

**N3 CARRIER TELEPHONE SYSTEM**  
**OVERALL SYSTEM**  
**DESCRIPTION**

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**1. GENERAL**

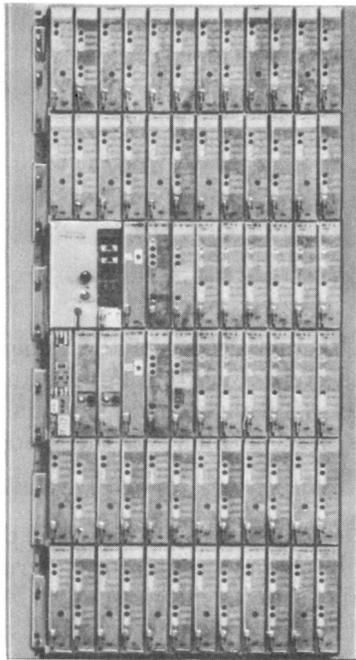
**1.01** This section describes the general features of the N3 Carrier Telephone System. Descriptive information for various equipment components may be found in the associated Plant Series sections.

**1.02** This section is reissued to include the J99300CA double channel regulator. Arrows indicate the necessary changes in this section.

**1.03** The N3 Carrier System provides twenty-four 2-way telephone channels arranged in two 12-channel groups. It is a solid-state system designed for short-haul use on two nonloaded pairs in the same aerial or underground exchange or toll cable.

**1.04** An N3 carrier terminal is shown in Fig. 1. N3 terminals are designed for use with N carrier repeatered lines equipped with N1 electron tube, N1A, or N2 transistorized repeaters, and where required, 240-type amplifiers. Figure 2 is a simplified schematic of the overall system. The principal parts shown are: (a) channel units, including voice-frequency terminal circuits, compandor, channel modulating and demodulating circuits; (b) double-channel regulators; (c) channel group modems, frequency correction circuits, and alarm and restoral units associated with each 12-channel group; (d) group transmitter and receiver units and other equipment common to all channels (line terminating unit, power unit, etc); and (e) high-low and low-high repeaters.

**1.05** The N3 System uses single-sideband transmission with 4-kHz channel spacing. All channels use upper sideband orientation in the first step of modulation. Even-numbered channel carriers with 8-kHz spacing are transmitted over the repeatered line for regulation and for demodulation at the receiving terminal. The combined power of these carriers controls the flat gain regulation in repeaters and in the group receiver units, and



**Fig. 1—N3 Carrier Terminal**

provides first-order correction for transmission changes caused by normal temperature variations. Each transmitted carrier controls the double-channel regulator at the receiving terminal associated with the two channels which occupy the immediately adjacent frequencies.

**1.06** Figure 3 shows the frequency allocations of sidebands and carriers of the N3 System for the various steps of modulation. All carriers for modulation and transmission and for demodulation of channels without transmitted carriers are provided by a common carrier supply. One or more of the normally transmitted carriers may be eliminated from the line for engineering considerations, such as the use of K and N3 carrier in the same cable. Transmitted frequencies may be low group, 36 to 132 kHz or high group, 172 to 268 kHz.

**1.07** One of the transmitted carriers in each of the two channel groups is used to control the frequency-correction units in the receiving channel group equipment. These units correct for frequency deviations of the received signal, accumulated primarily over the repeatered line.

**1.08** Two types of repeaters are used in the high-frequency line. As indicated in Fig. 4

the low-high repeater receives the low-group frequencies at its input and converts them to the high-group frequencies. The high-low repeater receives the high-group frequencies and converts them to low-group frequencies. The two types are used alternately along the repeatered line so that the frequency groups assigned to the two directions of transmission are transposed and inverted at each repeater. This is called "frequency frogging" and provides partial equalization of the line slope. By the use of different frequency groups at the input and output of each repeater, signals are prevented from crosstalking from high level points (repeater outputs) into low-level points (repeater inputs).

**1.09** Repeater spacing varies with cable type and noise performance engineering. Typical spacings are in the order of 5 miles although greater spacing was prevalent in earlier designs, before impulse noise requirements were established.

**1.10** Use of compandors eliminates the need for crosstalk balancing and minimizes special noise treatment of cable pairs. Compandors improve interchannel crosstalk performance and reduce nearly all of the usual types of noise and crosstalk interference which affect message circuit performance over carrier facilities. Compandors do not substantially reduce impulse noise.

**1.11** The N3 Carrier System is designed for the use of Type E or F inband signaling for the transmission of supervisory signals and dial pulses. No built-in signaling is provided.

**1.12** Power for terminals is derived from a standard -48 volt office power source. Power may be supplied from terminals over the cable transmission pairs to one adjacent N1 electron-tube repeater, or as many as three N1A, or four N2 transistorized repeaters in some instances. Details of repeater powering arrangements may be found in associated Plant Series sections and on SD-97272-01.

**1.13** Alarm circuits are provided for recognition of received carrier failure in each channel group. Alarms are also provided for fuse operation, for abnormal terminal power voltage, for removal of the alarm unit, for restoral oscillator failure, and for E-type signaling oscillator failure.

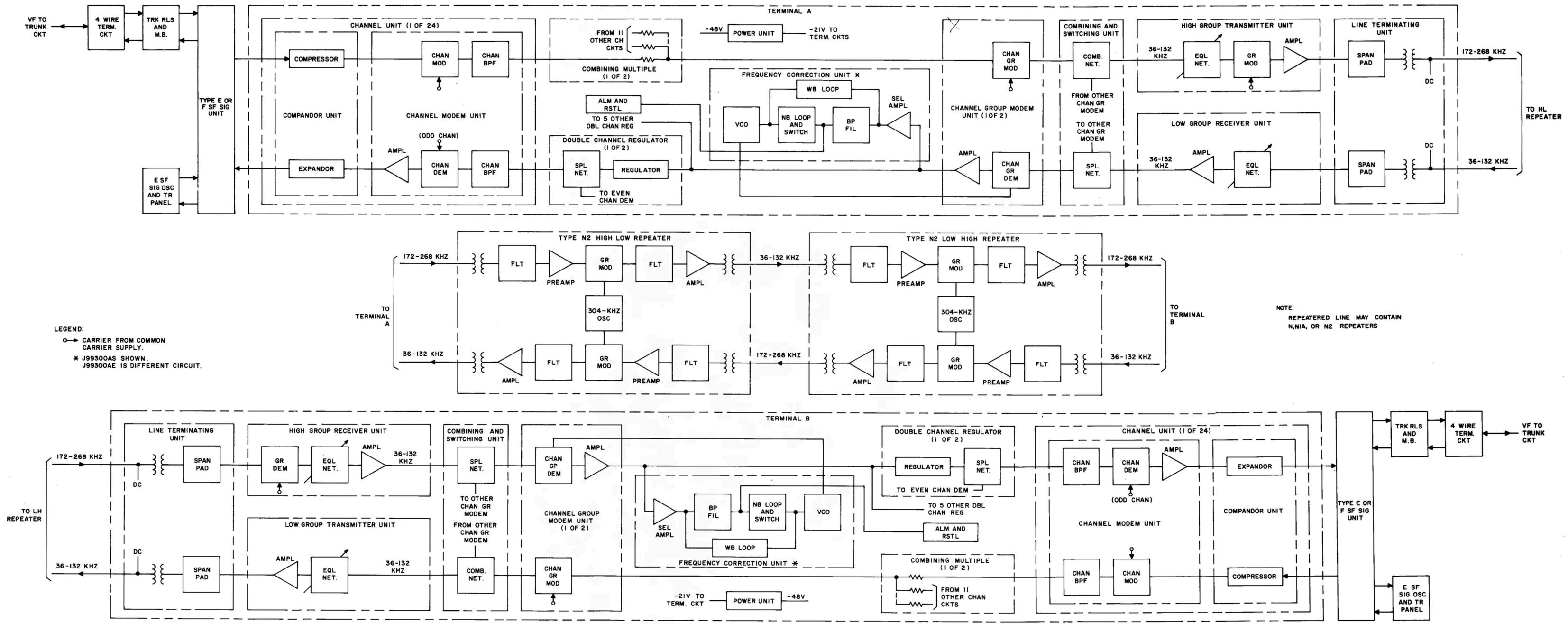


Fig. 2—N3 Carrier Telephone System

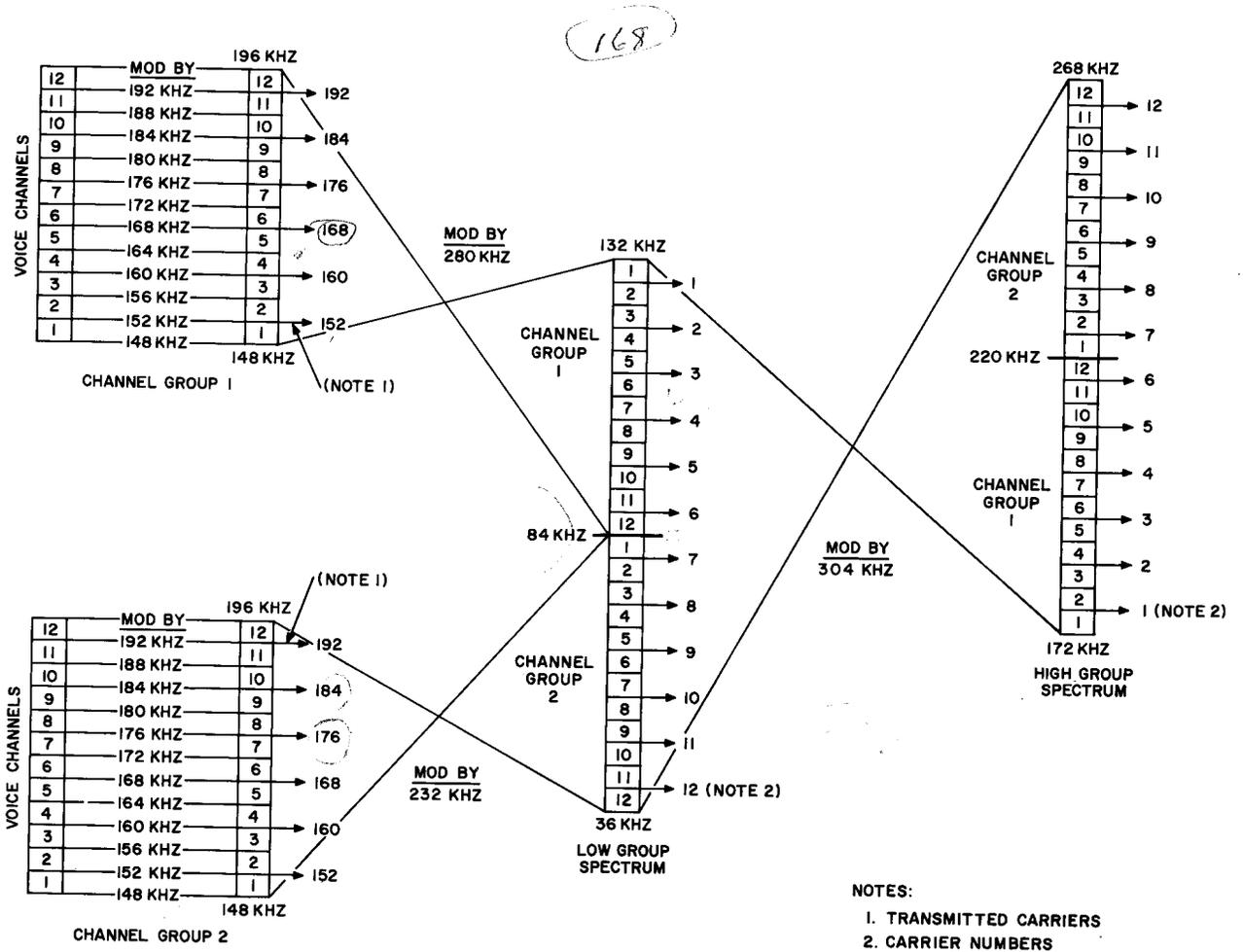


Fig. 3—N3 Carrier System Frequency Allocation and Modulation Steps

2. TERMINAL FEATURES

A. General

2.01 N3 carrier terminals are mounted in shop-wired double-bay duct-type frames with heights of 11 feet 6 inches, arranged for two 24-channel terminals; and 9 feet, and 7 feet arranged for one 24-channel terminal each. Front and back access is required for testing and maintenance. Therefore back-to-back or back-to-wall installation is unsuitable. The frames include provisions for signaling units, trunk-release and make-busy panels, secondary carrier distribution panels, signaling tone supplies, and optional voice-frequency patching jacks, with the carrier terminals in compact equipment arrangements. Optional arrangements permit the voice-frequency patching jacks to be centrally located.

