MULTISTATION PRIVATE LINE TELEPHONE SERVICE
VOICE ONLY
DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section describes arrangements to provide multistation private line telephone service over toll and exchange facilities in which all stations can communicate with all others with essentially the same grade of transmission. Frequently, circuits with special operating and/or equipment features are required for a specific customer. In these cases, the necessary instructions should be prepared by the operating companies involved to facilitate operation of the circuit.

1.02 This section is reissued to:

(a) Include information on the latest equipment available

(b) Revise transmission level point (TLP) levels

(c) Delete references to uses of these circuits for other than voice communications.

1.03 Since this is a general revision, arrows ordinarily used to denote changes have been omitted.

1.04 Multistation private line telephone services allow three or more stations to signal and communicate with each other either singly or collectively. These services are provided over nonswitched facilities with no access to the message network. Fig. 1 is an example of a multistation private line telephone circuit.

1.05 Some of the requirements for a multistation private line telephone service are:

(a) Each station should be able to communicate with all others with approximately the same volume level.

(b) The transmission characteristics should remain fairly constant regardless of the number of stations off-hook.

(c) Echo must not be objectionable.

(d) The circuit must be stable with respect to singing.

(e) Trouble on any branch of the circuit should have minimal effect on the rest of the circuit.

1.06 Certain terms used in referring to various parts of a multistation private line telephone circuit are defined as follows:

44-TYPE BRIDGE: A resistance network interconnecting four 4-wire facilities so arranged that each may transmit into the bridge and receive from the bridge.

BRIDGE TERMINAL: Each connection transmitting into the bridge is called a receive terminal and each connection transmitting from the bridge is called a transmit terminal.

BRIDGE LEG OR SIDE: A pair of terminals, one receive terminal and the corresponding transmit terminal.

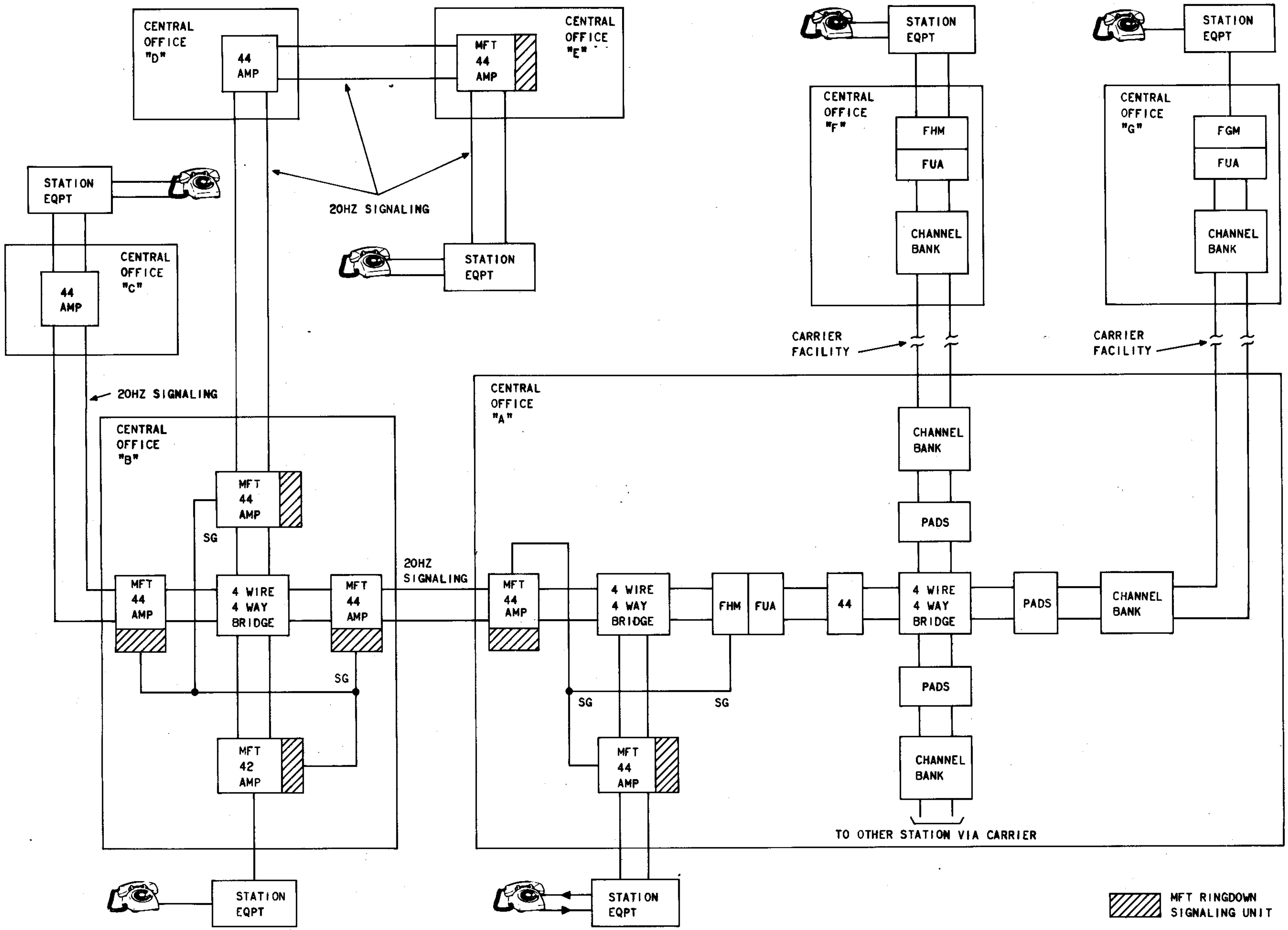


Fig. 1—Typical Multistation Voice Only Private Line Telephone Circuit

46-TYPE BRIDGE: Similar to the 44-type bridge except that it has six legs instead of four.

TOLL FACILITIES: Facilities between any two toll offices are called toll facilities. These are also referred to as interexchange facilities.

MAIN LINE OR BACK BONE CIRCUIT: The main line or back bone circuit is that portion of a multistation private line telephone circuit that extends from the control office to the most remote toll office. The main line circuit will usually be routed through one or more intermediate bridging offices from which end links or branches are fed. Where the circuit radiates in more than one direction from the control office, there will be more than one main line circuit.

MID LINK: The mid links are those portions of the main line circuit that connect the bridging offices together.

END LINK or BRANCH: The end link or branch includes all of the facilities between the central office bridge leg and the served station.

LOOP or LOCAL CHANNEL: The loop or local channel consists of all the facilities between the last toll office and the subscriber. The loop may be 2-wire or 4-wire. In the case of 4-wire loops, the portion used for transmitting from the station is called the transmit loop and the portion used for receiving at the station is the receive loop.

TOLL OFFICE: The office at which toll facilities terminate.

LOCAL CENTRAL OFFICE: The local central office is the telephone office at which the exchange portion of the loop is terminated.

EXCHANGE TRUNK FACILITIES: These are the facilities between two local central offices or between a toll office and a local central office.

SUBSCRIBER LOOP FACILITIES: These are the facilities between the local central office and the subscriber location.

TALK BACK: A circuit composed entirely of 4-wire facilities and stations has no connection between the transmit and receive paths; therefore, there is no sidetone. Also, when two or more stations are bridged at the same location, they will not be able to hear each other. To overcome this, a talk back path, usually in the form of an amplifier or resistance bridge, is provided.

1.07 The arrangements and type of equipment to be used at both the central offices and the private line station are determined by customer requirements and by the equipment and facilities available.

1.08 The type of signaling to be applied to a particular multistation service is also largely dependent on customer requirements. These will vary from a requirement for no signaling or perhaps signaling in one direction only between a few stations to the extreme case in which a large number of stations may signal any of the other stations individually, all of them at one time, or certain pre-selected groups.

1.09 A large multistation private line circuit will consist of a 4-wire back bone circuit extending through a number of offices, any of which may be bridging points.

1.10 Due to the complexity of multistation private line telephone circuits, it is preferable to have complete 4-wire layouts wherever possible. The multiple singing and echo paths involved with 2-wire layouts dictate higher net losses and critical balancing and equalizing procedures.

2. BRIDGING ARRANGEMENTS

2.01 Several standard bridging arrangements are currently available. These may be 2-wire or 4-wire bridges depending on circuit requirements.

2.02 A means of coding bridges for circuit layout purposes has been developed. A 6-character code is assigned to each type of bridge according to the following scheme per Section 001-683-501 LL.

CHARACTER POSITION	CODE	MEANING
1st and 2nd	BR	Bridge
3rd	2 or 4	2-wire or 4-wire
4th	3 to 9	Number of legs
	or M	More than 9 legs
	or T	Talk back
5th and 6th	01-99	Arbitrary numbers to achieve individuality

Therefore, a BR 2401 code describes a 2-wire bridge with four legs, and a BR 4601 code describes a 4-wire bridge with six legs.

2.03 For purposes of discussion, the bridging arrangements are usually referred to as 24-type, 44-type, 46-type etc, with the first number indicating either 2-wire or 4-wire and the second number indicating the quantity of legs available.

2.03 There are two essential requirements for a 4-wire bridge. They are:

(a) A relatively low and equal transmission loss from each input terminal to the other output terminals.

(b) The return current path loss from an input terminal to the output terminal of the same leg must be relatively high (50 dB or more depending on the usage of the bridge).

44 TYPE BRIDGE

2.04 The 44-type bridge is a resistance network designed to interconnect four 4-wire lines. As shown in Fig. 2, it consists of four legs, each leg having an input terminal and an output terminal. Within the bridge structure, there is a transmission path connecting each input terminal to each of the other three output terminals of the other three legs giving a total of 12 paths linking the desired input and output paths. In addition, there are also transmission paths between each bridge input and the other bridge inputs, and between each bridge input and the output of the same leg of the bridge. The paths between the bridge inputs are generally of no importance, but transmission paths between a bridge input terminal and the output terminal of the same leg will cause return currents on the 4-wire circuit which if of appreciable magnitude might result either in singing or objectionable echo. These return currents are controlled as follows: There are six individual paths from any input terminal to its corresponding output terminal. Each of the six paths consists of a direct path from the input terminal to the other three output terminals and from each of the three output terminals there are two paths, consisting of two direct paths in series, back to the output terminal associated with the input terminal. Turnovers suitably located in the bridge network as indicated in Fig. 2, cause three of these six paths to be 180 degrees out of phase with the other three paths. As these six transmission paths theoretically have the same loss, they will cancel each other in pairs and the resulting loss between an input and its corresponding output will be infinite. In practice, all of these paths will not have identical losses because of manufacturing tolerances in the resistances and because of differences in the impedance of the lines or repeaters connected to the other three legs of the bridge, since each of the latter constitute a shunt on any transmission paths that pass through the bridge terminal.

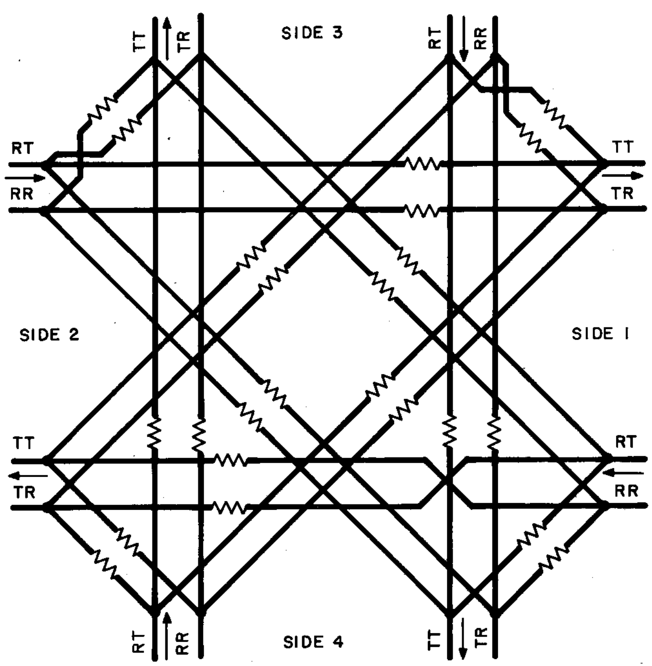


Fig. 2—Schematic of 44-Type Bridge

2.05 With all bridge terminals terminated in 600 ohms, the transmission loss between any input terminal and the output terminals of the other three legs will be approximately 15 dB and the loss between any input terminal and the output terminal of the same leg will be in excess of 75 dB. For some combinations of unbalances such as short-circuiting or opening two or more terminals of the bridge, this loss may be reduced to a value as low as 38 dB.

