NEGATIVE 330-VOLT SUPPLY CIRCUIT DESCRIPTION AND OPERATION

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1. GENERAL

1.01 This section provides coverage of the negative 330-volt supply which is used in dc telegraph systems utilizing service board No. 2 or 9B. The negative potential of 330 volts is used primarily as a grid bias supply for loop repeaters, cord circuits, miscellaneous voltage hub transmission circuits, and testing and maintenance circuits.

1.02 This section is reissued to provide coverage of changes caused by the replacement of the Weston Sensitrol* meter relay by the MI meter Relay LFE Corporation LFE/API † #0824232500, 0-60 mA meter relay (MI CURRENT milliammeter relay). The format has also been updated to conform with present specifications. Due to an extensive revision, change arrows have been omitted.

*Trademark of the Weston Co, Inc.

†Trademark of the Assembly Products, Inc.

1.03 The negative 330-volt supply circuit includes a primary source of rectified power, a reserve source of power derived from five 45-volt dry batteries, and a distribution network which provides 120 taps, each with a current-limiting series resistor.

1.04 In each of the power sources (primary or reserve) the rectifier or battery voltage is combined with a negative 130-volt telegraph battery to produce the negative 330-volt output.

1.05 The negative 330-volt supply circuit is designed for a maximum load of 50 mA although it will withstand a load of 75 mA (50% overload) for short periods of time. The circuit also provides for the automatic transfer of the load from the primary to the reserve source of supply when necessary.

2. PHYSICAL DESCRIPTION

2.01 The component units of the negative 330-volt power supply circuit are mounted on 19-inch relay racks as five separate panels occupying the vertical space of sixteen 1-3/4 inch mounting plates. The upper panel, which occupies the space of four 1-3/4-inch mounting plates, accommodates the distribution network. Each of the four panels occupies the space of three 1-3/4 inch mounting plates. The rectifier panel appears immediately below the distribution network. The battery supply unit is mounted on the three lower panels, the upper one of which accommodates the BAT ADJ switch. In order to protect personnel against a shock hazard, all local equipment and panel wiring is shielded with a grid of plastic material which will permit insertion of test probes for maintenance purposes. The negative 330-volt output wiring includes electrical protection in the form of series resistance to minimize shock.

A. Primary Source of Power

2.02 The rectifier panel employs a single, 5-1/4 inch mounting plate. On the front of the mounting plate, major apparatus units and those apparatus elements which require accessibility for observation and maintenance are mounted. The rear of the mounting plate accommodates resistance units, the voltage adjusting potentiometer, capacitor C4, and an Amphenol connector which mounts on a bracket. Miscellaneous power connections to the unit terminate on a terminal strip located at the left side on the rear of the mounting plate. All apparatus terminals and wiring on the rear of the plate are shielded by a removable plastic grid. Apparatus on the rear of the panel, together with the grid shield, is enclosed by a removable cover. The left end of the cover is slotted to permit passage of wiring to the unit. A 2-conductor Tyrex* cord (equipped with a plug) is provided for external connection to a 60-Hz 115-volt ac outlet box located on the bay framework. This cord passes through the opening in the rear cover and is connected to terminals on the terminal strip. Front apparatus and the rear cover extend approximately 4-3/4 inches and 5-3/8 inches in front of and behind the face of the bay framework, respectively.

*Trademark of the Rayon Tire Yarn and Cord Co., Inc.

