J86446 (105D) POWER PLANT

NEGATIVE 48-VOLT, 10-, 20-, AND 30-AMPERE SUPPLY

AND

J86251A REGULATED RECTIFIER UNIT

ELECTRON TUBE TYPE

1. GENERAL

1.01 This section describes the operation of the automatically regulated negative 48-volt power plant, J86446, and the J86251A, regulated tube-type rectifier unit which, either with or without one or two additional J86207J, rectifiers, are coded as the 105D power plant. This plant is intended for use with No. 12 manual switchboards, 605A manual PBXs, 701A-, 711A-, and 740-type dial PBXs, and 355A and 356A community dial offices. It may, however, be used for other equipment for which its capacity voltage range, and circuit arrangements are satisfactory. The rectifiers are rated 8 amperes for continuous, and 10 amperes for intermittent duty. The combined rating may be 10, 20, or 30 amperes, depending on the number of rectifiers employed. There is a battery reserve. The output voltage is regulated to within ±1.25 per cent of the nominal value at any load up to 8 amperes per rectifier, except that with 5 per cent low line voltage this regulation is maintained only to approximately 75 per cent of rated output. During power failure the output voltage is unregulated and depends upon the load and the available battery reserve. The input power requirements are either 105 to 125 volts or 200 to 250 volts ±5 per cent at 60 cycles ±2 per cent, single-phase. The rectifier is suitable for use in room temperatures from 0 to 104F (-18 to 40C).

> Caution: Voltages inside the rectifier case are over 150 volts. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time or destructive and dangerous short circuits may occur. Disconnect both the a-c supply and the d-c output before doing any work inside of the rectifier case.

1.02 This section is issued to add the J86251A, List 4 rectifier and a 230-volt input option. Changes are marked with arrows.

1.03 In this section, the term capacitor is used for all apparatus coded as either a capacitor or a condenser and the term resistor is used for all apparatus coded as either a resistor or a resistance.

1.04 The abbreviations CW and CCW, used herein, refer to clockwise and counterclockwise rotation, respectively.

1.05 Routine checks are intended to detect defects, particularly in infrequently operated parts of the equipment, and insofar as possible to guard against circuit failures liable to interfere with service. Checks and adjustments, other than those required by trouble conditions, should be made during a period when they will cause the least unfavorable reaction to service.

1.06 The instructions are based on drawings SD-81134-01 for the plant and SD-81138-01 for the J86251A rectifier. For detailed description of the operation, see the corresponding circuit descriptions.

1.07 The life of a grid battery starts with the completion of its manufacture. Time between that date and actual installation represents so much loss of useful life. This should be kept to a minimum consistent with other factors, such as availability and the necessity for immediate replacement in case of failure. It is important that the correct number of cells be used. Do not add cells to compensate for decreased battery voltage. When the regulated voltage can no longer be obtained by adjustment of the regulating rheostat, ADJ VOLTS, check the grid battery voltage with a voltmeter and replace a battery which measures less than 41.9 volts. A small automatically regulated metallic-type rectifier unit, not covered herein, is sometimes used instead of a grid battery.

1.08 Additional information on the operation and maintenance of individual pieces of apparatus, such as instruments and relays, is given in other sections and the attendant should be familiar with them. All apparatus is assumed to have been adjusted in accordance with these sections and with the circuit requirements table or the circuit description associated with the circuit drawing. Refer to such sections as:

A301.005 Continuous Float Charge
A301.338 J86207J Rectifier Unit
A401.001 Storage Batteries
A401.004 Counter Cells
A401.562 Meters and Instruments
A401.574 KS-5722 D-c Contactor
A438.961 Electrolytic Capacitors
A462.005 Relays, 260 and 261 Types, Weston Models 30, 534, and 546
A462.012 KS-5596 Time Delay Relay
A462.018 KS-5721 Mercury Relays
A462.026 KS-15528 Relay
A801.303 Regulated Tube Rectifiers
A801.910 Artificial Loads

1.09 Battery readings called for herein may be made with the plant voltmeter relay, a KS-8093 voltmilliammeter, or a Weston Model 280 voltmeter, provided that the instrument must have been calibrated for accuracy at float voltage.

1.10 Information in this section is arranged under the following headings:

1. GENERAL

2. OPERATION
2.01 Description of the Plant
2.10 Description of the Rectifier
2.16 Preparing to Start
2.17 Initial Adjustments
2.24 Routine Adjustments
2.25 Counter Cells
2.27 Batteries

3. ROUTINE CHECKS

4. TROUBLES

5. POINT-TO-POINT VOLTAGES

1.11 List of Tools and Gauges (Equivalents may be substituted)

Tools
Clips, No. 365 (2 reqd per cord)
Cord, 1W1AF
Test Picks and Cords, D-79650 and D-79651

Gauges
Voltmeter, d-c Model No. 280 ranges 150-60-3
Voltmeter, a-c Weston Model No. 155 ranges 300-150
Voltmilliammeter, KS-8039
M9B Meter or Volt-ohm-milliammeter, KS-14510

2. OPERATION

Description of the Plant

(See Fig. 1 - Simplified Plant Schematic)

2.01 Automatically regulated tube-type rectifiers are used to convert 60-cycle, single-phase power to 48-volt direct current, for loads up to 30 amperes. The originating rectifier unit, J86251A is connected through fuses, only, to the a-c and d-c circuits, with no other disconnecting means. The succeeding rectifier units, J86207J, are connected to the a-c supply by contactors, operating automatically, and to the d-c circuit only through fuses. All are regulated tube rectifier units, automatically controlled to permit operation on an unattended basis. Under normal conditions the rectifiers carry the load, float the batteries, and, after power failure, recharge the battery. Each unit is self-protecting by means of a ballast lamp, which also assists in connecting successive units to the power supply, as required to meet load conditions. The voltmeter relay also acts to start additional units, when furnished, as required by low voltage and to stop them when the voltage reaches the high limit.

2.02 A 24-cell battery, with one counter cell is furnished initially. Parallel strings of batteries are added as needed to meet reserve requirements and a second parallel counter cell is added when the load exceeds 15 amperes.

2.03 Provision is made to reduce the discharge voltage by about 2 volts, for test purposes, by operating the TST switch (not shown) to the TST position. This transfers the regulating lead from the load side to the battery side of the counter cell and operates the cemf contactor to remove a short-circuit from the counter cell, which is connected in the discharge circuit.

