PRIVATE LINE TELEPHONE SERVICE
SPECIAL MULTISTATION SYSTEMS
DESCRIPTION

CONTENTS

1. INTRODUCTION

1.01 This section describes two types of special purpose private line multistation circuits which were designed to meet the particular communication requirements of the military. Although the specific use of these private line circuits will not be described, the over-all operating features will be covered. In addition to the military, it is expected that these arrangements, or portions thereof, may have application elsewhere.

1.02 The two types of multistation circuits which will be described in this section are:

(1) One-way speech multistation circuits.

(2) Two-way speech multistation circuits.

In general, these circuits were designed for communication between a center and outlying points or stations. The over-all transmission aspects of these private line circuits will be covered in this section with primary consideration being given to the centralized amplifier installation used on these circuits. Although some transmission data relative to station apparatus will be included in order to provide a more complete picture of the over-all transmission system, station apparatus details will not be included.

2. ONE-WAY SPEECH MULTISTATION CIRCUITS

(A) General

2.01 This circuit provides one-way speech from the center to its outlying stations. Since all outlying stations monitor the circuit continuously, no signaling is required. The general circuit arrangements are shown on Fig. 1. The over-all 1000-cycle circuit loss for this arrangement is about 10 db and the over-all effective transmission loss is about -5 db assuming only one telephone set at each location.

(B) Station Equipment

2.02 Center: At the center, four positions have access to the line. Each position consists of an N1 transmitter, an HC4 receiver and a transformer (178F induction coil). Fig. 2 shows the simplified transmission schematic of this circuit at the center. Normally, only one position will be used for talking on the line at any one time. The other positions can monitor on the line and each monitoring position will add approximately 1.5 db loss. The telephone transmitter circuit of each monitoring position is opened by means of a switch in the cord to the head set. The line may also be connected to a radio transmitter at the center which serves to back up the wire network. Special station key equipment is provided so that the operator may have access to WIRE LINE ONLY. WIRE LINE and RADIO or RADIO ONLY. When the radio transmitter is not connected, it is replaced by a 600-ohm resistor. The bridging loss of the radio transmitter or its idle termination on the line is approximately 3.5 db. Thus, when the operation is WIRE LINE ONLY,

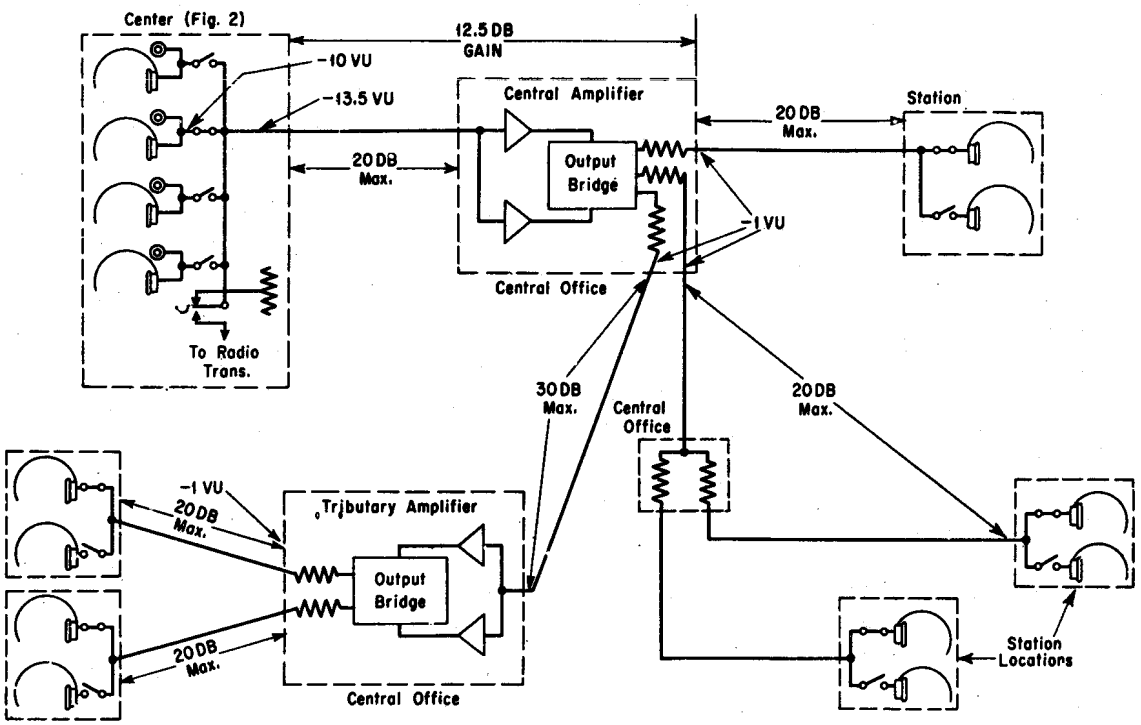
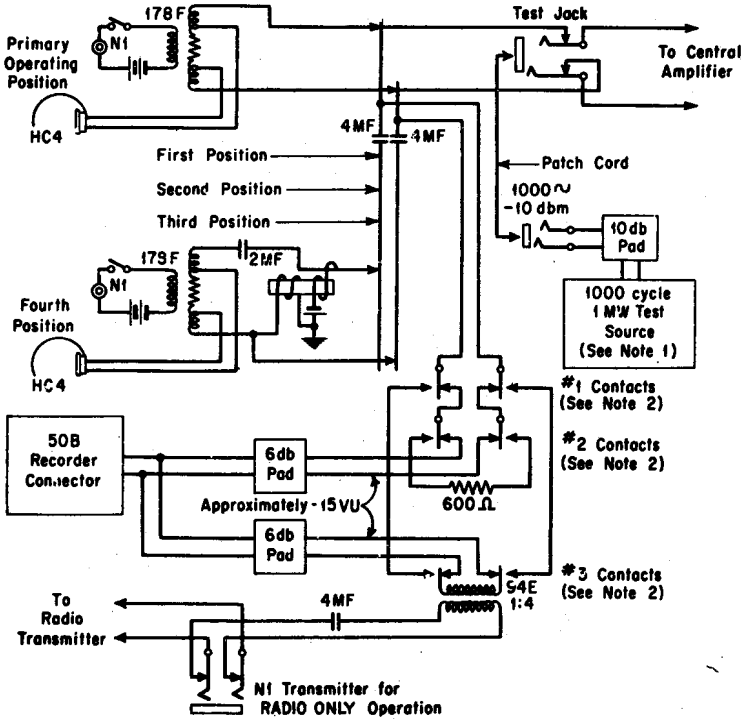


