N1 CARRIER TELEPHONE SYSTEM
GENERAL INFORMATION — TERMINAL EQUIPMENT
DESCRIPTION CHANNEL UNITS, TERMINAL MOUNTING, AND SHOP-WIRED BAYS

CONTENTS PAGE

1. GENERAL

A. Scope

1.01 This section describes the terminal mounting, shop-wired terminal bays, and the various channel units that are used with the N1 Carrier Telephone System. This section also provides general information on N1 terminal equipment.

1.02 Since this reissue incorporates a general revision, arrows ordinarily used to indicate changes have been omitted.

B. Equipment Purpose

1.03 The terminal mounting is a supporting framework which provides mounting facilities and electrical connections for transmitting and receiving group units and 12 channel units. There are three types of terminal mountings discussed in this section: a J98703A terminal mounting which provides facilities for one N1 system terminal, a J98703AW shop-wired terminal bay which provides facilities for two terminals, and a J98703AT shop-wired terminal bay which provides facilities for three terminals. The channel units discussed in this section consist of the J98703FA message channel unit with signaling and seven other channel units. Table A identifies and gives the purpose of each unit.

TABLE A

UNIT	CODE	PURPOSE
Message Channel Unit	J98703FA	Translates voice frequencies to one of 12 N1 carrier frequencies for transmission. In receiving direction, translates carrier frequencies to voice frequencies. This unit also supplies a signaling circuit which converts dc signaling indications to an audio tone for transmission over the carrier system and a compandor for control of speech levels.
Channel Unit Without Signaling	J98703AP	Same as J98703FA unit except this unit does not have signaling provisions.
Amplas Channel Unit	J98703BP	Electrically same as J98703AP unit. Additional temperature limitations apply.
Thru Channel Unit	J98703AH	Enables N carrier channels to be connected as through circuits to other N, O, or ON carrier channels.
Special Services Channel Unit	J98703AM	Used when data transmission and voice frequency carrier telegraph or telephoto is transmitted over the carrier system.
A and B Program Channel Unit	J98703W	Translates A or B program material in the same manner as the J98703FA unit translates voice frequencies. This unit does not have signaling provisions.
A and B Program Reversing Channel Unit	J98703Y	Transmits and receives program reversing carrier signals. Operation of this unit conditions a reversing circuit enabling a broadcast studio or control room to either transmit or receive A and B program material.
C and D Program Channel Unit	J98703TA	Translates C or D program material in the same manner as the J98703FA unit translates voice frequency. This unit does not have signaling provisions.

C. System Considerations

1.04 The N1 carrier telephone system is a 12-channel system designed for short-haul use on toll and exchange plant cables. The system employs double sideband transmission with channels spaced every 8 kc. The frequency plan provides for 13 channels (12 active and 1 spare) which are numbered 1 through 13. Channels 2 through 13 are normally used as the active channels and, at the output of the terminal, occupy a frequency range of 36 to 132 kc for transmission in one direction and 172 to 268 kc for transmission in the other direction. Carrier frequency allocations are shown in chart form in Fig. 1 and 2. Channel 1 is available for use in place of any other channel in the system which may be unsatisfactory as a result of radio or other interference. Channel 1 occupies a frequency band of 132 to 140 kc in the low-group band for one direction of transmission and 164 to 172 kc in the high-group band for the other direction of transmission. All carrier channels are generated in the high-group band (164 to 260 kc) to simplify filters and other circuit elements. The low-group frequency band is obtained by translating the high-group band to the lower frequency.

1.05 The N1 carrier system includes a number of features not formerly found in carrier transmission circuits. These features include built-in signaling circuits, compandor circuits, and a regulator circuit in the basic channel units; transmission of carrier plus both sidebands; and the use of miniature equipment.

1.06 The basic channel units include circuits which permit the transmission of supervisory signals and dial pulses over the N1 systems. Connections from switchboard or trunk equipment to this built-in signaling system are made in the same way as with present CX signaling circuits. On-hook and off-hook dc signals received on the M lead from the associated trunk circuit are transformed into corresponding interruptions of a 3700-cycle tone which is transmitted over the system at carrier frequency. At the distant terminal, these interruptions are transformed back into dc signals. Special features in the signaling circuit include amplitude limiting, which makes the 3700-cycle detector circuit insensitive to changes in the demodulator output; and time delay, which enables the circuit to discriminate between legitimate dial pulses and line hits or noise bursts (which are generally quite short in comparison with the dial pulses). Multifrequency pulsing, call announcer, or ringdown signals are sent over the speech channel.

1.07 A compandor circuit is provided in each channel unit. The compandor is made up of a compressor and an expandor; the compressor is used in the transmitting portion and the expandor in the receiving portion of the channel unit. This circuit reduces noise and crosstalk enabling the use of longer repeater sections and eliminating the need of crosstalk balancing on the cable pairs and noise treatment of noncarrier pairs.

1.08 Each channel unit transmits over the carrier line its carrier frequency plus both sidebands. This contributes to reduction in filter selectivity requirements through wider spacing of channels, avoids need for receiving carrier oscillators, and affords a simple means of regulating repeaters and individual channels.

1.09 A regulator is included in the receiving portion of the channel unit. It operates on the channel carrier power received and provides a relatively constant message level at the output of the demodulator.

1.10 Miniature equipment has been used throughout the N1 system. These miniature elements include filters, transformers, electron tubes, resistors, electrolytic paper and mica capacitors, potentiometers, and diodes. Thermoplastic strips are used to mount pigtail elements.

2. N1 TERMINAL EQUIPMENT

A. General Information

2.01 A complete 12-channel N1 carrier terminal consists of a terminal mounting, a transmitting group unit, a receiving group unit, and 12 message channel units. A photograph of a typical N1 carrier terminal is shown in Fig. 3.

2.02 The terminal mounting provides mounting facilities, jacks, interconnecting wiring, power circuits, and alarm circuits for the transmitting and receiving group units and the 12 channel units. The transmitting group unit

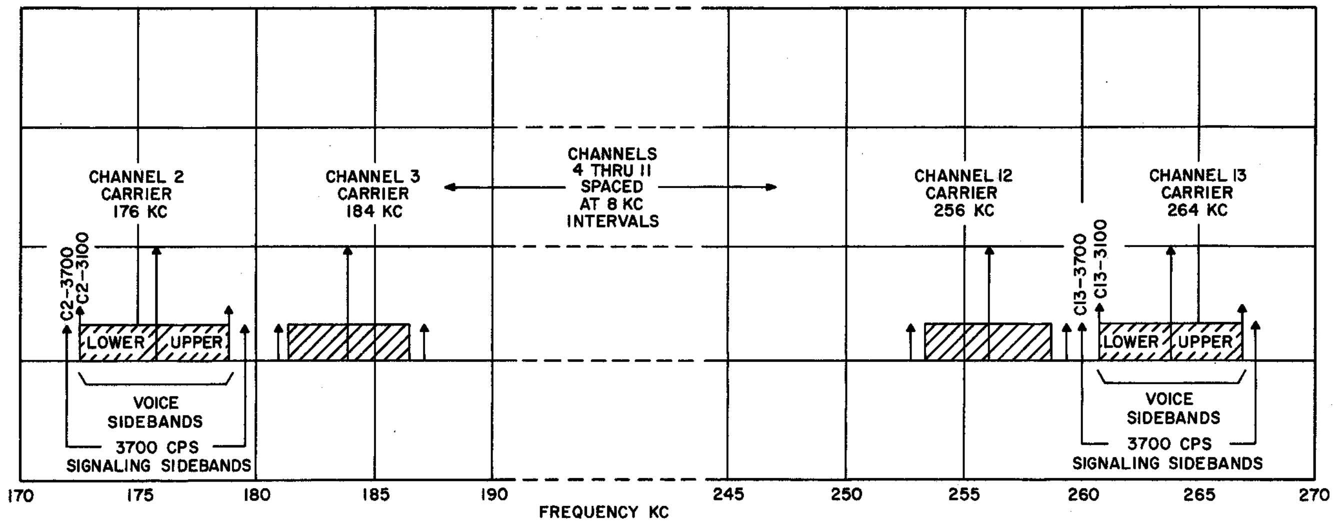


Fig. 1 — N1 Carrier Frequency Allocations, High Group

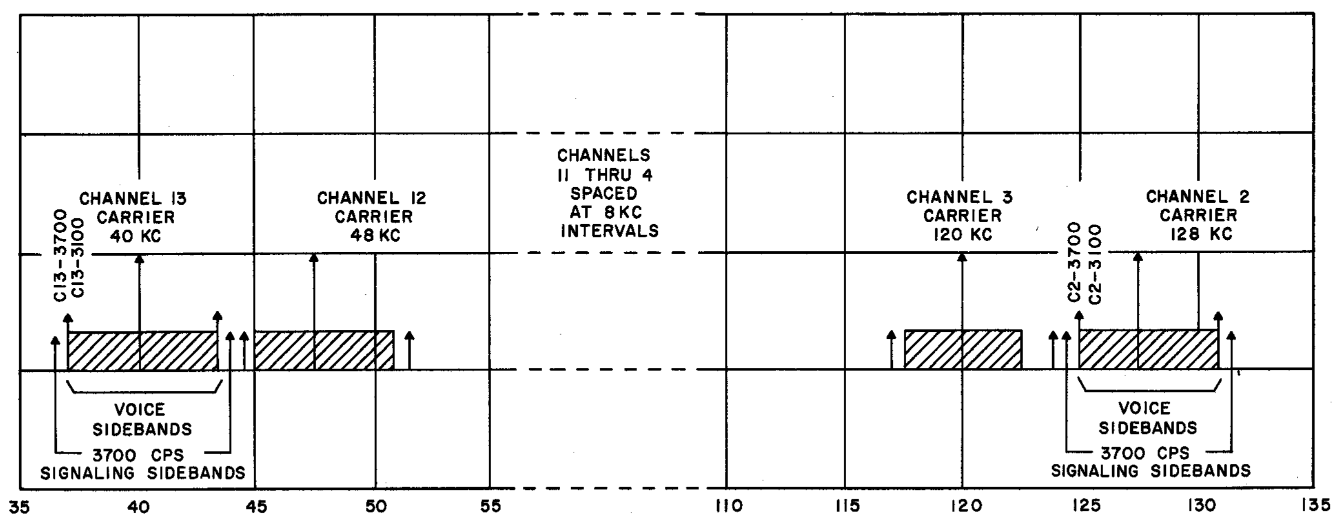


Fig. 2 — N1 Carrier Frequency Allocations, Low Group

receives 12 modulated signals from the channel units and amplifies them for transmission over the carrier line. The receiving group unit receives the low level signals from the carrier line, amplifies and regulates them, and applies the resultant signal to the channel units for demodulation. The basic channel units translate voice frequencies to carrier frequencies for transmission and, in the receiving direction, translates carrier frequencies to voice frequencies. The basic channel unit also supplies signaling circuits for transmitting signaling indications over the carrier line.

2.03 The terminal equipment mounts in a relatively small space so that three complete terminals can be mounted in an 11-foot 6-inch bay. The external connections of each channel and group unit terminate in a plug which is inserted into a jack in the terminal mounting. This permits testing the units without jack fields and allows the removal of any unit to a convenient location for maintenance and replacement by a spare unit. Facilities for routine maintenance are located on the front of the units which permits back-to-back mounting or mounting against a wall.

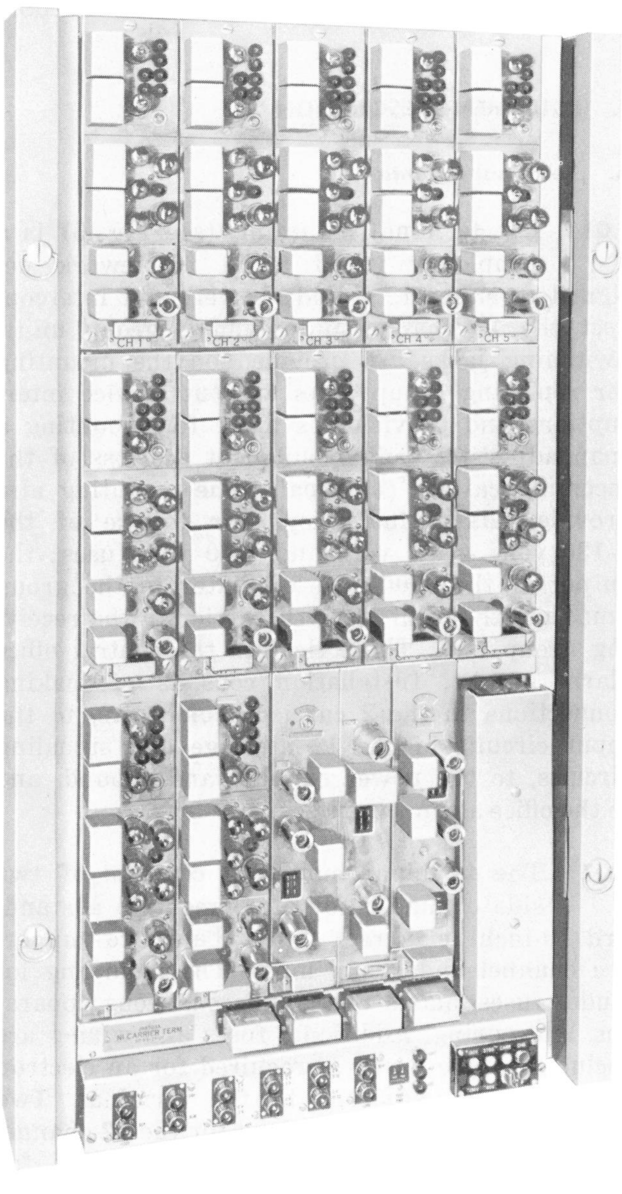


Fig. 3 — N1 Carrier System Terminal

B. Terminal Operation

General

2.04 To aid in understanding typical terminal operation, a simplified schematic and level diagram of terminal equipment is shown in Fig. 4. In this diagram it should be assumed that the channel unit connects to a toll switchboard and that the toll switchboard is the reference level point for the signal levels noted on the diagram.

Message Transmission

2.05 Speech currents originating at the toll switchboard pass to the terminal mounting through an external hybrid terminating circuit. Loss through the hybrid and pads in the transmitting direction is designed so that the signal level at the input of the compressor circuit is —16 db. The message channel unit operates on a 4-wire basis. Early channel units (now rated MFR DISC) provided an optional internal resistance hybrid for 2-wire operation.

2.06 From the external hybrid the speech currents are applied through a transformer, a variolosser, and an amplifier in the compressor subassembly. A portion of the amplifier output is rectified in the compressor control circuit to produce a direct current that varies in magnitude as the syllabic energy in the speech current varies. The varying dc flows through the diodes in the variolosser to change its loss and thus change the over-all compressor gain. Through this action the compressor reduces the range of speech power at its output to approximately one-half of that applied to its input.

2.07 Speech currents are applied from the compressor amplifier to the transmitting low-pass filter. The output level of the low-pass filter is adjusted to —1.5 db by the compressor gain control (COMP). A detailed explanation of compressor circuit levels is provided in 4.05 through 4.08.

2.08 The compressed speech currents from the compressor subassembly are applied to a 15-db pad in the carrier-frequency subassembly. This pad produces the desired —16.5 db message level at the input of the modulator. The transmitted carrier power into the 840-ohm load at the output of the modulator is —22 dbm. The level of a single sideband in the message circuit at this point is —37 db.

2.09 The speech sidebands and the carrier from the channel modulator are applied to the input of a combining multiple on the terminal mounting. The 12 combining pads (one per channel) are connected in parallel at their output ends to form the combining multiple. The combining multiple combines the outputs of the channel modulators for application to the transmitting group equipment. The loss through each pad is 33 db. The transmitting group unit applies the combined signals to the carrier line.

2.10 In the receiving direction, signals from the carrier line are applied through the terminal mounting to the receiving group amplifier. The amplified signals are then passed through appropriate channel band filters in the various channel unit carrier frequency subassemblies. The total carrier output of the receiving group amplifier is held relatively constant at +5.5 dbm. Individual channel carriers are normally in the range of —5.5 ±5 dbm at mean cable temperature. The spread in received channel carriers is due, for the most part, to imperfect line equalization.

2.11 The desired carrier and double sidebands are applied from the channel band filter to the channel regulator. The regulator can reduce channel carrier variations from ±8.0 to ±0.5 db and amplifies the signal for application to the demodulator. The nominal carrier power delivered to the demodulator is +13.5 dbm.

2.12 Following demodulation the signals are passed through a receiving low-pass filter located on the expandor-signaling subassembly. The message level at the output of the low-pass filter is —1.5 db, and this is reduced through use of a pad to the desired nominal level of —9 db at the expandor input control.

2.13 The compressed speech currents enter the control circuit of the expandor which produces a direct current that varies as the syllabic energy of the speech varies. This direct current flows through the diodes in the variolosser to alter its loss and thus alter over-all expandor transmission. The performance of the expandor variolosser is opposite to that of the compressor variolosser so that speech currents are restored to their original relative volumes. The variolosser is followed by a fixed gain amplifier whose output level is +10 dbm.

2.14 A variable attenuator is provided at the expandor amplifier output to permit adjustment of output levels delivered to connecting circuits. When operating with a 4-wire connecting circuit, the output level may be adjusted from +10 to —16 db. (For 2-wire operation, using the resistor hybrid 4-wire terminating set provided in the channel unit, the output level can be reduced from +7 db to approximately —19 db.)

3. EQUIPMENT DESCRIPTION

A. Terminal Mounting

3.01 The terminal mounting (see Fig. 5) is a completely wired metal framework designed to support, provide power, and interconnect the 12 channel units and 2 group units. Switching jacks are provided on the mounting for replacing group units without service interruptions and provision is made for mounting a span adjusting pad to build out the loss of the incoming carrier cable pair. The mounting also provides alarm indications for failure of the +130 volt, —130 volt, and —40 volt fuses; the output of the 3700-cycle oscillator in the group unit; and the total received carrier in the receiving group unit. These tie into the central office alarm system. Installation consists of making connections to the 2 carrier cable pairs, to the input circuits of the 12 message and signaling circuits, to the power supplies and ground, and to the office alarm circuits.

3.02 The terminal mounting consists of two side channels, for attachment to a standard 19-inch relay rack, with shelves to support the channel and group units. The mounting includes fuses, alarm relays, miscellaneous apparatus, and wiring. Additional fuses and wiring are included where power is required for an electron tube repeater adjacent to the terminal. Two and 2/5 of the shelves are used for the 12 channel units; the remaining 3/5 of a shelf is used for the group units and miscellaneous apparatus. The wiring terminates at jacks for the channel and group units and runs within the shelves, out each

TABLE 101 HGT OUTPUT (+7 DB SLOPE)			
CARRIER			SSB MESS. LEVEL
CHAN	KC	DBM	DB
1	168	−3.4	−18.4
2	176	−2.8	−17.8
3	184	−2.1	−17.1
4	192	−1.5	−16.5
5	200	−0.9	−15.9
6	208	−0.2	−15.2
7	216	+0.4	−14.6
8	224	+1.1	−13.9
9	232	+1.7	−13.3
10	240	+2.3	−12.7
11	248	+2.9	−12.1
12	256	+3.6	−11.4
13	264	+4.2	−10.8

TABLE 102 LGT OUTPUT (−7 DB SLOPE)			
CARRIER			SSB MESS. LEVEL
CHAN	KC	DBM	DB
1	136	−4.2	−19.2
2	128	−4.8	−19.8
3	120	−5.4	−20.4
4	112	−6.1	−21.1
5	104	−6.7	−21.7
6	96	−7.3	−22.3
7	88	−8.0	−23.0
8	80	−8.6	−23.6
9	72	−9.2	−24.2
10	64	−9.9	−24.9
11	56	−10.5	−25.5
12	48	−11.2	−26.2
13	40	−11.8	−26.8

TABLE 105 CARRIER OSCILLATOR	
CHAN NO.	CARR FREQ
1	168 KC
2	176 KC
3	184 KC
4	192 KC
5	200 KC
6	208 KC
7	216 KC
8	224 KC
9	232 KC
10	240 KC
11	248 KC
12	256 KC
13	264 KC

TABLE 103 LGR INPUT (TYPICAL)			
CARRIER			SSB MESS. LEVEL
CHAN	KC	DBM	DB
1	136	−50.2	−65.2
2	128	−49.6	−64.6
3	120	−49.0	−64.0
4	112	−48.3	−63.3
5	104	−47.7	−62.7
6	96	−47.1	−62.1
7	88	−46.4	−61.4
8	80	−45.8	−60.8
9	72	−45.1	−60.1
10	64	−44.4	−59.4
11	56	−43.8	−58.8
12	48	−43.2	−58.2
13	40	−42.5	−57.5

TABLE 104 HGR INPUT (TYPICAL)			
CARRIER			SSB MESS. LEVEL
CHAN	KC	DBM	DB
1	168	−53.4	−68.4
2	176	−54.1	−69.1
3	184	−54.7	−69.7
4	192	−55.4	−70.4
5	200	−56.0	−71.0
6	208	−56.7	−71.7
7	216	−57.3	−72.3
8	224	−58.0	−73.0
9	232	−58.6	−73.6
10	240	−59.3	−74.3
11	248	−60.0	−75.0
12	256	−60.6	−75.6
13	264	61.3	−76.3

Fig. 4 — N1 Carrier System Channel Unit, Simplified Schematic and Level Diagram

side of the bay, and extends up and down the rack at each side. All jacks are mounted so that the wiring and soldered connections can readily be inspected. All wiring for external connections, with the exception of the power leads, is routed to terminal strips which are mounted with the alarm relays and miscellaneous apparatus under front and rear covers adjacent to the group units. Each cover is attached by means of two quick-acting fasteners.

3.03 The power leads are terminated at a power bus assembly which is in back of the fuses at the bottom of the terminal mounting.

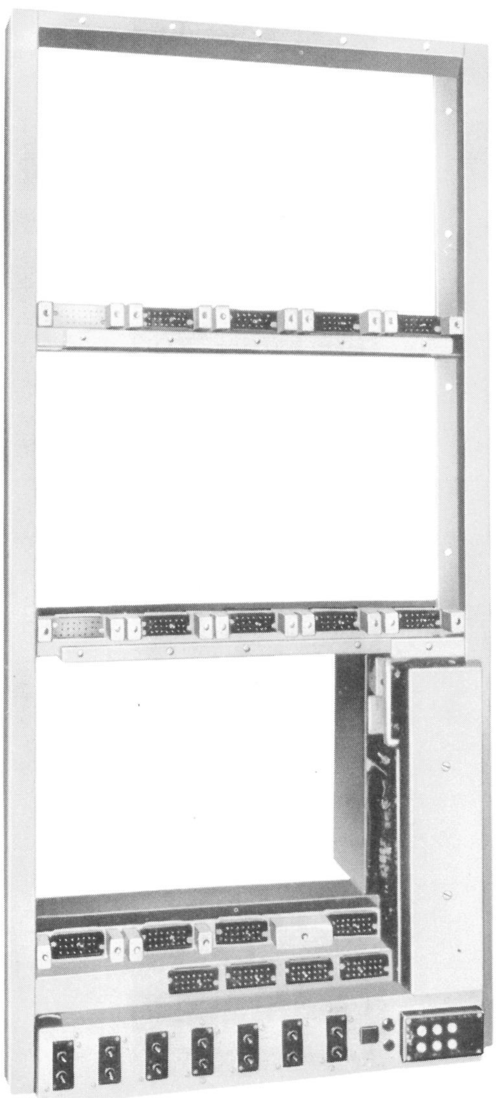


Fig. 5 — N1 Carrier Terminal Mounting

An adjustable resistance and 10 fixed resistances, which may be connected to change the —48 volt supply to —38.5 volts, are mounted under the front cover of the miscellaneous apparatus in front of the terminal strips. The terminal mounting is constructed of natural finish aluminum and is 40-1/4 inches high.

B. Shop-Wired Bays

3.04 The J98703AT terminal bay (see Fig. 6) is a completely wired metal framework containing mounting facilities for three N1 carrier system terminals. The equipment is mounted on an 11-foot 6-inch channel-type bay framework containing 3 die-cast shelves for each carrier terminal. Two of the shelves have facilities for five channel units and the third shelf has facilities for two channel units. The remainder of the space on the third shelf is for the transmitting and receiving group units and some of the miscellaneous items associated with the carrier terminals. All wiring for external connections is routed to terminal strips at the top of the bay. Wiring between the shelves and from connecting jacks on the shelves is routed behind the two common bay uprights. Alarm and power equipment common to the bay and filament voltage adjustment potentiometers for each of the three terminals is located at the top of the bay. A main fuse for incoming filament voltage is located in the center terminal. Fuses, alarms, and alarm control equipment peculiar to each terminal are located on the bottom shelf of the individual terminals. Also in this same location is the repeater power supply equipment for applying power over the line to a distant electron tube repeater unit. This power supply also provides power for up to three transistorized repeater units on the same system. All jacks are mounted so that wiring and soldered connections can be readily inspected. Temperature control equipment consisting of a blower, a control relay and thermostat, a manifold, and air distributing ducts may be ordered with the bay. This equipment will be mounted and wired at the factory with the exception of the blower and relay assembly which will be shipped separately. The blower is mounted at the bottom of the terminal bay with the manifold connected to the rectangular aluminum ducts extending vertically on each side of the terminal equipment.

3.05 The J98703AW terminal bay has facilities for mounting two N system terminals. These two terminals are identical with the lower two N system terminals on a J98703AT bay. The equipment is mounted on an 8-foot 8-inch channel-type bay framework. This bay is intended for use in locations having low ceiling height where the J98703AT bay cannot be used. The equipment arrangement in the J98703AW terminal bay is identical to the arrangements of common equipment in the J98703AT terminal bay.

C. Channel Units

J98703FA N1 Message Channel Unit

3.06 A plug-in method of construction is employed for the N1 channel unit. A complete channel unit (see Fig. 7 and 8) consists of three subassemblies, an optional slip-on can cover, and two screws for fastening the subassemblies together. The top subassembly, which is the compressor, contains all of the voice-frequency transmitting equipment. In the center is the expandor-signaling subassembly which contains all of the voice-frequency receiving and signaling transmitting and receiving apparatus. At the bottom is the carrier-frequency subassembly which contains all of the transmitting and receiving carrier-frequency apparatus.

3.07 The channel unit is 3-3/8 inches wide, approximately 12 inches high, and 10 inches deep. The optional can cover is used with the J98703A terminal mounting only and is attached to the channel units by means of a quick-acting fastener at the rear of the unit. The channel unit is attached to the terminal mounting by means of three quick-acting fasteners, one at the top and two at the bottom of the front panel.

3.08 The external connections of each channel unit terminate in a 20-conductor plug on the carrier subassembly which is plugged into the jack in the terminal mounting. This feature allows the removal of a unit in trouble to a convenient location for maintenance and line-up adjustment. Similar 20-conductor plugs and jacks are provided on each subassembly of the channel unit.

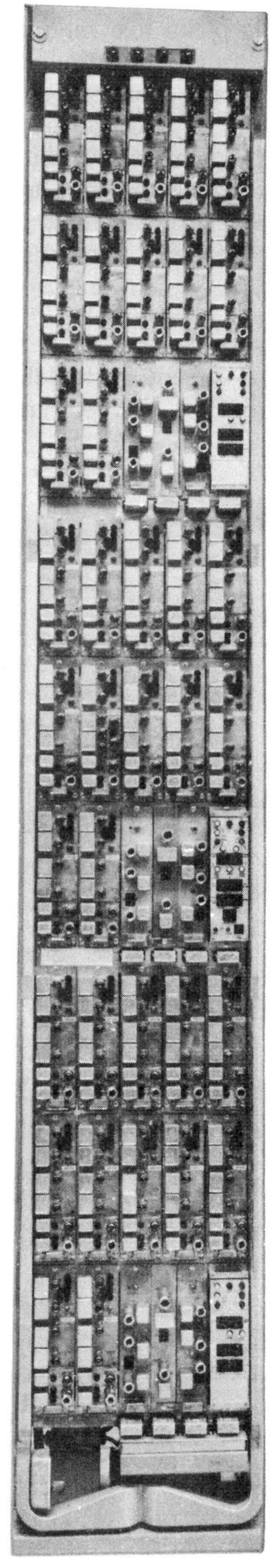


Fig. 6 — N1 Carrier 36—Channel Terminal Bay With Temperature Control

3.09 The compressor and expandor-signaling subassemblies are the same for all channels. Each carrier-frequency subassembly differs from the other 11 in a given terminal only in the crystal oscillator frequency and channel bandpass filter.

3.10 Tubes, output transformers, test points, and a potentiometer appear on the front of the unit. Input transformers, filters, and pigtail apparatus on thermoplastic strips are mounted under the optional slip-on can cover. A portion of the modulator circuit is mounted under a separate inner cover, provided as a shield, on the carrier-frequency subassembly.

3.11 A shield is provided on the oscillator tube but not on any of the other tubes. Reasonable care should be exercised in handling the channel units when they are out of the frame to protect the electron tubes which do not have shields. When a channel unit is placed in a terminal mounting, the tubes should be checked to insure that they are properly seated in their sockets.

J98703AP Channel Unit Without Signaling

3.12 The channel unit without signaling (see Fig. 9 and 10) is identical to the J98703FA message channel unit except the built-in signaling feature has been omitted. The unit is used where built-in signaling is not required or where external in-band signaling is provided. As in the J98703FA unit, the channel unit without signaling consists of three subassemblies fastened together to form one unit. The subassemblies are a compressor, expandor, and carrier subassembly. The compressor and carrier subassembly are identical to the subassemblies used in the J98703FA unit. The ED-92972-30 expandor subassembly without signaling replaces the expandor and signaling subassembly.

3.13 The channel unit without signaling is approximately 3-3/8 inches wide, 12 inches high, and 8-5/16 inches deep. The three subassemblies are mounted in a vertical position with the compressor, which plugs into the expandor, located at the top. The expandor subassembly plugs into the carrier subassembly which is located at the bottom of the channel unit. A

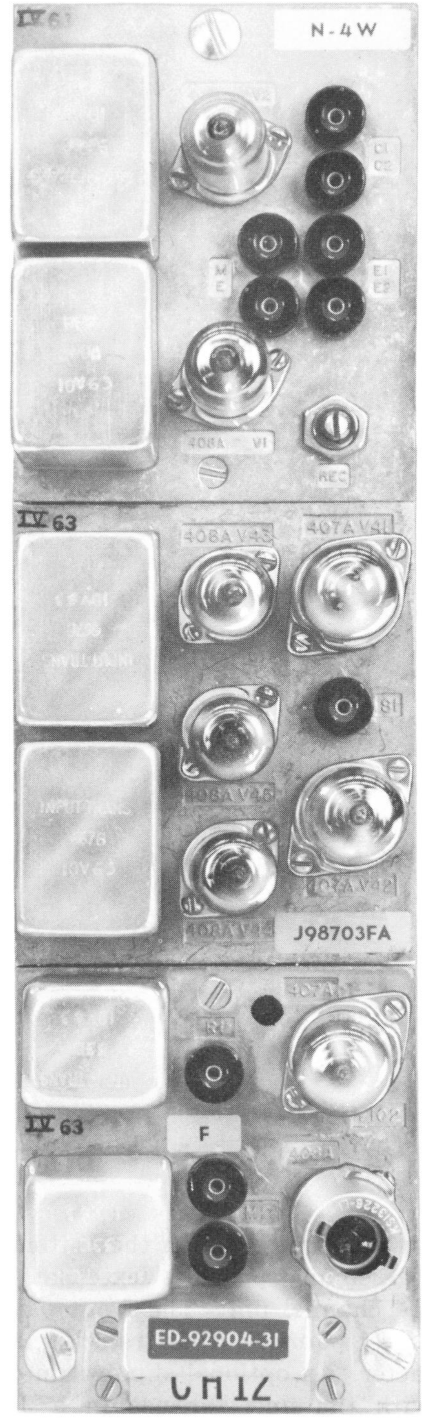


Fig. 7 — N1 Message Channel Unit, Front View

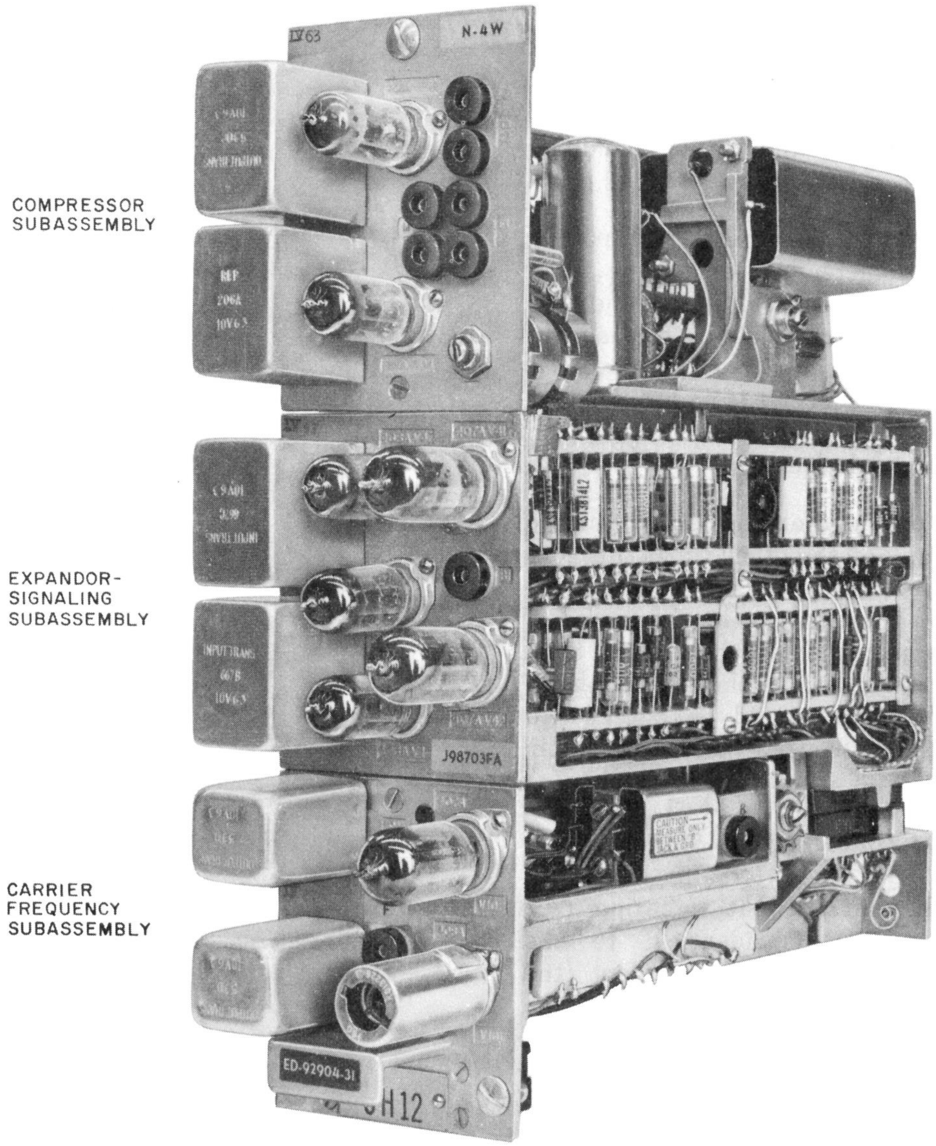


Fig. 8 — N1 Message Channel Unit, Cover Removed

20-conductor plug, mounted on the bottom of the carrier subassembly, provides external connections for the channel unit. The front panel contains tubes, test points, output transformers, and a potentiometer. An optional slip-on can cover is provided with the unit for use in a J98703A terminal mounting.

J98703BP Amplas Channel Unit

3.14 The J98703BP amplas channel unit (see Fig. 11 and 12) employs the same basic circuit as the J98703AP channel unit without signaling and is intended for the same use. The unit may be mounted interchangeably in the same bays or terminal mountings and, with the exception of certain restrictions in operating temperatures, performance is comparable with the J98703AP unit. Temperature restrictions may be found in AA388.074, Appendix 1.

3.15 The amplas channel unit consists of two subassemblies mounted in a single die-cast chassis. One of the subassemblies is a compandor, which is a combination of compressor and

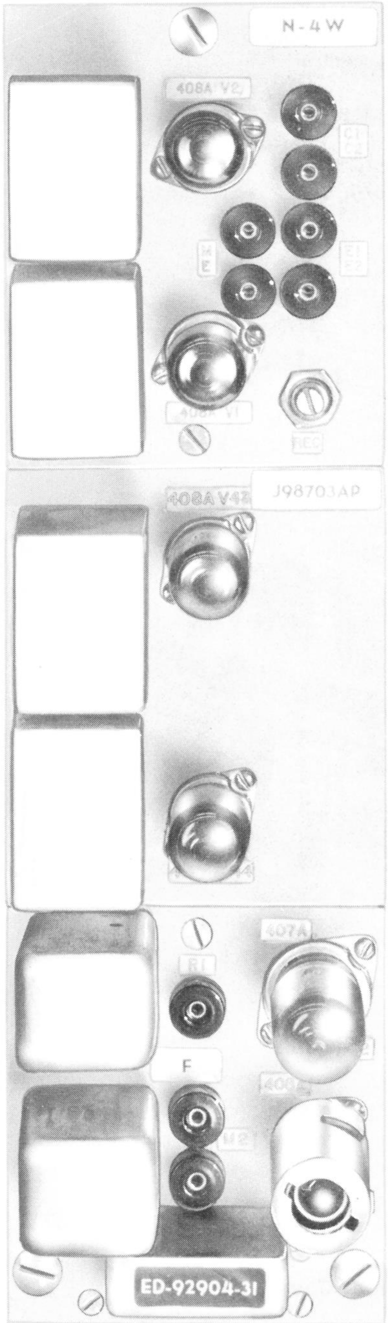


Fig. 9 — J98703AP Channel Unit Without Signaling, Front View

expandor, and the other subassembly is a carrier-frequency circuit. With the exception of some equipment mounted directly on the chassis, the components which make up the subassemblies are arranged on two amplas (Apparatus Mounted in PLAStic) boards. Interconnections of the subassemblies are made by direct wiring. A 20-conductor plug, mounted on the bottom of the carrier-frequency subassembly, provides external connections for the channel unit. The amplas channel unit is approximately 3-3/8 inches wide and 12 inches high. The two subassemblies are mounted in a vertical position with the compandor located at the top of the unit. The front panel provides test points and a potentiometer. An optional slip-on can cover is provided with the unit for use in a J98703A terminal mounting.