2.04 For overcharging the battery under manual control, at approximately 2.23 volts per cell, the OVERCHG switch (not shown) is operated to its MAN position, to cause the cemf contactor to insert a counter cell in the discharge circuit. This causes the battery voltage to rise by the amount of the drop over the counter cell, since the regulating leads remain connected at the load. An optional provision, including the OC relay and OC timer (not shown), permits overcharging the battery for a period of 24 hours, automatically terminated. In this case the OVERCHG switch is operated to its nonlocking AUTO position, causing the relay to operate and lock up. It is released by the timer at the end of the period.

2.05 The usual discharge fuse alarms are provided. The voltmeter relay provides for high-low voltage alarms as well as for the starting and stopping of rectifiers 48V G2 and 48V G3, when furnished. A 2- to 6-minute delay feature is available for the voltage alarm, on an optional basis.

2.06 Full load on rectifier 48V G1 causes relay ST1, when furnished, to

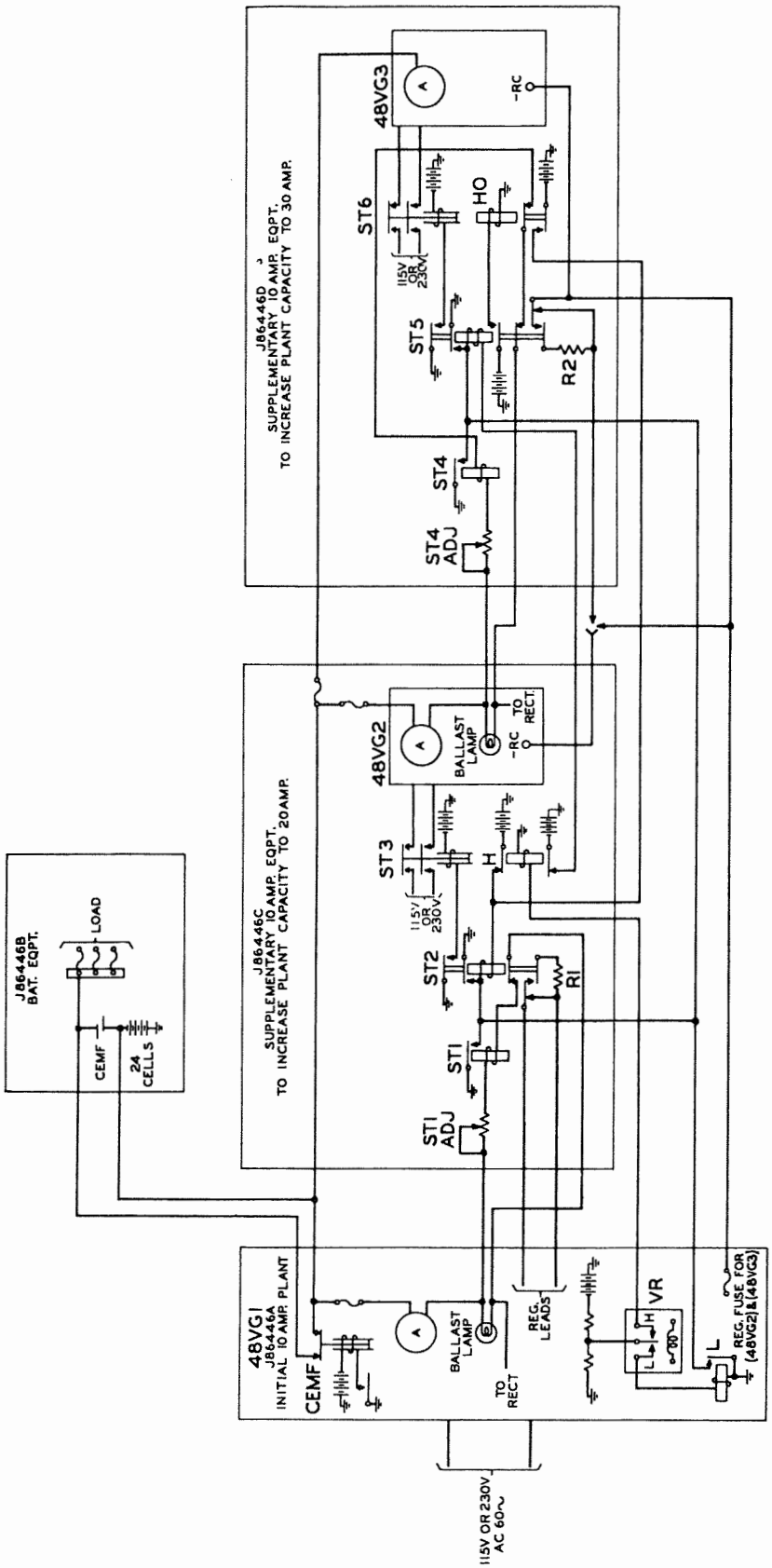


Fig. 1 - Simplified Plant Schematic

operate from the potential across the ballast lamp. Through relays ST1, ST2, and ST3, rectifier 48V G2 is connected to the power supply. Relay ST2 locks to ground and at the same time inserts resistor R1 in the regulating circuit of 48V G1 causing it to operate at approximately 10-ampere output. Rectifier 48V G2, after its warm-up delay, assumes its share of the load and regulates the battery voltage. If the load exceeds the combined capabilities of the two rectifier units, the battery will supply the excess with an accompanying reduction in output voltage. When the load subsequently decreases, the battery will be charged and its voltage raised. In the meantime the output current of 48V G2 will decrease to zero. When the battery voltage reaches 52.5 volts, voltmeter relay VR will make on its H contact to operate relay H, releasing ST2. Relay ST2 releasing removes 48V G2 from the power supply, and returns regulation to 48V G1 by short-circuiting R1.

2.07 In the event of low battery voltage, voltmeter relay VR will make on its low contact at 49.7 volts, to operate relay L, ST2 and ST3, and start 48V G2. When the battery voltage rises to 52.5 volts it will be removed from the power supply as covered above.

2.08 Rectifier unit 48V G3, when furnished, is ordinarily connected to power supply by overload on 48V G2 as described above. Operation of relay L, as described above will start 48V G2 and 48V G3 simultaneously. The former operates at approximately 10 amperes, due to ST5 inserting resistor R2 in its regulating lead. Unit 48V G3 regulates the battery as long as the load is within its range. On decreasing load, the battery will be charged and its voltage raised. At 52.5 volts voltmeter relay VR will operate, to operate relay H. Relay H removes battery from relays ST5 and ST2, releasing ST5, which disconnects 48V G3, removes battery from relay HO, and short-circuits resistor R2. Relay HO is slow releasing and holds battery on ST2, keeping 48V G2 in service until it returns to normal float voltage, causing VR to open its H contact releasing relay H, which returns battery to ST2. Relay ST2 continues operating and holds 48V G2 in service until rising battery voltage again causes VR to close its H contact, disconnecting that rectifier unit from the power supply.

