until the calibrate mark is legible on the chart paper.
 2. Release the CALIBRATE 2.5V switch.
 3. Observe the boost charge voltage recording on the chart paper in relation to the calibrate mark. If not at the specified value (2.35 or 2.55V), correct by adjusting the VOLT LIM potentiometer.
- (g) For a fully charged normal cell in a floated battery, the voltage will rise rapidly to the



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Fig. 5—Typical Cell Discharge-Recharge Voltage Characteristics (KS-15544 Cells)¶

regulated charge value at which time the current will decrease and level off indicating equilibrium at full charge.

(h) Observe that the current decreases to a value below 50 percent of the charge rate observed in (e).

(i) If the current becomes constant at a value higher than permitted in (h), lower the charge voltage to give a charge rate equal to 50 percent of the charge rate observed in (e).

(j) After checking that the current is stabilized in (h) or (i), personnel attendance is no longer required; the test will continue automatically to provide the boost charge.

(k) At the end of the preset time cycle for the boost charge, the programmer will advance to the DISCHARGE position for the discharge cycle at the cell's 5-hour rate until the cell reaches 1.70 volts. At this voltage, the programmer will advance to the RECHARGE position for the charge cycle to restore the cell's capacity.

(l) The test will be automatically terminated 8 hours after the cell voltage has reached the regulated voltage level.

4.04 Elimination of Boost Mode: If elimination of the boost mode is desirable (for example, if it is known that the cells are fully charged), perform 4.03(a) through (c), wait one minute, and then advance the programmer to the DISCHARGE position. The unit will then complete the discharge-recharge cycle. If leads at the battery are to be connected or disconnected, observe Warning in 4.01.

4.05 Elimination of Boost and Discharge Modes: To eliminate the boost and discharge modes (as when the KS-20142 is used only to recharge a cell), perform 4.03(a) through (c), wait one minute, and then advance the programmer to the RECHARGE position. The unit will then complete only the recharge part of the cycle. ¶If a boost charge only is desired, the recharge part of the cycle can be used for this. Refer to Section 157-601-701, Table F, for boost charge times.¶

4.06 Operation After AC Power Failure: If an ac power failure of more than one minute occurs during the discharge mode, the program will be automatically advanced to the recharge mode when ac power is resumed. If an ac power failure of less than one minute occurs any time during boost, discharge, or recharge, the test will

be continued with no change in program when ac power is resumed.

4.07 *Operation After Over Temperature Failure:*

In the event the operating temperature becomes excessively high (see 3.10), a thermal detection switch opens and disconnects the output of the discharger-recharger from the battery. After the thermal device has cooled, operate the ON-OFF switch momentarily to OFF and then to ON or restart the programmer manually as covered in 4.03, 4.04, or 4.05 as applicable.

4.08 *Recorder Calibration Check:* To check the calibration of the recording voltmeter (Fig. 5) during the discharge-recharge cycle, hold one of the two NORMAL—CALIBRATE voltage switches (1.80V or 2.5V) in the CALIBRATE position. The corresponding calibration voltage will be marked on the recording voltmeter chart. If the calibration does not check properly, refer to 6.04(h).

4.09 Under automatic operation, the discharger-recharger will continue through its preset cycle and shut down. To remove the unit from service during the cycle, operate the ac input ON-OFF switch to the OFF position.

5. ROUTINE CHECKS

5.01 Since the discharger-recharger contains rotating parts and is subjected to frequent moving and vibration, periodic inspection should be made of the blower motor, all mechanical connections, and dust accumulation as follows.

- (a) There are four motors in this unit, including the recorder motor. All but the blower motor are synchronous motors and require no maintenance. The blower motor, however, should be inspected periodically (see Section 157-001-013) for freedom of movement and dust-free operation. Periodic lubrication is not required.
- (b) Check mechanical connections on circuit card A1, blower assembly terminal strip A2, and all connections made with the discharge-charge cables.
- (c) Use a compressed-air gun to blow out any dust accumulations in the unit. This is very important since dust accumulations restrict cooling efficiency.