J98703AH Thru Channel Unit

3.16 The J98703AH thru channel unit (see Fig. 13 and 14) is intended for use where N-type carrier channels are connected or patched as through circuits to other N-, O-, or ON-type carrier channels. The equipment consists of two subassemblies which are fastened together to form one unit. The subassemblies are: the thru voice-frequency subassembly, which forms the top of the unit, and the carrier-frequency subassembly, which forms the bottom of the unit. The two subassemblies are connected electrically through a plug and jack arrangement. The carrier-frequency subassembly, which is identical to the carrier-frequency subassembly used in the J98703FA message channel unit, has a 20-conductor plug for external connections to the thru channel unit.

3.17 The thru channel unit is approximately 3-3/8 inches wide, 12 inches high, and 8-5/16 inches deep. The front panel contains tubes, transformers, test points, potentiometers, and a conditioning switch. An optional slip-on can cover is provided with the unit for use in a J98703A terminal mounting.

J98703AM Special Services Channel Unit

3.18 The special services channel unit (see Fig. 15 and 16) is used in place of the J98703FA message channel unit when data transmission and voice-frequency carrier telegraph or telephoto is to be transmitted over N carrier systems. The apparatus is mounted in two subassembly frameworks which are fastened together to form one unit. The subassemblies are the special services voice-frequency channel subassembly, which forms the top of the unit, and the carrier-frequency subassembly, which forms

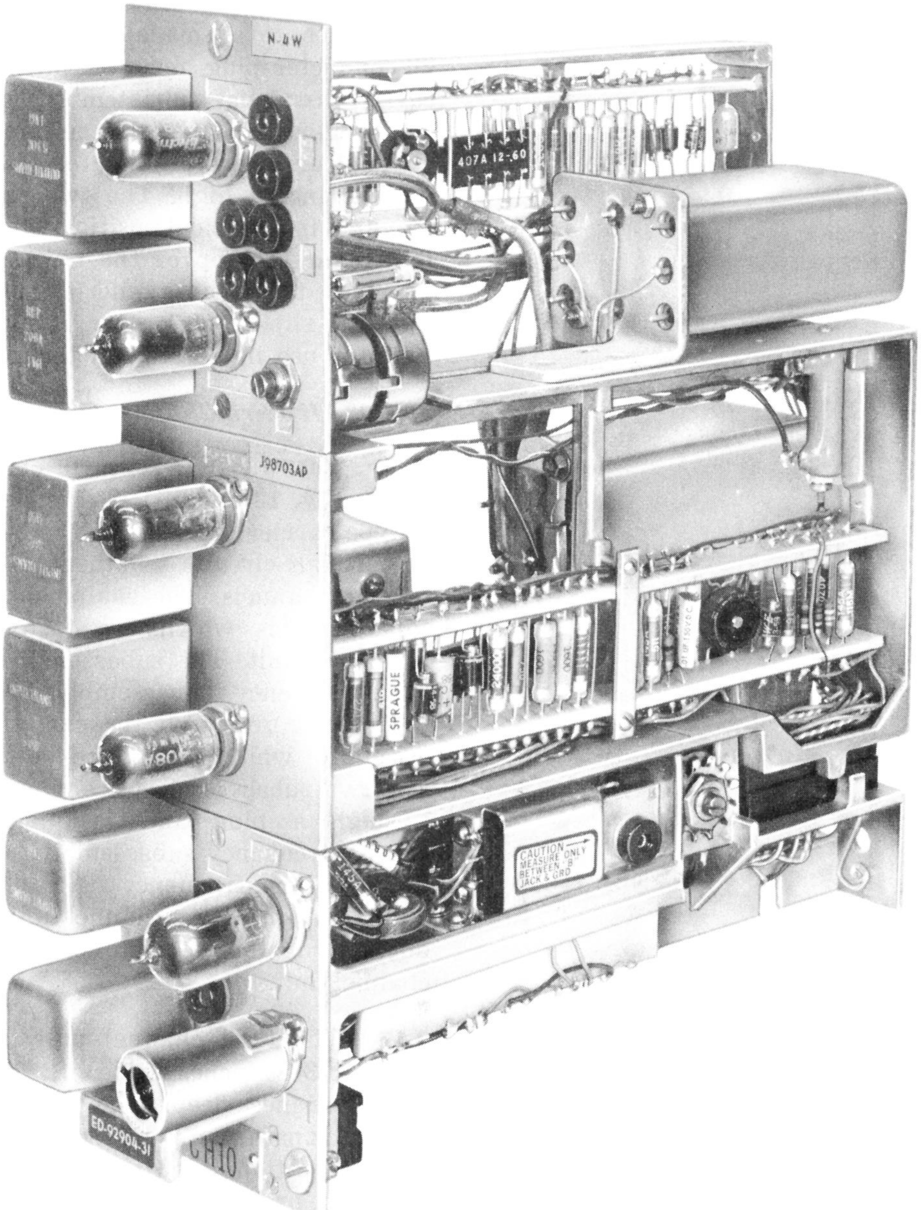


Fig. 10 — J98703AP Channel Unit Without Signaling, Cover Removed

the bottom of the unit. The subassemblies connect together by a plug and jack arrangement. The carrier-frequency subassembly, which is identical to the carrier-frequency subassembly used in the J98703FA unit, has a 20-conductor plug for external connections to the special services channel unit.

3.19 The special services channel unit is approximately 3-3/8 inches wide, 12 inches high, and 8-5/16 inches deep. The front panel contains tubes, transformers, test points, potentiometers, and a conditioning switch. An optional slip-on can cover is provided with the unit for use in a J98703A terminal mounting.

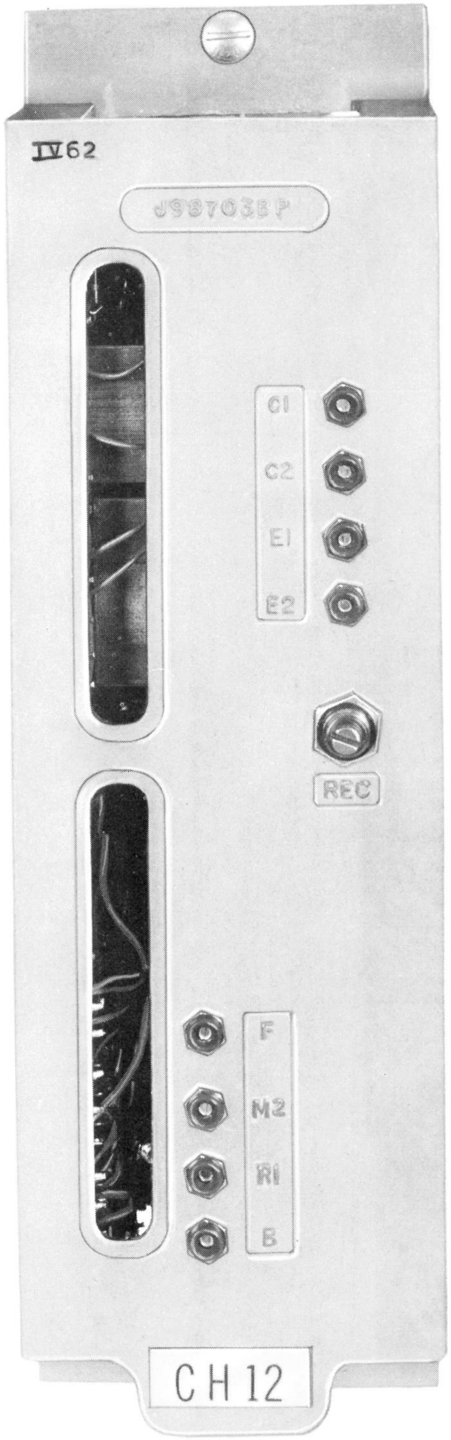


Fig. 11 — J98703BP Amplas Channel Unit, Front Unit

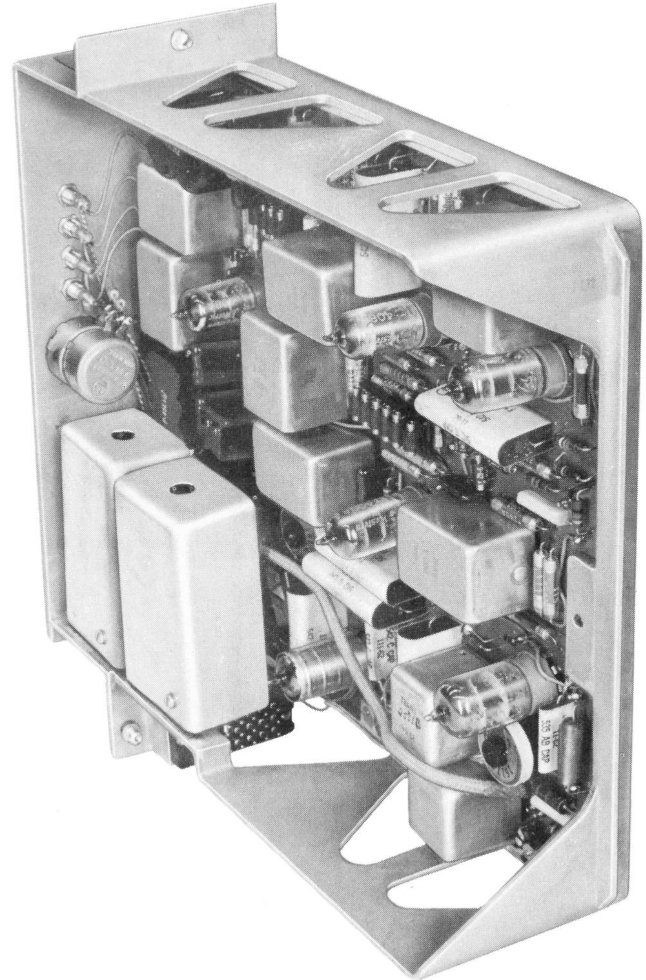


Fig. 12 — J98703BP Amplas Channel Unit, Cover Removed

J98703W A and B Program Channel Unit

3.20 The A and B program channel unit (see Fig. 17 and 18) is used for either schedule A or B program service. The equipment consists of two subassemblies which are fastened together to form one unit. The subassemblies are the voice-frequency subassembly, which forms the top

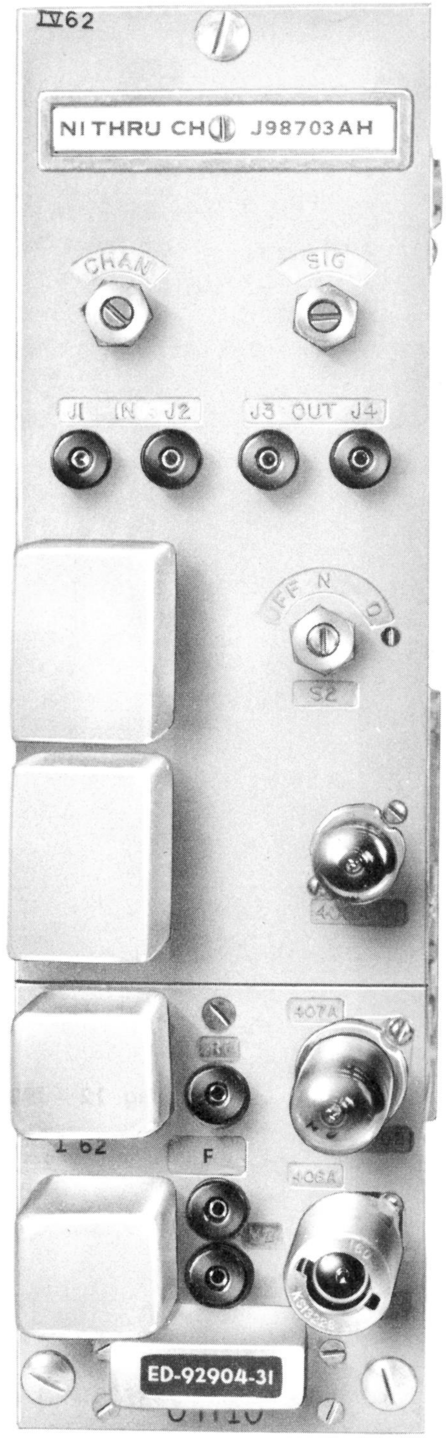


Fig. 13 — J98703AH Thru Channel Unit, Front View

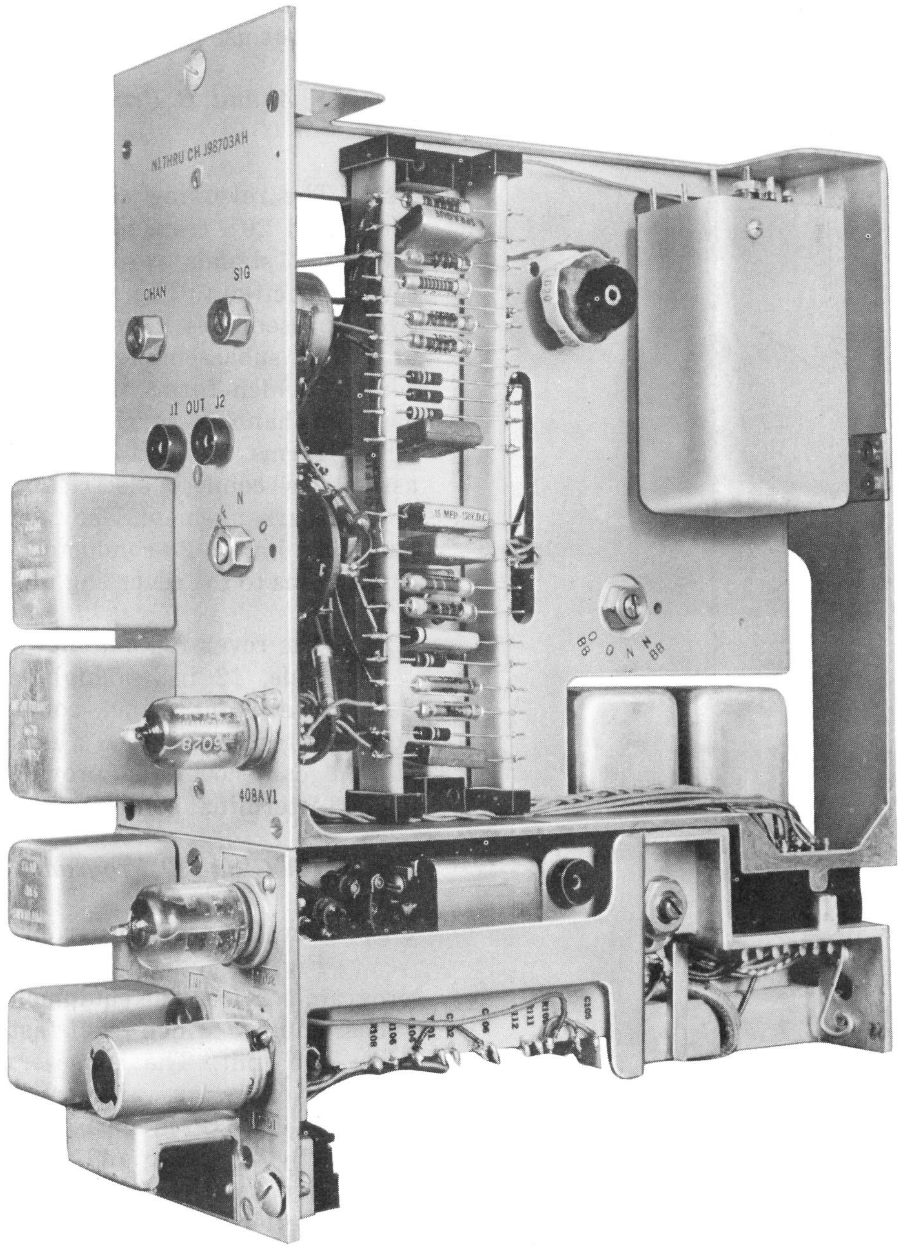


Fig. 14 — J98703AH Thru Channel Unit, Cover Removed

of the unit, and the carrier-frequency subassembly, which forms the bottom of the unit. Except for the use of 8-kc bandpass filters, the carrier-frequency subassembly is identical to the carrier-frequency subassembly in the J98703FA unit. The subassemblies connect electrically by a plug and jack arrangement. The carrier-frequency subassembly has a 20-conductor plug for external connections to the A and B program channel unit.

3.21 The A and B program channel unit is approximately 3-3/8 inches wide, 12 inches high, and 8-5/16 inches deep. The front panel contains tubes, transformers, test points, and a

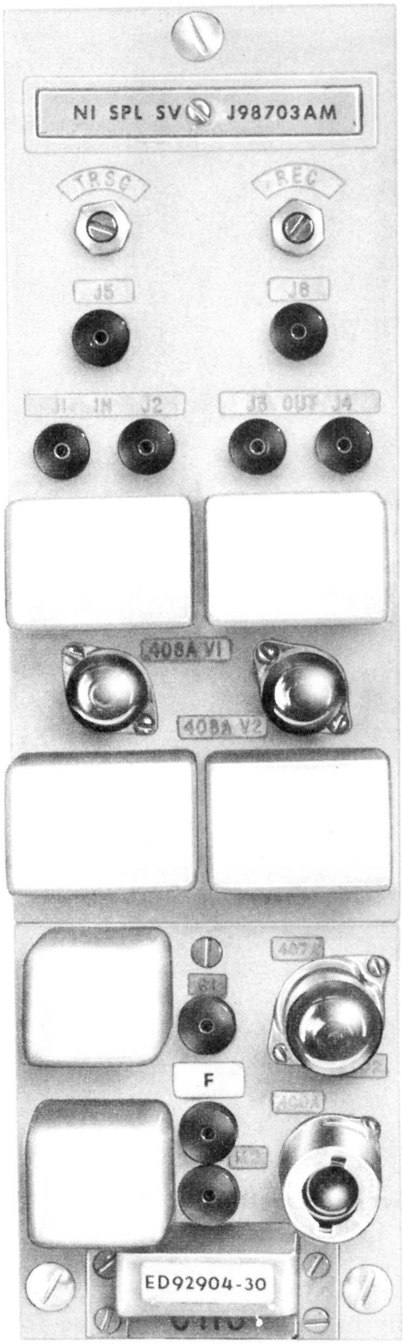


Fig. 15 — J98703AM Special Services Channel Unit, Front View

potentiometer. An optional slip-on can cover is provided for use in a J98703A terminal mounting.

J98703Y A and B Program Reversing Channel Unit

3.22 The reversing channel unit (see Fig. 19 and 20) transmits and receives program reversing signals which condition a remote reversing circuit. The reversing unit consists of two subassemblies fastened together to form one unit. The subassemblies are a switching subassembly, which forms the top of the unit, and a modified channel 5 carrier-frequency subassembly, which forms the bottom of the unit. The subassemblies connect electrically through a plug and jack arrangement. The carrier-frequency subassembly has a 20-conductor plug for external connections to the reversing unit.

3.23 The reversing channel unit is 3-3/8 inches wide, 12 inches high, and 8-5/16 inches deep. The front panel contains tubes, transformers, test points, and a test jack. An optional slip-on can cover is provided for use in a J98703A terminal mounting.

J98703TA C and D Program Channel Unit

3.24 The C and D program channel unit (see Fig. 21 and 22) is used for either C or D program service. The equipment consists of three subassemblies which are fastened together to form one unit. The subassemblies are a compressor, expandor, and carrier-frequency subassembly. The three subassemblies are connected electrically by a plug and jack arrangement. The carrier-frequency subassembly, which is identical to the carrier-frequency subassembly used in the J98703FA unit, has a 20-conductor plug for external connections to the C and D program channel unit.

3.25 The C and D program channel unit is 3-3/8 inches wide, 12 inches high, and 8-5/16 inches deep. The front panel contains tubes, potentiometers, and test points. The expandor subassembly contains a switch which enables the program unit to be used with N1 systems utilizing J98703F or J98703FA message channel units. An optional slip-on can cover is provided with the unit for use in a J98703A terminal mounting.

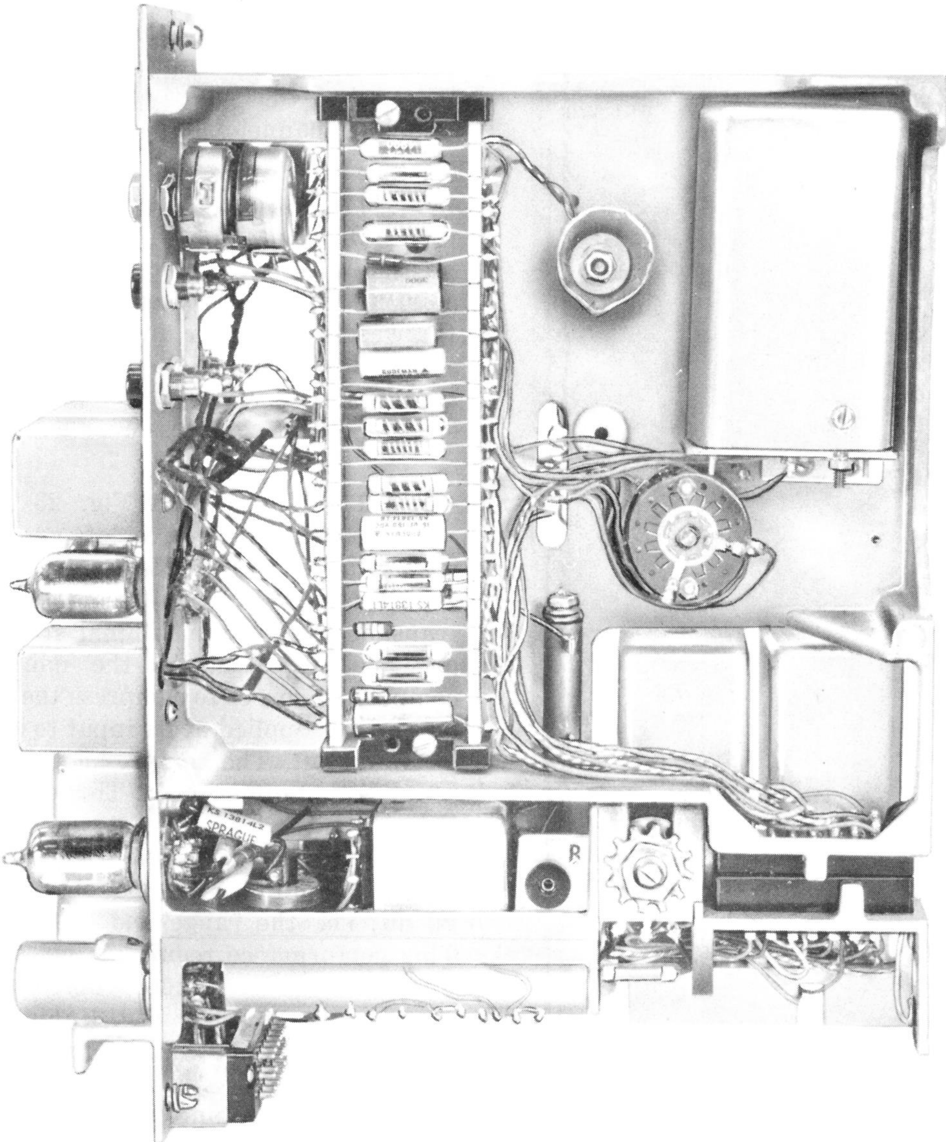


Fig. 16 — J98703AM Special Services Channel Unit, Cover Removed

D. Equipment Arrangement

3.26 With the exception of the J98703W and the J98703Y channel units, each channel unit discussed in the previous paragraphs is designated, according to a list number, for a specific channel in the N carrier system. For example, the J98703FA, List 43 message channel unit is designated for channel 2 in the N carrier system. The J98703FA, List 46 message channel unit is designated for channel 5 in the N carrier system. The units differ only in the receiving band filters and in the crystal unit which determines the channel oscillator frequency. The J98703W A and B program channel unit is designed for wideband transmission and normally replaces the channel 6 message channel unit. To insure wide frequency response it is also necessary to

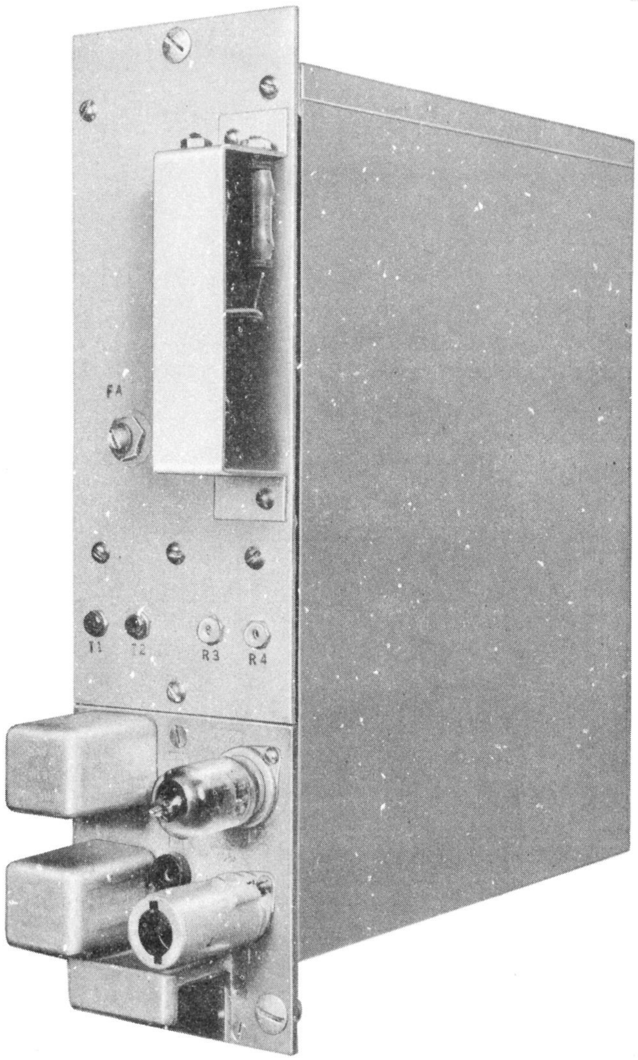


Fig. 17 — J98703W A and B Program Channel Unit, Front View

remove message channel units from channels 5 and 7. Channel 1 or 13 (whichever is not normally used in the system) may be substituted for channel 7 if an additional message channel is desired. The J98703Y reversing channel unit is not designated for a specific channel in the N system but is normally mounted in the channel 5 position.

4. CIRCUIT DESCRIPTION

A. General

4.01 Compandors have been designed in the N carrier system in order to take advantage of the economics effected by their use. They improve the relationship of message to crosstalk and noise in the transmission medium making possible longer repeater spacings, elimination of crosstalk balancing on the cable pairs, elimination of transmitting channel band filters, and easing the selectivity requirements of the receiving channel band filters.

4.02 The system is designed so that a signal of +5 dbm at zero level ahead of the compressor will also produce +5 dbm at a zero level point in the compressed portion of the circuit (between compressor and expandor) and also at a zero level point at the output of the expandor. Briefly stated, a +5 dbm signal is unaltered in level by either compressor or expandor.

4.03 The diagram in Fig. 23 illustrates the essential features of compandor action with relation to signal levels. The diagram shows a compressor and an expandor connected by a transmission medium. Signal strengths throughout are indicated. As the name implies, the compressor serves to compress the range of signal amplitudes applied at its input to a reduced range at its output. The compression ratio in the case of an N system is 2 to 1. This simply means that if the amplitude of a strong signal at the input of the compressor is dropped 40 db, the drop in output amplitude will be observed to be only 20 db; i.e., the range has been reduced 2 to 1. This performance requires a circuit having variable gain or loss under control of the applied signal. As indicated in Fig. 4, this is accomplished by the variolosser which is, in a sense, a variable loss pad whose loss is controlled by the strength of the signal passing through the device.

4.04 The speed with which the compressor adjusts from one condition of transmission to another is determined by time constants in the control circuit. Numerous factors have a bearing on the choice of time constants. For example, extremely fast-acting circuits are undesirable because of the wider bandwidth requirement for the transmission medium and also because of reduced expandor noise improvement on short duration line hits or bursts of noise. Conversely, slow-acting control circuits are undesirable because of distortion effects produced by the initial portion of strong signals. In the case of the N-type compandor, time constants have been

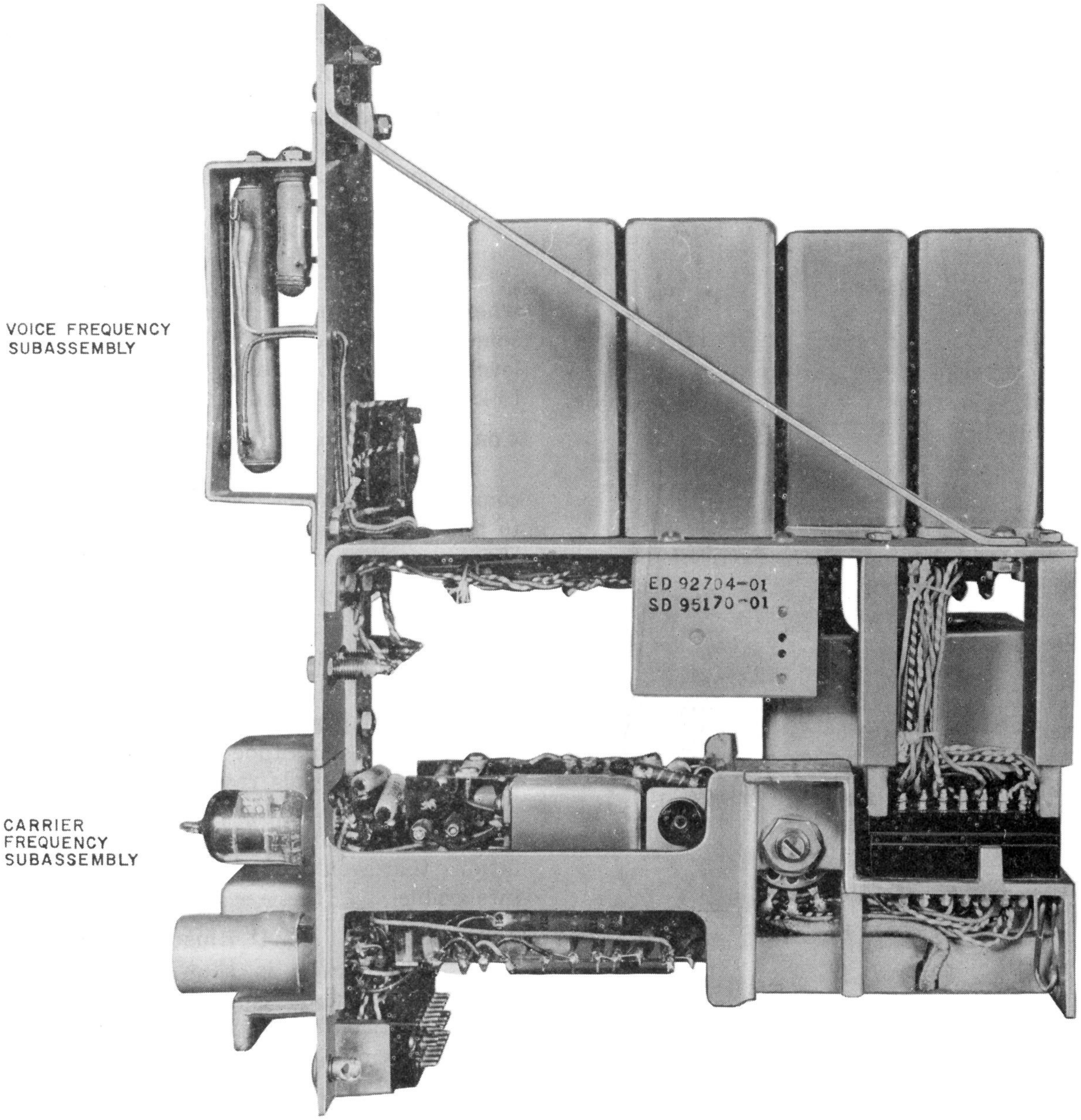


Fig. 18 — J98703W A and B Program Channel Unit, Cover Removed

chosen as a compromise between fast and slow action for best control of speech intensity variations on a syllabic basis.

4.05 Since transmission through the compressor varies depending on the strength of applied signal, the relationship of signal power and level in the compressed section of the system differs from that at the input of the compressor. The manner in which signal power is related to signal level is shown in Fig. 23.

4.06 The +5 db input power represents the power in the speech of the strongest talker and passes through the compressor without alteration or with unity transmission. As the

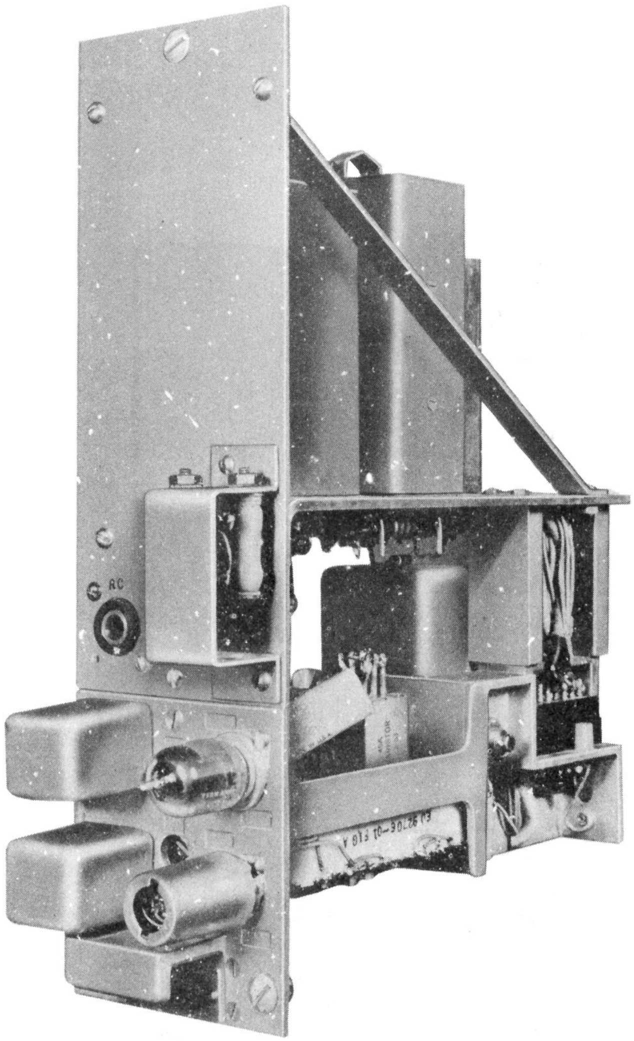


Fig. 19 — J98703Y Reversing Unit for A and B Program Transmission — Front View, Cover Removed

input signal is reduced, a given number of db, the signal after the compressor, is reduced only half this number of db. For example, an input signal of —20 dbm at zero level (a reduction of 25 db from the reference +5 dbm) becomes —7.5 dbm at zero level following the compressor (a reduction of only 12.5 db from the reference +5 dbm). A simple relationship specifying the powers at zero level ahead of the compressor and at zero level in the compressed section is

$$P_C = \frac{P}{2} + 2.5$$

where P is the power in dbm at the input of the compressor and P_C is the power in the compressed section, all at zero level.

4.07 The relationship given in the preceding paragraph may be generalized for signals at any level by applying a correction for levels as follows

$$P_C = \frac{P\text{-}L}{2} + L_C + 2.5$$

where P is the power in dbm and L the level at some point ahead of the compressor. L_C is the level after the compressor at which it is desired to know the corresponding power, P_C.

4.08 As an example, with a test tone of —32 dbm applied to the input of the compressor where the level is —16 db, it is desired to find the corresponding power at a point after the compressor where the level is —1.5 db.

$$P_C = \frac{(-32)\text{-}(-16)}{2} + (-1.5) + 2.5$$

$$= -\frac{16}{2} - 1.5 + 2.5 = -7 \text{ dbm}$$

4.09 The diagram in Fig. 23 illustrates the increased amplitude of weak signals relative to the strong signals resulting from compressor action. This permits the transmission of these weaker signals over lines with severe noise conditions that would otherwise make transmission intolerable.