2.02 An N3 terminal arranged for a full complement of message channels requires the following 71 plug-in units: 24 compandors, 24 channel modems, 12 double-channel regulators, 2 channel-group modems, 2 alarm and restoral units, 2 frequency-correction units, 1 group-receiver unit, 1 group-transmitter unit, 1 line-terminating unit, 1 power-supply unit, and 1 combining and switching unit as shown in Fig. 5. A voice-frequency amplifier may be used in any channel where a compandor is not desired. Schedule C and D program service may be provided over an N3 Carrier System using the regular message channel units. Equipment to provide other services may be used in conjunction with an N3 terminal, as follows.

- (a) The N carrier program terminal J99333 provides schedule A and B 5-kHz program service. When the N carrier program terminal

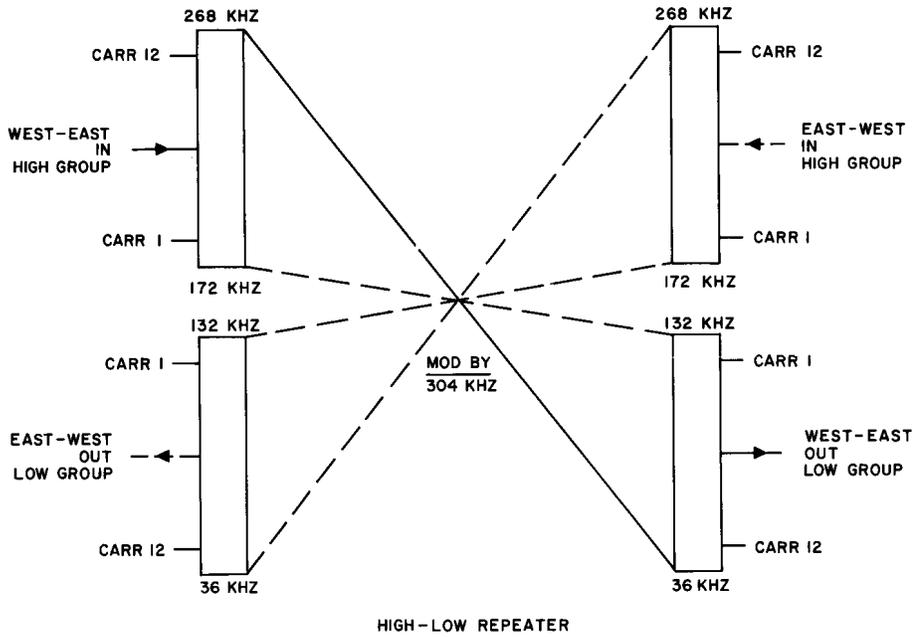
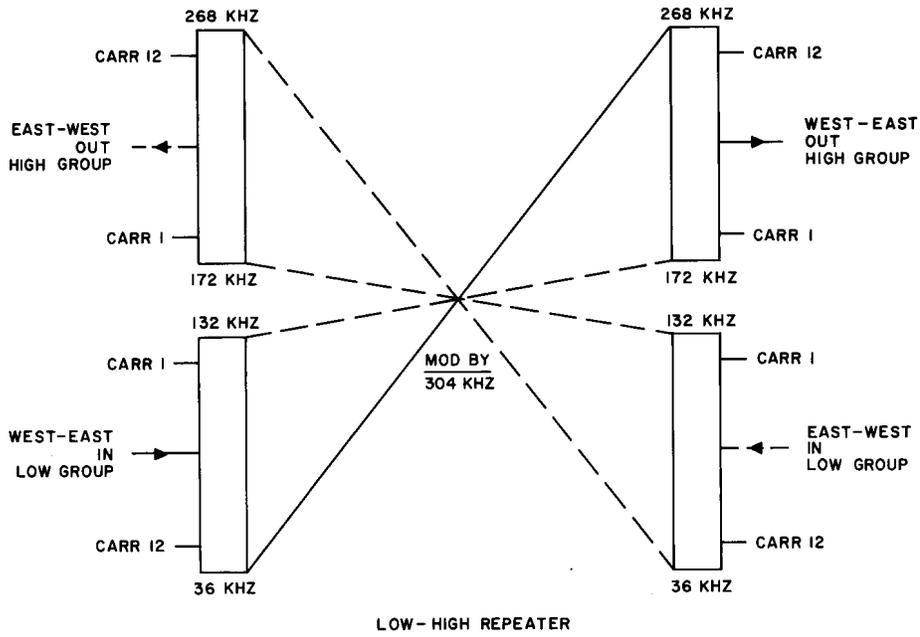


Fig. 4—Repeater Group Modulation

is used without the reversing option, group 1 message channels 8 through 11 and carrier 5 must be disabled in the N3 terminal. If the program terminal reversing option is used, channel 7 and carrier 4 must also be disabled.

(b) The N3-L Junction connects N3 and L facilities on a 12-channel group basis rather than on a voice-frequency basis. The N3-L Junction is available in three different types, designated A, B, and C. The type A junction is used at the interface of the N line and the L-group facilities. The type B junction is a terminal junction which is used instead of the A5 channel bank at the terminal end of the L carrier facilities. The type C junction is essentially half of an N3 terminal and half of a Type A Junction. It terminates 12 N3 channels in voice-frequency equipment at the N3-L interface while connecting the other 12 N3 channels to L carrier facilities. Detailed information on N3-L Junctions is covered in other sections in the 362 series of Plant Practices.

(c) The N2WT-1 wideband terminal provides wideband data service on an alternate basis. The N2WT-1 wideband terminal can be used, if necessary, with a partially equipped N3 terminal. However, the N2WT-1 terminal is normally used with an N1 or N2 carrier terminal to permit alternate use of the repeatered line for transmission of either voice or wideband data.

**2.03** Partially equipped N3 terminals should have the following minimum number of plug-in units to adequately load the power supply and to provide the necessary carriers for repeater regulation: one group transmitting unit, one group receiving unit, one frequency-correction unit, two channel-group modem units, two double-channel regulator units, three compandor units, and three channel-modem units. Each unused channel should be equipped with a channel-modem load unit replacing the modem, compandor, and double-channel regulator units. The channel-load unit contains three resistors to terminate the carrier supply leads that are normally terminated by the channel modulator and demodulator, and the leads from the 12-channel combining multiple which are normally terminated by the channel filter. Channels 1 and 2 must be equipped for each 12-channel group for which alarm operation is desired. An alarm link unit should be provided in place of the alarm and restoral unit, if the latter is not provided, to prevent

operation of the associated removal alarm. Except for channels 1 and 2, the order in which channels are added to a terminal is unimportant. In some instances, such as when operating in the same cable with K carrier, or in conjunction with the N carrier schedule A and B program terminal, it may be necessary to disable one or more of the N3 transmitted carriers. This is done in the secondary carrier-distribution circuitry.

**2.04** Voice-frequency input signals are compressed in the compandor, modulated and filtered in the 12-channel modems, and combined to form a channel group with a frequency band of 148 to 196 kHz. The two channel groups are then modulated in the channel-group modems, one by a 232-kHz carrier and the other by a 280-kHz carrier. The outputs are combined to produce a continuous spectrum of channels in the low-group frequency range of 36 to 132 kHz. The modulation steps are shown in Fig. 3.

**2.05** The group transmitting unit may be high-group transmitting or low-group transmitting. In both transmitter units, the signal is amplified and the slope is equalized for transmission over the repeatered line. In a high-group transmitter unit, an additional step of modulation by a 304-kHz carrier is used to provide the desired high-group output signal.

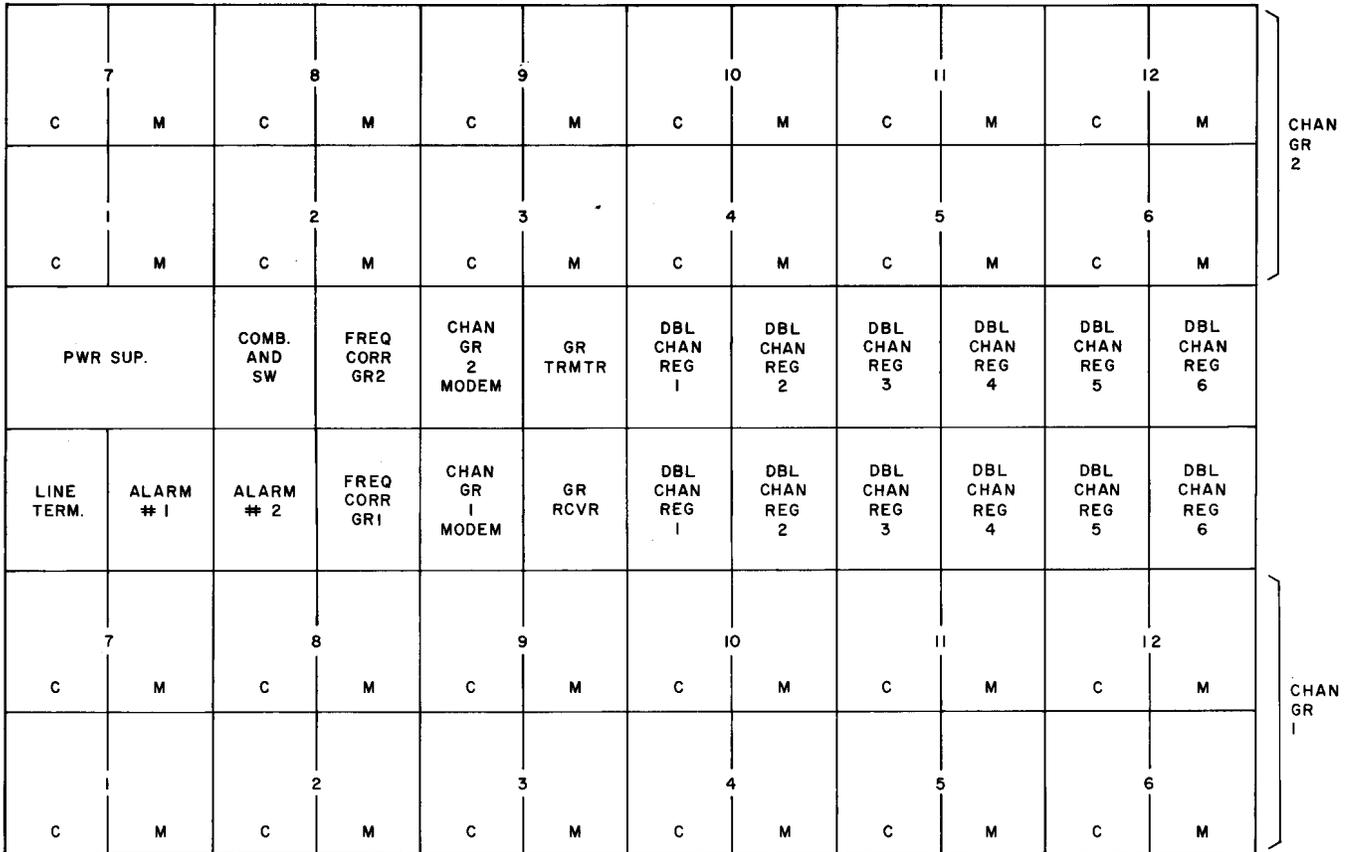
**2.06** The group receiver unit may be low-group receiving associated with a high-group transmitter unit or high-group receiving associated with a low-group transmitter unit. The modulation steps in the receiving terminal are reversed from those in the transmitting terminal. The group receiver unit always delivers low-group frequencies to the channel group modem units. The low-group receiver rejects unwanted frequencies, and amplifies, regulates, and provides proper slope equalization. The high-group receiver uses an added step of modulation to produce the low-group frequency range.

