TYPE L3 CARRIER

REPEATER POWER SUPPLY

CONTENTS PAGE

1. GENERAL

1.01 This section contains a description of the supply circuits used in the L3 carrier system at repeater locations. The term repeater locations includes auxiliary, equalizing auxiliary, equalizing main, switching main, and terminal main repeaters.

1.02 This section is reissued to include Table A, which is necessary for determining LOAD ADJ switch settings which should be indicated on repeater and power section layout drawings.

1.03 The repeaters which are fed from one power source, together with the associated two coaxials, constitute a power section.

1.04 Auxiliary and equalizing auxiliary repeaters operate on a constant current fed over the central conductors of the two associated coaxial cables. Equalizing main, switching main, and most terminal main repeaters are operated on power fed directly from a local 230-volt regulated source. Switching or terminal main repeaters may also be arranged to receive power over the coaxial cables in the same manner as auxiliary and equalizing auxiliary repeaters.

1.05 Each power section is supplied from a 505D power plant located at a main repeater (equalizing, switching, or terminal). The voltage applied to the coaxials at the power feed point is a function of the number and types of repeaters in the power section, and is, therefore, higher when a section is longer.

1.06 The 505D power plant uses a motor-alternator consisting of a self-excited alternator, an induction motor, and a dc motor mounted on one base with their shafts in line and directly coupled. The alternator, normally driven by the induction motor, furnishes power at approximately 230 volts to a power control circuit. The latter supplies a constant current at high voltage to a pair of coaxial lines. Because of the slip in the induction motor, the alternator runs less than synchronous speed so that the frequency is approximately 58 instead of 60 cps. The induction motor normally obtains its driving power from the commercial ac supply. When the latter fails, the dc motor, operating on a 130-volt battery, supplies the driving power for the alternator. The transfer from commercial to standby power is made without service reaction.

1.07 The power control portion of the power plant consists of a step-up transformer and regulating circuits which hold the primary current within ±1 percent of a selected value between approximately 1.3 and 1.6 amperes. As long as the impedance of the coaxial line remains constant, the primary voltage of the step-up transformer, nominally 230 volts, will be regulated to the same tolerance. One power control circuit is required for each power section. Section 167-671-326 describes the power control circuit.

2. POWER SECTION

2.01 Fig. 1 shows in simplified form a power section including two auxiliary repeaters, one being a junction repeater where adjacent power sections are looped, and the other being an intermediate repeater.

2.02 The power control circuit operates on 230 volts from the alternator and steps up the voltage to the value necessary to drive the constant line current through the impedance of a power section. The line current is transmitted to the center conductors of a pair of coaxials through power separation filters (PSF), shown in simplified form in Fig. 1. Transmission and power currents make common use of these center conductors until the first auxiliary repeater from the supply point is reached, where they are separated to pass to their own portions of the repeater circuit. The inductors designated L are power circuit loading coils, the purpose of which is discussed in 2.12. Coils identified as T are the primaries of two power transformers, with three secondary windings on each being omitted. At a junction repeater a connection is made between the ends of the transformer primary windings to close one power loop. The adjacent power section, which is fed from the opposite direction, is looped through a looping coil designated PL or through a power transfer circuit (see 3.27 through 3.32). The looping coil adds loss at the lower transmission frequencies, supplementing that of the power separation filter and thereby reducing crosstalk coupling. This crosstalk reduction is accomplished by the normal power transformers at other auxiliary repeaters.

A. Power Separation Filters

2.03 A power separation filter is used at each end of each section of coaxial so that the center conductor, used as the common path for transmission of both carrier and power frequencies, may be divided at the repeaters to separate

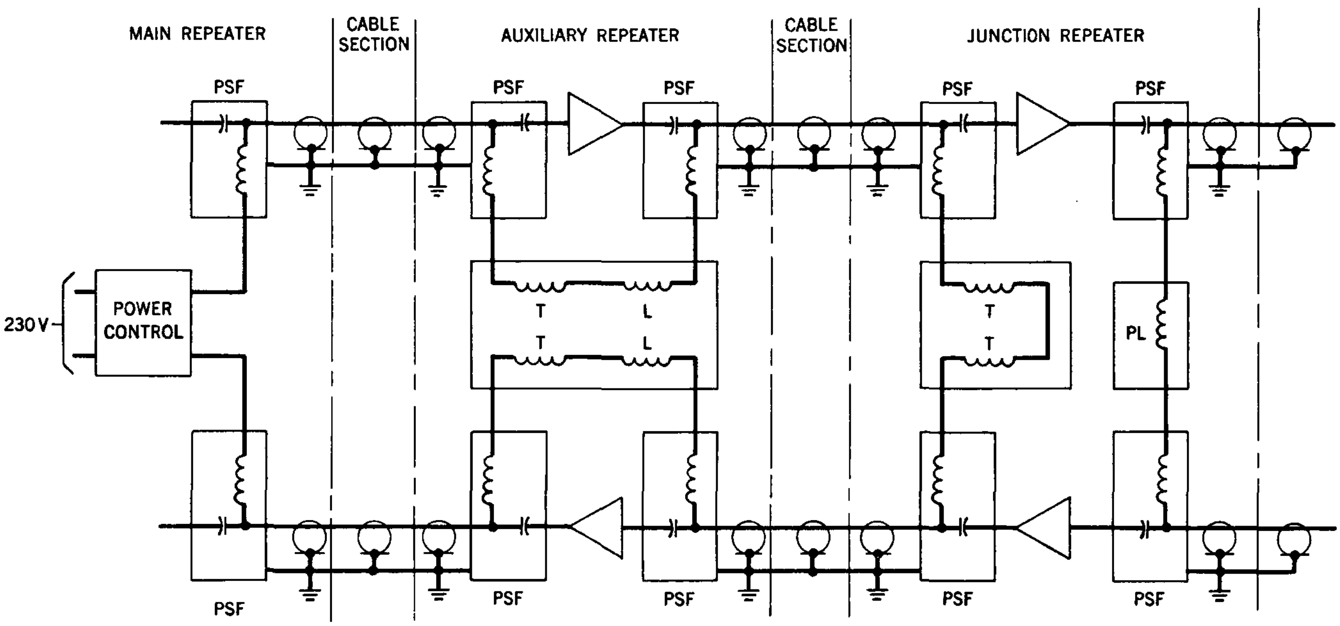

Fig. 1 — Power Section — Simplified Schematic

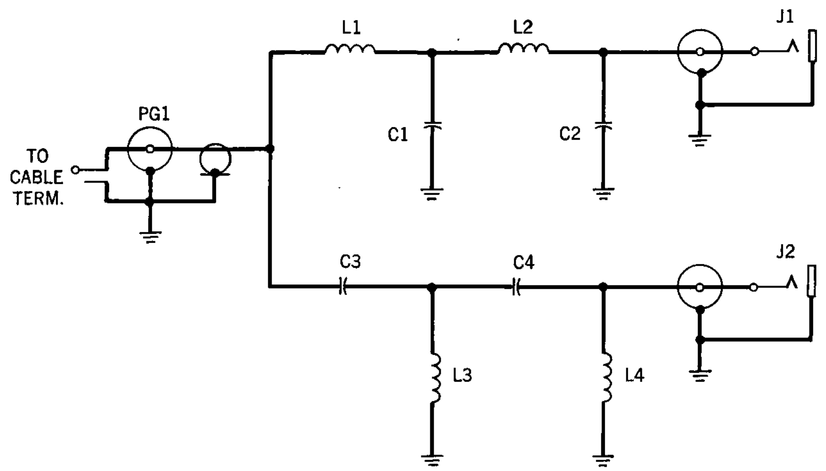

Fig. 2 — Power Separation Filter

the two groups of frequencies. Fig. 2 shows the circuit of the filter. Plug PG1 connects to a cable terminal at one end of a coaxial line. For repeaters in underground locations, this connection may be made via an extension cable to the cable terminal. The elements between plug PG1 and jack J1 form a low-pass filter which passes the power frequency with very small loss and rejects the carrier frequencies. The 75-ohm insertion loss of this section is about 41 db at 300 kc and 70 db from 1000 to 8000 kc.

2.04 The circuit beween plug PG1 and jack J2 is a filter to pass the carrier frequencies while rejecting the power frequency. It has less than 0.13-db loss at carrier frequencies.

2.05 Capacitors and inductors in a power separation filter are capable of withstanding the high voltage used for transmission of power. Capacitors in the transmission path are made so that the foil does not vibrate under the stress of the applied power voltage. This avoids placing an impedance, varying at the power frequency, in the transmission path and thus causing power-frequency modulation of the carrier frequencies. Special precautions are taken throughout to avoid development of corona discharge and its attendant high-frequency noise.

B. Power Circuit Loading

2.06 The power transmission circuit of a power loop is essentially a resistance-capacity network at the power frequency. Fig. 3 shows the equivalent circuit of a power section. When omitting the minor series inductance and shunt conductance of a coaxial, a cable section may be represented by a pi-network consisting of two shunt capacitors and a series resistor. Each power separation filter has capacitance to ground. In Fig. 3, each capacitor C represents the capacitance to ground of a section of coaxial cable plus that of a power separation filter. The primary impedance of each power supply transformer is nearly nonreactive so that it can be represented by a resistance in series with a small inductance.

2.07 Because of the capacitance shunts, the line current is not uniform at all of the repeaters in a power section unless inductive loading is used. The shunt currents lead the line currents in each respective section. The transformer primary current at each repeater is the vector sum of the current in the succeeding repeater and the current in the shunt capacitances. Since the primary voltage of each power transformer is the product of the transformer impedance and the primary or line current, it is essential that the line current be nearly the same at each repeater in order that secondary voltages applied to heater and plate circuits be reasonably alike.