2.06 The impedance of the bridge is about 650 ohms with nominal termination of 600 to 700 ohms. Since the bridge has a relatively high loss, its impedance does not vary greatly with various terminations. Some operating companies have changed the value of resistors in some 44-type bridges to make the impedance close to 600 ohms.

2.07 Although the standard 44-type bridge is for practical purposes a symmetrical circuit when properly terminated, it is unsymmetrical with respect to reflected or return currents. The level of any such extraneous currents entering the bridge may be at output 4, as much as 9.6 dB above that at any of the other outputs. For this reason, leg 4 should either be assigned to a branch circuit or be left spare. On some critical services where a spare leg might be used for rerouting or patching the main-line circuit, it is preferable to assign leg 4 to a branch and leave a different leg spare. Modifications of the standard bridges by some operating companies have eliminated the restriction regarding the use of leg 4. However, if in doubt, the above rule should be followed.

2.08 Section 332-434-100 describes the 4233A network. This network is a 4-way 4-wire bridge packaged in a plug-in can identical to the 359-type equalizer. Switchable pads and gain potentiometers are additional features of the network.

46-TYPE BRIDGE

2.09 The 46-type bridge is similar in nearly all respects to the 44-type bridge except that it has six instead of four legs. The bridge, shown in Fig. 3, has a transmission path connecting each input terminal with the five output terminals of the other five legs giving a total of 30 paths linking the desired input and output terminals. These paths, however, also provide transmission paths between each bridge input and the other bridge inputs and between each bridge input and the output on the same side of the bridge. As was the case in the 44-type bridge the paths between bridge inputs are generally of no importance, but transmission paths between a bridge input terminal and the output terminal of the same leg must be kept at a high loss in order to keep return currents to a minimum. There is a direct path from an input terminal to the other five output terminals, and from each of the five output terminals there are four paths, consisting of two direct paths in series, back to the output terminal associated with the input terminal. This makes a total of 20 paths from each input terminal back to the output terminal of the same leg, and providing all resistors are of exactly the same value, all of these paths will have exactly the same loss. Suitable turnovers in the above paths are such that 10 of these paths will be 180 degrees out of phase with the other 10 paths and thus will cancel. Theoretically with all inputs properly terminated the loss from an input terminal to the output terminal of the same leg will be infinite; but due to manufacturing tolerances of the resistors and due to differences in the impedance of equipment and facilities connected to the legs of the bridge, the loss will be less than infinity.

2.10 When all bridge terminals are properly terminated the transmission loss between any input and the output terminals of the other five legs will be 19.5 dB. Due to losses in cabling the loss of the 46-type bridge is many times considered to be 19.8 dB or 20.0 dB when engineering private line circuits. The loss from an input terminal to the output terminal of the same leg should exceed 80 dB if all terminals are terminated in 600 ohms. The impedance of the bridge is approximately 600 ohms with nominal terminations of 600 to 700 ohms. The bridge impedance does not vary greatly with various terminations.

2-Wire Straight Bridge

2.11 The arrangement shown in Fig. 4 is simpler and has less loss than other types of 2-wire bridges. It is frequently useful where the additional loss of another type of 2-wire bridge would necessitate a repeater not otherwise needed. The straight bridge has some severe limitations, however, which must be considered. Line or loop facilities having serious irregularities (such as might be presented, for example, by a loop of complex make-up) when connected together directly through a straight bridge arrangement will have a limiting effect upon the degree of balance obtainable across any repeater or hybrids connected to other bridge legs. Also, the calculated losses of the straight

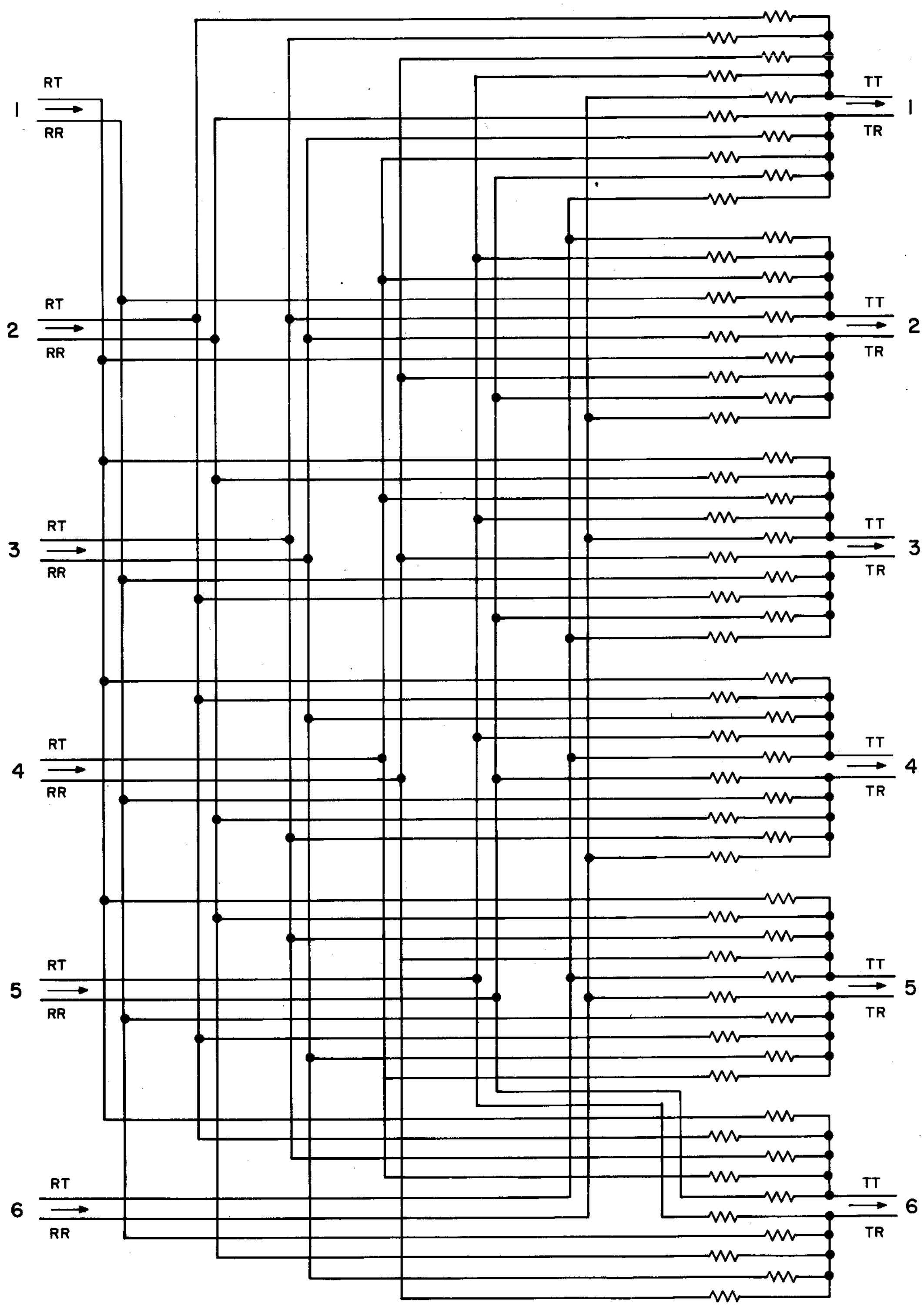


Fig. 3—Schematic of 46-Type Bridge

bridge arrangement assume 600-ohm terminations on all appearances. In actual use these terminations are likely to vary appreciably from 600 ohms, and consequently the real loss of the bridge arrangement may differ appreciably from the computed value. The losses for the several arrangements most commonly used are as follows:

TOTAL NUMBER BRIDGE LEGS	BRIDGING LOSS (db) ASSUMING SAME VALUE (USUALLY 600 OHMS) TERMINATIONS ON ALL LEGS
3	3.5
4	6.0
5	8.0
6	9.5

2-Wire Resistance Bridge

2.12 The loss of this type bridge, which is illustrated in Fig. 5, is several dB greater than the straight bridge arranged for the same number of legs, so that it is generally used where repeaters are employed on the circuit branches. Where the additional loss is not a governing factor this resistance bridge is usually preferable to the straight bridge. While use of this bridge will not always produce improvement in singing margin, trouble such as a short circuit on one of the circuit branches would be less likely to affect the other branches or the singing margin of the overall circuit. The value of R and the corresponding transmission losses for the several 600-ohm bridge arrangements most commonly used are as follows:

TOTAL NUMBER BRIDGE LEGS	RESISTOR R OHMS	BRIDGING LOSS (db) ASSUMING SAME VALUE (USUALLY 600 OHMS) TERMINATION ON ALL LEGS
3	100	6.0
4	150	9.5
5	180	12.0
6	200	14.0
7	214	15.5
8	225	17.0
9	233	18.1
10	240	19.2

2-Wire Pad Type Bridge

2.13 This bridge is shown in Fig. 6. Although the impedance improving features of this type of bridge makes it desirable for balancing reasons and minimizes the effects of a trouble on one circuit branch upon the other branches, its relatively high loss limits its application generally to those cases where each branch is equipped with a repeater. The losses for the several bridge arrangements most commonly used, with a 5 dB pad in each leg, are as follows:

TOTAL NUMBER BRIDGE LEGS	BRIDGING LOSS (db) ASSUMING SAME VALUE (USUALLY 600 OHMS) TERMINATIONS ON ALL LEGS
3	13.5
4	16.0
5	18.0
6	19.5

4-Wire, 2-Wire Bridging

2.14 Occasionally, it is necessary to feed a 2-wire loop from a predominately 4-wire layout. This is usually accomplished by connecting one leg of a 4-wire bridge to the 4-wire side of a 24V4 repeater and the loop to the 1-type terminating set. Other methods such as using older style hybrid coil bridge arrangements may still be used in isolated cases. The recently developed metallic facility terminal (MTF) family of equipment and customer premises facility terminal equipment may also be used for 4-wire to 2-wire conversion.

Talk-Back Features

2.15 A 4-wire layout (including 4-wire loops and station arrangements) provides the talker with no sidetone path since the standard 4-wire station arrangement has no connection between the transmitter side of the circuit and the receiver side of the circuit. In addition, if two or more stations are bridged together at the same location, these stations will be unable to hear each other. It is necessary, therefore, to provide an external transmission path, called a "talk-back" path. This must be so arranged that it does not cause objectionable echo or return currents on the main circuit. The talk-back arrangement must be inserted at a location that is not separated from the station by facilities having an appreciable time delay since this would cause the talkback to sound like echo rather than side-tone. Generally the talk-back path is placed at the toll office nearest the station or at the station. The several ways of accomplishing this as discussed in the following paragraphs, are:

(1) A talk-back amplifier

(2) A low echo talk-back bridge

(3) An arrangement which uses the spare leg of a 4-wire bridge.

2.16 *Talk-Back Amplifier:* One method, indicated in Fig. 7, uses an amplifier or one-half of a 4-wire repeater to interconnect the transmitting and receiving sides of the branch. With this arrangement there is no feedback from C to B since the amplifier is a one-way device. The two main transmission paths from A to B and from C to D each have a loss of about 3.5 dB due to the bridging effects of the amplifier. The gain of the talk-back path from A to D is the gain of the amplifier less 7.0 dB (the sum of the amplifier bridging losses). In general the amplifier gain will be set so that the transmission from the station talker to his own receiver and those of other receivers at the same location will be equivalent to transmission from distant talkers to the same receivers.

2.17 *Low Echo Talk-Back Bridge:* This method (Fig. 8) of providing talk back is particularly suitable because of the high loss in the echo path and low insertion loss. The echo path loss is about 62 dB (82 dB with optional pad) and the insertion loss is 2.7 dB. This talk-back path arrangement is shown in SD-55647-01, Fig. 25. It replaces Fig. 17 and 24 of the same drawing which have been rated, "Mfr Disc."

2.18 *Talk-Back by Spare Leg of 4-Wire Bridge:* A third talk-back arrangement (Fig. 9) takes advantage of a spare leg of the bridge when available. Although Fig. 9 shows a 44-type bridge, the same arrangement can be used with a 46-type bridge. The transmitting side of the branch is connected to the input terminals of leg 4 of the bridge, and the receiving side of the branch is connected to the output terminals of leg 3 of the bridge and the unused terminals are terminated in 600-ohm resistance. In this way transmission from the branch is returned to it through the 44-type bridge at the same level as it is fed to the main line section of the circuit. Therefore, if the bridge is lined up for equal transmission in all branches connected to the bridge, the talk-back transmission will be equal to the direct transmission. With this arrangement no additional echo paths are introduced.