2.09 A manually operated switch, designated 48V G2 MAN-NOR AUTO-48V G3 MAN, is provided for holding either of these units in operation under manual control, while adjusting its output.

Description of the Rectifier

2.10 The J86251A rectifier, proper (see Fig. 2) has essentially the same circuit arrangements as the J86207J rectifier (see A301.338), differing from it chiefly in the designations applied to some of the circuit components and in the circuit arrangement of the ammeter, ballast lamp, and retardation coil. Because J86251A is used as the originating rectifier in the plant, certain features, including the alarms and the charging control are incorporated in it. These are not shown in Fig. 2.

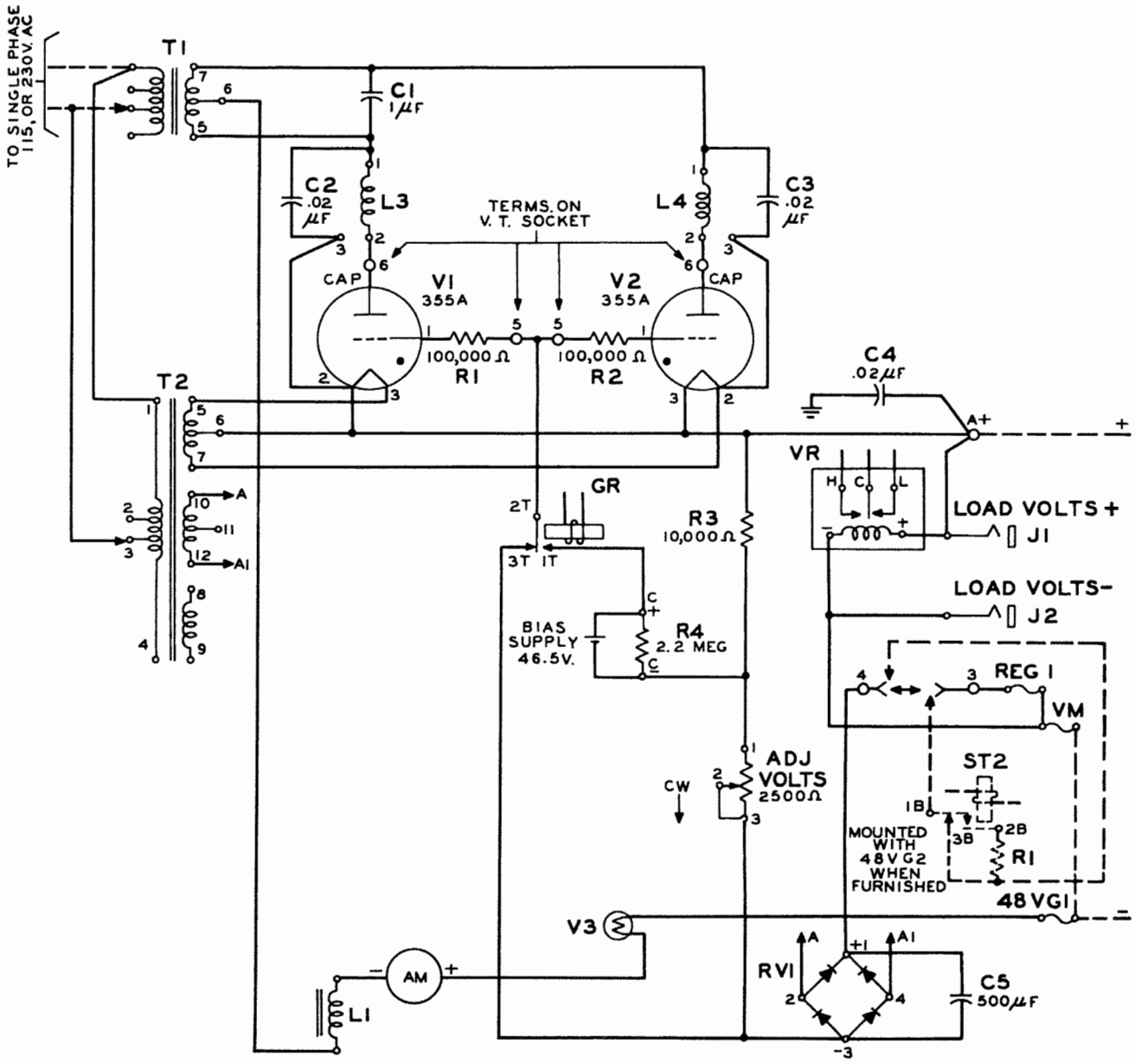
2.11 The J86251A rectifier receives single-phase, a-c power through transformers T1 and T2. Winding 10-11-12 of the latter transformer supplies varistor RV1 and the heater of relay TD (not shown). Winding 8-9 of T2 supplies the motor of timer OC (not shown).

2.12 Tubes V1 and V2 rectify the power under control of their grids, utilizing the magnitude of the grid-to-filament potential as a means of regulation. The d-c output is filtered by retardation coil L1 and limited by ballast lamp V3. Capacitors C2, C3, and C4 and retardation coils L3 and L4 suppress radio interference generated in the rectifier tubes, while capacitor C1 serves to prevent carrier and low radio frequencies from being induced in the a-c and d-c circuits. Ammeter AM is provided to indicate the output current.

2.13 The regulating potentiometer circuit consists of resistor R3, rheostat ADJ VOLTS, and varistor RV1 connected in series between the positive output lead and a fuse connected to the negative output. The varistor operates as a rectifier and inserts a d-c potential, filtered by capacitor C5, into the circuit, serving to compensate for changes in line voltage. The common point of R3 and ADJ VOLTS is connected through a grid bias supply shunted by resistor R4, to the 1T contact of relay GR which closes the circuit through to the common point of R1 and R2, and thence to the grids of the two tubes. The grid bias supply may be a 46.5-volt battery or a regulated metallic rectifier of the same output voltage.

2.14 A connection is carried from the negative terminal of varistor RV1 to the 3T contact of relay GR, which is closed when GR is released, and through R1 and R2 to the grids. This makes the grids 50 to 60 volts negative with respect to the cathode during the warming up period, thus protecting the filaments while they are coming up to operating temperature. On starting, relay GR remains released, until operated by relay TD (not shown) after a delay of approximately 45 seconds.