2.08 Uniformity of line currents in a power section is approximated by loading the power circuit inductively at certain repeaters. At the end of the line section, the voltage across

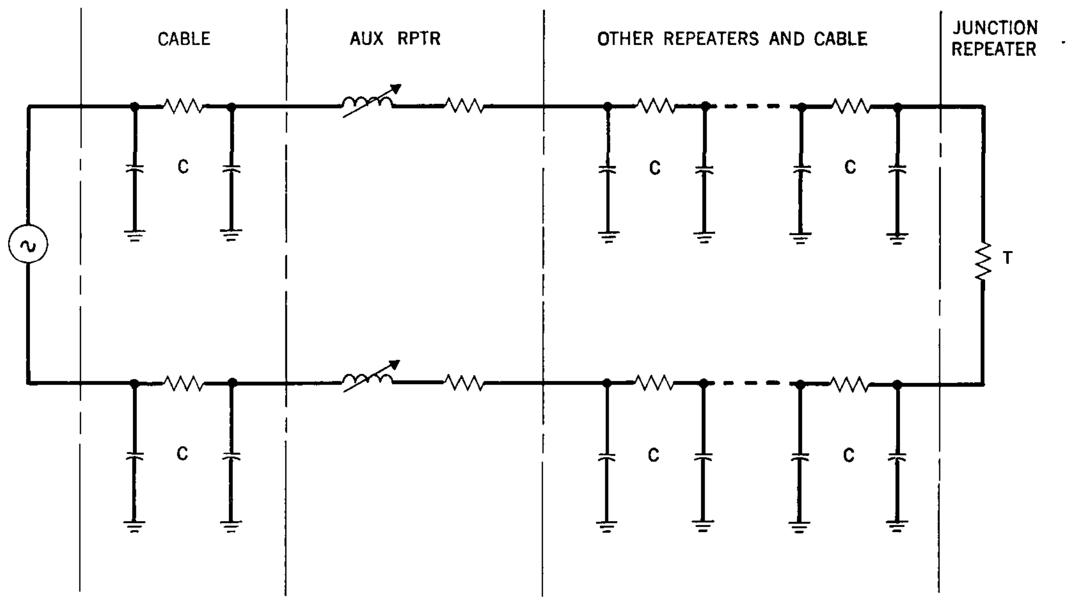

Fig. 3 — Equivalent Circuit of a Power Section

the power transformer load T (see Fig. 3) is in the order of 100 volts for normal operation. At the next repeater from the end, this voltage is increased by the voltage drop along the coaxial cable, and the higher voltage is applied to the shunt capacitors at that repeater. The line voltage and shunt currents thus continue to rise as the feed point is approached.

2.09 Voltage-to-ground is low at the last repeater fed from the power section, and the shunt capacitance currents are too small to balance the inductance in the repeater. The increase in shunt currents in each preceding section, as noted above, results in a capacitance-inductance balance at about the seventh repeater (fifth repeater if the power loop includes an equalizing auxiliary or terminal main repeater). At other repeaters in a power section, series inductance is added to restore the reactance balance. Larger and larger inductances are required as the power feed point is approached.

2.10 Accordingly, in a properly loaded power section, the line current is highest at the junction or looping repeater, decreases successively until the first loaded repeater is reached, and then remains constant for the rest of the repeaters. If the repeater nearest the power feed point is not loaded, the current will rise again at the feed point.

2.11 Repeater power packs include a LOAD ADJ switch which permits adjustment for uniform heater voltage with the line current variations.

2.12 The loading coils are inductors with identical windings in series with each coaxial. Two types of inductors are used: the 1006 type with two windings tapped for either 105 or 140 mh each, and the 343 type with four windings, two in series with each coaxial, so mounted that the coupling between them can be changed by rotating one coil with respect to the other by means of an external control. The relative positions of the two coils of each pair are indicated by a dial calibrated from 0 to 100, visible through a window in the case. The inductance of the coils in series with each coaxial is variable between about 20 and 150 mh. A typical inductance curve for this coil is shown in Fig. 4. Where only small amounts of inductance are required, only the variable coil is used. When more inductance than that provided by this coil is required, fixed coils are added. The maximum number of fixed coils used in conjunction with a variable coil is four. However, in power sec-

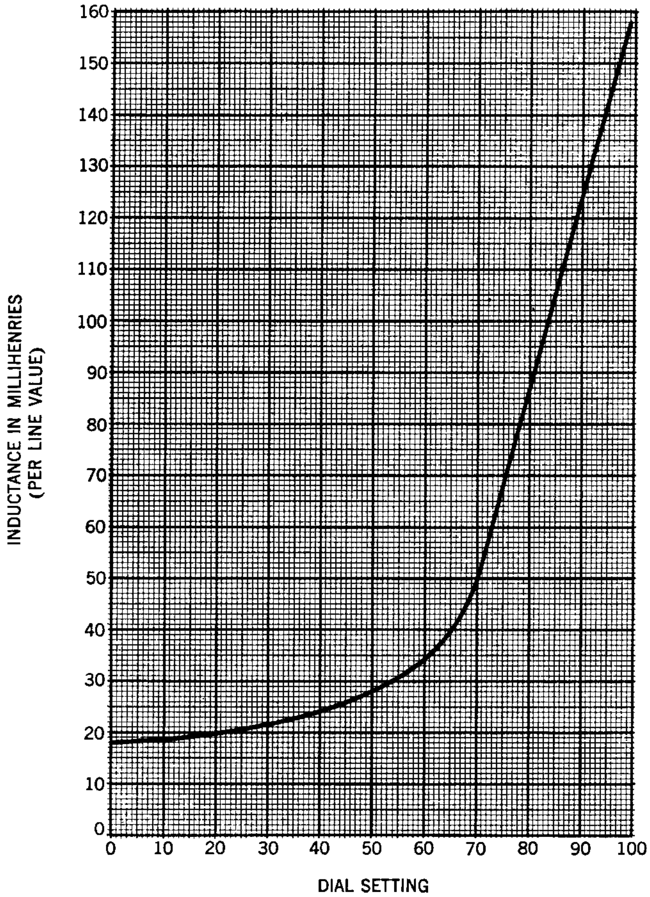

Fig. 4 — Variable Loading Inductor for L3 Power Sections

tions of extreme length, the variable coil is omitted at some repeaters to make room for up to two additional fixed loading coils.

2.13 Line voltage and current at a repeater are determined by the type of coaxial cable, the type of power system, and specific repeaters and repeater spacings between the particular repeater and the power looping point. Accordingly, specific values of loading inductance, voltage, current, etc. cannot be determined until repeater spacing is well established. However, tables in CD-59474-01 (for the auxiliary repeater application schematic) for each type of coaxial and power system specify coils which are adequate for each repeater in order to permit engineering and installation to proceed. When exact spacings have been determined, the customer (or the Bell Telephone Laboratories, in some cases) will compute exact inductance, current, and voltage for each repeater in the power section, using an IBM or similar computer. Using the current values and the correlation given in Table A, the LOAD ADJ switch settings for each repeater are determined. Loading coil inductance values and settings and LOAD ADJ switch normal settings are indicated on the customer repeater and power section layout drawings for use in initial line-up.

3. POWER SUPPLIES

A. Power Systems PS1 and PS2

3.01 The early standard power supply arrangements for use at auxiliary and main repeaters have been arbitrarily designated as the PS1 power system. Supplementing these earlier facilities, an improved power system, designated PS2, has been made available. The new power system is designed for use in power sections including repeater equipment at underground repeater locations. It may also be used in other power sections but cannot be mixed with PS1 in the same power section. The PS2 power system affords (a) more efficient and controllable rectification, (b) reduction of the harmonic distortion that is introduced on the coaxial line, and (c) reduction of operating voltages to more nearly their nominal values.

3.02 An improvement in rectification has been achieved for the PS2 system through the use of silicon diode rectifiers, replacing the selenium stacks used in power system PS1. Harmonic distortion on the line is reduced by improving the impedance terminating the filter sections in the repeater power supply. This improvement of impedance and the reduction of plate supply voltages have come about as a result of providing various series and shunt resistors in the power supply circuit, with optional values for the several repeater applications. Other power circuit changes related to the new PS2 power system will be discussed later.

3.03 Auxiliary and equalizing auxiliary repeaters, and in some cases terminal main repeaters, derive their input power from the

TABLE A

L3 CARRIER POWER SYSTEM

NOMINAL LINE CURRENT (AMPS) VS LOAD ADJ SETTING

LOAD ADJ SETTING	TYPE PS1		TYPE PS2
	PILOT REG	THERM REG	PILOT OR THERM REG
1	1.401 1.397	1.374 1.369	1.603 1.596
2	1.396 1.388	1.368 1.359	1.595 1.582
3	1.387 1.379	1.358 1.349	1.581 1.568
4	1.378 1.370	1.348 1.339	1.567 1.554
5	1.369 1.361	1.338 1.329	1.553 1.540
6	1.360 1.352	1.328 1.319	1.539 1.526
7	1.351 1.343	1.318 1.309	1.525 1.512
8	1.342 1.334	1.308 1.299	1.511 1.498
9	1.333 1.325	1.298 1.289	1.497 1.484
10	1.324 1.320	1.288 1.284	1.483 1.477

secondaries of transformers having the line current flowing through their primaries by reason of their insertion in series with the center conductors of a pair of coaxial cables. The impedance looking into the primary of a power transformer is essentially the parallel impedances of all the impedances connected to the secondary windings multiplied by the impedance ratios of the primary to respective secondary windings. Primary voltage is the product of the primary current and primary impedance. If the impedance connected to the secondary is decreased while the applied primary voltage is held constant, the primary current increases to maintain the same primary voltage drop. However, when the primary current is held constant, there can be no increase in primary current if the secondary load is decreased; thus, the primary voltage drop decreases, decreasing the secondary voltage. Repeater power supplies operating from the constant current supply system therefore show very poor regulation with changes in load. Further, if the secondary of a transformer operating on constant voltage is short-circuited, excessive currents flow and if continued can burn the windings. If the secondary is short-circuited while operating on constant current, the current cannot increase beyond normal and the transformer is not damaged. If the secondary circuit of a transformer operating on constant voltage is opened, primary current decreases to a minimum and the transformer is not damaged. If the secondary of a transformer operating on constant current is opened, the primary impedance and primary voltage rise and the transformer may be damaged.

3.04 For these reasons, care is taken to apply extra load to a repeater supply before disconnecting any part of the normal load, such as an amplifier or a regulator. The extra load prevents the rise of secondary voltages which might damage parts of the circuit subjected to the voltage. The extra load is called a change load and is coded J68815K.

3.05 Transformers for measuring line current are shown in Fig. 5 and 6. These transformers are usually located in the auxiliary repeater adjacent to the main repeater supplying power, at the furthermost loaded repeater, at the last auxiliary repeater fed from the power section, and at equalizing auxiliary repeaters. Terminal main repeaters operating on line power also include these transformers.