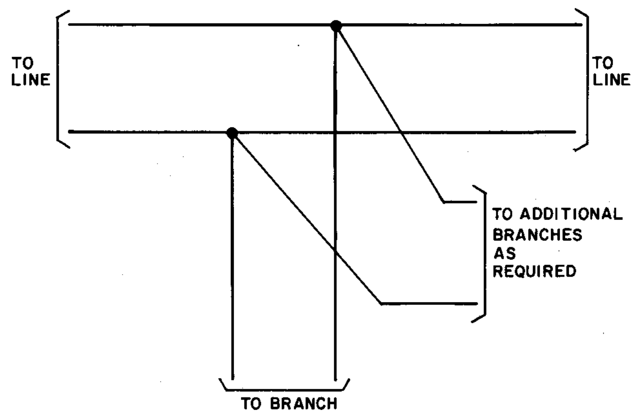


Fig. 4—Schematic of 2-Wire Straight Bridge

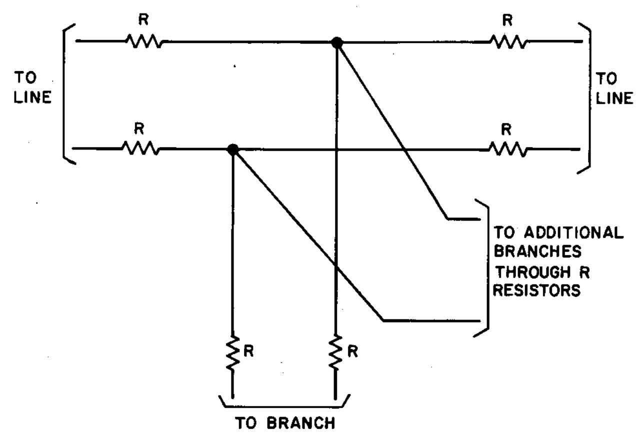


Fig. 5—Schematic of 2-Wire Resistance Bridge

3. TRANSMISSION EQUIPMENT

3.01 Variations of the V4 repeater are generally used for the amplification, equalization, and 4-wire to 2-wire terminating arrangements required for multistation private line circuits.

3.02 There are three general types of V4 repeaters. They are:

(a) The basic V4 repeater

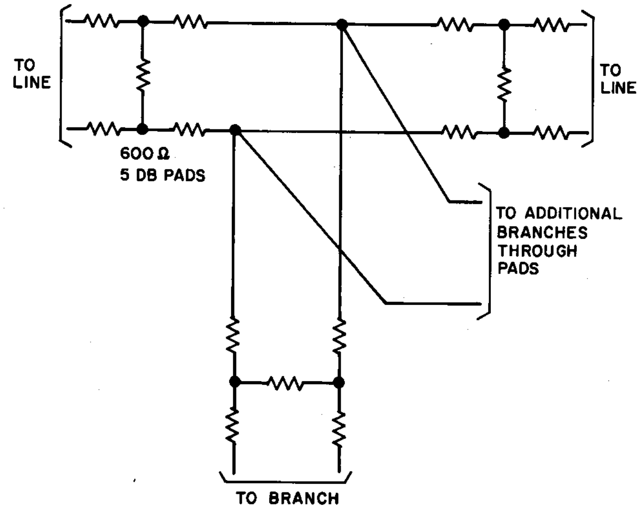


Fig. 6—Schematic of 2-Wire Pad-Type Bridge

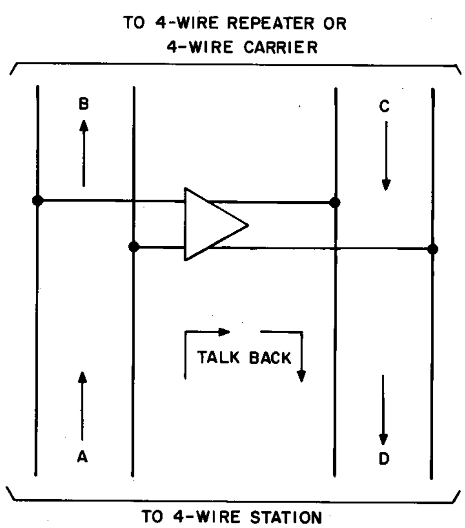


Fig. 7—Talk-Back Amplifier

(b) The 24V4 repeater

(c) The 44V4 repeater.

3.03 The basic V4 repeater was developed to permit the use of 227-type amplifiers or 849-type networks depending on transmission requirements.

3.04 The 24V4 repeater is used as a junction between the 2-wire and 4-wire portions of a circuit.

3.05 The 44V4 is used as an intermediate or terminal point on a 4-wire circuit.

A. 24V4 Repeater

3.06 There are four variations of the 24V4 repeater mounting arrangement.

3.07 The 24V4A and 24V4B mountings have space for the following plug-in units:

(a) 1-type terminating set or 4182-type network

(b) 227 type amplifier, F58122 amplifier, or 849-type network in the transmit side

(c) 227-type amplifier or 849-type network in the receive side

(d) 359-type equalizer.

3.08 The 24V4C mounting has additional space for the following plug-in units:

(a) 4066-type networks

(b) 648A low-pass filter

(c) 434A continuity plug.

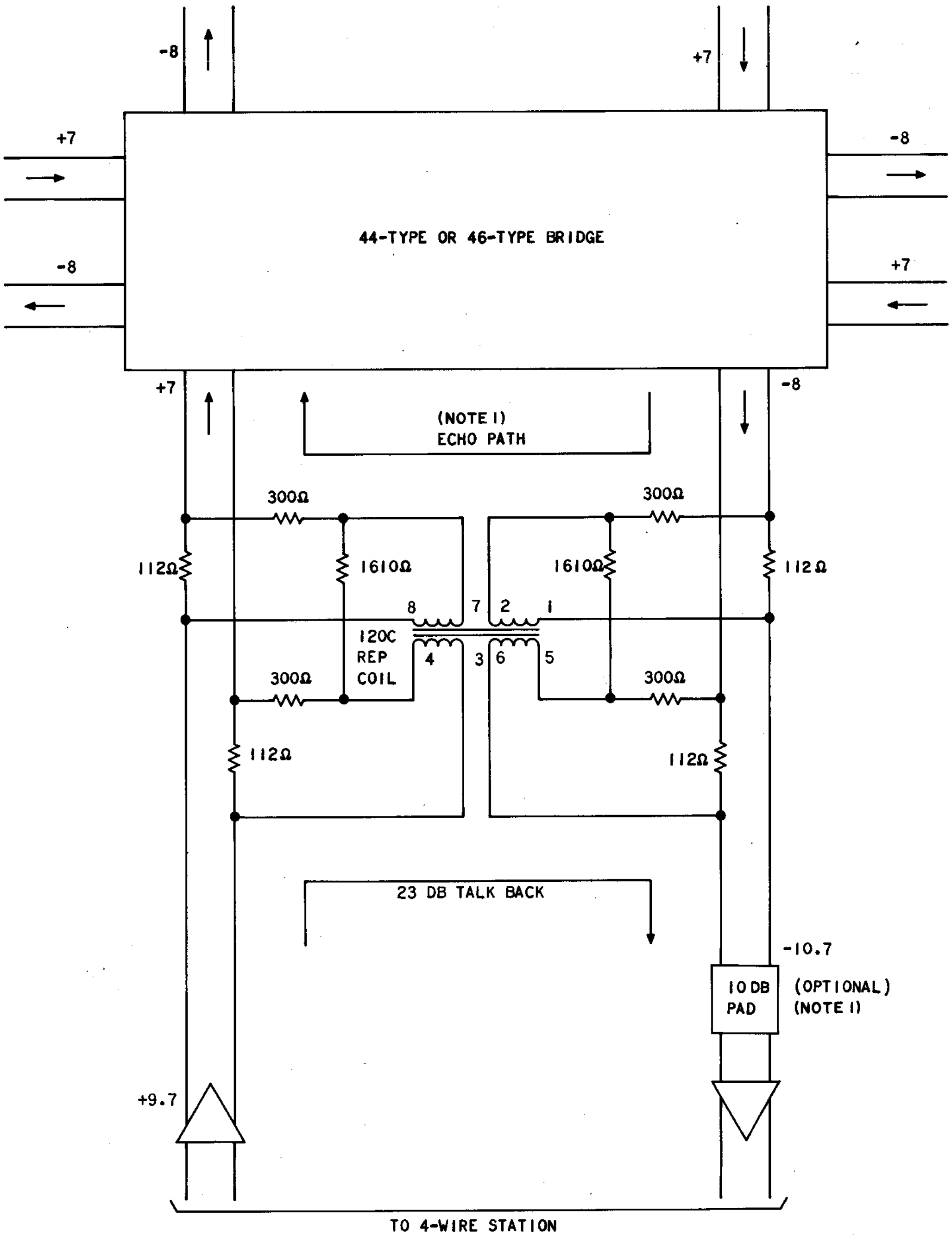
3.09 The 24V4D mounting has all the plug-in spaces of the 24V4C with an additional space for a 332A plug-in relay. This is required when emergency power is not available but continuity of service is essential. Whenever the power supply is interrupted, the relay automatically switches the transmission path around the amplifiers.

B. 44V4 Repeater

3.10 The 44V4 repeater is used to provide amplification and equalization in the 4-wire portion of a circuit. The 44V4A repeater mounting shelf has mounting space for two 44V4 repeaters. Each repeater consists of four mountings with space for one 227-type amplifier or 849-type network and one 359-type equalizer in each direction of transmission.

3.11 Simplex (SX and SX1) paths are available for dc and low-frequency signaling.

3.12 Test jacks are permanently wired into the repeater mounting shelf circuit to give access to the amplifier inputs and outputs for testing and



NOTES:
1. THE ECHO PATH LOSS IS ABOUT 62 DB WITHOUT THE 10 DB PAD AND ABOUT 82 DB WITH THE PAD.
2. RESISTOR TOLERANCES ARE ±1%.

Fig. 8—Low Echo Talk-Back Bridge BR4T03

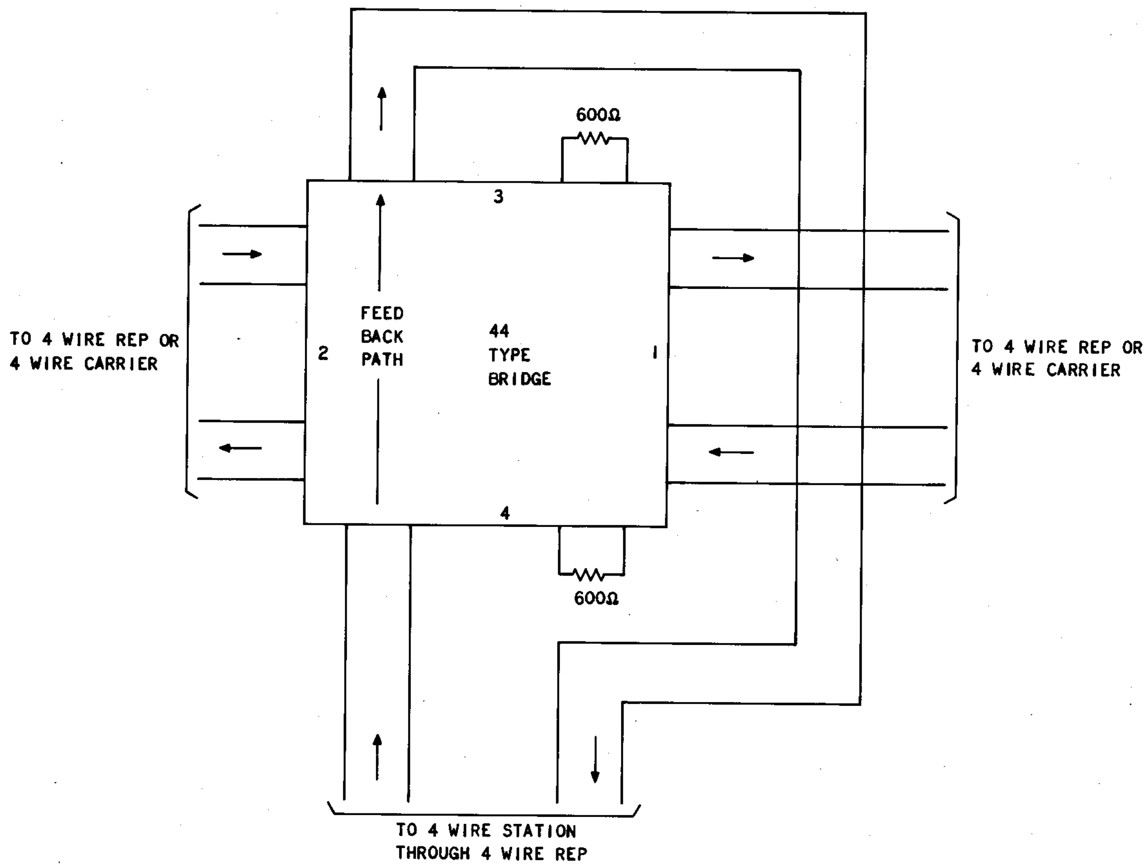


Fig. 9—Talkback Obtained From Spare Leg of 44-Type Bridge

maintenance and to permit high impedance monitoring at these points.