Fig. 1 - One-Way Speech Multistation Circuit



NOTES:

1. 1000 cycle 1MW Test Source may be supplied from either a local test oscillator or from the nearest Central Office over private pair.
2. Contacts #1, 2 & 3 are shown normal. The various methods of operation are as follows:
   a) WIRE LINE and RADIO #1 & 3 contacts operated, #2 contacts normal.
   b) WIRE LINE ONLY #1 & 3 contacts normal, #2 contacts operated.
   c) RADIO ONLY #1, 2 & 3 contacts normal. Headsets plugged into RADIO ONLY jacks and radio keys associated with these jacks operated.

Fig. 2 - Arrangement at Center
(One-Way Speech Multistation Circuit)

one-way communication is possible from any one of the four positions at the center to all outlying stations simultaneously.

2.03 When the operation is WIRE LINE and RADIO, speech is transmitted to the line and also to a local radio transmitter. The connection to the local radio transmitter is made through a transformer (94E repeating coil) and condenser. The repeating coil is strapped normally for a 4:1 ratio step down to the radio transmitter. The condenser is used so that a d-c bridge will not be placed across the input circuit of the radio transmitter. Operation of the key to WIRE LINE and RADIO also supplies a make contact to the radio equipment to satisfy the push-to-talk function of the radio transmitter. The radio room is provided with means for lighting special signal lamps at the four positions at the center when the radio transmitter and its associated units are ready for use. Assuming no bridged positions at the center, the speech volume provided across the input to the radio transmitter is expected to average about -14 vu in normal use. In some cases this level might be as low as -20 vu.

2.04 With RADIO ONLY operation the carbon transmitter of a 52-type telephone set is connected directly to a radio transmitter by plugging the head set into jacks marked RADIO ONLY. With this method of operation, talking battery current is supplied by the radio transmitter.

2.05 In general, each of the outlying stations will have two on-premise locations where the one-way speech circuit will terminate. This is illustrated in Fig. 3. Location A has two sets of jacks wired in parallel and connected to the output of a two-position switch. The two inputs of the switch are connected to the incoming wire line and to the output of a local radio receiver. Under some conditions both sets of jacks may be used simultaneously to connect two 52-type head sets directly to the line or to the output of the radio receiver depending upon the position of the two-position switch. When the 52-type head sets are used with these jacks, only the 600-ohm HC4 receiver units are actually connected to the circuit.