3.06 To reduce power losses, the power transformers used in high-voltage units at auxiliary, equalizing auxiliary, and terminal main

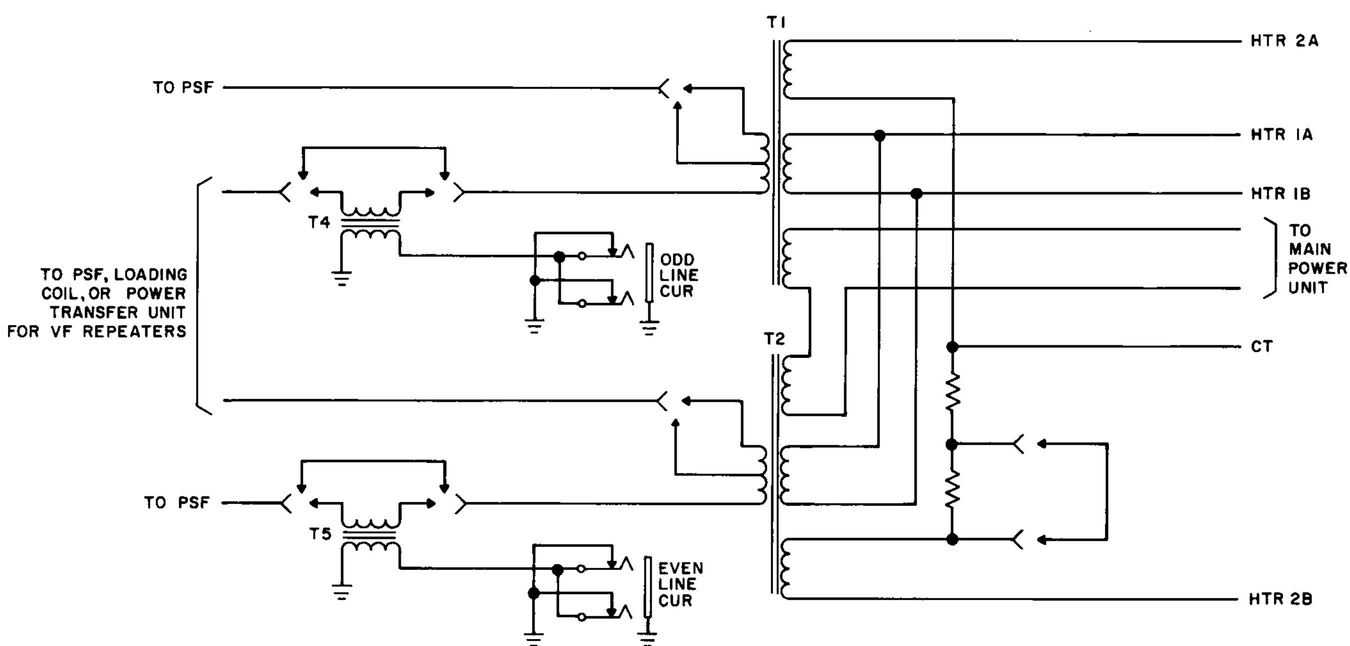

Fig. 5 — J68815A High-Voltage Unit for Auxiliary Repeater

repeaters fed over the cable, have cores of greater size than those used in ordinary transformers having the same rating in volt-amperes. Those used in some auxiliary repeaters are subject to high voltage to ground, and special precautions are taken in their construction to prevent formation of corona and its attendant noise in transmission circuits. These precautions are not necessary in those transformers used at equalizing auxiliary repeaters (or terminal main repeaters receiving power over the cable), since these repeaters are located at or near a looping point where voltages to ground are relatively low. Auxiliary repeater transformers have one tap on the primary to compensate for the reduced load of thermometer regulators at a repeater in the PS1 power system. For PS2 system applications, the same primary connections are used for both thermometer and pilot regulation. Other high-voltage transformers have three primary taps which may be used to obtain correct load voltages.

B. Power Supply Components

3.07 Power supplies at repeaters are composed of combinations of the units described in the following paragraphs.

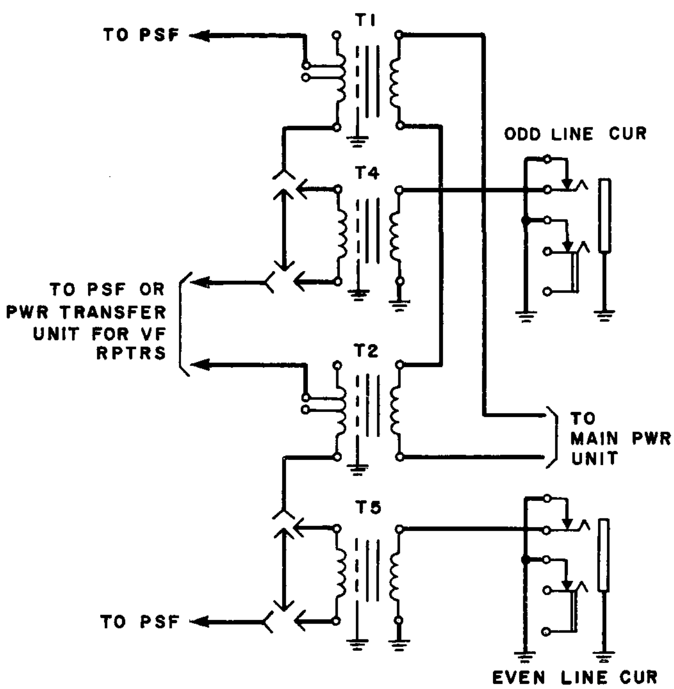

Fig. 6 — J68815G High-Voltage Unit

3.08 The ***high-voltage unit (J68815A),*** shown in Fig. 5, is used at auxiliary repeaters. This unit consists of two transformers, T1 and T2, with the primary windings connected in series. A constant current is supplied to the primaries. The secondary plate windings are connected in series to provide approximately 250 volts, which is applied to a main power unit. Additional secondary windings are provided to furnish two heater supplies of approximately 6.7 volts (HTR 1 and HTR 2). The primaries of transformers T4 and T5 are connected in series with the primaries of transformers T1 and T2, with the secondaries of T4 and T5 providing a means of measuring line current. Transformers T4 and T5 are used only at locations discussed in 3.05.

3.09 The ***high-voltage unit (J68815G),*** shown in Fig. 6, is used at equalizing auxiliary or terminal main repeaters. It is similar to the J68815A unit except that transformers T1 and T2 do not have heater windings.

3.10 The ***miscellaneous power unit (J68815J),*** shown in Fig. 7, operates in a manner similar to the high-voltage unit of Fig. 6, except that a voltage of approximately 230 volts is developed with the secondaries connected in series.

3.11 The ***main and auxiliary power units (J68815B and J68815H),*** covered in Fig. 8A, B, and C for ***power system PS1,*** furnish nominal, unregulated voltages of +190 and +315 volts with respect to ground. The plate secondary windings of the power transformers mounted in an associated high-voltage unit supply ac voltage to the main power unit, which contains two bridge-type full-wave selenium rectifiers, RECT 1 and RECT 2 in Fig. 8. When such a rectifier is terminated in a pure resistance, the reactive component of the impedance reflected into the primary of a transformer is a minimum, and the harmonic content of the primary current is minimized. This minimization eases materially the problem of loading the coaxial line properly.

3.12 If the power supply provides a filter having a constant-resistance characteristic at the output of a rectifier, dc current may be drawn from the circuit, while primary reactance and harmonics are both minimum. A constant-resistance filter consists of a low-pass section terminated in its characteristic impedance by the

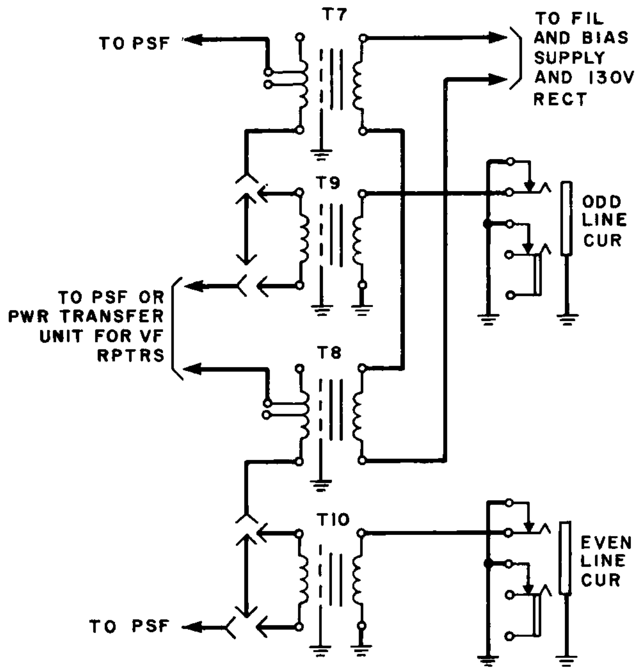

Fig. 7 — J68815J Miscellaneous Power Unit

output dc load, with a high-pass section in parallel with the low-pass section and terminated in a characteristic impedance resistance. The filter shown connected at the output of RECT 1 is designed to be such a filter, with the exception that RECT 2, through transformer T3, replaces the resistance which would otherwise terminate the high-pass section. This allows use of the appreciable amount of power which otherwise would be dissipated in the terminating resistor.

3.13 RECT 2 operates on the approximately 120-cycle ripple frequency and harmonics appearing at the output of RECT 1. This rectifier, with a second, constant-resistance filter, develops a dc voltage of about 125 volts, so connected that it adds to the +190 volt output of RECT 1 to create a +315 volt supply. Both of these voltages are nominal values and vary considerably in the PS1 power system because of load variations, rectifier efficiencies, and characteristics, as well as the accuracy of the terminations on the constant-resistance filters.

3.14 Tube V2, RECT 3, and associated circuit components (Fig. 8C) are used in the auxiliary power unit at auxiliary repeaters which include pilot regulators, where they supply a −100 volt bias for operation of the latter. RECT 3 operates on input power which would be dissipated in resistor R24 at thermometer-regulated auxiliary repeaters and at equalizing auxiliary repeaters, where RECT 3 and the associated circuit elements are omitted. The input power consists of the approximately 240-cycle ripple and its harmonics appearing at the output of the high-pass filter of RECT 2. The output voltage of RECT 3, smoothed by a conventional low-pass filter, is regulated to close tolerance by means of tube V1.

3.15 The ***main power unit (J68815B),*** for use in ***PS2 power systems,*** is shown in the simplified schematic of Fig. 9. In order to provide the improved performance of the power supplies for PS2 power systems at auxiliary, equalizing auxiliary, and terminal main repeaters receiving power over the cable, without redesigning transformers and filters, a number of component changes and additions were required. Referring to Fig. 9, the circuit modifications in the main power unit comprise the addition of the resistors shown, the relocation of the LOAD ADJ switch to the indicated position, and the substitution of silicon diodes for the selenium rectifier stacks. This rectifier modification also includes RECT 3, which is a part of the auxiliary power unit. Transformers in high-voltage units at equalizing auxiliary and terminal main repeaters are arranged with primary winding taps. The assignment of these tap combinations has been coordinated with other power circuit revisions for each application at these repeaters.

3.16 The function of the R_A resistor in Fig. 9 is to shunt down the input impedance of a repeater for those system applications in which the dc current requirements on the power supply are low, thereby reflecting normally a high impedance into the primaries of the power transformers. This resistor, in various values, is used at all terminal main and equalizing auxiliary repeaters (except the terminal main "A" supply) and at auxiliary repeaters which include thermometer regulators.