## **B. Compandors**

**2.07** Each compandor unit consists of a compressor for the transmitting direction and an expander for the receiving direction of transmission.

**2.08** The overall action of compandor circuits is such that the weaker speech is raised in volume between the compressor at one end of a

ARRANGEMENT OF PLUG-IN UNITS  
IN 24-CHANNEL N3 CARRIER TERMINAL



TERMINAL POSITION	UNIT	MFR DISC CODES	AT&T CO STD CODES
C-	MESSAGE COMPANDOR UNIT	—	J99300AA
	VOICE-FREQUENCY AMPLIFIER UNIT	—	J99300AM
M-	MESSAGE CHANNEL MODEM UNIT	J99300AB	J99300AY
PWR SUP.-	POWER SUPPLY UNIT	—	J87245A
COMB. AND SW-	COMBINING AND SWITCHING UNIT	—	J99300AP
FREQ CORR-	FREQUENCY CORRECTION UNIT	J99300AE	J99300AS
ALARM-	ALARM AND RESTORAL UNIT	—	J99300AK
CHAN GR MOD-	CHANNEL GROUP MODEM UNIT	—	J99300AD
DBL CHAN REG-	DOUBLE CHANNEL REGULATOR UNIT	J99300AC	J99300CA
LINE TERM.-	LINE TERMINATING UNIT	J99300AL	J99300AT
GR RCVR-	HIGH GROUP RECEIVER UNIT	—	J99300AH
	LOW GROUP RECEIVER UNIT	—	J99300AJ
GR TRMTG-	HIGH GROUP TRANSMITTER UNIT	—	J99300AF
	LOW GROUP TRANSMITTER UNIT	—	J99300AG

TPA 521855

Fig. 5—Bay Arrangements Shop-Wired N3 Terminal Bays Using 23-Inch Duct-Type Frame

channel and the expander at the other end thereby obtaining an improvement in its relationship to noise and crosstalk introduced into the system. The louder speech signals, which already have a favorable relationship to noise and crosstalk, are practically unchanged. Figure 6 illustrates the effects of compressor and expander action on input signals of various powers in transmission through a companded system.

**2.09** The compressor reduces the range of signal amplitudes applied to its input to a range approximately one-half as great. For example, if the amplitude of a signal at the compressor input is decreased by 20 dB, the decrease in compressor output amplitude will be only 10 dB. The speed with which the compressor adjusts the signal from one level to another is determined by the time constants of its control circuit. In the N-type systems, the time constants have been chosen to control at syllabic rates.

**2.10** At the receiving end of the transmission path, the expander reestablishes the original volume range by expanding the range of volume at its input to a range twice as great. A 1-dB change in input signal to the expander is increased to a 2-dB change in the output signal. The compandor tracking error is essentially zero for the average of several units with a standard deviation of approximately 0.4 dB. The expander maximum undistorted output power (load capacity) is +8 dBm referred to zero system level. This performance is maintained over the range of ambient temperature encountered by central office equipment.

#### C. Alarm and Restoral Units

**2.11** Separate alarm and restoral units are provided for each 12-channel group. Upon loss or failure of received carriers, transmitted carriers from the channel group are interrupted for several seconds to force registration of failure at the distant terminal. The 12 channels are conditioned to disconnect busy message trunks, stop subscriber charges, release trunks, and prevent subsequent trunk seizures by the trunk release and make-busy panel associated with each alarm and restoral unit. The trunk release and make-busy panel is located in the bay adjacent to the terminal in the double-bay packaged frame. The alarm and restoral unit also arranges channels 1 and 2 in the faulty channel group for transmission tests using a 2600-Hz test tone supplied by the restoral oscillator

mounted in the alarm, power, and miscellaneous panel. When the trouble condition is cleared and satisfactory transmission is measured at both terminals by the alarm circuit, the trunk circuits are automatically restored to normal. Restoration is essentially simultaneous at both terminals. Signaling units are not required for the transmission tests. A time delay feature prevents false action in response to momentary carrier interruptions or hits. The trunk release and make-busy panel also provides automatic disconnect of calling and called subscribers. It prevents subsequent seizures on most trunk circuit arrangements. The trunk release and make-busy panels provide optional strapping to manually override the circuit conditioning on any number of the channels. This option permits the circuits to be restored to service by patching to alternate transmission facilities. The alarm and restoral circuit is described in Section 362-908-100.

#### D. Group Equalizers

**2.12** Screw-connected 377-type slope equalizers are located in the group transmitter and receiver units. Over the frequency band, these provide nominal slope changes of +9, +6, +3, 0, -3, -6, or -9 dB. In addition, the group receiver units have a finer slope adjustment of -1, 0, or +1 dB controlled by operation of screw-down switches on the unit faceplate. This provision of variable slopes at terminal inputs and outputs achieves good control of the channel carriers with respect to line attenuation characteristics and, therefore, permits improvement of noise performance. Minimum overall system noise results when the line characteristics are compensated to provide minimum slope of input signals to terminal or repeater points with high-noise induction. Slope is defined as the difference in power of carrier 12 (associated with channels 11 and 12 of group 2) and carrier 1 (associated with channels 1 and 2 of group 1). Slope is positive when carrier 12 has the greater power.

#### E. Span Pads and Line Termination

**2.13** The N3 terminal uses 38- or 49-type plug-in span pads in the transmitting and receiving paths of the line terminating unit. The pads are available with attenuation values varying in 2-dB steps from 0 to 44 dB. These span pads and the slope equalizers in the group units are separated from the high-frequency line by a transformer located in the line terminating unit which suppresses

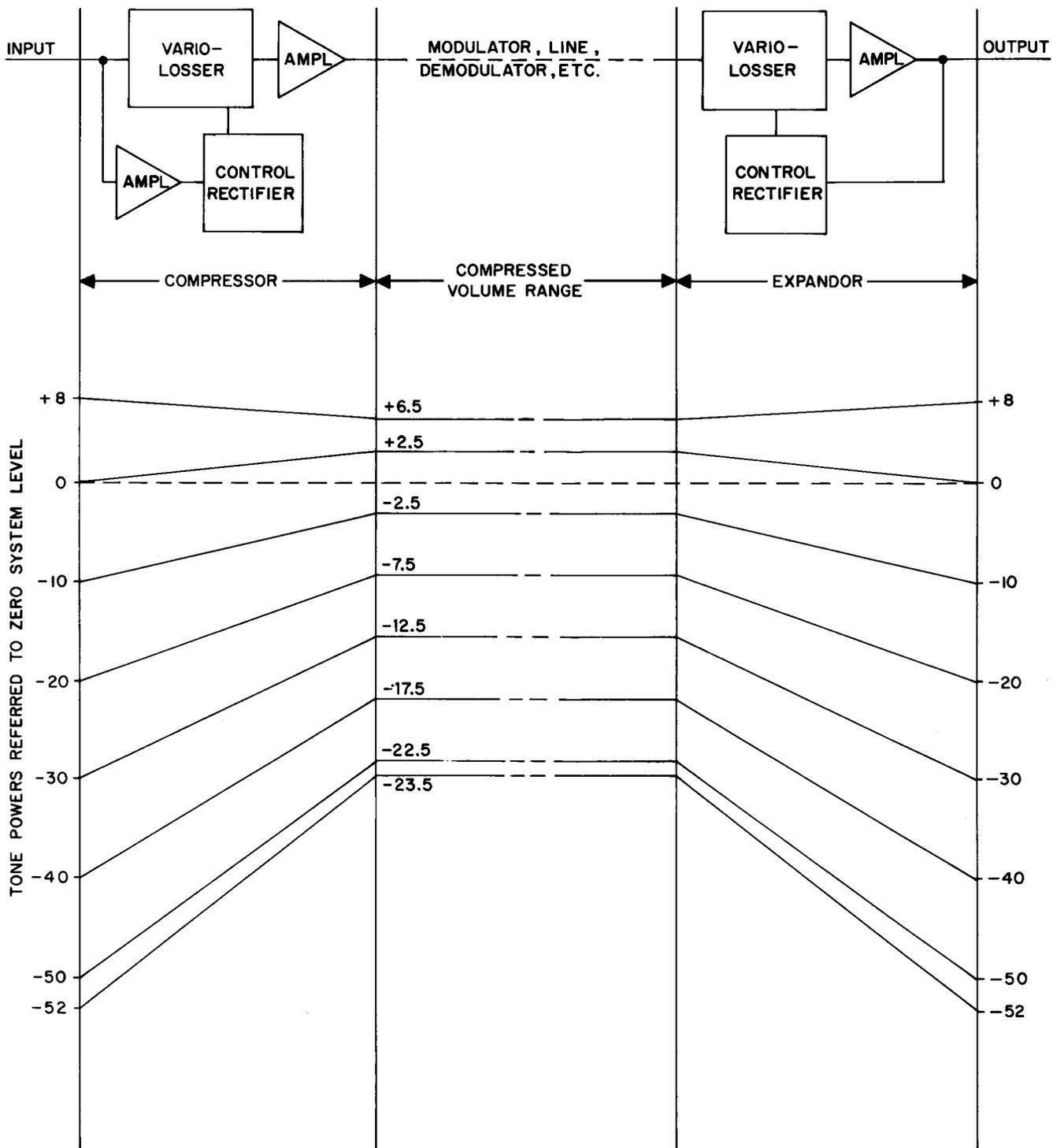


Fig. 6—Compandor Action on Steady Tones of Different Levels

longitudinal noise and provides a simplex connection for power feed to remote repeaters. When line build-out equipment mounted externally to the N3 terminals is required for flexibility reasons, slope networks, span pads, etc, may be provided in an N1 cross-connecting and line build-out cabinet or an N2 J99323 line build-out bay. However, in these cases, the 377-type slope equalizers are still required in the group units and span pads, usually 0-dB, are used in the line terminating unit. Line build-out and cross-connecting equipment is described in the 362-440 series of Plant Practices.