2.06 As noted in Fig. 3, Location B is another on-premise multiple of equipment similar to that described above in Paragraph 2.05. In addition, a 100-type loudspeaker (with 20 db pad) is connected to the circuit in such a manner that when the 52-type head set is inserted in the jacks, the loudspeaker will be disconnected. The use of a 20 db pad is based on the assumption of 65 db room noise. At locations where the room noise varies considerably from this value it may be necessary to change this pad value locally in accordance with the information given in Section 310-405-100. When the equipment for both stations A and B is provided, a permanent 6 db station bridging loss should be assumed in determining the line loss to the outlying station. Also, if an impedance

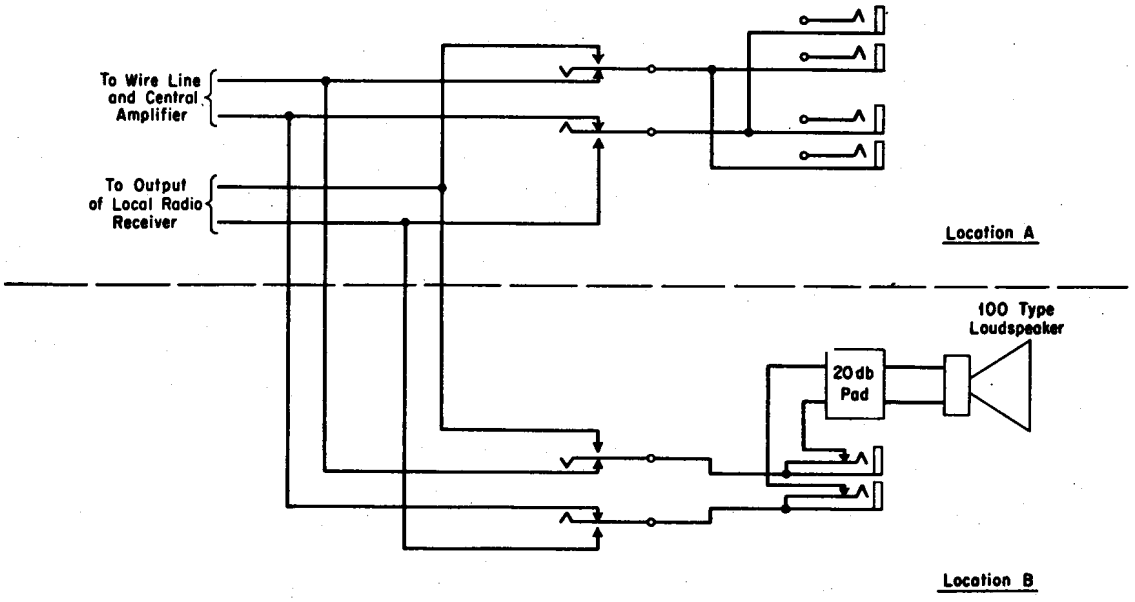


Fig. 3 - Arrangement of Outlying Station (One-Way Speech Multistation Circuit)

matching line transformer is not provided at the station, the line loss should also include the reflection loss between the combined impedance of the three station terminations (200 ohms) and the line impedance.

(C) Central Amplifier Arrangement

2.07 The central amplifier or the tributary amplifier is shown by Fig. 4 and each consists of two 124B Amplifiers or two Langevin Amplifiers per KS-12086 L1, whose inputs are connected in parallel to the trunk from the center. The arrangement of the central amplifier and the tributary amplifier, as discussed later in Paragraph 2.12, differs only in that the tributary amplifier is fed from a central amplifier rather than the center. The maximum number of outlying stations that can be fed from the central amplifier or the tributary amplifier is about 80. Circuit details are indicated on Schematic Drawing SD-96466-01. The outputs of the two amplifiers are connected to an output bus-bar arrangement through a bridge consisting of three 10-ohm resistances and the load which can be a value between 6 and 12 ohms depending on the number of station lines connected. This arrangement is similar to the subcenter amplifier of the 4A Time Announcement System and has the advantage that the circuit will continue to function (at reduced gains of 2.5 to 6 db) even though one of the amplifier units is inoperative.

2.08 The amplifier outputs must be connected to the bridge in the proper phase relationship. The wrong phase connection will result in a voltage across the load which is at least 10 db down from the voltage across the output of either amplifier. Improper phase relationship may be corrected by reversing the output leads of one of the amplifiers.

2.09 Each of the various lines to the outlying stations is connected to one of three bus-bars through two 300-ohm resistors in order to minimize the effect of trouble on the station lines. They also provide approximately a 600-ohm termination for the outlying station lines and this 600-ohm impedance should be used for reflection loss calculations. The three bus-bar arrangement, as shown in Fig. 4, provides each station with approximately the same received volume and thus avoids the need for pads or variable resistors on each line.