3.17 Resistor R_B, provided at auxiliary repeaters only, is intended to compensate for the lower forward voltage drop in the silicon rectifiers, and to adjust the ratio between the heater and plate supply voltages. The lack of

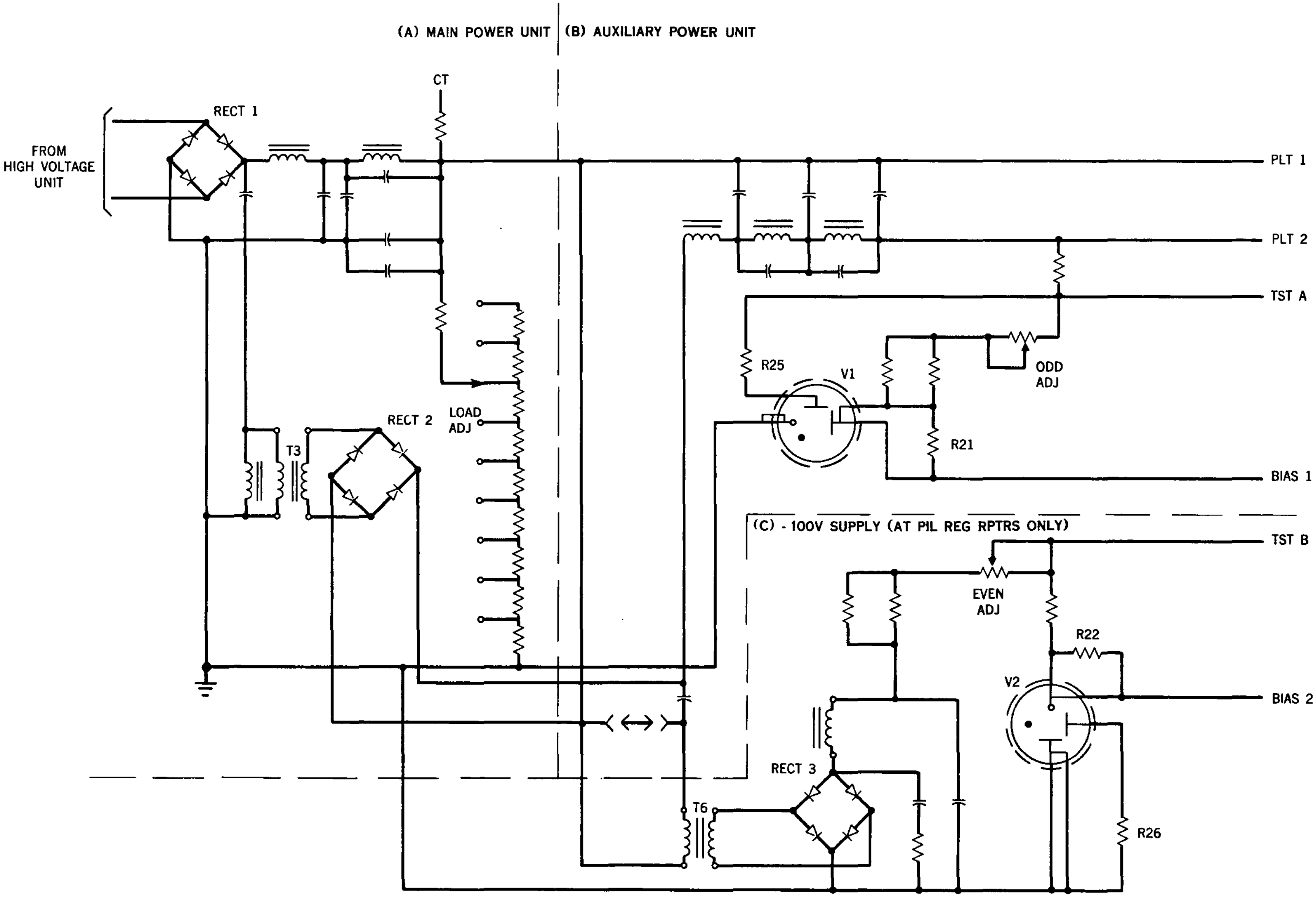

Fig. 8 — J68815B and J68815H Power Units

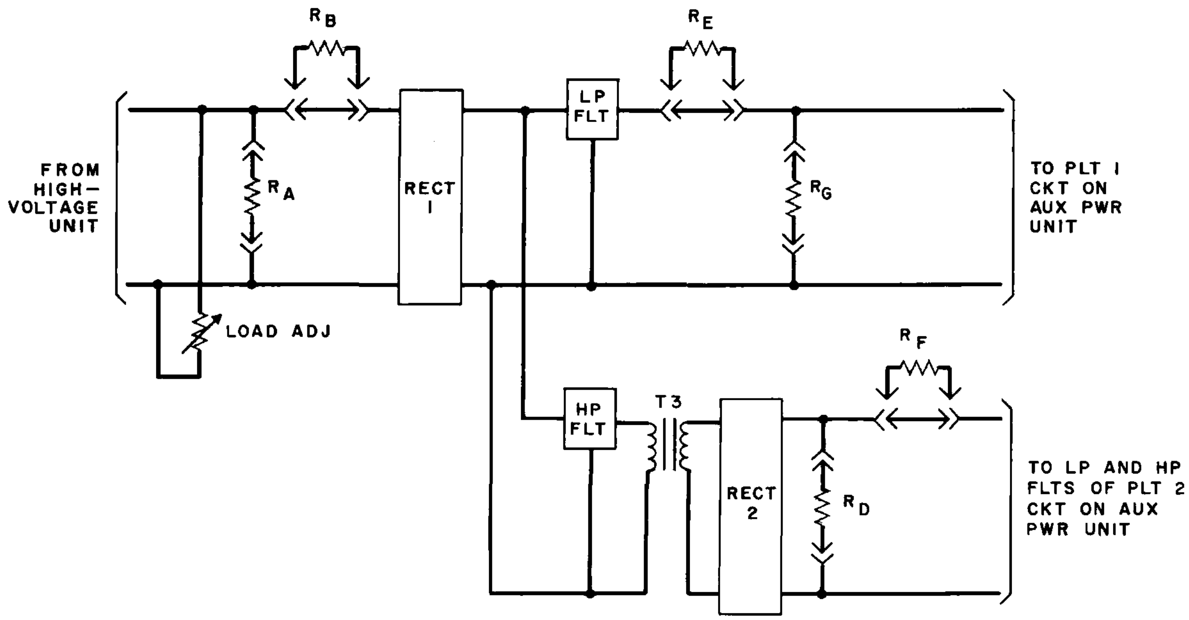

Fig. 9 — J68815B Main Power Unit for PS2 Power Systems — Simplified Schematic

heater windings on high-voltage units at other repeater locations obviates the need for this series resistor.

3.18 All repeater power supplies, except terminal main "A," utilize resistor R_C. Its purpose is to shunt the working dc load on RECT 1 to obtain the desired value of terminating resistance for the associated low-pass section of the constant-resistance filter. Resistor R_D performs a similar function for the high-pass filter section and RECT 2, and is used in all except terminal main "A" power supplies. This "A" power supply has a high dc current drain. The resulting working loads are therefore smaller than the optimum values of filter terminations. In this case, two alternate resistors, R_E and R_F, are furnished, each connected in series to build up the working load impedances. It should be noted that the values of these various series and shunt resistors will vary depending on the particular system application of a main power unit.

3.19 The ***plate voltage limiter*** circuit of Fig. 10 acts to limit the applied plate voltages during power turnup at equalizing auxiliary repeaters and at terminal main repeaters fed over the coaxial cable.

3.20 The thermal delay relays used in the circuit have their heaters connected to a 6.7-volt supply in a filament and bias supply unit. The contacts of the relays are closed when the heaters are cold, placing a short across the plate winding in each of the three power supply circuits. In the constant-current system, the transformer secondary current under short-circuit conditions is automatically limited to a safe value, dependent on the resistance of the secondary winding and the transformer turns ratio.

3.21 When line current flows, the heater windings have normal load, and normal voltage for a given line current results. The plate supplies, however, do not have normal dc loading until electron tubes reach operating temperatures. The shorts across the plate windings act to limit the application of excessive voltages while tubes are reaching the conducting stage.

3.22 The operating time of the contacts is about 2 minutes. If power is turned on too soon after being turned off, the relay heaters will not have time to cool off and excessive voltages will be applied to the repeater equipment. Therefore, it is advisable to wait for at least 5 minutes after turning power off before restoring it.

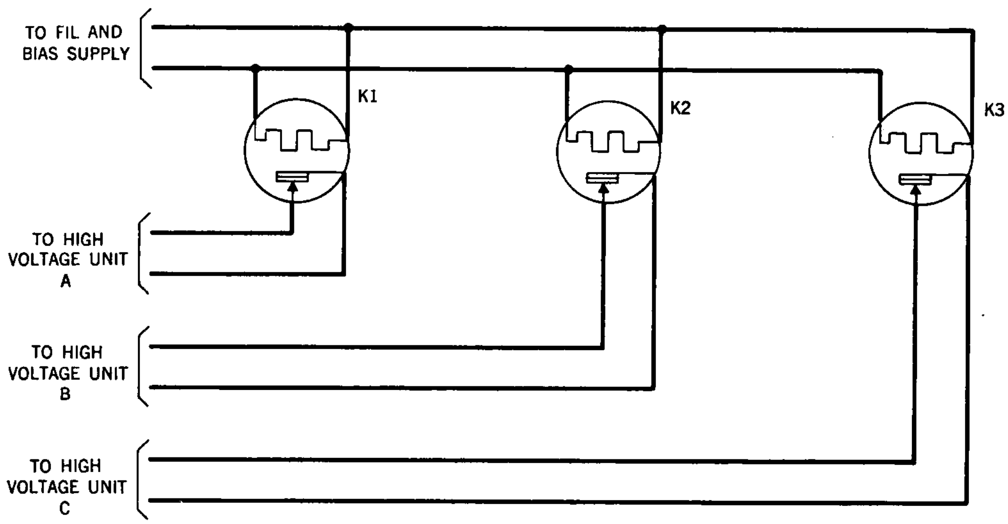

Fig. 10 — Plate Voltage Limiter Circuit

3.23 The *maintenance power supply* in Fig. 11 provides ac power for test and maintenance equipment at auxiliary and equalizing auxiliary repeaters which are inaccessible to truck-mounted mobile power sources or where commercial power is unavailable.

3.24 The unit consists of two transformers, with the primary of T1 connected in one side of a power loop and the primary of T2 in the other side. The secondaries of these transformers are connected to the load receptacle and also to a saturable reactor. The purpose of the reactor is to limit the rise in output voltage should the load be inadvertently disconnected while the load switch is in the ON position. Objectionable transmission hits and possible line switching are avoided by throwing the switch to its OFF position when connecting or disconnecting loads.