### 3. REPEATER FEATURES

#### A. General

**3.01** N1 and N1A repeaters are plugged into jacks on repeater mounting brackets which are assembled on 19-inch repeater mounting shelves. Each shelf mounts four repeaters and brackets, and requires 14 inches of vertical space or eight 1-3/4 inch mounting plate positions.

**3.02** N1 and N1A repeaters may be mounted in standard relay racks at nonpower and power supply offices, or in pole-mounted cabinets at nonpower supply points. The cabinet is approximately 6 feet high and provides space for a cable terminal block and a maximum of 12 repeaters.

**3.03** N2 repeaters and their associated equipment are designed for simplified engineering, installation, and maintenance. Repeater mountings and common equipment are mounted in shop-wired bays or cabinets, with equipment for individual carrier lines on a plug-in basis. Shop-wired bays use cable-duct type framework arranged for 23-inch mounting plates and bay heights of 11 feet 6 inches, 9 feet, and 7 feet. The bays may be equipped for locally powered or remotely powered repeaters. Shop-wired cabinets are arranged for remotely powered repeaters with line build-out equipment and line protectors. The cabinet may be pole- or pedestal-mounted, is 47-5/8 inches high, and provides space for a maximum of 15 repeaters.

**3.04** N2 repeaters are mounted in a repeater mounting shelf which has a capacity for five repeaters. Shop-wired bays contain from three to ten mounting shelves, depending upon bay height and other equipment required. Individual packaged shelf assemblies are also available for miscellaneous mounting.

**3.05** Span pads for N1 and N1A repeaters are mounted on the repeater mounting bracket, and are solder-connected, when required. N2 repeaters use plug-in 54-type span pads and 391- or 916- type equalizers. Sockets for these are provided in repeater line units or in old-style repeater mounting shelves.

**3.06** The N2 transistor repeater offers the advantages of superior transmission performance and reduced maintenance over the N1A transistor repeater, and the additional advantage of greatly reduced power requirements over the N1 electron tube repeater. Existing vacant N1 repeater mountings may be used in N2 repeatered lines for new systems by the use of the N2 repeater-to-N1 adapter. Vacant N1A mountings may be used in N2 repeatered lines by the use of the N2 repeater-to-N1A adapter. The adapters are basically identical electrically and in appearance, but are not interchangeable. Description of the adapters may be found in the associated Plant Series sections.

#### B. Equalization

**3.07** The frequency groups assigned to the different directions of transmission are interchanged in successive cable sections by modulation with a 304-kHz carrier in each repeater, as shown in Fig. 4. In this process, called "frequency frogging", the positions of the channels within a group are reversed. Carrier 12 is the highest transmitted carrier frequency (264 kHz) in the high-group allocation and the lowest carrier frequency (40 kHz) in the low-group allocation. This inversion nearly equalizes the line slope through two successive line sections of equal length by causing the combined loss to be nearly constant across the 24-channel group.

**3.08** When spans of unequal length or cables with different slope characteristics are used, slope equalization is obtained by the use of the repeater slope adjustment. The low-high and high-low repeaters both have nearly flat gain characteristics with three selectable amounts of slope (A, B, and C) built in. Table A shows the approximate slope values obtained from slope adjustments in N1, N1A, and N2 repeaters.

**3.09** With frequency frogging and some shaping of the repeater characteristics, the transmission slope introduced by the line can be reduced. Table B shows the equalization achieved by the losses

**TABLE A**  
**REPEATER SLOPE EQUALIZATION**

STEP DESIG	N1 ELECTRON TUBE REPEATER		N1A TRANSISTORIZED REPEATER		N2 TRANSISTORIZED REPEATER	
	LOW-HIGH*	HIGH-LOW*	LOW-HIGH*	HIGH-LOW*	LOW-HIGH*	HIGH-LOW*
	DB		DB		DB	
A	-0.6	-1.0	+1.8	+1.5	+2.0	-0.1
B	-3.0	-2.7	+0.1	-0.4	+0.1	-2.4
C	-5.1	-4.7	-1.8	-2.2	-1.8	-4.3

\* Each carrier amplifier is weighted in determining the slope values given here (see Section 362-400-510).

of typical adjacent cable sections and the equalized gains of associated N2 low-high and high-low repeaters. Another advantage of frequency transposition is that the maximum repeater gain need only compensate for the mean frequency loss rather than the loss at the highest frequency.

**3.10** The N2 repeatered line uses plug-in slope, bulge, cubic, and quartic equalizers at the input to each repeater to further correct for cable-loss deviations. The N2 repeaters use plug-in equalizers, but hard-wired equalizers are required for N1 and N1A repeaters. These equalizers provide nominal corrections of  $\pm 9$ ,  $\pm 6$ , and  $\pm 3$  dB of slope,

+2 or +4 dB of bulge, and  $\pm 1$  dB of cubic and quartic equalization.

**3.11** The same types of equalization are also combined in a single unit, the adjustable deviation equalizer. This equalizer is designed for use in the high-group range and is placed at the output of a locally powered low-high repeater or the input of a locally powered high-low repeater.

**3.12** Deviation regulators which may be used as required, automatically compensate for the varying residual line-loss deviations due to temperature changes on very long N-type systems. They are

**TABLE B**  
**TRANSMISSION THROUGH TWO N2 REPEATER SECTIONS**

CABLE LOSS AND REPEATER GAIN	CARRIER		
	1	6	12
	DB		
Low-Group Cable Transmission Loss (6.8 miles of 19 Gauge high-capacitance PIC cable)	43.5	36.4	27.0
High-Group Cable Transmission Loss (6.8 miles of 19 Gauge high-capacitance PIC cable)	51.1	56.9	64.0
Total Cable Loss	94.6	93.3	91.0
L-H Repeater Gain (slope setting C)	47.3	46.6	45.5
H-L Repeater Gain (slope setting B)	47.8	46.7	45.4
Total Gain	95.1	93.3	90.9
Overall Transmission Gain	+0.5	0.0	-0.1

used only as required, and must be placed at the output of locally-powered low-high repeaters.

**3.13** The 240-type transistorized flat gain amplifiers may be used in the high-frequency line between repeaters or between a terminal and a repeater to improve signal-to-noise ratio (impulse noise and message circuit noise) on long repeater spans. The amplifier may also be used to improve regulation by raising the average carrier level at the input of a repeater or terminal to the center of its regulating range.

#### 4. SYSTEM TRANSMISSION FEATURES

##### A. Levels

**4.01** The 4-wire voice-frequency input and output levels are  $-16$  and  $+7$  dB, respectively, relative to the zero transmission level point (0 TLP).

**4.02** N3 Systems transmit even-numbered channel carriers at a specific power level. With a 0-dBm voice-frequency input at the zero transmission level point, the transmitted carriers are 3.5 dB above the single sideband message power. In the carrier-frequency portion of the system, power levels relative to 1 milliwatt are used instead of transmission levels relative to the reference point. The transmitted carrier frequencies are used to establish power levels in the system. The phase relationship of the carriers is designed to minimize the peak power of the line signal.

**4.03** The power level of each transmitted carrier frequency is  $-45$  dBm at the input of the channel group modem. The total carrier power of the six carriers at the input of each of the two channel group modems is  $-37.2$  dBm. The individual carrier power at the output of the receiving channel group modem is  $-24.0$  dBm. The total carrier power at the output of each channel group modem is  $-16.2$  dBm.

**4.04** Individual carrier power at the input to the group transmitter unit is  $-53.5$  dBm. Total power of the 12 carriers at the same point is  $-42.7$  dBm. The carriers are then amplified, equalized to a predetermined slope as engineered for the system route and cable characteristics, and again amplified for transmission at the desired carrier power levels. In the group receiver unit, the carrier powers are equalized by an amount determined

from the slope of the input signals. This amount, together with the preequalization at the transmitting end, and slope equalization introduced along the high-frequency line, corrects for the accumulated line slope. In a perfectly equalized system, the power of each carrier at the output of the group receiver is  $-9.0$  dBm, and the total carrier power is  $+1.8$  dBm.

**4.05** Figure 7 shows the carrier power levels on the high-frequency line for the typical system shown in Fig. 2. In this illustration, parameters have been chosen to give slopes of  $+6$  dB for high-group outputs and  $-6$  dB for low-group outputs.

**4.06** Applying the same  $+6$  dB and  $-6$  dB slopes, Fig. 8 shows the distribution of individual carrier power and total power at the output of the group transmitter units and line repeaters.

**4.07** A more detailed level diagram for N3 terminals combined with repeatered high-frequency line is shown in Fig. 9.

##### B. Regulation

**4.08** The line repeaters and group receiver units use flat-gain regulation to compensate for changes in cable loss with varying temperature. Regulation is obtained by means of thermistors which vary the feedback of the amplifiers, and thus vary their gain, in response to changes in total output power. Normal output power is  $+3$  dBm for N1 and N2, and  $+2.5$  dBm for N1A high-low repeaters;  $+12.0$  dBm for N1 and N2, and  $+11.5$  dBm for N1A low-high repeaters, and  $+1.8$  dBm for N3 group receiver units. The group unit regulator holds the total power output within 1 dB of its normal value for cable temperature variations within the range of  $-15^{\circ}\text{F}$  to  $+110^{\circ}\text{F}$ . For greater temperature changes, the regulator is less efficient. Because of the loss characteristics of the repeatered line for various frequencies, and the effects of temperature on these characteristics, the individual channel levels may depart considerably from the assumed channel level at the regulated output of the group receiver unit. This variation is corrected by the double-channel regulators which maintain the received channel carriers within  $\pm 0.15$  dB of normal for input level variations within the regulator range of approximately  $\pm 15.0$  dB. Bulge, cubic, and quartic distortions of the repeatered line can cause a somewhat greater variation of the sideband level of a channel.