4.10 Another chart illustrating compressor performance is shown in Fig. 24. The solid line compressor curve shows an input-output characteristic of an ideal compressor. For ease of illustration, zero levels have been taken for input and output. It will be observed that the compressor output is +5 dbm for +5 dbm input. The load line shows a 2 for 1 characteristic down to an input of —51 dbm at zero level where the compressor becomes linear; i.e., a change of input level to the compressor produces an equal amount of change at the output. This is called the knee of the compressor characteristic. The compressor output at the knee of the characteristic is —23 dbm at zero level. This point represents the maximum benefit that can be given to weak signals. Signals which, without a compressor, would go out at —51 dbm at zero level, now are transmitted at —23 dbm at zero level, a signal-to-noise improvement of 28 db.

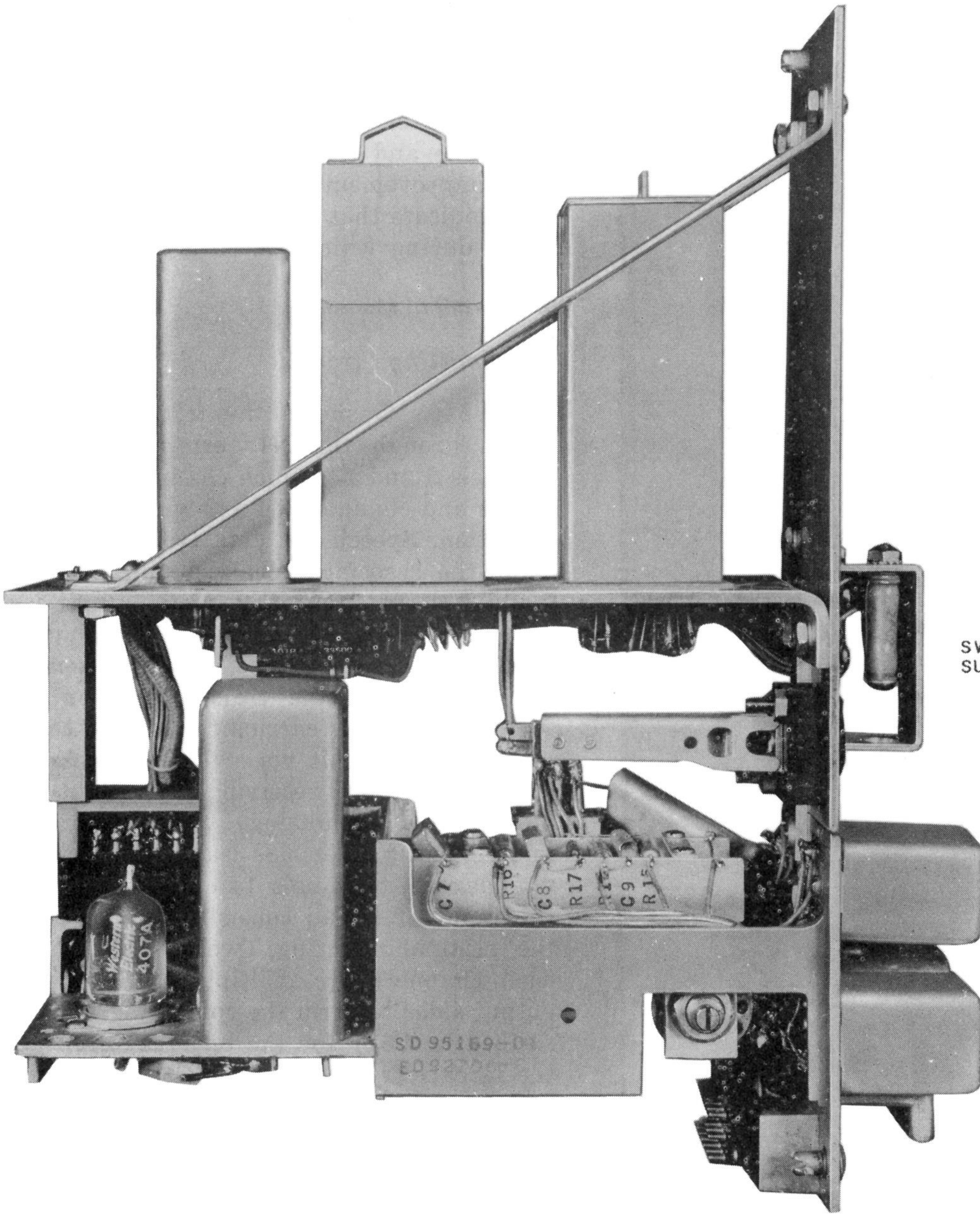


Fig. 20 — J98703Y Reversing Unit for A and B Program Transmission — Side View, Cover Removed

4.11 The expandor circuit, as illustrated in Fig. 23, does the inverse of the compressor to restore the original strength of signals. The expandor circuit can be considered as an amplifier preceded by a variable loss pad or variolosser which, as in the case of the compressor, is controlled by received signals and inserts a loss inversely proportional to the received signal strength. Transmission through the expandor may be considered unity when +5 dbm is applied at zero level at its input, thus delivering +5 dbm at zero level at its output. For each db reduction in applied input, the output drops 2 db because of an increase in variolosser attenuation of 1 db. This process continues as illustrated in Fig. 23 until the knee of the expandor characteristic is reached, at which point —23 dbm input produced —51 dbm output, both at zero level. Below this

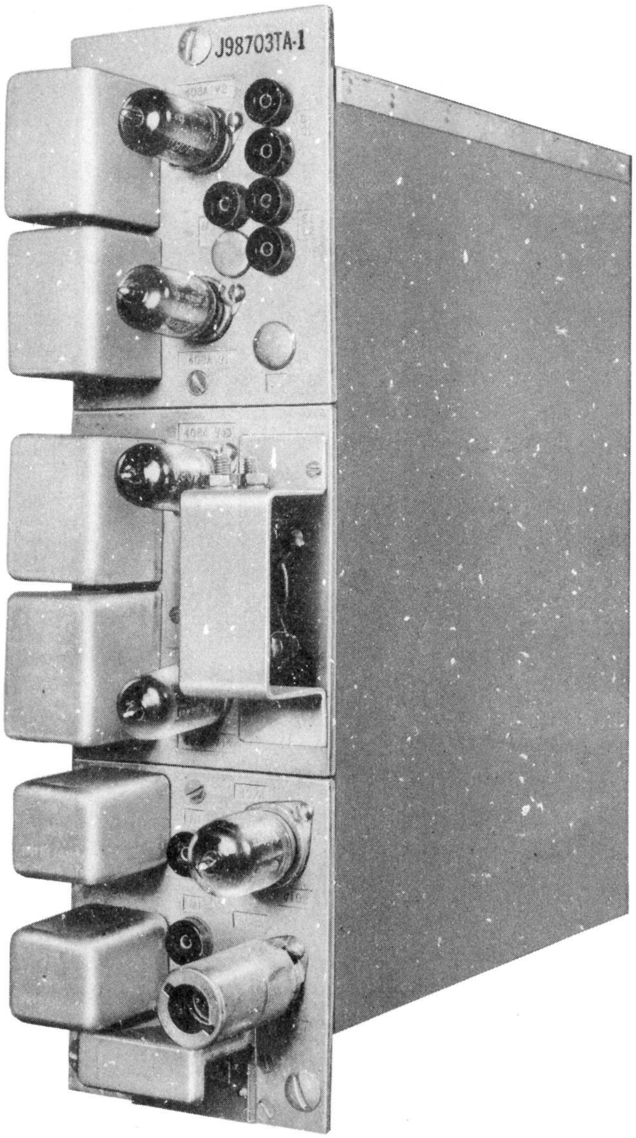


Fig. 21 — J98703TA C and D Program Channel Unit, Front View

point the expandor, like the compressor, is also linear; i.e., no further change is produced in the loss of the variolosser.

4.12 It is evident that there is 28 db more loss in the variolosser for weak inputs such as noise than there is when passing a strong signal like +5 dbm at zero level where unity transmission is achieved. Thus, during the silent intervals in conversation, the noise and crosstalk reaching a subscriber are reduced 28 db by the action of the expandor.

4.13 It is evident that as speech currents arrive and loss is removed from the expandor, variolosser noise currents are also permitted to increase. This increase in noise current persists slightly after a speech syllable in a decaying amplitude and the net effect is to decrease the noise improvement figure of the expandor. Recent tests indicate that this figure is 23 db for the interval during which speech is being transmitted.

B. Terminal Mounting

Transmitting Circuits

4.14 Fig. 25 shows the transmission circuits through the N1 terminal mounting for channels 2 and 13, which channel 2 arranged for 4-wire and channel 13 for 2-wire voice-frequency operation. Speech currents from a trunk circuit enter the associated channel unit via terminals 0 and 3 of the appropriate channel unit jack into which the channel unit has been plugged. The 3700-cycle signaling tone, which is generated in an oscillator in the transmitting or receiving low-group unit, is carried through to the channel unit carrier circuit via switching jacks J13 and J14 (low-group receiving) or J15 and J16 (low-group transmitting). The carrier and speech and signaling sidebands leaving the channel unit via jack J1, terminals 14 and 17, are applied to the input of a pad consisting of 2 resistors on the terminal mounting. Twelve such pads (one for each channel) are multipled together on their output sides to form the combining multiple (described in 4.67) for the terminal. At this point, the 12 carriers and their sidebands are combined and applied to the input of the transmitting group unit via switching jacks J15 and J16.

4.15 Patch plugs equipped with straps between terminals 3 and 0 and between terminals 4 and 1 normally are inserted in switching jacks J15 and J16 to provide removable links between the combining multiple and transmitting group unit. These switching jacks are used to test or replace group units without interrupting service. Other straps provide links between the group unit and the cable pair used for the transmitting carrier line, and between group unit and power and alarm circuits.

4.16 After passing through the switching jacks and plugs, the 12 carriers and associated sidebands enter the transmitting group unit via

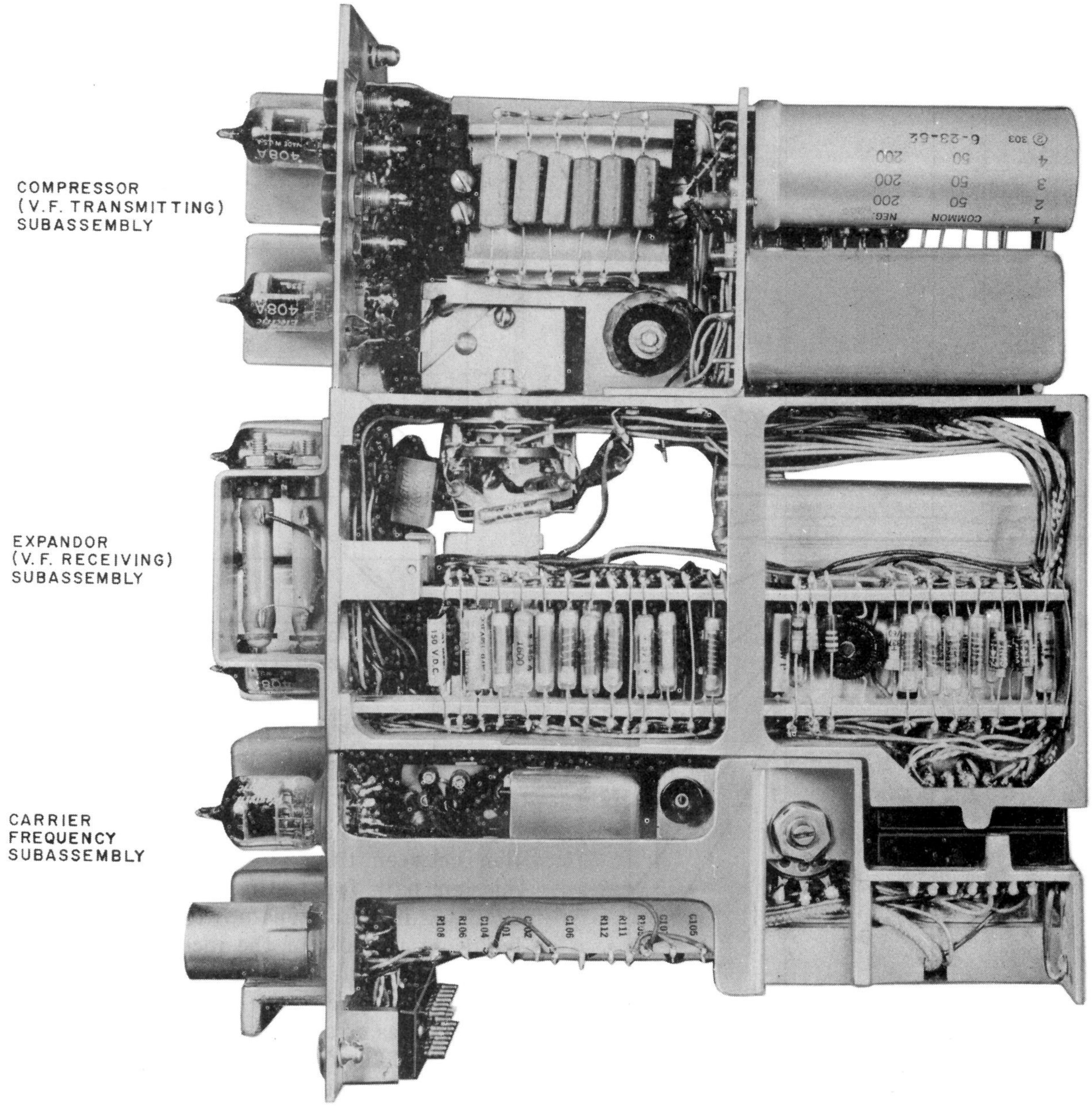


Fig. 22 — J98703TA C and D Program Channel Unit, Cover Removed

terminals 0 and 1 of the group unit jack J17 and are transmitted out of the group unit via jack J17, terminals 17 and 18. From the output of the group unit jack, the carriers and sidebands are transmitted to the transmitting cable pair via terminals 17-14 and 18-15 of switching jacks J15 and J16. The curves in Fig. 26A show the nominal carrier power for each channel at the output of both types of transmitting group units. The same data, together with single sideband message levels, is given in numerical form in Tables 101 and 102 of Fig. 4. For the low-group transmitting unit, channel 2 carrier is at —5 dbm, channel 13 carrier is at —12 dbm, and the other channel carriers are uniformly spaced between them. The total 12-channel carrier power is +3 dbm. For the high-group transmitting unit, the channel 2 carrier power is at —3 dbm, channel 13 carrier is

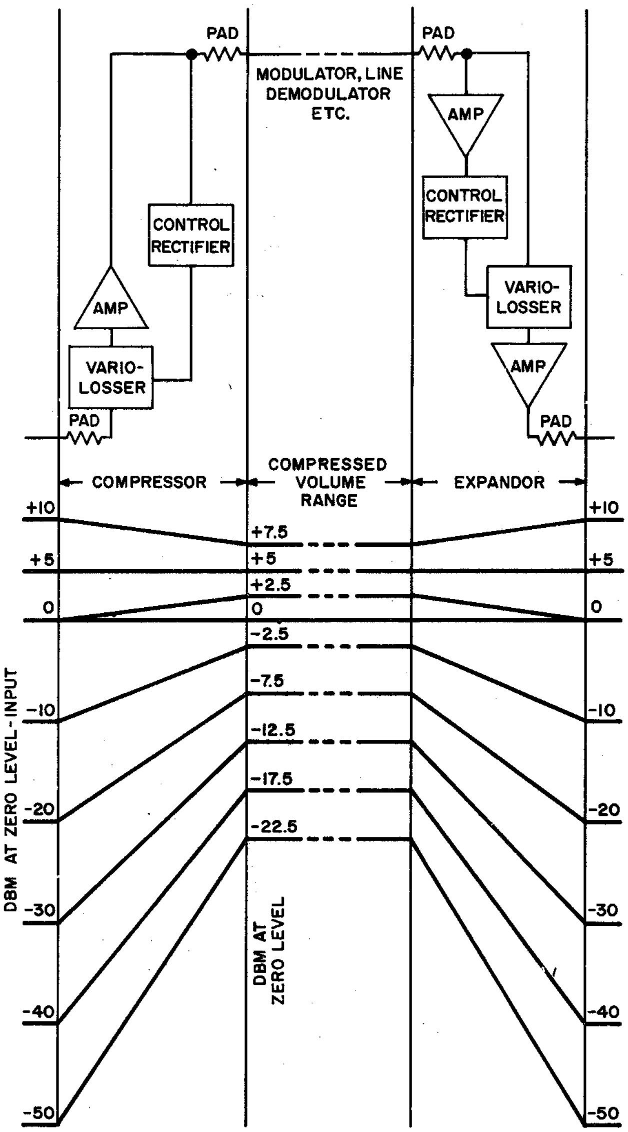


Fig. 23 — Compandor Action on Steady Tones of Variable Levels

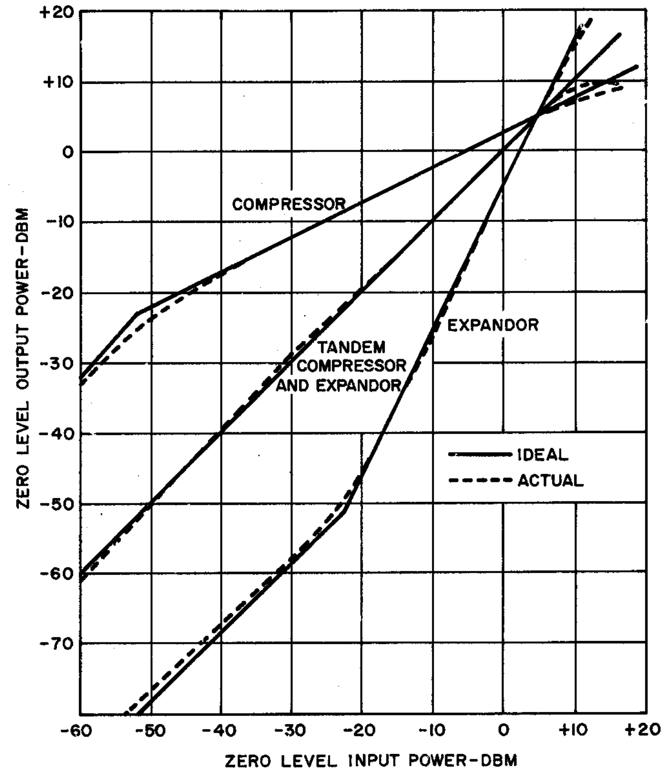


Fig. 24 — Input-Output Load Characteristics for N1 Compandor

at +4 dbm, and the other channel carriers are uniformly spaced between them. The total 12-channel carrier power is about +12 dbm.

Receiving Circuits

4.17 After transmission over the carrier line, the 12 carriers and associated sidebands entering the receiving terminals may, if required, pass through a span-adjusting pad. This is a 135-ohm H-type resistance pad with a series capacitor in the shunt branch to provide dc isolation between tip and ring wires of the transmission pair for testing purposes. The pad is available in 2-db steps up to 36 db. It is used to build out the loss of the incoming cable span to a nominal value of 46 db for low-group transmission or 50 db for high-group transmission. These losses are specified at channel 1 carrier which is 136 kc for low group and 168 kc for high group. The curves in Fig. 26B show the nominal carrier power for each channel at the input of both types of receiving group units. The same data, together with single sideband message level, is given in numerical form in Tables 101 and 102 of Fig. 4. For the high-group receiving unit, channel 2 carrier is at —53 dbm, channel 13 carrier is at —58 dbm and the other channel carriers are uniformly spaced between them. The total 12-channel carrier power is —45 dbm. For the low-group receiving unit, channel 2 carrier is at —51 dbm, channel 13 carrier is at —42.5 dbm and the other channel carriers are uniformly spaced between them. The total 12-channel carrier power is —36 dbm.

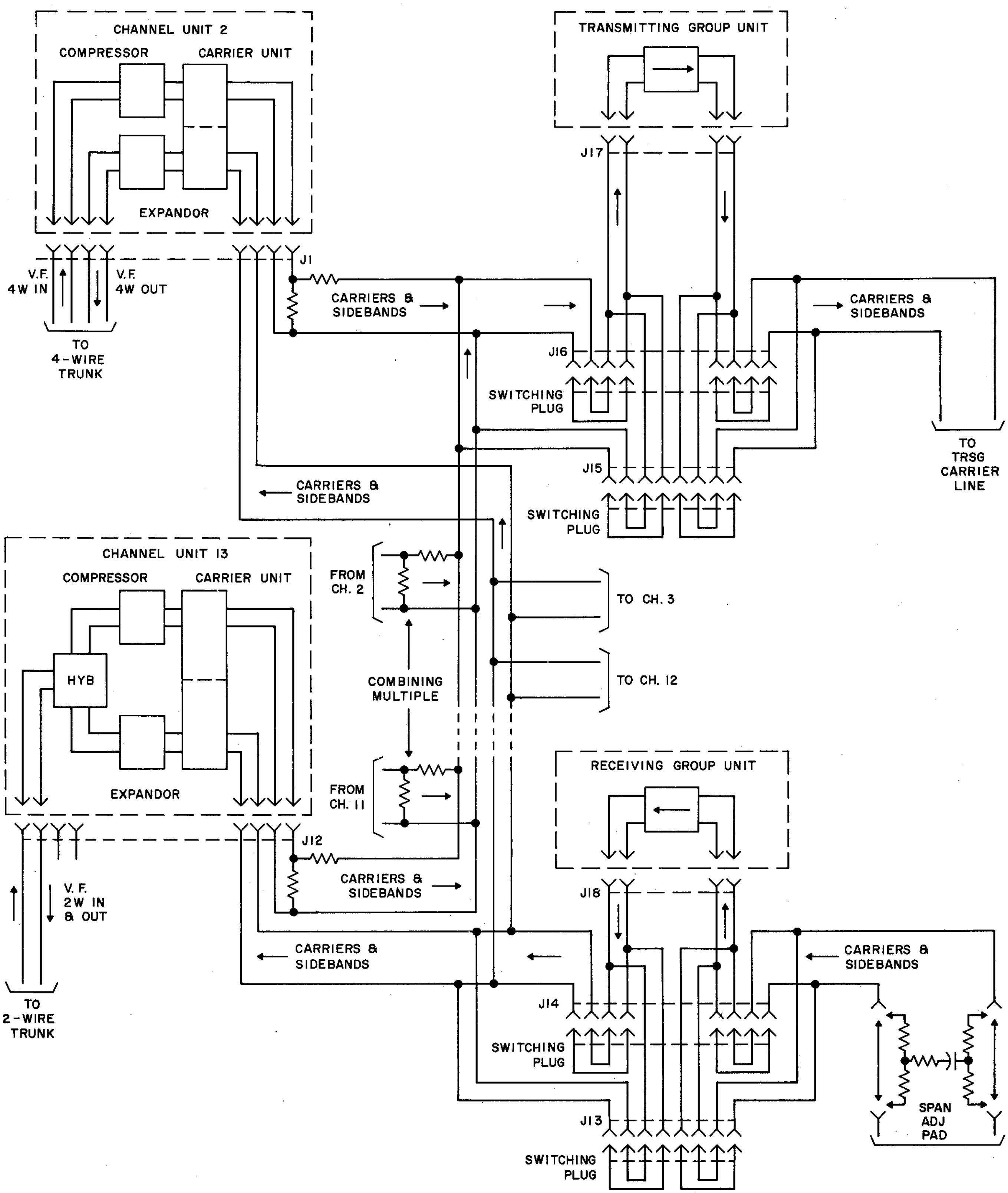


Fig. 25 — Terminal Mounting Transmission Circuits

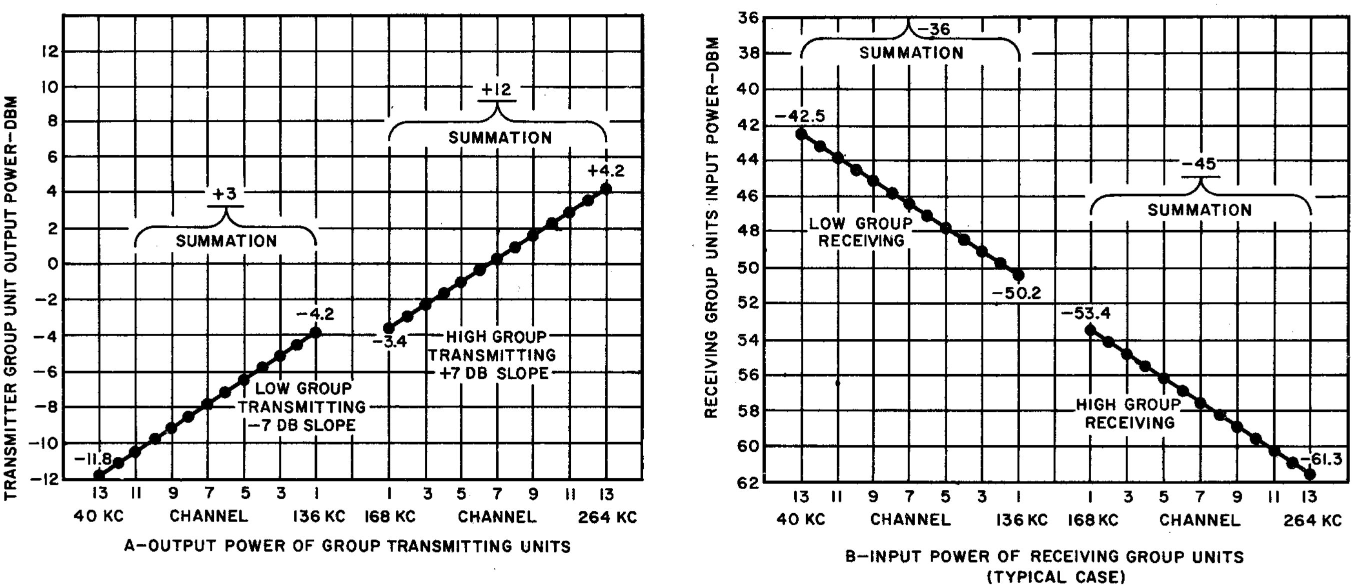


Fig. 26 — Transmitting Group Unit Output Carrier Power and Receiving Group Unit Input Carrier Power

4.18 From the output of the span-adjusting pad, the line frequencies go through receiving group unit switching jacks J13 and J14. The transmission path through terminals 0-3 and 1-4 is closed by straps in the patch plugs normally inserted in the jacks. The jacks serve the same purpose for the receiving group unit as jacks J15 and J16 for the transmitting group unit; they are used to replace group units without interrupting service.

4.19 After leaving the switching jacks, the carriers and sidebands enter the receiving group unit via terminals 0 and 1 of jack J18 into which the receiving group unit is plugged. The output of the receiving group unit, which appears at terminals 17 and 18 of jack J18, is transmitted to the channel unit via terminals 17-14 and 18-15 of jacks J13 and J14. Here, too, the necessary continuity between group unit and channel unit is provided by straps in the plugs inserted in the jacks. At this point, the carrier power is nominally constant on all channels, being about −5.5 dbm per channel and +5.5 dbm total for all 12 channels.

4.20 The 12 carriers and associated pairs of sidebands are applied to the inputs of 12 channel units multipled together on terminals 9 and 6 of jacks J1 through J12 into which the channel units have been plugged. The speech output of the channel unit appears across terminals 0 and 3 (2-wire operation) or terminals 16 and 19 (4-wire operation) of the channel unit into which it is plugged. The E-signaling lead and its associated ground lead are brought out to terminals 11 and 1 of the channel unit jack. The input and output voice frequency and signaling leads are then routed to the appropriate trunk circuit.

Power Circuits

4.21 The power supply circuits are shown in Fig. 27. Six fuse blocks, each holding two alarm-type fuses, appear on the fuse panel at the bottom on the terminal mounting. These protect the +130 volt, −130 volt, and −40 volt power circuits.

4.22 ***−38.5 Volt Power:*** The −38.5 volt supply for heater power and miscellaneous negative voltages for the channel and group units is obtained from the −48 volt central office signaling battery through a group of parallel dropping resistors and a series rheostat connected between the −48 volt bus and the terminal fuse panel. The proper voltage is obtained by strapping resistors in or out and adjusting the rheostat as required. Six 1-1/3 ampere fuses serve all 12 channel units (2 channel units per fuse), with a drain of 4.3 amperes. One 1-1/3 ampere fuse serves both group units with a total steady drain of 0.3 ampere. This fuse also supplies the carrier alarm circuit, the TST PWR receptable, and pin jack −38.5V. Another 1-1/3 ampere fuse furnishes power for the carrier alarm relay K3 and CARR lamp and for the channel unit M lead

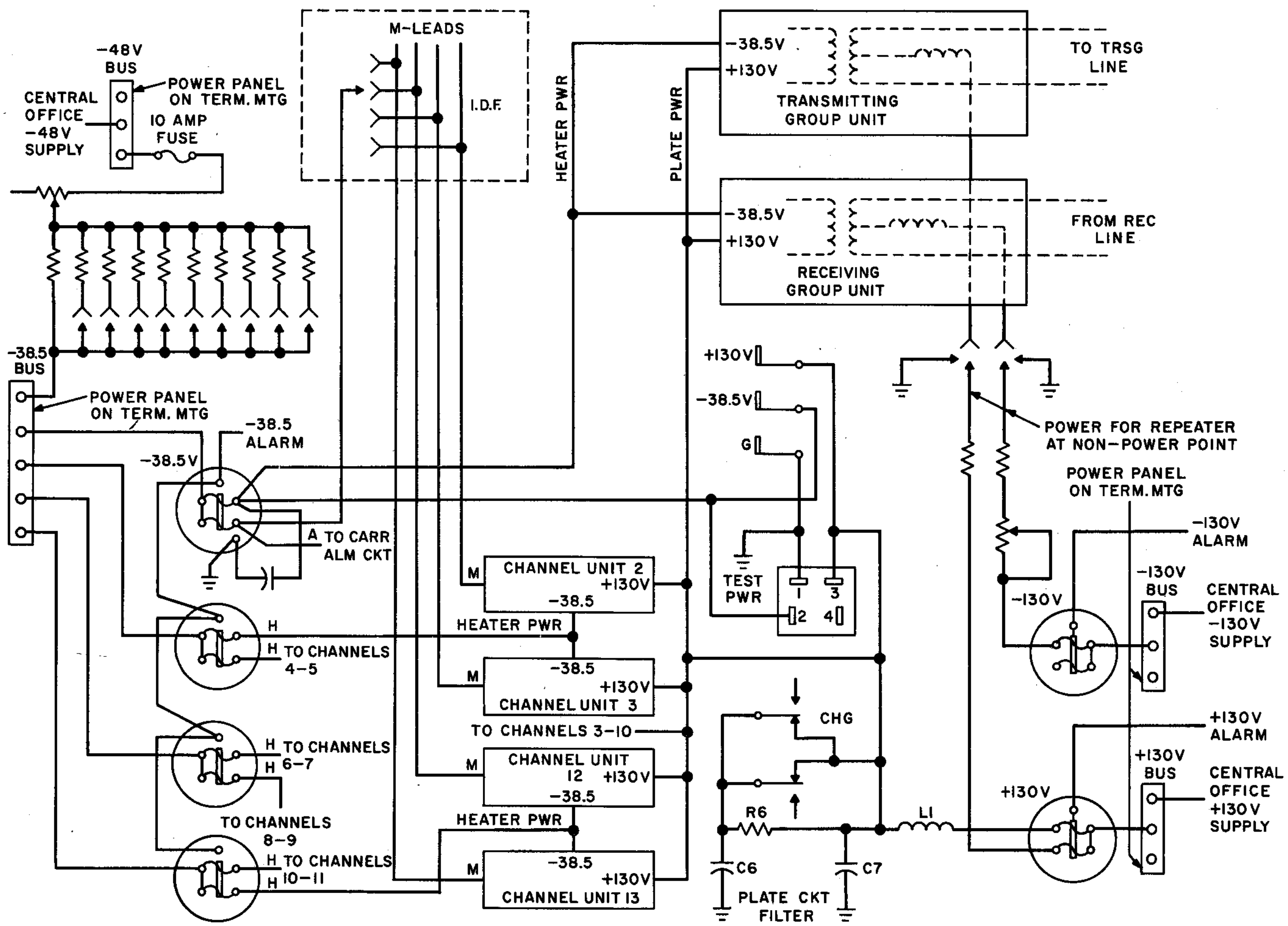


Fig. 27 — N1 Terminal Mounting Power Supply Circuits

to keep 3700-cycle signaling turned off when ringdown signaling is used instead of E and M lead signaling.

4.23 ***+130 Volt Power:*** The plate supply for the 12 channel units and the 2 group units is obtained from the +130 volt plate or telegraph battery through a filter consisting of a series-retard coil L1 and shunt capacitors C6 and C7 on the terminal mounting. Capacitor C7 acts at high frequencies where the electrolytic capacitor C6 had a relatively high impedance. The circuits which receive power through the +130 volt filter are the 12 channel units (1 ampere), the 2 group units (0.1 ampere), the 3700-cycle alarm lamp, the TST PWR receptacle, and pin jack +130V are serviced by a 2-ampere fuse.

4.24 ***Repeater Power:*** When repeaters and 240-type amplifiers adjacent to the terminal are located on a pole or other point not having a local source of power, power can be fed to them over the two cable pairs used for carrier transmission. This is done by a simplex arrangement in which a positive voltage is applied through a resistor and retard coil to the transmitting line via a center tap on the line winding of the transmitting group unit output transformer, and a negative voltage is applied through a rheostat, resistor, and retard coil to the receiving line via a center tap on the line winding of the receiving group unit input transformer. The rheostat, in series with the negative supply, compensates for the length of cable span so that the voltage supplied to the repeater may be adjusted. Each supply is fed through a 1/4-ampere fuse in the terminal fuse panel. When the adjacent repeater has a local power source available, the transmitting and receiving line transformers have their center taps grounded. The voltage and current requirements for various arrangements of repeaters and 240-type amplifiers are listed below.

EQUIPMENT POWERED	VOLTAGE	CURRENT
N1 Repeater	+130	0.170
	−130	0.170
	+130	0.170
	GRD	0.170
N1 Repeater	+130	0.190
(sealing current)	−130	0.190
N1 Repeater	+130	0.195
240 Amplifier	−130	0.195
N1 Repeater	+130	0.215
240 Amplifier	−130	0.215
(sealing current)		
N1A Repeater (1 rptr)	−48	0.110
(with or without	+130	0.110
sealing current)		
	+130	0.110
	GRD	0.110
(2 rptrs)	+130	0.110
	−48	0.110
	+130	0.110
	GRD	0.110
(3 rptrs)	+130	0.110
	−48	0.110
	+130	0.110
	−130	0.110
N1A Repeater (1 rptr,	+130	0.135
240 Amplifier 1 ampl)	−48	0.135
(with or without		
sealing current)	+130	0.135
	GRD	0.135
(2 rptrs,	+130	0.135
1 ampl)	−48	0.135
	+130	0.135
	−130	0.135
240 Amplifier	+130	0.025
	GRD	0.025
240 Amplifier	+130	0.045
(sealing current)	GRD	0.045
(sealing current only)	+130	0.020
	−48	0.020

4.25 ***Test Circuit Supply:*** The TST PWR receptacle on the terminal mounting is used for connecting −38.5 volt and +130 volt power to test sets used with the terminal. The +130V, −40V, and G (ground) pin jacks are for measuring the plate and heater supply voltages.

4.26 ***Alarm Circuits:*** The alarm circuits provided on the N1 terminal mounting are shown in Fig. 28. Alarm indications are given when the +130 volt, −130 volt, or −38.5 volt fuses are blown, when there are interruptions of carrier power at the receiving group unit, or when there is an interruption of the 3700-cycle signaling supply. All tie in with the office alarm system.

4.27 ***Fuse Alarms:*** When a fuse blows in the +130V, −130V, or −38.5V power circuits, battery is applied to the corresponding alarm bus to light the appropriate alarm lamp on the terminal fuse panel and energize one of the windings of auxiliary relay K1. When relay K1 operates, ground is applied through leads 1 and 2 of the central office alarm circuit to ring an audible alarm and light the aisle lamp.

4.28 ***3700-Cycle Oscillator Alarm:*** A full-wave rectifier bridged across the output of the 3700-cycle oscillator in the low-group transmitting or low-group receiving unit provides a dc voltage which holds relay K4 operated as long as 3700-cycle power is present. If the 3700-cycle output drops too low, relay K4 releases and its back contacts close a circuit between the tertiary winding of relay K1 and the 3700-cycle alarm lamp on the terminal fuse panel. Current then flows from +130 volt battery through a dropping resistor, through the alarm lamp and a shunt resistor, through relay K4 contacts, and finally, through the tertiary winding of relay K1 to ground, lighting the alarm lamp and operating relay K1. Ground is applied via the front contacts of relay K1 to leads 1 and 2 of the central office alarm system to turn on the audible alarm and aisle alarm lamp.