3.25 A door-actuated switch is provided to short the primary windings and avoid the penalty of voltage drop due to dissipation in the windings when the unit is not in use.

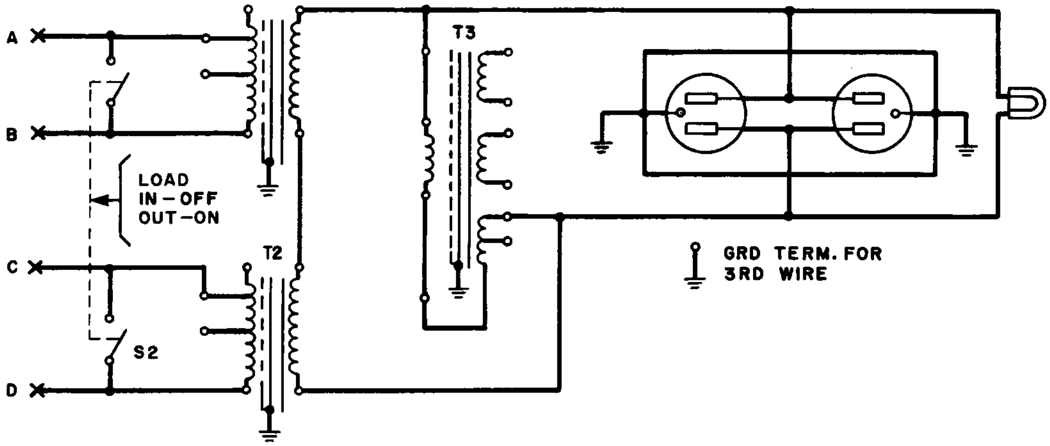

Fig. 11 — Maintenance Power Supply

3.26 Loads of less than 75 watts or more than 100 watts at 115 volts shall not be connected to this unit.

3.27 The ***power transfer circuit*** for use with voice-frequency repeaters is shown in Fig. 12. This circuit is used to supply primary power at approximately 115 volts to power supplies for voice-frequency repeaters from parallel coaxial power sections. Two types of power transfer units are available, one for a working line and one for use in a standby line. The load is changed from one unit to the other in the event of a power failure in a power section.

3.28 The primaries of transformers T4 and T6 are inserted in one side of a power loop, while transformers T5 and T7 are inserted in the other side of the same power section. If the repeater is at a power looping point, jacks B1 and C1 are connected together and jacks B and C are connected to the power section in place of the usual looping coil. Transformer primaries of T2 and T3 are connected in the two sides of a second parallel power section.

3.29 Power is fed through transformers T6 and T7 to the voice-frequency repeater power supplies through operated relay TRB. The standby circuit feeds power from the second power section through transformers T2 and T3 to the dummy load PWR ADJ AB.

3.30 A power failure in the working line allows relay TRB to release and connect the output of the standby circuit to the voice-frequency repeater power supplies. PWR ADJ AB is then connected to the working circuit through back contacts of TRB.

3.31 When power is restored in the first power section, relay TRA operates relay TRB and reconnects the repeater load to the working power transfer circuit.

3.32 Transformers T1 and T8 provide a means for connection of a dummy load in place of the regular power supply load if the latter is accidentally lost.

C. Regulation of Bias Voltages

3.33 Cold cathode gas tubes which sustain at a voltage between 98 and 104 volts are used for regulation of bias voltage, both in the auxiliary power unit used at auxiliary repeaters and in the filament and bias supply circuits used at equalizing auxiliary repeaters. Most tubes sustain at a voltage close to 100 volts and have characteristics such that control to ±0.1 volt around any sustaining voltage within the given limits is obtained over long periods of time.

3.34 Fig. 8B and C show the gas tube (432-type) circuits used in the auxiliary repeater power supply. Tube V1 regulates the nominal +100 volt bias required for operation of amplifiers and regulators. The nonregulated input voltage is +315 volts from the plate supply circuits. If this input voltage increases, for example, the current through the gas tube will increase to change the IR drop across the resistors in series with the gas tube by an amount which exactly equals the change. In the practical case, the tubes used permit a variation in output voltage of ±0.1 volt. In order that regulation of this quality be obtained, the current through the gas tube must be adjusted periodically to place it close to the center of the optimum regulating range for the tube. The ODD ADJ control is used for this purpose. The total current flowing through the gas tube and the external fixed load, in parallel, is determined indirectly by measuring the voltage drop across a test resistor, using a power test set on the TEST A and +315 volt leads. This voltage should be about 16.5 volts for the optimum adjustment of the ODD ADJ control. In practice, this voltage is increased by multipliers in the test set, resulting in higher values as requirements in maintenance practices. Gas tubes are replaced when the voltage to which they regulate is beyond an upper limit.

3.35 The rise in bias voltage which accompanies removal of a gas tube from the circuit would be intolerable without some means of limiting the rise. Resistor R21 is normally short-circuited by a connection within the tube when the tube is in place. Upon removal of the gas tube, the resistor is inserted in the circuit. Its resistance is such that, with a nominal voltage of +315 volts applied to the circuit, the bias output lead is tapped into a fixed potentiometer which is close to +100 volts with respect to ground. During the period while the tube is out of its socket, bias voltage may change somewhat but not enough to cause serious interference with the operation of an amplifier or a regulator.

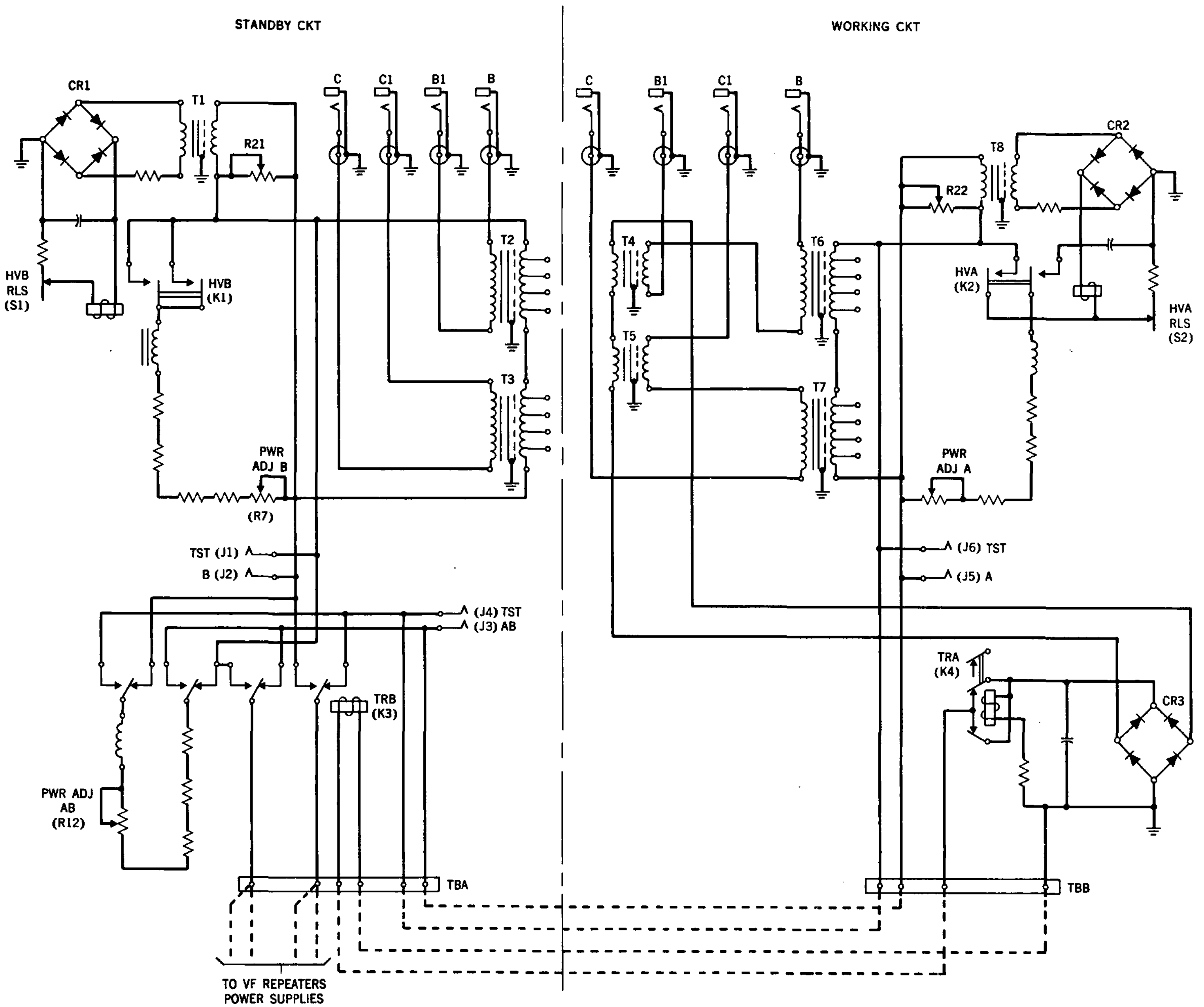

Fig. 12 — Power Transfer Circuits for Use With VF Repeaters

3.36 When a tube is replaced, any one of the base pins may make contact first. Assume that contacts are first made to short-circuit resistor R21 before the contact is made to the cathode of the tube. Under this condition the bias voltage is high and the tube will not flash. When the bias goes high the associated amplifiers draw heavy plate currents, thus lowering the +315 volt source voltage, and the tube will not flash when contact is made to the cathode. This condition could result in damage to an amplifier and possibly a service interruption.

3.37 The condition outlined is avoided by feeding voltage from the +315 volt source voltage through a separate resistor R25 to the starter anode of the tube. Since there will be no current flowing in the resistor prior to flashing, the full available voltage is applied. This voltage will be high enough to flash the tube immediately, even with reduced voltages. The starter and regulating anodes require about the same value of applied potential to cause breakdown and conduction within the tube.

3.38 Tube V2 operates with its anode at ground potential, thus holding the cathode at about −100 volts with respect to ground. In this circuit, R26 provides a means for flashing the tube. This resistor, which connects the starter anode to ground, is used to take advantage of the fact that in some particular gas tubes the starter anode may flash the tube at a slightly lower voltage than is required on the regulating anode. It does not assure flashing as does resistor R25 for tube V1, since it is not connected to a higher potential source. If it is assumed that resistor R22 is short-circuited by insertion of the tube pins without making the anode connection, thus giving the same conditions as those which were detrimental for tube V1, the supply voltage will not be dropped as in the previous case. Here the change in bias voltage does not affect the externally connected load and supply voltage remains unchanged. Therefore, there will always be sufficient voltage to cause flashing when the anode connection is made.