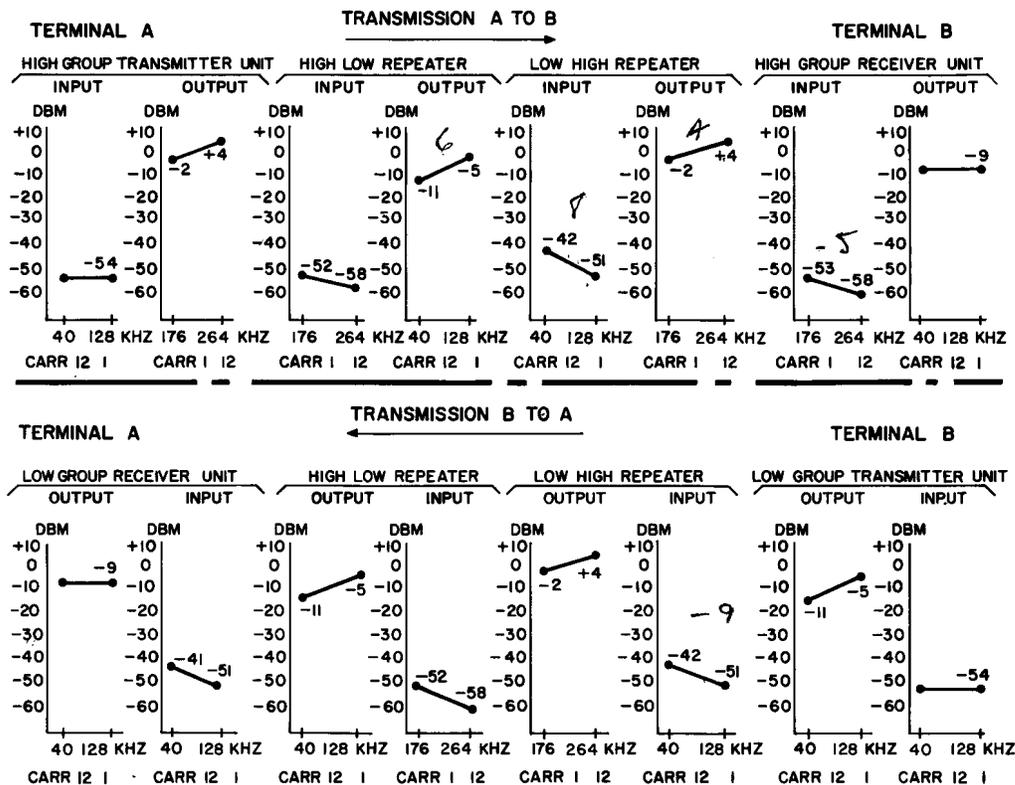


Fig. 7—Typical N3 Carrier Power Level Diagram

4.09 The group receiver regulation characteristic is shown in Fig. 10. The group receiver unit input changes are the result of the preceding cable span transmission variations and the residual variations from previous cable spans not removed by repeater regulators. The span transmission variations of 8 miles of 19-gauge high-capacitance PIC toll aerial cable for high-group frequencies is indicated for temperature ranges of  $-15^{\circ}\text{F}$  to  $+110^{\circ}\text{F}$  by arrows "A" and  $-30^{\circ}\text{F}$  to  $+130^{\circ}\text{F}$  by arrows "B". Within the range indicated by the "B" arrows, the unregulated residue is negligible; but with larger temperature variations the output deviates by a greater amount from the normal value. The group receiver regulation is somewhat less effective when receiving low-group frequencies because of the greater departure from perfect regulation of the preceding high-low repeater. This is somewhat offset by the lower dB change with temperature of the low group. Individual repeater regulation characteristics are shown in Fig. 11. As indicated in the curve for high-low repeaters, N1A and N2 transistorized repeaters have somewhat better regulation than N1 electron tube repeaters

when inputs are substantially below normal value. When underground cable is used, or when aerial cable spans between repeaters are kept shorter, temperature effects are reduced and line regulation is improved.

4.10 The thermistor regulator has sufficient reaction time to prevent channel voice-current peaks from altering the system regulation. The reaction time is three to five times as great to correct for a decrease in output as it is for an increase in output. This characteristic materially affects the waiting period for a circuit to stabilize within desired measuring accuracy after an abrupt change in system transmission. Stabilization times are shown in Fig. 12 for a single regulator. An abrupt increase in input of 2 dB would require a wait of approximately 4 minutes for regulation within 0.1 dB of ultimate change; an abrupt decrease in input of 2 dB would require a wait of approximately 14 minutes for an N1 or N1A repeater and approximately 17 minutes for an N2 repeater. When there are many repeaters between the point of circuit change and the point of observation, the

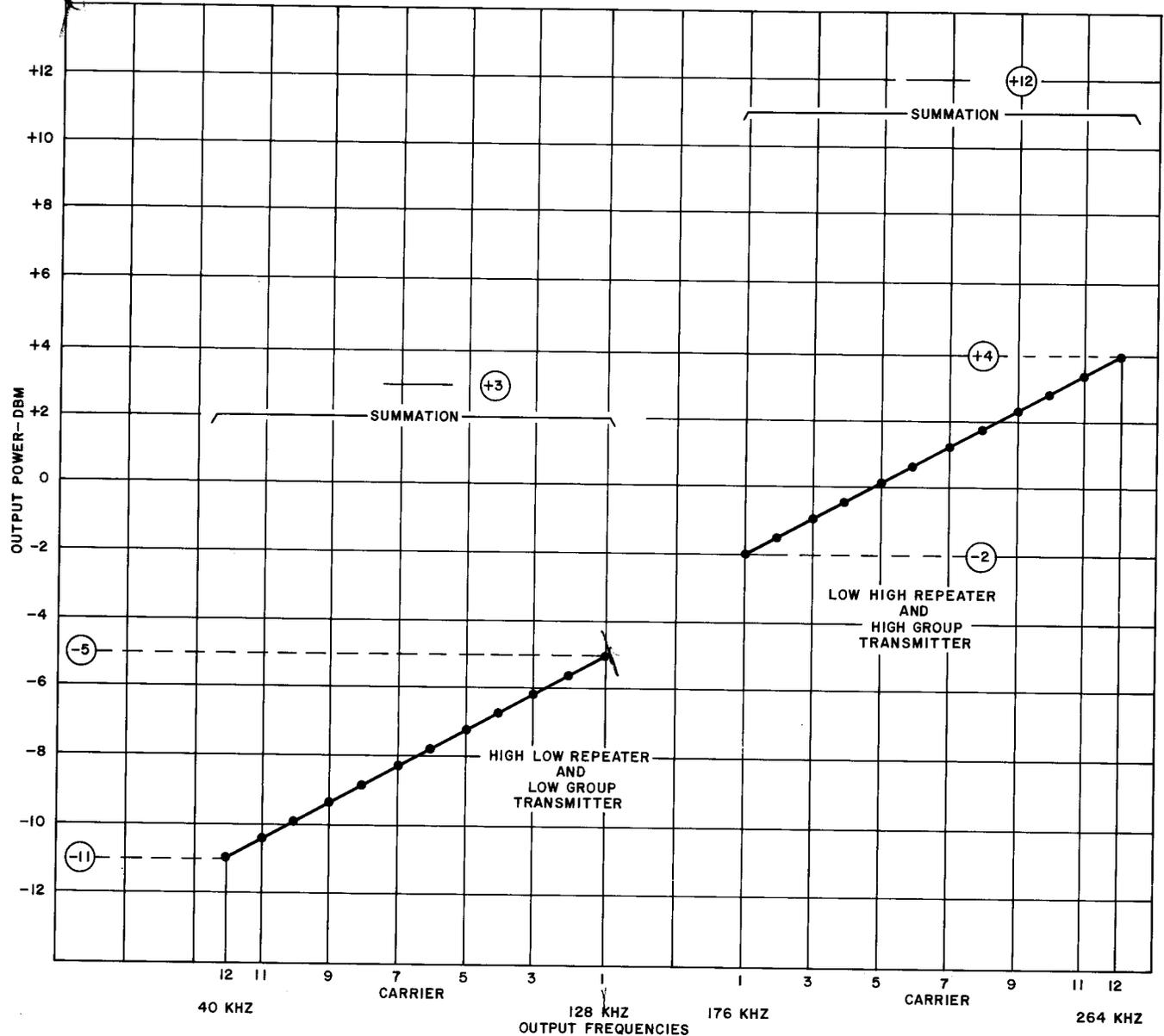


Fig. 8—Group Transmitter Units and Line-Repeaters Carrier Output Power Levels

tandem action of the regulators results in a shortening of the overall restoration time. However, in the intervening portions of the system, the levels may not have restored to normal values and there is a possibility of overload. The full waiting period is required for measuring accuracy. The tandem action of regulators may also cause wide gain variations of the overall repeatered line when a signal is applied to an idle line, for example, when a faulty line is repaired. Overshoots as high as 6 dB above and undershoots as low as 15 dB below normal signal levels have been observed.

4.11 The sideband speech power and signaling tones on a long term average do not appreciably affect the system regulation. The repeater regulators have an ambient temperature control which provides for operating temperatures from  $-20^{\circ}\text{F}$  through  $+130^{\circ}\text{F}$ . Beyond these extremes, the regulating action deteriorates.

4.12 The residual level variations present at the output of the group receiver regulators are corrected for each transmitted carrier by a double-channel regulator. This circuit automatically

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adjusts the received signal level of the transmitted carrier to regulate the two channel bands immediately adjacent to this carrier. There are two types of double channel regulators; a J99300CA unit replaces the older J99300AC unit. A comparison of the response characteristics of the two is shown in Fig. 13.

### C. Frequency Correction

**4.13** The frequency-correction units correct for frequency deviations accumulated primarily along the N repeated line. Accumulated deviations may be as much as 150 Hz.

**4.14** The frequency correction is accomplished by sampling one of the transmitted carriers in each of the two channel groups in a 24-channel system (168 kHz for channel group 1 and 152 kHz for channel group 2) to establish the modulation frequency applied to the channel group demodulator. The 280-kHz modulating frequency for channel group 1, or the 232 kHz for channel group 2, is shifted in the same direction and by the same amount as the frequency deviation present in the transmitted carrier. The frequency shift present in the incoming line signal is thus corrected to within a fraction of a hertz for the entire output band at the output of the channel group demodulator. The frequency correction circuit for the J99300AS unit is shown in block-diagram form in Fig. 2.

### D. Transmission Performance

**4.15** Within the 4-kHz channel band, the approximate high and low frequencies at which the gain of an average channel is a given number of decibels less than the 1000-Hz gain are shown in Table C. Figure 14 shows a typical overall channel-frequency characteristic measured from compressor input to expander output with the terminals connected back-to-back. This does not include amplitude distortion which may result from residual repeated line-frequency characteristics. A circuit composed of four N3 channels, patched in tandem at 4-wire voice-frequency jacks, is expected to have the 3-dB points occurring at approximately 300 and 3360 Hz and the 10-dB points at approximately 185 and 3500 Hz.

**4.16** The nominal 1000-Hz transmission variations versus time, temperature, and battery voltage (expressed as the standard deviation) are expected

to be less than  $\pm 0.5$  dB for any length of N3 Carrier System.

**4.17** Envelope delay distortion is typically less than 200 microseconds between 1000 and 2600 Hz and less than 800 microseconds between 500 and 3000 Hz. Figure 15 shows the typical envelope delay-versus-frequency characteristics of an N3 channel. The minimum absolute delay (1800 Hz) of a pair of N3 terminals is approximately 1000 microseconds. The absolute delay of a typical N-repeated line is about 10 microseconds per mile.

**4.18** Noise performance for companded channels is typically quieter than 10 dB for terminals back-to-back.

## 5. COMMON CARRIER SUPPLY

**5.01** The 16 carrier frequencies needed in an N3 terminal are obtained from a common carrier supply. The carrier frequencies used are: 12 channel carriers, two channel-group carriers, a group carrier, and a 256-kHz carrier for modulation of the channel groups for an N3-L Junction. The common-carrier supply can simultaneously furnish the 16 frequencies to a maximum of 26 N3 terminals or 26 N3-L Junctions or to a combination of terminals and junctions. Figure 16 is a front view of a fully equipped carrier supply mounted in the bay frame.