2.15 A discussion of the theory of the magnitude control operation of these rectifier units is given in the Educational Information Section, A801.303.



NOTES:

1. THE FOLLOWING ARE OMITTED FOR SIMPLIFICATION: RELAY (TD), SWITCH (TST), CONTACTOR (CEMF), OVER-CHARGE SWITCH, LAMP RELAY & TIMER DISCHARGE FUSES, ALARM EQUIPMENT.

2. A RES. WHOSE VOLTAGE AFFECTS OPERATION IS SHOWN VERTICALLY. THE VOLTAGE PICK-UP POINT OF A CONTROL GRID IS SHOWN AT A LOWER LEVEL THAN THAT OF THE CATHODE, TO REPRESENT GRID BIAS GRAPHICALLY.

FIG. 2

Fig. 2 - Functional Schematic of J86251A Rectifier Unit

Preparing to Start

2.16 When preparing the plant for intial operation, check against the SD drawings for the plant and the rectifiers to see that:

(a) The transformer taps used are correct for the power service voltage.

(b) The correct tubes are in the sockets.

(c) The regulating rheostat, ADJ VOLTS, in each rectifier unit is in its extreme CCW position.

(d) Voltmeter relay VR has been calibrated in accordance with 2.17.

(e) The proper grid bias battery or rectifier unit is in the circuit.

(f) The regulated metallic type rectifier unit, if used in place of the grid bias battery, has been adjusted correctly.

(g) The correct a-c and d-c fuses are in place.

(h) There is available sufficient office load to fully load one rectifier unit or an artificial load of like capacity.

Initial Adjustments

2.17 To calibrate voltmeter relay VR, connect a recently calibrated KS-8039 voltmeter in parallel with it by plugging in, at the LOAD VOLTS jacks. With the ADJ VOLTS rheostat bring the voltage to 51.6 volts as indicated by the portable instrument. Adjust the torsion spring adjusting arm to bring the indication of the relay to the same value. See Section A462.005 for the procedure for adjusting the tension of the torsion spring in Weston Model No. 534 relays. After any adjustment, recheck the H and L contacts.

2.18 To adjust rectifier unit 48V G1 to the correct float voltage, rotate the ADJ VOLTS rheostat in a CW direction until the battery voltage, as indicated by the voltmeter relay is 51.6 volts with the output current within the limits given in the following table. These limits depend upon the power service voltage at the time of making the adjustment. Use a portable a-c voltmeter for reading the service voltage and observe the rectifier ammeter. Due to the fact that the output voltage will be higher at light loads, the average voltage will be slightly higher than this.

Power Supply			Output	
Nominal	Observed Volts		Amperes	
Volts	Min.	Max.	Min.	Max.
105	102	113	2	7
	97	102	2	5
115	112	124	2	7
	106	112	2	5
125	121.5	135	2	7
	115	121.5	2	5
190	185	203	2	7
	175	185	2	5
210	204	226	2	7
	194	204	2	5
230	224	248	2	7
	212	224	2	5
250	243	270	2	7
	230	243	2	5

2.19 If the plant load at the time of adjustment is less than the minimum value as given in 2.18, an artificial load may be used to bring it up to the required value. As an alternative allow the battery to discharge, by rotating rheostat ADJ VOLTS to its extreme CCW position. After a suitable interval try again to raise the adjustment to the required value, relying on the battery charging current to provide sufficient load on the rectifier unit to maintain the output above the minimum. If, however, the load is in excess of the desired value, charge the battery by operating the OVERCHG switch to its MAN position until the battery voltage is above the float value. Return the switch to its OFF position and proceed to adjust the rectifier, relying on the battery to furnish a part of the load. When supplemental rectifier unit 48V G2 is furnished it may be used, if necessary, to help carry the load while 48V G1 is being adjusted to the float voltage. For this purpose, adjust its output current by means of its ADJ VOLTS rheostat after it has been brought into service by operating the NOR AUTO switch to 48V G2 MAN. At this time the ST1 ADJ rheostat should be in its extreme CW position and relay ST2 blocked in its released position.

2.20 To adjust relay ST1, hold the output of rectifier unit 48V G1 at 8 amperes for at least 30 seconds, by means of the ADJ VOLTS rheostat. If necessary, to avoid exceeding the maximum voltage for the office, add artificial load. If the office load requires more than 8 amperes use 48V G2, as covered above to help carry it. With the output of 48V G1 at 8 amperes, rotate rheostat ST1 ADJ in a CCW direction until relay ST1 operates. Recheck, by lowering the output of 48V G1 and raising it very slowly again, until the adjustment of ST1 ADJ is such that ST1 operates when the output of 48V G1 is 8 amperes. When the relay adjustment has been completed,

readjust the ADJ VOLTS rheostat on 48V G1 to regulated float voltage and remove the block from relay ST2.

2.21 To adjust rectifier unit 48V G2 to regulated float voltage, proceed as given in 2.18 and 2.19 for 48V G1 but with 48V G1 shut down, or block relay ST2 in its released position and operate the NOR AUTO switch to its 48V G2 position. The two rectifier units will be regulating in parallel. With 48V G1 adjusted correctly, rotate the ADJ VOLTS rheostat of 48V G2 until the two units are sharing the load equally, the output of each being within the limits specified in 2.18. As line and load conditions change, the load will not necessarily remain equally divided.

2.22 When 48V G3 is furnished, it and its associated ST4 relay should be adjusted in accordance with the foregoing paragraphs.

2.23 For each rectifier unit, check the time between turning on the power and the operation of the TD relay, as evidenced by the operation of the GR relay. Readjust, if this time is other than 45 ±5 seconds.

Routine Adjustments (Day to Day Operation)

2.24 Regulation is entirely automatic at the normal output voltage and should not require adjustment from day to day, but only when required, as determined by observation.

Counter Cells

2.25 Maintain counter cells clean and solution level within limits.

2.26 When doing any work on the counter cells, such as changing solution, check that the TST and OVERCHG keys on the J86251A rectifier are at NOR and OFF respectively. These keys, in the positions indicated, short circuit the counter cells and prevent accidental sparks from exploding the gases.

Batteries

2.27 Refer to Section A401.001 for general information on storage batteries such as precautions to be taken against explosions and damage from electrolyte, method of taking readings, battery data, general care of cells, etc.

> Caution: Avoid the creation of sparks, including those from static electricity, or the use of an open flame near storage batteries since the gas is explosive.