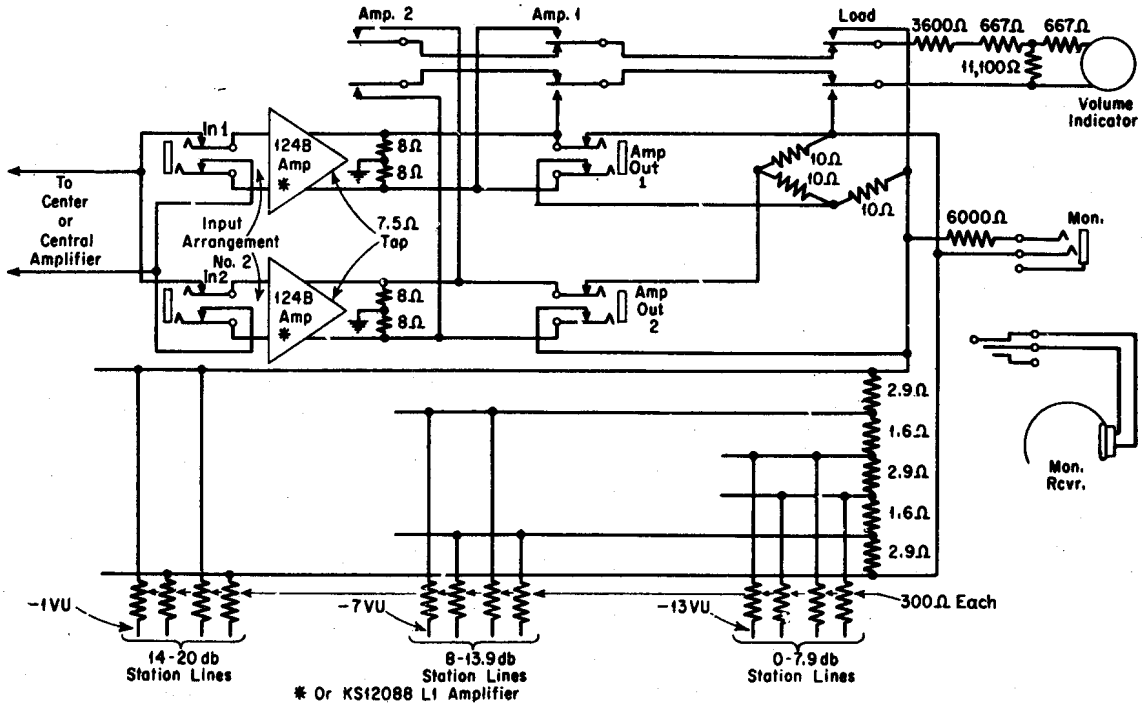


Fig. 4 - Central or Tributary Amplifier
(One-Way Speech Multistation Circuit)

2.10 A monitoring arrangement is connected to the central amplifier so that the central office personnel can monitor the circuit for testing and maintenance reasons. Also, an alarm system is provided as shown by Schematic Drawing SD-96466-01 which operates when there is power failure within either amplifier.

2.11 A volume indicator meter (KS-8207) is used for lining up and checking the cir cuit. As indicated in Fig. 4, it can be connected to the output of either amplifier or across the load by means of a pushbutton key arrangement. The gains of the two amplifiers are adjusted so that the volume indicator reads the same across either amplifier. The reading across the load should be within a decibel of the reading across the individual amplifier outputs assuming proper phasing of the amplifier outputs. Failure of one amplifier will cause a reduction of the reading across the load of about 6 db and about 20 db across the output of the disabled amplifier.

(D) Line Facilities

2.12 In general, any of the standard types of line facilities provided for private line telephone service may be used for these special private line multistation circuits. The maximum allowable line losses are indicated on Fig. 1. These line losses include the loss of the line facilities, line bridging losses, terminal reflection losses and permanent station bridging losses.

2.13 It might be desirable to serve two outlying stations with a single pair in which case a 3.5 db bridging loss should be included in the calculation of the line loss. At a non-amplified bridging point, two or three lines may be multipled, provided that the total loss from the central office containing an amplifier to any of the bridge stations does not exceed 20 db and that the difference in loss to the highest and lowest loss stations of a given bridge is 3 db or less. Also, Schematic Drawing SD-96466-01 shows arrangements for bridging several station lines at a central office and connecting this bridge to a tributary amplifier.