6. TROUBLES

6.01 *General:* Observing the dual-range ammeter on the unit during operation or evaluating the chart from the recording voltmeter after the cycle is completed will indicate whether or not the unit is operating properly. Indicator lamps on the control panel will also give an indication of trouble conditions.

6.02 *Open Fuses:* Input fuse F1 is located on the control panel. To gain access to fuses F2, F3, F4, F7, F8, and F11, remove the side cover of the unit. Output fuse F2 is located at the upper left. Fuses F4 and F11 are located to the right of the swing-out mounting panel. Transistor supply rectifier fuses F3, F7, and F8 are located behind the swing-out panel. To gain access to F3, F7, and F8, loosen two screw-type fasteners at the left side of the panel and swing the panel outward on the hinges at the right side. If it becomes necessary to replace any of these fuses, replace only with the following size and type, or equivalent:

F1, F3—15-Ampere, Bussmann ABC
 F2—400-Ampere, Chase-Shawmut
 F4, F11—4-Ampere, Bussmann MTH
 F7, F8—15-Ampere, Bussmann MDL

Note 1: One spare fuse each of Bussmann ABC, MTH, and MDL is located in individual spare fuse blocks to the right of the swing-out panel.

Note 2: If diode(s) CR501 and/or CR502 short, the corresponding protection fuse(s) F501 and/or F502 will open. Replace circuit card A5 on which the diodes and fuses are mounted. The same applies to circuit card A6. If diode(s) CR601 and/or CR602 short, fuse(s) F601 and/or F602 will open.

6.03 If trouble symptoms indicate that any circuit card or assembly is defective, replace the card or assembly as a unit. Refer to 1.08 for replacement part numbers. Check and replace semiconductor devices in accordance with applicable Bell System Practices.

6.04 *Trouble Chart:* The list of troubles, possible causes, and suggested corrective procedures is intended as an aid in troubleshooting. If the trouble is not located with the assistance of the

trouble chart or the use of point-to-point voltages (Part 8), it is advisable to make component resistance measurements (Part 7) with the circuit completely de-energized and compare the measured values with values shown on the circuit drawing.

Caution: Use standard precautions as described in the appropriate Bell System Practices to avoid component damage when making ohmmeter measurements on circuits containing diodes or transistors.

CONDITION	POSSIBLE CAUSE	PROCEDURE
(a) No output current, POWER ON lamp extinguished	No input voltage or input voltage extremely low	Correct cause of low input voltage.
	Open input fuse	Check fuse; replace, if open.
	Defective input cord or plug	Replace input cord or plug.
	Programmer switch M4-1 inoperative	Check switch M4-1 for continuity; replace, if necessary.
(b) No output current, POWER ON lamp lighted, programmer in any automatic position	S1 (ON-OFF) switch defective	Check continuity; replace switch, if defective.
	No drive voltage	Check F3, F3 holder, C6, L3, F7, F8, CR204, CR205, wiring; replace, as required.
	No drive current	Check Q217, Q218, Q19; replace, if necessary. Check Q102, Q103, Q104, CR106, CR107; if defective, replace A1 as a unit.
	Open output fuse F2	Check fuse; replace, if necessary.
	Defective diodes or fuses CR501, CR502, F501, and F502 on A5 or CR601, CR602, F601, and F602 on A6	A5 or A6 should be replaced as a whole in the event of a defective component. (See 6.02, Note 2.)
	No reference voltage	Check F11, C8, A6, T2; replace, if necessary. Check CR106, CR107. Replace A1 as a unit, if necessary.
	Excessive voltage (normal 7.5 volts) from A1 terminal 15 to A1 terminal 8	Check resistors on A3 assembly. Check CR8 and S301. Check L2 for short (approximately 60 ohms per leg). Replace, as necessary.
	Defective voltage limiting	Check voltage on A1 terminals 1-2 (normal 21V dc). Check CR107 and Q101. Replace A1 as a unit, if necessary.

