L3 CARRIER
OVERALL SYSTEM
DESCRIPTION

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1. GENERAL

1.01 This section is reissued to add information for PEARL (Performance Evaluation of Amplifiers at Remote Locations) and to update existing L3 information. Due to the general revision of this section, marginal arrows have been omitted.

1.02 The L3 system operates in the frequency range of 308 to 8320 kHz over coaxial conductors. Eighteen hundred and sixty 4-wire message circuits or two television circuits (one in each direction) plus six hundred and sixty 4-wire message circuits may be transmitted simultaneously over each pair of coaxial conductors. The telephone circuits are 4000-mile quality circuits.

1.03 Figure 1 is a block diagram indicating the major components of the system. The medium of transmission between terminals is the high-frequency line consisting of a coaxial conductor, associated repeaters, and connecting equipment. Separate high-frequency lines are used for the two directions of transmission of a 4-wire circuit. One high-frequency line is required for each direction of a television circuit. The overall features of the terminal, the line connecting equipment, and the high-frequency line are discussed herein.

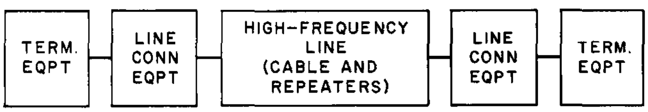


Fig. 1—L3 Carrier System—Major Components

1.04 The high-frequency line of Fig. 1 is built up of switching sections, so called because such a section of line is backed up by a similar standby line which is switched into service automatically upon failure of one of the regular lines. Several types of switching may be used. A standby line may be provided for each working line or for as many as twelve working lines.

1.05 A switching section (Fig. 11) consists of switching or terminal facilities at each end, connected by means of a number of auxiliary repeater sections operating between intervening equalizing auxiliary and equalizing main repeaters when required. When signals have passed through a maximum of 32 auxiliary repeaters, the accumulated deviations in transmission are large enough to require equalization to prevent signals from becoming too close to noise or from being high enough to cause modulation or overloading in amplifiers. When the spacing between main repeaters exceeds this limit, an equalizing auxiliary repeater is inserted.

1.06 The terminal facilities (Fig. 11) provide the frequency-translating equipment to place the voice-frequency circuits into the transmitted frequency band or to put the received line frequencies into the voice-frequency band. The frequency-translating equipment used to place a television circuit into the line-frequency band is separate from the telephone terminal equipment.

1.07 Power is supplied to auxiliary and equalizing auxiliary repeaters through a power loop (Fig. 2) from main repeater stations. The primary winding of the power supply transformers at the several repeaters are inserted in series within this loop with the inner conductor of the cable carrying both power and carrier frequency currents. The power and transmission paths are isolated from each other at each repeater by input and output power separation filters. Closure of the loop takes place only in the power circuit.

2. DESCRIPTION OF SYSTEM

2.01 The general overall features of the L3 system are described in this part. Figure 11 shows a system terminal to terminal with a brief description of the individual components. These descriptions are enlarged upon in later paragraphs. An ***all-message*** system transmits and receives messages only; a ***combined*** system transmits and receives messages and television signals.

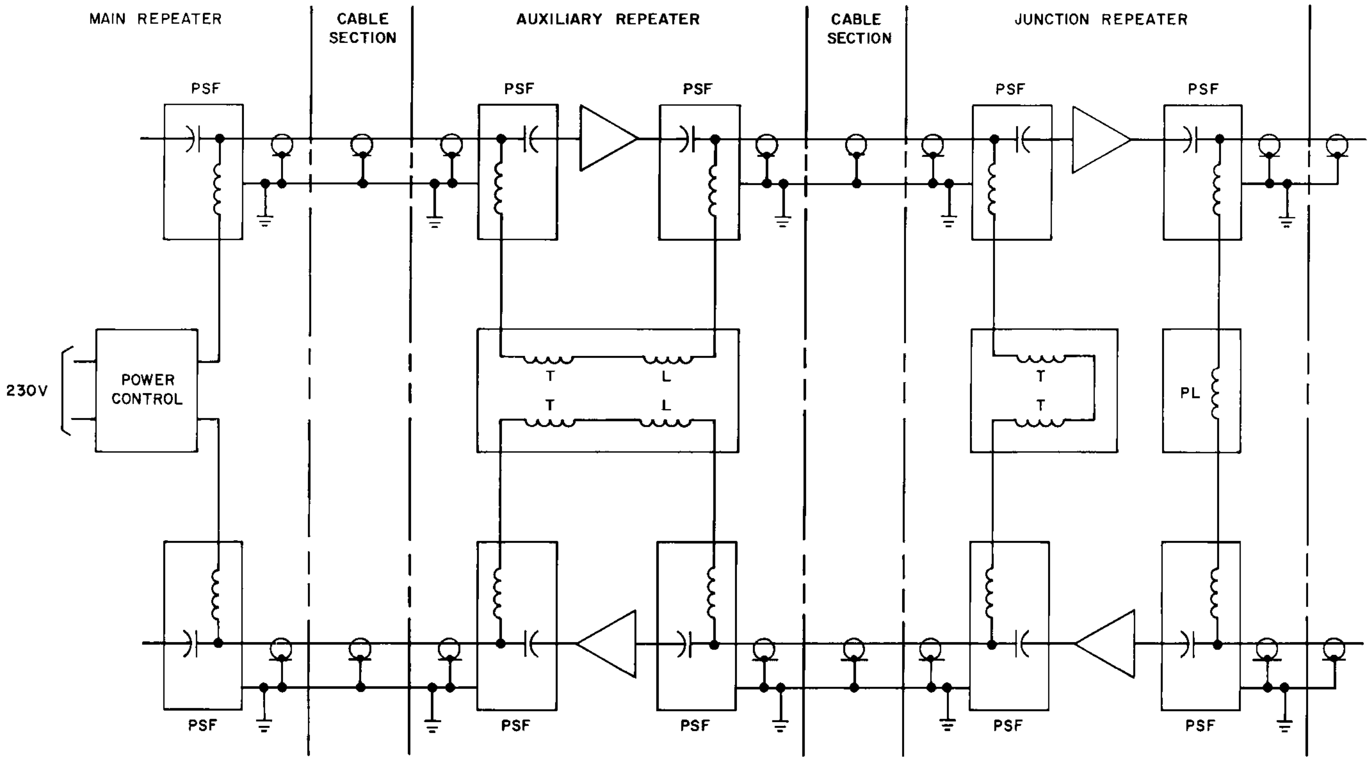


Fig. 2—Power Section—Simplified Schematic

2.02 As shown in Fig. 11, a maximum of 1860 telephone circuits (all-message system) are changed from voice frequency to the transmitted line-frequency band in the terminal equipment, the output is connected to the terminal repeater where the level is raised, and line pilots are inserted. The output of the repeater is fed to the coaxial line where it is transmitted, amplified, and equalized by the components of the high-frequency line. Upon reaching the receiving terminal repeater, the received frequency band is fed to the terminal equipment where the line frequencies are translated again into the voice-frequency band. Identical equipment is required for the reverse direction of transmission of a 4-wire telephone circuit.

2.03 When a combined telephone and television system is used, the telephone terminal of Fig. 11 converts 660 telephone circuits to the line frequencies. The television terminal in the figure converts the video signal to the line frequencies. The outputs of the telephone and television terminals are then combined and connected to the terminal repeater. From this point on, the operation of the system is the same as the all-message system with the exception that delay equalization is provided for the television circuit at switching and terminal repeaters and equalizing auxiliary repeaters when required. The delay equalization, in addition to the gain-frequency equalization, is normally furnished at these locations.

A. Cable Facilities

2.04 A 2-way circuit requires the use of two coaxial conductors, one for each direction of transmission. Figure 3 shows a section of an 8-coaxial cable. Additional coaxial cables that may be used are described in Section 632-035-120. The pairs shown in the center are used for alarms and other control purposes. In many cases, additional quads are included in the cable for voice-frequency telephone circuits or other types of service.

B. Frequency Allocation

2.05 The line frequency allocations employed by the L3 carrier systems are shown in Fig. 12. When the the system is employed to transmit combined message and television service, the

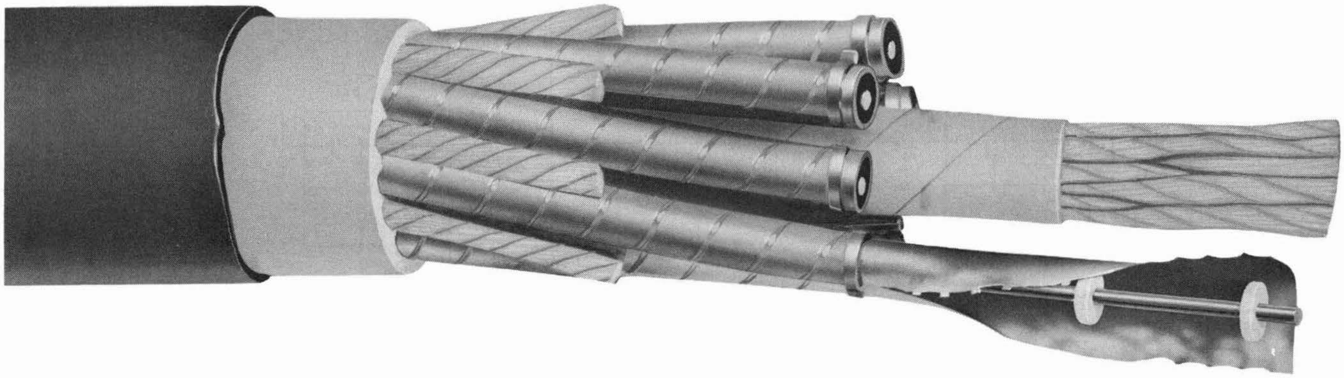


Fig. 3—8-Coaxial Cable

television band requires 2 mastergroups located between 3640 and 8340 kHz. One L3 mastergroup, for message transmission, is located between 564 and 3084 kHz. When the entire system is used to transmit all-message service, the channels are grouped into three L3 mastergroups (10 supergroups, 600 channels each) with mastergroup 1 between 564 and 3084 kHz, mastergroup 2 between 3164 and 5684 kHz, and mastergroup 3 between 5764 and 8284 kHz. Space is also available for 60 additional message channels between 312 and 552 kHz (L supergroup 112). When the system is used for all-message service, the additional 60 channels are 4000-mile quality while on a combined system these channels are restricted to short-haul circuits.

2.06 Pilot frequencies for regulating the gain or loss characteristics of the repeater are transmitted at 308, 556, 2064, 3096, 7266, and 8320 kHz. The 7266-kHz pilot is used to control the gain of the line amplifier at main and auxiliary repeater stations.

C. Equalization and Regulation

2.07 The general plan of gain equalization, regulation, and delay equalization is outlined herein and discussed in greater detail in Part 3.

2.08 The gain equalization and regulation provided for in the L3 system is divided into four main categories as follows.

(a) Fixed equalization provided by the shaped auxiliary amplifier characteristic, the basic equalizers at each repeater, and the fixed equalizers at equalizing auxiliary, equalizing main, switching main, and terminal main repeaters.

(b) Line regulation provided by the line amplifier, the gain of which is controlled either by the auxiliary regulator (7266-kHz line pilot) or by the thermometer regulator at auxiliary repeaters. At equalizing auxiliary, equalizing main, switching main, and terminal main repeaters, the gain of the line amplifier is controlled by the 7266-kHz pilot frequency operating through a computer.

(c) Dynamic equalization provided by five gain shapes. The magnitude of each shape is controlled by a specific pilot, 308, 556, 2064, 3096, or 8320 kHz, operating through the computer.

(d) Manually controlled equalization provided by the 308-kHz equalizer and a series of 15 harmonic shapes. The harmonic shapes are called "cosine shapes."

2.09 Delay equalization is divided into three main categories as follows.

(a) A fixed delay equalizer located in the television branch of the receiving branching filter in the line connecting circuits. A choice of several fixed equalizers is provided to accommodate different circuit lengths.

(b) Adjustable delay build-out equalizers located in the high-frequency line circuits at switching and terminal repeaters.

(c) Adjustable delay equalizers in the line connecting circuits at widely spaced points for the final trimming of the delay equalization.

D. Repeaters

2.10 Several types of repeaters are used in the L3 system to meet the transmission and power requirements of the high-frequency line. The types of repeaters employed are as follows:

(a) Auxiliary

(b) Equalizing auxiliary

(c) Equalizing main

(d) Switching main

(e) Terminal main

These repeaters will be discussed in some detail in Part 4.

E. Line Connecting Arrangements

2.11 The line connecting equipment includes all of the circuits and equipment required to interconnect the incoming and outgoing high-frequency lines (L units) at a switching main repeater, or to connect the high-frequency line to the terminal equipment at a terminal main repeater. It includes the line switching equipment, television-message separating filters, and message branching equipments. These arrangements are discussed in a general manner in Part 5.

2.12 Line switching arrangements are provided, which makes it possible to have one standby high-frequency line protect as many as 12 regular high-frequency lines. When more than one line is protected, it is necessary to switch at both the transmitting and receiving ends of the circuit. The operation and synchronization of the transmitting and receiving line switches are accomplished by means of switching signals. These signals (280, 282, 284, 286, 288, 290, and 296 kHz) are transmitted between transmitting and receiving ends of the switching section over the L3 high-frequency line. When only two lines are equipped for L3 operation, transmitting switches and associated equipment are not required. The standby line is connected directly to the transmitting hybrid coil and the switching occurs only at the receiving end. These switching arrangements are discussed in Part 5.

2.13 When the system is used for all-message service, the line connecting equipment at a switching main repeater consists of either (a) a pad and a band-elimination filter (to block switching tones) through which the receiving line is connected directly to the transmitting line equipment or (b) branching equipment. (See Fig. 13.) The branching equipment includes arrangements for dropping mastergroup 1 or certain supergroups of mastergroup 1. Filters for bypassing line pilots are also included. See Fig. 14(A) and (B).

2.14 When the system is used for transmission of combined message-television service, the line connecting equipment includes branching filters for separating the message and television signals; message bridging, branching, and blocking equipment; and television equalizing equipment. The message connecting equipment provides for dropping mastergroup 1 entirely or for dropping certain supergroups in mastergroup 1. Filters for bypassing certain line pilots in the frequency range of mastergroup 1 are included. See Fig. 14(C).

F. Terminals

2.15 The message terminal equipment (see Fig. 4 and 10) includes channel banks, group banks, supergroup panels, submastergroup and mastergroup modulators, high-frequency patch bays, and carrier and pilot supplies. When the system is used for the transmission of combined message-television service, the message terminals provide a maximum of 11 supergroups, or 55 groups, or 660 channels. When the system is used for all-message service, the message terminal provides a maximum of 31 supergroups or 155 groups or 1860 channels.

2.16 The television terminal is known as the T3-R3 television terminal, T3 being the transmitting terminal and R3 being the receiving terminal. It provides for the transmission of a 4200-kHz television band over the L3 system.