(E) Tone Device

2.14 By use of a 50B recorder-connector an intermittent tone is applied to the line and transmitted to the outlying stations from the center whenever the line is not being used for speech transmission. This same recorder-connector is used to supply tone to the input of a local radio transmitter when the transmitter is turned ON but when no operators' head sets are connected to the radio input circuit. Schematic Drawing SD-69213-01, Issue 5, shows the manner in which this recorder-connector is inserted in the circuit. The tone on the wire line will be discontinued when the key at the center (explained in Paragraphs 2.02 and 2.03) is operated to WIRE LINE ONLY. When the key is operated to WIRE LINE and RADIO, the tone to both the WIRE LINE and RADIO will be disconnected. This is illustrated in Fig. 2. The normal output tone of the recorder-connector (-5 vu) is attenuated about 10 db by the two pad circuits before it is applied to the line. This is necessary to keep the volume indicator meter reading of this tone on scale at the central office amplifier installation. With this pad arrangement, the -15 vu tone applied at the center will cause the vu meter at the central office to read about -3.5. This reading can be used for a quick check of circuit performance since the recorder-connector will operate continuously. The tone is also applied to the input of the radio circuit at a level of approximately -15 vu.

3. TWO-WAY SPEECH MULTISTATION CIRCUITS

(A) General

3.01 This circuit is a 4-wire, two-way speech, two-way signaling arrangement connecting the center and a maximum of six outlying stations. Fig. 5 is the simplified schematic of the two-way speech multistation circuit. The over-all 1000-cycle circuit loss for this arrangement is about 20 db and the over-all effective transmission loss is about +1 db assuming one telephone set at each station location. By the use of a grouping arrangement at the center it is possible for several two-way speech circuits associated with a center to be switched together so that one position at the center may talk to all stations and hear any station. All other positions at the center are cut off from these circuits and there is no transmission between stations of different two-way circuits.

(B) Station Equipment

3.02 Center: Five positions at the center have access to the two-way circuit. It is intended that only one of these positions will be talking at any one time. However, the other positions may monitor on the line. When the monitoring positions open their transmitter circuits by means of a switch in the cord to their head sets, only a receiving loss will result at the center. This loss will be approximately 3.5 db for one and 6 db for two monitoring bridges. The station arrangements at the center are covered by Drawing SD-69212-01.

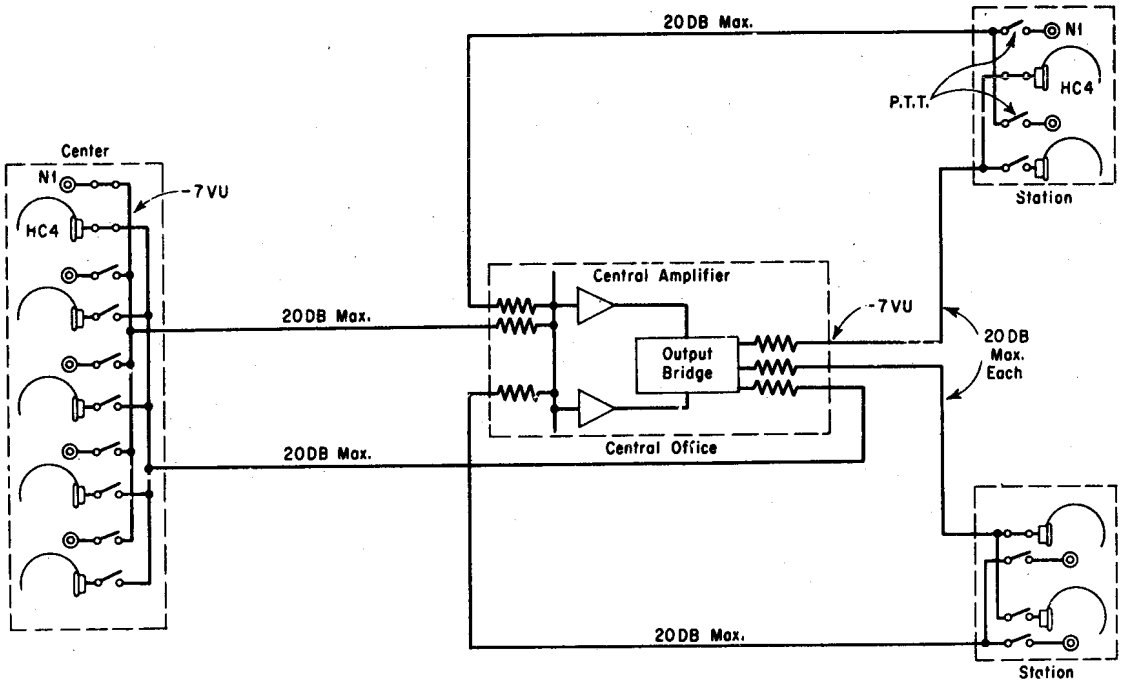


Fig. 5 - Two-Way Speech Multistation Circuit

3.03 As mentioned in Paragraph 3.01, a grouping arrangement is also provided at the center. A simplified schematic of this arrangement is shown by Fig. 6. The maximum number of two-way speech circuits that may be grouped is 13. In order to obtain satisfactory transmission to and from the center with the grouping key operated, two amplifiers are required at the center. In the following discussion the amplifiers are called the conference transmitting amplifier and the conference receiving amplifier. These amplifiers can be either the 124B or the KS-12086 L1 type.