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CONDITION	POSSIBLE CAUSE	PROCEDURE
(c) No output current, POWER ON lamp lighted, programmer in BOOST or RECHARGE position only	Relays K6 and K7 do not pull in even with approximately 21V dc on coils	Check coils of relays for continuity (approximately 70 ohms). Replace relays, if necessary.
	Relays K6 and K7 do not pull in; no coil voltage	Check CR16, K8-1, and M4-3; M4-4, K11, S201, and A5; and all wiring between A5 and relays. Replace or repair, as required.
	No voltage on C1 and C2 (normal) 3.8V dc during charge)	Check CR201, CR202, L1, and T1 voltages and all wiring between T1 and C1. Replace, as required.
	No drive current	Check K9-1 and replace, if necessary.
(d) No output current, POWER ON lamp lighted, programmer in TEST or DISCHARGE position only.	Excessive voltage from A1 terminal 15 to A1 terminal 8 (normal 7.5V dc)	Check resistors on A3 assembly and S301. Replace, if necessary.
	Relays K8 and K9 do not pull in even with approximately 21V dc on coils	Check coils of relays for continuity (approximately 70 ohms). Replace, if necessary.
	Relays K8 and K9 do not pull in; no coil voltage	Check S2, CR15, K6-1, and M4-3; M4-4, K11, S201 and A5; and all wiring between A5 and relays. Replace or repair, as required.
	No drive current	Check K7-1 and replace, if necessary.
(e) Uncontrolled output current, programmer in any automatic position	Excessive voltage between terminals 15 and 8 of A1 (normal 7.5V dc)	Check resistors on A3 assembly and S301. Replace, if necessary.
	Defective error detection circuit	Check A3 assembly resistors and switch. Check K8-2 and K9-2. Replace, if necessary.
	Defective ammeter	Check and replace, if necessary.
(f) Voltage limiting inaccurate	Shorted driver transistors	Check Q217, Q218, and Q19; replace, if necessary. Check Q102, Q103, and Q104. Replace A1 as a unit, if necessary.
	R123 out of adjustment	Readjust. See 4.02(a).

CONDITION	POSSIBLE CAUSE	PROCEDURE
(f) (Cont)	Extended reference leads open or high resistance connections	Check wires, clips, and connections. Check voltage at A1 terminals 3-2 (should be battery voltage).
	Defective components on circuit card A1	Check CR101, Q101, R102, R103, and R123; replace, if necessary.
	Recording voltmeter in error	Check accuracy of voltmeter and replace, if necessary.
(g) Turn-around voltage inaccurate	R1205 on A12 out of adjustment	Readjust. See 4.02 (c).
	Extended reference leads open or high resistance connections	Check wires, clips, and connections. Check voltage at A12 terminals N-S (should be battery voltage).
	Defective components on circuit card A12	Replace A12 as a unit.
(h) 1.8- and 2.5-volt calibration points not correct	R405 and R406 on circuit card A4 out of adjustment	Readjust or replace A4 as a unit.
	Defective components on A4	Replace A4 as a unit.
	Switch and relay contacts dirty	Check K14, K15, S3, and S4. (Voltage at recorder should be same as voltage at circuit card A4.) Replace or clean contacts, as necessary.
(i) Cannot obtain discharge when activating TEST DISCHARGE switch S2	Defective S2 or wiring	Check S2 and wiring from S2 to terminal 12 of K11. Replace or repair, as necessary.
(j) Programmer advances rapidly through entire cycle without stopping	Improper motor interruption	Check continuity of contacts of M4-2, K12, K13, and K10. Replace switch or relays, as necessary.
	Incorrect functioning of timer M3	Check contact continuity of M3 and readjust timer, if necessary. See 4.02 (b).