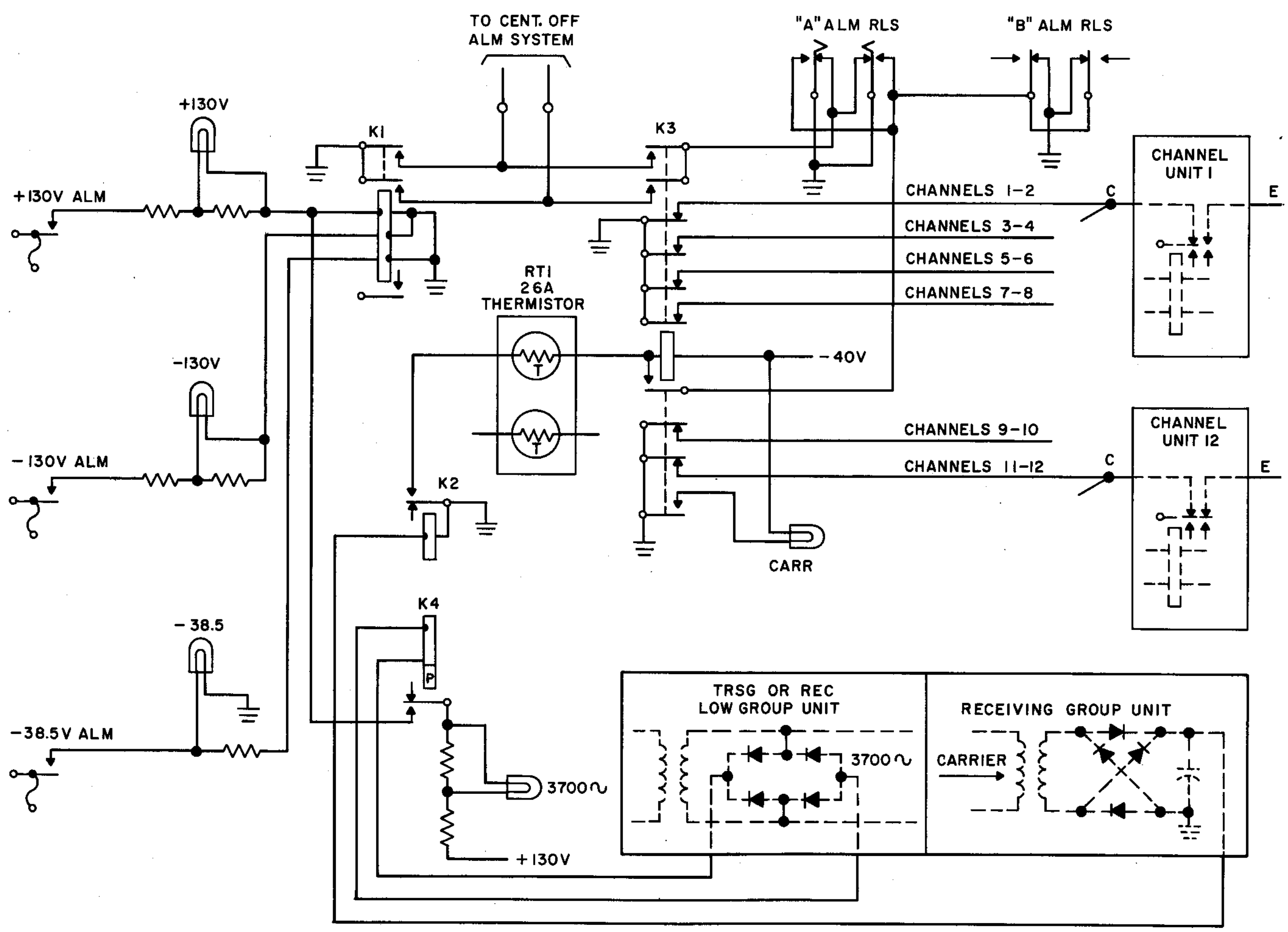


Fig. 28 — N1 Terminal Mounting Alarm Circuits

4.29 *Carrier Alarm:* The carrier output of the receiving group unit is amplified and rectified by a full-wave rectifier. The dc output of this rectifier is used to hold relay K2 operated. When the carrier output of the receiving group unit falls too low, the rectifier dc output falls and relay K2 releases. Closure of the back contacts of relay K2 applies ground through thermistor RT1 to the winding of auxiliary relay K3. The thermistor delays operation of relay K3 to avoid giving an alarm on an occasional momentary carrier disturbance. If the carrier failure is long enough to operate relay K3, it locks up, lights the CARR lamp on the terminal fuse panel, disables the E lead circuits, and actuates the office alarm. The locking circuit for relay K3 is through its own front contact and the contacts of the non-locking-type B ALM RLS key so that the relay cannot release until this key has been manually operated. (This locking feature is necessary because otherwise the automatic regulating features of the system might alleviate the symptoms and thus clear the alarm without the real trouble having been remedied.) Ground is applied through the normally closed contacts of the locking-type A key ALM RLS and the contacts of K3 to leads 1 and 2 of the central office alarm system. The grounds supplied via leads G1 through G6 to the contacts of the signal relays, which pulse the E leads of the channel units, go through back contacts of relay K3 so that a carrier failure will not cause permanent signals. Operation of A ALM RLS key removes ground from the central office alarm leads 1 and 2 to shut off the audible alarm and aisle alarm lamp. When A ALM RLS key is used to shut off the central office alarm, it provides a ground for locking relay K3 which supplements that from B ALM RLS key so that operation of B ALM RLS key will not release the relay until the other key has been returned to normal, restoring the connection to the office alarm system.

Caution: The B ALM RLS key should never be used in an attempt to clear a carrier alarm indication until the carrier and line noise have been checked and any discrepancies accounted for and corrected.

C. Shop-Wired Bays

Transmission Circuits

4.30 The transmitting and receiving circuits in the shop-wired bays are identical to those in the J98703A terminal mounting, described in 4.14 and 4.17.

Power Circuits

4.31 *Filament Supply:* Three filament supplies are provided for each shop-wired 36-channel bay (one for each 12-channel terminal). The −38 volt supply for each circuit (see Fig. 29) is obtained from a —48 volt central office signaling battery through a rheostat FIL and series resistor R11. The proper voltage is obtained by adjusting the rheostat as required. The filament supply provides three fuses within the terminal mounting to protect the individual channel units and the transmitting and receiving group units. The filament supply also provides a main bay fuse and two auxiliary fuses to protect various alarm and signaling circuits. Jack J22 (—38.5V) provides facilities for connecting a voltmeter while adjusting the rheostat. Resistor R26 protects the fuse in case of accidental grounding. Capacitor C8 in the filament supply of channel positions 11 and 12 is provided to reduce high-frequency oscillations in these units. Diode CR4 in the bay fusing circuits eliminates the possibility of applying filament power to the terminals through the alarm circuits when certain combinations of fuses are blown. Jack J23 (GRD) provides a ground point for test purposes. The TST PWR receptacle provides —38.5 volt power for auxiliary equipment.

4.32 *Plate Supply:* The plate supply (see Fig. 30) for each shop-wired 36-channel bay is obtained from a +130 volt plate or telegraph battery through a low-pass filter consisting of inductor L1 and capacitor C6. The filter suppresses low-frequency disturbances which may appear in the +130 volt bus. From the filter, the plate voltage is supplied to each 12-channel terminal for use in the individual channel and group units. A fuse is provided in each terminal to protect the channel and group units.

4.33 *Repeater Power Transmission:* In addition to showing the plate supply circuits, Fig. 30 also shows the circuit for transmitting

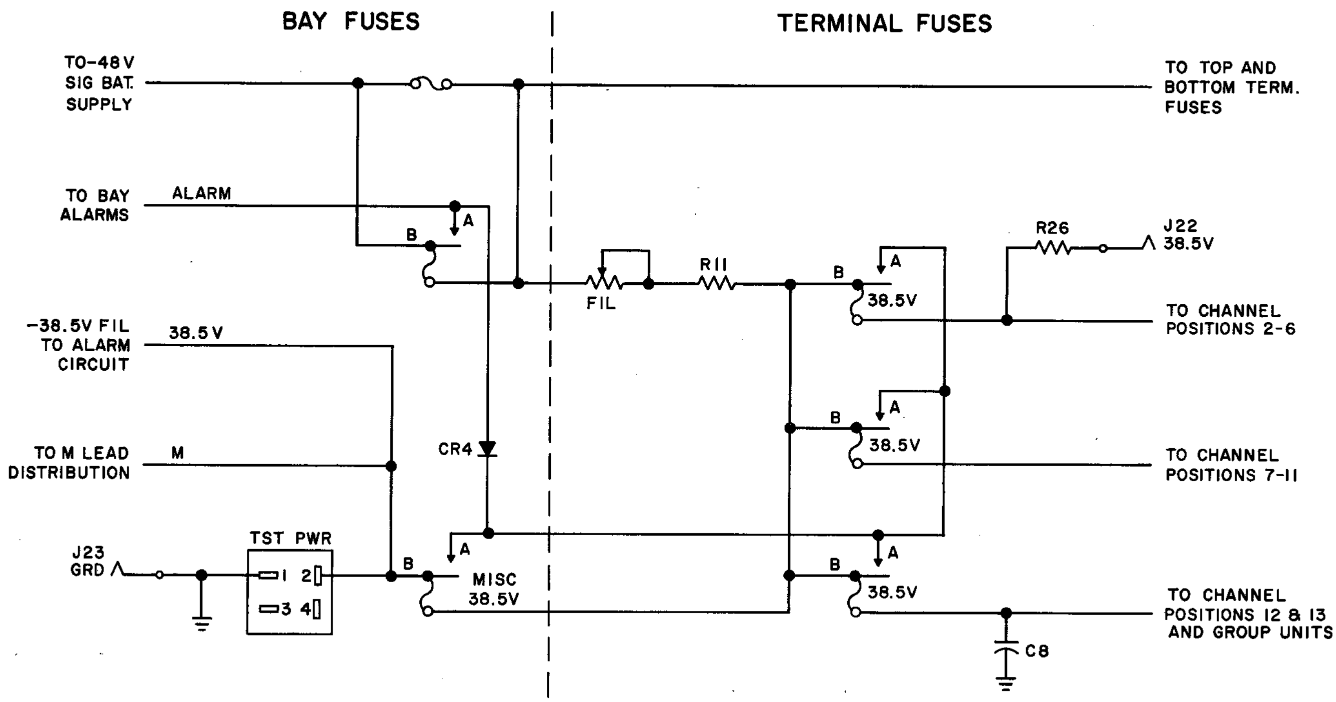


Fig. 29 — —38.5 Volt Filament Power Circuit

dc power to one remote electron tube repeater or up to 3 transistor repeaters. A +130 volt supply is applied through fuse +130V REP and resistor R9 to the transmission line via a simplex connection to the transmitting group unit. Similarly, a —130 volt supply is applied to the receiving line through fuse —130V REP, resistor R7, and rheostat R8 to the receiving line via a simplex connection to the receiving group unit. Rheostat R8 is adjusted to compensate for different line lengths in order to obtain the correct voltage at a remote repeater. Capacitors C9 and C10 provide power surge protection for +130 and —130 volt power supplies.

Blower Motor

4.34 The blower motor circuit is shown in Fig. 31. When equipment temperature rises to 110F, thermoswitch (S1 THERMAL) operates, activating relay ST. The contacts of relay ST close, enabling +115 volts to be applied to the blower motor (M) which operates to cool the equipment.

Alarm Circuits

4.35 ***Bay Alarm Circuit:*** For each of the shop-wired bays, an alarm circuit is required as shown in Fig. 32. This circuit provides a visual indication on the bay that +130, —130, —48, and —38.5 volt fuses have been blown. Also provided is a failure indication of received carrier or 3700-cycle supply. The windings of relay K1 are energized by operation of the +130 or —130 volt fuses which connect 130 volts to the relay through resistor R15 or R16. Operation of the fuse will also light lamp +130 which is in parallel with a portion of resistor R15 or lamp —130 in parallel with a portion of resistor R16. A blown —48 or —38.5 volt fuse or operation of the bay terminal alarm circuit (Fig. 33) will also energize the winding of relay K1 and will light the FIL CARR lamp. When relay K1 operates under any of these conditions, ground is supplied through its contacts to leads 1, 2, and 3 for initiating office alarms. The circuit ground on lead 2 may be optionally removed and replaced

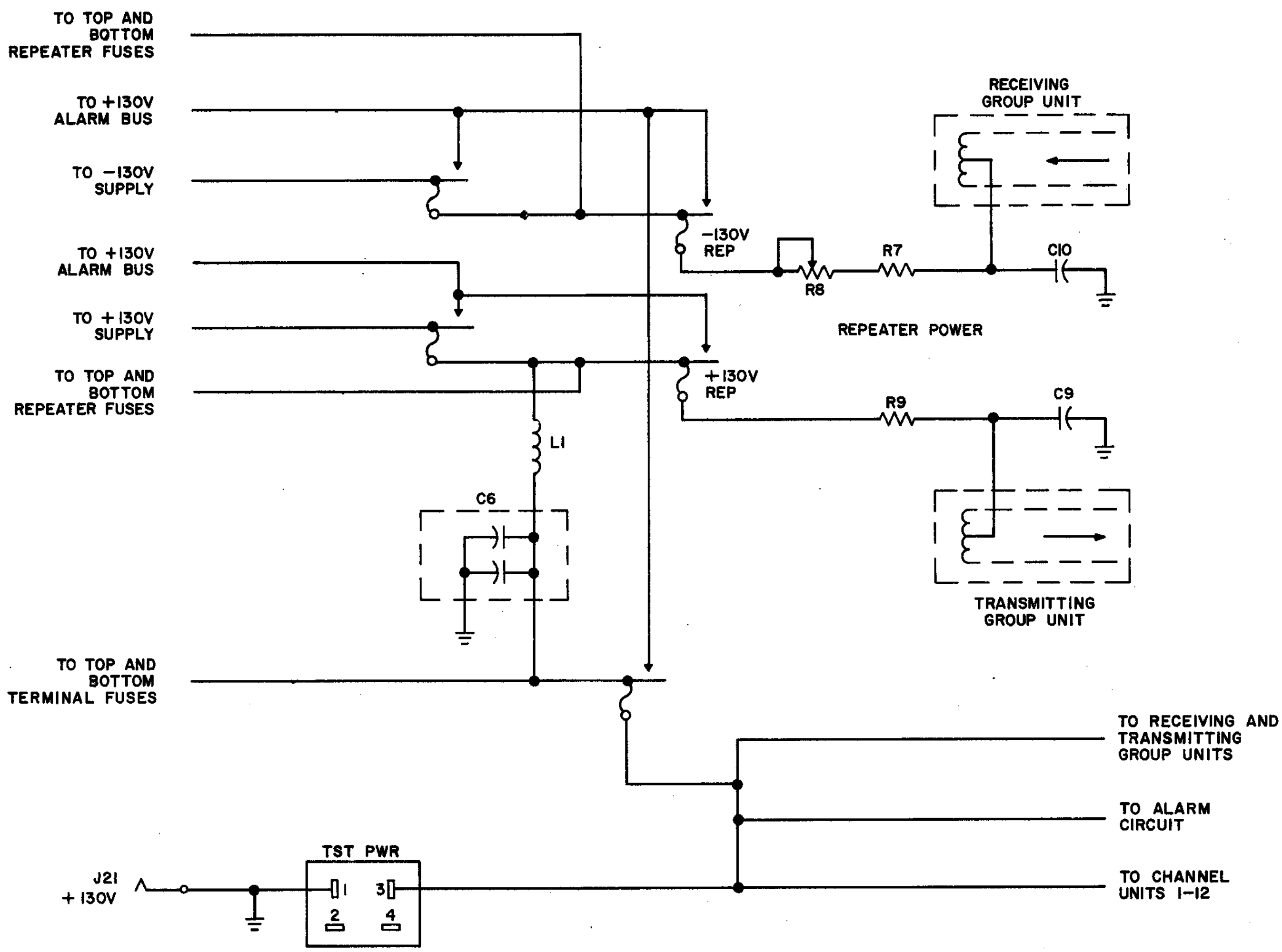


Fig. 30— +130 and —130 Volt Power Circuit

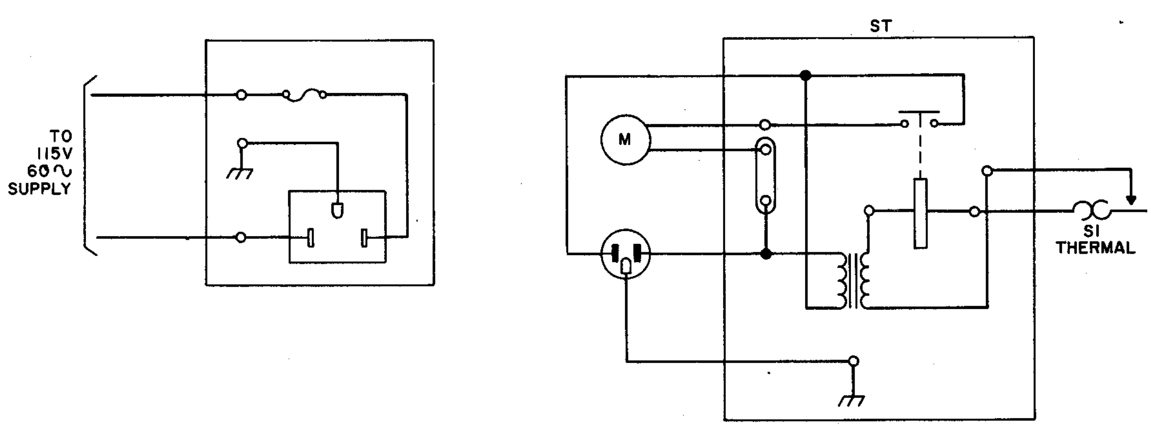


Fig. 31 — Blower Motor Circuit

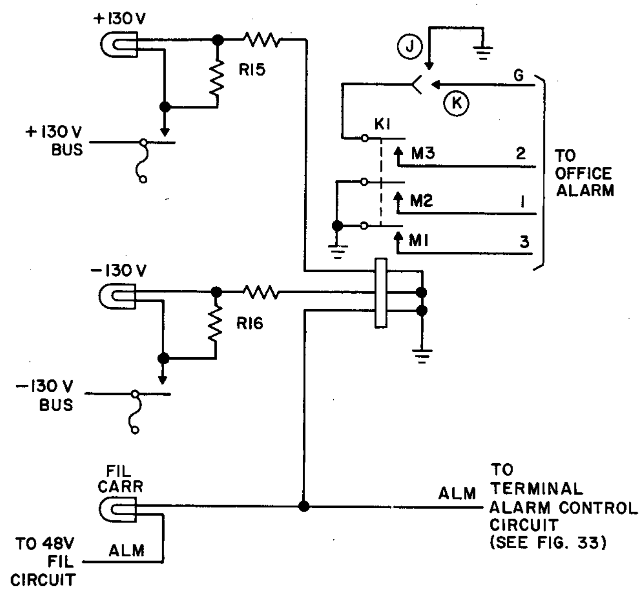


Fig. 32 — Bay Alarm Circuit

by ground on lead G from the office alarm circuit for manually disabling the audible alarm in partially attended offices.

4.36 ***Terminal Alarm Control Circuit:*** The terminal alarm control circuit (see Fig. 33) registers carrier failure or loss of 3700-cycle signaling supply. The circuit is used in conjunction with a trunk conditioning circuit and the bay alarm circuit. The sequence of operation for the terminal alarm circuit is shown, in chart form, in Fig. 34.

4.37 When the monitor circuit of the receiving group unit detects a loss of carrier signal the ground is removed from the (T) lead. This releases relay K2 in the terminal alarm control circuit. Release of relay K2 applies power to heat the bottom contacts of relay K7. After 2 to 6 seconds the bottom contacts of relay K7 close, operating relay K3B. Relay K3B also operates when relay K4 releases as a result of 3700-cycle oscillator failure. Release of K4 also causes the 3700-lamp to light. Operation of relay K3B causes lamp 3700/CARR to light, bay alarm circuit to operate; removal of plate voltage from the group transmitting unit to force a carrier failure to the far terminal, power to be applied to the top heating element of relay K7, power to be removed from the bottom heating element of relay K7 allowing it to cool and then to release, and a ground to be placed on lead SA to operate the E-lead open circuit.

4.38 The top contacts of relay K7 close in approximately 10 to 20 seconds after relay K3B operates. Operation of the top contacts of relay K7 causes relay K3T to operate. Operation of K3T removes power from the top element of relay K7, allowing it to cool and the contacts to release; restores plate voltage to the group transmitting unit; locks up relay K3B; and places a ground on lead DS to operate the make busy circuit. To process trunks with E and M lead supervision, the alarm control circuit furnishes two signals to the E-lead open and make busy unit. The first is a ground signal on lead SA which occurs 2 to 6 seconds after a carrier failure is detected or immediately after the failure of the 3700-cycle oscillator. The 2 to 6 seconds delay in the alarm registration for a carrier failure is to guard against alarming for momentary hits on the system. The first alarm signal causes the E-lead open circuit to disconnect the E leads of the associated trunk circuits from their respective signaling circuits. This provides an on-hook indication to the trunk circuit and stops charges on outgoing calls. The second alarm signal occurs 10 to 20 seconds after the first. A ground is placed on lead DS which operates the make busy circuit. The make busy circuit grounds the E lead toward the trunk circuit. This makes the trunk circuits appear busy to any subsequent calls. The delay between the first and second alarm signals is to allow time for the subscribers to recognize that the failure has occurred and to go on-hook.

4.39 During a failure, the trunk circuits of the associated failed terminal may be made good by patching to standby facilities and by operating the ALM OVRD key. This removes ground from the SA lead and releases the E-lead open circuit to reconnect the E leads. All 12 channels of a system have to be made good since operation of the ALM OVRD key will remove the make busy condition from all 12 trunk circuits.

4.40 The office alarms caused by a carrier or 3700-cycle oscillator failure can be silenced by the operation of the ALM RLS key. After the alarm control circuit has been restored to normal, the office alarm will again operate to signify the restoral. They are silenced by releasing the ALM RLS key.

4.41 ***Manual Loop Testing and Restoral:*** A loop testing feature is provided on channel 1 (or channel 2 if the channel 2 to 13 allocation is used) if this channel uses built-in 3700-cycle signaling. The sequence of operation is shown, in chart form, in Fig. 35.

4.42 After the received carrier or 3700-cycle oscillator failure has been cleared, the TST A key (see Fig. 33) is manually held depressed while the TST B key is manually pulsed. If the TST lamp flashes in synchronism with the pulsing of the TST B key, satisfactory system operation in both directions of transmission has been verified. The system should not be restored to service without first checking for satisfactory noise level.

4.43 After a fault has been cleared, the system may be restored. A chart showing the sequence of operation is shown in Fig. 36.

4.44 In restoration after the loop test has confirmed satisfactory system operation, the system may be restored by depressing the RST SYS key (see Fig. 33). This releases alarm relays K3B and K3T and trunk conditioning relays K5 and K6 restoring the system to normal service.

4.45 An unattended terminal may be restored from a remote location by originating a telephone call to a subscriber set at the unattended terminal. In this case, ringing of the subscriber set closes a pair of contacts to perform the same electrical function as depressing the RST SYS key at that location. An unattended terminal may also be restored from the attended terminal through use of the N1 carrier remote release circuit, SD-56464-01, if provided.

D. Message Channel Unit (J98703FA)

General

4.46 Each message channel unit is composed of three subassemblies which fasten together with plugs and jacks to form the complete plug-in unit. These are identified as the compressor, expandor-signaling, and carrier-frequency subassemblies. The compressor and expandor-signaling subassemblies are alike for all 12 channel units while the carrier-frequency sections differ only as to oscillator crystals and channel bandpass filters.

Message Channel Unit

4.47 The circuits to be found on the three subassemblies are illustrated in block form in Fig. 37. The compressor section includes a compressor and a voice-frequency low-pass filter as components in the transmitting side of the channel unit. A variable attenuator is also provided for control of the output message level. The expandor-signaling subassembly includes a voice-frequency low-pass filter, a pad, and an expandor circuit as message circuit components on the receiving side. The signaling circuit components included are a keyer on the transmitting side and a bandpass filter, amplifier, limiter, cathode follower, delay circuit, dc amplifier, and signaling relay on the receiving side. The carrier-frequency subassembly contains all the channel unit circuits operating at carrier frequency and the networks performing the transformation between voice and carrier frequency. On the transmitting side it includes a pad, carrier oscillator, and modulator. For receiving, it contains a channel band filter, regulator, and demodulator.

4.48 All connections to and from the channel unit are made through the main plug which is mounted on the carrier-frequency subassembly. The expandor-signaling section is located between the carrier and compressor sections so that transmitted voice signals pass through the connectors on this section to reach the compressor and then retrace a similar route to reach the modulator. The received message signals at carrier frequency pass through the carrier section where demodulation to voice frequency occurs and then go through the expandor-signaling section prior to connection to external voice-frequency circuits.

Transmitting Circuits — Message

Compressor Subassembly

4.49 The compressor subassembly may be divided into the following parts (see Fig. 38): variolosser, voice-frequency amplifier, control circuit, and low-pass filter. Voice signals

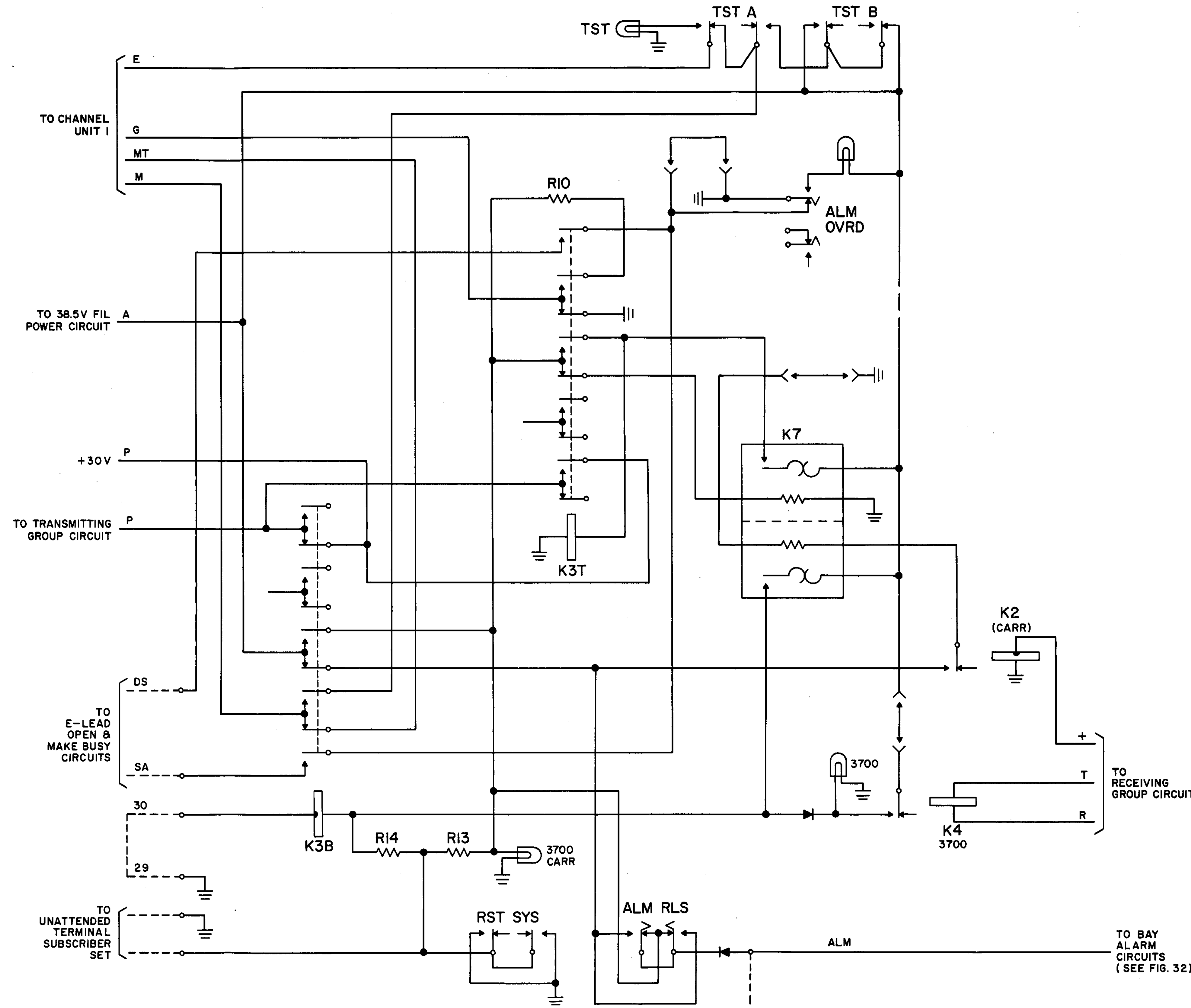


Fig. 33 — Shop-Wired Bay Terminal Alarm Circuit

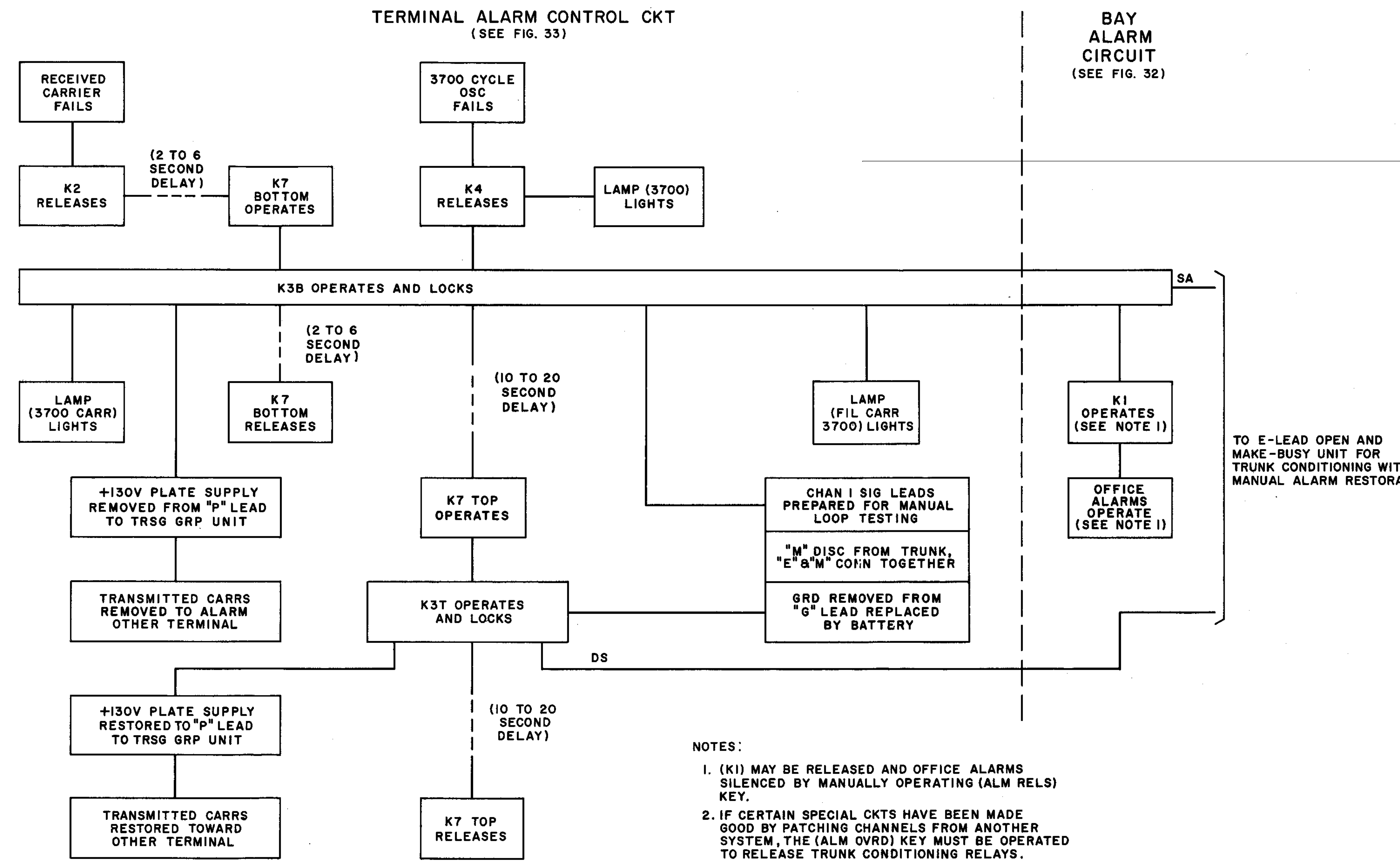


Fig. 34 — Sequence Chart for Alarm Circuit Operation

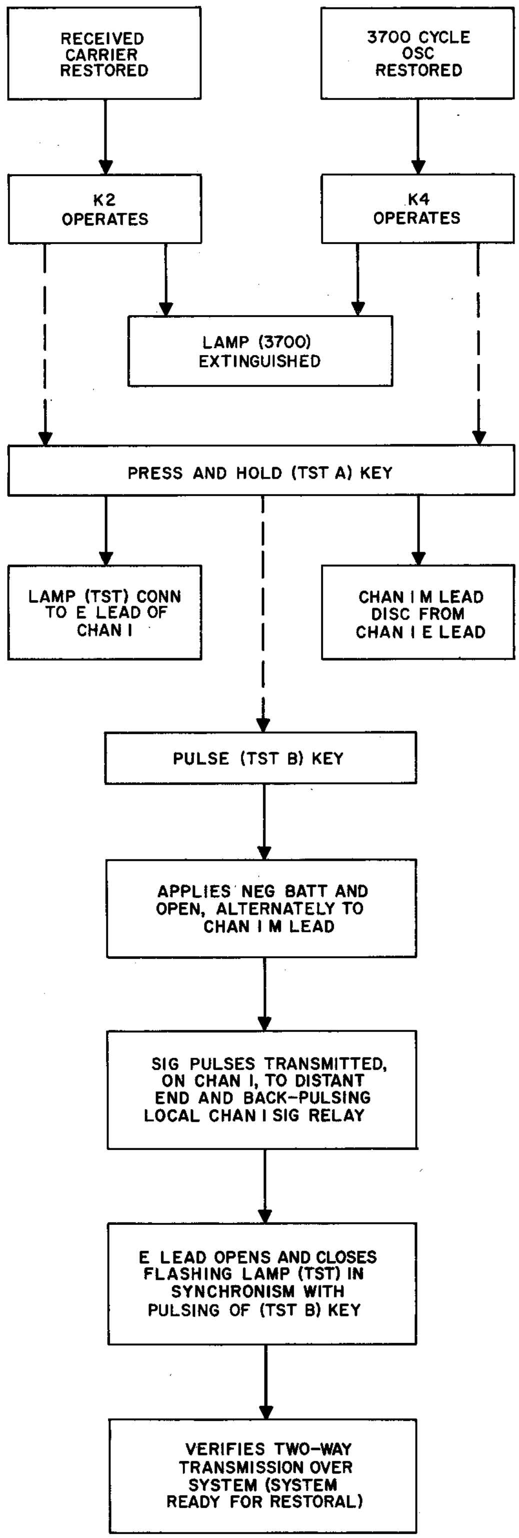


Fig. 35 — Manual Loop Testing Sequence Chart

from the associated trunk or line which are to be transmitted to the channel modulator pass through the variolosser (where compression occurs), voice-frequency amplifier, and low-pass filter to a pad on the modulator input. Voice signals received from the expandor are transmitted to the associated trunk or line.

4.50 Four pin jacks furnish test points to be used for measuring compressor input and expandor output voltages. Two test points for observing supervisory and dialing signals on the E- and M-signaling leads are also provided on the compressor subassembly.

4.51 All circuits, including +130V and —38.5V power and input and output voice-frequency leads, enter or leave the compressor chassis via the plug which connects to the jack on the expandor-signaling subassembly. The heaters of the two amplifier tubes operate in series across the —38.5 supply.

4.52 ***Variolosser:*** The variolosser is a balanced attenuator in the voice-frequency path with shunt arms consisting of germanium diodes whose resistance varies as the current flowing through them varies; the resistance becomes smaller as the current increases and larger as the current decreases. Thus the attenuation increases or decreases as the current rises or falls. A portion of the compressor output voltage is rectified and applied longitudinally to the variolosser in the form of current which varies in accordance with the syllabic envelope of the speech in the voice-amplifier output. If the amplifier output rises as a result of a rise in input, the current in the diodes increases, which increases the variolosser attenuation, so that the input to the amplifier tends to drop. In this way (within limits) a 2-db change in variolosser input results in only 1-db change in variolosser output. The variolosser operates at a —16 db input at zero level.