3.13 The test jack designations and their wiring in the repeater circuit are permanently marked on the faceplate of the test jack field.

3.14 Descriptive information for V4-type repeaters is covered in the 332 series of Bell System Practices.

C. 227-Type Amplifiers

3.15 Although there are several types of voice frequency (VF) amplifiers still in use in the Bell System, the most widely used is the 227-type. The 227-type amplifier is a plug-in, transistorized unit with a gain range of approximately 0 to 36 dB. On the face of the amplifier are three screw-type switches for coarse gain setting and a potentiometer for fine gain adjustments.

3.16 Any of the 227-type amplifiers may be used on multistation private line telephone services; however, the 227A, B, E, and F types are preferred. The 227C and D amplifiers have extended low-frequency gain characteristics required for data services, which may cause difficulty in meeting singing margin limits on 2-wire branches.

> ***Note:*** The 227A and 227B amplifiers are rated, "Mfr. Disc."

3.17 Descriptive information on the 227-type amplifiers is available in Sections 024-140-101 and 024-140-103.

D. 4-Wire Terminating Sets

3.18 The interface between a 4-wire circuit and a 2-wire loop is referred to as a terminating set. One method of providing a 4-wire to 2-wire termination or conversion is with the use of a 24V4 repeater and a plug-in 1-type terminating set.

3.19 The 1-type terminating sets that will be used on multistation private line telephone services have built-in adjustable network building out capacitors (NBOC) and provision for connecting external precision networks if needed to meet balance requirements.

3.20 Table A of this section is a list of 1-type terminating sets available and the characteristics of each. References for descriptive information is included in the table.

3.21 Two other methods of terminating 2-wire stations on 4-wire facilities make use of type F signaling on customer premises (CPFT-F Sig) and the recently developed Metallic Facility Terminal (MFT) equipment which are discussed later in this section.

E. Equalizer Units

3.22 Improper equalization affects the frequency response or slope characteristics of a circuit. Most of this type of distortion is caused by the cable facilities used in the makeup of a circuit; however, carrier systems, repeaters, signaling equipment, and terminating equipment all contribute distortion.

3.23 Various types of equalizers are in use to compensate or correct for frequency response. The 359-type equalizer is currently the most widely used. The 359-type equalizers are plug-in units generally used in V4 type repeaters but are also used in other equipment units such as CPFT.

3.24 Table B lists the various 359-type equalizers available and the characteristics of each. The table also lists BSP references for detailed descriptive information on the equalizers.

F. Metallic Facility Terminal (MFT)

3.25 The MFT (SD-1C359-01) is a standard central office arrangement which supplies all necessary transmission and signaling functions to terminate metallic subscriber loop facilities.

3.26 In the MFT, transmission functions are performed by one group of plug-ins, transmission units, and signaling functions are performed by a second set of plug-ins, signaling units. Fig. 10 shows the MFT signaling to transmission unit interface.

3.27 MFT mounting arrangements are available in two basic types. The single module shelf is available for cases where only transmission or only signaling equipment is required. A double module shelf arrangement is available for applications requiring both transmission and signaling equipment. All wiring between the transmission and signaling slot is permanent and does not change for different combinations of plug-in equipment.

3.28 With the use of MFT, all cross connections have been eliminated except for the facility terminations.

3.29 The MFT signaling units applicable to multistation private line telephone service are covered in Part 5 of this section.

3.30 Descriptive information on MFT is contained in Section 332-910-100.

4. STATION TERMINATIONS

A. SD-69566-01 4-Wire Private Line Termination

4.01 With the exception of CPFT and MFT applications which are discussed later, the recommended station termination is the 4-wire private line station arrangement per SD-69566-01.

4.02 The SD-69566-01 4-wire private line terminating circuit, Fig. 11, permits signaling and talking on 4-wire private lines using a loudspeaker, 20 Hz, or dc signaling. This equipment is intended to be installed at the customer location.

4.03 The 4-wire terminating unit provides 150- or 600-ohm impedances on the line side and a low impedance bus on the station side. The low impedance connection for station sets minimizes transmission level changes when the number of bridged sets is increased or decreased. Two 227-type amplifiers are included for setting the station transmit and receive levels and a third 227-type amplifier (optional) is available for talk-back purposes.

4.04 A loop-back relay arrangement is available to permit testing of the transmission facilities between the serving control office and the station, without telephone company personnel at the station. The loop-back relay, when operated, furnishes a transmission path from the test center through the receive loop and receive amplifier, the level compensating pad, the transmitting amplifier and

TABLE A

I-TYPE TERMINATING SETS

TERM. SET (Notes 7 and 8)	SECTION NO. 332-800-	NOMINAL 2-WIRE IMPEDANCE (OHMS) (Note 2)	2-WIRE D.C. RESISTANCE (OHMS) (Note 3)	1 kHz 2W-TO-4W POWER LOSS BETWEEN NOMINAL IMPEDANCES (Note 10)			NOMINAL MIDPOINT CAPACITANCE (Mf)	EQUIPPED WITH SIMPLEX INDUCTOR (Notes 4, 5, and 6)	EQUIPPED WITH PAD SOCKETS (Note 9)
				HYBRID ALONE	HYBRID WITH AMPL SCREWS DOWN	HYBRID WITH NO AMPL SCREWS DOWN			
1A	101	900	51.6	3.8	4.1	4.2	1	Yes	No
1B	102	600	42.8	3.7	4.4	4.5	1	Yes	No
1C*	103	900	51.6	4.2	—	—	1	No	Yes
1D*	104	600	42.8	4.5	—	—	1	No	Yes
1F*	103	900	51.6	4.2	—	—	1	Yes	Yes
1G*	105	900	51.6	4.2	—	—	1 or 4	No	Yes
1H	106	Note 1							
1J	107	Note 1							
1K	101	900	51.6	3.8	4.1	4.2	1	Yes	No
1L	102	600	42.8	3.7	4.4	4.5	1	Yes	No
1M*	103	900	51.6	4.2	—	—	1	Yes	Yes
1N*	104	600	42.8	4.5	—	—	1	Yes	Yes

TABLE A (Cont)

Notes:

1. See SD-97138-01 for Term. Set circuits. Special purpose 1H and 1J Term sets are not to be used in general applications. These sets are listed for reference only.
2. Nominal 4-wire impedance is 600 ohms for all Term. sets.
3. For calculations of signal ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
4. All Term. sets equipped with inductors allow optionally shorting the inductors (except the 1F).
5. The simplex inductors are wired in series with the A and B leads on Term. sets 1F, 1K, 1L, 1M, and 1N. They are wired in series with the SX and SX1 leads on Term. sets 1A and 1B.
6. Term. sets with inductors in series with A & B leads must be used to prevent transmission of longitudinal noise from the 4-wire circuit over the simplex leads to the 2-wire circuit. This applies when used in combination with Dial Long Line circuits. (See Note 5.)
7. Maximum 2-wire current is 120 milliamps.
8. 4182-type networks may be used interchangeably with 1-type Term. sets. Substitution of a 4182-type network for the 1-type Term. set effectively converts the 24V4 to a 44V4 repeater. This should be considered where 2-wire and 4-wire flexibility advantages outweigh space losses.
9. See Section 852-307-102 for pad information.
10. This is the loss used in computations of levels.

* This unit is equipped with a hybrid circuit with a fixed impedance improving shunt. It does not have AMPL screws.

back to the test center. The loop-back relay is operated by applying −48 volts to the simplex of the test center receive loop and ground to the test center transmit loop. The simplex resistance, made up of the parallel resistance of the transmit and receive loops from the serving central office test center to the station, is limited to 1500 ohms.

4.05 LINE IN and LINE OUT jacks allow bare loop transmission measurements to be made. BUS IN and BUS OUT jacks allow the adjustment of the transmit, receive, and talk-back amplifiers of the 4-wire private line terminating circuit.

4.06 An exclusion circuit permits disabling of the pick-up relays of selected groups of telephone sets at one location to prevent their gaining access to a line in use.

4.07 Transmitter talk battery is supplied locally by the 4-wire private line terminating circuit.

TABLE B

359-TYPE EQUALIZERS

EQUALIZER	SECTION NO. 332-116-	4-WIRE FACILITY	EQUALIZATION		1 KHz Loss BETWEEN NOMINAL IMPEDANCES (Note 3)	TRANSFORMER IMPEDANCE RATIO		IMPEDANCE FACING FACILITIES (OHMS)	ADJUSTABLE	SIMPLEX PATH RESISTANCE PER TRANSFORMER (OHMS) (Note 1)
			TRMT	RCV		EQPT	LINE			
359A	101	Loaded Cable — H88 With Gain (Amplifier) Required	No	Yes	6.2 to 9.2	—	—	1200	Yes	No Tap
359B	102	Long Lengths Nonloaded Cable	Yes	Yes	0.5 (Note 5)	600	150	150	No	1.3
359C Dummy	103	600-ohm Eqpt (No Equalization)	No	No	0	—	—	600	No	No Tap
359D	104	Loaded Cable — H88 With 849B Network Required	No	Yes	0 to 3.0	—	—	1200	Yes	No Tap
359E Dummy	105	Short Lengths Loaded Cable — H88 With Amplifier (No Equalization)	No	No	0	—	—	1200	No	No Tap
359F	106	Short Lengths Nonloaded Cable	Yes	Yes	0.5 (Note 5)	600	600	600	No	6.75
359G	107	Loaded Cable or Carrier Channels Data	No	Yes	8.5 to 20.0	—	—	1200 (Note 4)	Yes	No Tap
359H	108	Loaded Cable or Carrier Channels Data	No	Yes	0.9 to 1.2	—	—	600	Yes	No Tap

TABLE B (Cont)

359-TYPE EQUALIZERS

EQUALIZER	SECTION NO. 332-116-	4-WIRE FACILITY	EQUALIZATION		1 KHz LOSS BETWEEN NOMINAL IMPEDANCES (Note 3)	TRANSFORMER IMPEDANCE RATIO		IMPEDANCE FACING FACILITIES (OHMS)	ADJUSTABLE	SIMPLEX PATH RESISTANCE PER TRANSFORMER (OHMS) (Note 1)
			TRMT	RCV		EQPT	LINE			
359J Dummy	109	Short Lengths Loaded Cable — H88 With 849B Network Required (No Gain or Equalization)	No	No	0	—	—	1200	No	No Tap
359K (Note 2)	110	Loaded Cable — H44 With Gain (Amplifier) Required	No	Yes	6.2 to 7.8	—	—	600	Yes	No Tap
359L	111	Loaded Cable — H44 With 849G Network	No	Yes	0 to 1.6	—	—	600	Yes	No Tap
359P (Note 2)	114	Unigauge	No	Yes	6.2 to 24.5	—	—	1200	Yes	No Tap

Notes:

1. For calculations of signaling ranges, add 15% to the tabulated average values. This compensates for manufacturing variations and temperature.
2. Includes a 6.2 dB pad.
3. This is the loss used in computation of levels. See Section 852-307-101 for 359-type equalizer screw settings.
4. Shelf wiring provides connection from the 4-wire line through the equalizer to the 1200-ohm side of the 227-type amplifier. The equalizer is wired in tandem with the receiving amplifier input circuit where it works between nominal 600-ohm terminations.
5. Transformer loss only.