3.39 The power test set is used to measure the voltage between the TEST B lead and —100 volts by obtaining the voltage drop across a test resistor in order to determine the gas tube circuit current. In this case a voltage drop of about 20 volts indicates optimum adjustment of the EVEN ADJ control.

3.40 The LOAD ADJ switch, shown in Fig. 8A and Fig. 9, is used as a means of adjusting heater voltage within normal variations of line current. For PS1 power systems, this switch is connected across the low-pass filter at the transformer.

D. Filament and Bias Supplies

3.41 Filament and bias supply units consist of one or two identical transformers each having a tapped primary winding, one secondary bias winding, and two secondary heater windings. The units also include gas tube circuits for regulation of bias supply voltages. One of the transformers is arranged with only the secondary heater windings active, with the bias secondary winding being unused.

3.42 Fig. 13 shows the transformer which supplies power for an associated bias rectifier. The latter operates with the positive side grounded to provide −100 volts to ground, regulated by means of a cold-cathode gas tube. The gas tube circuit is provided with a parallel-wired socket, which is not used except when tube replacement is required. A new tube is plugged into the parallel socket immediately before removing the defective tube. Tube replacement is required when the voltage at which the tube sustains has reached an upper limit, and not usually because of an inoperative condition. A tube that is plugged into the parallel socket will not flash because the applied voltage is held down to sustaining value by the tube already in use. When the latter tube is removed, however, the voltage rises momentarily and the new tube flashes. With the exception of this parallel-tube feature, the circuit operates as described for the positive bias supply of Fig. 8B.

3.43 Fig. 14 shows the circuit which is contained in a filament and bias supply for regulation of +100 volt bias. The input voltage is obtained from a 315-volt plate supply. This circuit operates the same as the positive bias supply of Fig. 8B except that it has a parallel tube socket as does the regulator circuit of Fig. 13, and for the same purpose.

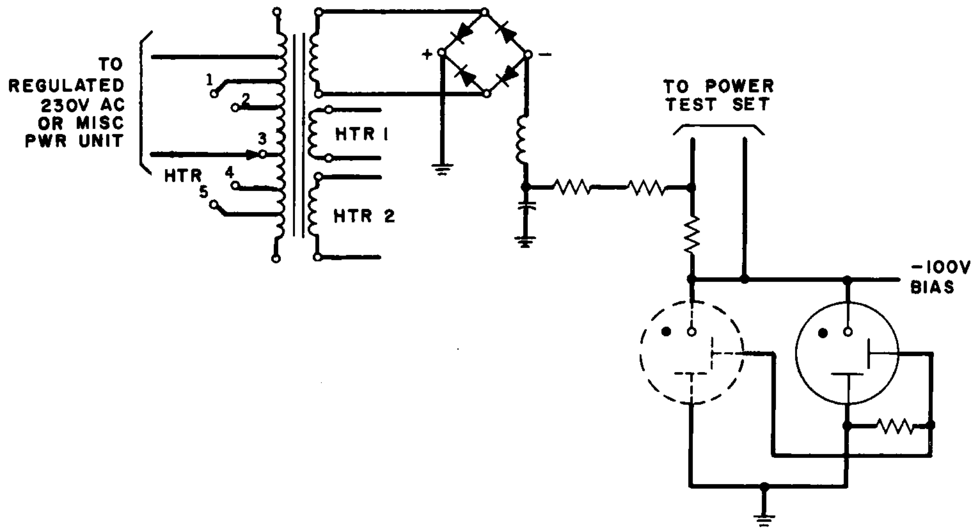

Fig. 13 — Negative Bias Circuit in Filament and Bias Supply

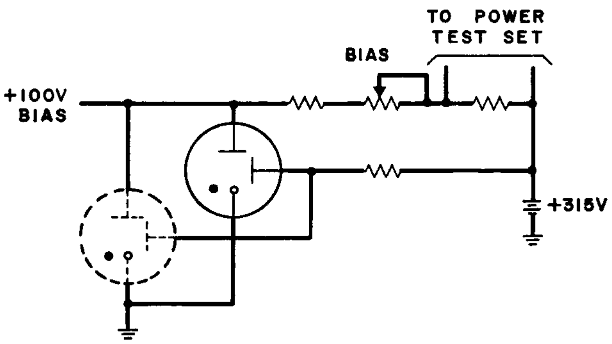

Fig. 14 — Positive Bias Circuit in Filament and Bias Supply

3.44 The HTR A and HTR B switches in the filament and bias supply change the transformer primary taps to which the input voltage is connected when the circuit is operated on constant input voltage from a local power source. Adjustment is made to obtain nominal HTR 1 voltage. When the supply is operated on constant input current, HTR A and HTR B switches connect various shunt resistors across the primaries of the transformers for adjustment of heater voltages. Since the power test set, used for measurement of HTR 1 voltage, can measure only one such voltage at a time while the filament and bias supply furnishes two, provision has been made in the supply panel for the second measurement. Fig. 15 shows the control panel of the supply, which is accessible upon removal of the front dust cover. The TST switch changes connections of the power test set (via the TST jack just above the switch) to the various circuits for making measurements and adjustments.

3.45 The two switch positions designated BIAS & HTR are for measurement of voltages, and the three designated BIAS are for measuring the voltage drop in test resistors to indicate gas-tube circuit currents.

3.46 The BIAS & HTR 1A and 1B positions direct the HTR 1 measuring circuit of the power test set to the A and B circuits, respectively, which produce HTR 1 voltage within the filament and bias supply. The controls which adjust the A and B supply voltages also change HTR 2 voltage, so that the adjusting controls are designated only HTR A and HTR B, which may readily be identified with the switch positions when measuring and adjusting.

3.47 The circuit for measurement of BIAS 1 (+100 volts to ground) in the power test set is directed by the TST switch to either the BIAS 1A or BIAS 1B supply. The tube sockets for these circuits may be identified by corre-

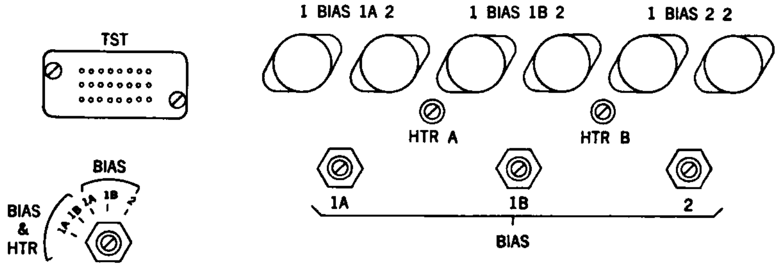

Fig. 15 — Face of Filament and Bias Supply

sponding designations. The BIAS 2 voltage (−100 volts) is measured directly with the power test set without going through the TST switch, since there is only one such source.

3.48 The power test set contains one circuit for measurement of voltage drops to indicate gas-tube currents. Since there may be three gas-tube circuits in a filament and bias supply, the TST switch in the BIAS position directs the power test set to each of the three. The gas tubes are readily identified with the switch positions and adjusting controls.

4. POWER ARRANGEMENTS AT AUXILIARY REPEATERS

4.01 The high-voltage, main power, and auxiliary power units shown in Fig. 16 are installed at auxiliary repeater locations. The line loading, power transfer, or maintenance power units are placed in the indicated positions at the repeater as required.

4.02 If the repeater is at a power looping point, option Y of Fig. 16 is provided. Otherwise, X wiring is furnished. The power looping

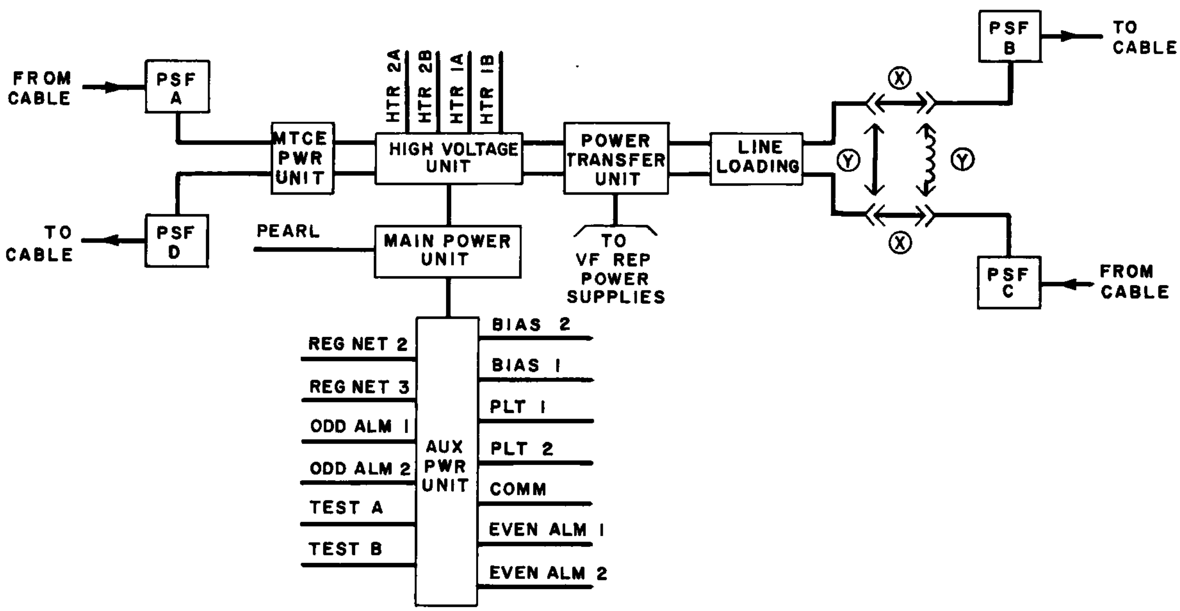

Fig. 16 — Power Arrangements at an Auxiliary Repeater

coil of option Y should be connected to PSF B and PSF C, when required.

5. POWER ARRANGEMENTS AT EQUALIZING AUXILIARY REPEATERS

5.01 Fig. 17 shows the power supplies used at an equalizing auxiliary repeater for one pair of coaxials. The power transfer and maintenance power units are optional equipment and are installed as required. The division of the total ac and dc load among the various power supplies is also shown in Fig. 17.

5.02 The power looping coil per option Y is shown connecting to PSF A and PSF D. Since power looping may take place on either side of the repeater, the coil may also be connected to PSF B and PSF C when required.