4.53 To prevent low-frequency oscillation or other undesirable effects resulting from feedback around the loop including the variolosser, amplifier, and control circuit, and to reduce second harmonics generated in the rectifier, the balance between longitudinal and transverse circuits is closely controlled by using matched diodes and close-tolerance resistors in the vario-

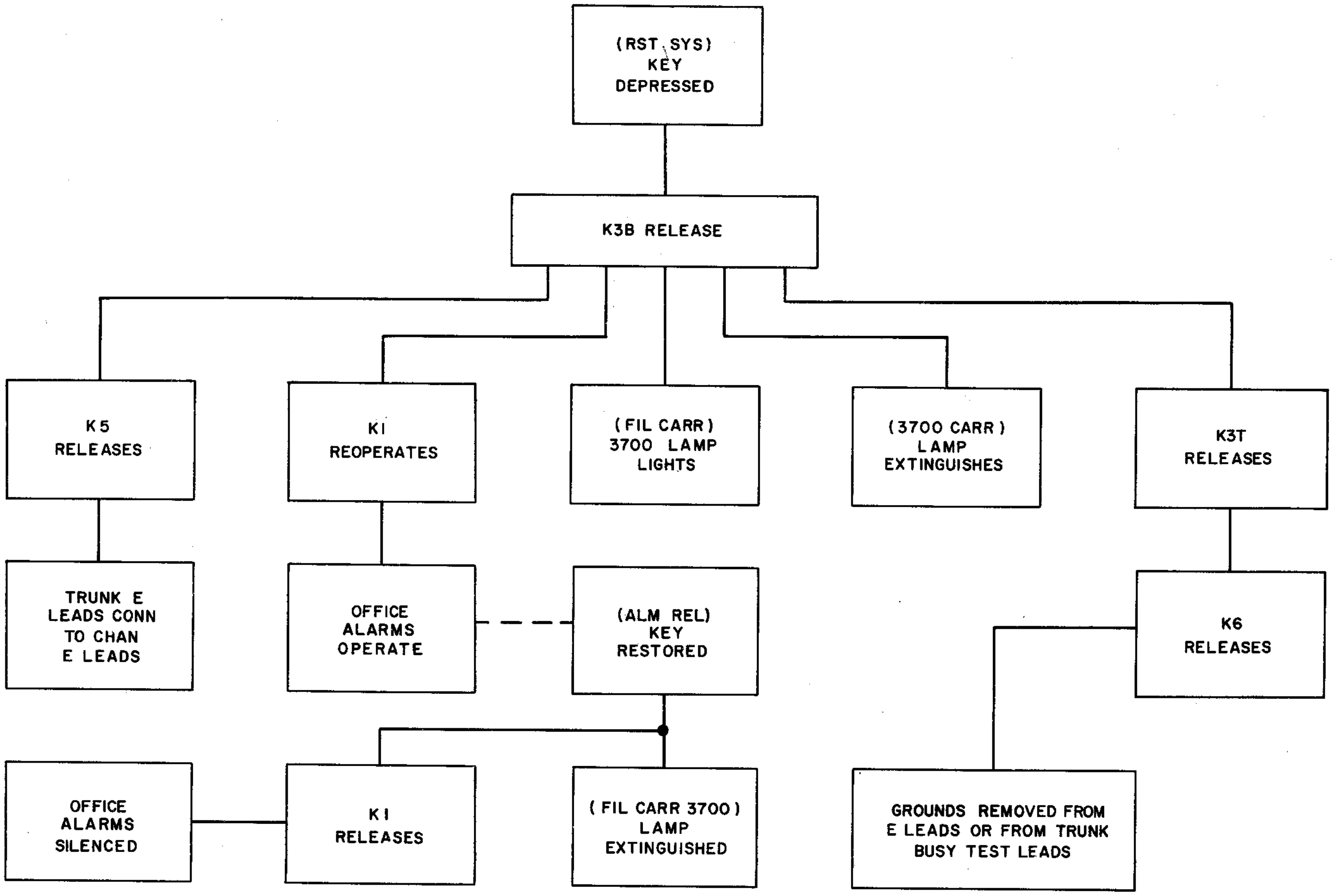


Fig. 36 — Restoral Sequence Chart

losser. The high-pass filter consisting of capacitor C7 and resistor R7 also helps to reduce the low-frequency feedback effects.

4.54 *Voice-Frequency Amplifier:* The purpose of the voice-frequency amplifier (Fig. 38) is to transmit speech currents to the modulator and to furnish the power required for driving the rectifier which controls the variolosser attenuation. It is a 2-stage feedback amplifier using two 408A pentodes and has a voltage gain of approximately 60 db between the primary winding of the input transformer and the input of the transmitting low-pass filter when operating with normal feedback.

4.55 Feedback is provided by applying a portion of the amplifier output voltage, as determined by the voltage divider consisting of potentiometer COMP and resistor R28 (see Fig. 38), to the cathode of the first stage through a series resistor. The COMP potentiometer regulates the amount of feedback, thus adjusting the over-all gain of the amplifier. The normal feedback is about 10 db.

4.56 The output transformer has two secondary windings, 300 ohms and 600 ohms. The 300-ohm winding is terminated in 10,000 ohms, which is the impedance of the low-pass filter through which speech is transmitted to the modulator via a pad. The 600-ohm winding is terminated in a 600-ohm pad on the control circuit input so that practically all of the amplifier output power goes to the control circuit rather than to the low-pass filter. A capacitor C8 bridged across the 300-ohm winding shapes the high-frequency feedback characteristic of the amplifier to prevent high-frequency oscillation.

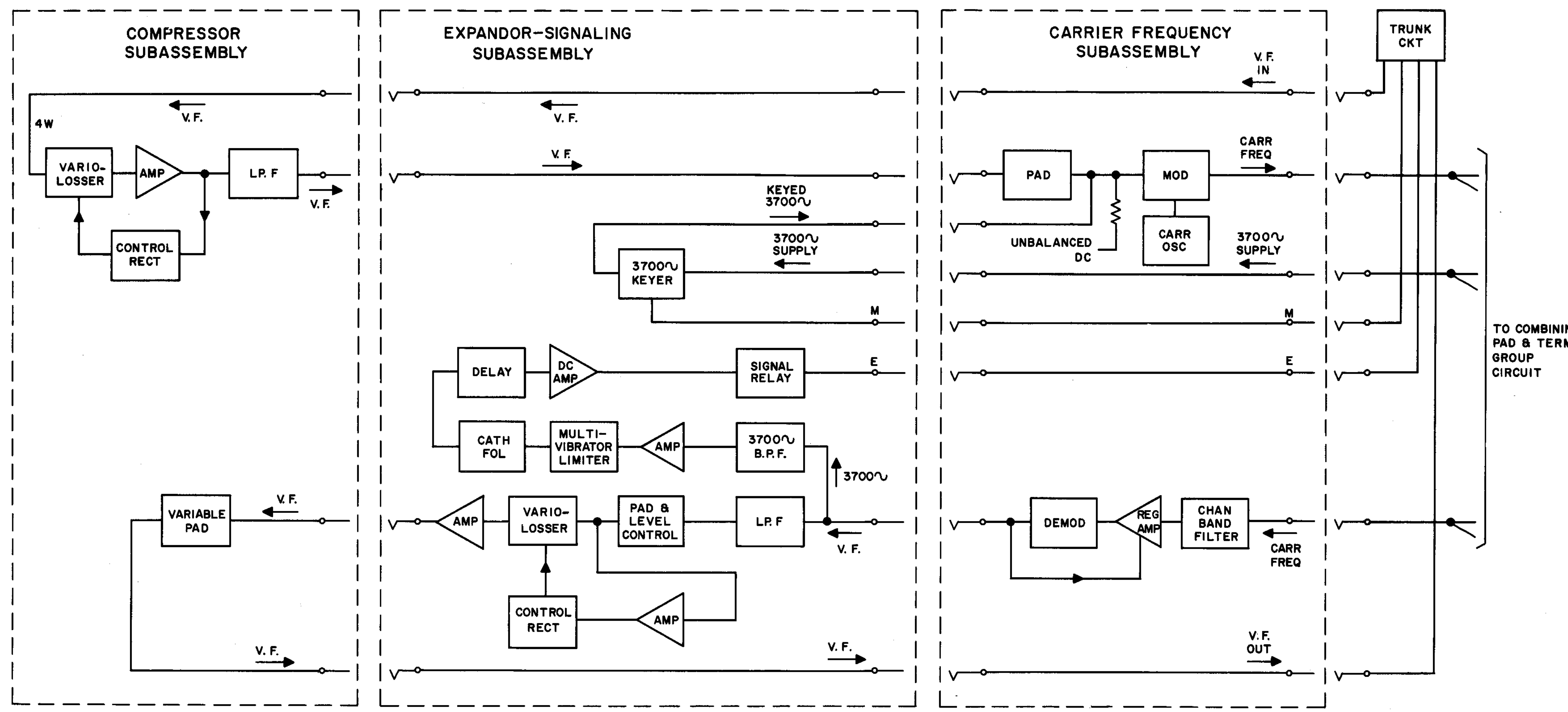


Fig. 37 — Channel Unit, Block Diagram

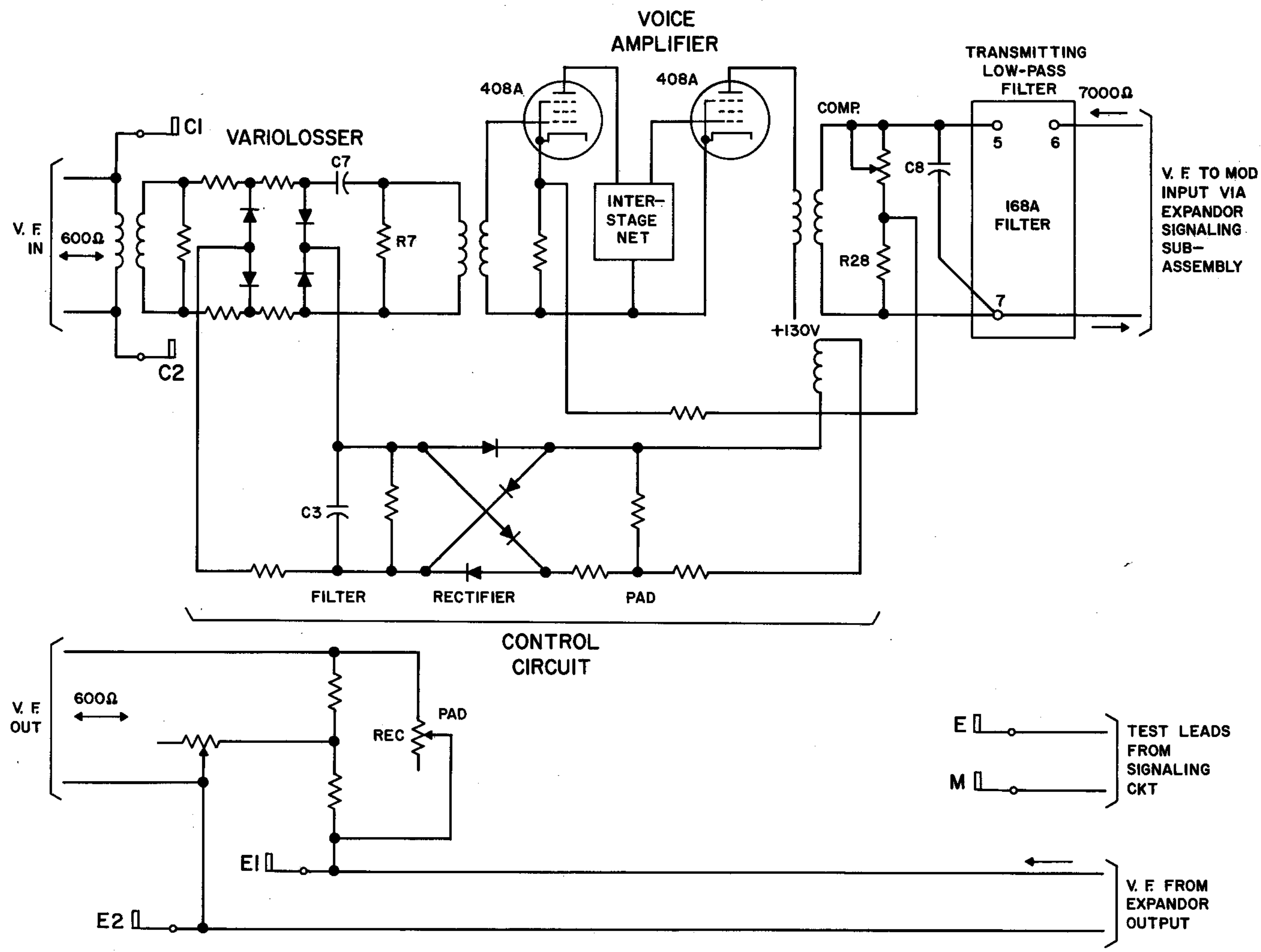


Fig. 38 — Compressor Subassembly, Schematic Diagram

4.57 The output tube of the amplifier is operated in such a manner that it limits input signals greater than +11 dbm at 0 level as indicated in Fig. 24. This is to prevent speech currents applied to the modulator from causing greater than 100 per cent modulation of the transmitted carrier. If the modulation exceeds 100 per cent, the distortion products generated in the demodulator at the far end of the circuit will interfere with operation of the 3700-cycle signaling circuit, and might also seriously impair the quality of the received speech.

4.58 ***Control Circuit:*** The control circuit of the compressor consists of a pad, control rectifier, and resistor-capacitor filter. Part of the voice-amplifier output is fed through one winding of the output transformer and the pad to the rectifier, which is a lattice arrangement of germanium varistors. The dc output of this rectifier, which varies in accordance with the syllabic envelope of the speech voltage on its input, is applied longitudinally to the variolosser circuit by the resistor-capacitor filter circuit to control the variolosser attenuation, as described in 4.52.

4.59 The control circuit filter network serves three purposes:

(1) It provides the proper buildup and decay times for the current which flows into the variolosser.

(2) It filters out harmonics generated in the rectifier circuit to prevent their reaching the input of the amplifier via unbalances in the variolosser.

(3) By filtering out nearly all components of speech except the syllabic envelope, it helps to prevent undesirable feedback effects such as low-frequency oscillations around the loop consisting of control circuit, variolosser, and amplifier.

Buildup is determined by the length of time it takes to charge the shunt capacitor C3 through the resistance seen looking back toward the rectifier circuit. Decay time is determined by the time required to discharge this capacitor through the capacitor shunting resistance and the resistance seen looking forward toward the variolosser. If delay were not provided, the variolosser would operate on the instantaneous value of speech rather than on the syllabic envelope, so that frequencies not present in the original signal would be generated in the variolosser, and these would then have to be transmitted over the line without amplitude or phase distortion in order for the original signal to be restored at the receiving end of the circuit. The transmission of these additional products would call for increased bandwidth for each channel.

4.60 *Compressor Characteristics:* A typical compressor input-output load characteristic for a 1000-cycle tone is shown in Fig. 24. Limiting in the voice-amplifier output stage is indicated by the leveling off of output above +11 dbm input. At low levels the curve does not change from a 2:1 to 1:1 slope sharply, as the ideal curve indicates, because the shunt diodes in the variolosser cannot change suddenly from moderately high to very high resistance; this change must occur gradually. A typical transmission-frequency characteristic for the compressor circuit, exclusive of the low-pass filter, is shown in Fig. 39 for —16 dbm input at zero level. The shape of this curve will change with operating level because the variolosser impedance, and hence the reflection losses, change with level.

4.61 ***Transmitting Low-Pass Filter:*** The loss-frequency characteristic of the low-pass filter, through which compressed speech currents pass to reach the modulator is shown in Fig. 40. The filter works between impedances of 300 ohms on its input and 3000 ohms on its output, an arrangement which permits a quite simple filter design. It filters out speech components above 3000 cycles and has a peak loss at 3700 cycles to prevent speech currents near this frequency from getting through to interfere with operation of the 3700-cycle signaling circuit, and also helps to prevent 3700-cycle signaling tone from getting back into the compressor amplifier to cause intermodulation between speech and signaling tone. The filter has a slight drop in loss in the vicinity of 2800 cycles to partially pre-equalize for the shape of the receiving channel bandpass filter. The output of the transmitting low-pass filter is adjusted to operate at —1.5 db input at zero level by means of the compressor gain control COMP.

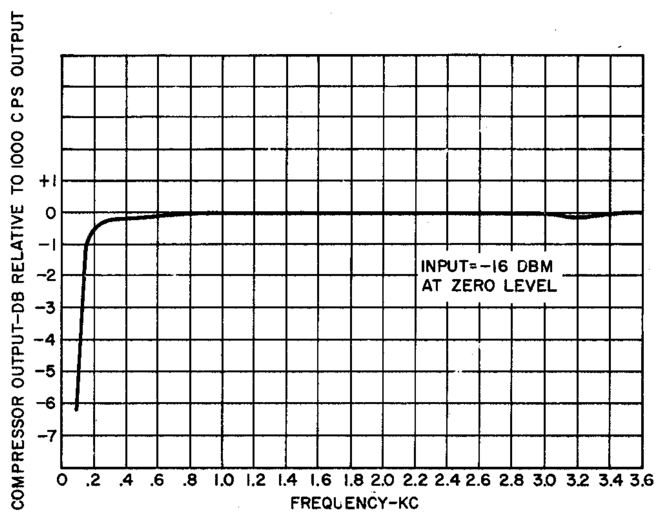


Fig. 39 — Typical Transmission Frequency Characteristics of Compressor Circuit

Carrier-Frequency Subassembly — Transmitting

4.62 The transmitting portion of the carrier subassembly (see Fig. 41) includes the input pad, the modulator, and a carrier oscillator. A combining multiple pad at the modulator output consisting of two resistors on the terminal frame assembly is provided for each channel. Compressed speech currents from the output of the compressor subassembly pass through plugs and jacks on the expandor-signaling subassembly and through the input pad to the modulator where they modulate the carrier. The resulting products, including upper and lower sidebands and excess carrier and their harmonics, are then transmitted

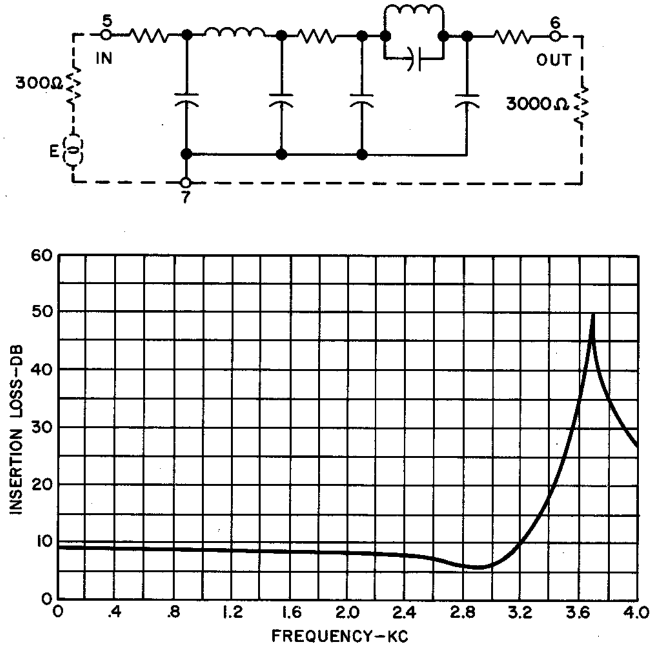
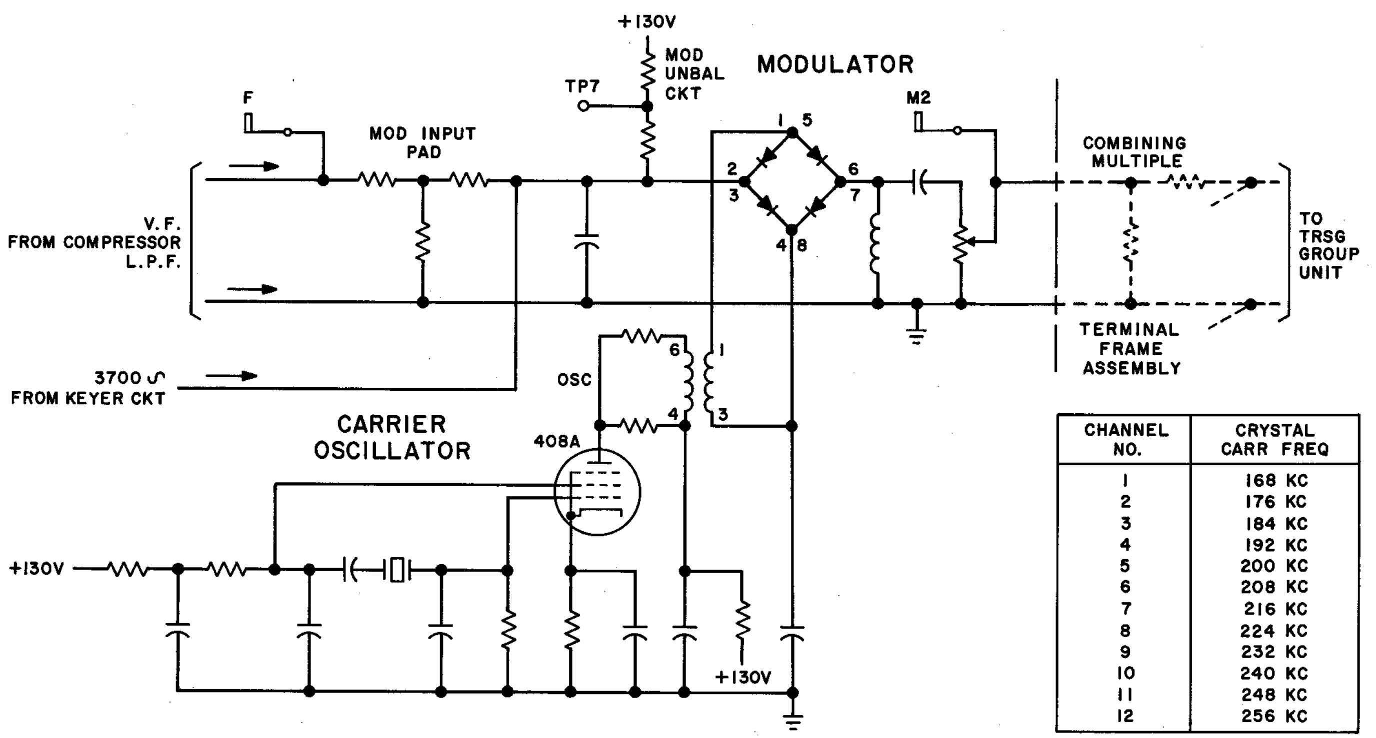


Fig. 40 — Schematic and Loss-Frequency Characteristics of Transmitting Low-Pass Filter

to the output of the combining multiple where they are combined with the similar outputs of the other 11 channels, and applied to the input of the low- or high-group transmitting circuit. From this point on, until the input of the receiving channel band filter is reached, the 12 carriers and their sidebands are transmitted as a group. Fig. 1 shows how this group of carriers and their sidebands are distributed across the carrier-frequency spectrum, beginning with channel 2 carrier at 176 kc, and the other carriers spaced at 8 kc intervals up to 264 kc for channel 13. Undesired harmonics of these frequencies are filtered out in the group unit.

4.63 TP7 furnishes means for removing the dc input to the modulator which normally produces carrier unbalance by biasing the modulator. Applying the short circuit balances out the carrier, permitting measurement of double sideband energy out of the modulator without using a selective analyzer. Pin jack M2 is used for measuring carrier power or sidebands at the modulator output. The carrier subassembly con-



CHANNEL NO.	CRYSTAL CARR FREQ
1	168 KC
2	176 KC
3	184 KC
4	192 KC
5	200 KC
6	208 KC
7	216 KC
8	224 KC
9	232 KC
10	240 KC
11	248 KC
12	256 KC

Fig. 41 — Carrier Frequency Transmitting Circuit

nects to the expandor-signaling subassembly through a jack and to the terminal mounting through a plug. The 20V heater of the oscillator tube operates in series with the heater of a tube in the signaling subassembly across the —40V supply. Pin jack F is used for measuring the signal level at the input to the modulator.

4.64 *Modulator Input Pad:* The modulator input pad is a 3000-ohm pad. It has a 15-db loss to attenuate speech currents out of the compressor so as to produce the desired input to the modulator. Since the output of the signaling keyer circuit is bridged across the output of this pad, it also serves to reduce the amount of 3700-cycle tone fed back into the compressor amplifier, thereby reducing the intermodulation between speech and signaling tone. The message level at the pad output is —16.5 db.

4.65 *Carrier Oscillator:* The carrier is generated in a crystal-controlled electron-coupled oscillator. The cathode, control grid, and screen grid of a 408A pentode, with a crystal operating at series resonance and connected between screen and control grid, make up the oscillator. Oscillations are coupled to the plate circuit via the electron stream. The carrier power supplied to the modulator through an output transformer is nominally +9 dbm.

4.66 *Modulator:* The bridge-type germanium diode assembly which comprises the modulator is connected in series with one lead of the pair across which the compressed speech voltage is impressed. On the positive half-cycle of the carrier the diodes are driven toward low resistance, so that speech voltage is transmitted through the modulator. On the negative half-cycle the diodes are driven toward high resistance, so that speech voltage is blocked from the output. Thus the speech voltage transmitted through the modulator is interrupted periodically at a carrier-frequency rate which produces upper and lower sidebands. Although the diodes are well matched for balance, in normal operation the bridge is intentionally unbalanced by applying direct current to two opposite legs so that carrier is transmitted with the sidebands. The reason for providing well-balanced units is to assure a ***controlled*** unbalance when the direct current is applied. As discussed in 4.57, limiting in the compressor prevents the voice-frequency drive from modulating the carrier in excess of 100 per cent. There is some unmodulated speech present on the modulator output; this is filtered out by an inductor shunted across the output. The carrier is prevented from feeding into the compressor output circuit by a filter capacitor shunted across the modulator input. At the test jack M2 the carrier power is —22 dbm and the single sideband voice level is —37 db. The impedance at this point, looking toward the combining multiple, is about 840 ohms.

Combining Multiple

4.67 The output of each channel modulator is fed into a pad consisting of two resistors on the terminal mounting. Twelve such pads are multipled together on their output sides to form the combining multiple for the terminal. At this point the 12 carriers and their sidebands are combined and applied to the input of the transmitting group unit. These pads prevent interchannel modulation in their respective modulators by reducing the amount of energy fed back into the modulators from the 11 other channels. Since the loss in each pad is 33 db, the energy at the output of any modulator undergoes 66 db of attenuation before reaching the output of another modulator. This amount of loss maintains interchannel modulation at a satisfactorily low level. As indicated in Fig. 1, the energy at the combining multiple output consists of 12 carriers between 176 kc and 264 kc spaced 8 kc apart, and the 12 pairs of sidebands associated with the carriers. The power in each carrier at the output of the combining multiple is —55 dbm; the single sideband level is about —70 dbm. The total carrier power of all 12 channels is —44 dbm.

Transmitting Circuits — Signaling

Expandor-Signaling Subassembly

4.68 Fig. 42 shows a schematic of the keyer circuit which controls the 3700-cycle tone used for transmitting supervisory and dialing signals on each channel. The circuit is located on the expandor-signaling subassembly. The 3700-cycle supply is furnished by a common oscillator in the low-group transmitting or receiving unit of the terminal. The oscillator output of 1.2 volts is multipled to all 12 channel unit keyer circuits. In the idle or on-hook condition, a 3700-cycle tone is transmitted through the signaling keyer circuit

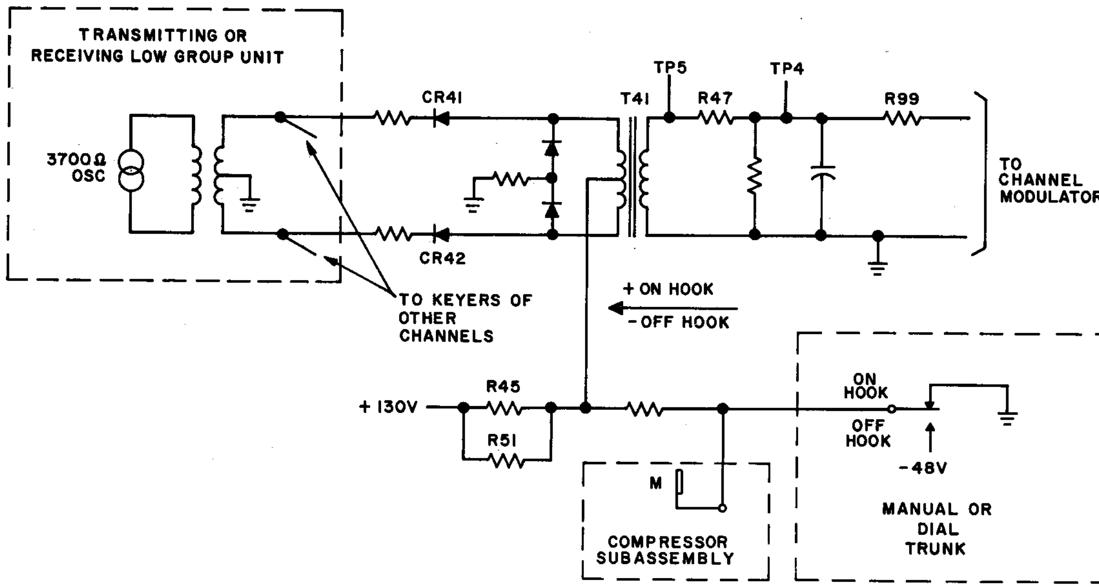


Fig. 42 — Signaling Keyer Circuit, Schematic

and is applied to the input of the channel modulator in parallel with the speech output of the compressor circuit. When the trunk associated with this channel is seized, the 3700-cycle tone is turned off. Dial pulsing consists of turning the tone on and off in synchronism with the opening and closing of the dial contacts.

4.69 Two test points are furnished for testing this circuit. Pin jack M located on the compressor subassembly enables checking the M-signaling lead. TP4 is connected to the junction of R47 and R99 and is used for bridging when measuring signal power and also for short-circuiting the output of the keyer circuit to simulate an off-hook condition. The expandor-signaling subassembly is connected to the compressor through a jack and to the carrier subassembly through a plug.

4.70 ***Keyer Circuit:*** As indicated in Fig. 42, the keyer circuit is an arrangement of germanium diodes, resistors, and two center-tapped transformers, in which the signaling tone is turned on and off by applying ground or —48V battery to the M lead from the associated trunk circuit. During the on-hook condition, when a 3700-cycle tone is to be transmitted, the M lead has ground applied to it from the trunk, which causes a positive potential with respect to ground to be applied to the center tap of the primary of the signaling transformer T41. The current which flows through diodes CR41 and CR42 to ground on the center tap of the 3700-cycle oscillator output transformer is in such a direction as to cause these diodes to be low in resistance, thereby transmitting 3700-cycle tone through the keyer transformer to the modulator. The 3700-cycle signaling frequency power at the input to the modulator is —16.5 dbm. In the off-hook condition ground on the M lead is replaced by —48V, and the negative potential thus applied to the center tap of the transformer causes diodes CR41 and CR42 to have high resistance so that the 3700-cycle tone is blocked from the keyer transformer.

4.71 The circuit which applies battery and ground to the M lead may be located at some distance from the N1 carrier terminal, and hence there may be considerable resistance in the M lead. There may also be considerable difference of potential between ground at the two places. The keyer circuit will operate satisfactorily with an M lead resistance up to 200 ohms and ground potentials not exceeding 5 volts. Above 5 volts the tolerable M lead resistance drops very rapidly, being 100 ohms at 6 volts and 0 ohms at 7 volts. Above 7 volts the circuit may not operate at all. For cases where the N1 signaling circuit is not used, the 3700-cycle tone is removed from the channel by connecting —38.5 volts to the M lead.

Carrier-Frequency Subassembly

4.72 The operation of the channel modulator for a 3700-cycle signaling tone input is the same as for a speech input, as described in 4.62 through 4.66.

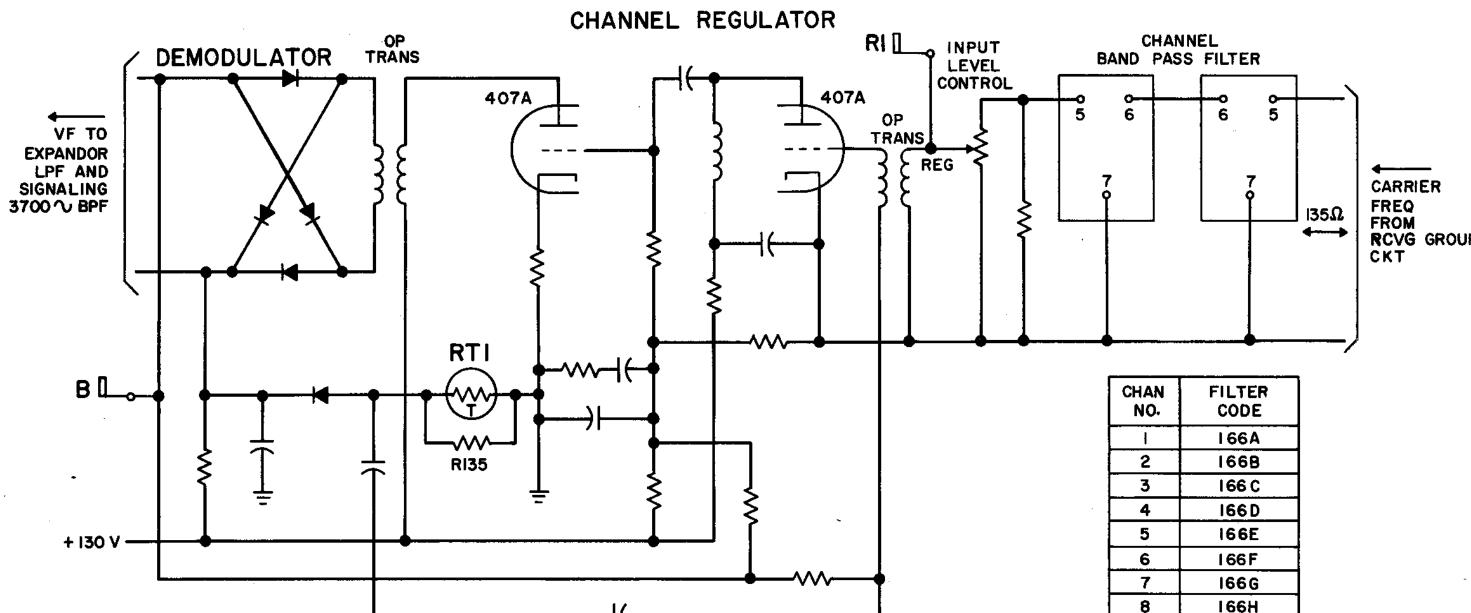
Receiving Circuits — Message

Carrier-Frequency Subassembly

4.73 The receiving portion (see Fig. 43) of the carrier-frequency subassembly includes the channel band filter, channel regulator, and demodulator. As indicated in Fig. 1, the input to the channel band filters consists of 12 carrier frequencies between 176 and 264 kc, spaced 8 kc apart, and the 12 pairs of sidebands associated with these carriers. The total carrier power received from the group amplifier is relatively constant but the individual channel carrier power may vary because of imperfect line equalization. The ideal carrier power for each channel is —5.5 dbm at the channel band filter input and should not vary more than ±5 db from this ideal. The single sideband voice level is —20.5 db. The carrier and sidebands selected by each band filter are transmitted through the channel regulator, which compensates for variation in carrier power, to the demodulator where intermodulation of the received carrier and the sidebands produces speech currents which are applied to the input of the low-pass filter on the expandor-signaling subassembly. A pin jack R1 is provided in the carrier receiving circuit for measuring the output of the bandpass filter. The heater of the regulator tube is operated directly across the —38.5 volt supply.

4.74 ***Channel Bandpass Filter:*** For apparatus standardization reasons, the complete channel band filter consists of two identical filter sections in separate containers, connected in tandem. When connected as shown in Fig. 43, the input and output impedance of the filter is 135 ohms. One carrier and its sidebands (which occupy about 4 kc on either side of the carrier) are selected by each channel band filter and are transmitted to the carrier level control potentiometer REG at the input of the channel regulator. The carrier power at the output of the filter is nominally —15.5 dbm and the single sideband level is —30.5 db. The loss of the complete filter, when tested individually, is about 8 to 9 db at the carrier frequency. This is increased to around 10 db when the other 11 filters are bridged across its input. A typical loss-frequency characteristic for a complete channel band filter is shown in Fig. 44. Equalization for the slope at those sideband frequencies corresponding to high speech frequencies is provided in the shaping of the transmitting and receiving low-pass filters in the compressor and expandor-signaling subassemblies, respectively. The use of inductors and capacitors in the filters, rather than crystals, is especially suitable for double sideband transmission where there is no need for eliminating unwanted sidebands with filter sections peaked close to the carrier.