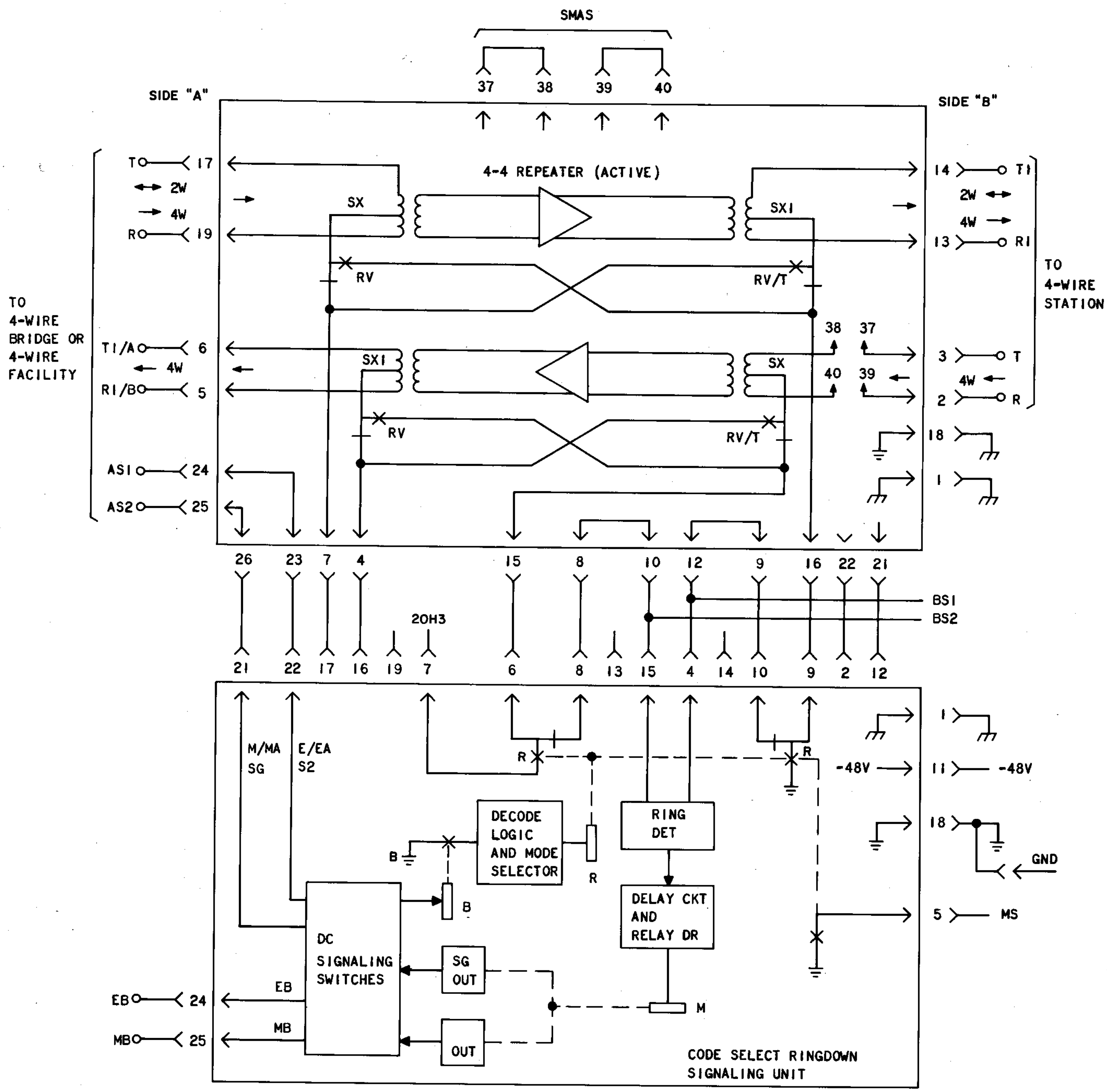


Fig. 10—MFT Signaling to Transmission Unit Interface

4.08 Instructions on installation and lineup procedures are contained in Section 480-615-100.

B. Type F Signaling On Customer Premises (CPFT-F Sig)

4.09 The Customer Premises Facility Terminal (CPFT-F Sig), Fig. 12 and 13, may be used to terminate one or two 4-wire metallic lines in 2- or 4-wire telephone sets.

4.10 Through the application of standard design techniques, the CPFT may be assembled, lined up, and tested prior to installation.