G. Frogging of Message Circuits

2.17 When signals, either message or television, are transmitted over long distances through many amplifiers in tandem, the accumulation of modulation products along the line becomes an important system problem for two reasons: (1)

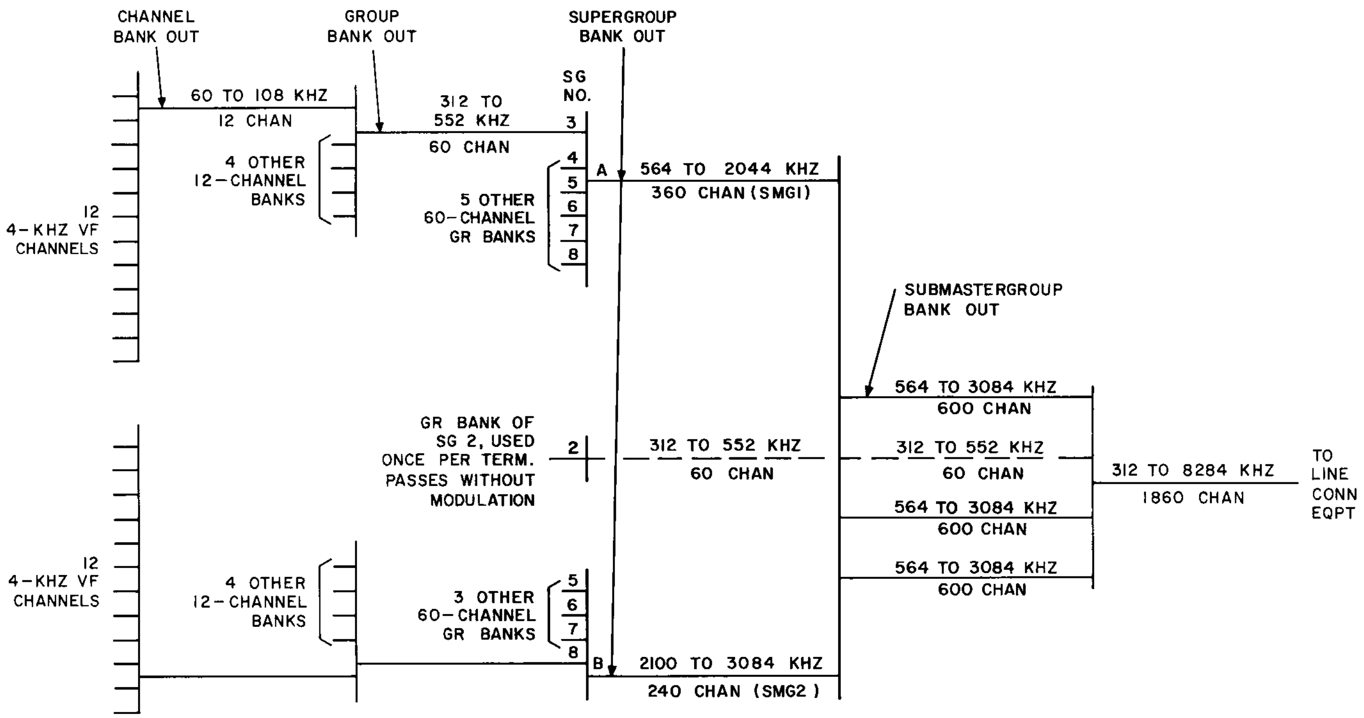


Fig. 4—Frequency Translation at Terminals

the accumulation of certain types of third-order products tends to follow a direct or in-phase law and (2) the distribution of modulation products over the band produces more modulation noise in certain parts of the band than in others. Both of these cumulative problems are alleviated if, at intervals along the line, the signals are shifted with respect to one another in the band, a process known as frogging.

2.18 In the L3 system, signal-to-noise performance is substantially improved by frogging the supergroups at intervals of about 800 miles. When the system is used for combined message-television signals, the message circuits are frogged in supergroup blocks at approximate 800-mile intervals except for supergroups 113 and 114, which must be frogged at 400-mile intervals. This procedure is necessary to prevent second-order sum and difference products of message and television signal components from cumulating excessively, especially those products that involve television signal components close to the television carrier. Frogging these supergroups more frequently than others results in a 3-dB improvement in television signal-to-noise performance.

3. EQUALIZATION AND REGULATION

3.01 Equalization is the process of correcting system gain and delay deviations sufficiently to permit the satisfactory transmission of signals. Regulation refers to that part of equalization which, by automatic means, corrects for changes in transmission.

3.02 The magnitude of the equalization requirements of the L3 carrier system is exemplified in the statement that a 4000-mile coaxial cable has a gain distortion of nearly 40,000 dB between 0.3 and 8.5 MHz. The line amplifiers provide the bulk of the equalization required and the residue is adjusted by means of fixed, manual, and dynamic equalizers. Gain distortion cannot be permitted to exceed about 5 dB at any point in the line as the signal misalignment will result in degraded signal-to-noise ratios. See Fig. 15 for equalization arrangements.

3.03 The gain equalization and regulation provided for in the L3 system is divided into four main categories as follows:

(a) Fixed equalization

(b) Line regulation (amplifiers and regulators)

(c) Dynamic equalization

(d) Manual equalization

A. Fixed Equalization

3.04 Fixed equalization is provided by the line amplifier which has a gain-frequency characteristic closely equal to the loss of 4.0 miles of 0.375-inch coaxial cable. This is supplemented by a basic equalizer at each repeater, its primary function being to match the amplifier to different types of cable. For 0.375-inch coaxial cable, with 12-mil outer conductor, the basic equalizer is a flat 0.75-dB pad. A fixed equalizer section, designated DESIGN on the block diagram of Fig. 15, is provided at each equalizing auxiliary, equalizing main, switching main, and terminal main repeater. The design equalizer is a part of equalizer A2 and compensates for the accumulated design deviation from the ideal characteristic at each repeater.

B. Line Regulation (Amplifiers and Regulators)

3.05 The amplifiers and regulators are demountable units which may be replaced and taken to a maintenance center for servicing when measurements indicate that they are not functioning properly. There are two types of amplifiers and eight types of regulators, which are described briefly herein.

3.06 The two types of amplifiers are designated the line amplifier (J68816A) and the flat amplifier (J68816B). The flat amplifier provides a gain of 34 dB over a frequency range of 300 to 8500 kHz, which is flat to the order of ±0.1 dB. The line amplifier has a sloping gain-frequency characteristic which closely equals the loss-frequency characteristic of 4.0 miles of 0.375-inch coaxial cable. Figure 16 shows a simplified schematic representing both of these amplifiers. The two gain-frequency characteristics result from different element configurations within the input beta, output beta, and interstage networks.

3.07 The nominal gain of the line amplifier varies as the square root of frequency from 8 dB at 300 kHz to 46.5 dB at 8500 kHz. This gain is controlled by a 7266-kHz regulator to compensate for changes in cable loss caused by cable temperature changes and variations in repeater spacing tolerances. The regulation range is about 6 dB at 7266 kHz above and below the nominal (55-degree) cable loss.

3.08 The nominal gain of the flat amplifier is 34 dB. This gain is variable over a range of ±1.0 dB in 0.2-dB steps by a switch in the output beta network. The gain change is flat with frequency.

3.09 The different types of regulators used in this system are as follows.

(a) The auxiliary regulator (J68817A) controls the gain of the line amplifier to keep the 7266-kHz pilot at the proper output power at an auxiliary repeater. (See Fig. 17.)

(b) The thermometer regulator (J68817T) controls the gain of the line amplifier as a function of the temperature of the cable near the auxiliary repeater hut. (See Fig. 5.)

(c) The 7266-kHz regulator (J68817G) is designed to regulate the loss of a computer-directed network in accordance with the variation in power of the 7266-kHz pilot modified by equalizing pilots at the output of the line amplifier. (See Fig. 6.)

(d) Regulators for 308 kHz (J68817AB), 556 kHz (J68817B), 2064 kHz (J68817C), 3096 kHz (J68817D), and 8320 kHz (J68817H) monitor the respective pilots and feed a dc voltage via the computer to the dynamic networks of the equalizers.

3.10 The regulation is divided into two general parts as follows:

(a) A dc control circuit to adjust the power fed to the regulating thermistor in the line amplifier

(b) An ambient temperature oscillator to maintain the control thermistor at a constant temperature in the absence of dc regulating current.

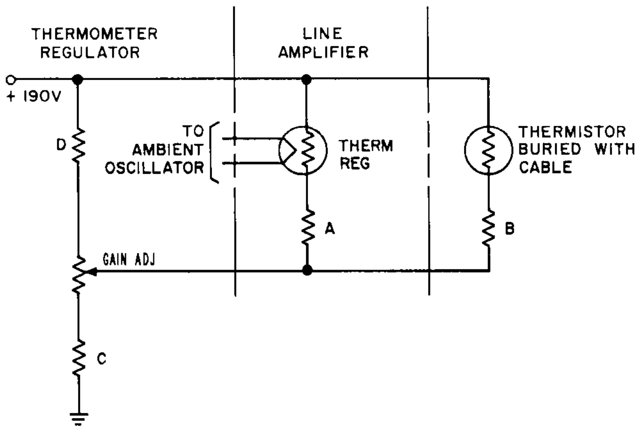


Fig. 5—Thermometer Regulator—Simplified Sketch

Power to the thermistor is controlled by the operation of the GAIN ADJ potentiometer (manually operated control) (Fig. 5), and an externally connected regulator whose resistance in series with resistor B shunts the regulating thermistor and resistor A in series.

3.11 The gain of the line amplifier is controlled by a thermistor connected as a shunt element in a regulating network inserted between the input and output amplifiers that comprise the line amplifier. The resistance of this thermistor and its control of the amplifier gain is determined by the power delivered to the thermistor by the thermometer regulator. The resistance of this thermistor varies with the cable temperature. The resistance, determined by the series combination of resistor B and this thermistor, controls the power applied to the line amplifier.

3.12 The ambient temperature oscillator (V5) (Fig. 17) is used to adjust the temperature of the regulating thermistor in the line amplifier so that performance of the line amplifiers is not affected by changes in the temperature of their surroundings. To accomplish this, a temperature-compensating thermistor, identical with the regulating thermistor, is mounted in close proximity to the regulating thermistor. The resistance of the compensating thermistor is determined by the amount of oscillator power flowing through it as well as its ambient temperature. When the ambient temperature of the thermistor changes, the resistance will change momentarily. The change in power will be such that the resistance of the compensating thermistor is returned to its original equalibrium value to again balance the bridge at the point where the loop gain is unity.

C. Computer

3.13 The computer is a multiterminal voltage divider. It provides a combined dc voltage from rectified pilots to drive the thermistors in the regulating network of the line amplifier and in dynamic equalizers.

3.14 Major deviations in the gain-frequency characteristic of the high-frequency line are due to the following causes:

(a) Variations in the temperature of the repeater.

(b) Change in the transconductance of the electron tubes.

(c) Line regulation departing from ideal characteristics.

The gain-frequency curves (shapes) resulting from the effects of these causes are called "cause shapes."

3.15 The use of cause shapes presents a problem to which the computer provides the solution. These cause shapes are broad effects covering the entire band and more. By a process equivalent to the solution of simultaneous equations, the pilots determine the amounts of an equal number of cause shapes that will restore the pilots to normal. The computer thus translates pilot errors into shape errors and drives the appropriate regulating networks to obtain the corrections. The resistors in this computer provide portions of the rectified pilots in predetermined amounts to be delivered to the thermistors via the dc amplifiers. By inserting selected resistors between the proper terminals, it is possible to add or subtract portions of all rectified pilots to obtain the desired regulation performance. In Fig. 6 the dc amplifiers are shown with two inputs. The resultant voltage applied to one of these inputs increases the magnitude of equalization. Voltage applied to the other input decreases the magnitude of equalization. If one pilot changes, all regulating networks react but in such proportions and polarities as to produce no gain change at any pilot frequency except at the one originally disturbed. Thus, the use of the computer in the regulator circuit prevents interaction between broad equalization shapes due to one regulator tending to correct for

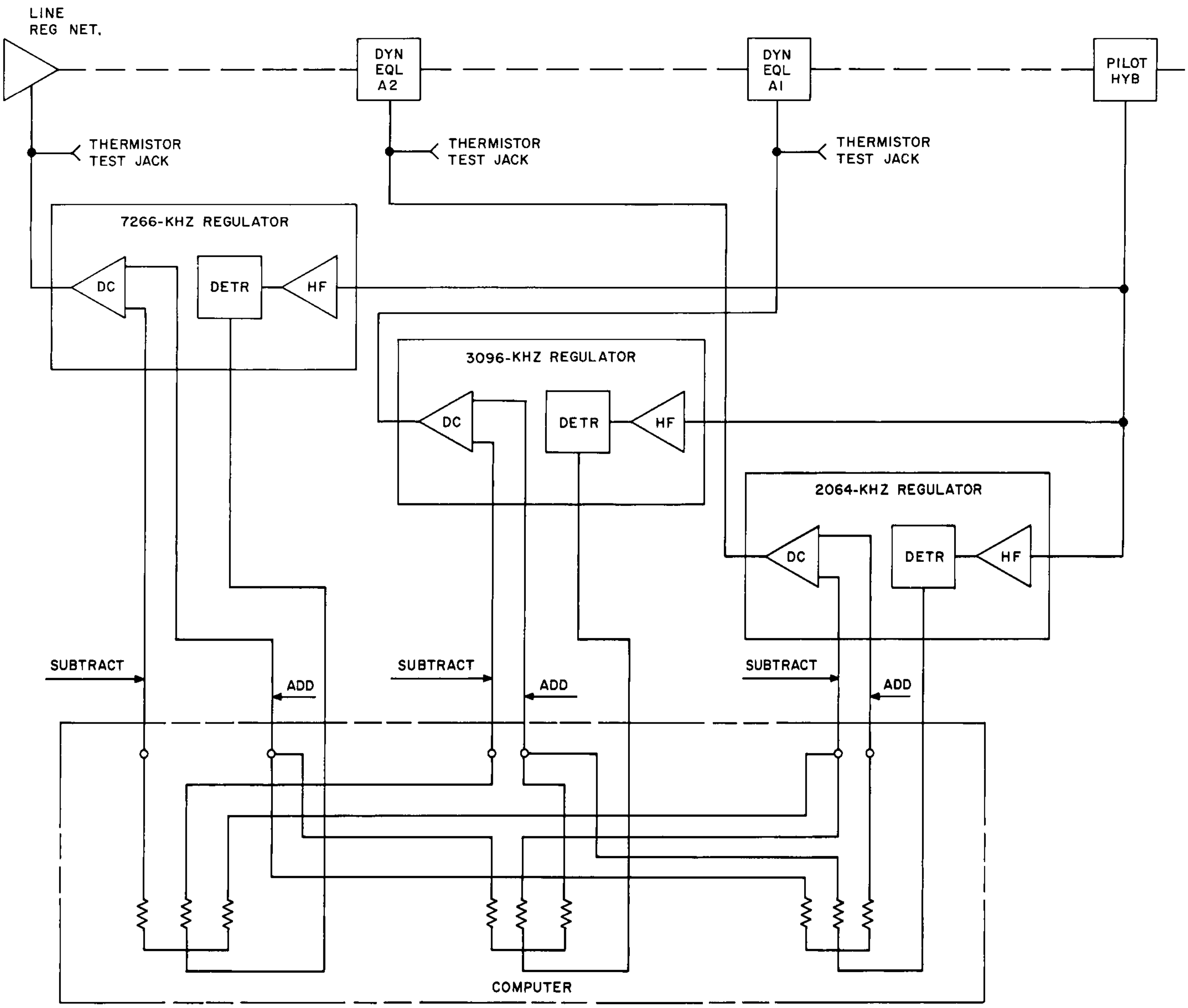


Fig. 6—Use of the Computer at the Equalizing Auxiliary Repeater—Block Diagram

a change in a characteristic introduced by another regulator.

D. Dynamic Gain Equalization

3.16 Line level regulation is provided by the line amplifier, the gain of which is controlled either by the auxiliary regulator (7266-kHz line pilot) or by the thermometer regulator at auxiliary repeaters. At equalizing auxiliary and equalizing main repeaters, the gain of the line amplifier is controlled by the 7266-kHz line pilot operating through a computer (Fig. 6).

3.17 Dynamic (active) gain equalization is provided by five gain shapes, the magnitude of each shape being controlled by the five line pilots, 308, 556, 2064, 3096, and 8320 kHz, operating through a computer.

3.18 The gain of the line amplifier is controlled by one of two types of demountable, hermetically sealed regulators. Normally, every fourth auxiliary repeater is of the pilot-regulated type, which has the same external appearance as the thermometer-regulated type. Deviations from ideal characteristics which vary with time at such a rate that they would cause excessive departures from the required gain-frequency characteristic within normal line-up periods, are equalized automatically. The principal contributor to the above type of deviation is the change in the cable loss with temperature. This is equalized at an auxiliary repeater by varying the gain of the line amplifier by means of a thermistor-controlled regulating network in the amplifier. The current controlling this thermistor is fed in one of two ways as follows.

(a) At a dynamic-regulated auxiliary repeater, the current through the thermistor is fed from a regulator controlled by the 7266-kHz pilot. The gain of the line amplifier is varied to hold this pilot at a predetermined power.