2.28 The electrolyte level shall be maintained between the top of the high-level line and top of the low-level line by the addition, at 2- to 3-month intervals or as required, of water, distilled or approved for storage battery use. Just before an equalizing or boost charge, add water to bring the electrolyte level to the high mark but no higher.

2.29 Routine readings of specific gravity and voltage of the pilot cells should be taken at intervals of 2 to 3 months.

2.30 A boost charge shall be given to the battery at the first visit after an emergency discharge of 5 or more hours. The boost charge is applied by operating the OVERCHG switch to its MAN position, and will continue at approximately 53.6 volts until terminated manually just before leaving the office. The charge may be terminated automatically at the end of approximately 24 hours if the optional equipment has been installed. The usual boost charge records may be omitted.

2.31 Equalizing Charge: An equalizing charge should be given if the full charge specific gravity of the pilot cell falls more than 5 points (0.005) in any one year or if there is sulfation or other indication of undercharge. The equalizing charge should be at approximately 53.6 volts and should continue for 20 hours after the specific gravity has reached its maximum. Hourly, record the specific gravity of pilot cells, corrected to 70F or 77F.

> Note: With any reading or group of readings, the time at which the reading was made or the time the group of readings was started should be recorded. All records should be dated.

3. ROUTINE CHECKS

3.01 Periodically, or at each visit, observe the voltage and current to see that the average float voltage is close to 51.6 volts, with lower values under heavy load and higher values during the night periods, for example, not exceeding 52 volts, under light loads. Make minor adjustments of the ADJ VOLTS rheostat of 48V G1, as required, during light load periods. During periods of heavy load, make minor adjustments of the ADJ VOLTS rheostat of 48V G2 or 48V G3 as existing in the office. Adjust only that unit which is doing the regulating and only when its current is within the limits specified in 2.18.

3.02 The output current of a single rectifier unit may usually be brought within the limits for adjustment by the use of one of the following procedures. If the current is high, raise the output voltage for a short period to charge the battery, and proceed to make the adjustment

while the battery is carrying a part of the load. If the current is low, lower the output voltage for a short period allowing the battery to discharge, and proceed to make the adjustment while the rectifier is carrying the load and recharging the battery. In either case, avoid going outside the voltage limits applying to the office.

3.03 The following alternate method of adjusting a rectifier unit will be of advantage where the load is so high at the time the maintenance man visits the installation that it does not permit charging the battery as outlined above. This method is essentially one of applying to the regulating potentiometer circuit a voltage of the value at which cutoff of the tubes is desired, and of adjusting the ADJ VOLTS rheostat to produce cutoff at that value. Obtain a portable voltmeter, a 4.5-volt dry cell battery (preferably a block battery) and a small potentiometer of 500 ohms resistance, minimum, and one watt rating, minimum. Connect the resistance terminals of the potentiometer to the battery and bring out connections from one of these terminals and from the movable contact of the potentiometer. To proceed, open the regulating potentiometer circuit at the negative end, for example at the -RC terminal in a J86207J unit, or at terminal 4 in a J86251A unit, or at the REG fuse of either type unit. Connect the voltmeter from the open end of the potentiometer circuit to its positive end, to indicate the voltage across it and connect the potentiometer and test battery across the open to add to the voltage. Turn rheostat ADJ VOLTS to its extreme CW position. By varying the test potentiometer bring the voltage across the regulating potentiometer circuit to 52.4 volts. Turn ADJ VOLTS slowly CCW until the tubes stop firing. Check this adjustment by varying the test rheostat and then restore the circuit to normal without changing the position of the ADJ VOLTS rheostat.

3.04 The following routine is suggested for periodically checking the operation of the plant.

(1) Check that the regulating rectifier is floating the battery at 51.6 volts, with the power supply and output in accordance with 2.18.

(2) Disconnect all rectifier units by removing the a-c supply fuses.

(3) Allow the battery to carry the load until the low voltage alarm operates. Check that L relay operates, lighting ALM lamp at 49.7 volts as indicated by voltmeter relay VR. If necessary, readjust the L contact of VR.

(4) Replace the a-c supply fuses in 1-2-3 order and check the time required for the first rectifier, 48V G1, to start as evidenced by the operation of its GR relay. If not 45 ±5 seconds, readjust the TD relay per A462.012.

(5) If the load is sufficient to bring in the second rectifier unit, 48V G2, check the time between the operation of ST1 relay and the starting of 48V G2, as evidenced by the operation of its GR relay. Adjust the associated TD relay if the time is not 45 ±5 seconds.

(6) If the load is sufficient to bring in the third rectifier unit, 48V G3, check the time between the operation of ST4 relay and the starting of 48V G3. Adjust, as above, if the time is not 45 ±5 seconds.

(7) Check that the float voltage of the rectifier unit which is regulating is correct. See (1) above.

(8) If the load on unit 3 (or unit 2) reduces to zero, note the battery voltage when the operation of the H contact of VR relay causes relay H to operate and relay ST5 (or ST2) to release. If not 52.5 volts, readjust the H contact of VR.

(9) Check that the float voltage of the rectifier unit which is now regulating is correct unless it has been checked under (1) or (7).

3.05 When a tube fails, or it becomes necessary to install a new grid battery, adjustment of the ADJ VOLTS rheostat will usually be required.

3.06 The discharge fuse alarm may be checked by inserting a blown alarm fuse in a spare fuse block. As an alternative, connect a W1AF cord, equipped with a 365 tool at each end, between terminals A and B of a spare fuse block. This should light the ALM lamp and bring in the regular office alarms. The terminals of the fuse block in 48V G1 are made accessible by releasing two turn-fasteners at the top of the panel and swinging it downward on its hinge. The fuses associated with 48V G2 and 48V G3 are accessible from the rear.