3.04 When the grouping key is operated, the N1 transmitter of the grouping position is connected to the conference transmitting amplifier through a transformer (178F induction coil) and a 30 db pad. Each two-way speech circuit transmitting line is connected to the 8-ohm load resistance of this amplifier through two 300-ohm resistors. These resistors provide a 600-ohm termination for these lines and protect the system against trouble on the individual lines.

3.05 When the grouping key is operated the receiving lines of the two-way speech circuits are connected to the input of the conference receiving amplifier through the equivalent of a balanced "H" pad of 23 db loss. The HC4 telephone receiver of the grouping position is connected to the output of this amplifier by means of an arrangement which provides proper termination for this receiver and enough loss to protect the listener from accidental clicks.

3.06 A spare amplifier may be provided as a standby for the two amplifiers of the grouping arrangement at the center. This is put into service by patching it into the patching jacks of the disabled amplifier or an amplifier which has been removed for maintenance or other reasons.

3.07 Stations: Two sets of line jacks are provided at each station location. Normally only one set is used with an operator's head set equipped with an N1 transmitter and an HC4 receiver. These components are connected so that they present a terminal impedance to the line of approximately 600 ohms. This impedance should be used in the calculation of the terminal reflection losses which are to be included as part of the line loss. Each set of jacks has an associated non-locking push-to-talk key which opens the transmitter circuit in the non-operated condition. When both sets of jacks are used at the outlying station a 3.5 db receiving bridging loss is added. However, this is not a normal operating procedure and the bridging loss should not be included in the calculation of the line loss. The station arrangements at the outlying points are covered by Drawing SD-69214-01.

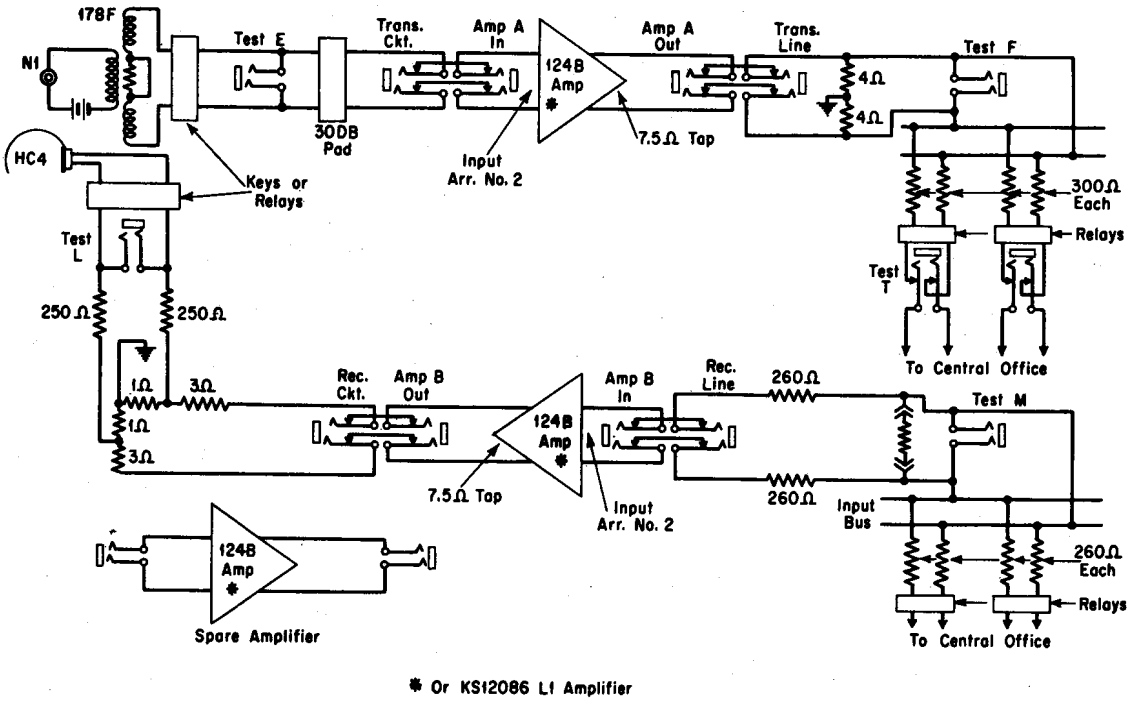


Fig. 6 - Grouping Arrangement at Center
(Two-Way Speech Multistation Circuit)

(C) Signaling

3.08 Three methods of signaling are provided for the two-way speech circuit. First, the center is able to signal all six outlying stations on the circuit simultaneously. Second, each outlying station is able to signal each other outlying station but without signaling the center. Third, each outlying station is able to signal the center without signaling each other outlying station. Depending upon local conditions either a hand generator or an equivalent separate ringing supply can be provided at the outlying stations. At the center a separate ringing supply with an associated ringing key is provided.