B. Distribution Network Panel

2.03 The distribution network panel includes a rectangular steel chassis, approximately 3 inches deep, mounted on the bay framework by means of two flanged-end members. Each member is secured to the framework by two machine screws. The front of the chassis is open and the rear is flanged inward on all four sides to partially support two longitudinal plates of 1/4-inch insulating material which enclose the rear of the chassis. The front side of the longitudinal plates accommodate the GT resistors, a few terminal lugs, and four mounting studs supporting a removable plastic grid which serves as a guard for shock protection. The rear sides of the longitudinal plates accommodate 120 terminal lugs for connection of the supply leads, four mounting studs which support the rear cover, and several local cable supports. An internal flanged member attached to the left end of the chassis provides a mounting for the two electron tubes near the front of the panel. The M2 voltmeter and the associated Littelfuse* fuse are mounted in the middle of the chassis and are supported by a vertical plate which is fastened to upper and lower internal flanges attached to the front edges of the chassis. The front of the panel is equipped with a mat or cover having cutouts for the voltmeter and Littelfuse fuse mounting and including openings opposite the tubes to provide for ventilation and observation. The ends of the front cover are superimposed over the flanged-end members that secure the chassis to the framework. Each end of the cover is fastened to the framework by two machine screws which project through holes in the flanged member beneath. The rear cover, which is removable, is fastened to four mounting studs by machine screws. Slotted openings are on opposite ends of the rear cover to permit entry of wiring and cabling to the unit and to provide ventilation. The front and rear covers extend approximately 5/16 inch and 5-3/8 inches in front of and behind the face of the bay framework, respectively.

*Trademark of Littelfuse, Inc.

C. Reserve Source of Power

2.04 Three reserve battery panels or cabinets are required. Two of the panels, which are identical in design, accommodate two 45-volt batteries each; the third panel, normally mounted above the others, mounts the fifth battery, together with the apparatus, for manually adjusting the supply voltage. Each battery cabinet is mounted with vertical flanged members, one of which is fastened to each end of the cabinet. The front and rear of each cabinet are enclosed by doors hinged at the top. Each door is equipped with a brace to support the door in an opened position. A knob at the bottom of each door latches the door in the closed position. The front and rear cabinet doors, not including the latch knob, extend in front of and behind the face of the framework by approximately 4-5/16 inches and 6-21/32 inches, respectively. The terminals of each battery are shielded by a plastic grid which is held by four studs attached to a fiber plate slipped beneath the battery terminals for support. All three cabinets have openings in the left ends for passage of wiring and cable. Each battery rests on fiber material between two parallel strips of wood extending along the floor of the cabinet so as to limit the position of the battery from front to rear.

2.05 The upper cabinet differs from the others in that its right half accommodates the apparatus for manually adjusting the voltage. The structure for supporting this apparatus is based on two parallel steel strips extending from front to rear. The steel strips rest on and are secured to the two parallel strips of wood. The batteries normally rest between the strips of wood. The rotary switch and Amphenol connector are mounted directly on an upright panel which is flanged at the bottom for connection to the horizontal steel strips. The knob of the switch and the body of the connector appear on the front of the panel to facilitate maintenance. A horizontal terminal card is bracketed to the rear of the upright panel. This card includes 16 terminals and accommodates 5 resistance units associated with the rotary switch circuit. Resistors R1 and R2 are mounted between two horizontal brackets extending from the rear of the upright panel. Apparatus terminals and wiring on the rear of the panel are shielded by a removable plastic grid similar to those used in the other battery cabinets.

3. FUNCTIONAL DESCRIPTION

A. Primary Source of Power

3.01 The primary source of power is shown schematically in Fig. 1. It includes a full-wave rectifier which rectifies 60-Hz 115-volt ac power to approximately negative 200 volts dc. The negative 330-volt dc output is obtained by combining the output of the rectifier circuit with the negative 130-volt telegraph battery. The negative 200-volt output potential of the rectifier circuit is held practically constant by means of three regulator tubes. The M1 CURRENT relay is connected in series with the negative 330-volt output for measuring the primary power source and actuating an alarm in the event the load varies beyond predetermined limits. The output voltage also may be adjusted manually by means of a potentiometer associated with the regulator tube circuit. Terminals −TEST and +TG are provided to permit the output voltage of the primary source to be measured while it is disconnected from the distribution network.