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CONDITION	POSSIBLE CAUSE	PROCEDURE
(k) Programmer advances rapidly through boost and recharge but not discharge	Premature operation of K12	Check contact continuity of timer M3. Replace M3, if necessary.
(l) Programmer advances rapidly through discharge but not boost or recharge	Premature operation of K12	Check contact continuity of K10 relay and replace, if necessary. Replace circuit card A12, if necessary.
(m) OVERTEMP lamp lights	Excessive heat	Check for blower operation and dust accumulation. Check Q201 through Q216, Q217, and Q218. Replace, if necessary.
	Defective thermal switch	Check S201 for continuity at room temperature. Replace, if defective.
(n) Both POLARITY lamps extinguished	Defective bulb, socket, or wiring	Check bulb, socket, and wiring. Replace as necessary.
	Defective diode	Check CR17 and replace, if necessary.
(o) Both POLARITY lamps lighted	Defective diode	Check CR18 and replace, if necessary.

7. COMPONENT TEST PROCEDURES

7.01 Component test procedures are made with the discharger-recharger completely de-energized.

Caution: In making continuity checks, use the ohmmeter portion of the KS-14510 volt-ohm-milliammeter or equivalent. Do not use the X10,000 position for testing transistors or diodes as the higher voltage used may damage them. The X1 position may damage some diodes due to high current.

7.02 Before disconnecting leads, mark or record the connections.

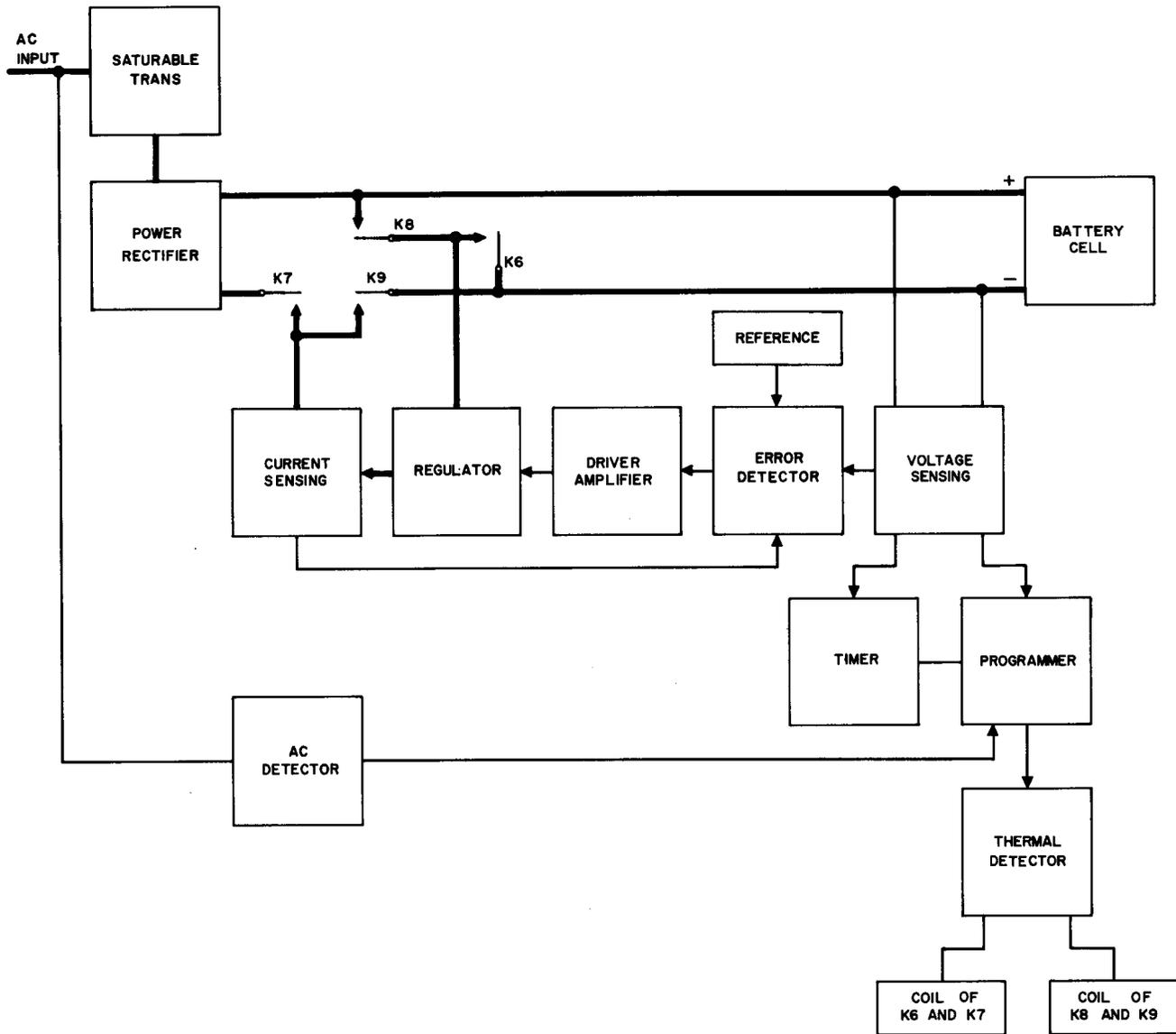
7.03 For checking semiconductor devices, refer to Section 032-173-301. Improper use of an ohmmeter in some cases can damage semiconductor devices. For checking capacitors, inductors, relays, transformers, and similar components, refer to the appropriate Bell System Practice listed in the numerical index for Divisions 028, 032, or 401.