4.75 ***Channel Regulator:*** The output of the channel bandpass filter is transmitted to the regulator through a level control potentiometer REG. This control provides a means for adjusting the incoming channel carrier to the middle of the regulator operating range. The regulator is an automatic gain control circuit which maintains its output at nearly constant level for relatively large changes in its input. It does this by means of an amplifier whose gain is under control of its output. Its input and output impedances are 135 ohms and 9000 ohms, respectively. The 2-stage amplifier consisting of two halves of a 407A double triode transmits the carrier and sidebands to the demodulator. Part of the dc output voltage of the demodulator (which depends upon the carrier magnitude) is added in series with an opposing voltage (the drop across thermistor RT1 shunted by resistor R135, Fig. 43) and the difference is used to control the bias of both stages of the amplifier to adjust its gain. The difference voltage may be monitored at the B jack. As the regulator input and hence the demodulator output increases, the differential voltage which is applied between grid and cathode of both stages becomes more negative and reduces the transconductance of the tubes; this tends to reduce the amplifier output. As the input decreases, the demodulator output decreases and the differential voltage which is applied between grid and cathode of both stages becomes less negative, causing the transconductance to rise, which tends to increase the amplifier output. Fig. 45 is a curve which shows how nearly constant the carrier output voltage tends to remain as the input to the regulator varies. At the center



CHAN NO.	FILTER CODE
1	166A
2	166B
3	166C
4	166D
5	166E
6	166F
7	166G
8	166H
9	166J
10	166K
11	166L
12	166M

Fig. 43 — Carrier-Frequency Receiving Circuit

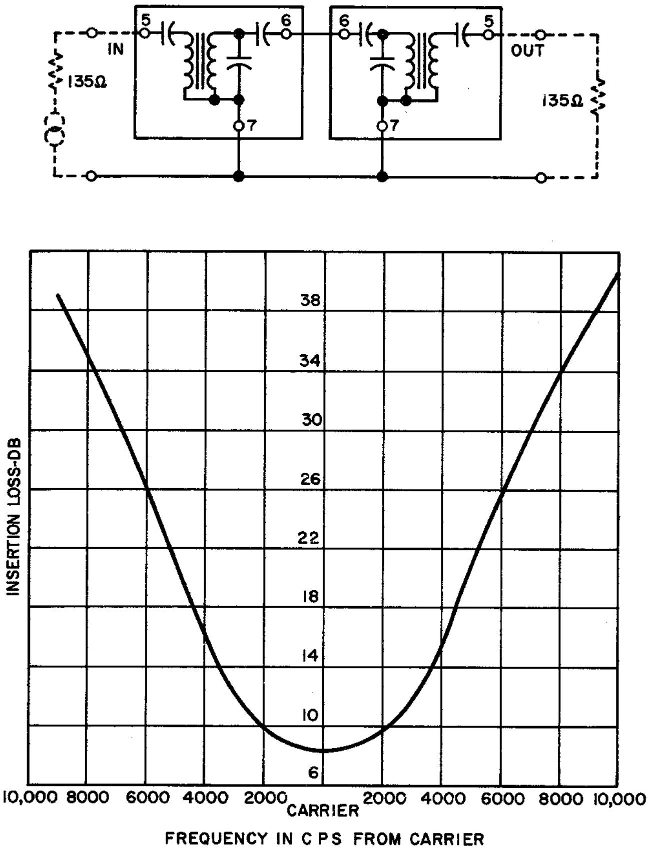


Fig. 44 — Schematic and Loss-Frequency Characteristic of Typical Channel Bandpass Filter

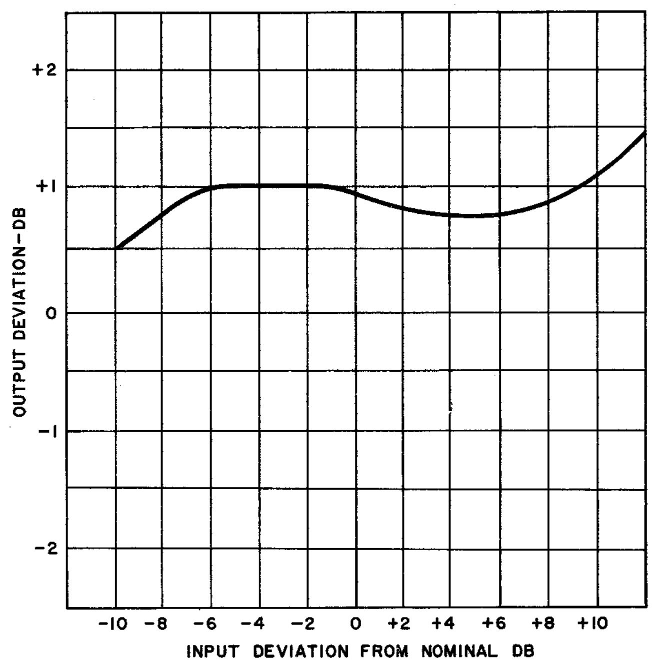


Fig. 45 — Channel Regulator, Typical Input-Output Deviation Curve

of its operating range, this circuit is said to have a "stiffness factor" of 1/20; i.e., the change in carrier output in db is roughly 1/20 as great as the input change in db.

4.76 ***Demodulator:*** The channel demodulator consists of silicon diodes in a lattice arrangement. The carrier power at its input is +13.5 dbm and the single sideband voice level is —1.5 db. Its input impedance is 9000 ohms. It receives the carrier frequencies and sidebands from the regulator circuit and demodulates the sidebands against the carrier by rectifier action so as to produce direct current (corresponding to the steady value of carrier on its input), speech currents (corresponding to the sidebands), and a carrier leak, which is filtered out by a shunt capacitor on the input of the signaling 3700-cycle bandpass filter in the expandor-signaling subassembly. The direct current, which is a measure of the carrier power, is used to control the operation of the regulator and has a magnitude of approximately 19 volts at the output of the demodulator; the voice level is +0.5 db and the 3700-cycle signaling frequency power is —4.5 dbm.

Expandor-Signaling Subassembly

4.77 A schematic drawing of the expandor circuit, which is part of the expandor-signaling subassembly, is shown in Fig. 46. The expandor circuit includes a low-pass filter, pad, level control potentiometer, variolosser, control amplifier, control rectifier, and output amplifier. Speech currents at the demodulator output are transmitted through the low-pass filter to the pad and input level control through the variolosser, where volume expansion occurs, and then through the output amplifier to the pair of leads which connect to external voice-frequency circuits.

4.78 All circuits enter or leave the expandor-signaling chassis via either a plug which connects to the carrier-frequency subassembly or a jack which connects to the compressor subassembly. The heaters of the two amplifier tubes operate in series across the —38.5 volt supply.

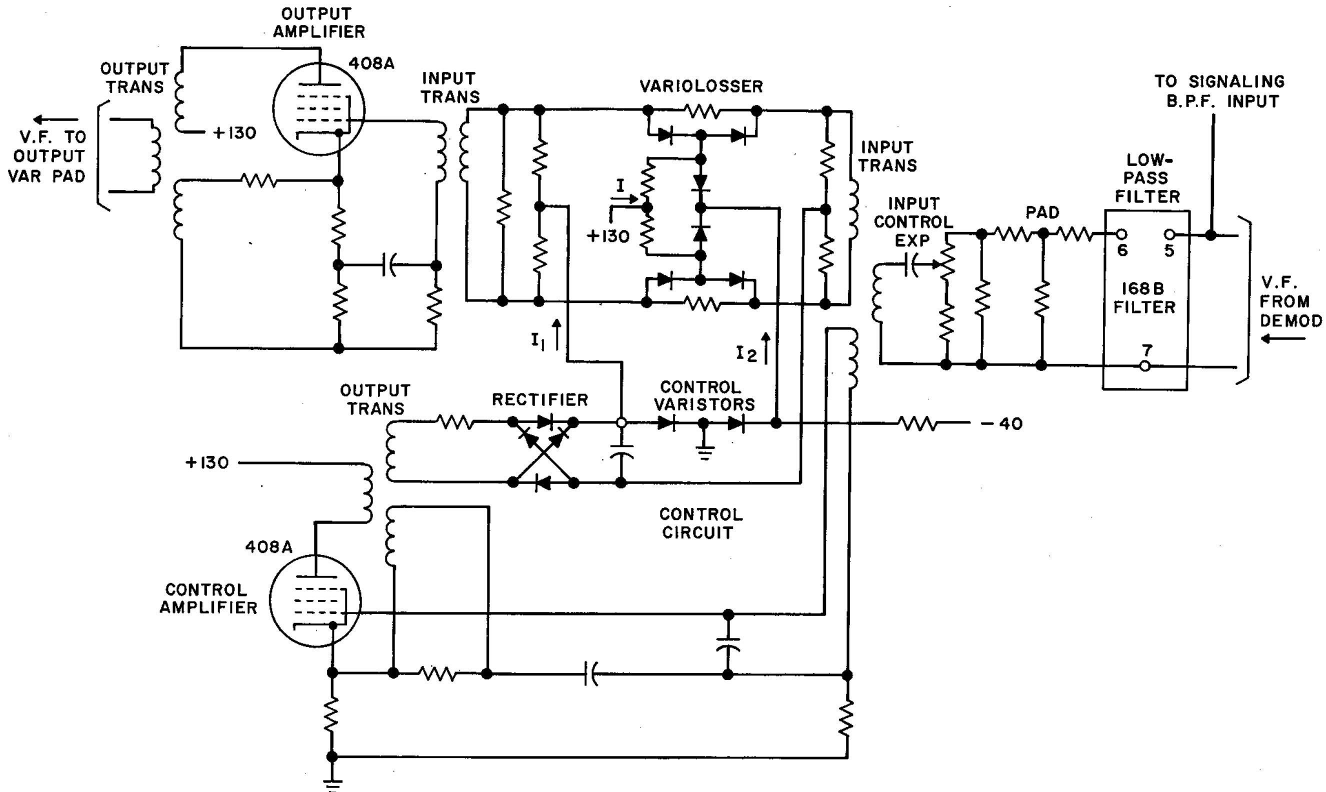


Fig. 46 — Expandor Subassembly, Schematic Diagram

4.79 ***Receiving Low-Pass Filter:*** Fig. 47 shows the loss-frequency characteristic of the receiving low-pass filter. The filter passes voice-frequency currents in the range below 3100 cps (including noise and crosstalk) received from the demodulator. The loss at 1000 cycles is about 2 db. The sag in loss between 2000 and 3000 cycles helps to equalize for the channel band filter characteristic. The peak of loss at 3700 cycles serves to prevent signaling tone from causing interference in the talking circuit. Another peak of loss at 4900 cycles maintains high loss at 4300 cycles where there is an unwanted product resulting from demodulation of adjacent channel signaling sidebands. When the filter is terminated as shown in Fig. 46, the input and output impedances are each 15,000 ohms.

4.80 ***Expandor Input Pad and Input Control:*** The pad at the output of the low-pass filter has a loss of 7.5 db. It provides a 10,000-ohm termination for the filter and reduces speech currents to a level suitable for proper operation of the expandor circuit. The potentiometer EXP which follows this pad provides means for adjusting the variolosser input to the level required for line-up purposes.

4.81 ***Variolosser:*** The variolosser is a balanced attenuator in the voice-frequency path having germanium diodes for series and shunt elements. The resistance of these diodes varies as the current flowing through them varies; the resistance becomes smaller as the current increases and larger as the current decreases. Thus the attenuation may be varied by changing the current through the diodes. Compressed voice currents from the input control potentiometer are applied simultaneously to the grid of the control amplifier tube and the variolosser network via separate windings of the input transformer. That portion of the input applied to the control circuit is amplified and rectified, and the current so produced, which varies as the syllabic

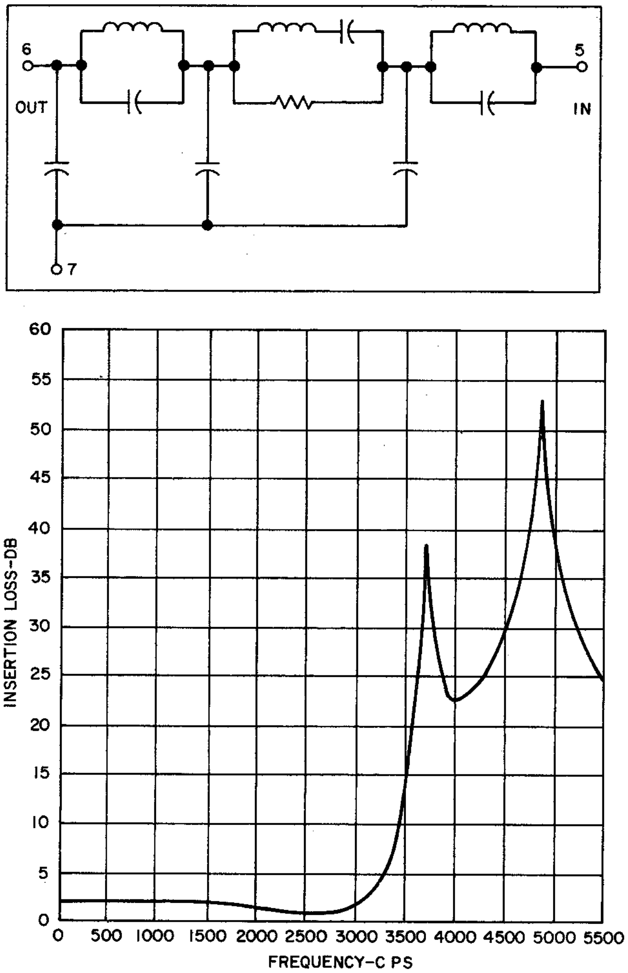


Fig. 47 — Schematic and Loss-Frequency Characteristics of Receiving Low-Pass Filter

envelope of the input speech, is applied longitudinally to the variolosser network to control its attenuation to speech currents transmitted through it. The control current flows in two longitudinal circuits. In one of these circuits, the current (I1, Fig. 46) controls the resistance of the series diodes and is effective at the lower levels of input. In the other circuit, the current (I2, Fig. 46) flowing in opposition to the bias current (I bias), controls the resistance of the shunt diodes and is effective chiefly at the higher levels of input, taking hold as the current in the series diodes begins to lose effect. In this process high input signals are only slightly attenuated, and low input signals, including noise and cross-talk, are greatly attenuated. The relationship between loss and current is such that, within limits, a 1 to 2 volume expansion occurs; that is, a 1-db change in variolosser input produces very nearly a 2-db change in output, and speech signals which were compressed at the sending end of the circuit have their full volume range re-established at the variolosser output.

4.82 ***Output Amplifier:*** The output amplifier is a one-stage amplifier using a 408A pentode to raise the level of speech signals received from the variolosser and transmit them to the associated 4-wire trunk. It has 12 db of feedback and the voltage gain between the primary of its input transformer and its 600-ohm output is 35 db. Connections to the trunk are made via the compressor subassembly where a pad is provided for adjusting the output level. The amplifier output operates at +10 db level.

4.83 ***Control Circuit:*** The control circuit consists of the control amplifier, rectifier, filter capacitor, and control diodes. A portion of the variolosser input signal is transmitted through one winding of the input transformer to the input of the control amplifier, which is a one-stage feedback amplifier employing a 408A pentode, is amplified, and applied to the input of the rectifier. The rectifier is a lattice arrangement of germanium diodes whose output varies in accordance with the syllabic envelope of the speech voltage on its input. A capacitor across the rectifier output filters out nearly all speech components except the relatively slowly varying envelope. The filtered dc output is applied longitudinally to the variolosser to control its attenuation as described in 4.81. The rectifier output follows two paths, one directly into the variolosser to control the series arms of the variolosser; the other, which controls the shunt arms, through a pair of control diodes. One control diode determines the point on the expandor load characteristic at which the shunt arm control current takes effect; the other prevents biasing current in the variolosser from backing up into the rectifier. A time delay characteristic complementary to that of the compressor circuit is furnished by the capacitor on the rectifier output. The resistance looking back into the rectifier determines the charging or buildup time; decay time is determined by the resistance looking into the variolosser.

4.84 *Expandor Characteristics:* A typical expandor load characteristic for a 1000-cycle tone is shown in Fig. 24. At low levels the curve does not change from a 1:2 to 1:1 slope sharply, as the ideal curve indicates, because the series diodes in the variolosser can not change suddenly from moderately low to very high resistance but must go through such a change gradually. However, as long as the gradual change complements the corresponding change in the compressor, no distortion occurs. A typical transmission-frequency characteristic for the expandor circuit, not including the low-pass filter, is shown in Fig. 48 for an input power to the expandor of —5.5 dbm at zero level. A —5.5 dbm, 1000-cycle input will produce —16 dbm output from the expandor at zero level. The shape of this curve will change with operating level because the variolosser impedance, and hence the reflection losses change with level.

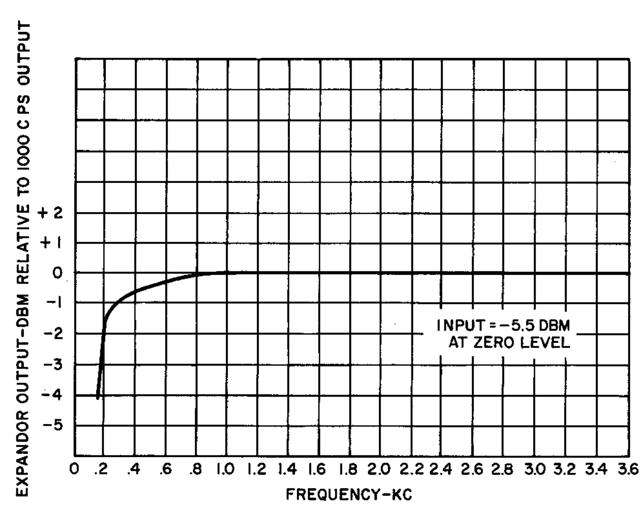


Fig. 48 — Typical Transmission Frequency Characteristic of Expandor Circuit

Receiving Circuits — Signaling

Carrier-Frequency Subassembly

4.85 The operation of the carrier-frequency circuits when receiving 3700-cycle signaling sidebands is the same as when receiving speech sidebands described in 4.73 through 4.76. The 3700-cycle output of the demodulator is then transmitted to the input of the 3700-cycle band-pass filter on the expandor-signaling subassembly. The voltage at the filter input is approximately 2.4 volts rms.

Expandor-Signaling Subassembly

4.86 Fig. 49 shows a schematic of the signal detector which receives supervisory and dialing information from the channel modulator in the form of pulses of 3700-cycle tone and translates this information into opens and closures of ground on the E lead for use by the trunk circuit. The circuit consists of a 3700-cycle band-pass filter, amplifier, limiter-multivibrator circuit, cathode follower, voltage doubler rectifier, delay network, dc amplifier, and pulse relay. It uses two —38.5 volt heater tubes supplied directly across the —38.5 volt supply and one tube operated in series with the heater of the oscillator tube in the carrier subassembly across the —38.5 volt supply.

4.87 *3700-Cycle Band Filter:* The 3700-cycle band filter is sharply tuned to 3700 cycles and admits signaling tone to the signal receiving circuit while preventing unwanted frequencies from interfering with the signal circuit operation. Fig. 50 shows a typical transmission characteristic for this filter. The filter has a voltage gain over a small band of frequencies centered about 3700 cycles, with about 8 db at the peak. At the signaling frequency the input impedance is 80,000 ohms; at frequencies within the speech band the impedance approaches open circuit. Two test points are provided between the filter and the amplifier. Pin jack S1 enables measuring the filter output. TP3 is a bare wire which is used for placing a shunt on the filter output for reducing the voltage as required for line-up tests.

4.88 *Voltage Amplifier:* The signal band filter output drives the grid of the voltage amplifier stage which uses one triode section of a 407A tube. The gain in this stage is adjustable. The gain control changes the amount of negative feedback effective in the cathode circuit of the triode. This control is so adjusted that the circuit

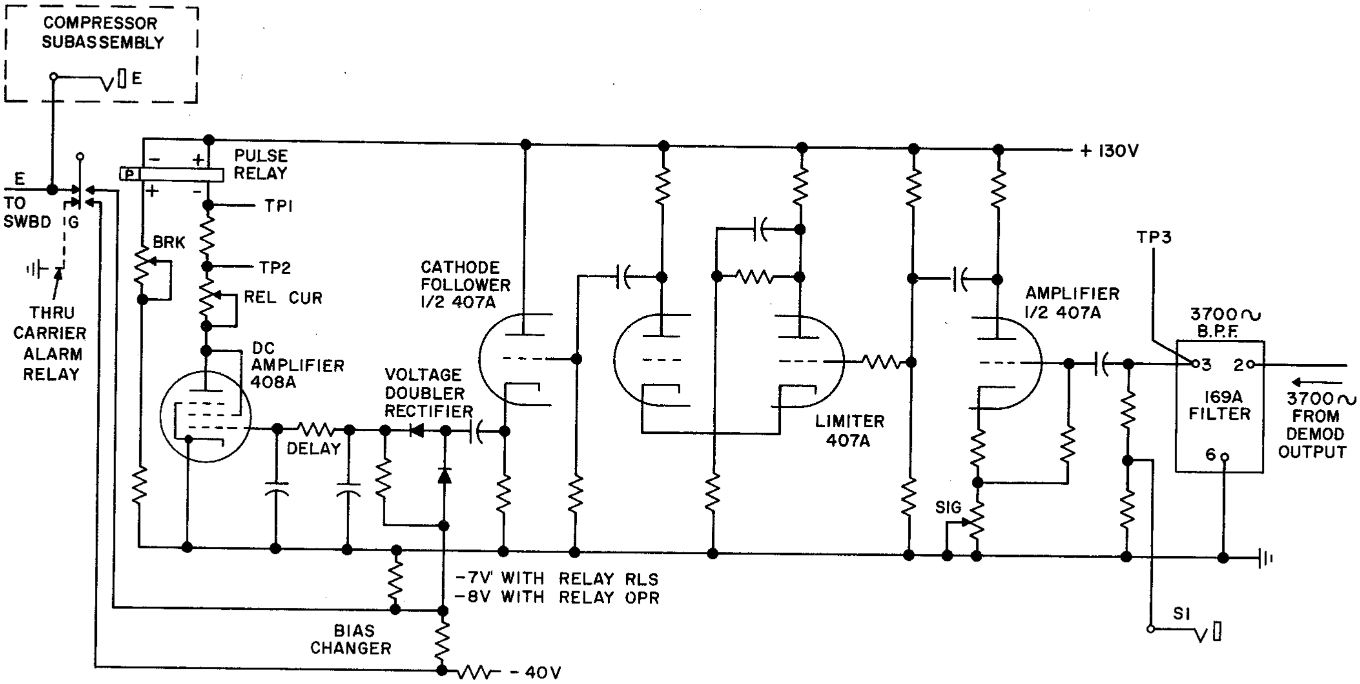
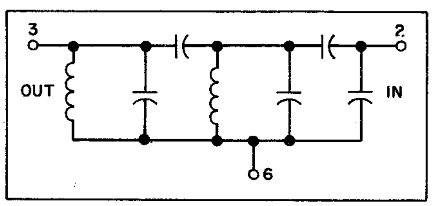


Fig. 49 — Signal Receiving Circuit, Schematic Diagram



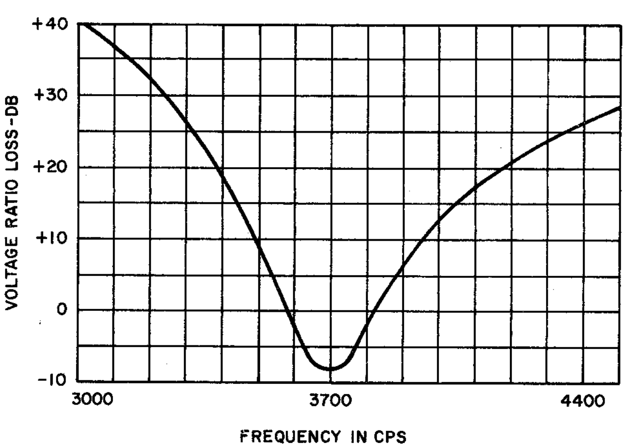


Fig. 50 — Schematic and Loss-Frequency Characteristic of Signaling Filter

will just operate the pulsing relay at a specified value of input voltage which is 7 db below that normally applied in a working circuit. Compensation can thus be made for 3700-cycle signal variations from channel to channel and for various limiter-multivibrator circuit thresholds. The amplified output of this stage is capacitively coupled to the limiter-multivibrator.

4.89 ***Limiter - Multivibrator Circuit:*** The limiter-multivibrator circuit is shown in detail in Fig. 51A. It uses both halves of a 407A double triode to convert 3700-cycle sine wave, whose peak amplitude may vary to 3700-cycle square wave of constant peak amplitude. If the 3700-cycle amplitude were not held constant in this manner, the time delay circuit which follows would introduce excessive pulse width distortion each time the output of the demodulator varied. With no input to this circuit the grid of the first triode (A) is held at a positive voltage with respect to ground by the voltage divider consisting of resistors R57 and R94. The cathode of this triode is, however, at a still higher positive potential by virtue of conduction of the second triode section of the tube and the voltage drop through the common cathode resistor R58. Thus for inputs below a specific threshold, the grid and the cathode potentials result in a net *negative* grid-cathode voltage and the input triode remains in a cutoff or nonconducting condition. However, the output triode (B) conducts under this condition and hence its plate voltage is low as a result of the voltage drop across its plate load resistor R92.

4.90 If the input to the first grid is of sufficient amplitude, a threshold is reached (at t_1 in Fig. 51B) in the positive half cycle where the grid-cathode voltage of triode A is lowered sufficiently to cause a small plate current to flow. The current causes a voltage drop in the plate load resistor R93. This negative voltage excursion is coupled to the grid of triode B through coupling resistor R98 and capacitor C43. The negative voltage drives the grid of triode B in the negative direction, reducing its plate current, causing its plate voltage to rise and the cathode voltage of both tubes to decrease, so that the grid-cathode voltage of triode A increases. This action results in an increase of plate current in triode A which in turn drives the grid of triode B more negative. Thus the action is cumulative once the input wave rises above cutoff voltage and the conduction conditions of the two triode sections rapidly interchange. At a point later in the cycle (at t_2 in Fig. 51B) the input wave will be of such a magnitude that the reverse process takes place. Conditions will then return to those encountered before any input was applied. These rapid transitions from no plate current to very high current produce an output wave form which is rectangular, as shown in Fig. 51C. This circuit may be thought of as a dc amplifier with positive feedback. For input voltages below the threshold value no output is obtained. Above the threshold, however, a constant amplitude of 3700-cycle square wave is obtained. The threshold region is about 0.3 db wide; i.e., the highest input producing no output needs to be increased only 0.3 db to produce full constant output.

4.91 *Cathode Follower:* The 3700-cycle square wave from the limiter-multivibrator circuit is fed through a capacitor to the cathode follower which is one triode section of a 407A whose other section is used for the input ac amplifier. This stage provides no voltage amplification, but as a result of its high input and low output impedances, it affords means for interconnection of the high-impedance multivibrator to the low-impedance rectifier.

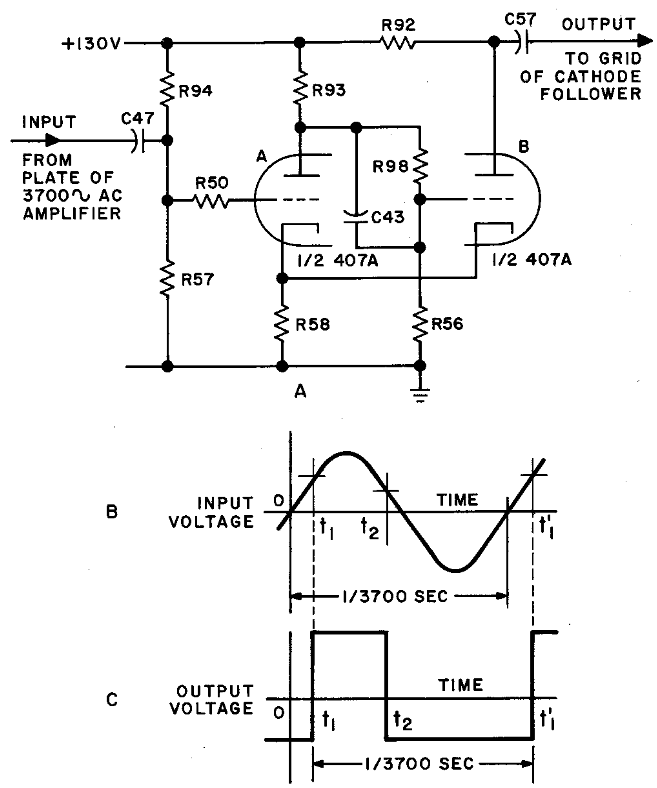


Fig. 51 — Simplified Schematic of Multivibrator—Limiter Circuit and Wave Forms on Input and Output

4.92 *Voltage Doubler Rectifier:* The 3700-cycle output of the cathode follower is coupled via a capacitor into the voltage doubler rectifier circuit. During the negative half cycle of the 3700-cycle voltage, the shunt diode conducts and charges the coupling capacitor from the cathode follower. During the positive half-cycle of the 3700-cycle square wave, the series diode conducts and charges the capacitor shunted across the rectifier output to a value dependent upon the sum of the peak amplitude of the positive half cycle voltage and the voltage left on the coupling capacitor as a result of the action during the negative part of the cycle. In an idle circuit this would result in a dc voltage being developed across the shunt capacitor which is twice the amplitude of the applied wave. In practice, the actual voltage developed is somewhat less than this. A dc bias voltage is also applied through the rectifier network to the grid of the dc amplifier stage.

4.93 *Delay Network:* The delay network is a resistor-capacitor filter connecting the rectifier output to the grid of the dc amplifier stage. In order to reach the grid of the dc amplifier, the dc voltage on the first capacitor in the delay network must charge the second capacitor through the series resistance of the network. The time constant of this network is such that the over-all response time of the circuit from input to output is 15 to 20 milliseconds. This means that it takes 15 to 20 milliseconds for an input signal to cause the pulse relay to operate, and that input voltages of shorter duration than this will not cause the relay to operate. Thus short noise bursts and line transients will not cause false operation of the circuit.

4.94 *DC Amplifier:* The voltage from the delay network is applied to the grid of the dc amplifier which is a triode-connected 408A pentode with a double-wound mercury contact polarized relay in the plate circuit. In the absence of 3700-cycle tone the amplifier tube is held in the nonconducting condition by a negative bias obtained from the —38.5 volt supply through a voltage divider and the relay is held in the non-operated position by action of current through its biasing winding so that the E lead is grounded. When 3700-cycle tone is applied, the rectifier voltage overcomes the bias on the grid of the tube and a high plate current is drawn. This current through the operating winding of the relay causes the relay to operate and remove ground from the E lead. A potentiometer REL CUR is provided to set the amplifier plate current to a predetermined value, and the potentiometer BRK adjusts current flow in the relay biasing winding to control the per cent break interval of the signal applied to the trunk circuit. A resistor with bare wire test points TP1 and TP2 on each side is provided in the plate circuit of the tube for measuring its current. When the relay operates, this bias is changed to about —8 volts by the front contacts shorting a resistor in the bias supply. This bias-changing arrangement is used to minimize first pulse distortion due to residual charge remaining on the delay network capacitors between pulses. By making the bias more negative after the relay has operated, the capacitor attempts to reach a more negative voltage and hence reach the value of cutoff for the tube in a shorter time. This tends to equalize the durations of the individual pulses in a train.

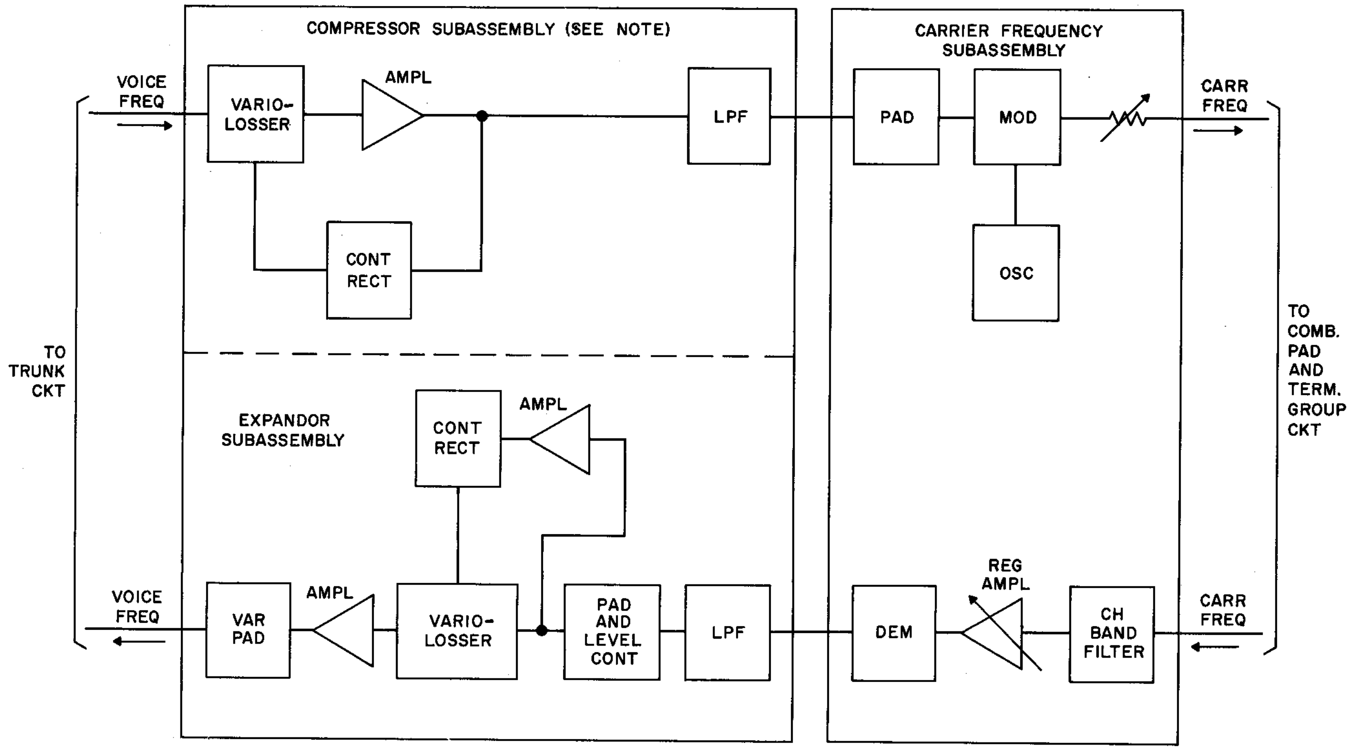
4.95 The ground supplied to the E lead comes through contacts of the carrier alarm relay, so that if a total carrier failure occurs, no permanent signals are registered.

E. Channel Unit Without Signaling (J98703AP)

4.96 The channel unit without signaling is identical to the J98703FA message channel unit except the built-in signaling feature has been omitted. This unit consists of three subassemblies: a compressor, expandor, and carrier subassembly. The compressor and carrier subassemblies are identical to the subassemblies used in the J98703FA unit. The ED-92972-30 expandor without signaling subassembly replaces the expandor and signaling subassembly.

4.97 The circuits which make up the three subassemblies are illustrated in block diagram form in Fig. 52. The compressor and expandor circuits have been combined in the diagram to simplify the circuit description. In the transmitting direction voice signals from the associated trunk circuit pass through a variolosser where compression occurs, a voice amplifier, and a low-pass filter to the modulator where they modulate the carrier frequency. The resulting signals are transmitted to a combining pad, where they are combined with the outputs of the other 11 channel units, and then applied to the input of the low- or high-group transmitting circuit. In the receiving direction the channel band filter selects the proper incoming signal and applies it through a regulator-amplifier to the demodulator. The resultant signal is then applied through the low-pass filter to the pad and input level control through the variolosser, where volume expansion occurs, to the output amplifier. Connections to the trunk circuits are made through the compressor subassembly where a pad is provided for adjusting output level.

4.98 A detailed circuit analysis of the channel unit without signaling may be found in 4.49 through 4.67 and 4.73 through 4.84.



NOTE:
THE COMPRESSOR AND EXPANDOR SUBASSEMBLIES ARE COMBINED INTO ONE SUBASSEMBLY, (COMPANDOR) FOR THE AMPLAS CHANNEL UNIT.

Fig. 52 — Without Signaling and Amplas Channel Unit, Block Diagram

F. Amplas Channel Unit (J98703BP)

4.99 The amplas channel unit employs the same basic circuit as the J98703AP channel unit without signaling. A block diagram description of the amplas unit may be found in 4.96 and 4.97. A detailed circuit analysis may be found in 4.49 through 4.67 and 4.73 through 4.84.

G. Thru Channel Unit (J98703AH)

General

4.100 The thru channel unit consists of a thru voice-frequency subassembly and a carrier-frequency subassembly. The carrier-frequency subassembly is identical to the carrier-frequency subassembly in the J98703FA message channel unit. A detailed circuit description of this subassembly may be found in 4.73 through 4.76.

4.101 The circuits which make up the thru channel unit are illustrated in block diagram form in Fig. 53. The thru voice-frequency subassembly consists of a transmitting circuit and a receiving circuit. The receiving circuit accepts the compressed output of the carrier-frequency subassembly demodulator, separates the message and 3700-cycle signaling frequency with low-pass and bandpass filters, adjusts their respective signal levels, and recombines and amplifies the adjusted signals for connection to a thru channel unit in another N, O, or ON carrier system. The transmitting circuit receives signals from a thru channel unit in another system, provides equalization as required, and applies the resulting signals to the modulator in the carrier-frequency subassembly.