6. POWER ARRANGEMENTS AT EQUALIZING MAIN REPEATERS

6.01 The following complement of power supplies is used at equalizing main repeaters to supply power for transmission equipment op- → erating in two directions of transmission:

2 — Filament and Bias Supplies

2 — +315 Volt Semiconductor Rectifiers

4 — +190 Volt Semiconductor Rectifiers

2 — −130 Volt Metallic Rectifiers

6.02 These supplies are divided into two equal groups, with each group being fed from one of the two power control circuits used to feed power sections on the two sides of the office. The outputs of each of the two groups provide

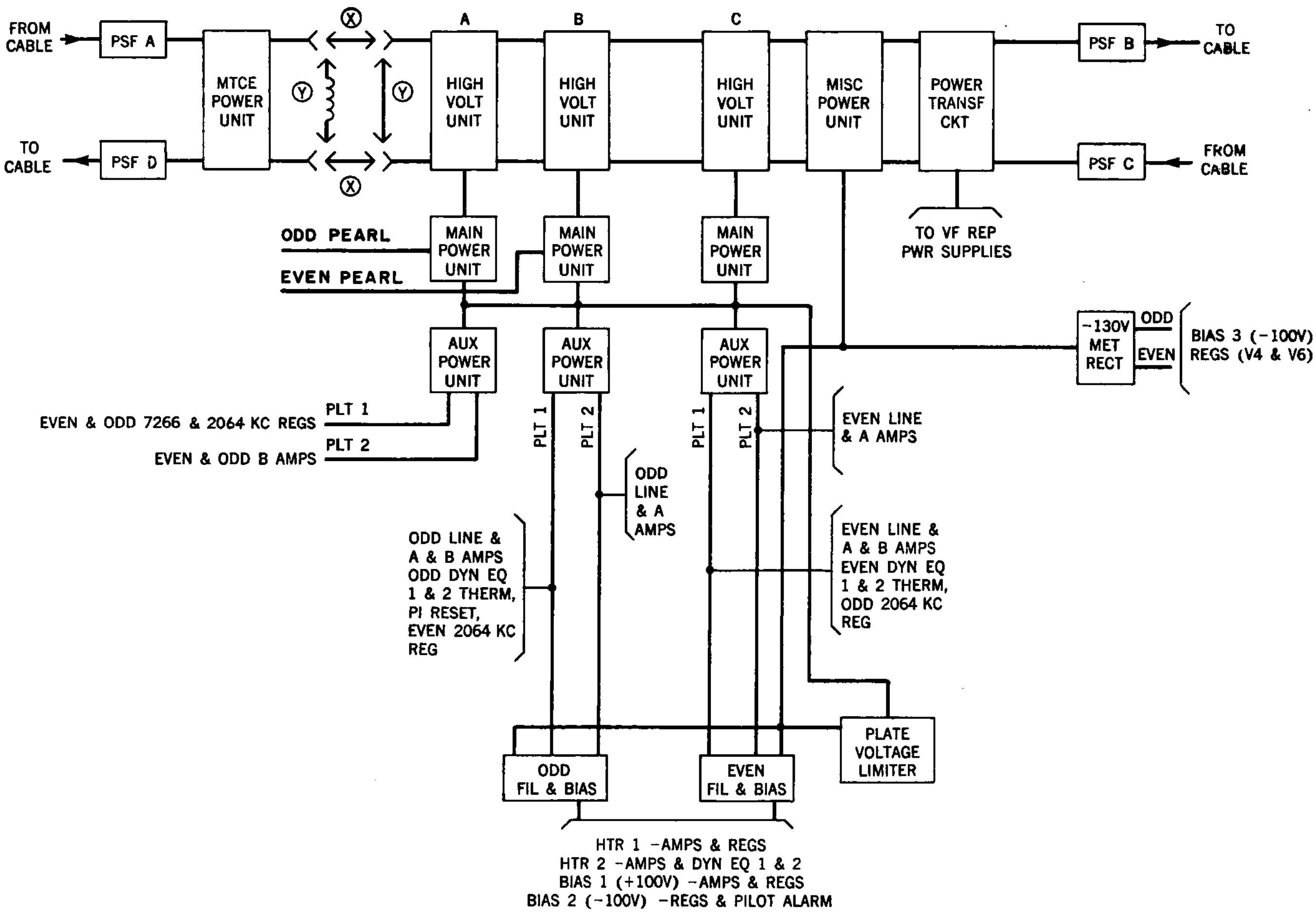

Fig. 17 — Power Arrangements at an Equalizing Auxiliary Repeater

power to transmission equipment for one direction of transmission, so connected that if power is turned down in one section, the receiving equipment associated with the remaining power section will remain active. Fig. 18 shows interconnection of the power supply units.

6.03 The +315 volt supply in each group feeds plate current to all amplifiers, either ODD or EVEN, and to the filament and bias supply in its own group for generation of the −100 volt bias. The load is divided among the two +190 volt rectifiers in each group as follows:

(a) ***First Group:*** +190 SEMICOND RECT A supplies plate current to the ODD line, amplifier, thermistor current to the three ODD regulators, and current for the ODD PEARL* panel. It also connects to the filament and bias supply in this group to raise the HTR 2 circuit above ground. +190 SEMICOND RECT B supplies plate current to ODD flat amplifiers A and B and plate current to the three ODD regulators.

(b) ***Second Group:*** +190 SEMICOND RECT A furnishes plate current to the EVEN line amplifier, thermistor current to the three EVEN regulators, and current for the EVEN PEARL panel. It also connects to the filament and bias supply in this group to raise the HTR 2 circuit above ground. +190 SEMICOND RECT B supplies plate current to EVEN flat amplifiers A and B and plate current to the three EVEN regulators.

* Performance Evaluation of an Amplifier from a Remote Location.

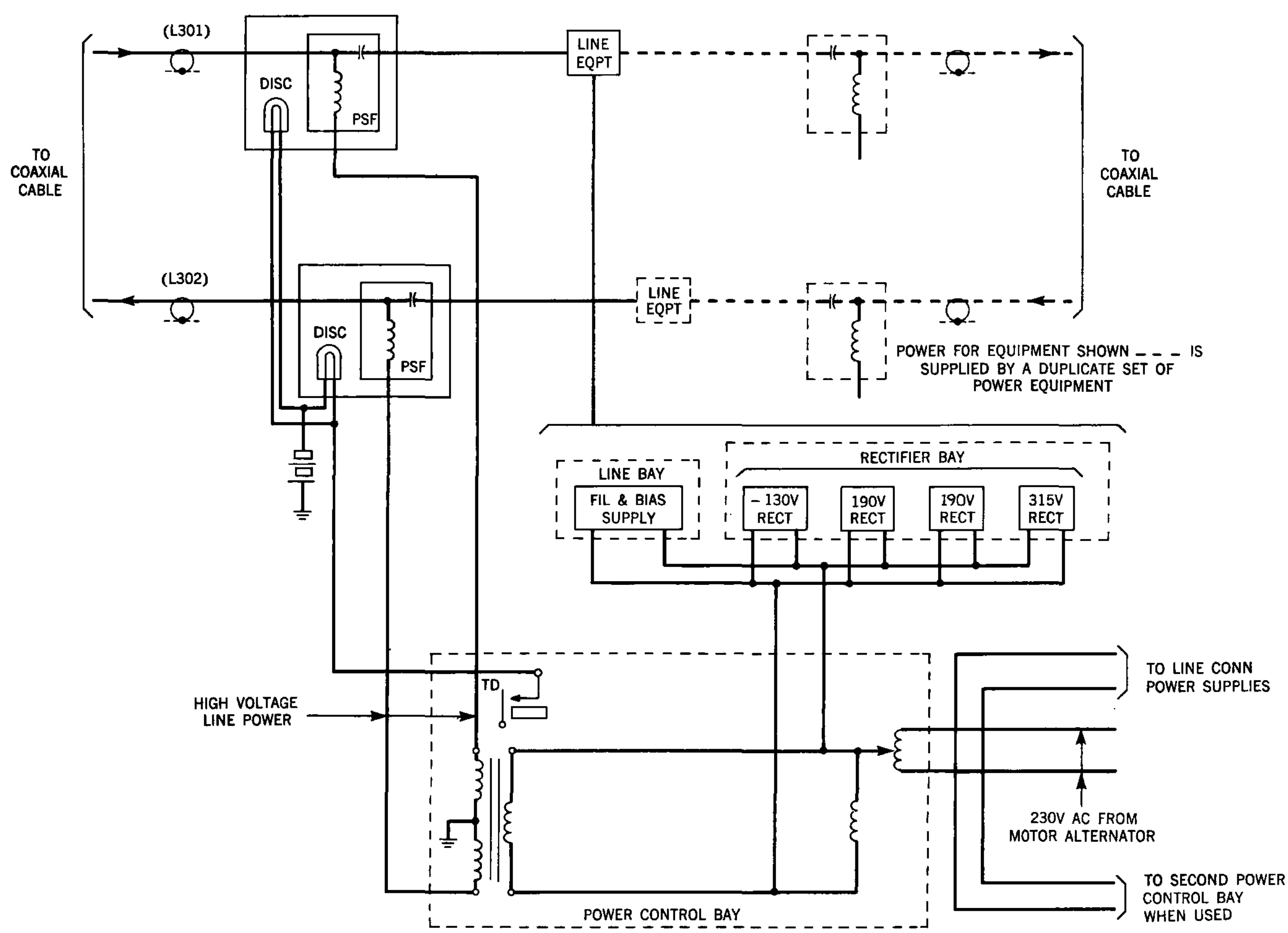

Fig. 18 — Power Arrangement at an Equalizing Main Repeater — Block Schematic

6.04 The first group, which is associated with the ODD direction of transmission, obtains its input power at 230 volts ac from the power control circuit feeding the power section to the north or west of the main repeater, while the second group receives power from the one sending power to the south or east.

7. POWER ARRANGEMENTS AT SWITCHING MAIN AND TERMINAL MAIN REPEATERS — LOCAL POWER SOURCE

7.01 The following complement of power supplies is used to supply the transmitting and receiving transmission equipment at a terminal main repeater:

1 — Filament and Bias Supply

1 — +315 Volt Semiconductor Rectifier

2 — +190 Volt Semiconductor Rectifiers

1 — −130 Volt Metallic Rectifier

At a switching main repeater, twice the amount of transmission equipment used at terminal main repeaters is required, so that these quantities of power supplies are doubled at a switching point. The group of supplies receives its input power normally from the regulated 230-volt source within the power control circuit that feeds the lines with which the transmission and power equipment is associated. (See Fig. 19.) At a switching main repeater, therefore, if power is turned down in one power section, the transmission equipment terminating the power section fed in the opposite direction is left operating.

7.02 The filament and bias supply furnishes heater power for the operation of all regulators and amplifiers at a terminal main repeater. It also supplies a regulated −100 volt bias for operation of regulators and +100 volt bias for both regulators and amplifiers.

7.03 The −130 MET RECT feeds power at −100 volts to all regulators and furnishes a bias for the line switching circuit. The +315 SEMICOND RECT supplies all amplifiers.