(b) At a thermometer-regulated auxiliary repeater, the current through the thermistor in the regulating network is fed from a thermometer regulator that is controlled by a thermistor in the 154-type regulator buried near the cable. The gain of the line amplifier at these auxiliary repeater stations varies in accordance with the earth temperature (which varies the cable temperature) at the point where the 154-type regulator is buried. (See 3.11).

3.19 The remaining gain deviations are corrected by equalizer networks whose loss-frequency characteristics are varied by means of thermistors. These equalizer networks are designated as DYN EQL 1, DYN EQL 2, etc., in Fig. 15. The two "major" deviations (gain changes due to variations in the temperature of the repeater and aging of the electron tubes) are corrected at intervals of approximately 32 auxiliary repeater sections at equalizing auxiliary or equalizing main repeaters and the remaining three dynamic equalization deviations by DYN EQL 3, 4, and 5, located in equalizers B1 and B2 at switching main repeaters. The characteristics provided have been referred to as "cause shapes" (See 3.14) and are outlined as follows.

(a) DYN EQL A1 is designed to regulate the loss of an equalizer network in accordance with the variation in power of the 3096-kHz pilot appearing at the output of the receiving line. The major cause of deviations in power is due to variations in the temperature of the repeater.

(b) DYN EQL A2 is designed to regulate the loss of an equalizer network in accordance with the variation in power of the 2064-kHz pilot. The primary cause of deviations in power is due to the change in the transconductance of the electron tubes (aging).

(c) DYN EQL B1 equalizer supplements equalizers A1 and A2. This equalizer is controlled by 556 kHz. Deviations in gain are largely due to variations in the temperature of the repeater.

(d) DYN EQL B2 consists of two dynamic equalizers, one controlled by the 308-kHz regulator and the other by the 8320-kHz regulator.

3.20 The above-mentioned deviations are all "broad shapes" and cover the major portion of the frequency range. The equalizer correction characteristics tend to interact with one another if each is controlled directly by a regulator. To overcome this, a computer is employed. The computer is connected to all of the regulators at equalizing auxiliary, equalizing main, switching main, and terminal main repeaters in the dc portion of the regulator, thus interconnecting all of the regulators. The controlling current for the thermistor in each of the dynamic equalizers (and the regulator network in the line amplifier) is controlled by the dc amplifier of the associated regulator via the computer.

E. Manual Adjustable Gain Equalization

3.21 Manually controlled gain equalization is provided by a group of equalizer networks that have loss-frequency characteristics harmonically related to each other and each affecting the entire frequency range of 308 to 8320 kHz. There are 15 of these networks in an all-telephone system or in a combined telephone and television system at equalizing points. These networks are called "cosine equalizers" and the designation is derived from the mathematical formula used in the computations for the networks. The basic network provides the loss-frequency characteristic representing the fundamental shape for the harmonic series with supplementing sections providing loss-frequency characteristics which are second, third, fourth, etc., harmonics of the fundamental loss-frequency characteristics. These sections are designated 1 (first cosine shape) (fundamental), 2 (second cosine shape), 3 (third cosine shape), etc., and are shown in block form in Fig. 15.

3.22 The cosine equalizers cannot be lined up by transmitting specific test tones and adjusting a single equalizer knob since each knob affects the entire frequency range. A sweep signal, flat with frequency, 350 kHz to 8250 kHz, is transmitted from a switching or terminal main repeater. At the equalizing repeaters a cosine adjustment set is provided and each cosine equalizer adjusting knob is adjusted until the reading on the meter is at a minimum. The meter reading is an indication of the power in the harmonics; therefore, with a minimum reading the amplitude of the harmonics has been decreased and flattened out so that all frequencies have the same power. Hence, it can be stated that the line is equalized.

3.23 The 308-kHz equalizer has a manually adjustable equalizer which furnishes added "bump" equalization at the low-frequency end of the line-frequency band. This enables the 308-kHz pilot to operate on the low-frequency portion of the band. This equalizer supplements the cosine equalizers to optimize the pilot power when the lines are equalized. (See Fig. 13.)

F. Delay Equalization

3.24 The transit time of the line frequencies is not uniform, the higher frequencies being delayed with respect to the lower frequencies in travel time. This difference in speed of transmission is not noticeable in a telephone system as each individual channel occupies a very small percentage of the line frequency spectrum. However, in a system being used for television, the frequency spread of the television signal is more than 4 MHz and the difference in the transit time of this bandwidth is considerable and requires equalization for the transmission of a satisfactory television signal. Delay equalization is accomplished as follows.

(a) Delay equalization is provided for combined systems.

(b) The delay equalization is in the television branch of the line connecting circuits. This equalization is provided at each switching main and terminal main repeater. A choice of several fixed equalizers is provided to accommodate different circuit lengths. (See DELAY EQL and EQL in Fig. 13.)

(c) Adjustable delay build-out equalizers are included in the receiving high-frequency line equipment at each switching main and terminal main repeater. (See DEL BO in Fig. 13.)

(d) In long circuits supplemental adjustable mop-up gain and delay equalization is provided at approximately 400-mile intervals. These equalizers are in the television branch of the line connecting circuits at switching main or terminal main repeaters.

4. REPEATERS

4.01 The various types of repeaters used in the L3 carrier system are as follows.

(a) ***Auxiliary Repeater:*** Spaced at nominal 4.0-mile intervals on 0.375-inch coaxial cable and powered from the cable (Fig. 11 and 18)

(b) ***Equalizing Auxiliary Repeater:*** Provides supplemental equalization for approximately 32 auxiliary repeater sections and is powered from the cable (Fig. 11 and 19)

(c) ***Equalizing Main Repeater:*** Same as an equalizing auxiliary repeater except that it has facilities for supplying power to adjacent power sections (Fig. 11 and 20)

(d) ***Switching Main Repeater:*** Provides additional equalization, line switching, arrangements for message dropping facilities, and power feed to auxiliary repeaters (Fig. 11 and 13)

(e) ***Terminal Main Repeater:*** Substantially the same as a switching main repeater but all facilities are modulated down to at least supergroups in all-message systems. See Fig. 21 for the transmission circuit.

A. Auxiliary Repeater

4.02 An auxiliary repeater is a 2-way repeater providing amplification and regulation over the frequency band of 308 to 8320 kHz, closely equal to the loss of 4.0 miles of 0.375-inch coaxial cable or 2.87 miles of 0.27-inch coaxial cable. The repeater is generally located in unheated, insulated, concrete block structures. The equipment for use in a standard auxiliary hut consists of a shop-wired, duct-type bay 6 feet high by 22-5/16 inches wide by 15-3/4 inches deep. A transmission panel for the odd direction of transmission and a second one for the even direction of transmission are mounted at the top of the bay. Three panels comprising the power supply are mounted at the bottom of the bay. The line loading equipment, when used, is mounted at the bottom of the bay with the power supply. Figure 7 shows the bays in a typical auxiliary repeater hut. Where repeater spacing is less than 3.8 miles, build-out networks are required. Power separation filters are used to separate and combine high-frequency line currents and power. Power for the repeater is derived, by means of transformers, from a constant-current source power loop formed by looped center conductors of the two coaxial cables making up the 2-way circuit. Figure 18 is a block schematic of the repeater showing the units for transmission in two directions.

4.03 Two types of auxiliary repeaters are provided as follows.

(a) The thermometer-regulated repeater in which the gain of the line amplifier is controlled by a thermistor mounted in the 154-type regulator buried near the transmission cable and adjacent to the repeater station. Thermometer-regulated repeaters are not equipped with alarms.

(b) The pilot-regulated repeater in which the gain of the line amplifier is controlled by an auxiliary regulator operating from the 7266-kHz pilot. A pilot alarm unit is provided which gives an indication of abnormal 7266-kHz pilot power over an alarm pair to an alarm locating point at a main station.

B. Equalizing Auxiliary Repeater

4.04 The equalizing auxiliary repeater performs the same function as an auxiliary repeater and furnishes added equalization through the A1 and A2 equalizers. It employs the same type power separation filters, basic equalizers, artificial lines, and amplifiers. The dynamic equalizer characteristics and gain of the line amplifier are controlled through regulators controlled by the pilot pair of the 3096-, 2064-, and 7266-kHz pilots via the computer. Figure 19 is a block schematic showing the units employed in this repeater. This repeater is generally housed in a 15-foot by 15-foot building and consists of a transmission bay for each direction of transmission per coaxial cable, several power bays, and one rectifier bay per repeater location. Transmission panels are double-sided, an amplifier being mounted on the front and a regulator on the rear of each of three panels. Mounting and connecting arrangements are similar to those used in the auxiliary repeater except that dust covers are used. The test jacks and activity switches are accessible without cover removal. The pilot alarm unit gives an indication of the individual pilot levels and transmits an alarm to the alarm indication point whenever the level is abnormal. Power for the repeater is derived from the constant-current power loop.

C. Equalizing Main Repeater

4.05 The equalizing main repeater contains the same transmission equipment as the equalizing auxiliary repeater and in addition contains equipment for supplying power to local equipment and adjacent auxiliary repeaters. The equipment is mounted on 11-foot 6-inch bays in heated buildings. Alarm, alarm locating, and alarm transfer equipment is provided, where required, to permit unattended operation of the station. (See Fig. 20.)

D. Switching Main Repeater

4.06 A switching main repeater is a 2-way repeater providing the same functions as an equalizing main repeater and, in addition, contains switching equipment which automatically replaces a failed line with a standby line. Additional equalization (to that provided at an equalizing auxiliary or main repeater) is furnished to enable all lines to be made as nearly alike as possible for line switching purposes. A block schematic of this repeater (one direction only) is shown in Fig. 13. Delay equalization is provided for the coaxial cables that are used for television. Blocking circuits are furnished which provide for the dropping of mastergroup 1, certain supergroups, or television at this repeater. Figure 14 shows some of the possible combinations of dropping facilities. The equipment is arranged for mounting on 11-foot 6-inch, duct-type bays, with approximately 32 bays being required for eight coaxial cables fully equipped. Generally this type of a repeater is located in an attended repeater office and alarm locating equipment is provided. Alarm, alarm locating, and alarm transfer equipment is also provided to permit unattended operation of the station.

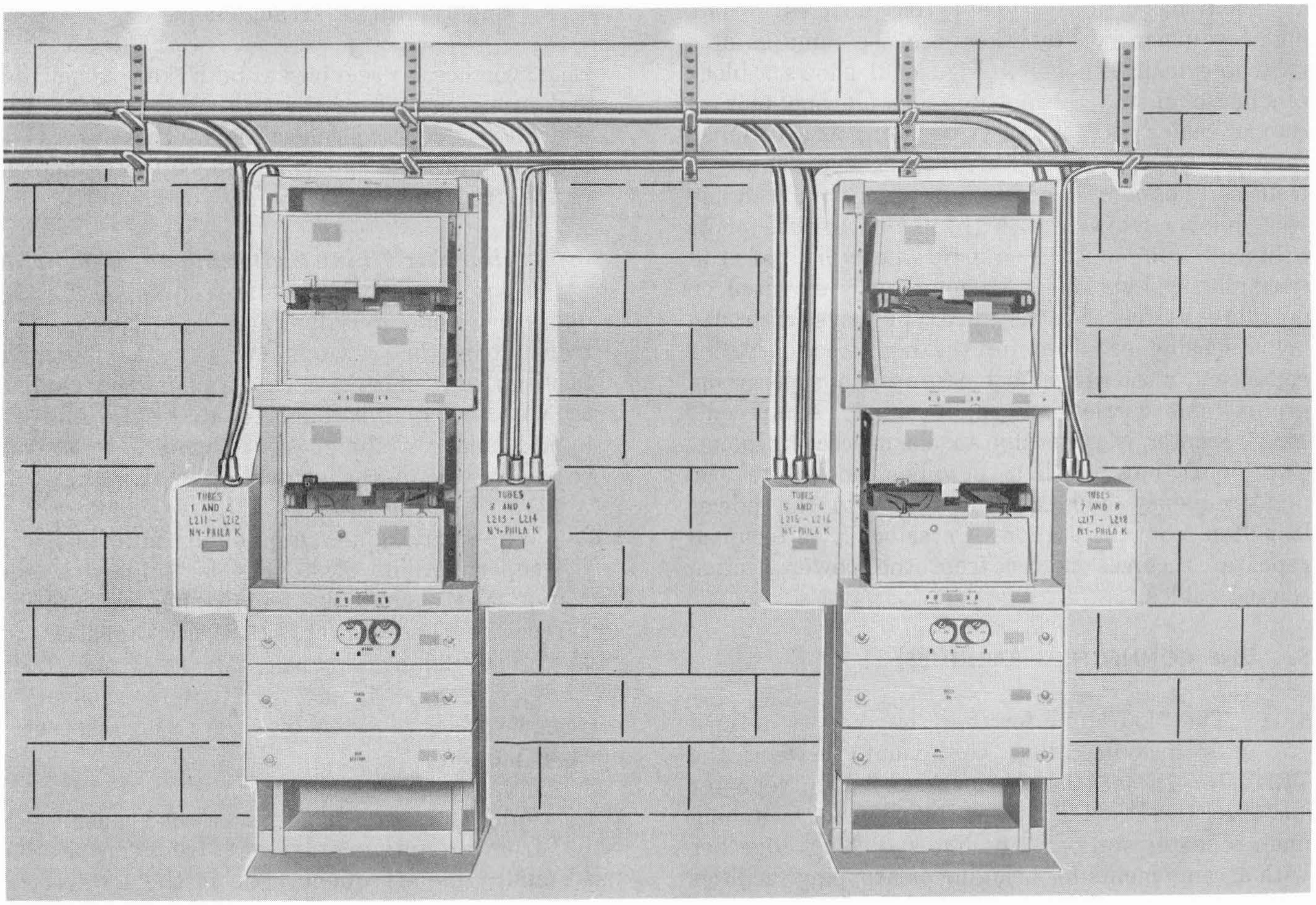


Fig. 7—Typical Auxiliary Repeater Station, Pilot Regulated

E. Terminal Main Repeater

4.07 A terminal main repeater is a repeater in which all frequencies are brought down to at least basic mastergroup frequencies. The high-frequency line functions are the same as at a switching main repeater. Figure 21 shows a block schematic of the terminal circuit for one pair of coaxial cables such as might be found at a terminal repeater that provides TV dropping and adding as well as message blocking, dropping, and adding with pilot removal and with all appropriate pilots reintroduced at the hybrid network of the transmitting hybrid. All equipment is mounted on standard 11-foot 6-inch, duct-type bays with bay layouts being provided for the high-frequency line equipment, mastergroup, submastergroup, supergroup, group, and carrier and pilot supply equipment. This repeater is generally an alarm locating point. The 505D power plant supplies power to the high-frequency line equipment and to the power loops fed from the station. Occasionally, a terminal repeater receives power from the power section coaxial cables.

5. LINE CONNECTING FACILITIES

5.01 The "L UNIT" for the L3 system is defined as including that equipment between the TRSG HY IN jack at one switching main repeater and the PIL HY OUT jack at the adjacent switching main repeater station. The line switching, together with arrangements for bridging or dropping facilities (message or television), is considered to be a part of the line connecting facilities. This includes the delay and supplementary gain equalization when television facilities are transmitted over the system. Line connecting arrangements are different for the two types of services provided for by the system.

A. Line Switching Arrangements

5.02 Two general types of automatic line switching arrangements are provided as follows.

(a) ***Automatic Multiline, Expanded Multiline, or Supermultiline Switching Arrangements:*** These arrangements permit one standby line in each direction to serve the following:

(1) Two to four regular lines in the multiline arrangement

(2) Four to eight regular lines in the expanded multiline arrangement

(3) Six to twelve regular lines in the supermultiline arrangement.

Line switches are required at both the transmitting and receiving ends of the switching section. The operation and synchronization of these switches are accomplished by means of switching signals in the frequency range of 280 to 296 kHz.

(b) ***Automatic 2-Line Switching Arrangement:*** When only two lines are equipped for L3 operation (one regular and one spare), the transmitting line switch and associated control facilities are omitted. The transmitting end of the standby circuit is connected to the transmitting hybrid and switching is provided only at the receiving end of the switching section.