4.11 The CPFT-F Sig unit is described in Section 332-601-200.

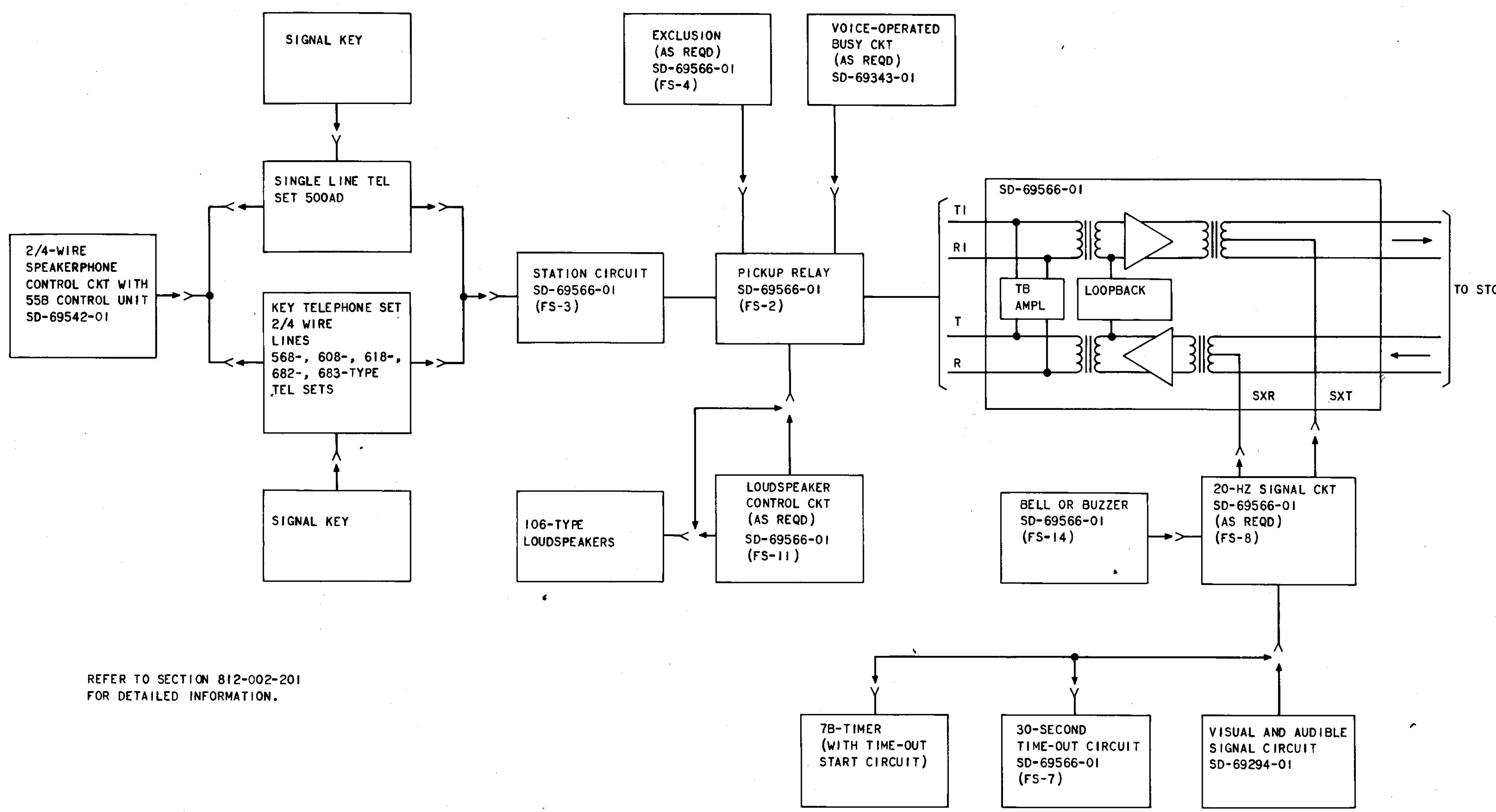


Fig. 11—4-Wire Private Line Station Arrangement Per SD-69566-01

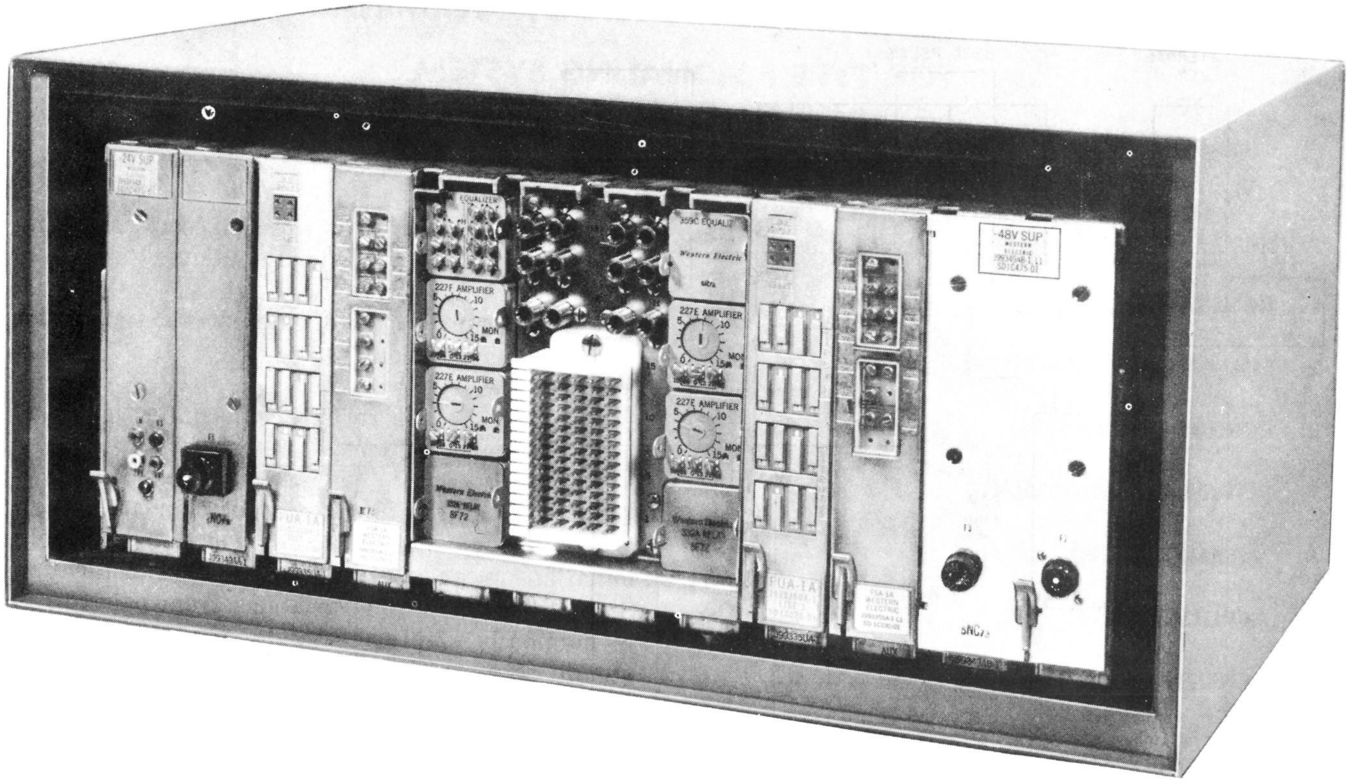


Fig. 12—CPFT-F Sig Terminal Unit

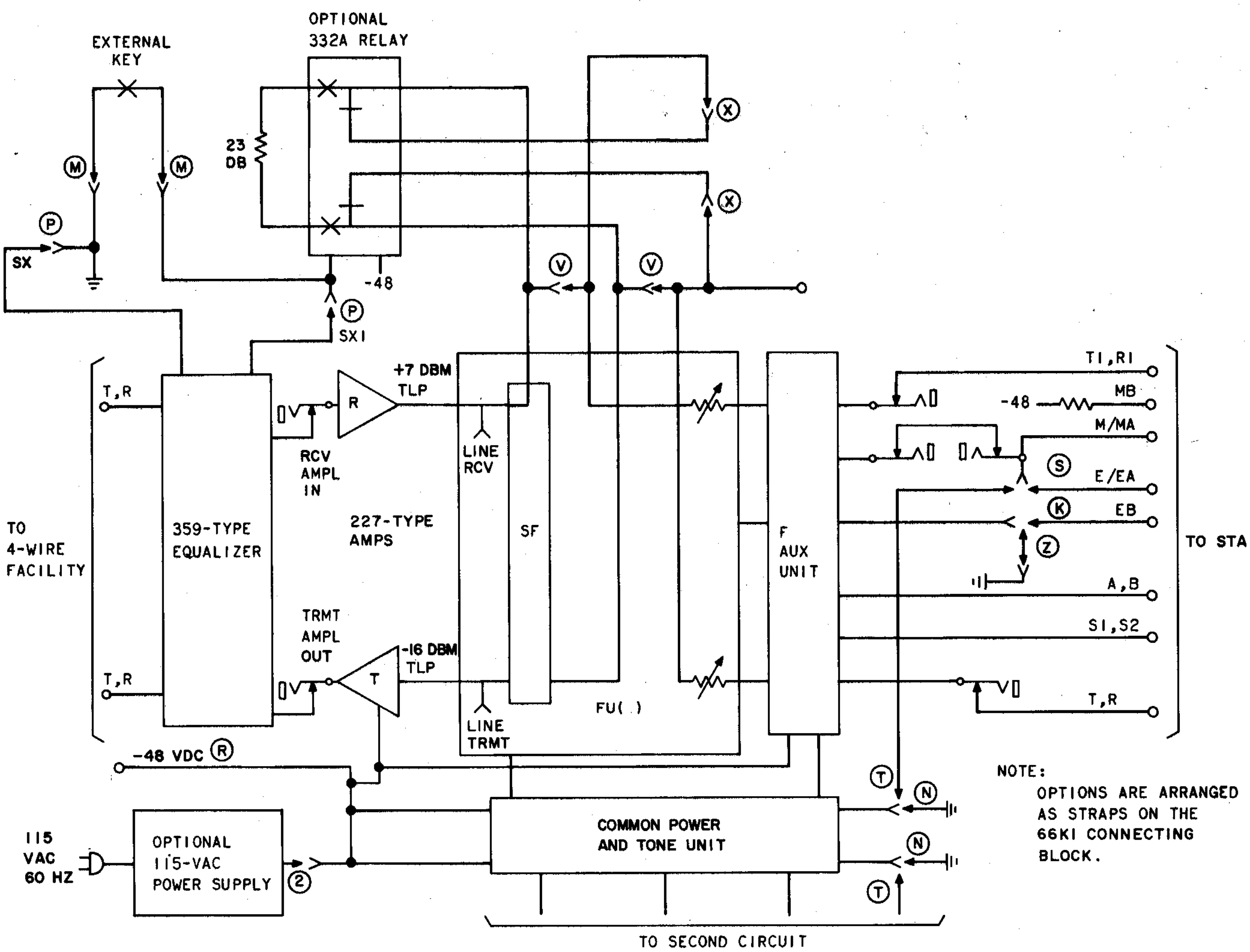


Fig. 13—Block Diagram of CPFT-F Sig Station Terminal

4.12 When this section was being prepared a new CPFT using MFT plug-in units was under development. When information on the new CPFT-MFT becomes available, this section will be reissued.

5. SIGNALING ARRANGEMENTS

5.01 Various types of signaling are used on multistation private line telephone services. The specific signaling arrangement for each circuit is determined by considering customer requirements, facilities, and equipment available.

5.02 The equipment units used for receiving, converting, and transmitting signals are listed below.

NAME	FUNCTION	REFERENCE
D1B	E&M to 20-Hz converter	SD-56163-01
D0B	E&M to SG lead converter	SD-56159-01
10D	SG lead to 20-Hz converter	SD-55560-01
SF Units	E&M to 2600-Hz	BSP 179 series
FGM Aux. Unit	20-Hz to 2600-Hz 2-wire	BSP 332-601-100
FHM Aux. Unit	20-Hz to 2600-Hz 4-wire	BSP 332-601-100
Ringdown Converter Signaling Unit (RCSU)	SG lead to 20-Hz converter	BSP 332-911-104
	SG to E&M lead converter	BSP 332-911-104
	E&M to 20-Hz converter	BSP 332-911-104

5.03 When it is required that selective signaling be provided, ringing of certain stations or groups of stations, the following units or systems are also used. The WA-21633-SD Code Selector is shown in Fig. 14.

NAME	FUNCTION	REFERENCE
Code Selector	Counts and responds to preset number of manual rings	WA-21633-SD or ES-13338-SD
Code Select Ringdown (CSR) Signaling Unit for MFT	Counts and responds to preset number of manual rings	BSP-332-911-104
SS-1 and SS-1A Selective Signaling Systems	Permit selective signaling with 2-digit dialing	BSP 982-326-100

5.04 As dc and 20 Hz are not in the voice frequency range, they cannot be transmitted through a bridge but must be transmitted around the bridge using signal conversion equipment. An example of how this is done is shown in Fig. 15.

A. Loudspeaker Signaling

5.05 With this type of signaling, the called party is summoned to the circuit by means of bridged loudspeakers. When the summoned party lifts the handset off the cradle, operates his push to talk button, or plugs into jacks, depending on the option used, the loudspeaker is removed from the circuit allowing normal conversation.

5.06 The private line terminating circuit SD-69566-01, FS11 provides the loudspeaker cutoff function.

5.07 A talk-back arrangement is necessary with loudspeaker signaling. This should be furnished at the customer location if SD-69566-01 is used. Otherwise it may be located at the central office using one of the methods mentioned in 2.14 through 2.17.

5.08 As only voice signals are transmitted, no signal conversion equipment is required at the central office.

B. Ringdown Signaling

5.09 Ringdown or key signaling arrangements have a key or button at the station which, when operated, causes a 20-Hz ringing signal to be transmitted, alerting all stations on the circuit.

5.10 With ringdown signaling, signal conversion is required to convert the 20 Hz to a signal suitable for transmission over the facilities. This may be accomplished by:

(a) Using a D1B signal converter at the central office which converts the 20 Hz from the station to E&M lead signaling which in turn controls an SF unit

(b) The use of CPFT with F-type signaling equipment which converts the signal at the station to 2600 Hz

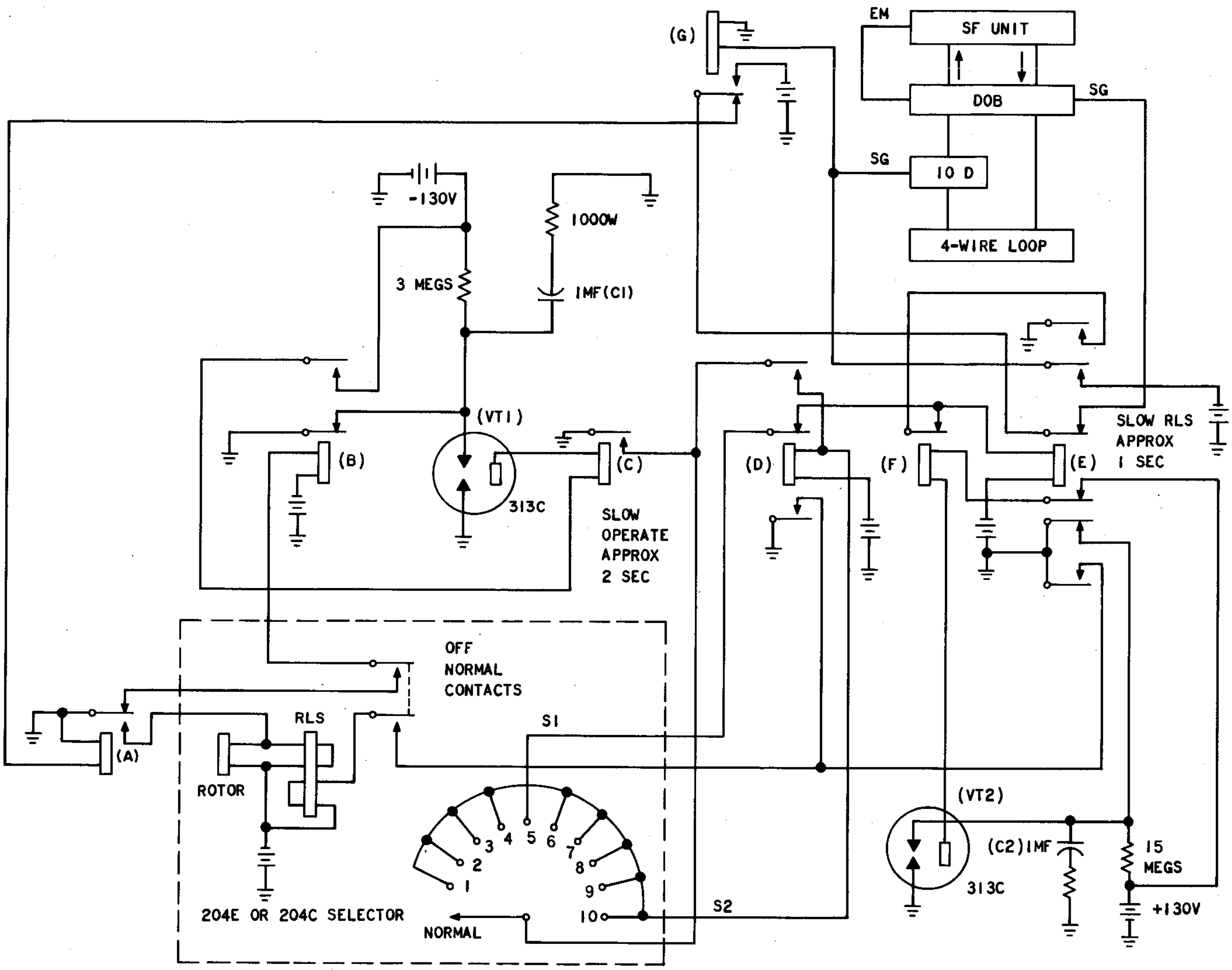


Fig. 14—Central Office Code Selective Signaling Arrangement Per WA-21633-01

(c) The use of MFT equipment with a Ringdown Converter Signal Unit (RCSU) controlling an SF unit.

C. Code Selective Ringdown Signaling

5.11 Code selective ringdown signaling permits stations on the circuit to selectively signal any other station or group of stations on the circuit by operating the signal key or button a pre-determined number of times.

5.12 With this type of signaling, each loop to be signaled requires equipment which counts the ringing bursts and responds when the code for which it is set, is received.

5.13 There are two basic types of code select ringdown units. They are:

(a) Electro-mechanical types such as

(1) WA 21633-SD

(2) EA 13338-SD

(b) Electronic Type

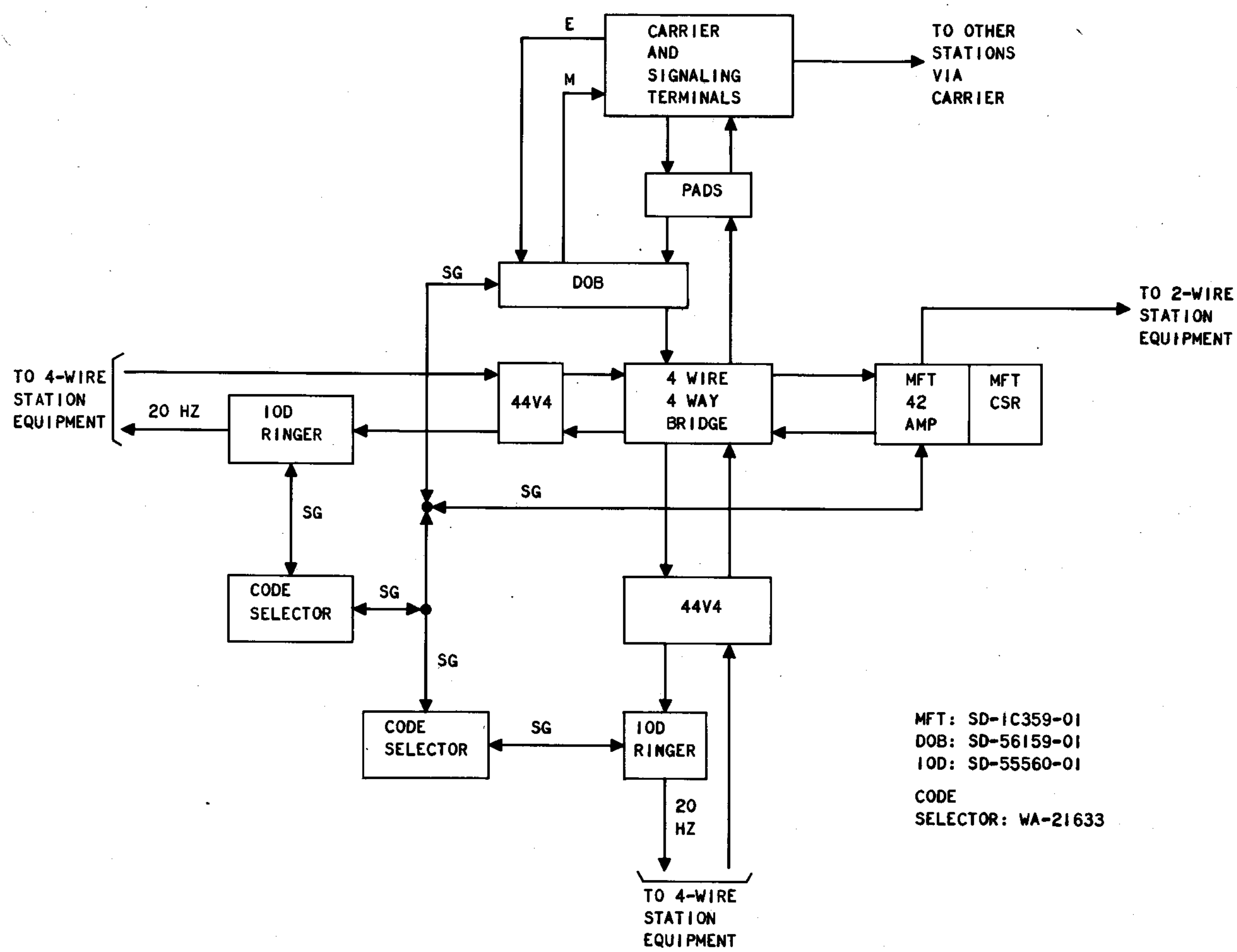


Fig. 15—Typical Bridging Point Using Signal Converters and Code Selectors

(1) MFT Code Select Ringdown (CSR) signaling unit.