3.07 The high-low battery voltage alarm is checked in routines 3.04 (3) and (8) above.

4. TROUBLES

4.01 Unsatisfactory operation of either rectifying tube in a full-wave rectifier using two rectifying tubes gives unsatisfactory operation of the rectifier unit. To eliminate the defective tube, change both tubes to get satisfactory operation. Then put back the old tubes one

at a time to determine which is defective. Flashover of a tube is current passing in the wrong direction through the tube and it renders the tube unsatisfactory for further use. It usually occurs after a tube has been used for some time and is nearing the end of its life. Flashover will probably blow the charge fuse and burn out the ballast lamp. Cathode trouble usually consists of open filament or low emission and tubes with cathode trouble are unsatisfactory for further use. Grid trouble may be high firing point or grid emission. High firing point is the condition where too high voltage is necessary to fire the tube. While this can be compensated for to some extent by changes in ADJ VOLTS rheostat setting, the tube is inclined to be unstable at light loads. It should be replaced if causing erratic operation. Grid emission sometimes occurs due to cathode material which has been carried over to the grid. The effect of this is negligible until the temperature of the tube becomes high enough to cause this active material on the grid to give off electrons, which causes the grid to lose control. This effect disappears as the tube cools so that satisfactory operation may be possible at light loads when it is not possible at full load after one hour of operation. Cathode-to-grid shorts may also show up only after tube heating. ←

4.02 When a rectifier unit is functioning properly, clockwise operation of the ADJ VOLTS rheostat will increase the output and counterclockwise operation decrease it. For battery charging, counterclockwise operation of this rheostat should decrease output current to 10 per cent of rated output or less and if smooth control stops at a higher value, it is know as high drop-out. High drop-out may be due to the use of the wrong transformer tap or to a tube having a high firing point. (See 4.01)

4.03 Large fluctuations or "kicks" of the ammeter needle may be due to a depleted grid battery even when the ADJ VOLTS rheostat has not been turned to its extreme CW position. Any grid battery whose voltage, as read on a Weston Model 280 voltmeter, is less than 41.9 volts should be replaced. Similarly, if full output cannot be obtained with the ADJ VOLTS rheostat in its extreme CW position, the grid battery should be replaced.

4.04 Any of the following apparatus should be replaced if it becomes defective in any respect.

Delay Relays	KS-14392
Switches	KS-13674
Control Rheostats	All

4.05 In a plant equipped with more than one rectifier unit, after replacing a defective ballast lamp, recheck the adjustment of the ST-ADJ rheostat in the succeeding rectifier unit.

Trouble Chart

4.06 Should any of the following troubles develop, it is suggested that the possible cause be checked in the order given. If the trouble is not found, look for loose or open connections, or short circuits due to foreign matter lying across wiring terminals. If a check of the possible causes listed below or the use of the point-to-point voltage table does not lead to the location of the trouble, it is advisable to make resistance measurements with the circuit completely de-energized, comparing the measured values with the values shown on Fig. 2.

Trouble	Possible Cause
No output current	Power failure Blown a-c fuse Failure of rectifying tube Failure of ballast lamp Charge fuse blown Failure of GR relay to close its contact
A-c input fuse blown	Defective rectifying tube
Low d-c voltage Low output current	Low output from grid bias supply Low emission in rectifying tube ADJ VOLTS rheostat out of adjustment or contact failing Ballast lamp defective Voltmeter relay VR out of adjustment or low contact failing Rheostat ST1 or ST4 out of adjustment Relays ST1, ST2, ST3, ST4, ST5, or ST6 failing
High d-c voltage High output current	Open in regulating circuit REG fuse blown Grid emission in rectifying tubes ADJ VOLTS rheostat out of adjustment Voltmeter relay VR out of adjustment or contact failing Relays H or HO failing GR relay failing to close its contact Capacitor associated with varistor either open or of low capacity
Output erratic under light load	Capacitor associated with the varistor is defective Variable voltage from grid bias supply Rectifying tube has high firing point or high drop-out

5. POINT-TO-POINT VOLTAGES

5.01 As long as the rectifier unit operates satisfactorily, point-to-point voltage values are not needed and are not

operating requirements to be checked in routine. In case the rectifier output cannot be obtained, they may be useful in locating defective conditions.

5.02 High voltages to ground are present within the rectifier unit and every precaution should be observed to avoid any contact with exposed metal parts or terminals when the rectifier unit is in operation, or when not in operation, but connected to the line.

Caution: When using any portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be connected at the instrument before making contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the test picks should first be removed from the equipment being tested.

5.03 The readings given in the table are approximate and typical of a rectifier unit adjusted as indicated. They are made with the M9B meter which is accurate to ±5 per cent on alternating current and to ±2 per cent on direct current. It will not seriously affect the output of the rectifier unit when connected for making the readings.

Caution: The readings shown in the following table are for a typical rectifier unit in good working condition. A defect in a rectifier unit may leave a high voltage charge on a capacitor and other parts of the circuit with the power off. A defective rectifier unit with the power connected may have quite different voltages than those shown. Therefore, it may be desirable to use a higher voltage jack in the meter until readings indicate the proper jack to use for the defective condition.

5.04 Rectifier unit adjusted to 51.6 volts at the output terminals, output current as indicated in the table, with normal power supply.

POINT-TO-POINT VOLTAGES

Voltage Across	M9B Preparation		Connection of M9B to Apparatus				Typical Reading Volts Output	
			+V Jack		-V Jack			
	V Jack	Toggle Switch	App	Term.	App	Term.	1 Amp	8 Amp
Filament	15	A-c	V1	2	V1	3	2.6	2.6
Bias	15	D-c	Term	A+	GR	2T	3.8	2.6
Varistor	15	A-c	RV1	2	RV1	4	8.3	8.2
Varistor	15	D-c	RV1	1	RV1	3	10.0	9.6
Output	150	D-c	Jack	J1	Jack	J2	51.6	51.6
Grid Battery	150	D-c	R4	C+	R4	C-	46.5	46.5
Ballast Lamp	15	D-c	V3	Term	V3	Term	.2	4.4

Bell Telephone Laboratories, Inc.

ADDENDUM A301.808
Issue 1, Jan., 1956
AT&TCo Standard

J86446 (105D) POWER PLANT

NEGATIVE 48-VOLT, 10-, 20-, AND 30-AMPERE SUPPLY

AND

J86251A REGULATED RECTIFIER UNIT

ELECTRON TUBE TYPE

1. GENERAL

1.001 This addendum supplements Section A301.808, Issue 2.

1.002 This addendum is issued to replace the Weston model 280 dc voltmeter; to omit references to the M9B meter, manufacture of which has been discontinued; to cover the automatic removal of the countercell or countercells from the discharge circuit during a power failure; to add information concerning the effect on the output current of the starting of additional rectifier units; to revise the instructions for initially adjusting the battery voltage to the correct float voltage; to revise the charging instructions; and to revise Fig. 1.