5.03 When multiline, expanded multiline, or supermultiline switching is employed, the operation and synchronization of the transmitting and receiving line switches are accomplished by means of switching signals. These signals (280, 282, 284, 286, 288, 290, and 296 kHz) are transmitted between switching repeaters over the L3 high-frequency lines in parallel.

(a) Fully automatic facilities switch transmission from a faulty regular high-frequency line to a standby high-frequency line in the L3 system.

(b) Fully automatic facilities restore transmission to the regular high-frequency line after its fault has been cleared.

(c) Manual facilities release a regular high-frequency line or the standby line for either corrective or preventive maintenance.

(d) Visual and audible alarms enable an attendant to rapidly analyze the condition of the switching circuit at an attended as well as a remote unattended repeater.

(e) Patching arrangements facilitate the tracing of switching signals for maintenance or troubleshooting.

5.04 Briefly, the multiline, expanded multiline, and supermultiline switching facilities operate in the following manner.

(a) At the receiving end, a 2-dB deviation from the required level of any of the pilots causes the switch initiator associated with the deviated line to cause a slow switch by:

(1) Blocking the transmitting switch control in the succeeding switching section for several seconds in order to prevent all switching sections from transferring

(2) Sending out an identification tone which initiates the switch transfer at the "head" or transmitting end of the section in trouble

(b) When the transmitting switch transfers, a verifier tone is sent back to the receiving end of the switching section where it causes the switch initiator associated with the deviated line to transfer the receiving line switch.

(c) When normal levels are restored, the switch initiator restores the receiving line switch to normal and sends out a release signal to the transmitting end of the switching section where it causes the transmitting line switch to restore normal connections. When this occurs a release check tone is transmitted to the receiving end of the section where it cuts off the release signal and restores the interlock circuit in the switch initiator to normal.

(d) In order to reduce the time required to initiate a switch, the dc output of the 7266-kHz regulator is also applied to an expandor circuit, which causes an automatic switch when the 7266-kHz pilot deviates beyond a normal range of ± 3 dB. This electronic control eliminates the operating time of the 7266-kHz ALM relay so that a "fast" automatic switch results from a quick change in the 7266-kHz pilot.

5.05 When only two lines are equipped for L3 operation, a 2-dB deviation from the required level of any of the pilots causes the switch initiator associated with the deviated line to:

(a) Block the transmitting switch control in the succeeding switching section for several seconds in order to prevent all switching sections from transferring.

(b) Cause the line switch (at the receiving end only) to transfer and receive service from the standby line in place of the deviated line.

The "fast" switch also applies to 2-line switching.

B. Branching Arrangements—General

5.06 Optional equipment is provided at switching main repeaters, which permits dropping of message facilities. Typical arrangements are shown in Fig. 13(A). The delay equalizer and supplementary gain equalizer required in the television circuits are included in the line connecting circuits for the system transmitting combined message and television service.

5.07 As shown in Fig. 13(A), the message dropping path is through the receiving branch filter REC BR FLT LP OUT to the TEL TERM IN jacks for the received signals and the transmitted signals are fed into the transmitting combining filter. If there is no message service to be dropped, the message service is bypassed through the TEL PASS PAD. If neither television nor message service is to be dropped, the LINE CONNECT PAD is used.

5.08 If multiline switching is employed, it is necessary to eliminate the switch control tones (280 to 296 kHz) to prevent activation of the following switching section. The switch tone band-elimination filter is provided for this purpose. It is shown in the TEL PASS PAD and LINE CONNECT PAD circuits. (See Fig. 13.)

C. Branching in an All-Message System

5.09 Branching or dropping of facilities is accomplished as follows.

(a) At terminals, all of the line frequencies are brought down to basic mastergroup frequencies and branching connections are made at the high-frequency patch bay. This involves the use of message terminal equipment which is not considered as line connecting equipment. New line pilots are introduced at the transmitting hybrid.

(b) Partial dropping or branching at switching main repeaters in which mastergroup 1 or certain supergroups are separated from the through transmission path at line frequencies. The equipment required to accomplish this is considered to be a part of the line connecting arrangements.

5.10 Figure 13(C) shows the method used when it is desired to drop mastergroup 1 or submastergroup 1. The wanted frequencies are blocked by the proper selection of filters and the pilots are bypassed by the pilot pass filters. Figure 13(D) shows the arrangements at a terminal.

5.11 More detailed block diagrams of blocking circuits for all-message systems are shown in Fig. 14(A) and (B). In Fig. 14(A) mastergroup 1 is dropped and the four indicated pilots are bypassed. Figure 14(B) shows supergroups 12 through 18 blocked with pilots being bypassed. The 7266- and 8320-kHz pilots are not affected by the blocking filters, so it is not necessary to bypass them.

D. Television Branching in a Combined Message-Television System

5.12 Figure 21 is a block schematic showing the line connecting circuits at a combined system dropping location. The pilot-elimination filter in the television path suppresses transmission of the 7266- and 8320-kHz pilots. Six new pilots are reinserted on the outgoing side of this repeater. The interconnecting circuits to the local television receiving terminal are taken from the through path by means of the television branch hybrid. The television transmitting branch for a locally initiated program is through the combining filter and through to the transmitting hybrid.

E. Message Branching in a Combined Message-Television System

5.13 The filters and arrangements outlined in Part 5C for dropping less than the full mastergroup are also used for message branching in a system transmitting combined message-television facilities. The location of these filters in the circuit is illustrated in Fig. 14(C).

6. SYSTEM CONTROL AND SUPERVISORY ARRANGEMENTS

6.01 The facilities required for the control and supervision of system transmission are described in this part. Briefly, these consist of pilot frequencies supplied to the line at pilot insertion points, pilot indicators and alarms, line switching, remote supervision of auxiliary repeater alarms, remote supervision of unattended main stations, order circuits, and PEARL test arrangements.

A. Pilot Arrangements

6.02 The dynamic transmission control of the system is provided by the use of six pilot frequencies, 308, 556, 2064, 3096, 7266, and 8320 kHz. These pilot frequencies are generated and made available through a pilot supply. The pilot supply is patched to the system at the HY NET jack of the transmitting hybrid of a terminal main repeater (see Fig. 21). Figure 22 is a block schematic of the circuit used to generate the pilots and various other frequencies.

6.03 In general, a long-haul carrier route will have pilots blocked and reinserted at several points to facilitate pilot handling at complex dropping or branching points and to simplify system transmission line-up. The line between pilot insertion points is called a pilot link and usually consists of several switching sections. The number of pilot links in an all-message system depends upon the number of points at which all line frequencies are brought down to supergroups to meet service or frogging requirements.

6.04 Switching main repeaters with message dropping facilities are provided with combinations of mastergroup or supergroup blocking and pilot passing filters to permit through transmission of the pilots to succeeding line sections as is shown in Fig. 14(A) and (B). The blocking and pilot passing filters required depend upon which facilities are to be dropped. Pilot passing filters are available for the 308-kHz, 556-kHz, 2064-kHz, and 3096-kHz pilots. The 7266- and 8320-kHz pilots do not require pilot passing filters as they are not blocked by the mastergroup or supergroup blocking filters.

B. Functions of Pilot Indicators

6.05 A pilot indicator panel is provided for the high-frequency receiving line at switching main, terminal main, and equalizing main repeaters. At switching or terminal main repeaters, the pilot indicator panel is equipped with indicating meters and relays (Sensitrol®) to measure and provide alarm circuits for all six pilots. At equalizing auxiliary and equalizing main repeaters, three pilots are used for regulating purposes and the pilot indicator panel is equipped accordingly.

6.06 Operating currents for the indicating meters and Sensitrol relays are obtained by interconnection to the pilot regulators at the repeaters. Figure 8 is a schematic of two of the circuits used. The pilot regulators at the equipped repeaters perform the following functions.

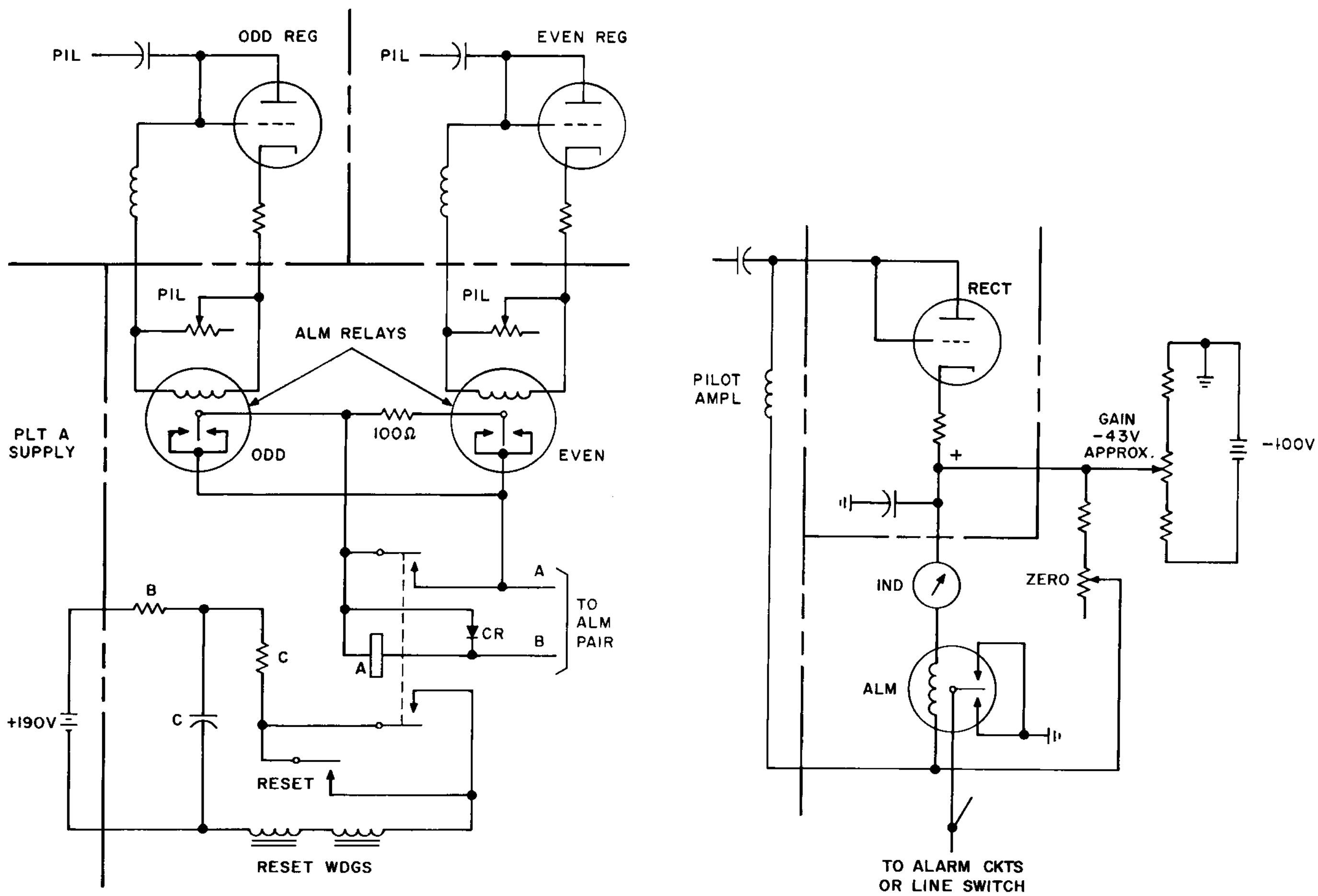
(a) Provide operating currents for computer-equalizer control.

(b) Provide operating currents to indicate pilot power and for Sensitrol relay control at the pilot indicator panel.

6.07 The Sensitrol relays on the pilot indicator panel are arranged with contacts to provide for operation of the alarm circuits and the operation of the line switch initiator at switching main repeaters. A pilot caused to vary from normal setting by more than 2 dB at the pilot hybrid in a switching main repeater will initiate the alarm and cause the line switch control circuits to operate and perform a slow switch. Provisions are included for a pilot alarm lamp and a Sensitrol relay resetting key. Operation of the Sensitrol relay resetting key, designated ALARM RESET, permits the relay to be reset for normal operation after an alarm has been cleared.

C. Remote Indications and Control

6.08 Pilot alarm units are furnished for the auxiliary repeaters equipped for pilot-operated regulation. Thermometer-operated repeaters are not equipped with alarm units. The auxiliary regulator furnishes operating current (proportional to the pilot power) to a Sensitrol relay on the pilot alarm unit. The relay and associated circuit are connected to the pilot alarm cable pair so that variations of more than ±3 dB in pilot level at



A. CIRCUIT OF AN AUXILIARY PILOT ALARM UNIT

B. ALARM CIRCUIT USED AT A MAIN REPEATER

Fig. 8—Pilot Alarm Circuits

the auxiliary repeater will initiate a minor alarm at the "home office." Alarm location equipment is provided at the main repeater for determining the auxiliary repeater station at which an alarm has originated.

6.09 Alarms for pilots, power, etc., at an unattended or partially attended repeater are transferred to an attended repeater by means of an alarm transfer circuit, or a remote alarm facility such as the B1 Alarm and Control System is used when required. When an alarm is received, a PEARL test set can be used to locate the repeater causing the alarm. Since each amplifier is equipped with PEARL, the exact location of a troubled amplifier can be determined.

D. PEARL

6.10 PEARL is designed for use with L3 carrier systems to provide remote identification and location of a failed or faulty amplifier in a switching section of the repeatered coaxial line. This is accomplished by inserting unique identification tones at each amplifier and then making in-service level measurements of the tones and out-of-service modulation product measurements at terminal and switching main repeater stations.

6.11 The KS-19895 PEARL test set is used for measuring the PEARL identification and modulation tones and as a source of the 4-MHz tone inserted at transmitting main repeaters for modulation tests. The PEARL test set can be used as a portable instrument for measurements at repeater locations or it can be installed as a bay-mounted instrument at switching and terminal main repeater stations. When the test set is bay-mounted, a J68830R jack field is also provided as the access and control interface between the test set and all repeatered L3 lines coming into the office.

6.12 The patching panel can also be used for other measurements requiring bridging on the L3 lines. It is possible to measure pilots or other signals from this location.

E. Order-Wire Facilities

6.13 A circuit operating over a 19-gauge cable pair is provided for local communication between auxiliary and adjacent main repeaters. Each auxiliary repeater point is bridged on this circuit and terminates in a telephone set. This set is usually placed in a wall-mounted cabinet. An adjacent main repeater may be signaled from any auxiliary repeater in the section. Provision is not furnished for signaling between auxiliary repeaters or from a main repeater to an auxiliary repeater.

6.14 Additional order circuits between main stations can be provided on a 4-wire basis. These order circuits are as follows:

(a) The express order circuit for communication between switching main stations.

(b) The super express order circuit for communication traversing several switching main repeaters.

(c) The cable order circuit.

7. TERMINALS

7.01 A general description of the terminal facilities and line pilot supplies provided for operation with the L3 carrier high-frequency line is contained in this section. Bridging, blocking, and pilot-pass equipment for message circuits, together with supplementary equalization for television circuits, are considered to be part of the line connecting equipment.

A. Television Terminals

7.02 The television terminals provided are known as the T3 transmitting and the R3 receiving television terminals. The frequency translations are shown in Fig. 9. Figure 23 is a block schematic showing the two terminals. This equipment functions as follows.

(a) The transmitting terminal passes a video signal from about 0 to about 4200 kHz, limits the maximum amplitude in the video signal, and translates the video band to the assigned band in the L3 system (3640 to 8340 kHz) in a single modulation step with a 4139-kHz carrier. The peak amplitude of the transmitted carrier is maintained at the minimum value required to transmit the television signal to achieve a minimum loading of the line repeaters. The vestigial sideband is shaped by the high-pass filter which selects the upper sideband of this modulation.

(b) The receiving terminal translates the signal in the L3 band back to the 0- to 4200-kHz video band in a single modulation step with a 4139-kHz carrier. This carrier frequency is generated locally and is synchronized with the transmitted carrier by means of a control circuit operating from information conveyed with the transmitted signal.