Rectification

3.02 The 60-Hz 115-volt ac power, when applied to the primary winding of transformer T1 of the rectifier circuit (Fig. 1), is transformed to approximately 290-0-290 volts on winding 9-Y-13 of the secondary. The output of winding 9-Y-13 is rectified by full-wave rectifier V1. Rectified power passes through the low-pass filter consisting of capacitors C1, C2, and retard coil L1. The filter removes most of the ac component of the rectified power and leaves it relatively free of voltage ripple. The output of the filter passes over lead A and through the plate circuit of V2, the main regulator tube, to the negative terminal of the negative 130-volt telegraph battery. The lower output lead B, which is normally at a potential of approximately −340 volts, extends via the winding of M1 CURRENT relay to V2 of the distribution network via an Amphenol connector. The output voltage of the rectifier circuit is connected between the negative 130-volt battery terminal and output lead B, which is at a potential of approximately −340 volts.

Voltage Regulation

3.03 The V2, V3, and V4 tubes act as regulators to maintain a constant output voltage. The potential on the cathodes of the V3 amplifier tube is held constant with respect to the −130 lead by means of the V4 voltage regulator tube. The voltage on the output lead of V4 is impressed on the right grid (pin 4) of V3 via resistors R4, R5, and R6. Any variation of output voltage will be amplified about 25 times on the right plate (pin 5) of V3, and will be of opposite polarity to that of the original variation. The right plate of V3 is connected to the left grid (pin 1) via resistor R9, with resistors R10 and R11 providing the proper grid bias. The original variation will be amplified 10 times more by the left section of V3, making the total amplification about 250 times. The polarity of the variation on the left plate (pin 2) will be the same as that of the original variation, that is, an increase in the negative value of the −330 volts will be accompanied by a negative swing on the left plate of V3. The control grid (pin 5) of the V2 main regulator tube is connected to the left plate of V3 via resistor R2. A variation of the grid voltage of V2 will increase or decrease the voltage drop from plate to cathode. The overall action of the regulating circuit is such that a change in output voltage is canceled out by nearly equal change in the voltage drop across the V2 series regulator tube, resulting in a substantially constant voltage between the −130 and output leads. Any variation in the telegraph battery voltage, however, will appear in the same amount on the output lead.

Alarm Circuit

3.04 The alarm circuit, shown in Fig. 1, operates in conjunction with the primary source of power. It includes the K1 relay which is normally held operated by current from the negative 130-volt telegraph battery. The M1 CURRENT relay is also included and performs in conjunction with the K1 relay as an alarm relay. The rectified output current passes through the winding of the M1 CURRENT relay. For a load of 30 mA, the relay armature stands in the middle of the 0-60 mA scale. The stationary contacts 4 and 5 are adjusted so that contact closure occurs whenever the load current varies by ±10 mA or more from the initial value. Closure of either contact pair short-circuits the winding of the K1 relay and causes the release of this relay. Release of the K1 relay causes the ALM alarm lamp to light and also actuates other remote visible and audible alarms provided in the office. The alarms may be interrupted by operation of the ALM key to OFF. This causes the GUARD lamp to light and serves as a reminder that the ALM key must be released to its ON position to restore the alarms. When the supply circuit is used only in conjunction with a 119C1 telegraph signal distorting set, only the primary source of power is provided. In this case the distribution network and the alarm circuit, including the M1 CURRENT relay, are omitted and the load is connected to terminal −TEST of the rectifier circuit. The voltage of terminal −TEST is adjusted to −300 volts after the load has been connected owing to the voltage drop across resistor R16.