Note: Switch positions "O" and "O-BB" of switch S1 and switch position "O" of switch S2, which are located on the front

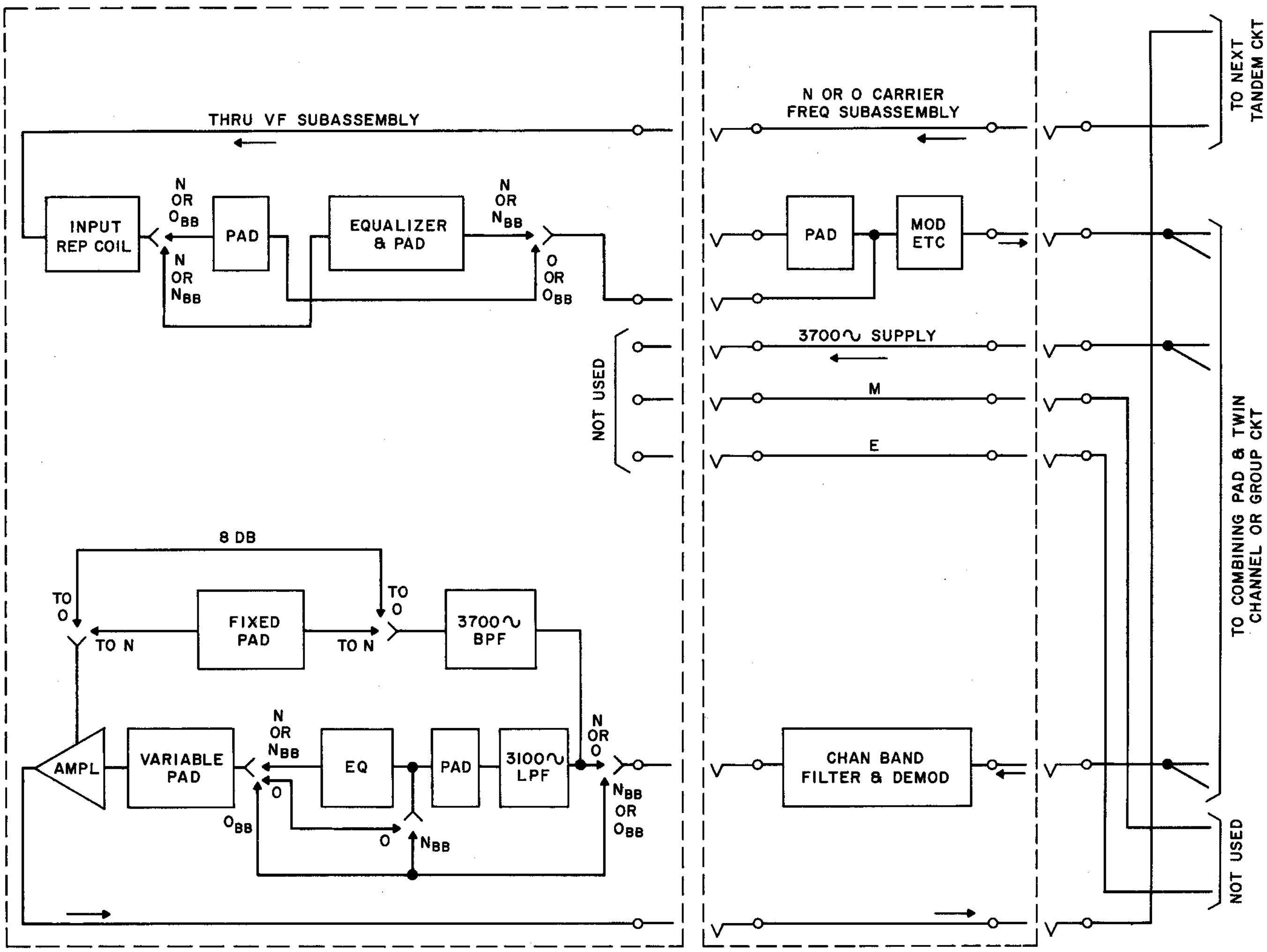


Fig. 53 — Thru Channel Unit, Block Diagram

panel of the thru channel unit, are not used in the N1 carrier telephone system.

Receiving Circuit — Message

4.102 Fig. 54 shows a schematic diagram of the thru channel unit receiving circuit. Capacitor C1 at the input of the receiving circuit filters the carrier leak from the N carrier demodulator. The low-pass filter FL2 and the 6-db isolating pad are connected into the circuit by switch S1 when the switch is set at the "N" position. The loss-frequency characteristic of the filter is shown in Fig. 55. This filter passes speech frequencies of up to 3100 cycles and rejects the 3700-cycle signaling tone as well as adjacent channel components. The 6-db pad which consists of resistors R19, R20, and R21 minimizes impedance interaction between the low-pass filter and the equalizer. Resistor R1 is placed in series with the input to the circuit when switch S1 is set at the "N-BB" position (N broadband). This insures a 15,000-ohm termination resistance for the demodulator in the carrier-frequency subassembly.

NOTE:
S1 CONDITIONS THE CIRCUIT FOR USE IN AN N OR O TERMINAL AND FOR STANDARD MESSAGES OR BROADBAND USE. S2 CONDITIONS THE CIRCUIT FOR CONNECTION TO AN N OR O SYSTEM.

(S1) SETTING	CONTACTS CONNECTED TOGETHER
"N-BB"	1-3, 7-8
"N"	1-3-4, 7-10
"O"	1-4, 7-10
"O-BB"	1-6, 7

(S2) SETTING	CONTACTS CONNECTED TOGETHER
OFF	7-8, 1
N	7-10, 1-4
O	7-12, 1-6

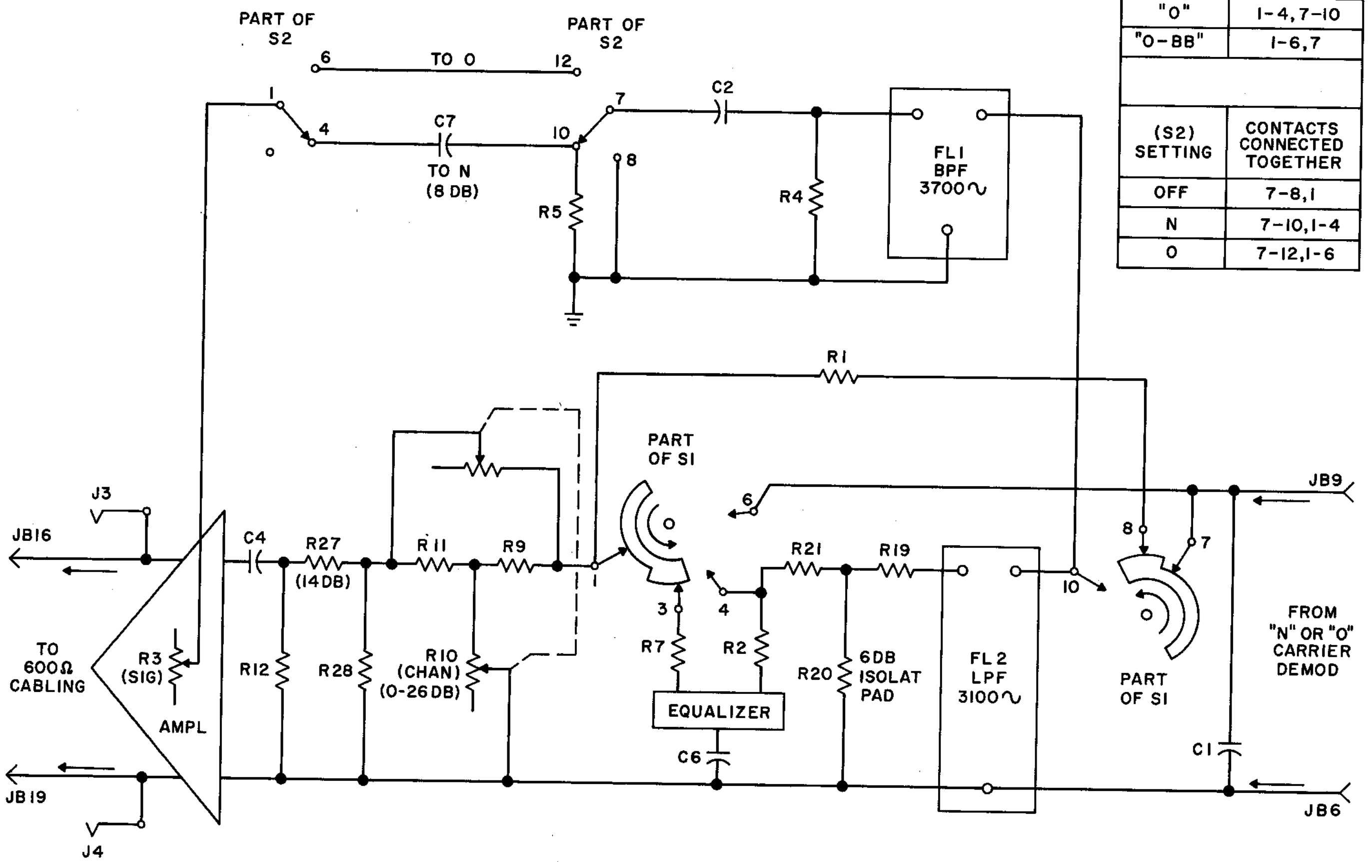


Fig. 54 — Thru Channel Unit — Receiving Circuit, Schematic Diagram

4.103 Placement of the equalizer in the circuit is controlled by switch S1. When switch S1 is set at the "N-BB" position, the equalizer is connected across the CHAN potentiometer through resistor R7. The equalizer provides additional equalization for the channel bandpass filter characteristic. When switch S1 is set at the "N" position, the equalizer is connected across the CHAN potentiometer through resistors R2 and R7. In this case the equalizer provides additional equalization for the channel bandpass filter characteristic and counteracts the bridging effect of filter FL1 on the input of low-pass filter FL2. A schematic diagram of the equalizer circuit is shown in Fig. 56. The filter consists of resistor R8, inductor L1, and capacitor C3. Capacitor C6 blocks the dc shunting effect of the equalizer.

4.104 Resistors R9, R11, and CHAN potentiometer R10 form a variable attenuator. The attenuator provides up to 26 db of attenuation to control signal level. A 14-db fixed pad consisting of resistors R12, R27, and R28 follows the CHAN potentiometer to provide additional attenuation. Capacitor C4 shapes the low-frequency characteristic of the amplifier input transformer.

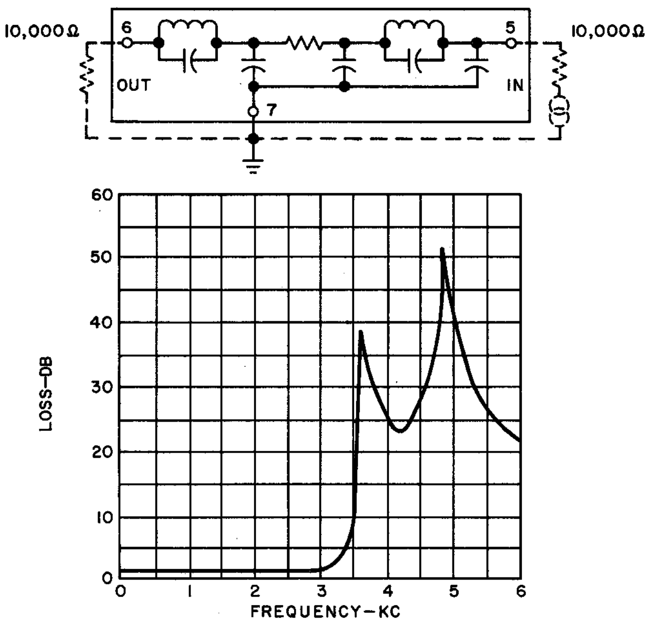


Fig. 55 — Receiving Low-Pass Filter (168G) (FL2)

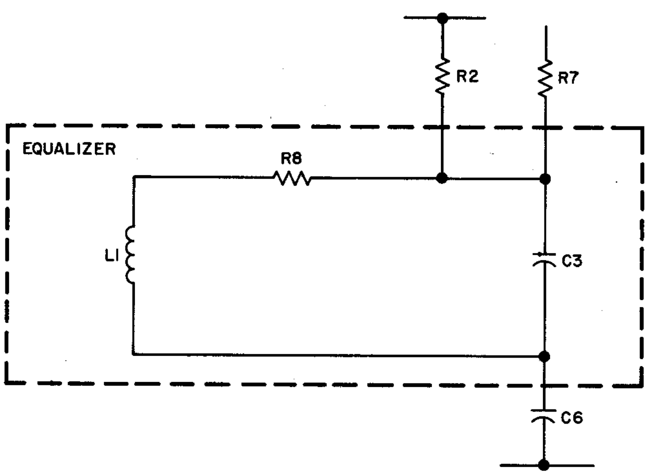


Fig. 56 — Thru Channel Unit — Receiving Circuit Equalizer, Schematic Diagram

Receiving Circuit — Signaling

4.105 When switch S1 is placed at the "N" position, the input of bandpass filter FL1 is connected to the circuit at the input of low-pass filter FL2. The bandpass filter is tuned to 3700 cycles and admits signaling power to the signaling adjustment path.

4.106 The output of the bandpass filter is terminated by resistor R4. Capacitor C2 isolates the filter impedance from the amplifier grid circuit. Switch S2, when set at the "N" position, connects the output of filter FL1 through an 8-db pad to the SIG potentiometer in the amplifier. The pad consists of capacitor C7 and resistor R5. The SIG potentiometer is provided to adjust the 3700-cycle signaling tone to its required level. When switch S2 is set to the OFF position, the signaling tone is applied to ground so that amplifier gain can be adjusted without interference.

Receiving Circuit — Amplifier

4.107 The amplifier (see Fig. 57) provides 30 db of gain for both the message and signaling information. Input transformer T1 matches the impedance of the 14-db pad to the combining circuit at the grid of tube V1. The combining circuit consists of resistors R13 and R3. Cathode resistors R14 and R16 form a voltage divider which provides grid bias through resistor R15 and the secondary of transformer T1. One output winding of transformer T2 provides 17 db of feedback through resistor R18 and capacitor C5. The other output winding provides impedance matching to office cabling. Pin jacks J3 (OUT) and J4, across the output windings of transformer T2, provide facilities for measuring the output level.

Receiving Circuit — Characteristics

4.108 The receiving circuit frequency versus gain characteristics for the different settings of switch S1 are shown in Fig. 58.

Transmitting Circuit — Message

4.109 Fig. 59 shows a schematic diagram of the thru channel unit transmitting circuit. Input transformer T3 matches the impedance of the 600-ohm cabling to the modulator in the carrier-frequency subassembly. When switch S1 is set at the "N" or "N-BB" position, signals are applied through switch S1 to a fixed pad and equalizer network. The pad and equalizer network consists of resistors R6, R24, R25, and R26, capacitor C9, and inductor L2. The equalizer network provides partial pre-equalization for the

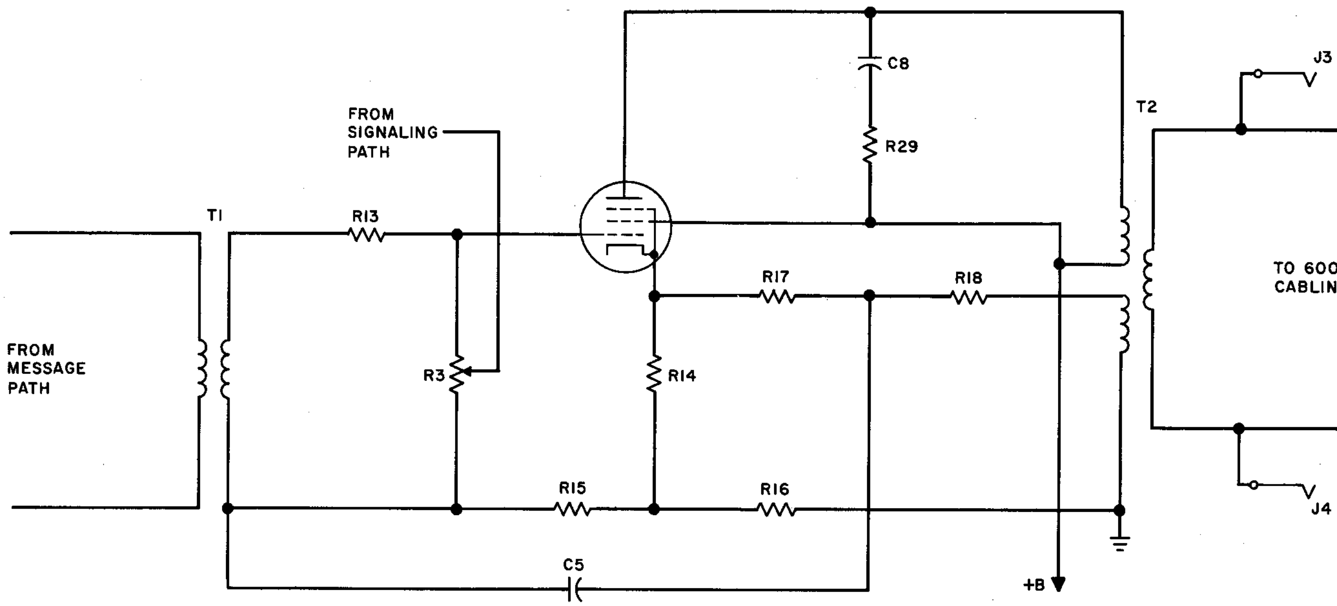


Fig. 57 — Thru Channel Unit — Amplifier, Schematic Diagram

receiving channel band filter. Pin jacks J1 (IN) and J2 across the output provide facilities for measuring signal level.

Transmitting Circuit — Characteristics

4.110 The transmitting circuit frequency versus gain characteristics are shown in Fig. 59.

H. Special Services Channel Unit (J98703AM)

General

4.111 The special services channel unit consists of the special services voice-frequency subassembly and a carrier-frequency subassembly. The carrier-frequency subassembly is identical to the circuit described in 4.73 through 4.76.

4.112 The special services channel unit is made up of a transmitting circuit and a receiving circuit. In the transmitting direction (see Fig. 60) input signals are amplified, adjusted by a variable attenuator, passed through a low-pass filter and applied through an equalizer and pad network to the modulator in the carrier-frequency subassembly. In the receiving direction (see Fig. 61) input signals are received from the demodulator in the carrier-frequency subassembly and passed through a low-pass filter to a pad and equalization network. The signals are applied, from the equalization network, to an adjustable attenuator, a fixed pad, and an amplifier. After amplification the signal is applied to the output of the channel unit.

Transmitting Circuit

4.113 The transmitting amplifier (see Fig. 62) is a single-stage feedback amplifier providing a gain of 31 db. Input transformer T3 matches the 600-ohm impedance of the modulator in the carrier-frequency subassembly to the amplifier input. Cathode resistors R20 and R21 form a voltage divider which provides grid bias through resistor R19 and the secondary of transformer T3. One output winding of transformer T4 provides 20 db of feedback through resistor R23 and capacitor C7. Output transformer T4 matches the 600-ohm impedance of the variable attenuator to the amplifier. Pin jacks J1 and J2 at the input of the amplifier provide facilities for measuring signal levels.

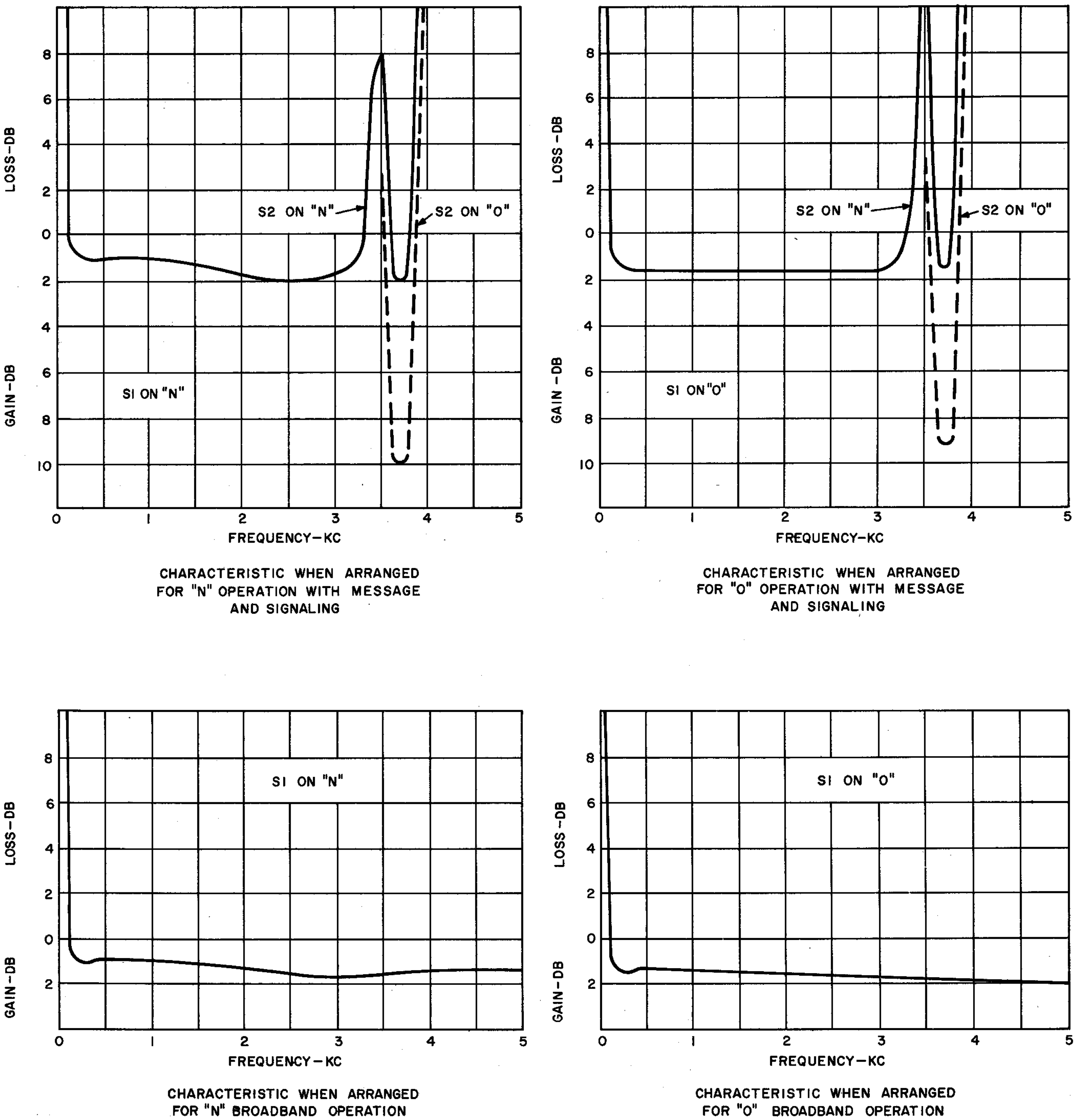
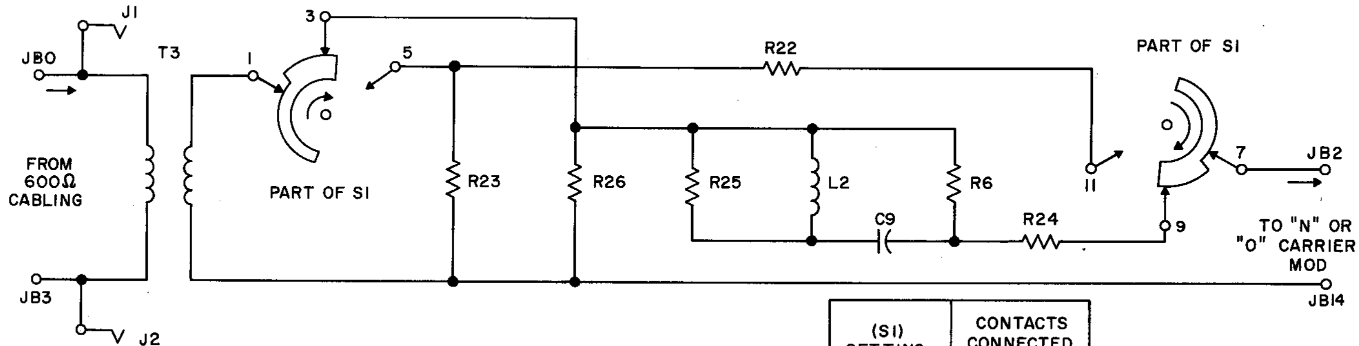
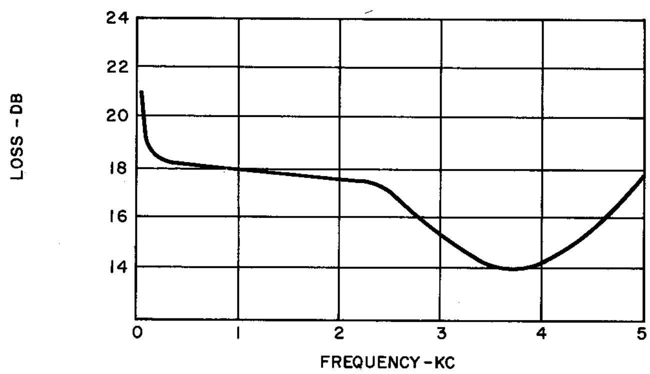


Fig. 58 — Thru Channel Unit, Receiving Circuit Characteristics

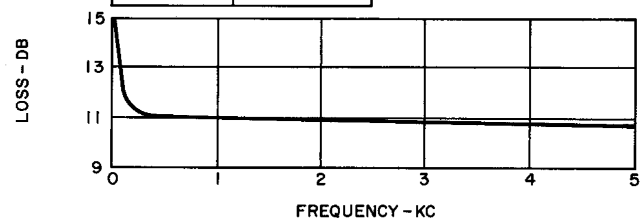
4.114 The output of the amplifier is applied to a 0- to 26-db variable attenuator consisting of resistors R24, R25, and R26 (see Fig. 60). The attenuator is used to adjust signal level. This level may be measured at the MOD IN jack J5. Transformer T5 matches the impedance of the 600-ohm attenuator to a 168L low-pass filter FL2. The insertion loss characteristics of



(S1) SETTING	CONTACTS CONNECTED TOGETHER
"N-BB"	1-3, 7-9
"N"	1-3, 7-9
"O"	1-5, 7-11
"O-BB"	1-5, 7-11



CHARACTERISTIC FOR MESSAGE OR BROAD-BAND WHEN USED IN AN "N" TERMINAL



CHARACTERISTIC FOR MESSAGE OR BROAD-BAND WHEN USED IN AN "O" TERMINAL

Fig. 59 — Thru Channel Unit — Transmitting Circuit, Schematic Diagram and Characteristics

this filter are shown in Fig. 63. Switch S1, when set at the "N" position, inserts a pad and equalizer into the transmitting circuit. The pad and equalizer consists of resistors R29, R30, R31, and R32, capacitor C8, and inductor L2. The equalizer provides partial pre-equalization for the receiving channel bandpass filter in the carrier-frequency subassembly.

Receiving Circuit

4.115 Capacitor C6 (see Fig. 61) across the input of the receiving circuit filters carrier leak from the demodulator in the carrier-frequency subassembly. The 168E low-pass filter passes frequencies of up to 3500 cycles and applies them to a 6-db 10,000-ohm pad which follows the filter. The 6-db pad, which consists of resistors R15 and R17, is used to isolate the filter from the final equalizer network. Switch S1 when set at the "N" position places the final equalizer network into the circuit. The equalizer network consists of resistors R13 and R14, capacitors C4 and C5, and inductor L1. This network in conjunction with the pre-equalization network in the transmitting circuit provides equalization for the receiving bandpass filter in the carrier-frequency subassembly. The output of the equalizer network is applied to a 0- to 26-db variable attenuator consisting of resistors R10, R11, and R12. The attenuator is used to adjust the output level of the channel unit. A 14-db 10,000-ohm pad follows the attenuator. The pad, which consists of resistors R7 and R8, sets the proper input level for the receiving amplifier. Capacitor C3 shapes the low-frequency characteristic of the amplifier input transformer.

4.116 The receiving amplifier (see Fig. 64) is a single-stage feedback amplifier providing a gain of 31 db. Circuit operation is essentially the same as the transmitting amplifier described in 4.113. The network consisting of capacitor C1 and resistor R1 in the plate circuit shapes the output characteristic.

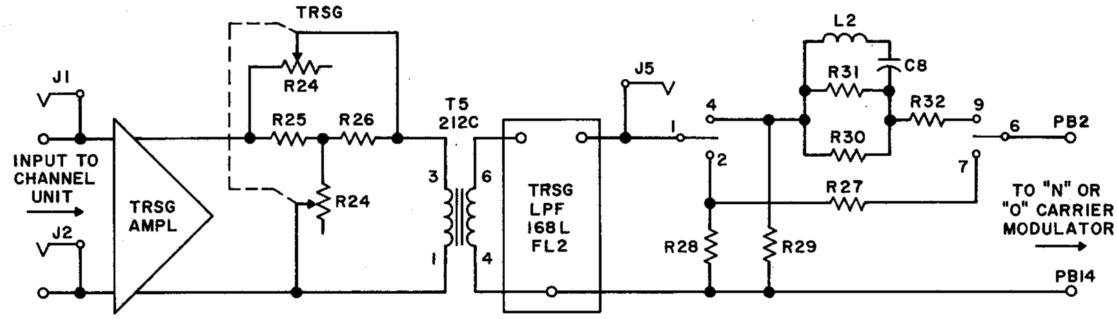


Fig. 60 — Special Services Channel Unit — Transmitting Circuit, Simplified Schematic Diagram

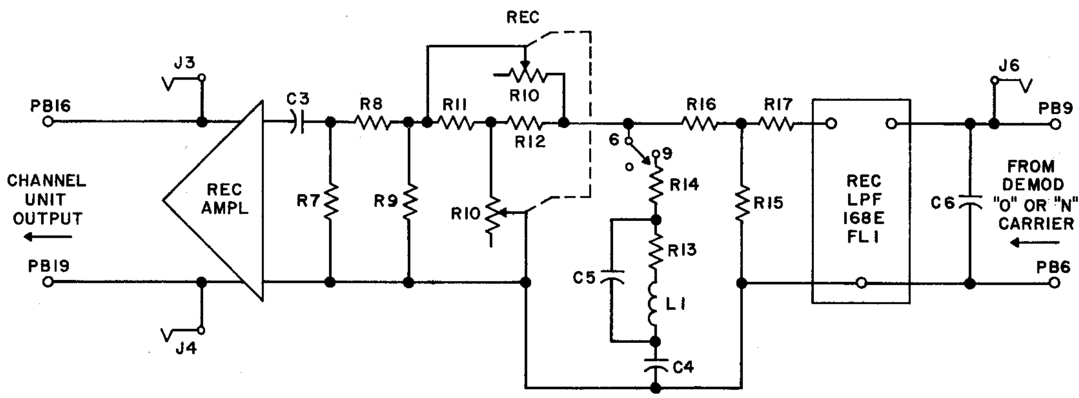


Fig. 61 — Special Services Channel Unit — Receiving Circuit, Simplified Schematic Diagram

Power Supply

4.117 The filtering arrangement of resistors R34 and R35 and capacitor C9 in the power supply circuit (not shown) reduces crosstalk between the transmitting and receiving circuits. Resistor R33 (also not shown) is a dummy load that operates in conjunction with the demodulator amplifier filament (in the carrier-frequency subassembly) to drop the —38.5 volt supply.

I. A and B Program Channel Unit (J98703W)

4.118 The A and B program channel unit (see Fig. 65) consists of a voice-frequency subassembly and a carrier-frequency subassembly. The carrier-frequency subassembly is similar to that circuit described in 4.73 through 4.76.

4.119 The voice-frequency subassembly simply consists of an input circuit to the transmitting portion of the carrier-frequency subassembly and an output circuit from the receiving

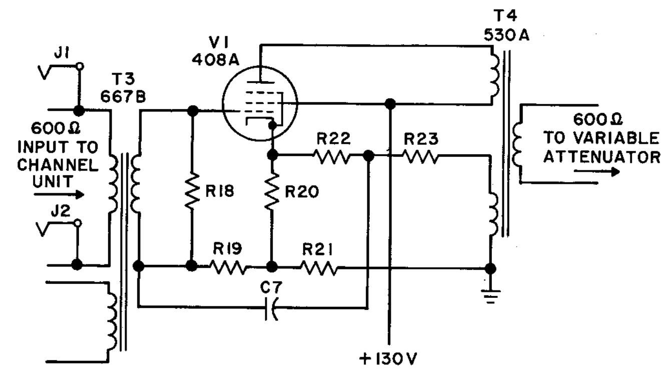


Fig. 62 — Special Services Channel Unit — Transmitting Amplifier, Schematic Diagram

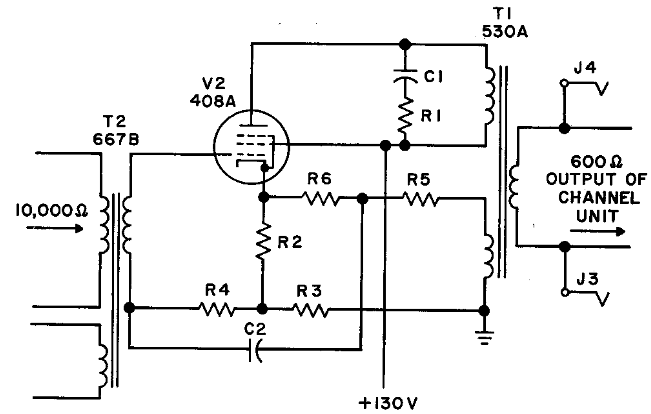


Fig. 64 — Special Services Channel Unit — Receiving Amplifier, Schematic Diagram

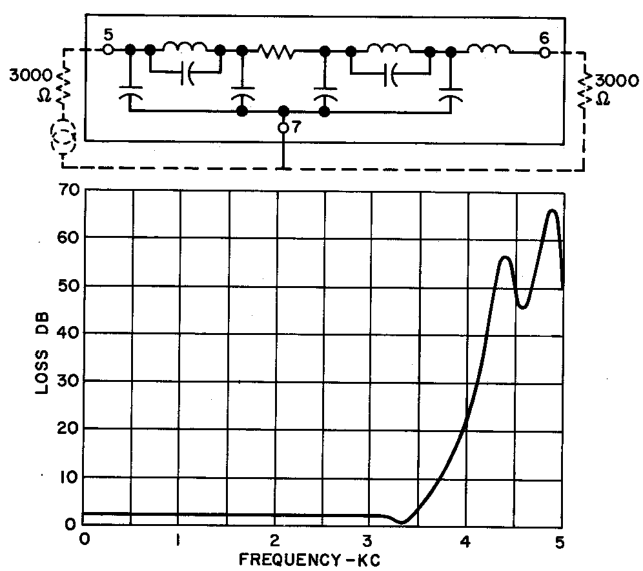


Fig. 63 — Transmitting Low-Pass Filter (168L)

portion of carrier-frequency subassembly. The input circuit consists of an impedance matching transformer and a resistor-capacitor network. The resistor provides the correct dc resistance for proper operation of the modulator. The capacitor provides an ac bypass. The input circuit also has test jacks which provide facilities for measuring signal level.

4.120 The output circuit consists of an impedance matching transformer, a resistor-capacitor network, test jacks, and an equalizing network. The equalizing network provides partial compensation for the loss introduced by the receiving bandpass filter at the high-frequency end of the program band. The purpose of the other components is identical to the input circuit.

J. A and B Program Reversing Channel Unit (J98703Y)

General

4.121 The reversing channel unit consists of a switching subassembly and a modified carrier-frequency subassembly. The switching subassembly contains two relays; the carrier-frequency subassembly contains an amplifier-rectifier circuit and a crystal oscillator.

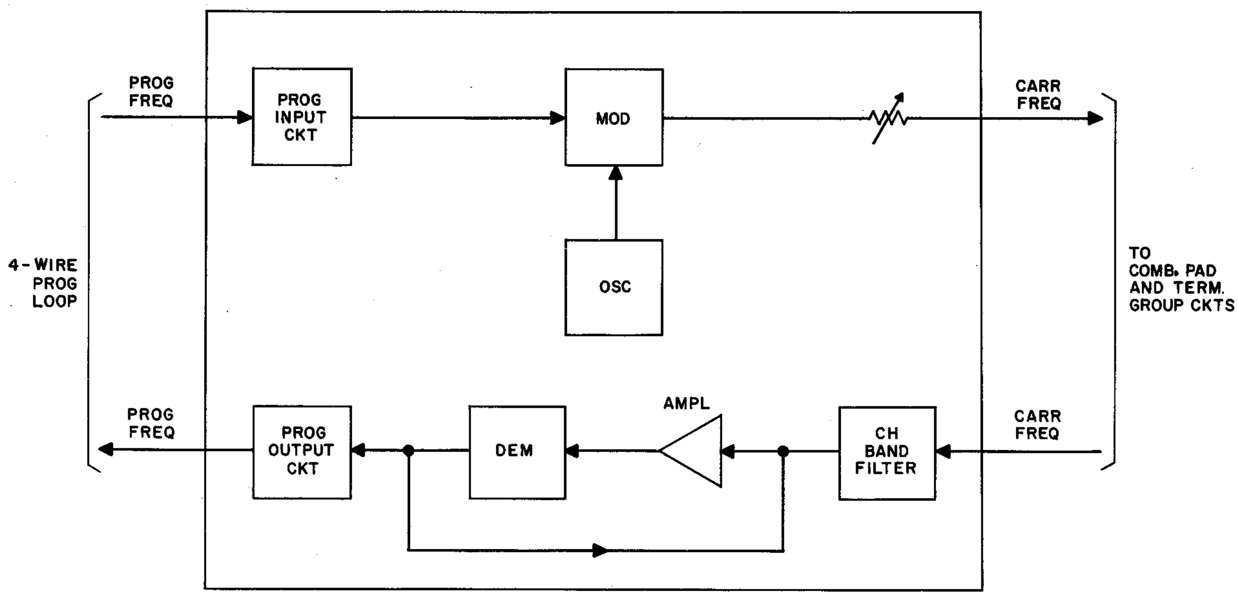


Fig. 65 — Schedule A and B Program Channel Unit, Block Diagram

Carrier-Frequency Subassembly

4.122 ***Reversing Frequency Oscillator:*** The oscillator (see Fig. 66) is a 200-kc crystal-controlled oscillator with a feedback path from screen grid to control grid. The screen grid is coupled to the control grid through a network consisting of capacitors C3, C4, and C5, crystal Y1, and resistors R8 and R5. This network provides the feedback voltage with proper amplitude and phase for oscillation at a frequency determined by the crystal. Resistor R7 provides cathode bias for the tube and resistor R6 prevents spurious oscillations at approximately 200 mc. The oscillator output is connected through resistors R1 and R2 to transformer T1.

4.123 Plate voltage is applied through a filtering network consisting of resistor R3 and capacitor C2. Screen voltage is applied through resistor R4 and capacitor C1. Resistor R5 reduces the voltage applied to the screen, thus limiting the amplitude of oscillation.

4.124 When the carrier-frequency subassembly connects to a channel unit multiple, the OSC potentiometer R9 enables adjusting the level of the transmitter reversing carrier frequency applied to the transmitting group unit. The M2 jack provides facilities to check the carrier-frequency output.