7.03 The T3 and R3 terminals are powered from a 505D power plant if it is available.

B. Message Terminals

7.04 Figure 24 illustrates the frequency translations involved in the L3 message terminal. The basic supergroup is made up the same as in the L1 carrier system. Supergroup 112 is shown separate from L mastergroup 1 because it is not involved in the translations employed for L mastergroups 2 and 3. This supergroup is applied to the line through the equipment associated with submastergroup 1 for mastergroup 1 only. When the system is used for combined message-television service, supergroup 112 is restricted to short-haul circuits. There are no restrictions on this supergroup when the system is used for all-message facilities. L mastergroup 1, 564 to 3084 kHz, plus supergroup 112, is fed directly to the high-frequency line; L mastergroups 2 and 3 pass through two additional stages of modulation to place them in their assigned space in the frequency spectrum of the high-frequency line.

7.05 The 3-digit numbers shown in the supergroup boxes (Fig. 24) on the high-frequency line are the supergroup designations employed for circuit layout records. These designations make it possible to trace a supergroup through the system. Section 682-200-017 describes the derivation of the designations.

7.06 The block schematic of the terminal of an all-message system is shown in Fig. 10. In a combined message-television terminal, the message terminal contains the supergroup and submastergroup equipment comprising mastergroup 1. The message and television circuits provided by these arrangements are as follows.

(a) The terminal for the combined system provides 600 channels for long-haul service and an additional 60 channels for restricted service. Eleven regular group banks and 55 regular channel banks are required.

(b) The terminal for the all-message system provides 1860 channels for long-haul service. This involves 31 regular group banks and 155 regular channel banks. (See Fig. 10.)

7.07 The L3 pilot and carrier supply arrangements are illustrated by the simplified block diagram

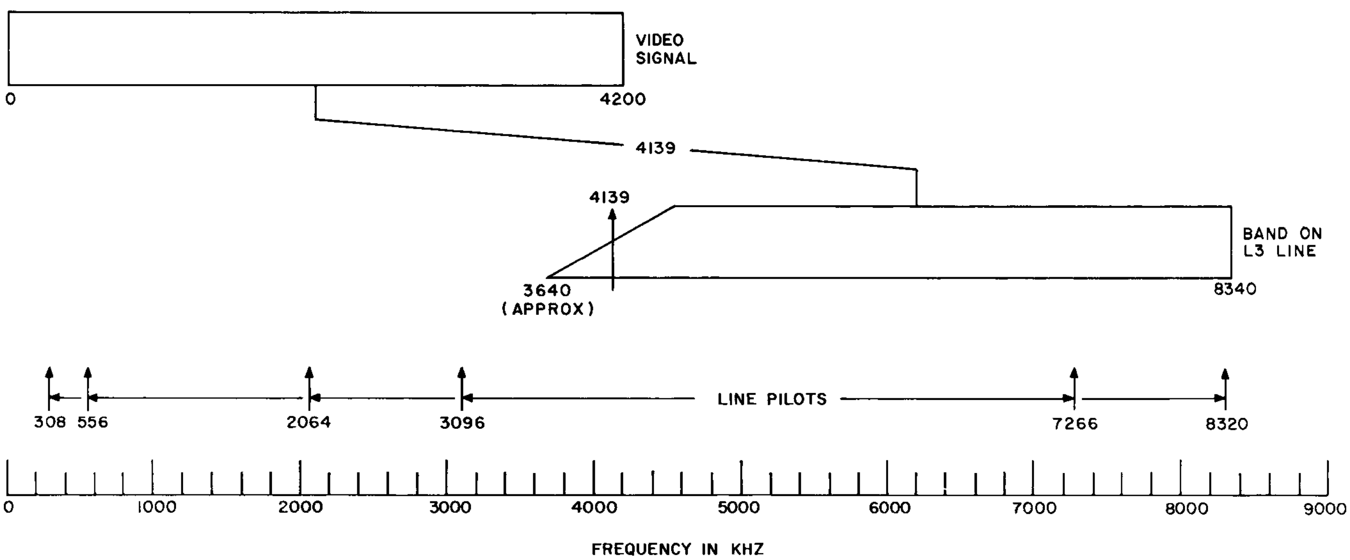


Fig. 9—Frequency Conversion Involved in the T3-R3 Television Terminal in Placing the Video Signal on the High-Frequency Line

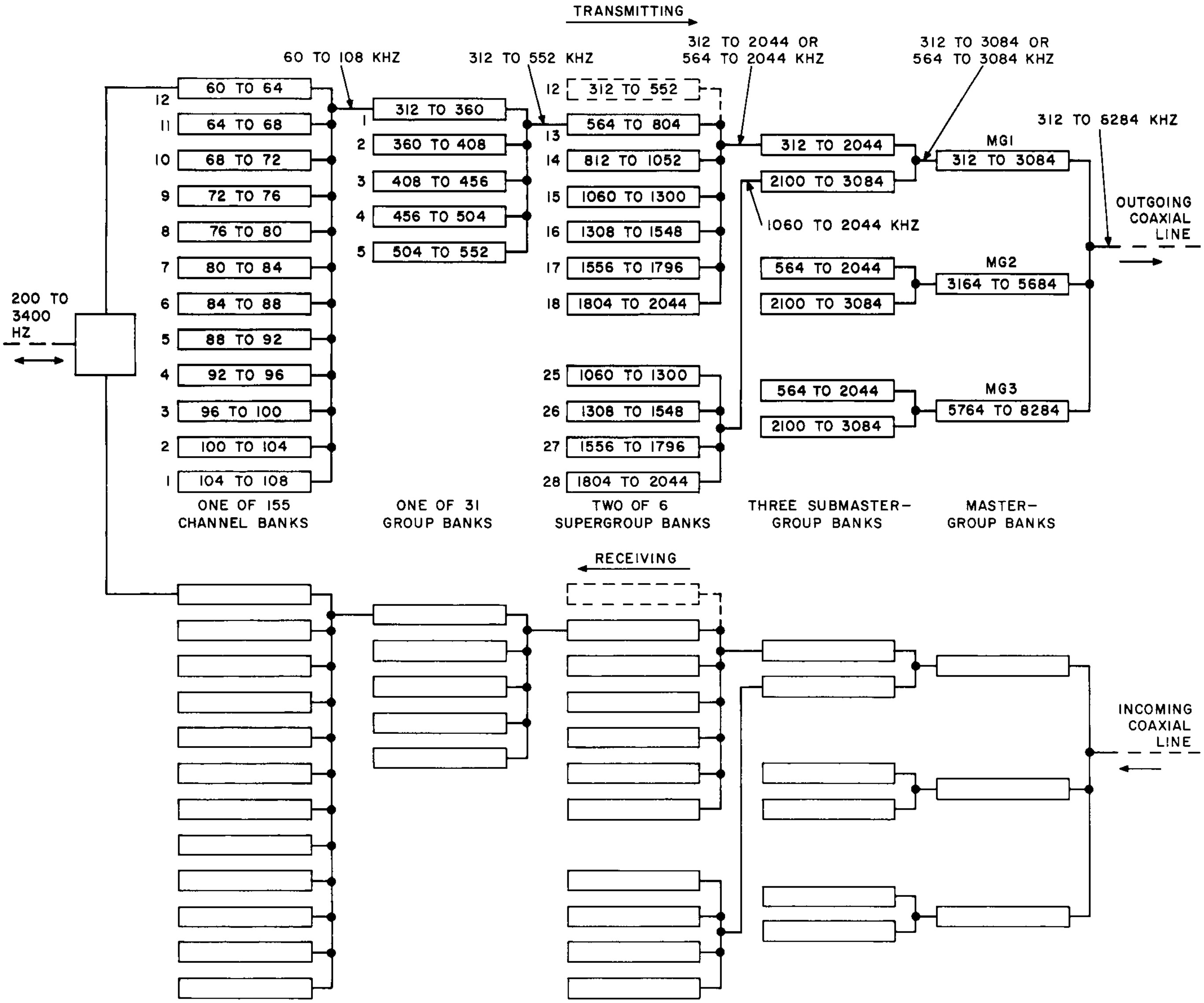


Fig. 10—L3 Carrier Message Terminal Facilities

in Fig. 22. These arrangements provide the line pilot frequencies, 308, 556, 2064, 3096, 7266, and 8320 kHz, together with the carrier frequencies, 13.0, 14.04, 15.6, and 18.2 MHz, required for the submastergroup and mastergroup modulation steps.

8. POWER FACILITIES

A. General

8.01 Power is supplied from main repeaters located at intervals of 50 to 160 miles. Unattended auxiliary and equalizing auxiliary repeaters receive power over a power loop formed by the center conductors of a pair of coaxial lines. A simplified block diagram of these power supply arrangements is given in Fig. 25.

8.02 As indicated previously, the basic spacing for L3 repeaters is 4.00 miles for 0.375-inch coaxial cable and 2.87 miles for 0.27-inch coaxial cable. This spacing is about half that for the auxiliary repeaters on the L1 system and the power required to each L3 auxiliary repeater is approximately three times that required by an L1 repeater. By using a higher line current and providing for higher voltages between the center conductor and the outer conductor, it is possible to supply power to approximately twice the number of auxiliary repeaters in the L3 system as is now being supplied over the L1 power loops. This makes it possible to use most of the existing L1 power supply points when conversion is made from L1 to L3.

8.03 The coaxial power loop is fed with ac power with a line current being held at a selected value in the neighborhood of 1.3 to 1.5 amperes. Because of slippage in the ac motor, the alternator runs at less than synchronous speed so that the frequency is approximately 58 Hz instead of 60. The value of the line current is set by the power required in the auxiliary repeater. When supplying power to a number of auxiliary repeaters in series, the line current is still held at the above value by increasing the voltage at the power transmitting point.

8.04 The power section lengths are determined by several factors, but the maximum length is restricted by the voltage limitations of the coaxial cable. Excess voltage produces corona noise and breakdown which interfere with transmission. The corona threshold can be raised by the application of sulphur hexafluoride gas (SF_6) to the cable in place of the normal nitrogen gas. When SF_6 is used, it is blocked at a point in the cable where voltages are low enough not to cause difficulty when nitrogen filled.

B. Arrangements at Main Repeaters

8.05 The arrangements at main repeater points that provide and maintain the constant alternating current on the power loop are shown in Fig. 25. The motor-alternator set and its controls, together with a power control panel, are known as the 505D power plant. The power plant is described in Section 167-671-326.

8.06 The motor-alternator set provides a continuous supply of 230 volts alternating current to a power control circuit. This set consists of an ac motor, a dc motor, and an alternator on the same shaft. Under normal conditions, switch A is closed with the ac (induction) motor, fed from commercial power, rotating both the alternator and the dc motor. When the commercial ac power fails, the ac supervisory circuits operating through the dc control cause the dc motor to take power from the battery and rotate the alternator. The ac motor is disconnected from the commercial supply (contacts A opened). This provided a continuous supply of 230 volts alternating current to the power control circuit.

8.07 The power installation includes an emergency 505D power plant. This spare supply is operated continuously with no load. A transfer circuit changes the power feed from the regular to the emergency supply when the 230-volt ac output of the regular supply fails.

8.08 The power control unit, shown in Fig. 25, provides means of maintaining the line current within required limits. This unit consists of two motor-driven, continuously variable transformers which energize the line transformer. The COARSE CONTROL variable transformer is relay controlled and maintains the line current with ±3 percent of the prescribed magnitude. The range of this transformer is sufficient to permit reducing the voltage to zero in order to turn down power on the system for maintenance purposes. The FINE CONTROL transformer provides for minute control of the voltage and is regulated by an electronic regulator to maintain the line current within ±1 percent of the desired magnitude.

8.09 The power supplies for the office equipment are shown in Fig. 25. The power supplies (metallic rectifiers, etc.) for the high-frequency line equipment are connected on the line side of the power control circuit so that when power is turned down on the line it will also be removed from the high-frequency line repeater equipment. When line connecting and television equipment is provided, its power supplies are connected on the alternator side of the power control circuit, thereby providing power to this equipment even though the high-frequency line power is turned down.

C. Arrangements at Auxiliary and Equalizing Auxiliary Repeater Stations

8.10 Power for the auxiliary and equalizing auxiliary repeater is fed over a power loop formed by the center conductors of the two coaxial cables required for 2-way transmission (Fig. 25). An auxiliary repeater equipped with a pilot regulator requires approximately 166 volt-amperes, and one equipped with a thermometer regulator requires approximately 135 volt-amperes. An equalizing auxiliary repeater requires a total of 350 volt-amperes.

8.11 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 more efficient and controllable rectification, reduction of the harmonic distortion that is introduced on the coaxial line, and reduction of operating voltages to more nearly their nominal values. PS1 and PS2 power supplies are described in Section 359-010-120.

8.12 Four dc voltages are provided at auxiliary repeaters as follows:

(a) +315 volts—used for the plate supplies on the output stage of the amplifiers

(b) +190 volts—used for the plate supplies on the first three stages of the amplifiers and for the plate supplies on the regulators

(c) +100 volts—used for grid bias for all stages of the amplifiers

(d) -100 volts—used for grid supplies for the regulators.

8.13 The power arrangements at equalizing auxiliary repeaters are shown in simplified form in Fig. 19. This power supply employs, in general, the same types of units as those used at auxiliary repeaters. It is necessary, however, to supply plate, heater, and bias power for six amplifiers and six dynamic regulators. The three units, feeding main and auxiliary power, supply the +190 and +315 volt plate supplies for both the amplifier and the regulators but do not supply heater power. The heater power for the amplifiers and regulators and the -100 volt and +100 volt bias for the amplifiers and regulators are supplied by the fourth unit. The miscellaneous power unit of this group supplies 230 volts alternating current to a 130-volt rectifier for -100 volt bias and two heater and bias supplies. The latter two units are of the same type as those used at the main repeater station.

D. Miscellaneous Power

8.14 The ***plate voltage limiter*** (Fig. 19) limits the plate voltage applied to the electron tubes, during power turn-up operations, until the tube heaters have warmed up. This prevents injury to the tubes. The unit is installed at equalizing auxiliary repeaters and is also installed at terminal repeaters which are power receiving.

8.15 The ***maintenance power supply*** provides ac power for test and maintenance equipment at auxiliary and equalizing auxiliary repeaters which are inaccessible geographically to truck-mounted mobile power sources or where commercial power is not available. (See Fig. 18 and 19.)

8.16 The ***power transfer unit*** connects power supplies for voice-frequency repeaters to parallel power sections. It has a working and a standby circuit, with the working circuit connected to one pair of coaxial lines and the standby circuit connected to a second pair. In event of a power failure on one pair, the load is changed automatically to the other. (See Fig. 18 and 19.)

8.17 The power required for L3 carrier system that is not supplied from the motor-alternator in the 505D power plant is listed as follows.

(a) The terminal equipment and the carrier and pilot supply equipment derive their power from central office batteries. They require 130-volt plate and 24-volt signal and filament supplies.

(b) The line switching equipment derives its power from the central office batteries. It requires 130-volt plate and 24-volt signal and filament supplies. (This equipment also requires a negative bias supply which is derived from the -130 volt metallic rectifiers supplying power to the L3 line connecting equipment.)

(c) The alarm locating circuit requires a 150-volt source. This is derived from a separate dry battery located in a cabinet in the top of the miscellaneous bay when the alarm locating equipment is provided.

9. MAINTENANCE CENTERS

9.01 Maintenance centers for testing and adjusting regulators and for testing amplifiers are provided at various main repeater locations. The regulators are serviced and repaired at these centers. The only permissible field changes to amplifiers are a tube change, the soldering of a loose wire, or other similar work. Any change of components in an amplifier is done at an amplifier service center.