**5.02** The carrier supply circuit uses a 4-kHz generator unit which includes a 61A oscillator, or a tap from an L carrier supply to provide a primary 4-kHz sine wave, used to drive a harmonic generator. The desired carrier frequencies are selected at the output of the harmonic generator by means of crystal filters, amplified to the desired levels, and delivered to a primary distribution circuit. They are then fed to the secondary distribution circuit located in the N3 terminal bays. One secondary carrier distribution circuit is required for each 11-foot 6-inch frame, and only one for every other 9-foot or 7-foot frame. Final distribution, level adjustment, and close level regulation of the frequencies used as transmitted carriers are accomplished in the secondary distribution circuitry.

**5.03** Each of the 16 carrier frequencies is maintained at all times within six parts per million of its designated frequency by periodic recalibration of the 4-kHz generator. The output

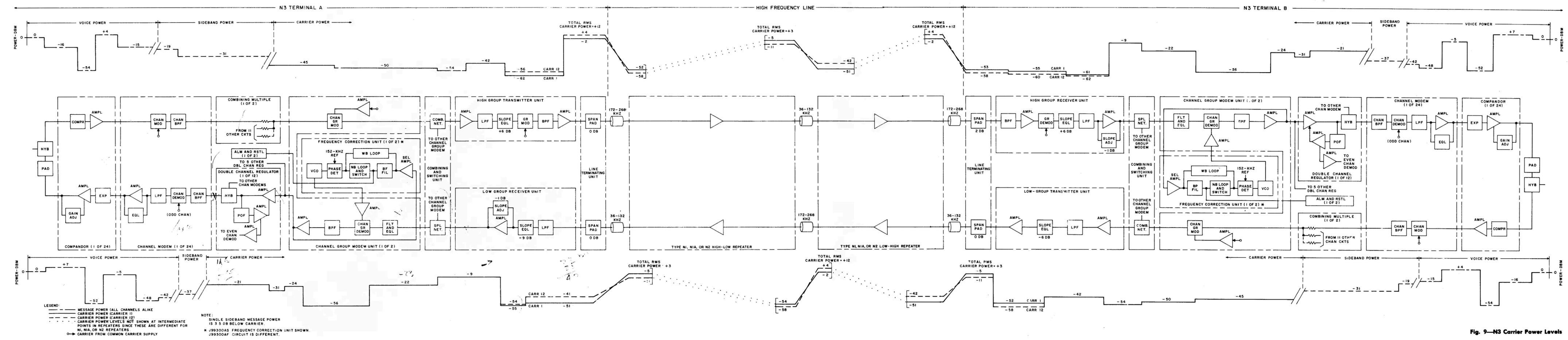


Fig. 9—N3 Carrier Power Levels

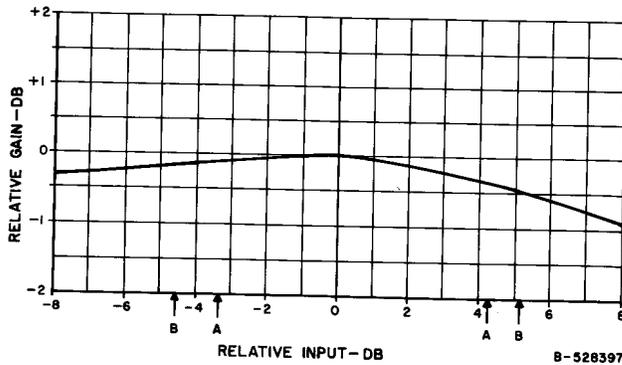


Fig. 10—N3 Group Receiver Unit Regulation Characteristic

levels of the carriers are regulated to within  $\pm 0.50$  dB. In addition, level variations of those carriers to be transmitted will not exceed  $\pm 0.05$  dB.

## 6. POWER SUPPLY

**6.01** Only standard office  $-48$  volt power supply is required for N3 terminals exclusive of repeater power feed requirements. However,  $+130$  volts is required for early E-type signaling test sets. Each terminal requires a plug-in power supply unit which contains a 48- to 21-volt converter to drop the supply voltage and provide a closely regulated  $-21$  volt supply. The power supply unit may be manually adjusted for  $-21$  volts with an output load of 0.7 to 4.0 amperes. Before the power supply unit is plugged in, each terminal must be equipped with at least the following plug-in units to maintain the minimum 0.7-ampere current drain: one group transmitter unit, one group receiver unit, one frequency-correction unit, two channel-group modem units, two double-channel regulator units, three compandor units, and three channel-modem units. No plug-in power load units are provided in the N3 terminal when all channels are not equipped. Also, channel modem load units are required for each channel not equipped with channel modem units.

**6.02** The common carrier frequency supply bay has a power supply unit of the same type as that used in the N3 terminal. It requires a standard office  $-48$  volt power supply and has a maximum current drain of 2.5 amperes.

**6.03** Standard  $+130$  and  $-130$  volt office supplies may also be required at an N3 terminal to supply power from the plug-in line terminating

unit to remote repeaters. The proper combination of ground,  $-48$ ,  $+130$ , and  $-130$  volts, is connected to the high-frequency line simplexes for the number and type of repeaters to be powered. The proper line current is established by the adjustment of line-terminating unit screw switches, and in older line-terminating units, a slide-wire resistance. Means are provided for in-service current readings, but adjustments are on an out-of-service basis.

## 7. MAINTENANCE FEATURES

### A. Testing Arrangements

**7.01** In-service transmission or voltage measurements may be made at the inputs and outputs of the compandors, channel modems, group transmitter and receiver units, and the power supply unit through pin jacks or switching jacks located on the face of the plug-in units. Similar pin jacks permit measurement of the emitter voltages of the transistors in the group transmitter, group receiver, channel group modem, and frequency-correction units, and measurement of the simplex current being fed to adjacent repeaters. Use of the portable J99300AU N3 switching set affords in-service switching of group transmitter, group receiver, and power units. It also allows accurate adjustment of the power supply unit output voltage. Terminal alarm and restoral units may be replaced without service interruption. Terminated measurements and maintenance of channel units, channel group units, double-channel regulator units, and frequency-correction units may be accomplished on a channel turn-down basis. The system must be removed from service for adjustments and maintenance of the line terminating unit. Small sized plug-in units make practical the removal and replacement of defective units in N3 terminals, which simplifies maintenance. Screw-connected slope equalizers and plug-in span pads simplify system rearrangements.

**7.02** Compandors, voice-frequency amplifiers, channel modems, and alarm units may be tested with a portable J99300AW test stand on a terminated basis. Use of this stand also permits bridging access to all input and output connections of the compandor, voice-frequency amplifier, and modem units.

**7.03** An out-of-service message channel may be used as a temporary maintenance talking circuit by connecting 52K head telephone sets to

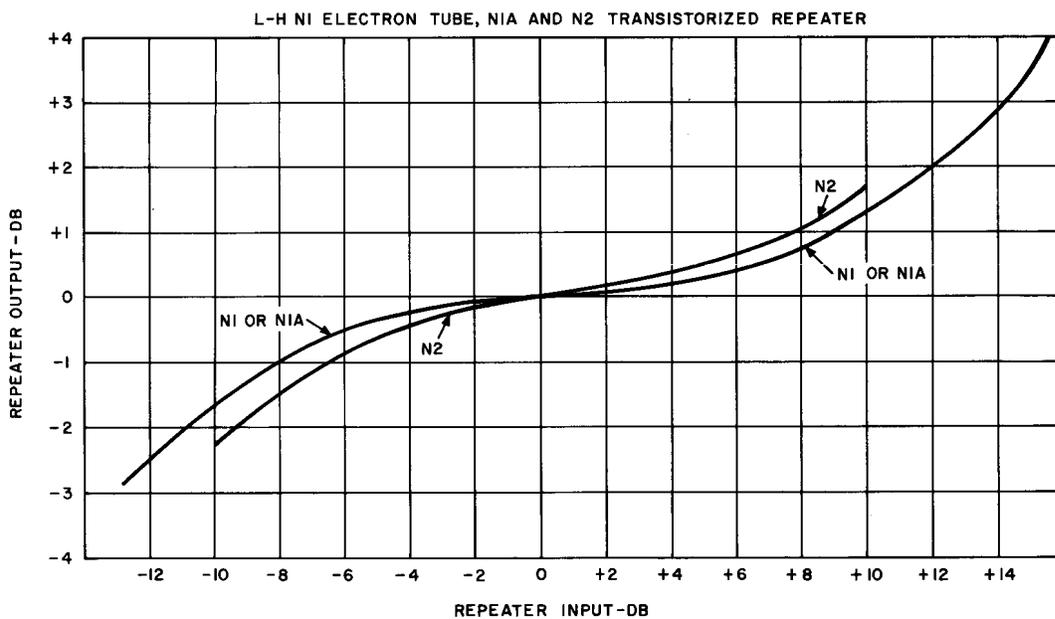
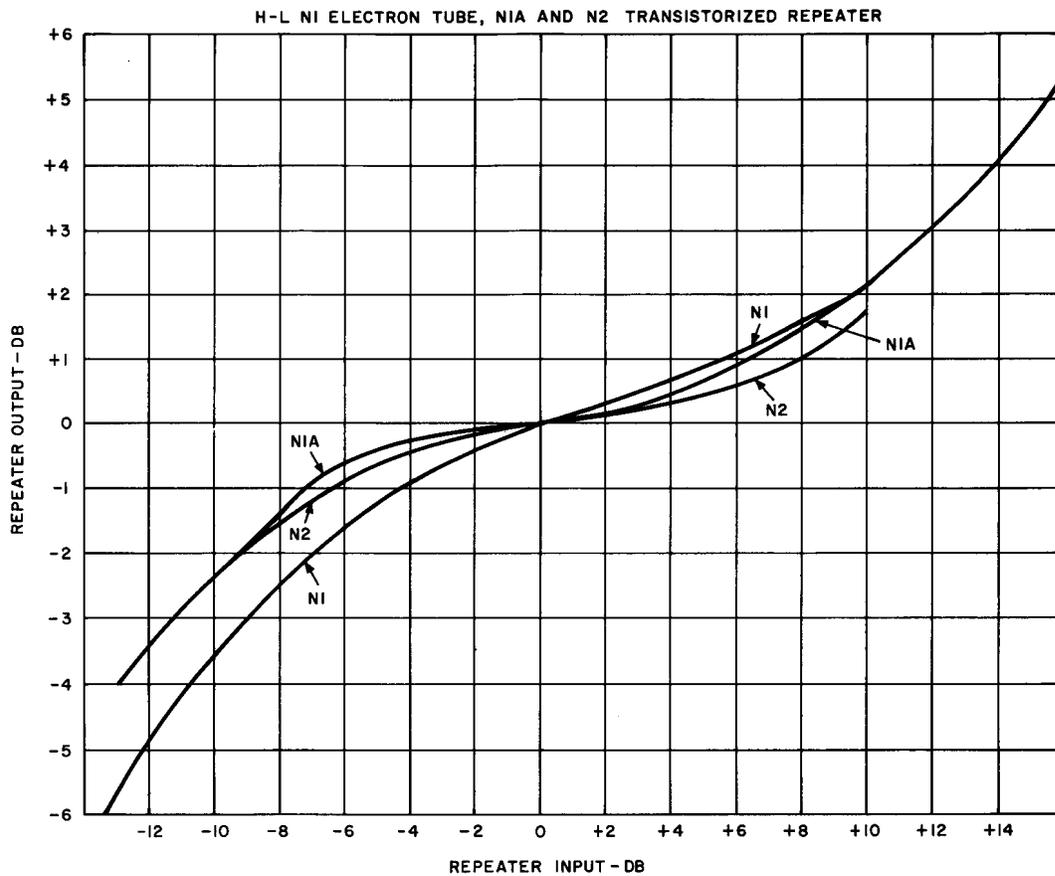
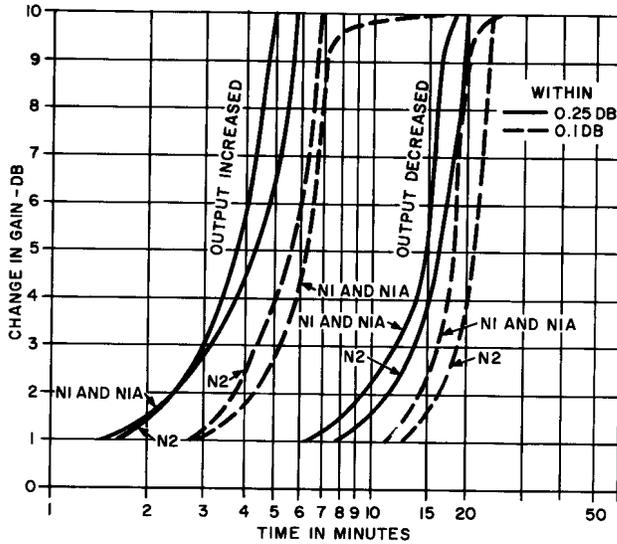