3.09 The receiving line is used for the first and second methods mentioned above. A ringup relay circuit is connected from the center point of the low impedance output bus to ground. Ringing to ground on any receiving line will actuate this relay circuit which in turn will ring out on the transmitting lines to all outlying stations, except the transmitting line to the center.

3.10 For signaling from any outlying station to the center, ringing to ground on the transmitting lines of these outlying stations will actuate a ringup relay circuit which will in turn ring out on the transmitting line to the center only.

(D) Central Amplifier Arrangement

3.11 The central amplifier, shown schematically by Fig. 7 and circuit details on Schematic Drawing SD-96465-01, is arranged somewhat similar to the central amplifier arrangement of the one-way speech circuit described in Paragraphs 2.07, 2.08, 2.09, 2.10 and 2.11. It differs in that not only is it a two-way circuit rather than a one-way circuit, but also a signaling feature is provided as described in Paragraphs 3.08, 3.09 and 3.10. The transmitting legs from the station are bridged to the input of the amplifier and the receiving legs bridged to the output. The output portion of the two-way speech central amplifier differs only in that a signaling channel is provided by connecting the center taps of the 12-ohm load resistance to signaling

equipment and omitting the ground on the center of the 16-ohm resistor bridged across the output of each amplifier. The three bus-bar arrangements, 300-ohm protective resistances and the output bridge are essentially the same as the one-way speech circuit and the remarks made in Paragraph 2.09 concerning these items also apply to the two-way speech amplifier arrangement.

3.12 Each station transmitting line is connected to the parallel amplifier inputs through a transformer, a pad and protective resistors. The transformer is used to derive a simplex signaling channel. The pad is used to equalize the volume levels from various locations and is shown by Fig. 8. The pad loss which is adjusted in 4 db steps should be used as follows:

Transmitting Line Loss	Adjust Pad Loss to
0- 4.9 db	16 db
5- 8.9	12
9-12.9	8
13-16.9	4
17-20	0

The two 150-ohm resistors serve as protection against line faults. The impedance of the input circuit looking from the line is roughly 600 ohms resistive in most cases and this impedance should be used for terminal reflection loss calculations.

3.13 The volume indicator connection is the same as in the one-way speech circuit described in Paragraph 2.11 except for the meter pad. The meter pads are shown in detail on Schematic Drawing SD-96465-01.

3.14 A telephone station circuit is provided at the central amplifier installation with each two-way central amplifier. This telephone is connected to the central amplifier so that central office personnel can communicate with both the center and the outlying stations over the two-way speech circuit for testing and maintenance purposes. The central amplifier gain is not significantly affected by the addition of this telephone station. No signaling is required for this telephone station. Also, an alarm circuit arrangement is provided at the central office. As shown by Schematic Drawing SD-96465-01, this alarm circuit is connected to the power leads of the amplifier. Thus, when there is power failure in either amplifier the alarm circuit will operate.

(E) Line Facilities

3.15 The maximum allowable line losses are indicated on Fig. 5 and, in general, any of the standard types of line facilities provided for private line telephone service may be used. These line losses include the loss of the line facilities, line bridging losses, terminal reflection losses and permanent station bridging losses. They do not include the losses caused by station bridges which are connected occasionally as mentioned in Paragraph 3.07. The length of the station wiring from the induction coil and battery supply retard coils to the head set jacks should be limited to a maximum of 20 ohms loop resistance and an impairment at the rate of 1 db for each 10 ohms should be included in the design calculation for these lines.

3.16 Also, in some cases, two of the outlying stations may be located near each other and thus served by a total of two pairs (one receiving and one transmitting) from the central amplifier. Under these circumstances 1 db loss should be added to the transmitting line loss and 3.5 db should be added to the receiving line loss.