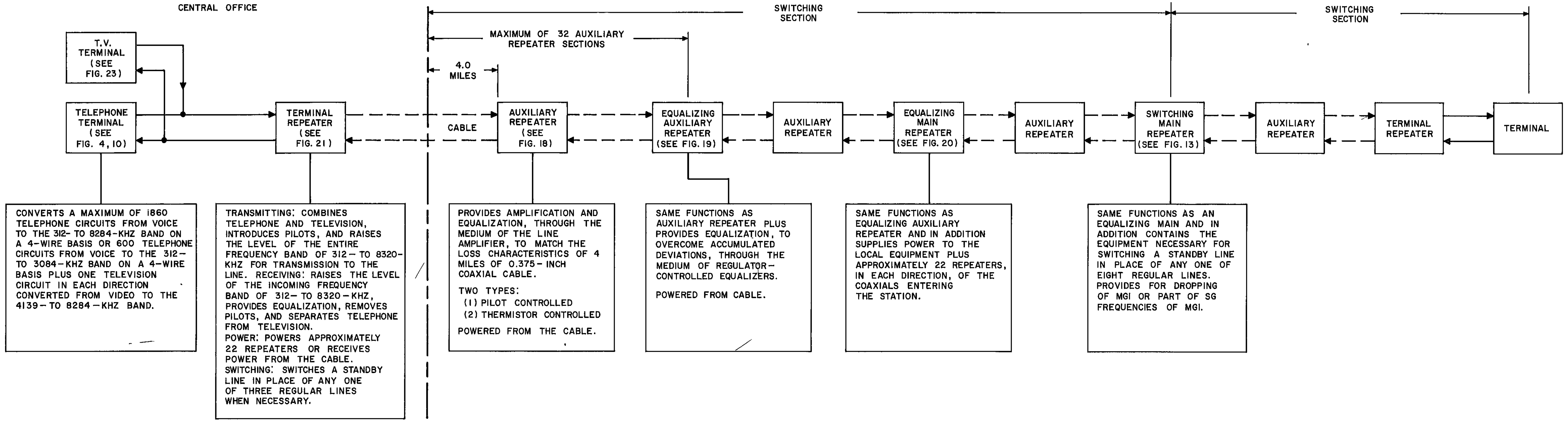


Fig. 11—L3 Carrier Overall System

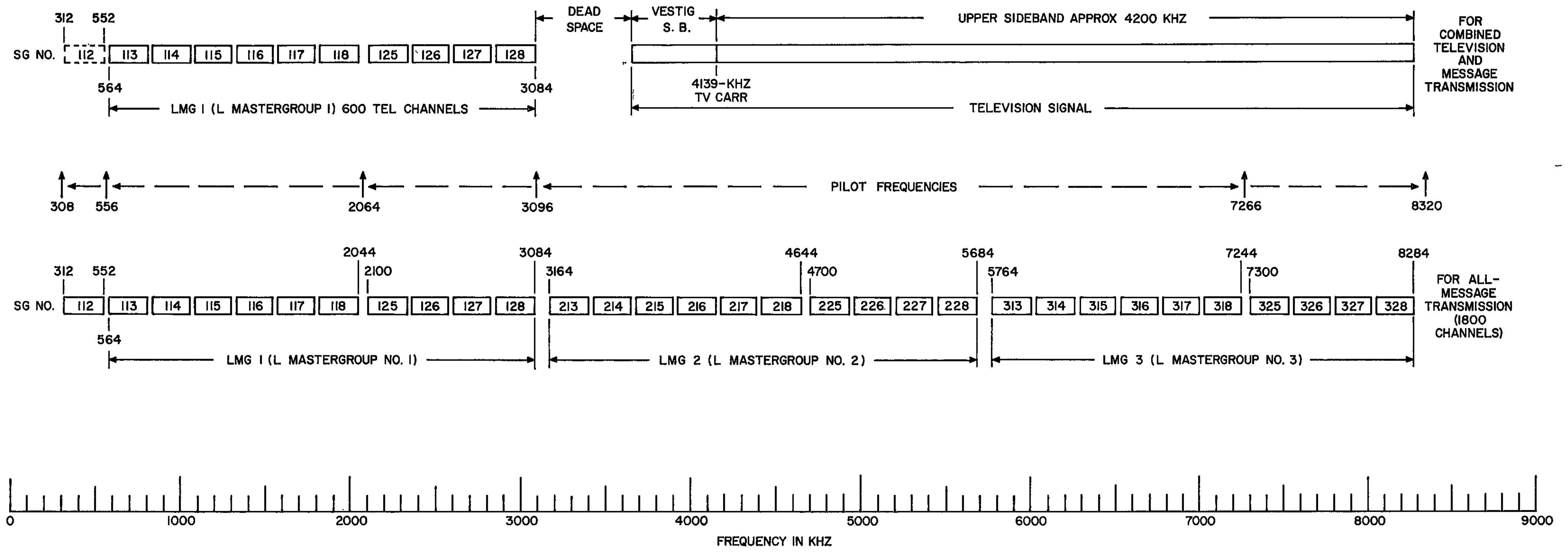


Fig. 12—Line Frequency Allocations for Systems Used for Combined Message-Television Transmission and for All-Message Transmission

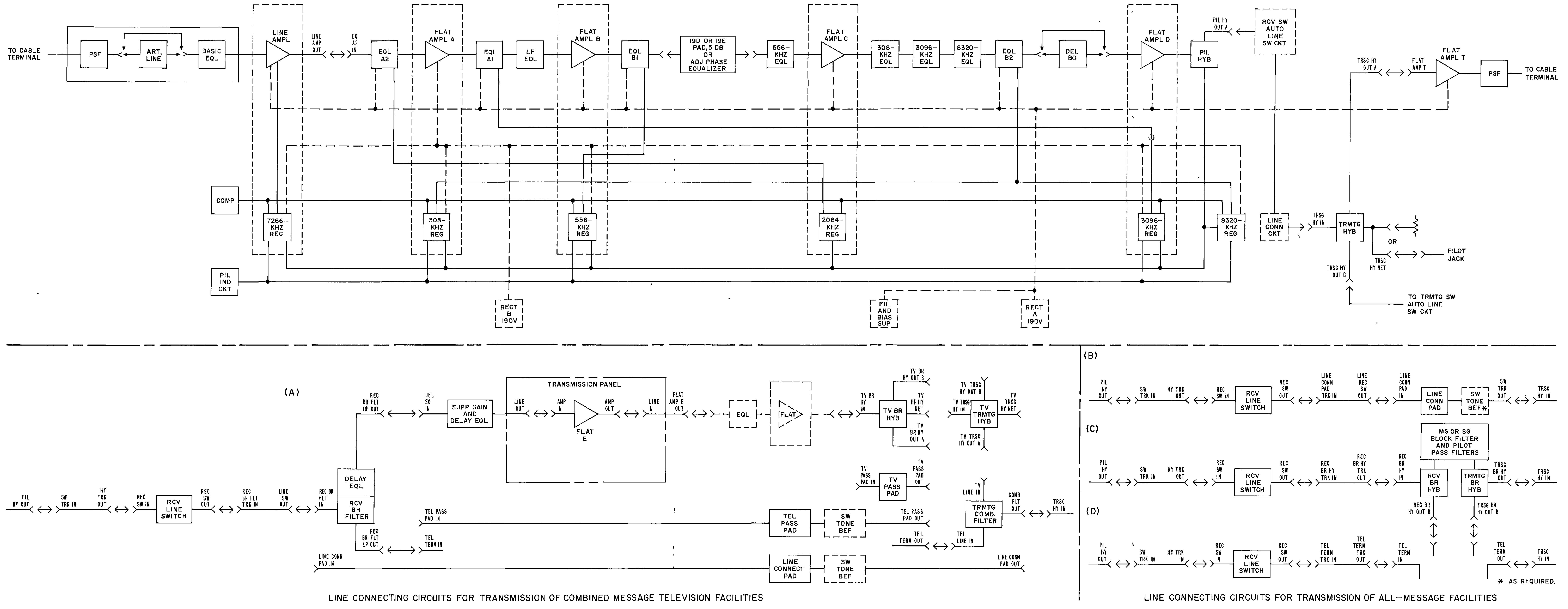
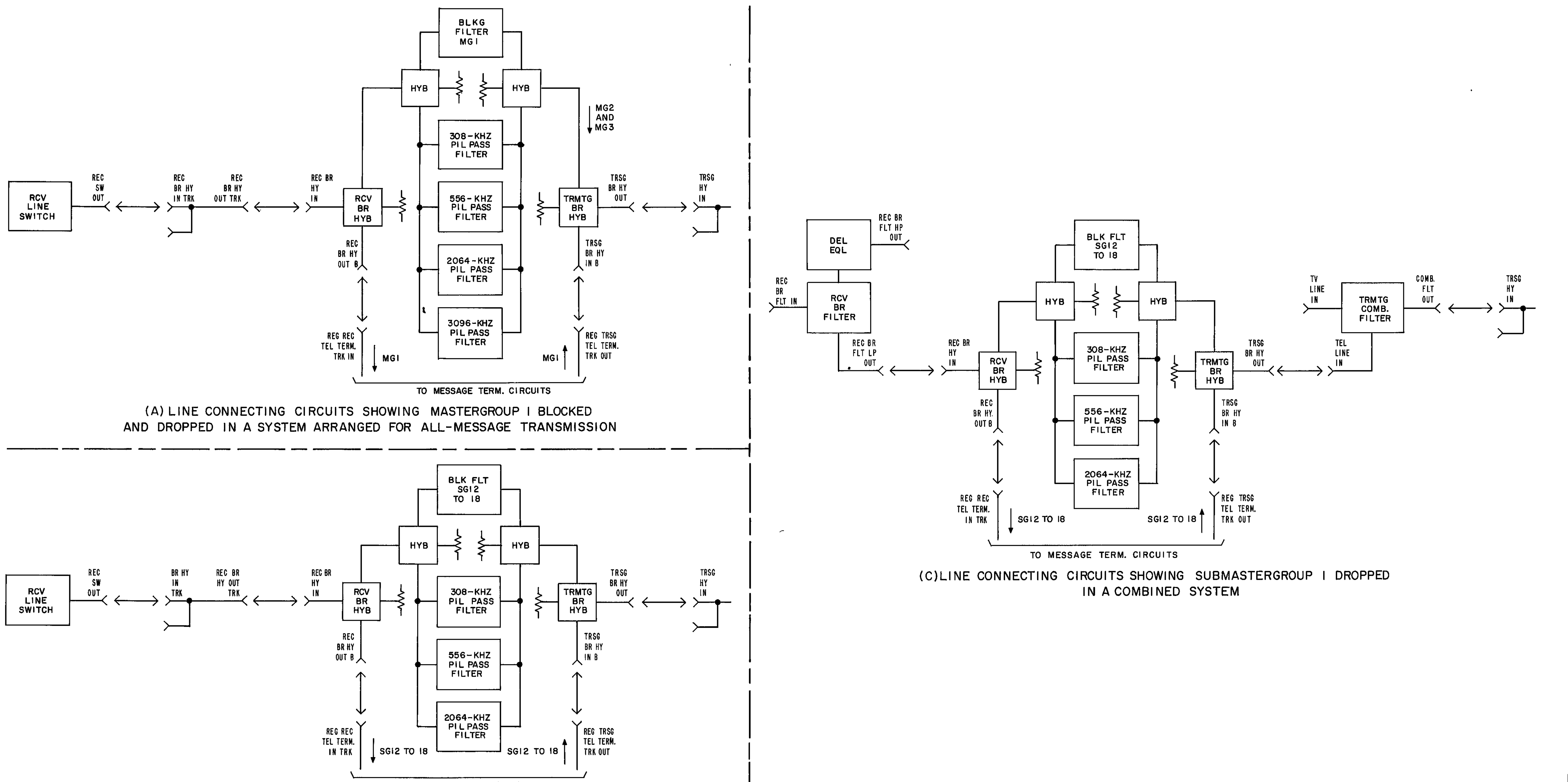


Fig. 13—Switching Main Repeater—Block Schematic



(A) LINE CONNECTING CIRCUITS SHOWING MASTERGROUP I BLOCKED AND DROPPED IN A SYSTEM ARRANGED FOR ALL-MESSAGE TRANSMISSION

(B) LINE CONNECTING CIRCUITS SHOWING SUBMASTERGROUP I BLOCKED AND DROPPED IN A SYSTEM ARRANGED FOR ALL-MESSAGE TRANSMISSION