8. POINT-TO-POINT VOLTAGES

8.01 If point-to-point voltage readings are required in the troubleshooting procedures, refer to Table A for check points and their values. Use the KS-16979 volt-ohm-milliammeter, or equivalent, set on the appropriate ac or dc scale, to make these measurements.

TABLE A
NOMINAL VOLTAGE MEASUREMENTS
WITH UNIT ON BATTERY

TERMINAL NUMBER	90A CHG (VOLTS)	180A DISCHG (VOLTS)	OPEN CKT (VOLTS)
T1: 1-2	115 ac	115 ac	115 ac
3-4	600 ac	600 ac	600 ac
5-6	5.7 ac	5.7 ac	5.7 ac
6-7	5.7 ac	5.7 ac	5.7 ac
8-9	5.6 ac	5.6 ac	5.7 ac
9-10	5.6 ac	5.6 ac	5.7 ac
T2: 1-2	11 ac	11 ac	12 ac
3-4	44 ac	44 ac	46 ac
4-5	44 ac	44 ac	47 ac
6-7	25 ac	25 ac	26 ac
8-7	25 ac	25 ac	26 ac
9-10	33 ac	33 ac	35 ac
3-5	87 ac	87 ac	92 ac
6-8	47 ac	47 ac	52 ac
C1,C2: +,-	4.0 dc	4.8 dc	4.8 dc
C6: +,-	4.3 dc	4.1 dc	4.8 dc
C8: +,-	44 dc	43 dc	44 dc
C1201: +,-	22 dc	21 dc	24 dc
CR101: +,-	8.8 dc	8.8 dc	9.0 dc
CR106: +,-	22 dc	23 dc	23 dc
CR107: +,-	8.8 dc	8.8 dc	8.8 dc



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Fig. 6—KS-20142 L1 (Lorain) Discharger-Recharger—Block Diagram