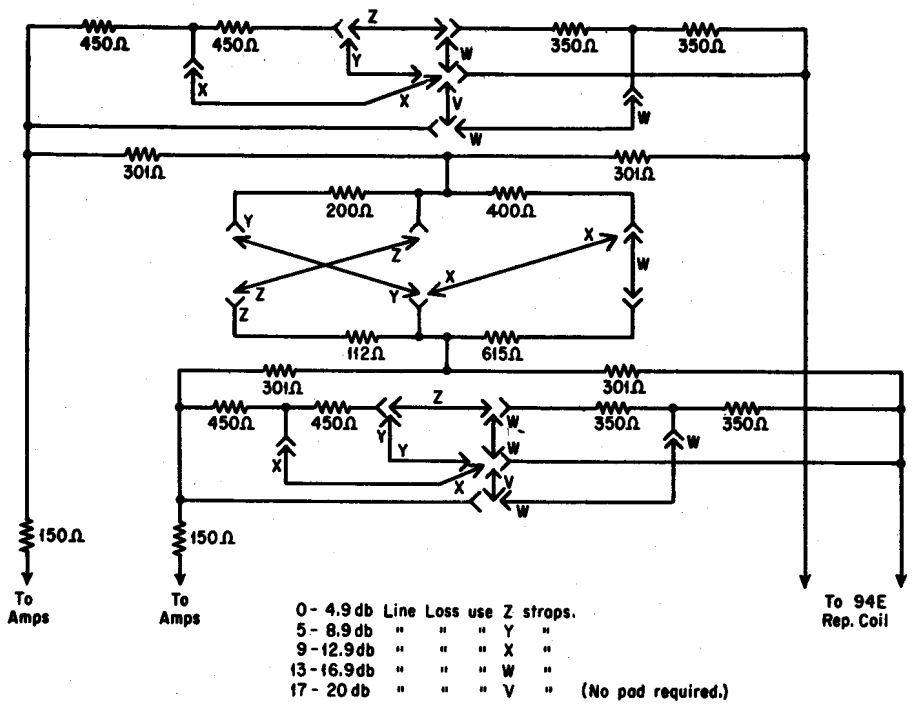


Fig. 7 - Central Amplifier
(Two-Way Speech Multistation Circuit)

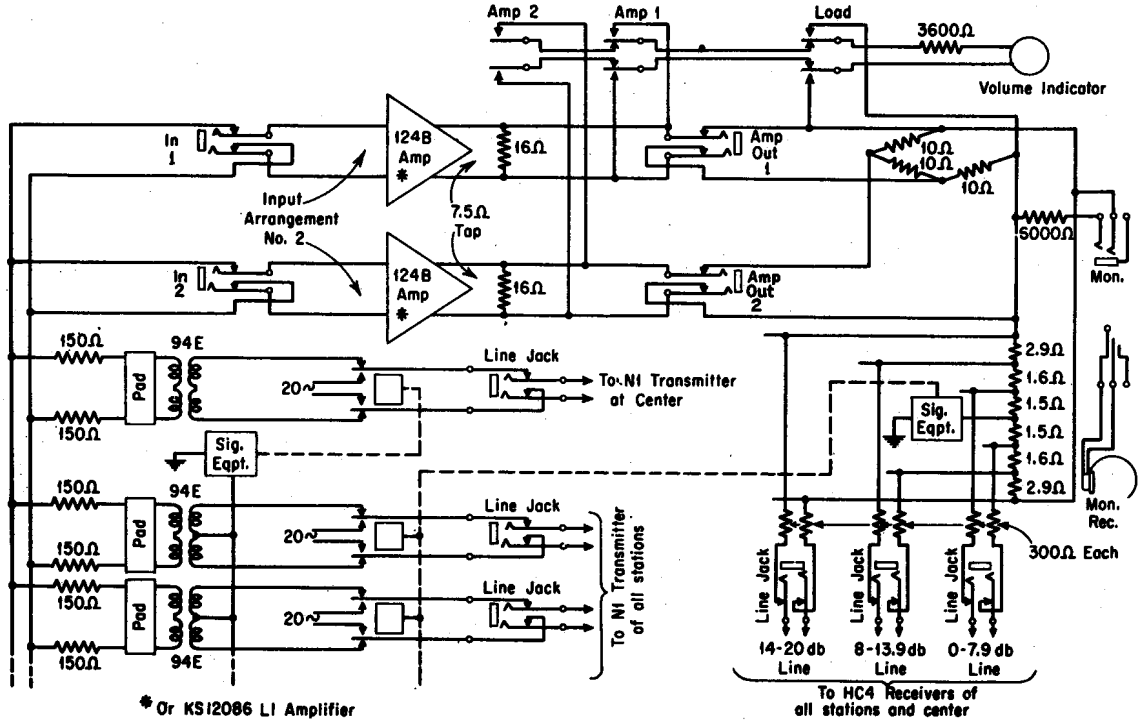


Fig. 8 - Input Pad Details
(Two-Way Multistation Circuit)