(C) LINE CONNECTING CIRCUITS SHOWING SUBMASTERGROUP I DROPPED IN A COMBINED SYSTEM

Fig. 14—Line Connecting Circuits—Block Diagram

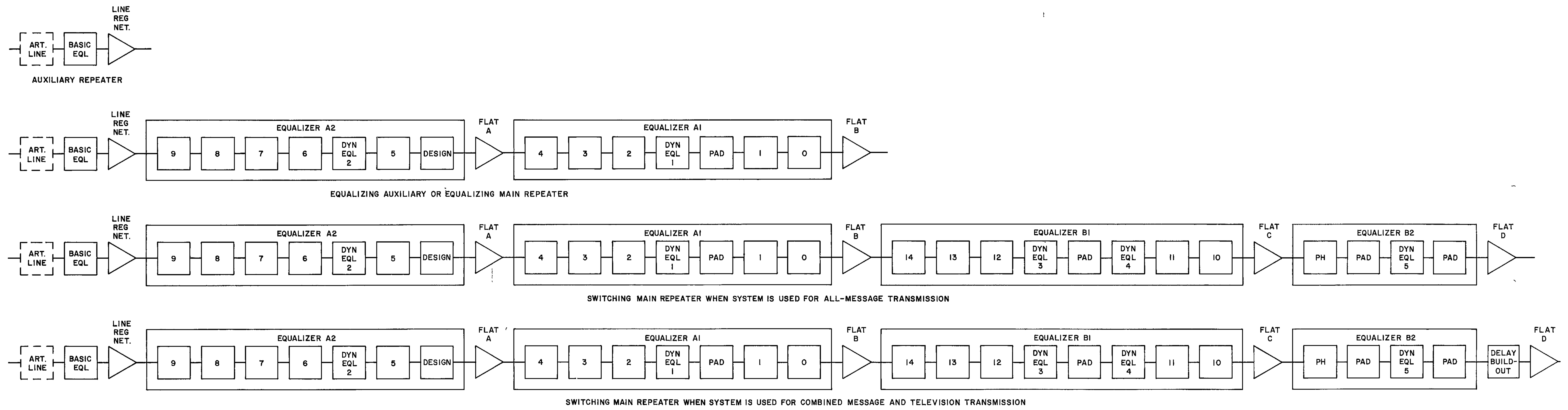


Fig. 15—Equalization and Regulation Provided at Various Repeaters—Block Diagram

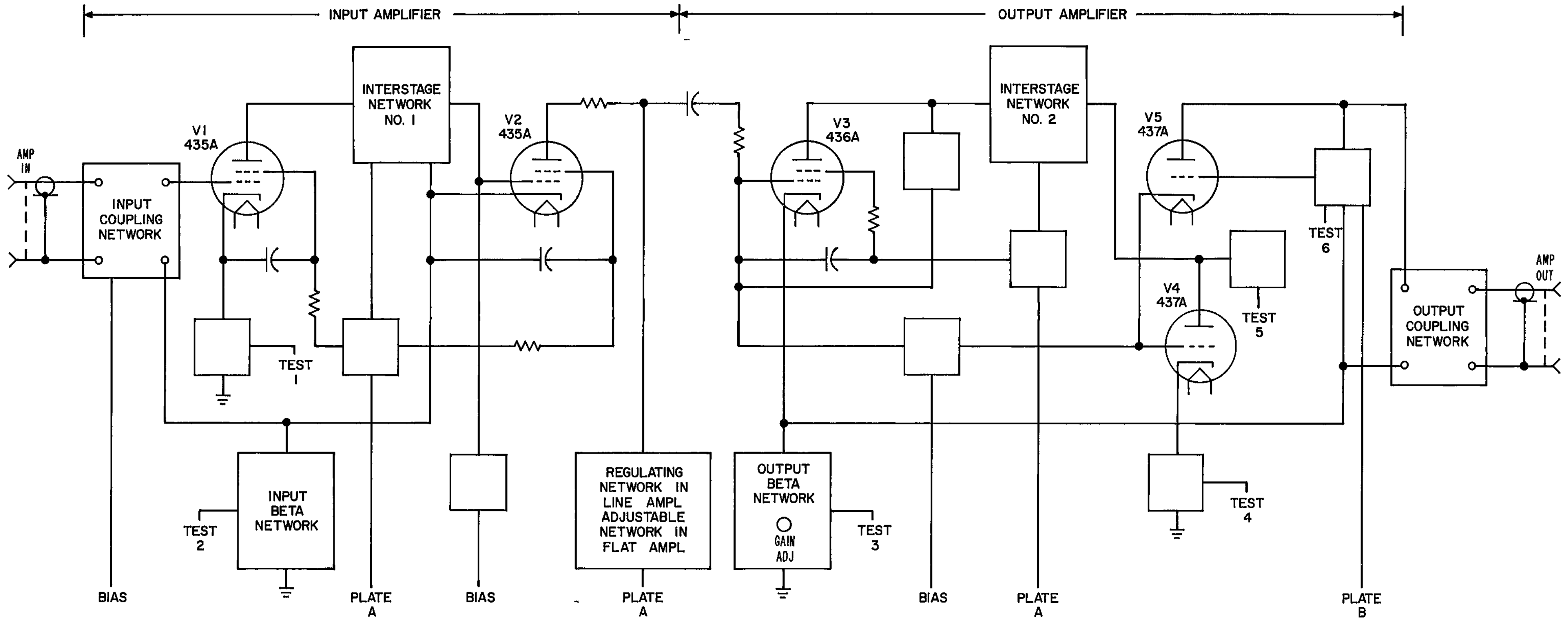


Fig. 16—Line and Flat-Gain Amplifiers—Simplified Schematic

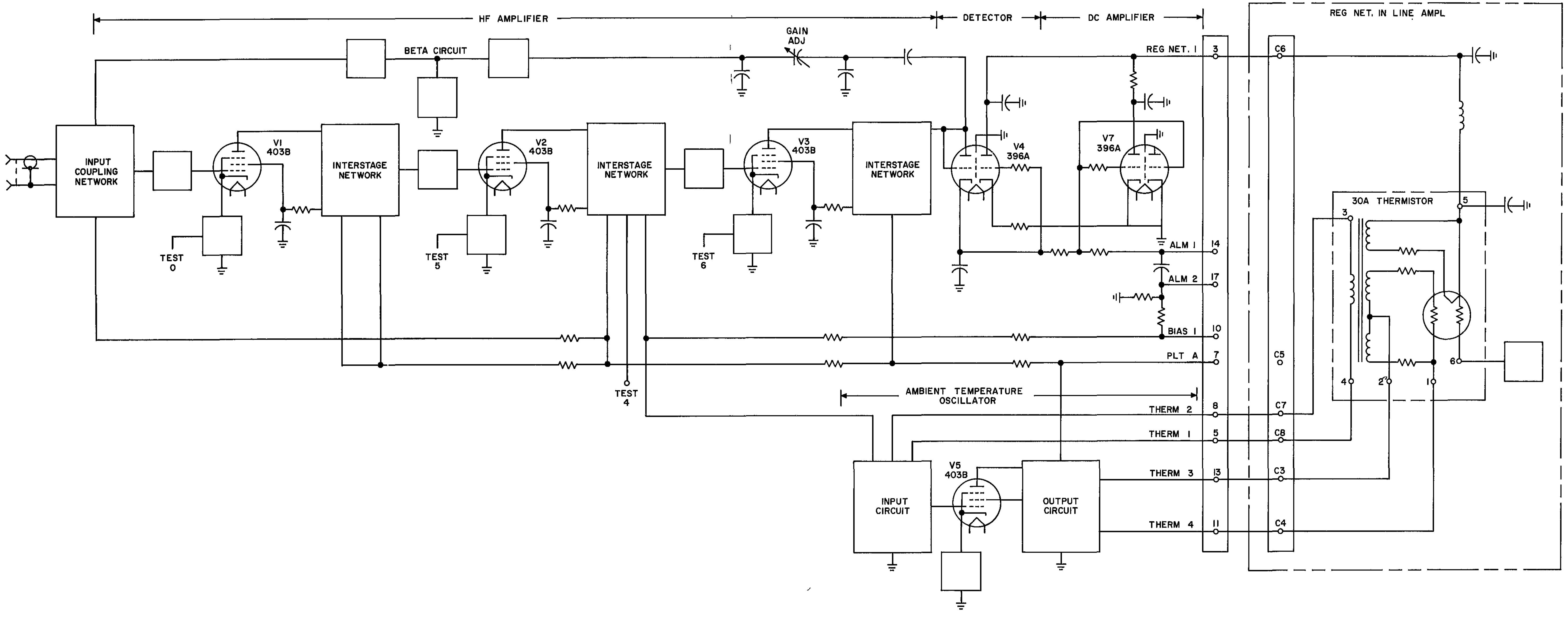


Fig. 17—Auxiliary Regulator—Simplified Schematic

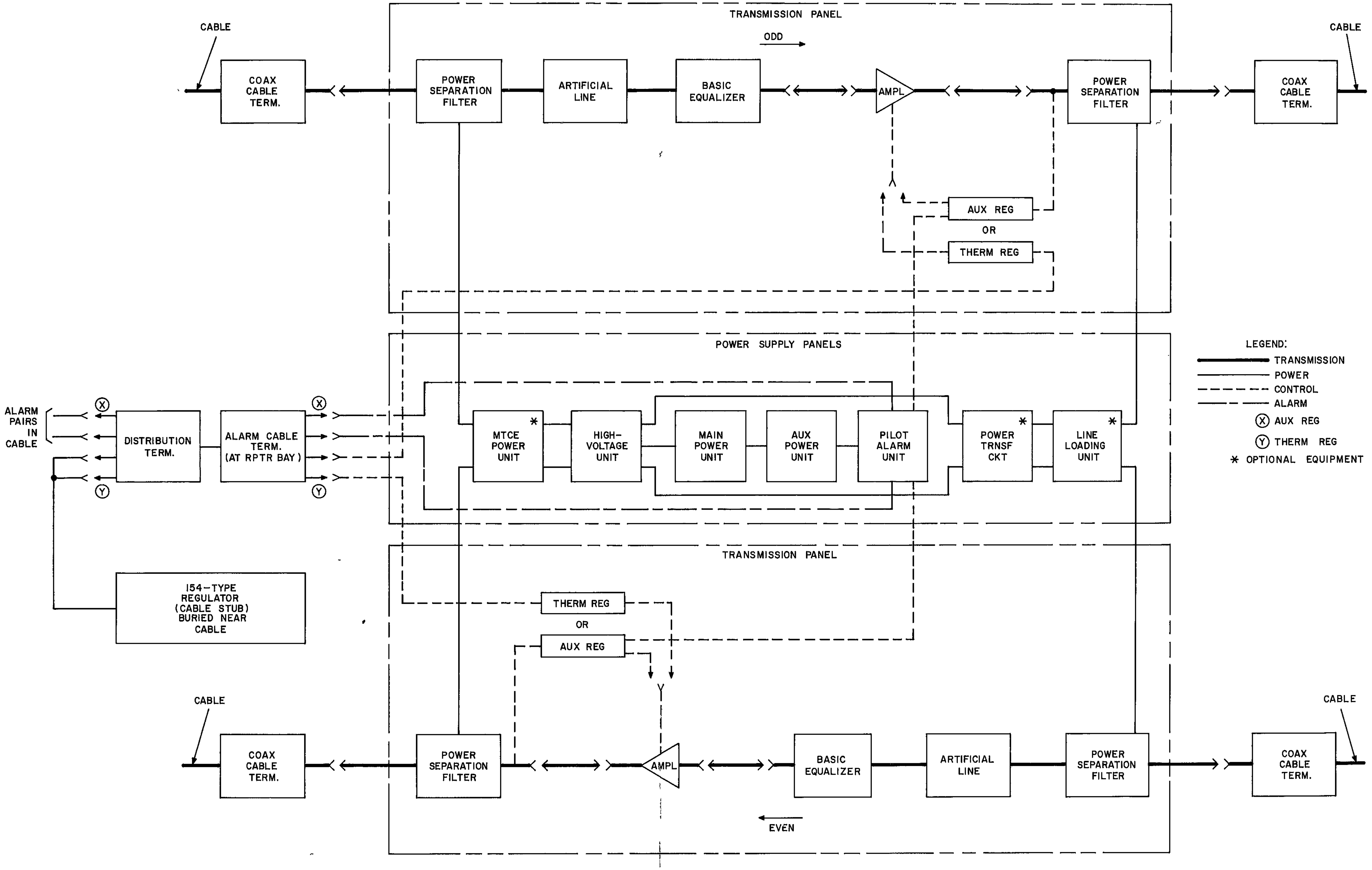


Fig. 18—Auxiliary Repeater—Block Diagram

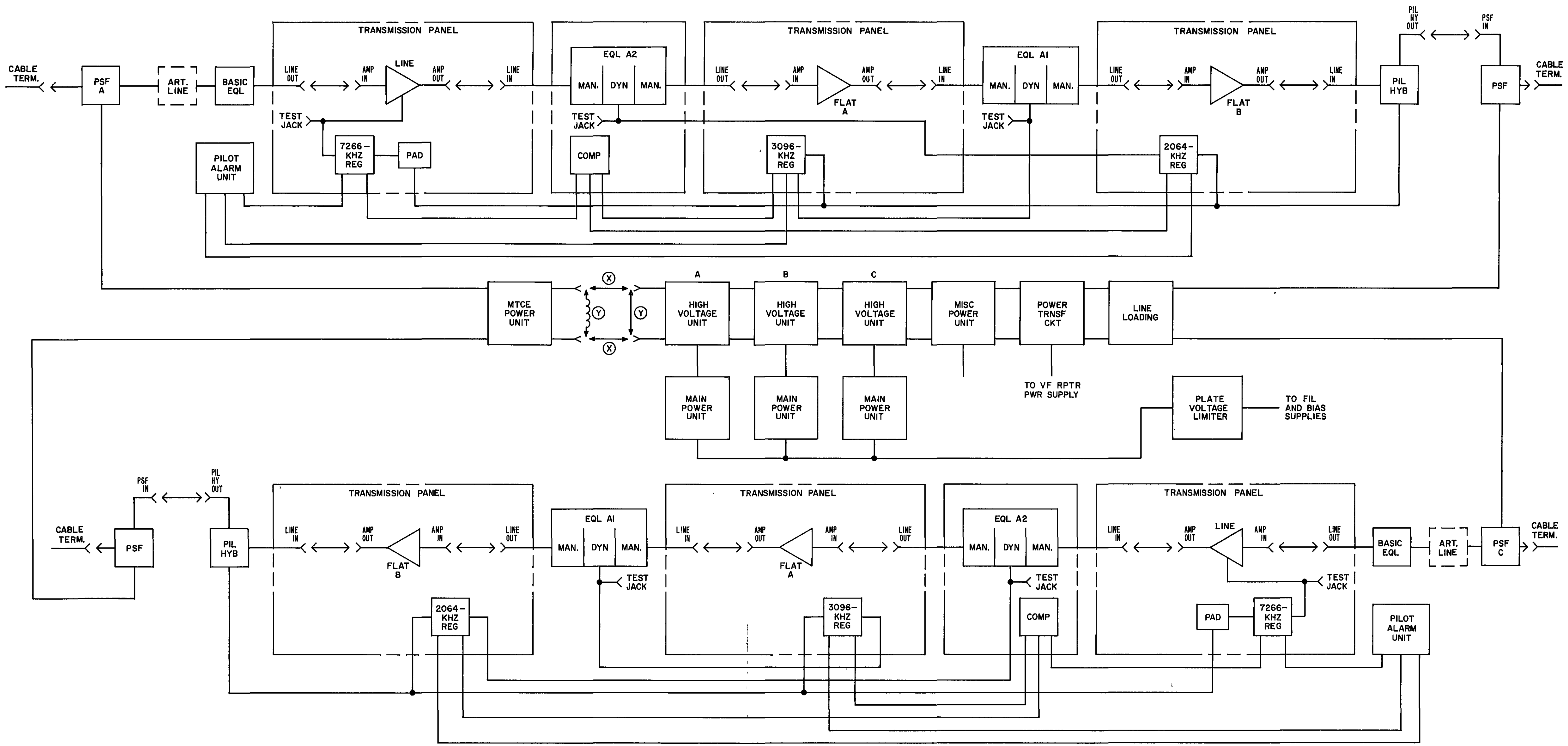


Fig. 19—Equalizing Auxiliary Repeater—Block Schematic

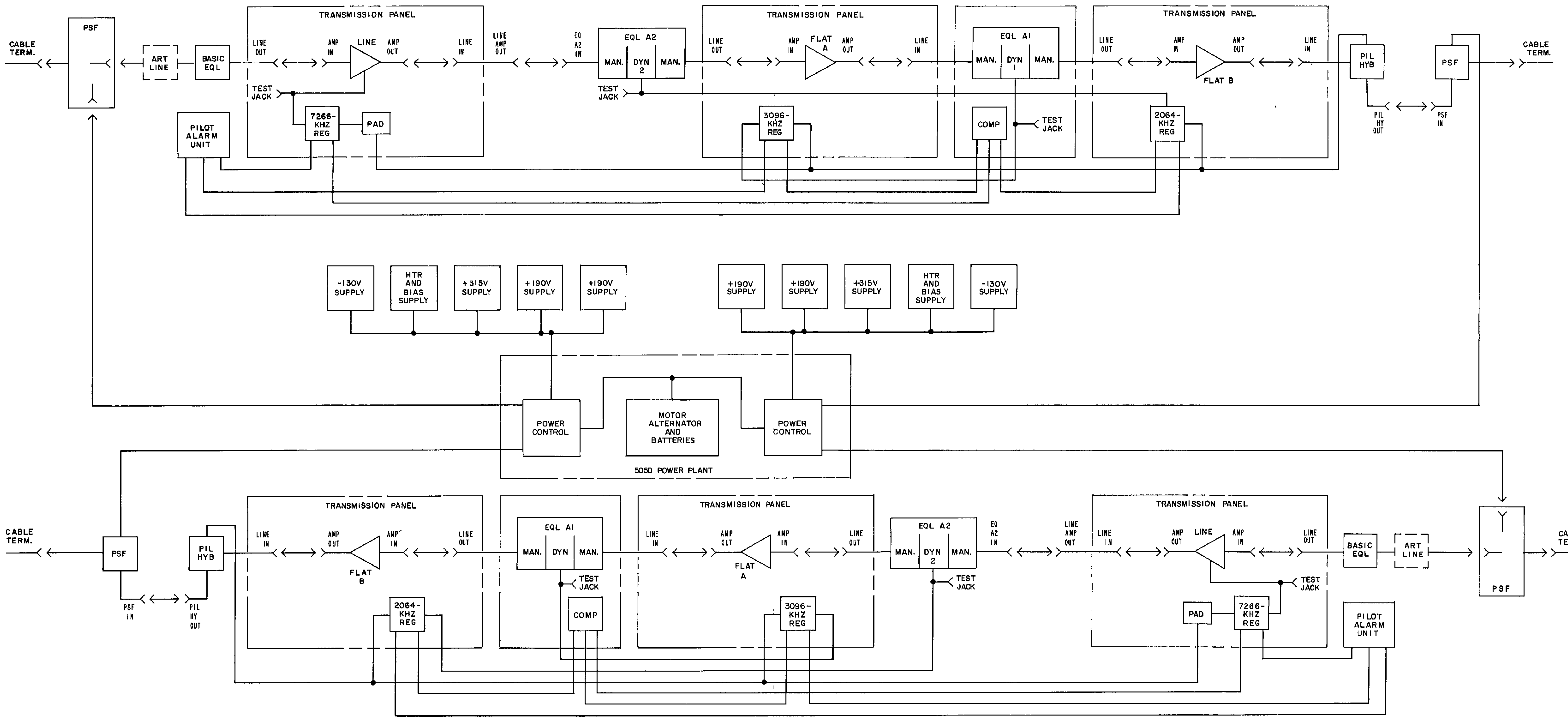
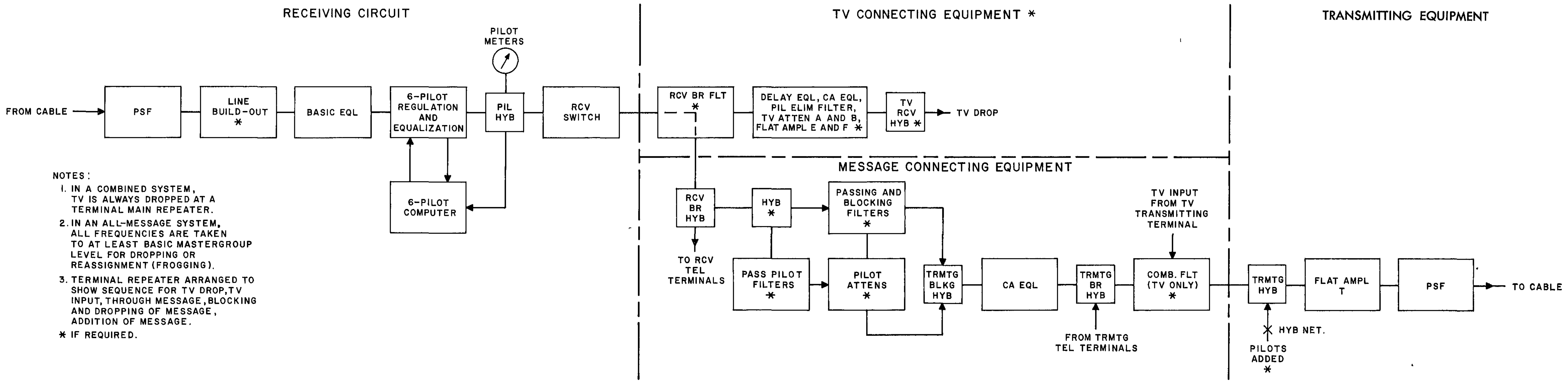


Fig. 20—Equalizing Main Repeater—Block Schematic



NOTES:
1. IN A COMBINED SYSTEM, TV IS ALWAYS DROPPED AT A TERMINAL MAIN REPEATER.
2. IN AN ALL-MESSAGE SYSTEM, ALL FREQUENCIES ARE TAKEN TO AT LEAST BASIC MASTERGROUP LEVEL FOR DROPPING OR REASSIGNMENT (FROGGING).
3. TERMINAL REPEATER ARRANGED TO SHOW SEQUENCE FOR TV DROP, TV INPUT, THROUGH MESSAGE, BLOCKING AND DROPPING OF MESSAGE, ADDITION OF MESSAGE.