NOTE:
UNLESS OTHERWISE SPECIFIED,
RESISTANCE VALUES ARE IN
OHMS AND CAPACITANCE
VALUES ARE IN MICROFARADS

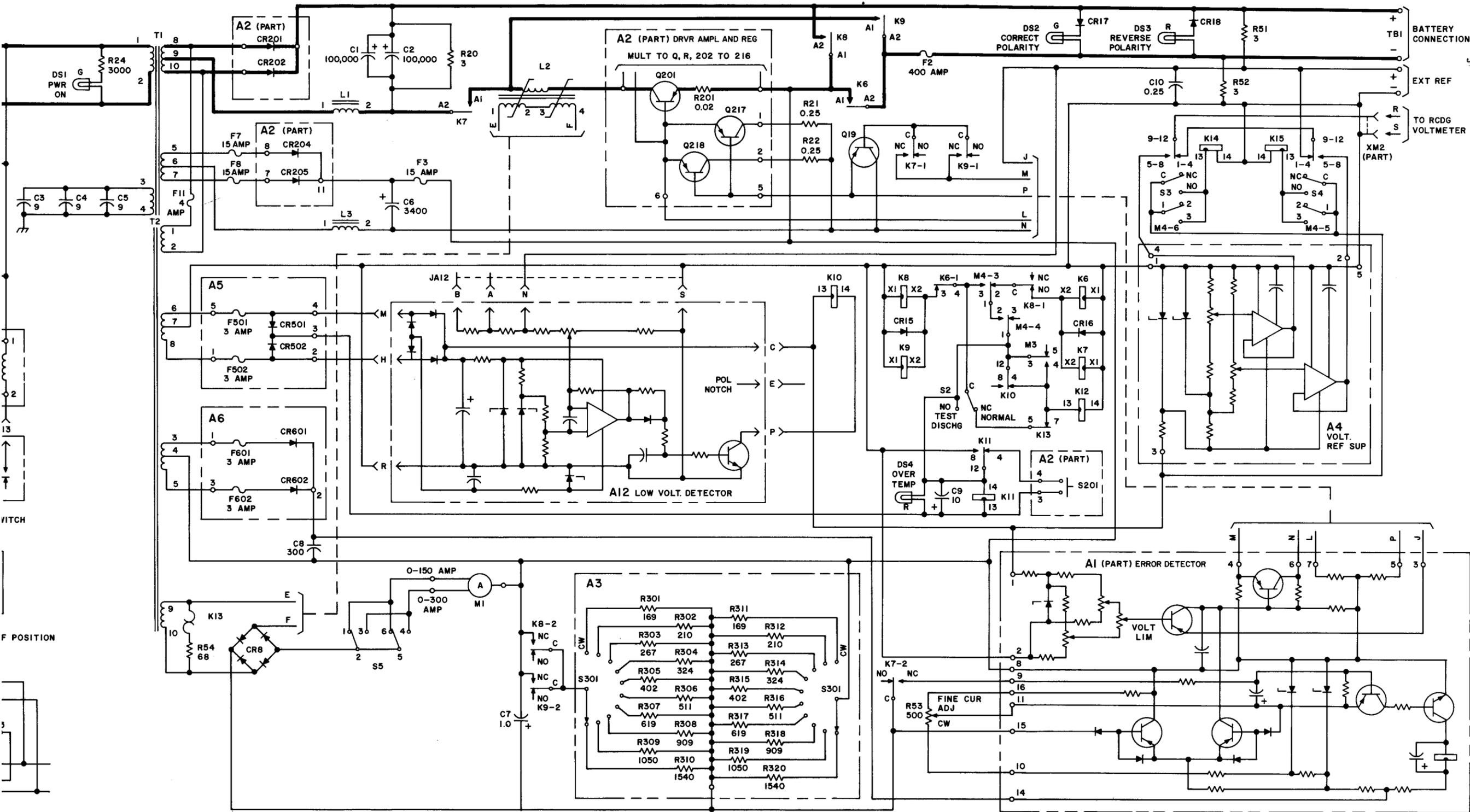
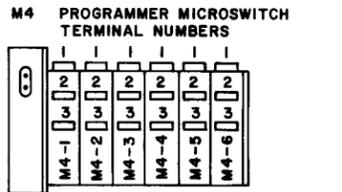