B. Distribution Network

3.05 The distribution network, which is shown on the right of Fig. 1, consists of a bus bar which is normally at −330 volts potential. The primary and reserve sources of power are connected to the bus bar through V2 and V1, respectively. M2 VOLTAGE voltmeter, which has a 0-500 volt range at 5000 ohms per volt, is permanently connected between ground and the bus bar. A 1/200-ampere Littelfuse fuse is inserted in series with the voltmeter circuit to prevent interruption of the negative 330-volt supply in the event the negative meter terminal or adjacent wiring should be accidentally grounded. The circuit provides for a full load of 50 mA which may be distributed to a maximum of 120 individual points, each of which will draw a current of several tenths of a milliampere. The negative 330-volt bus bar is to be connected to a maximum of 120 supply leads. Each lead includes a 68,000-ohm series protective resistor (GT). The protective resistor is employed in order to minimize the possibility of shock injury to operating personnel and to reduce the magnitude of bus bar voltage surges resulting from accidental grounding of one or more supply leads.

3.06 Each of the two sources of power supply is connected to the negative 330-volt bus bar through a 412A or 351A electron tube which operates as a double diode. This manner of interconnecting the distribution network to the two sources of power permits the load to be automatically transferred from the primary to the reserve source whenever the negative 330-volt bus bar potential (normally supplied from the primary source), becomes sufficiently positive with respect to the potential of the reserve source of power. Similarly, when the output of the primary source again raises the output voltage to the proper negative value, the load will be automatically restored to the primary source of power.

3.07 In the event of failure or accidental removal of regulator V3 or V4 of the rectifier circuit, the bus bar voltage of the distribution network will tend to become appreciably more negative. Under such conditions, the bus bar voltage may become sufficiently high to cause service interruptions unless a substantial load exists to serve as a stabilizer. It is, therefore, desirable that a normal load of at least 25 mA exist at all times. When the useful load is below this value, it should be supplemented by an artificial load resistor R122. This artifical or dummy load may be strapped to two or more supply leads when required. Connection of the dummy load to only one supply lead may tend to overheat the associated GT resistance and should be avoided.

C. Reserve Source of Power

3.08 The reserve source of power, as shown schematically in the upper part of Fig. 1, includes BAT ADJ (S1) switch and five 45-volt dry batteries which are connected in series. Switch S1 is connected to the positive end of the batteries