* IF REQUIRED.

Fig. 21—Terminal Main Repeater

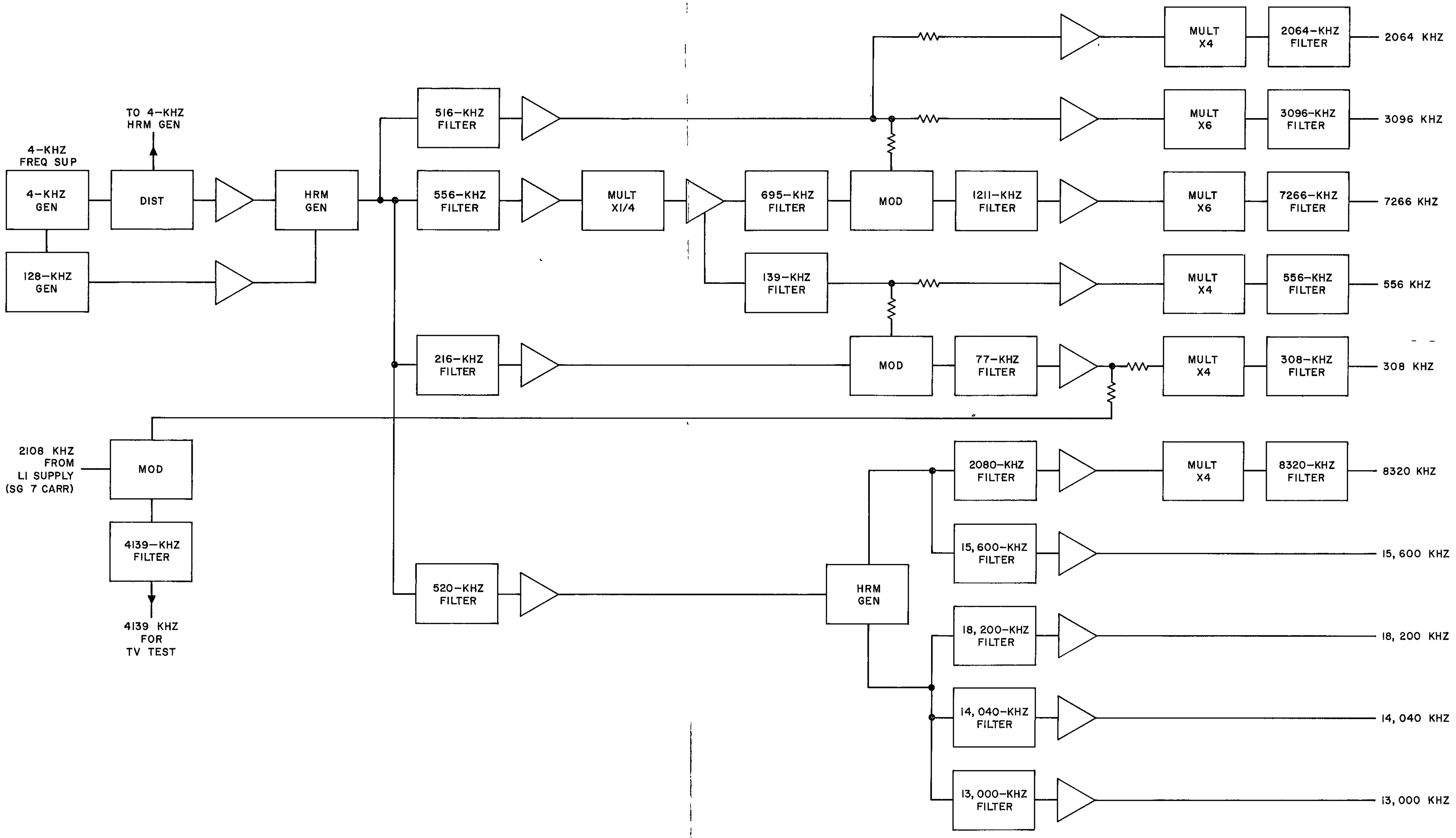


Fig. 22—Method of Generating the Line Pilot and Carrier Frequencies—Block Schematic

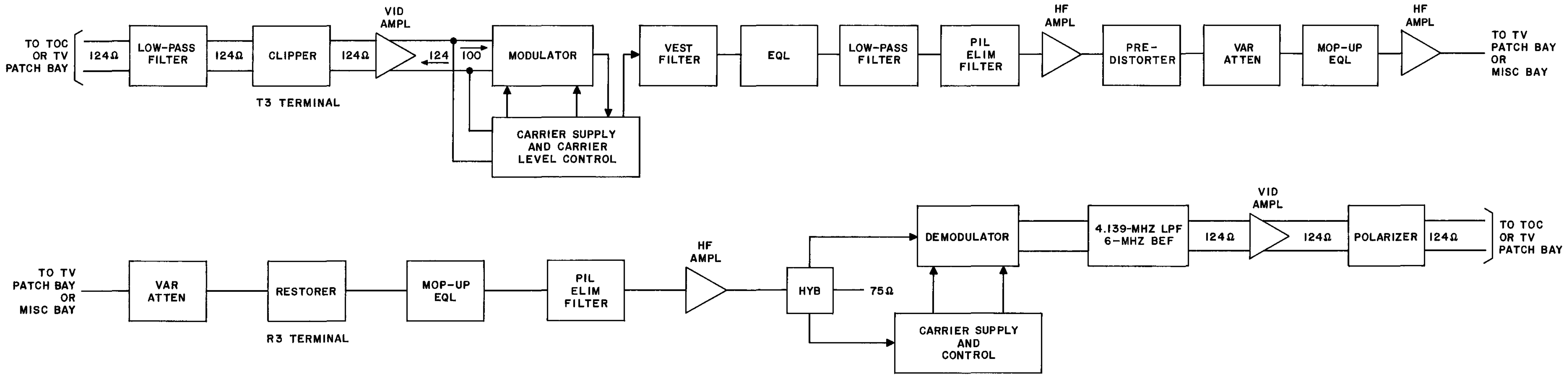


Fig. 23—T3-R3 Television Terminal—Block Diagram

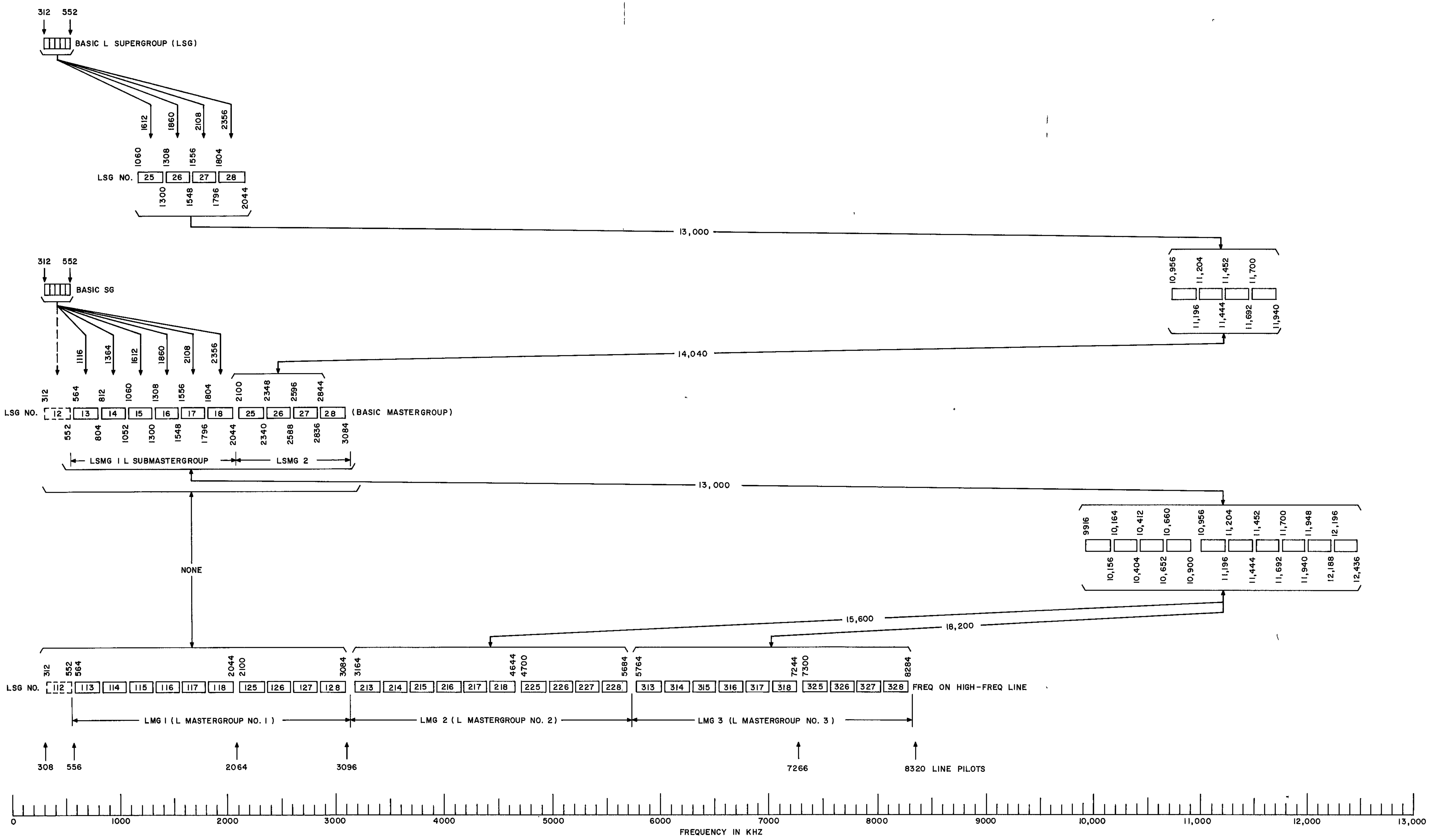


Fig. 24—Frequency Conversions Involved in Translating the Basic L Supergroup to Its Position on the L3 High-Frequency Line

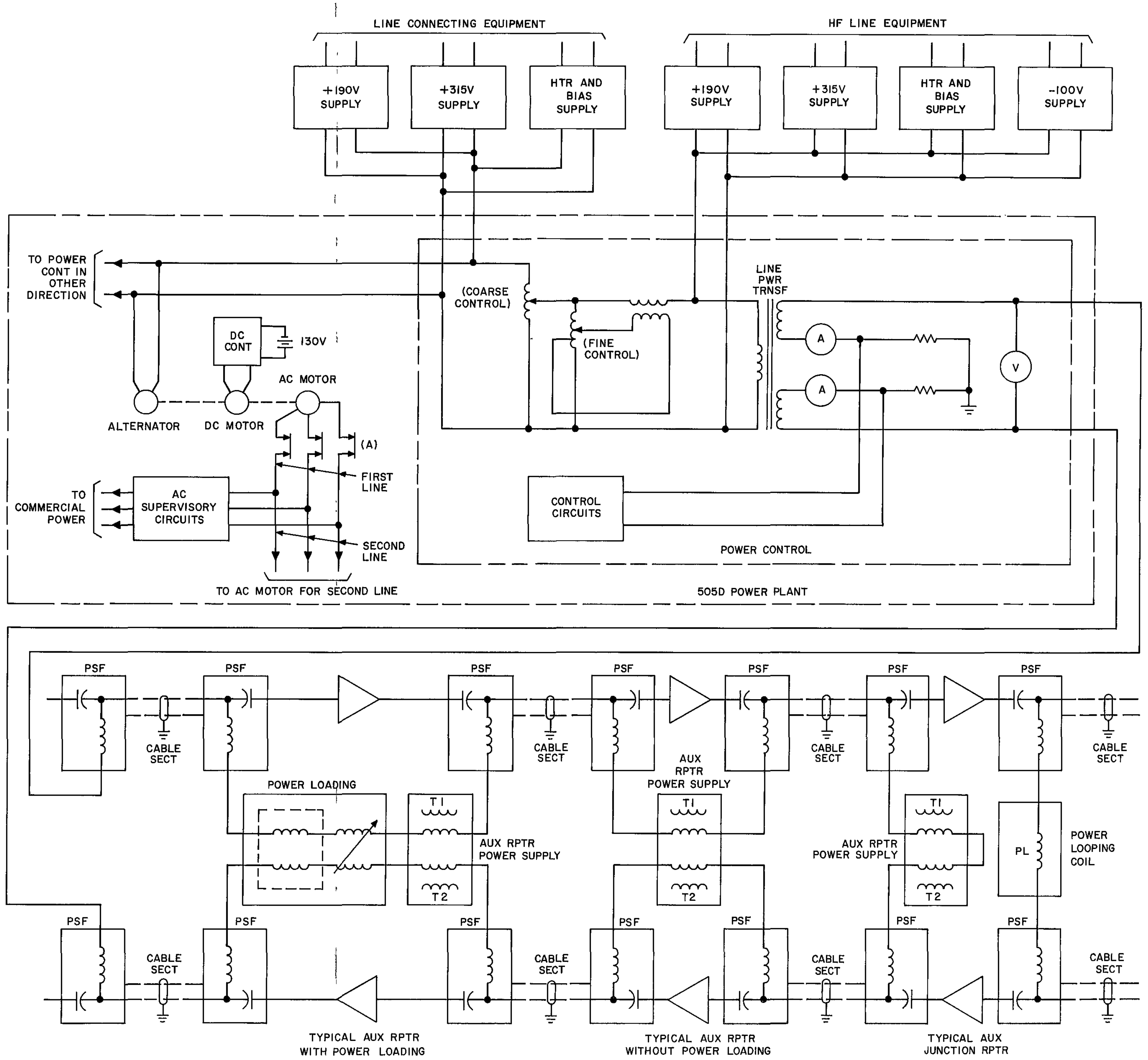


Fig. 25—Power Supply Arrangements—Block Diagram