The following changes apply to Part 1 of the section:

(a) 1.09 - omitted

(b) 1.11 - revised

1.11 List of Tools and Gauges (Equivalents may be substituted)

Tools

Clips, No. 365 (2 reqd per cord)

Cord, 1W1AF

Test picks and cords, D-79650 and D-79651

Gauges

Voltmeter, ac Weston model 155, ranges 300-150

Voltmeter, dc Weston model 931, ranges 300-150-75-30

Voltmilliammeter, KS-8039

Volt-ohm-milliammeter, KS-14510

2. OPERATION

The following changes apply to Part 2 of the section:

(a) 2.02 - revised

(b) 2.04 - revised

(c) 2.06 - revised

(d) 2.08 - revised

(e) 2.17 - revised

(f) 2.18 - revised

(g) 2.30 - revised

(h) 2.31 - omitted

(i) Fig. 1 - revised

2.02 A 24-cell battery and one manually controlled countercell are furnished initially. Parallel strings of batteries are added as needed to meet reserve requirements, and a second countercell is added in parallel when the load exceeds 15 amperes. In case of power failure, the countercell or countercells, if previously inserted manually in the discharge circuit, are automatically removed. When the power is restored, the countercell or countercells are automatically reinserted in the discharge circuit.

2.04 For overcharging the battery under manual control at approximately 2.23 volts per cell, the OVERCHG switch (not shown) is operated to its MAN position to cause the countercell contactor to insert a countercell in the discharge circuit. This causes the battery voltage to rise by the amount of the drop over the countercell, since the regulating leads remain connected at the load.

2.06 Full load on rectifier 48V G1 causes relay ST1, when furnished, to operate from the potential across the ballast lamp. Through relays ST1, ST2, and ST3, rectifier 48V G2 is connected to the power supply. ST2 locks to ground and at the same time inserts resistor R1 in the regulating circuit of 48V G1, causing the circuit to operate at an output of approximately 10 amperes. This output decreases somewhat as 48V G2, after warming up, assumes its share of the load and assists 48V G1 in increasing the battery voltage to normal float voltage. If the load exceeds the combined capabilities of the two rectifiers, the battery supplies the excess, and its voltage decreases. When the load subsequently is lessened, the battery is charged, its

voltage is thereby raised, and the output current of 48V G2 decreases. When the battery reaches 52.5 volts, 48V G2 is at zero output, and voltmeter relay VR makes on its H contact to operate relay H, releasing ST2. This removes 48V G2 from the power supply and, by short-circuiting R1, returns regulation to 48V G1.

2.08 Rectifier 48V G3, when furnished, is ordinarily connected to the power supply as described in 2.07 for 48V G2 alone. Operation of relay L starts 48V G2 and 48V G3 simultaneously. Relay ST5 inserts resistor R2 in the regulating lead of 48V G2, causing 48V G2 to operate at an output of approximately 10 amperes. This output decreases somewhat as the battery voltage is being raised to normal float voltage. 48V G3 regulates the battery as long as the load is within its range. With decreasing load, the battery is charged and its voltage raised. At 52.5 volts, voltmeter relay VR makes on its high contact H, operating relay H. Relay H removes the battery from relays ST5 and ST2, releasing ST5, which disconnects 48V G3, removes the battery from relay HO, and short-circuits resistor R2. While the battery voltage is dropping to normal float voltage, relay HO, which is slow-releasing, holds the battery on ST2, thereby keeping 48V G2 in service. When the battery voltage reaches the normal float voltage, VR opens its H contact, releasing relay H, which then holds the battery on ST2, so that 48V G2 remains in service after relay HO releases. Relay ST2 continues operating and keeps 48V G2 in service until rising battery voltage causes VR to close its H contact again, disconnecting 48V G2 from the power supply.

2.17 To calibrate voltmeter relay VR, plug in a recently calibrated KS-8039 volt-milliammeter or Weston model 931 dc voltmeter at the LOAD VOLTS jacks, thereby connecting it in parallel with VR. With the ADJ VOLTS rheostat, bring the voltage to 51.6 volts as indicated by the portable instrument. Adjust the supporting arm of the torsion spring to bring the indication of the relay to the same value. See Section A462.005 for the adjustment procedure for Weston model 534 relays. After calibrating VR, recheck its H and L contacts.

2.18 To adjust rectifier 48V G1 to the correct float voltage, rotate the ADJ VOLTS rheostat in a cw direction until the battery voltage, as indicated by the voltmeter relay, is 51.6 volts with the output current within the limits given in the following table. These limits depend upon the power service voltage at the time the adjustment is made. Use a Weston model 155 portable ac voltmeter for reading the service voltage and observe the rectifier ammeter. Since the output voltage will be higher at light loads, the average voltage will be slightly higher than 51.6 volts.

Power Supply			Output	
Nominal	Observed Volts		Amperes	
Volts	Min	Max	Min	Max
105	102	113	5	7
	97	102	4	5.5
115	112	124	5	7
	106	112	4	5.5
125	121.5	135	5	7
	115	121.5	4	5.5
190	185	203	5	7
	175	185	4	5.5
210	204	226	5	7
	194	204	4	5.5
230	224	248	5	7
	212	224	4	5.5
250	243	270	5	7
	230	243	4	5.5

Note: The rectifier regulation is such that the output voltage is high at light loads with high power service voltage, and that conversely, the output voltage is low at heavy loads with low power service voltage. Accordingly, if the float voltage is adjusted to 51.6 volts during the day when the load is heavy and the power service voltage low, the average float voltage over a 24-hour period is expected to be close to the recommended value of 2.17 volts per cell, since the load is light and the power service voltage high during the night.

2.30 Boost Charge: Check individual-cell voltage, individual-cell corrected specific gravity, and pilot cell corrected specific gravity periodically, as detailed in Section A301.005. Keep all records specified in Section A301.005 and make reports to the supervisor in accordance with that section. A boost charge shall be given annually, when ordered by the supervisor, and when otherwise required, using the OVERCHG switch as in 2.04. Boost charges are required in this plant as follows:

(a) A boost charge should be given to the main battery if any individual-cell voltage, uncorrected for temperature, is more than 0.03 volts below the average individual cell voltage for the entire string.

(b) A boost charge should be given to the individual cell or to the entire string if a drop, in 3 months, of more than 4 points (0.004) in the corrected specific gravity of any cell cannot be explained by the recent addition of water, a low electrolyte level at the previous reading, or any emergency discharge.

(c) A boost charge should be given to the main battery and to the emergency cells if they have had any appreciable discharge, or if it is known that there has been one emergency discharge or a series of short discharges which (1) were the equivalent

of 1/2 hour or more during the heavy-load period of the day, or (2) caused the corrected specific gravity to drop 15 per cent or more of the cell's gravity range for full discharge.

(d) A boost charge should be given under certain other conditions, as outlined in Section A301.005, 1.06.