Fig. 11—Repeater Regulation Characteristics



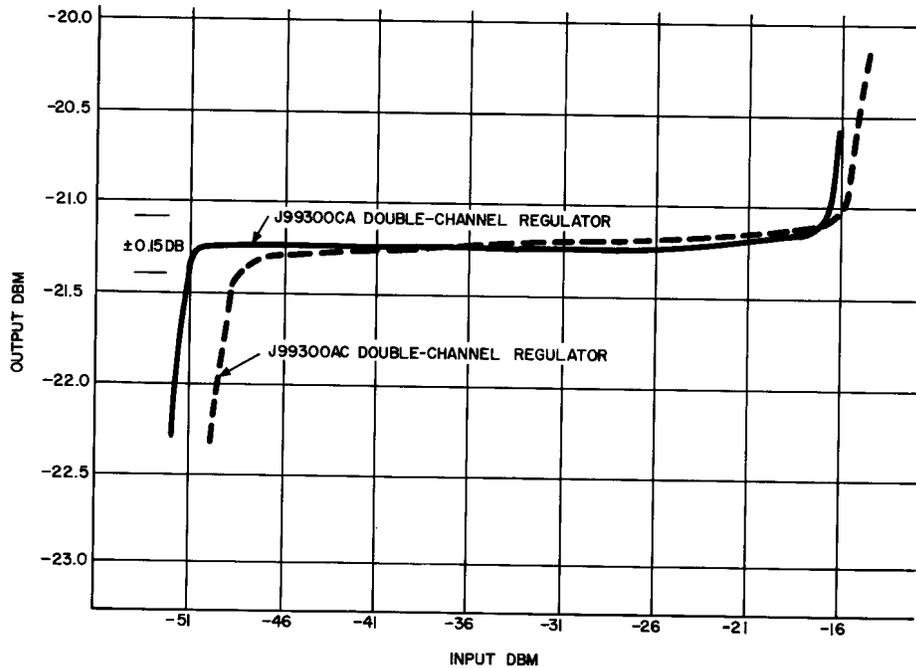
**Fig. 12—Regular Stabilization Time N1 Electron Tube, N1A or N2 Transistorized Repeaters**

pin jacks on the compandors of the idle channel at the terminals of the system.

**7.04** The use of transistors reduces heat dissipation, permitting compact assemblies without requiring the use of forced ventilation.

**B. Order-Wire and Alarm Circuit**

**7.05** The J98704 order wire and alarm circuit aids in the testing and maintenance of the N3 System. The circuit provides complete talking service, transmission of alarms from unattended locally powered main repeater stations to attended stations, and power for the repeater switching set. A simplified schematic of a complete order wire and alarm facility is shown in Fig. 17. The description and maintenance is covered in Sections 362-010-150 and 362-010-501.



**Fig. 13—Double-Channel Regulator Characteristics**

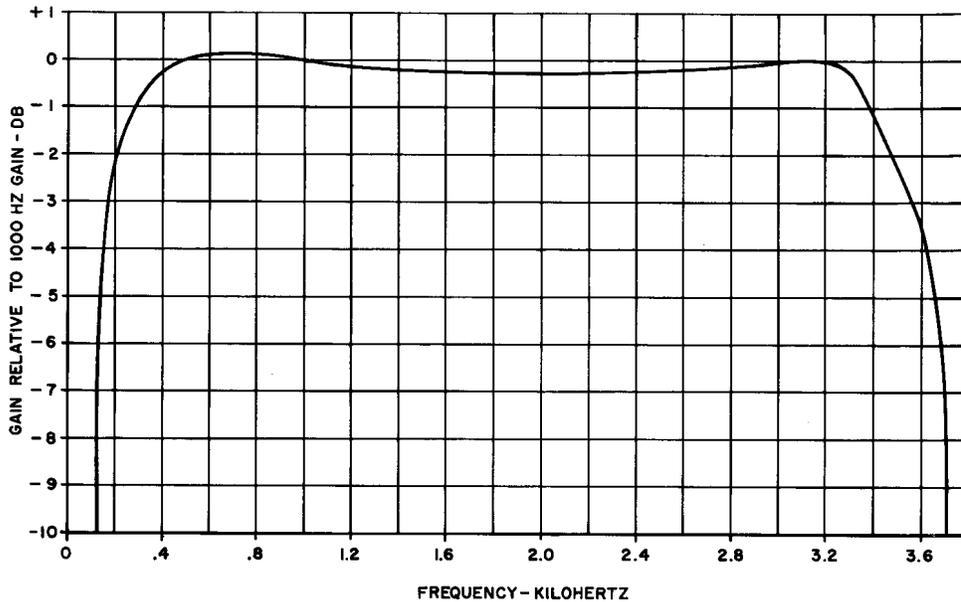


Fig. 14—Typical Channel-Frequency Characteristic Back-to-Back Terminals

TABLE C  
N3 FREQUENCY RESPONSE

DOWN FROM 1000-HERTZ POINT	FREQUENCY	
	LOW	HIGH
DB	HERTZ	
1	260	3400
3	175	3520
10	135	3660

7.06 Two pairs are required along each system route. One pair is used for order-wire arrangements, which are designed to use 16- or 19-gauge pairs with H88 or H172 loading. Signaling is provided, using an interrupted 1900-Hz tone. At pole-mounted repeater points, calling-in signals are generated by an appropriate whistle.

7.07 The second pair is used for the alarm circuit, which brings in an alarm at attended points from unattended locally powered main repeater stations by means of voice-frequency tones spaced 400 Hz apart. Each unattended station generates one tone capable of one alarm indication which may be fuse failure, low or high voltage, open door, etc., or a combination of these alarms. Four tones may be used on an alarm circuit with frequencies

of 700, 1100, 1500, and 1900 Hz, allowing a maximum of four unattended stations to be served by one alarm circuit. At each unattended locally powered station, alarm tone is removed from the line under control of relays, to give an audible and visual alarm indication at the attended station. A control is provided for silencing the audible alarm. When the trouble has been cleared at the unattended station, the audible alarm will again sound at the attended station until the control is returned to normal. The alarm has a 5-second delay interval to guard against false operation from static or hits caused by maintenance. When an unattended station has more than one alarm condition possible, the single alarm may be used as a general alarm.

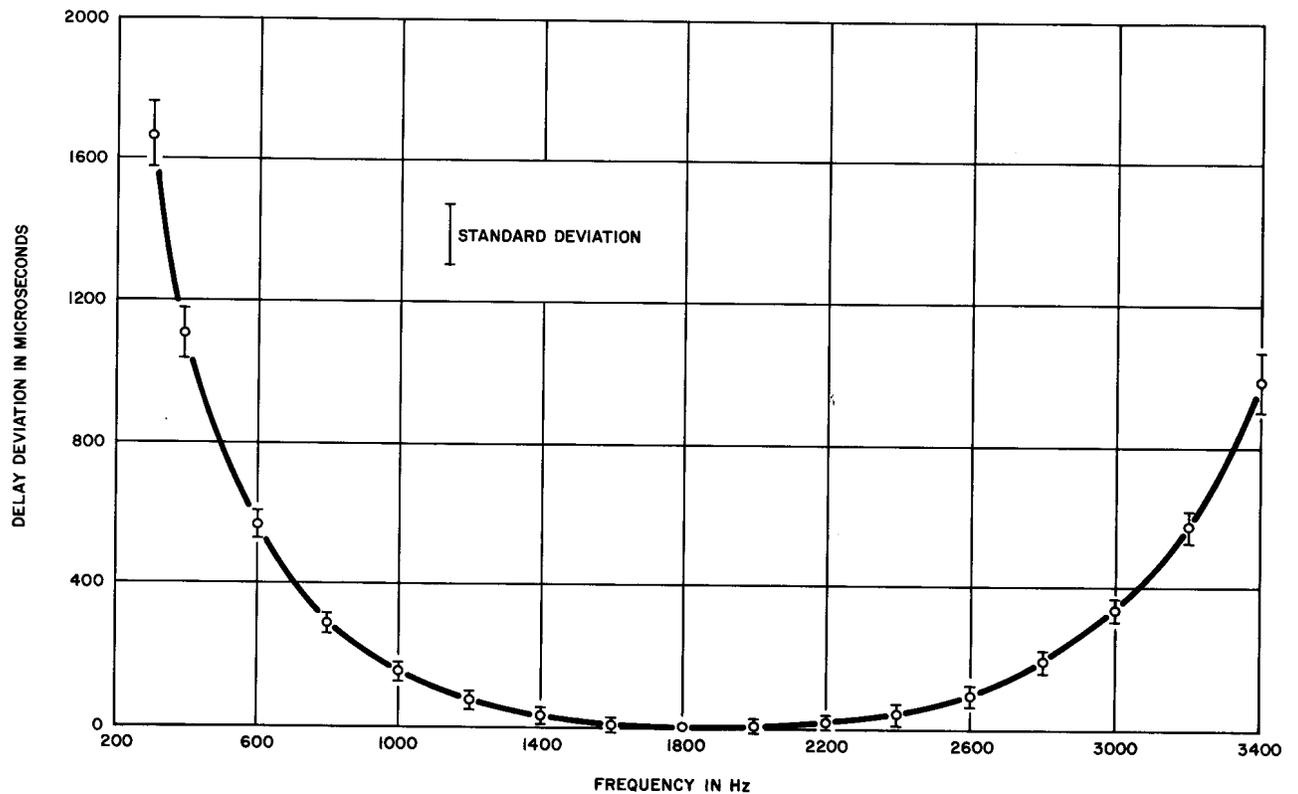
7.08 All terminal or locally powered repeater points may supply dc power over the simplexes of the order wire and alarm pairs. This provides the power supply required for repeater switching at nonpowered repeater stations.