7.04 The load is divided between the +190 volt SEMICOND RECT A and B as follows: +190 volt SEMICOND RECT A supplies plate current to the line amplifier, flat amplifiers B, C, D, and T, and thermistor current to all regulators; +190 volt SEMICOND RECT B supplies plate current to flat amplifier A and to the six pilot regulators. Its voltage is also supplied to the filament and bias supply to raise the HTR 2 circuit above ground.

7.05 At a switching main repeater, the second pair of transmission bays is fed in the manner described. When line connecting equipment includes amplifiers, a filament and bias supply, a +190 SEMICOND RECT, and a +315 SEMICOND RECT are used in addition to the equipment listed in 7.01. These extra units supply amplifiers in the line connecting equipment and obtain their input power from the unregulated output of an alternator, and not after regulation by a power control circuit as is the case with the other power supplies.

8. POWER ARRANGEMENTS AT TERMINAL MAIN REPEATERS — POWER FED FROM CABLE

8.01 A terminal main repeater may receive its operating power from the constant current in a power section instead of from a local source of regulated 230-volt ac as is the usual case. (See Fig. 20.)

8.02 The following supplies are used:

1 — Filament and Bias Supply

1 — −130 Volt Metallic Rectifier

3 — Power groups similar to those at equalizing auxiliary repeaters

These supplies are fed primary power from one constant-current power section.

8.03 The line connecting equipment for combined message and TV systems is supplied power by:

1 — +315 Volt Semiconductor Rectifier

1 — +190 Volt Semiconductor Rectifier

1 — Filament and Bias Supply

These supplies receive primary power from a local 230-volt ac source.

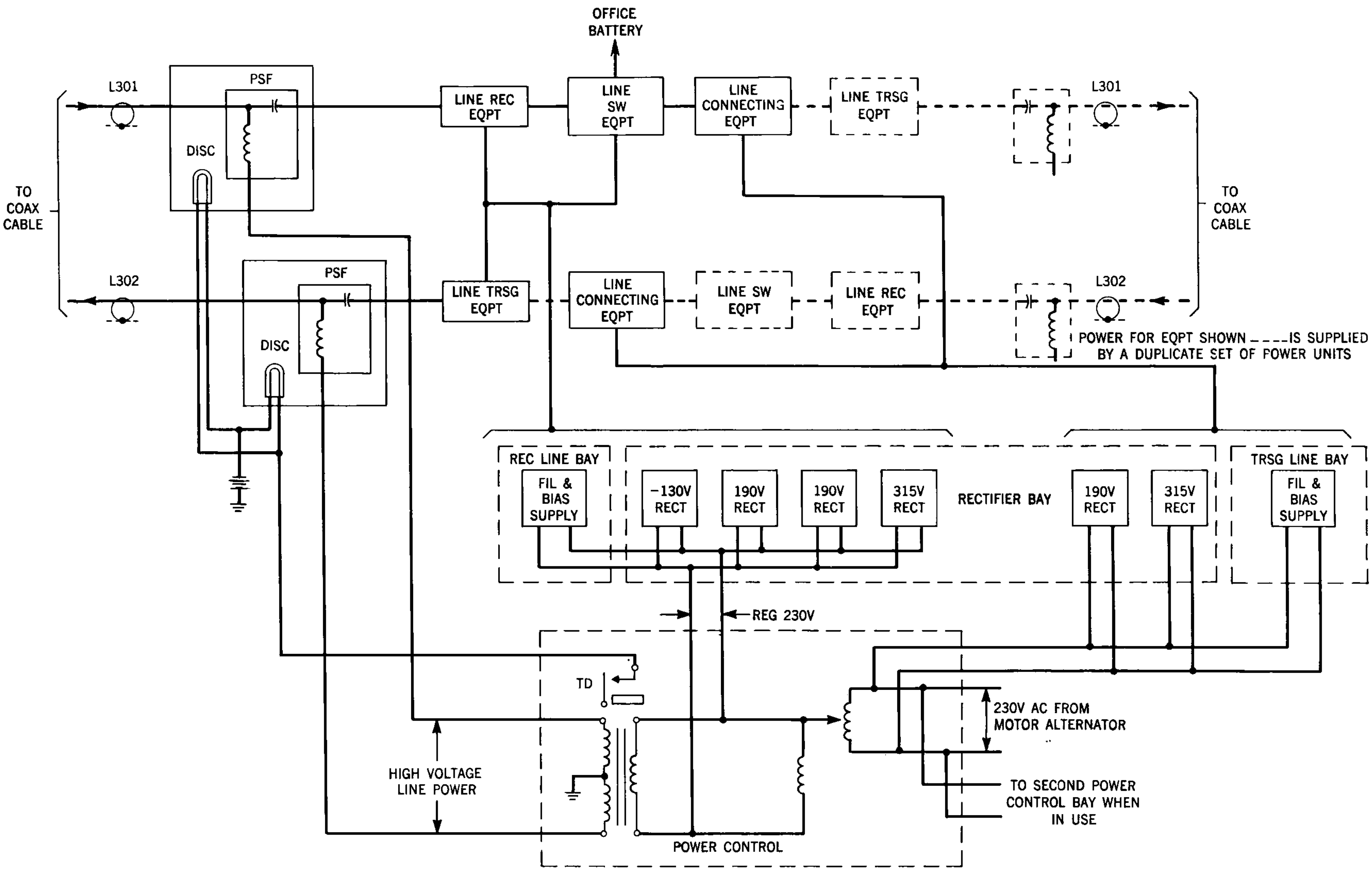

Fig. 19 — Power Arrangement at a Switching or Terminal Main Repeater — Block Schematic

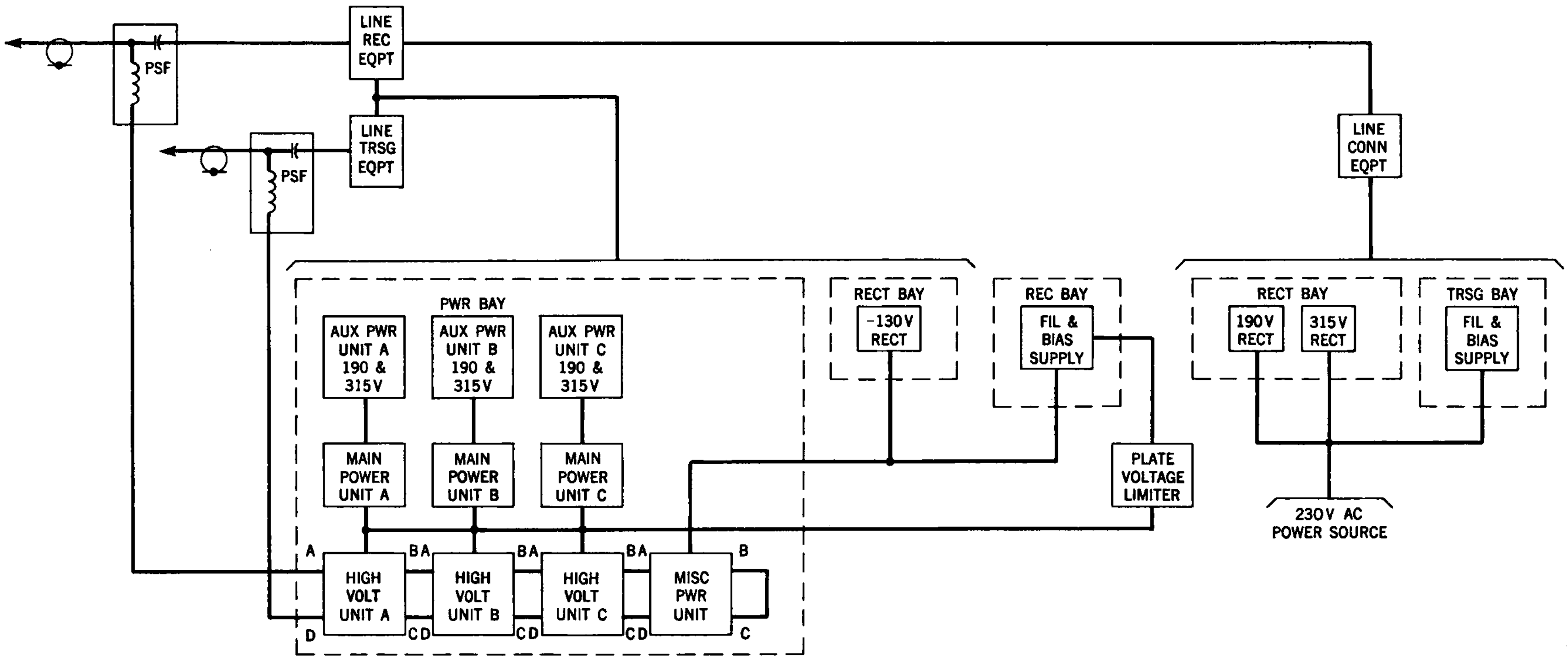

Fig. 20 — Constant-Current Power Feed to a Terminal Main Repeater

8.04 Division of load among the power supply circuits is different from that used when a terminal main repeater is fed from a local power source. Table B provides this load division. The plate supplies are similar to those used at equalizing auxiliary repeaters.

9. DRAWINGS (NOT ATTACHED)

9.01 The following drawings (not attached) are related to this section.

SD-59486-01 — Filament and Bias Supply Circuit

SD-59572-01 — Power Supply Circuit for Auxiliary and Equalizing Auxiliary Repeaters and Main Repeaters Receiving Power from a Remote Point

SD-59579-01 — Dc Power and Filament Supply Circuit for Equalizing Auxiliary Repeater

SD-59595-01 — Dc Power and Filament Supply Circuit for Main Repeaters

SD-59637-01 — Dc Power and Filament Supply Circuit for Terminal Main Repeaters — Power Fed from Cable

SD-59641-01 — Maintenance Power Unit

SD-59682-01 — Power Transfer Circuit for Use with Voice-Frequency Repeaters

SD-59699-01 — Plate Voltage Limiter

SD-81149-01 — 230-Volt Ac Power Supply Circuit

SD-81152-01 — Power Control Circuit

SD-81215-01 — 190-Volt Rectifier

SD-81216-01 — 315-Volt Rectifier

SD-81235-01 — 130-Volt Rectifier

TABLE B

LOADING OF PLATE SUPPLY CIRCUITS

SUPPLY DESIG	EQUIPMENT FED FROM	
	+ 190 VOLT SOURCE	+ 315 VOLT SOURCE
A	All Regulators	Line Amp, Flat Amp A
B (See Note)	Flat Amps B, C, and D Thermistor Current to 308-, 556-, 2064-, 3096-, and 8320-kc regulators	Flat Amps B and C
C	Line Amp, Flat Amp A, Flat Amp T for opposite direction of transmission	Flat Amp D, Flat Amp T for opposite direction of transmission Filament and bias supply

Note: +190 volt circuit also connects to HTR 2 circuit in filament and bias supply to raise it above ground.