5.14 The electromechanical units, composed essentially of relays and a mechanical selector will respond to a maximum of 10 codes. These units, located in the central office, require dc signaling (SG or E&M); therefore, a signal converter is required when working directly into the station loop.

5.15 The electronic CSR signaling unit mounts in the signaling slot of double module MFT bays. This unit may be set to respond to 15 codes by adjustment of screw switches.

5.16 The MFT CSR:

(a) Detects ringing from a station and converts it to dc signaling (E&M or SG)

(b) Receives dc signaling from the facility side and converts it to 20 Hz toward the station.

D. SS-1A Selective Signaling System

5.17 The SS-1A Selective Signaling System SD-69594-01 replaces the SS-1 system which has been rated Mfr. Disc. The SS-1A system is designed to be installed at the customer premises.

5.18 The standard station termination to be used with the SS-1A is the 4-wire private line termination SD-69566-01. The SS-1A equipment is inserted between the line termination circuit and the station circuit or pickup relays of the 4-wire termination. This permits stations at the same location to signal each other as well as distant points on the circuit.

5.19 The SS-1A systems use two-digit codes with a possibility of 81 codes. The digit one is not assigned in any combination, but is reserved as a first digit cancellation code. If an erroneous first digit is dialed, the digit one may be dialed to cancel the first digit.

5.20 Dial pulses are converted to 2600 Hz and 2400 Hz frequency shift pulses by the keyer circuit of the SS-1A for transmission over the 4-wire line facility.

5.21 Upon receipt of the first pulse of any code, the SS-1A system applies a busy signal to all stations until the second digit has been received or until a 6-second time out interval has occurred. Failure to dial the second digit within 6 seconds of the first is recognized as call abandonment and the calling station is released from the keyer circuit.

5.22 Detailed descriptions of the SS-1 and SS-1A systems are contained in Sections 982-325-100 and 982-326-100 respectively.

6. SWITCHING ARRANGEMENTS

6.01 Typical arrangements for switching multistation private line telephone circuits terminated at the same location are shown schematically in Fig. 16 through 21. Switching operations are accomplished by 4-wire switching relays using 4-wire bridges as interconnecting devices. The operation of the switch relays is controlled by one or more private line stations using dc channels between the central office and a station or by using one of the selective signaling systems. From a transmission standpoint a switching arrangement is similar to a plain bridging arrangement since in the switched condition two or more circuits are interconnected and appear as one circuit to the bridge. In the nonswitched condition, the circuits appear as terminal circuits either routed through a bridge or without a bridge. Some of the more commonly used switching arrangements are described in the following paragraphs.

6.02 ***Arrangement for Interconnecting Two Circuits at a Bridging Point. Use of Loop Normally Connected to Bridge During Switched Condition:*** An arrangement to switch two circuits as discussed above is shown in Fig. 16. If both circuits have bridges the transmission path designated "Line of Circuit 1" will connect to a 4-wire bridge via a 4-wire repeater. A 44-type bridge is used with the line and branch of circuit 2 connected respectively to legs 2 and 3 of the bridge, the loop of circuit 2 to the local station being connected to leg 4. In the nonswitched condition the line of circuit 1 connects through contacts of the SL1 relay to its loop, side 1 of the bridge being terminated. In the switched condition operation of the SL1 relay connects the line of circuit 1 to side 1 of the bridge, leaving the loop of circuit 1 open. With the branches illustrated a talk-back bridge is used for circuit 2 but a talk-back amplifier is used for circuit 1 since the talk-back bridge can only be used where gain is available in the loop. Other talk-back arrangements may be used for circuit 2.

6.03 Since all bridge levels in any given office are kept at a standard level, pads TL2, RL2, TL3, and RL3 may be required to convert from the levels at the facility to the bridge level. Pads TL1, RL1, TD1, and RD1 are not always required since, as in the case shown in Fig. 16, adjustment of levels can be made by adjusting the loop repeater gains. In the description of other switching arrangements that follow, discussion of pads will be limited to those pads that pertain directly to the switching arrangement. Pads TL1, RL1, TD1, and RD1, shown in Fig. 16, are frequently required. The RD1 pad and TL1 pad are used to obtain the proper level into the toll circuit from the transmitting loop and the bridge respectively. Pads TD1 and RL1 permit the desired levels to be set in the receiving loop and bridge respectively. Although the levels from the loop and bridge will be alike or will have a planned difference, the RD1 and TL1 pads will not both be required if a repeater is associated with the toll circuit since one of the pads can be 0. Similarly, TD1 and RL1 may not both be required. When fixed gain carrier channels appear in the line, however, the value of the level as well as the difference is fixed by circuit conditions and both pads may be required.

6.04 ***Arrangement to Interconnect Two Circuits at a Bridged Point. Loop of Switched Lines Used on Switched Connections:*** This arrangement is shown in Fig. 17 and is similar to Fig. 16 except that in the switched condition the loop of circuit 1 is substituted for the loop of circuit 2 on leg 4 of the bridge, the loop of circuit 2 being left open. The values of Pads RD1, TD1, RL1, and TL1 are so chosen that the same levels exist on the line of circuit 1 when connected to its loop and when connected to leg 1 of the bridge. The

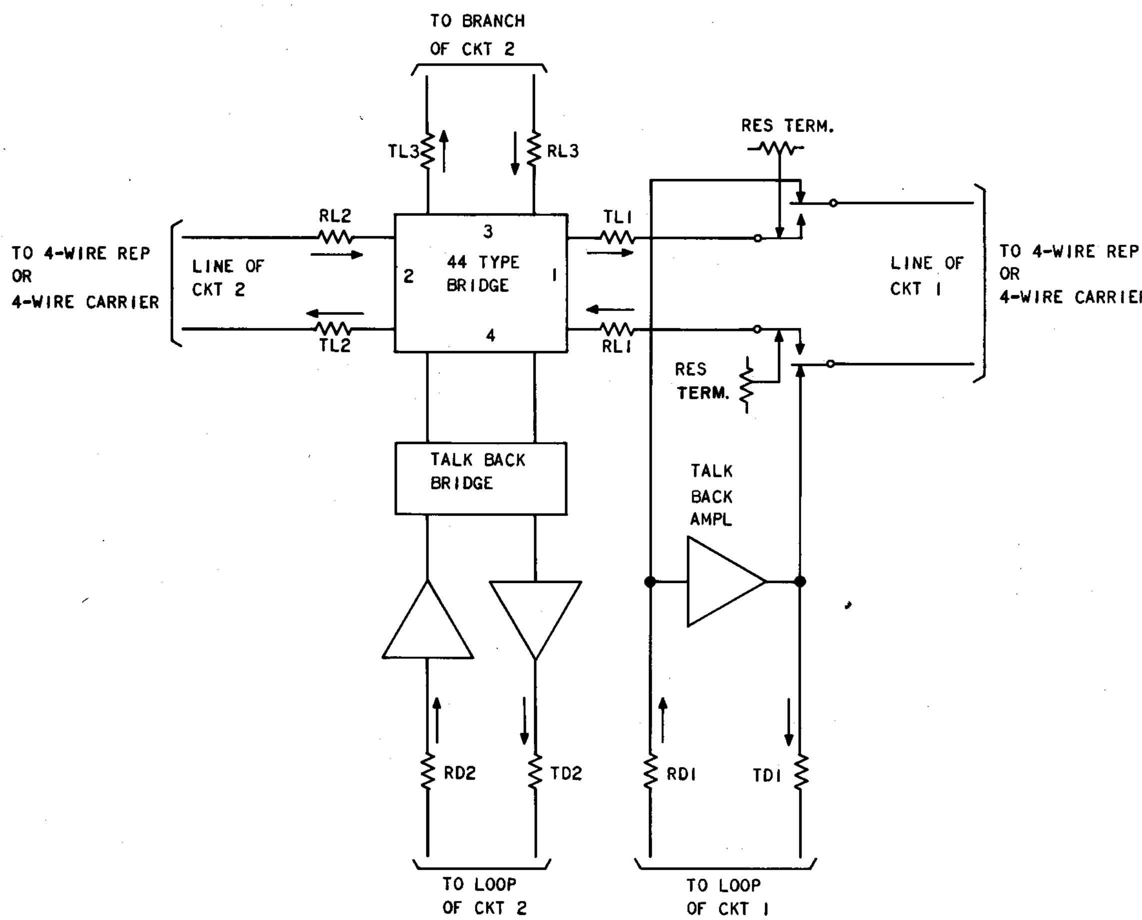


Fig. 16—Typical Switching Arrangement for Interconnecting Two Circuits at Bridging Point. Loop of Switched Line Not Used in Switched Condition

levels on the loop side of the repeater of leg 4 of the bridge, to which the loop of circuit 1 may be switched are thus determined by the levels from pad RD1 and into pad TD1. Therefore, with this arrangement pads RD2 and TD2 will usually be required to adjust the levels from the transmitting loop and into the receiving loop of circuit 2 respectively.

6.05 ***Arrangement to Interconnect Two Circuits at Nonbridging Points:*** A third arrangement to interconnect two circuits is shown in Fig. 18. In the nonswitched condition both loops are connected to their respective lines through line relays SL1 and SL2. In the switched condition the interconnection of the two circuits is accomplished by introducing a 44-type bridge, so arranged that loop 2 through relay SD5 connects to a repeater on leg 4 of the bridge, loop 1 being left open. This arrangement permits the adjustment of the net loss of the loop connected to the bridge in the switched condition. This adjustment may be of advantage when a 2-wire loop is employed and the loop is used only for supervision and monitoring, since the loss to the loop may be increased, thereby reducing echo and return currents on the overall connection.

6.06 ***Arrangement to Interconnect any Two of Three Circuits:*** An arrangement to interconnect three circuits, any two at a time, is shown in Fig. 19. The circuits shown as lines 1, 2, and 3 in Fig. 19 may have their own individual bridges in addition to the switching bridge that is shown. If the circuit or circuits have bridges, the lines will connect to a 4-wire repeater and then to their individual bridges. Under control of three keys at the station the toll lines of any two circuits may be connected to the 44-type bridge through