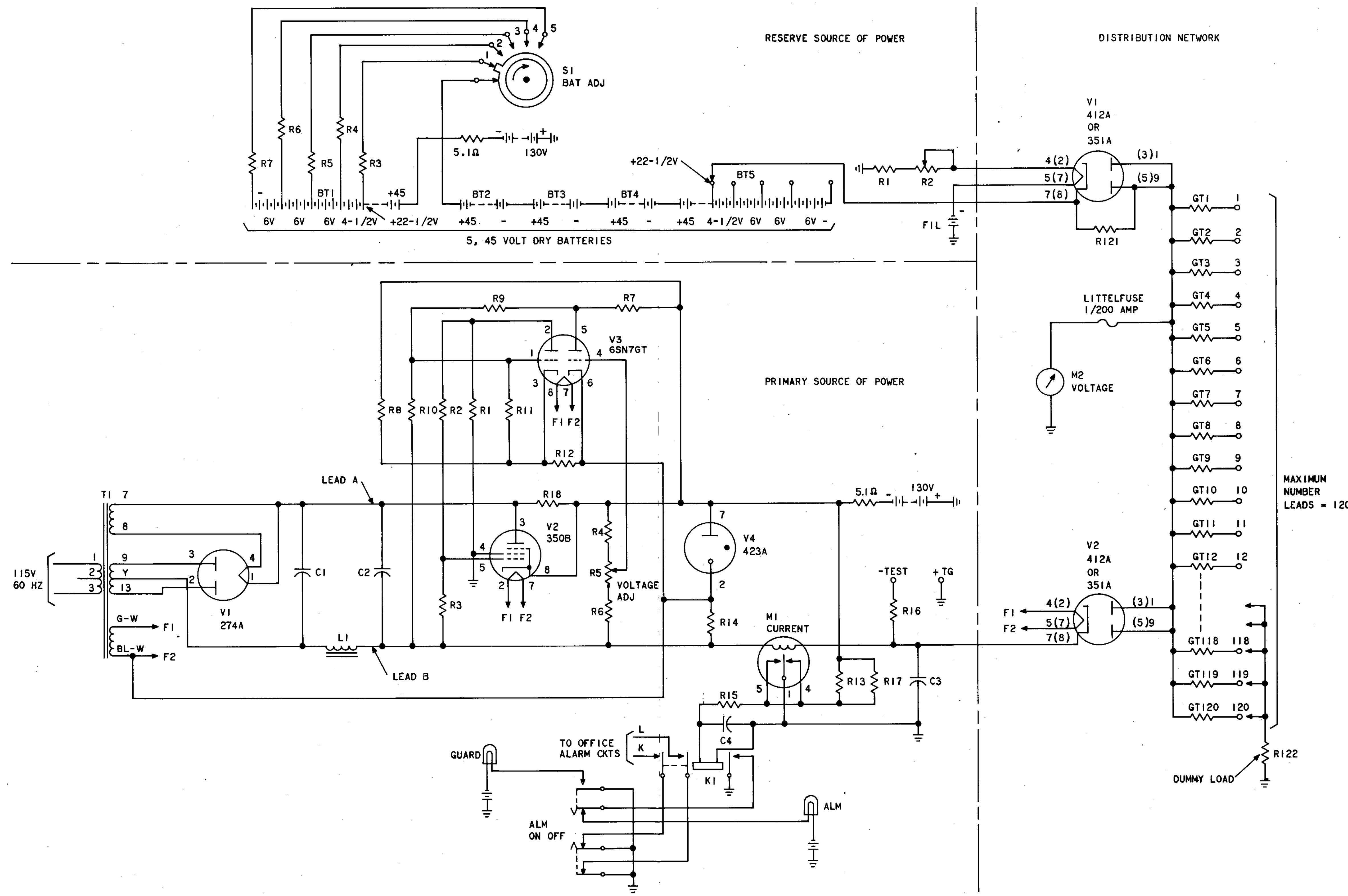

Fig. 1—Negative 330-Volt Supply Circuit—Schematic

and is used to connect the batteries in series with the negative 130-volt telegraph battery as shown. The negative output voltage of the dry battery circuit extends to V1 of the distribution network via an Amphenol connector. This voltage is manually adjustable with respect to that of the negative 130-volt telegraph battery by rotating BAT ADJ (S1) switch. This varies the number of end cells included in the dry battery circuit. The end cell groups appear as voltage steps obtained from five terminals on the negative half of the least negative dry battery. Resistors R3, R4, R5, R6, and R7 are provided to prevent end cell groups from being momentarily short-circuited when switch S1 is rotated. The output voltage supplied by the reserve battery supply circuit is adjusted so that it is several volts less negative than the voltage of the negative 330-volt bus bar of the distribution network. Adjustable resistor R2 provides for the adjustment of filament current for V1 of the distribution network.

3.09 In normal operation, while the primary source is supplying power, the circuit is arranged so that a small amount of current will pass through the dry batteries of the reserve source in the reverse direction. This tends to increase the life of the dry batteries. This current is caused to flow because the bus bar voltage is slightly more negative than that of the reserve source of power. The current passes through resistor R121 which is parallel with the plate circuit of V1.

4. REFERENCES

4.01 For further information concerning the negative 330-volt supply, refer to the following sections:

SECTION	TITLE
312-215-500	Negative 330-Volt Supply Circuit—Test Procedures
807-401-162	Negative 330-Volt Supply for No. 2 and No. 9B Telegraph Serviceboards—Equipment Design Requirements—Data Systems

4.02 For further information concerning the negative 330-volt supply, refer to the following circuit description (CD) and schematic drawing (SD):

CD- & SD-70627-01 Negative 330-Volt Supply Circuit