4.125 ***Amplifier-Rectifier Circuit:*** A simplified schematic diagram of this circuit is shown in Fig. 67. The channel band filter FL1 selects the 200-kc reversing frequency from the group receiving unit and applies it to the grid of the cathode follower (first half of tube V103). The cathode follower provides a high impedance to the filter and couples the output of the filter to receiving amplifiers V103 and V102. The input signal to the amplifier is obtained from the SENS potentiometer R14. The potentiometer controls the signal level applied to the amplifier stage. Test jack R1 provides facilities for measuring the output of the cathode follower. The output of the amplifier stage is transformer-coupled to varistor CR1 where the signal is rectified to a varying direct current. Capacitor C10 filters the varying direct current.

Switching Subassembly

4.126 The switching subassembly and its associated circuits are shown in block diagram form in Fig. 68. Operation of the

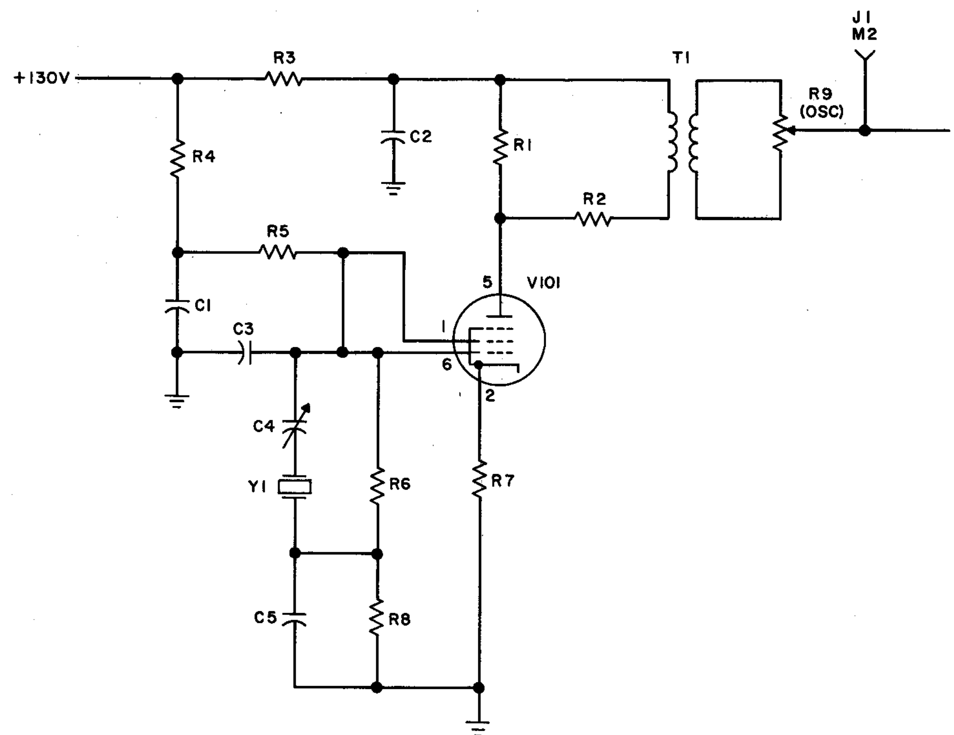


Fig. 66 — Schedule A and B Program Reversing Unit — Oscillator, Simplified Schematic

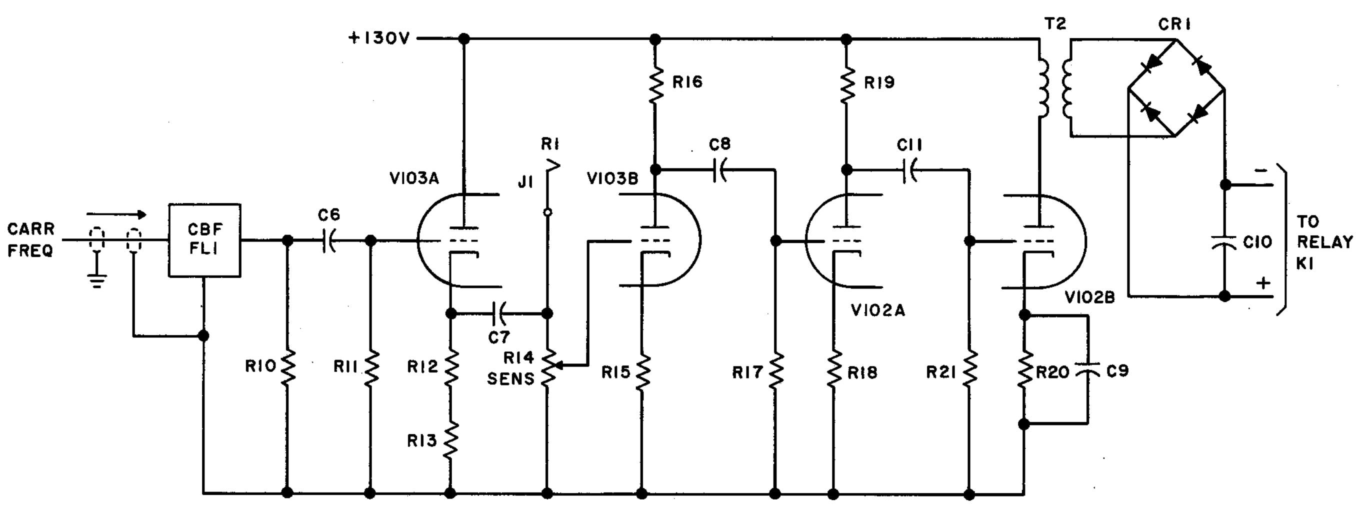


Fig. 67 — Schedule A and B Program Reversing Unit — Amplifier-Rectifier, Simplified Schematic

switching relays in the program reversing unit conditions a reversing circuit, which is located in a remote bay, to either transmit or receive A and B program material. In the transmitting direction signals are applied to the reversing circuit from the customer program loop. These signals initiate relay operation in the program reversing unit enabling the oscillator to apply a 200-kc signaling frequency to a similar program reversing unit at the receiving end of the line.

4.127 In the receiving direction a 200-kc signaling frequency is applied to the program reversing unit from a similar unit at the transmitting end of the line. The signal is amplified, rectified, and applied to relay K1. Operation of relay K1 conditions the reversing circuit to accept the transmitted program information.

4.128 ***Relay Operation:*** The sequence chart shown in Fig. 69 illustrates the sequence of operation which enables the reversing circuit

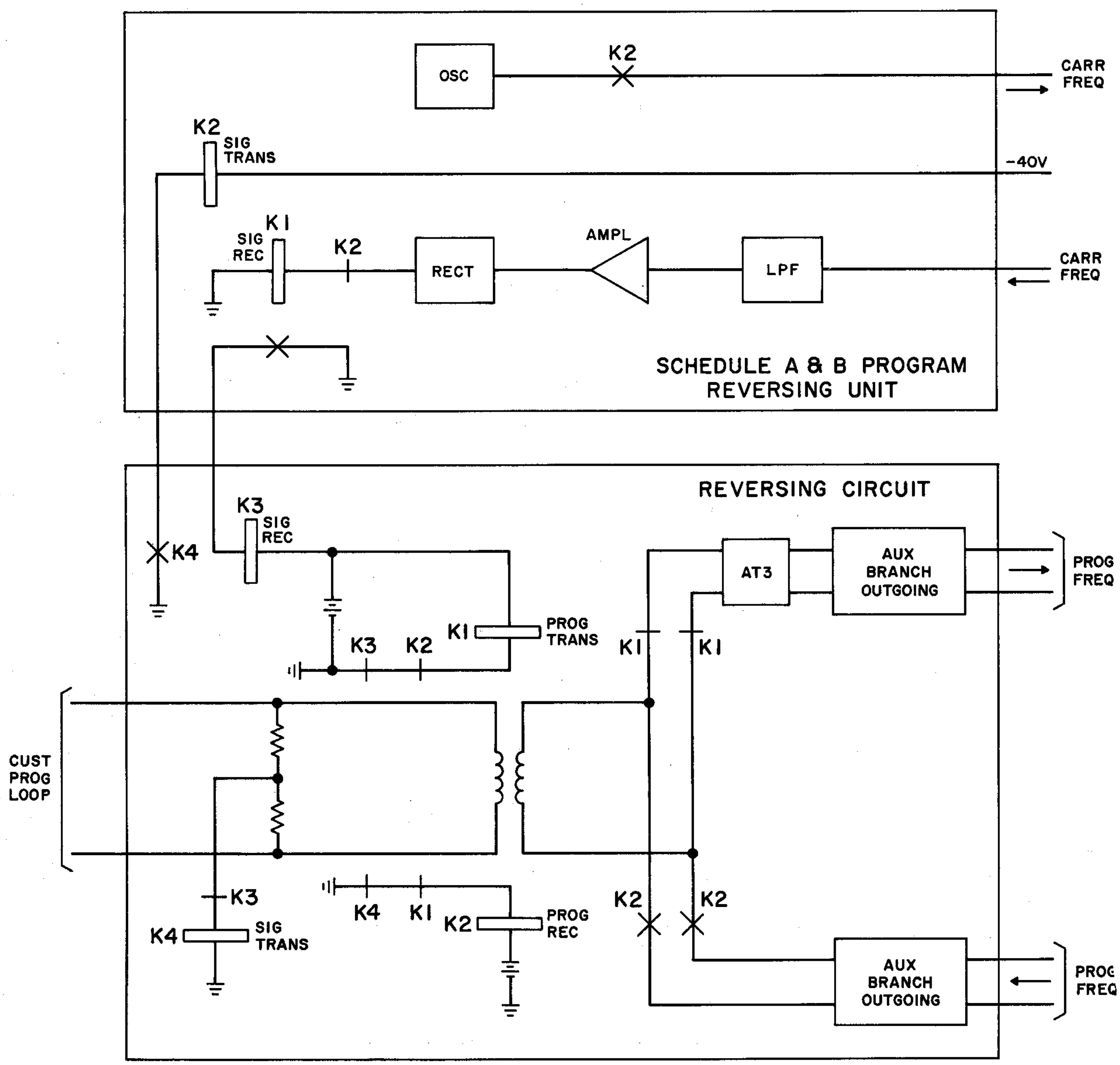
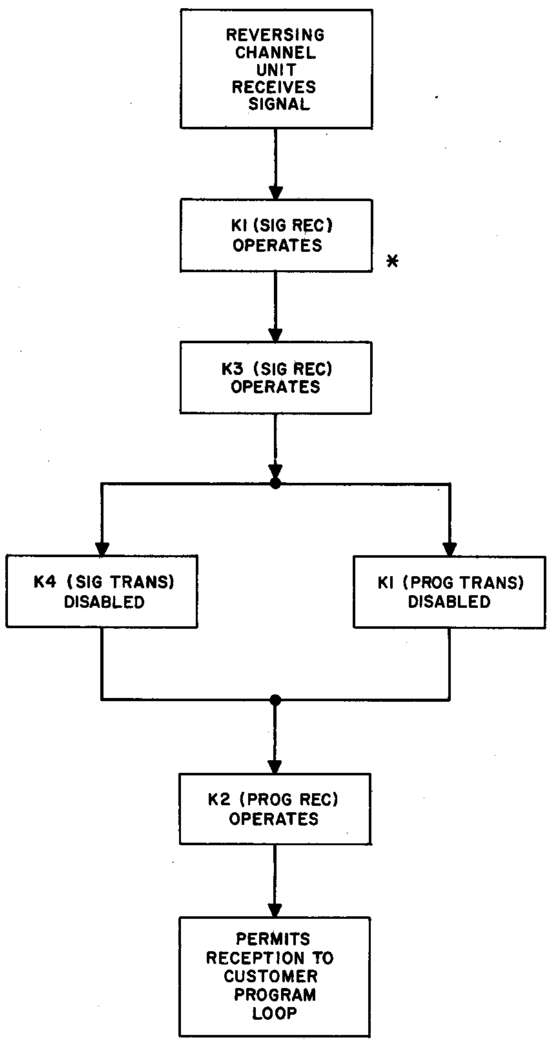


Fig. 68 — Schedule A and B Program Reversing Unit and Reversing Circuit, Block Diagram

to receive A and B program material. A 200-kc signaling frequency is applied to the program reversing unit and operates SIG REC relay K1. Operation of SIG REC relay K1 energizes SIG REC relay K3 in the reversing circuit. When SIG REC relay K3 operates, normally energized relays K1 (PROG TRSG) and K4 (SIG TRSG) are de-energized, enabling PROG REC relay K2 to operate. When PROG REC relay K2 operates, associated relay contacts in the receiving branch close, thus enabling the reversing circuit to receive A and B program material.



* IF K2 (SIG TRANS) IS NOT OPERATED.

Fig. 69 — Sequence Chart for A and B Program Reception

4.129 The sequence chart shown in Fig. 70 illustrates the sequence of operation which enables the reversing circuit to transmit A and B program material. A simplex voltage is applied to the reversing circuit between the customer program loop and ground. This voltage energizes SIG TRSG relay K4 in the reversing unit. Operation of relay K4 will energize SIG TRANS relay K2 in the program reversing

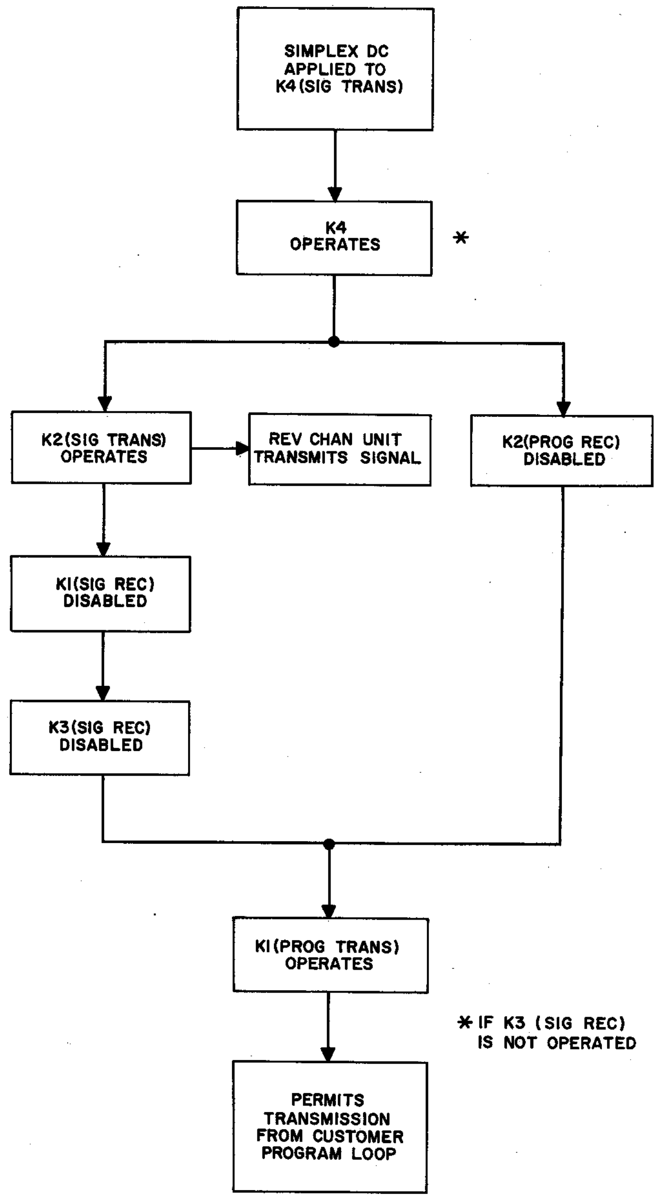


Fig. 70 — Sequence Chart for A and B Program Transmission

unit. Operation of relay K2 enables the oscillator to transmit a 200-kc signaling frequency to a similar program reversing unit at the receiving end of the line. When SIG TRANS relay K2 operates, a contact opens preventing accidental operation of SIG REC relay K1. An open contact of SIG REC relay K1 also disables SIG REC relay K3 in the reversing circuit. Operation of SIG TRSG relay K4 will also disable PROG REC relay K2 and energize PROG TRANS relay K1 in the reversing circuit. When PROG TRANS relay K1 is energized, associated relay contacts in the transmitting branch close, thus enabling the reversing circuit to transmit A and B program material.

K. C and D Program Channel Unit (J98703TA)

4.130 The C and D program channel unit consists of three subassemblies: a compressor, expandor, and carrier-frequency subassembly. This unit employs the same basic circuits as the J98703AP channel unit without signaling. A block diagram description of this unit may be found in 4.96 and 4.97. A detailed circuit analysis may be found in 4.49 through 4.67 and 4.73 through 4.84.

5. TESTING AND MAINTENANCE FEATURES

A. Terminal Mounting and Terminal Bays

5.01 Pin jacks +130, −40, and GRD which appear on the power distribution panel are used for measuring the terminal heater and plate voltages and for providing various test conditions when checking channel units. (Fig. 6 shows a 36-channel terminal bay and the terminal mounting.) The four-terminal TST PWR receptacle is an outlet for obtaining power for operating test equipment used with the terminal.

5.02 As described in Part 4 of this section, switching jacks are provided in the terminal mounting to permit replacing group units without interrupting service. The transmitting group unit is served by switching jacks J15 and J16 in multiple, the receiving group unit by jacks J13 and J14. Circuits to be connected to the group unit are wired to terminals of the switching jacks and the corresponding circuits of the group unit are wired to other terminals of the same jacks. Continuity between the two sets of terminals is established by inserting patch plugs having straps connected between the appropriate terminals. To replace a group unit, one or the other of the two switching plugs is removed and a test set is connected to the empty jack via a patch cord. Another patch cord connects the test set to the alternate or replacement group unit. Then the other switching plug is removed and the switching is now under control of the test set. A key in the test set provides means for switching the circuits back and fourth between the regular and replacement units. For normal operation, plugs are inserted in both jacks of the multiple pair to provide greater safety against dirty contacts and against service interruption due to accidental removal of plugs.

B. Channel Units — Test Points and Controls

5.03 Test points and potentiometer controls are furnished in each channel unit for line-up and trouble localizing purposes. Certain tests may be made without removing the channel unit from its position on the terminal mounting or terminal bay. Pin jacks mounted on the front panels permit bridging the circuits with an electronic voltmeter or 20,000 ohms-per-volt dc voltmeter or standard signaling test equipment for observing transmission and supervisory signals. Many of the pad or potentiometer screwdriver controls used for adjusting the circuits are found on the front panels of the units.

5.04 Certain test points and controls are available only by removing the units from their mountings and taking off the covers. Multiconductor test cords used in conjunction with the J98705M Test Stand provide a means for reconnecting the channel units to the jack in the terminal mounting or terminal bay with the controls and test points accessible. Some of the adjustments provided by the controls are as follows: compressor gain, modulator output, regulator input, expandor input, signaling amplifier gain, signaling relay operate, and biasing current. In some cases these are screwdriver controlled, and in other cases, the controls are small knurled knobs. The test points provided for bridging with test equipment are pin jacks, bare pigtails, or apparatus terminals. Table B lists the name, location, and function of each test point and control.

TABLE B

CHANNEL UNIT	CONTROL OR TEST POINT	LOCATION	FUNCTION
J98703FA Message Channel Unit	C1 and C2 (test points)	Compressor Subassembly (front panel)	Enable measuring input of compressor subassembly
	E and M (test points)	Compressor Subassembly (front panel)	Enable a check of the dc signaling leads
	E1 and E2 (test points)	Compressor Subassembly (front panel)	Enable measuring output of expandor subassembly
	COMP (control)	Compressor Subassembly (internal)	Adjusts gain of compressor circuit
	REC (control)	Compressor Subassembly (front panel)	Adjusts output of expandor circuit
	S1 (test point)	Expandor Subassembly (front panel)	Checks output voltage of filter FL41. Reading will be approximately 1/4 of filter output.
	EXP (control)	Expandor Subassembly (internal)	Adjusts input level of expandor circuit
	REL CUR (control)	Expandor Subassembly (internal)	Adjusts relay K41 current
	SIG (control)	Expandor Subassembly (internal)	Controls gain of signal tone amplifier
	BRK (control)	Expandor Subassembly (internal)	Adjusts bias of relay K41
	TP1 and TP2 (test points)	Expandor Subassembly (internal—on the end of resistor R44)	Enable checking secondary winding current of relay K41
	TP3 (test point)	Expandor Subassembly (internal—on terminal 3 of filter FL41)	Enables shunting down filter FL41 output voltage as required in certain line-up tests
	TP4 and TP5 (test points)	Expandor Subassembly (internal—on the ends of resistor R47)	Enable measuring the 3700-cps output from the keyer or for shorting this output to ground
	TP7	Carrier Subassembly (internal)	(Same as M1)
	R1 (test point)	Carrier Subassembly (front panel)	Enables checking received carrier power at input to regulator
	M1 (MFR DISC) (test point)	Carrier Subassembly (front panel)	When connected to ground, reduces amount of transmitted carrier so that sideband output can be measured without interference

Table B (Cont)

CHANNEL UNIT	CONTROL OR TEST POINT	LOCATION	FUNCTION
J98703FA Message Channel Unit (Cont)	F (test point)	Carrier Subassembly (front panel)	Enables measuring compressor output
	M2 (test point)	Carrier Subassembly (front panel)	Enables checking total carrier and sideband output
	MOD (control)	Carrier Subassembly (internal)	Adjusts carrier signal level to transmitting group unit
	OSC (MFR DISC) (control)	Carrier Subassembly (internal)	Adjusts signal level of carrier supplied to modulator
	R2 (MFR DISC) (test point)	Carrier Subassembly (internal)	Enables checking plate current of tube V102
	REG (control)	Carrier Subassembly (internal)	Adjusts amount of signal applied to regulator in carrier signal subassembly
	B (test point)	Carrier Subassembly (internal)	Enables checking filament activity
J98703BP Amplas Channel Unit	C1 and C2 (test points)	Front Panel	Enable measuring input to compandor subassembly
	E1 and E2 (test points)	Front Panel	Enable measuring output of compandor subassembly
	REC (control)	Front Panel	Adjusts output of compandor subassembly
	F (test point)	Front Panel	Enables measuring input to carrier signal subassembly
	M2 (test point)	Front Panel	Enables checking total carrier and sideband output
	R1 (test point)	Front Panel	Enables checking input to regulator in carrier signal subassembly
	B (test point)	Front Panel	Enables checking filament activity
	COMP (control)	Compandor (internal)	Adjusts gain of VF amplifier
	EXP (control)	Compandor (internal)	Adjusts input level to expandor portion of compandor
	MOD (control)	Carrier (internal)	Adjusts level of carrier frequency applied to transmitting group unit

Table B (Cont)

CHANNEL UNIT	CONTROL OR TEST POINT	LOCATION	FUNCTION
J98703BP Amplas Channel Unit (Cont)	REG (control)	Carrier (internal)	Adjusts amount of signal applied to regulator in carrier-frequency subassembly
	TP7	Carrier (internal)	When connected to ground reduces amount of transmitted carrier so that sideband output can be measured without interference
J98703AH Thru Channel Unit	CHAN (control)	Voice-Frequency Subassembly (front panel)	Adjusts amount of signal applied to amplifier
	SIG (control)	Voice-Frequency Subassembly (front panel)	Adjusts the 3700-cycle signaling tone to the required level
	J1 and J2 (test points)	Voice-Frequency Subassembly (front panel)	Enable checking input to thru channel unit
	J3 and J4 (test points)	Voice-Frequency Subassembly (front panel)	Enable measuring output of thru channel unit
	S2 (control)	Voice-Frequency Subassembly (front panel)	Connects 3700-cps signal tone receiving amplifier
	S1 (control)	Voice-Frequency Subassembly (internal)	Conditions circuit for use in an N or O terminal and for standard messages or broadband use
Note: See J98703FA message channel unit in this table for the controls and test points of the carrier-frequency subassembly.			
J98703AP Channel Unit Without Signaling	EXP (control)	Expandor Subassembly (internal)	Adjusts input level to the expandor
Note: See J98703FA message channel unit in this table for the controls and test points of the carrier-frequency and compressor subassemblies.			
J98703AM Special Services Channel Unit	J1 and J2 (test points)	Voice-Frequency Subassembly (front panel)	Enable checking input to the transmitting amplifier
	J3 and J4 (test points)	Voice-Frequency Subassembly (front panel)	Enable checking output of special services channel unit

Table B (Cont)

CHANNEL UNIT	CONTROL OR TEST POINT	LOCATION	FUNCTION
J98703AM Special Services Channel Unit (Cont)	J5 (test point)	Voice-Frequency Subassembly (front panel)	Enables checking input level to the modulator
	J6 (test point)	Voice-Frequency Subassembly (front panel)	Enables checking output of the demodulator
	TRSG (control)	Voice-Frequency Subassembly (front panel)	Adjusts signal level applied to modulator
	REC (control)	Voice-Frequency Subassembly (front panel)	Adjusts output level of the channel unit
	S1 (control)	Voice-Frequency Subassembly (front panel)	Connects equalizer into circuit in "N" position. "O" position not used.
Note: See J98703FA message channel unit in this table for the controls and test points of the carrier-frequency subassembly.			
J98703W A and B Program Channel Unit	S1 (control)	Voice-Frequency Subassembly (front panel)	Incorporates proper impedance when used with low-impedance combining multiple ("F" position) or high-impedance combining multiple ("FA" position).
	T1 and T2 (test points)	Voice-Frequency Subassembly (front panel)	Enable checking input of the program input circuit
	R3 and R4 (test points)	Voice-Frequency Subassembly (front panel)	Enable checking output of the program output circuit
	R1 (test point)	Carrier-Frequency Subassembly (front panel)	Enables checking input to regulator in carrier-frequency subassembly
	M1 (test point)	Carrier-Frequency Subassembly (front panel)	When connected to ground, reduces amount of transmitted carrier so that sideband output can be measured without interference
	M2 (test point)	Carrier-Frequency Subassembly (front panel)	Enables checking total carrier and sidebands output
	R2 (test point)	Carrier-Frequency Subassembly (internal)	Provides means to measure the plate current of tube V102

Table B (Cont)

CHANNEL UNIT	CONTROL OR TEST POINT	LOCATION	FUNCTION
J98703W A and B Program Channel Unit (Cont)	MOD (control)	Carrier-Frequency Subassembly (internal)	Adjusts level of the carrier-frequency applied to the transmitting group unit
	REG (control)	Carrier-Frequency Subassembly (internal)	Adjusts amount of signal applied to regulator in carrier-frequency subassembly
J98703Y A and B Program Reversing Channel Unit	R1 (test point)	Carrier-Frequency Subassembly (front panel)	Enables checking cathode follower output voltage from first half of tube V103
	M2 (test point)	Carrier-Frequency Subassembly (front panel)	Enables checking total carrier and sideband output
	OSC (control)	Carrier-Frequency Subassembly (internal)	Adjusts level of transmitted reversing carrier to the transmitting group unit
	SENS (control)	Carrier-Frequency Subassembly (internal)	Adjusts input level to grid of second half of tube V103
	RC (test point)	Switching Subassembly (front panel)	Enables measuring current applied to relay K1 SIG REC
J98703TA C and D Program Channel Unit	C1 and C2 (test points)	Compressor Subassembly (front panel)	Enable measuring input to compressor subassembly
	E1 and E2 (test points)	Compressor Subassembly (front panel)	Enable measuring output of expandor subassembly
	M (test point)	Compressor Subassembly (front panel)	Enables measuring output of compressor subassembly
	COMP (control)	Compressor Subassembly (internal)	Adjusts gain of VF amplifier
	EXP (control)	Expandor Subassembly (internal)	Adjusts input level to expandor subassembly
	S1 (control)	Expandor Subassembly (internal)	Connects correct pad into circuit to make the subassembly operable with a J98703T channel unit (MFR DISC)

Note: See J98703FA message channel unit in this table for the controls and test points of the carrier-frequency subassembly.

C. Tube Testing

5.05 In those cases where a tube has a resistor in its cathode circuit, its space current may be checked by using a 20,000 ohms-per-volt dc voltmeter to measure the cathode voltage with power turned on. To check the activity of a tube, it must be removed from the circuit and tested in a vacuum tube test set.

D. Troubleshooting

5.06 It is expected that troubleshooting will be done at a servicing center where a J98705U Test Set is used to connect power and input and output leads to each of the channel unit subassemblies. This provides accessibility of circuit elements and also prevents interference with the operation of other channel units while clearing trouble.

6. TRANSMISSION PERFORMANCE

A. Over-All Frequency Characteristic

6.01 Over-all voice-frequency transmission characteristics for a typical N1 channel are shown in Fig. 71 for three different input levels. The differences between these curves are due to the changes in reflection loss in the compressor and expandor variolossers caused by changes in impedance with level. In all cases, the transmission is flat to within ±1 db between 300 cycles and 2900 cycles. The channel net loss is 10 db greater than the 1000-cycle loss in the vicinity of 150 cycles and 3200 cycles. Tube aging has a significant effect on channel frequency response.

B. Limiting

6.02 Fig. 72A and 72B show the over-load characteristics of the over-all compandor, the compressor, and the expandor. Fig. 72A indicates, for the complete compandor, the change in over-all circuit loss between zero level input and zero level output plotted against input dbm at zero level. Fig. 72B shows the contributions to the change in over-all loss due to the compressor and expandor, plotted against actual output dbm at zero level. It will be noted that the sharp limiting above +9 db at zero level output is due primarily to the compressor. As discussed in 4.57, it is necessary to provide limiting in the compressor circuit to prevent the voice-frequency drive from modulating the carrier beyond 100 per cent because with greater than 100 per cent modulation, the demodulator output may contain frequencies capable of interfering with the 3700-cycle signaling circuit.

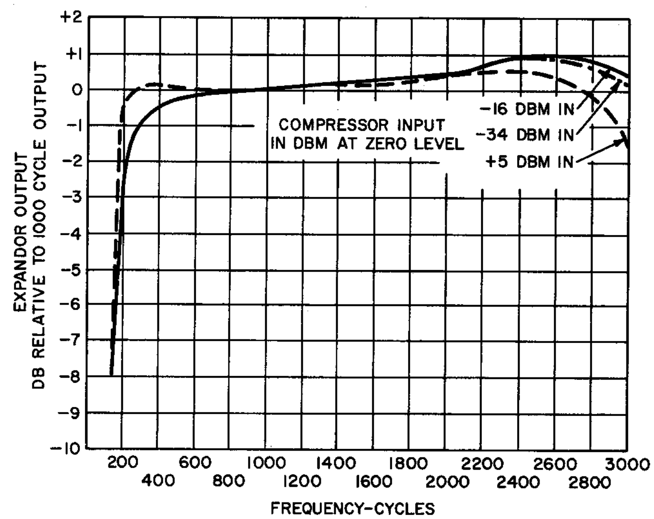


Fig. 71 — Typical Over-All Channel Voice-Frequency Transmission Characteristic

C. Stability

Oscillator Stability

6.03 The variation of transmitted carrier frequency in any channel is expected to be less than 70 parts per million. Additional shift occurs in the repeater but since the sidebands are demodulated against the transmitted carrier, there is no frequency-shift distortion such as might occur in a single-sideband system having unsynchronized carrier oscillators at both ends of the circuit. Changes in carrier amplitude at the oscillator output due to nominal limits of oscillator tube transconductance and crystal activity are not expected to exceed 3 db. This variation is accommodated by the modulator saturation characteristic.

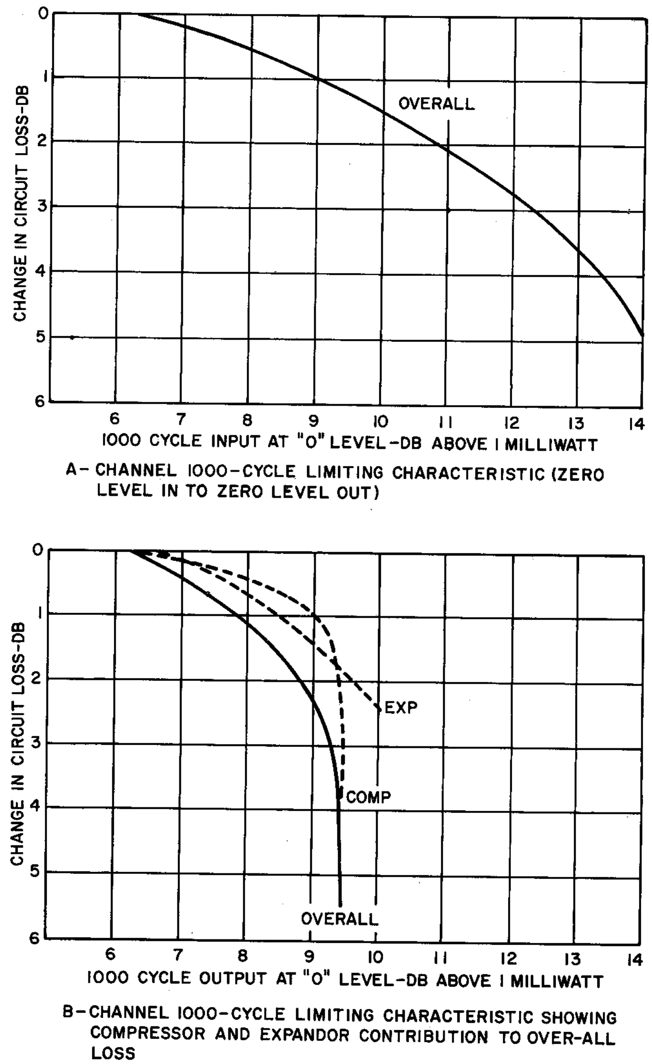


Fig. 72 — Channel Limiting Characteristics

Compandor Temperature Stability

6.04 Fig. 73 shows typical input versus output load characteristics for two different temperatures (100F and 130F) for the N1 compressor and expandor, and for a complete compandor. It will be noted that while temperature has appreciable effect in both the compressor and expandor variolossers (because of the temperature coefficients of the diodes), changes in the expandor largely compensate for changes in the compressor so that the over-all performance is held fairly uniform over a considerable range of temperatures, provided the temperature changes at both ends of the circuit are similar. This latter condition is usually satisfied because of the relatively short links encountered in the N1 carrier system.

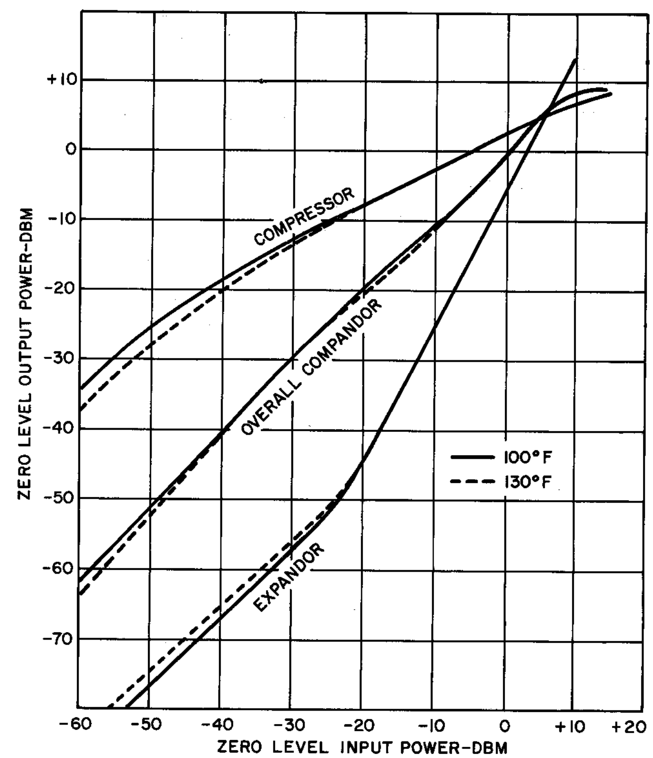


Fig. 73 — Effect of Temperature on Input-Output Load Characteristics of Typical Compandor

7. DRAWINGS

7.01 The following drawings (not attached) provide additional information.

SD Drawings (not attached)

SD-95118-01—Message Channel Unit Circuit
SD-95118-02—Channel Unit Ckt for Schedule C and D
SD-95119-01—High-Group Transmitting Circuit

SD-95120-01—Low-Group Receiving Circuit
SD-95121-01—Terminal Application Schematic
SD-95129-01—Low-Group Transmitting Circuit
SD-95130-01—High-Group Receiving Circuit
SD-95169-01—Reversing Channel Unit Ckt for Schedule A and B
SD-95170-01—Channel Ckt for Schedule A and B
SD-95182-01—Application Schematic Reversing Ckt for Schedule A and B
SD-95191-01—Thru Channel Circuit
SD-95246-01—Special Services Channel Circuit
SD-95252-01—Channel Circuit Without Signaling
SD-95252-02—Amplas Channel Circuit
SD-97031-01—Application Schematic for Shop-Wired Terminal Bays

J Drawings (not attached)

J98703A—N1 Carrier Terminal Mounting
J98703G—High-Group Transmitting Unit
J98703H—Low-Group Transmitting Unit
J98703J—High-Group Receiving Unit
J98703K—Low-Group Receiving Unit
J98703W—Schedule A and B Program Channel Unit
J98703Y—Reversing Unit for Schedule A and B
J98703AH—Thru Channel
J98703AM—Special Services Channel Unit
J98703AP—Without Signaling Channel Unit
J98703AT—N1 Carrier 36-Channel Terminal Bay
J98703BP—Amplas Channel Unit
J98703FA—Message Channel Unit
J98703TA—Schedule C and D Program Channel Unit