3. ROUTINE CHECKS

The following changes apply to Part 3 of the section:

(a) 3.03 - added note

(b) 3.04(2) - revised

3.03 (Add at the end of this paragraph)

Note: Use a Weston model 931 dc voltmeter or a KS-8039 voltmilliammeter to read the voltage across the regulating potentiometer circuit when making the above adjustment.

3.04

(2) Disconnect all rectifiers by removing the ac supply fuses. The manually controlled countercell or countercells, if previously inserted manually in the discharge circuit (see 2.03 and 2.04), are automatically removed by the removal of the ac supply fuses. When the fuses are restored, the countercell or countercells are automatically reinserted in the discharge circuit.

4. TROUBLES

The following change applies to Part 4 of the section:

(a) 4.03 - revised

4.03 Large fluctuations or "kicks" of the ammeter needle may be due to a depleted grid battery even when the ADJ VOLTS rheostat has not been turned to its extreme cw position. Any grid battery whose voltage, as read on a Weston model 931 dc voltmeter, + is less than 41.9 volts should be replaced. Similarly, if full output cannot be obtained with the ADJ VOLTS rheostat in its extreme cw position, the grid battery should be replaced.

5. POINT-TO-POINT VOLTAGE

The following changes apply to Part 5 of the section:

(a) 5.03 - revised

(b) Table - revised

5.03 The readings given in the table are approximate and typical of a rectifier unit adjusted as indicated. They are made with a KS-14510 volt-ohm-milliammeter, ← which is accurate to ±5 per cent on alternating current and to ±2 per cent on direct current. It will not seriously affect the output of the rectifier unit when connected for making the readings.

Caution: The readings shown in the following table are for a typical rectifier in good working condition. A defect in a rectifier may leave a high-voltage charge on a capacitor and other parts of the circuit with the power off. A defective rectifier with the power connected may have quite different voltages than those shown. Therefore, it may be desirable to use a higher voltage jack in the meter until readings indicate the proper jack to use for the defective condition.

POINT-TO-POINT VOLTAGES

Voltage Across	Connection to Apparatus				Typical Reading Volts Output	
	+V Jack		-V Jack			
	App	Term.	App	Term.	1 Amp	8 Amp
Filament	V1	2	V1	3	2.6	2.6
Bias	Term.	A+	GR	2T	3.8	2.6
Varistor	RV1	2	RV1	3	8.3	8.2
Varistor	RV1	1	RV1	4	10.0	9.6
Output	Jack	J1	Jack	J2	51.6	51.6
Grid Battery	R4	C+	R4	C-	46.5	46.5
Ballast Lamp	V3	Term.	V3	Term.	0.2	4.4

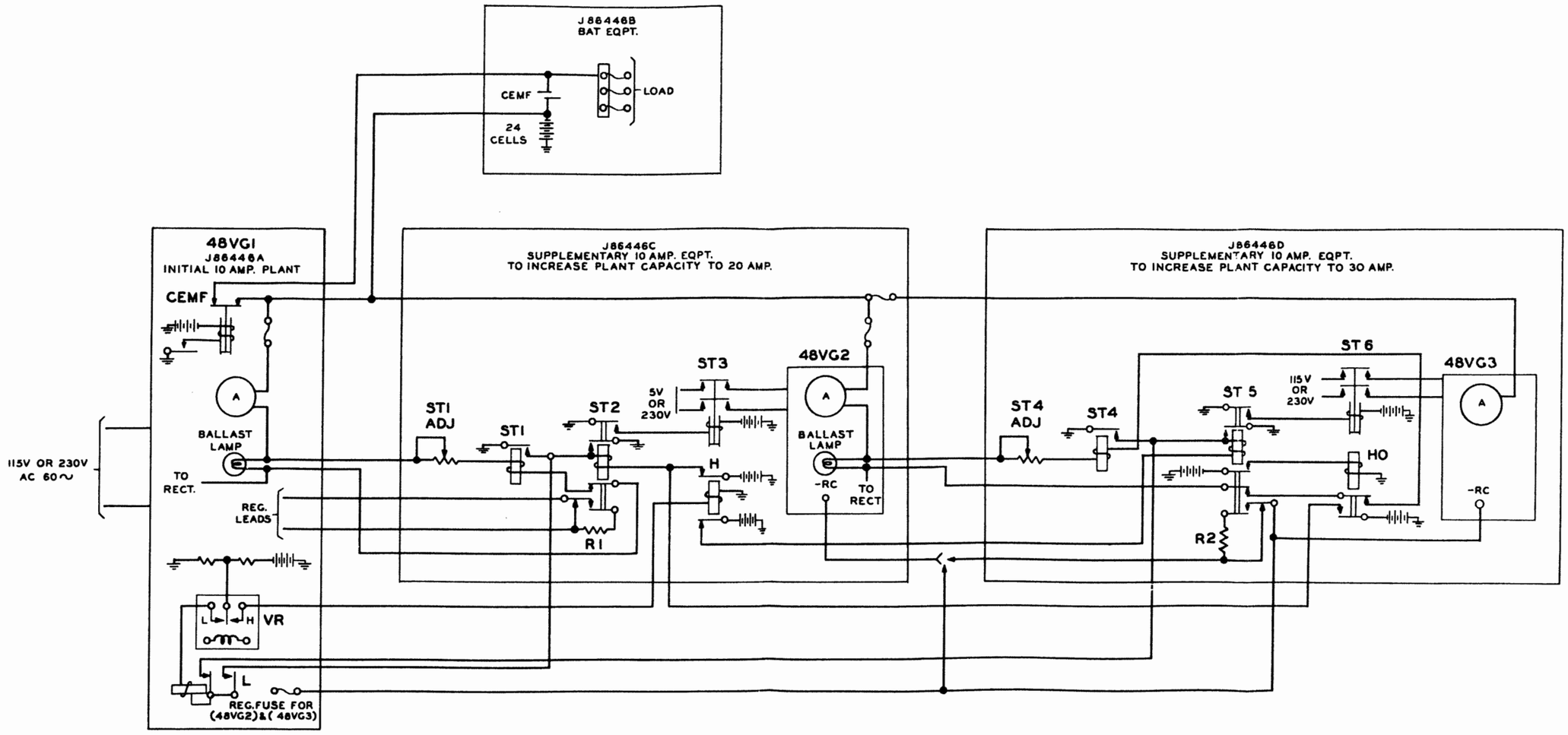


FIG. 1 105D POWER PLANT
SIMPLIFIED SCHEMATIC