8. DRAWINGS (NOT ATTACHED)

8.01 The following drawings give additional information:

SD-56073-01 Telephone Set Circuit

SD-64048-01 4-Wire Monitor and Talk Circuit



**Fig. 15—Typical N3 Channel Envelope Delay Distortion Characteristic**

SD-81770-01	Power Systems—Typical Battery Distribution Systems	SD-97174-02	N3 Compandor Circuit
SD-95124-01	N1 Repeater Application Schematic	SD-97175-02	N3 Channel Modem Unit
SD-95124-02	N1 Transistorized Repeater Application Schematic	SD-97176-02	N3 Double Channel Regulator Unit
SD-95162-01	1000-Hz Outlets, Receiving Jacks, and Controls	SD-97177-01	N3 Channel Group Modem Unit
SD-95178-01	N1 High-Low Repeater Circuit	SD-97178-01	N3 Frequency Correction Unit J99300AE
SD-95179-01	N1 Low-High Repeater Circuit	SD-97178-02	N3 Frequency Correction Unit J99300AS
SD-95290-01	N1A High-Low Repeater Circuit	SD-97179-01	N3 Low Group Transmitting Unit
SD-95291-01	N1A Low-High Repeater Circuit	SD-97180-01	N3 Low Group Receiving Unit
		SD-97181-01	N3 High Group Transmitting Unit
SD-95900-01	Transmission and Noise Measuring Circuits	SD-97182-01	N3 High-Group Receiving Unit

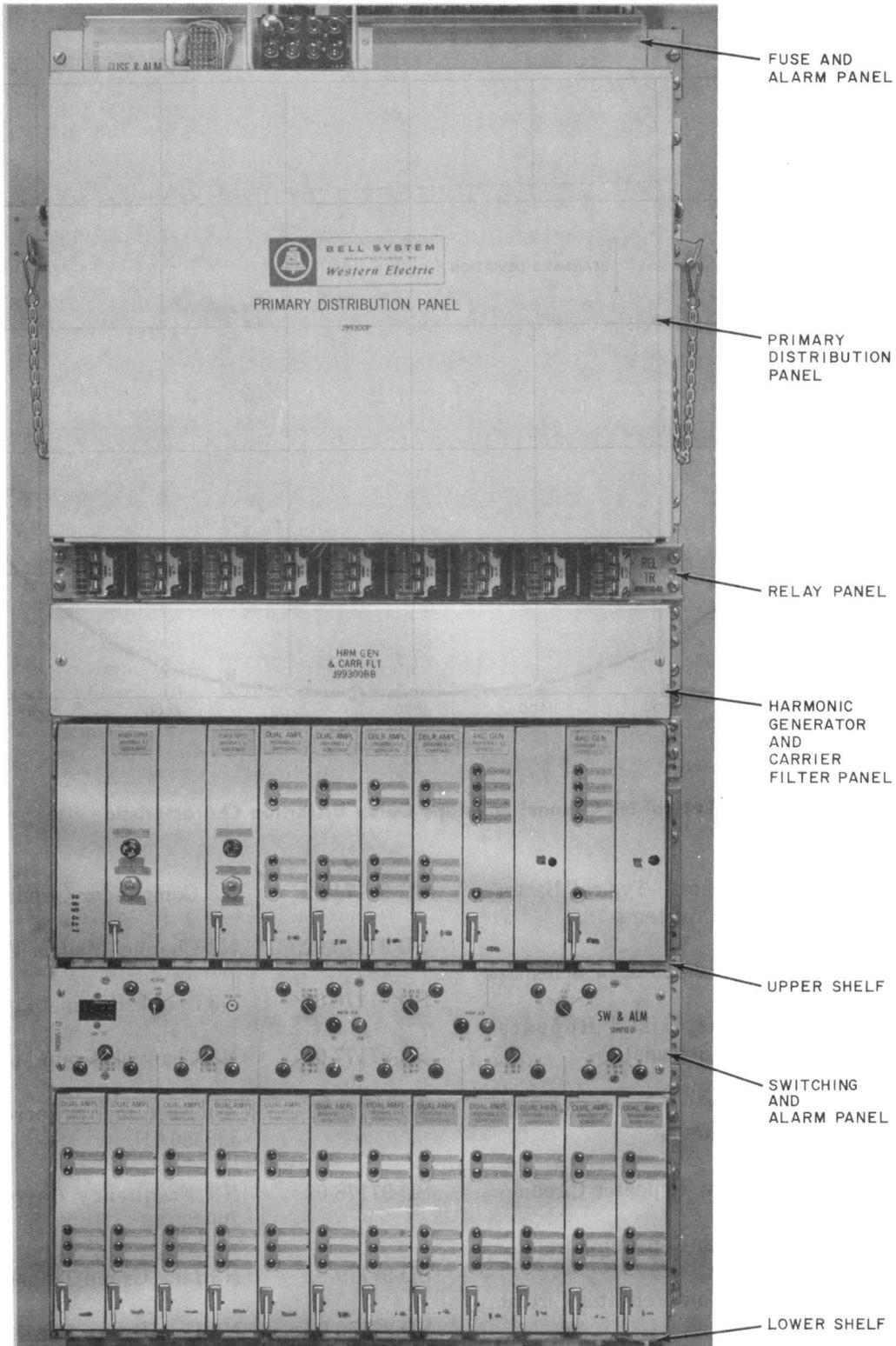


Fig. 16—N3 Carrier Supply

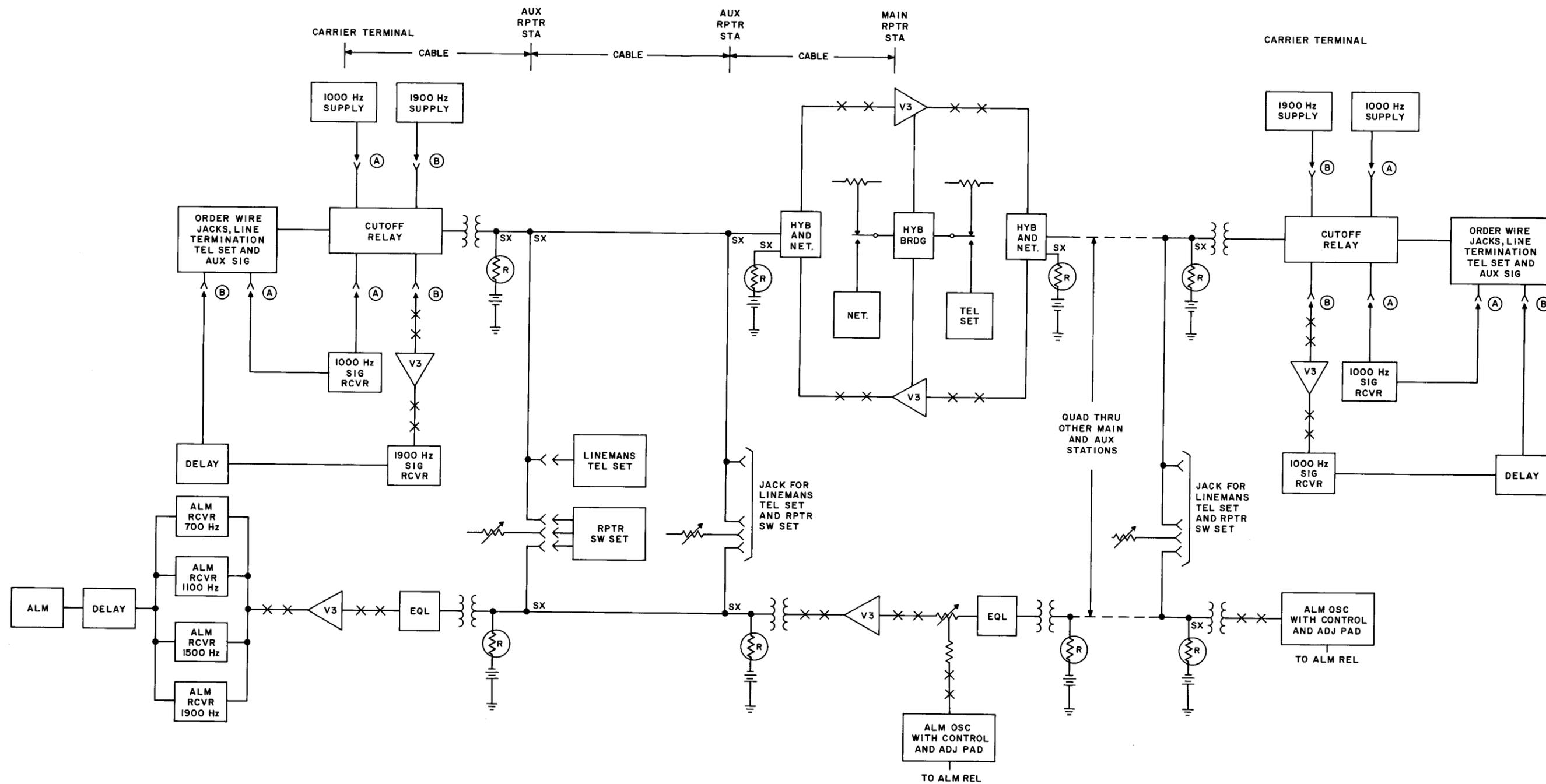


Fig. 17—Order-Wire and Alarm Circuit

SD-97183-01	N3 Line Terminating Unit J99300AL	SD-97402-01	N2 Repeater Switching Set
SD-97183-02	N3 Line Terminating Unit J99300AT	SD-99730-01	N3 Common Carrier Supply—4-kHz Oscillator and Amplifier Unit
SD-97184-02	N3 Alarm and Restoral Unit J99300AK	SD-99732-01	N3 Common Carrier Supply—Switching and Alarm Panel
SD-97185-01	N3 Shop-Wired Terminal Circuit	SD-99733-01	N3 Common Carrier Supply—Dual Amplifier Unit
SD-97186-02	N3 Trunk Release and Make-Busy Circuit	SD-99734-01	N3 Common Carrier Supply—Doubler Amplifier Unit
SD-97187-01	N3 Alarm, Power, and Miscellaneous Panel	SD-99735-01	N3 Common Carrier Supply—Harmonic Generator and Carrier Filter Panel
SD-97188-01	Packaged Frame For N3 Terminals, Type B and C N3-L Junction Application Schematic	SD-3C029-01	N3 Secondary Carrier Distribution Amplifiers for 232 and 152 kHz or 280 and 168 kHz
SD-97191-01	N3 Voice-Frequency Amplifier Unit	SD-3C030-01	N3 Secondary Carrier Distribution Amplifier For 304 kHz
SD-97192-02	N3 Channel Modem Load Unit	SD-3C031-01	N3 Secondary Carrier Distribution Amplifiers for 148 and 156 kHz
SD-97271-01	N3 Switching Test Set	SD-3C032-01	N3 Secondary Carrier Distribution Amplifiers for 188 and 160 kHz, 164 and 176 kHz, 172 and 184 kHz, or 180 and 192 kHz
SD-97272-01	Application Schematic For Powering N1, N1A, N2, ON1, and ON2 Repeaters	SD-3C033-01	N3 Secondary Carrier Distribution Amplifier for 256 kHz.
SD-97274-01	N1 Repeater Connecting Circuit		
SD-97279-01	N3 Terminal Test Stand J99300AW		
SD-97374-01	N2 Repeater Application Schematic		
SD-97375-01	N2 Repeater Circuit		