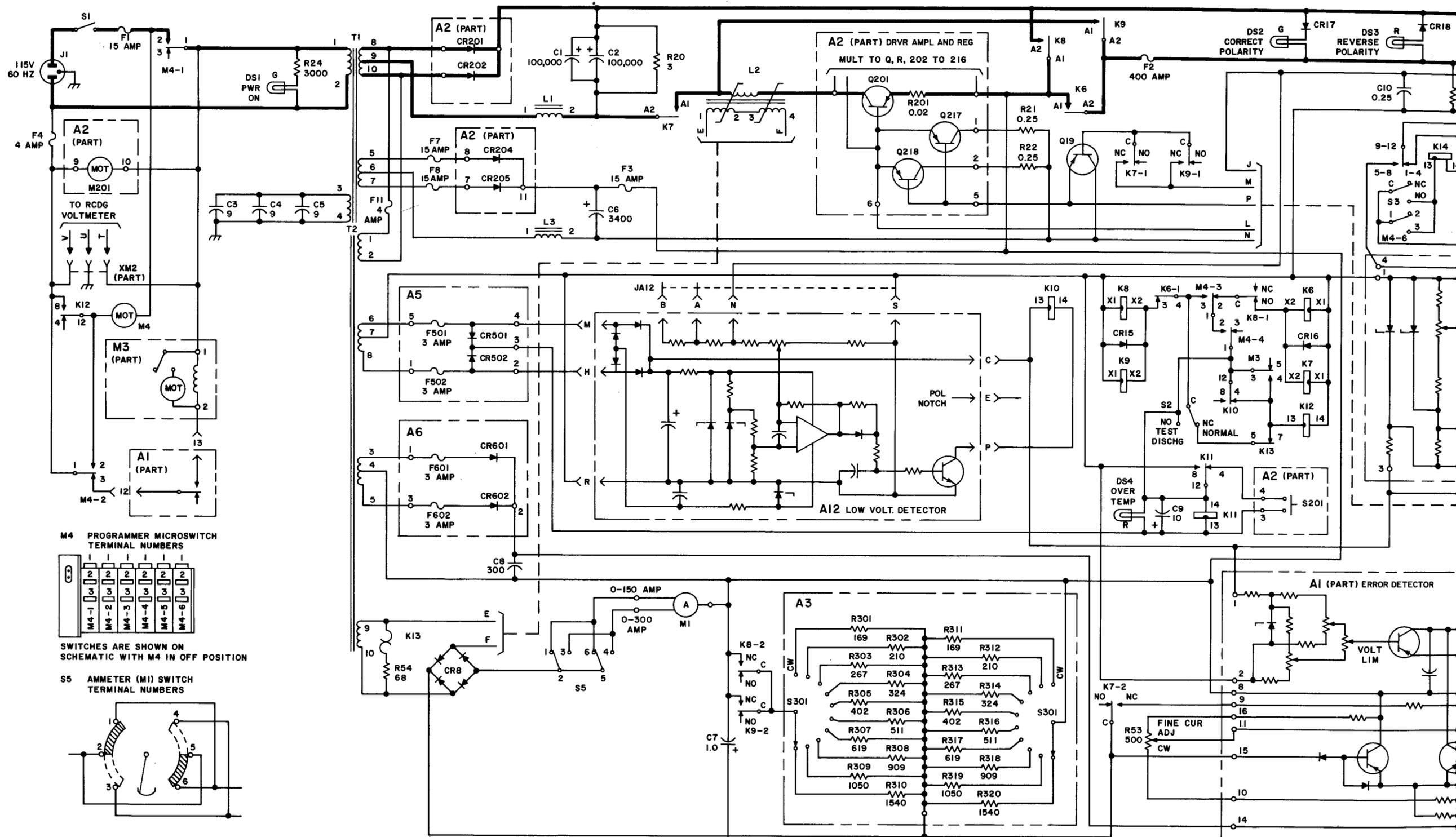


Fig. 7—KS-20142 L1 (Lorain) Discharger-Recharger,
Schematic Diagram



SWITCHES ARE SHOWN ON SCHEMATIC WITH M4 IN OFF POSITION