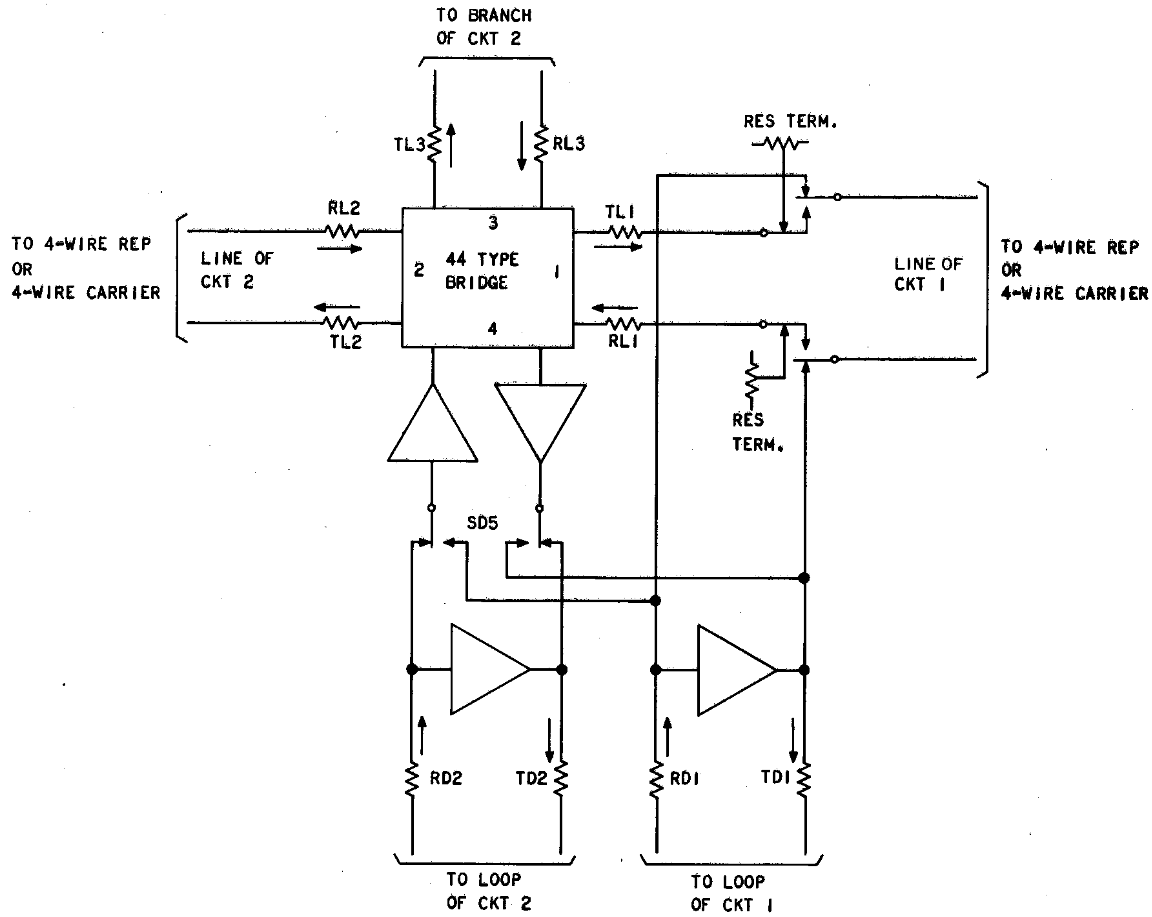


Fig. 17—Typical Switching Arrangement for Interconnecting Two Circuits at Bridging Point. Loop of Switched Line Used In Switched Condition

operation of the SL relays and the loop of one of the circuits is connected to the repeater on Leg 4 of the bridge by operation of the SD4 or SD7 relays.

6.07 Provision is made for including the RD5, TD5, RD4, and TD4 pads to adjust the levels into the repeater connected to Side 4 of the bridge. Usually these pads may be omitted by adjusting the RD2, TD2, RD3, and TD3 pads to provide the same losses for loops 2 and 3. Where it is necessary to use different line levels for circuits 2 and 3, however, the loop losses cannot be adjusted to the same value and RD4 and TD4 or RD5 and TD5 pads will be required. When circuit 3 is in a nonswitched condition, pads RD4 and TD4 are bridged across it. Relay AS6 is provided with these pads to open their shunt paths and thus prevent their causing a bridging loss.

6.08 ***Arrangement to Interconnect Three Circuits in Any Combination:*** An arrangement to switch three circuits in any combination is shown in Fig. 20. With this arrangement a switching bridge is used and no loops are disconnected in the switched condition. The levels at all legs of all bridges will be the same. The three 4-wire repeaters are lined up the same as though they were used to interconnect two bridges directly.

6.09 ***Arrangement to Interconnect Four Circuits in Any Combination:*** Fig. 21 shows an arrangement that permits connecting four circuits in any combination of two, three, or all four. Two, two-circuit combinations can be switched at the same time by switching two of the circuits into the first switching bridge and by switching the other two circuits into the second switching bridge.

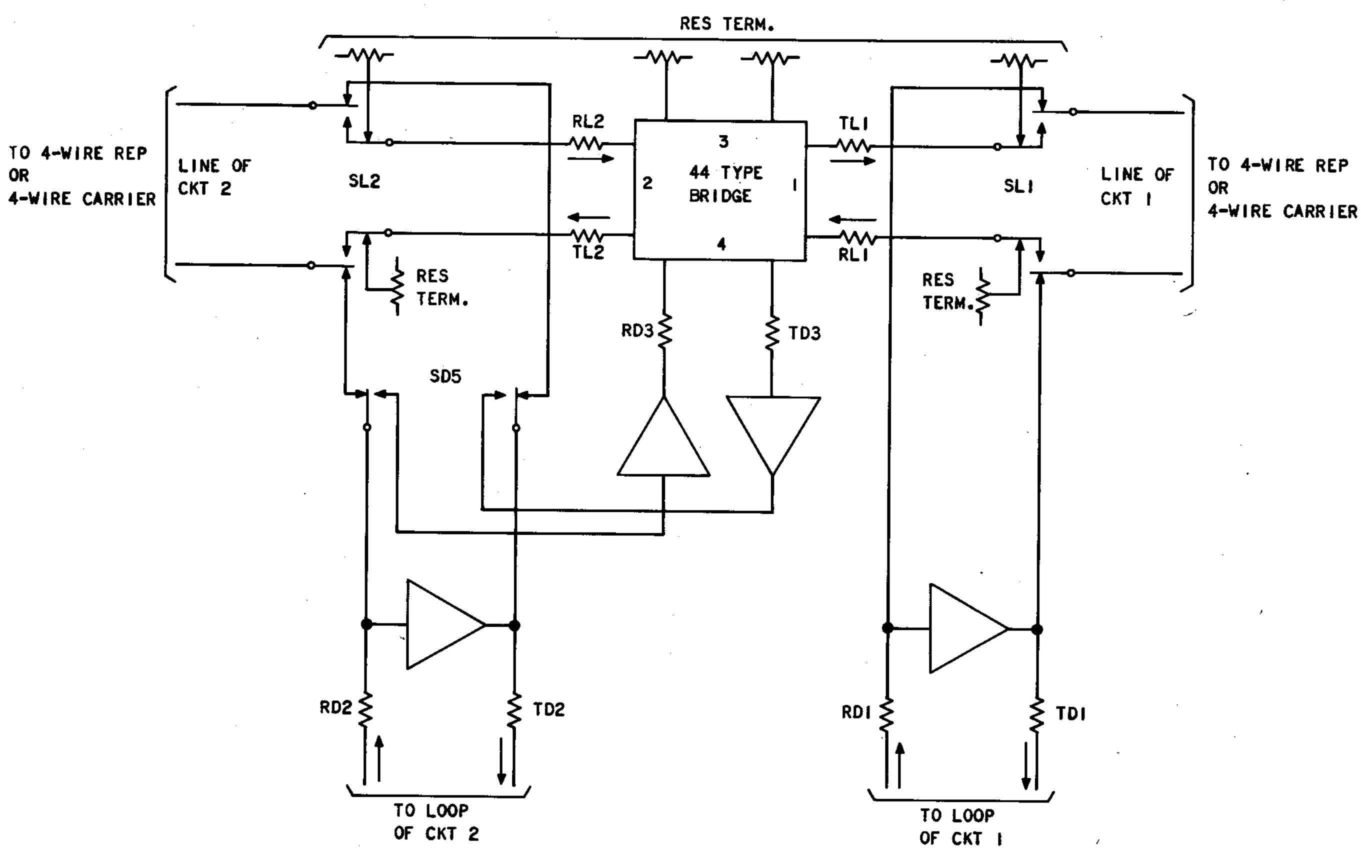


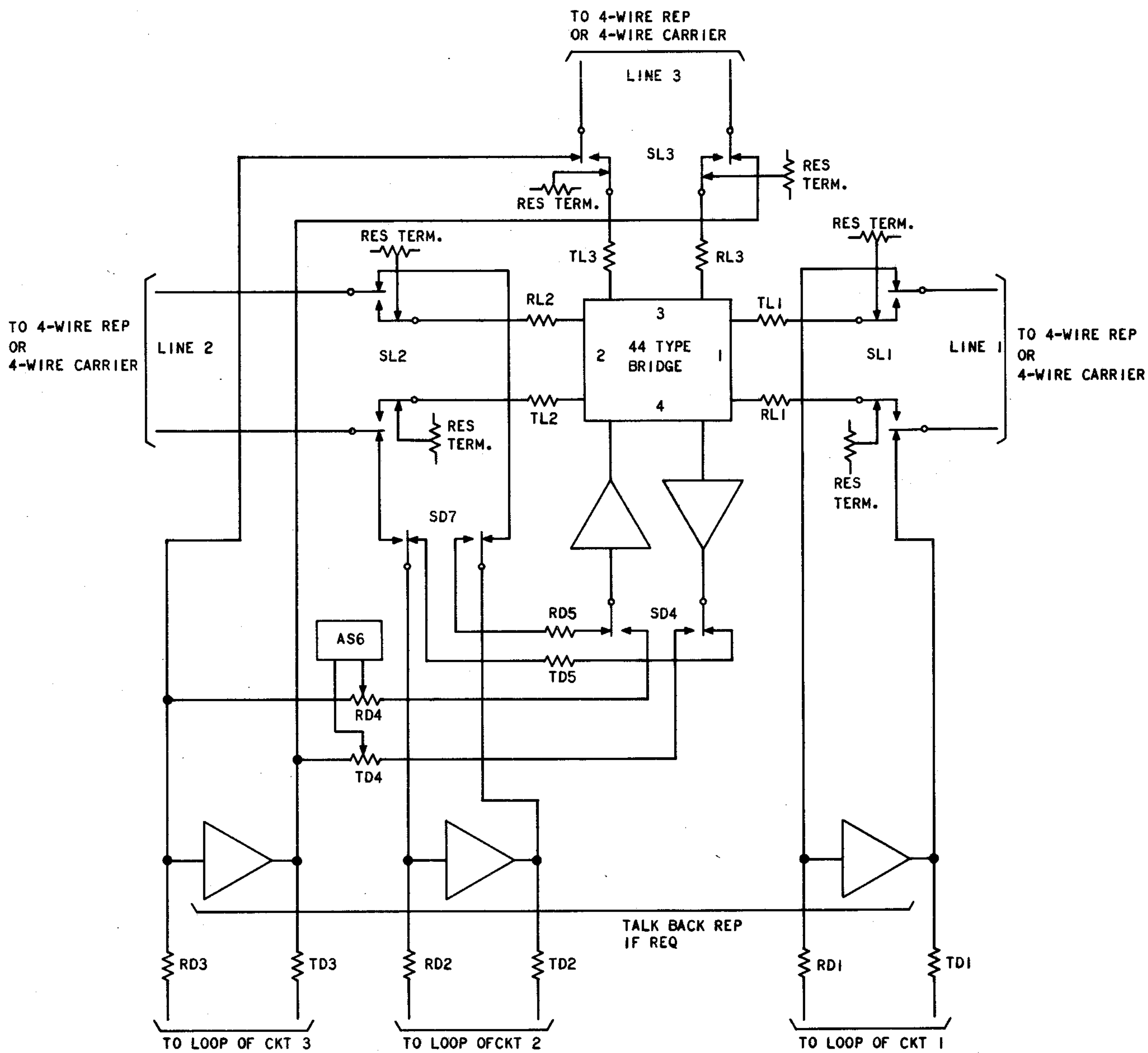
Fig. 18—Typical Switching Arrangement for Interconnecting Two Circuits at a Nonbridging Point

No loops are disconnected in the switched condition. The repeaters shown in Fig. 21 are lined up the same as repeaters used to connect two bridges without a switching arrangement.

7. REFERENCES

7.01 The following documents contain additional information applicable to multipoint private line telephone service.

SD-, CD-	TITLE
SD-, CD-1C359-01	Metallic Facility Terminal Circuit
SD-, CD-69566-01	4-Wire Private Line Terminating and Station Circuit
SD-, CD-1C475-01	Customer Premises Facility Terminal for F-Type Signaling
SD-, CD-69594-01	Station Systems SS-1A Selective Signaling System
SD-, CD-69254-01	Station Systems 2-Wire and 4-Wire Private Line Station Circuit
SD-, CD-55647-01	Signaling Line and Balancing Multistation Line Circuits
310-405-500	Private Line Telephone Service Multistation Systems Test and Adjustments
332-104-100	V4 Telephone Repeater—Description
332-105-10Z	24V4 Repeater—Description
332-115-10Z	849-Type Networks—Description
332-116-1ZZ	359-Type Equalizer—Description
332-601-ZZZ	Customer Premises Facility Terminal for Type F Signaling System



CIRCUITS INTERCONNECTED	SWITCHING RELAYS OPERATED
1-2	SL1, SL2, SD7
1-3	SL1, SL3, SD4
2-3	SL2, SL3, SD4

Fig. 19—Typical Switching Arrangement for Interconnecting any Two of Three Circuits

332-910-100	Metallic Facility Terminal—General Description	332-911-ZZZ	Metallic Facility Terminal—Signaling Units
332-910-180	Metallic Facility Terminal—Application Information	332-912-ZZZ	Metallic Facility Terminal—Transmission Units

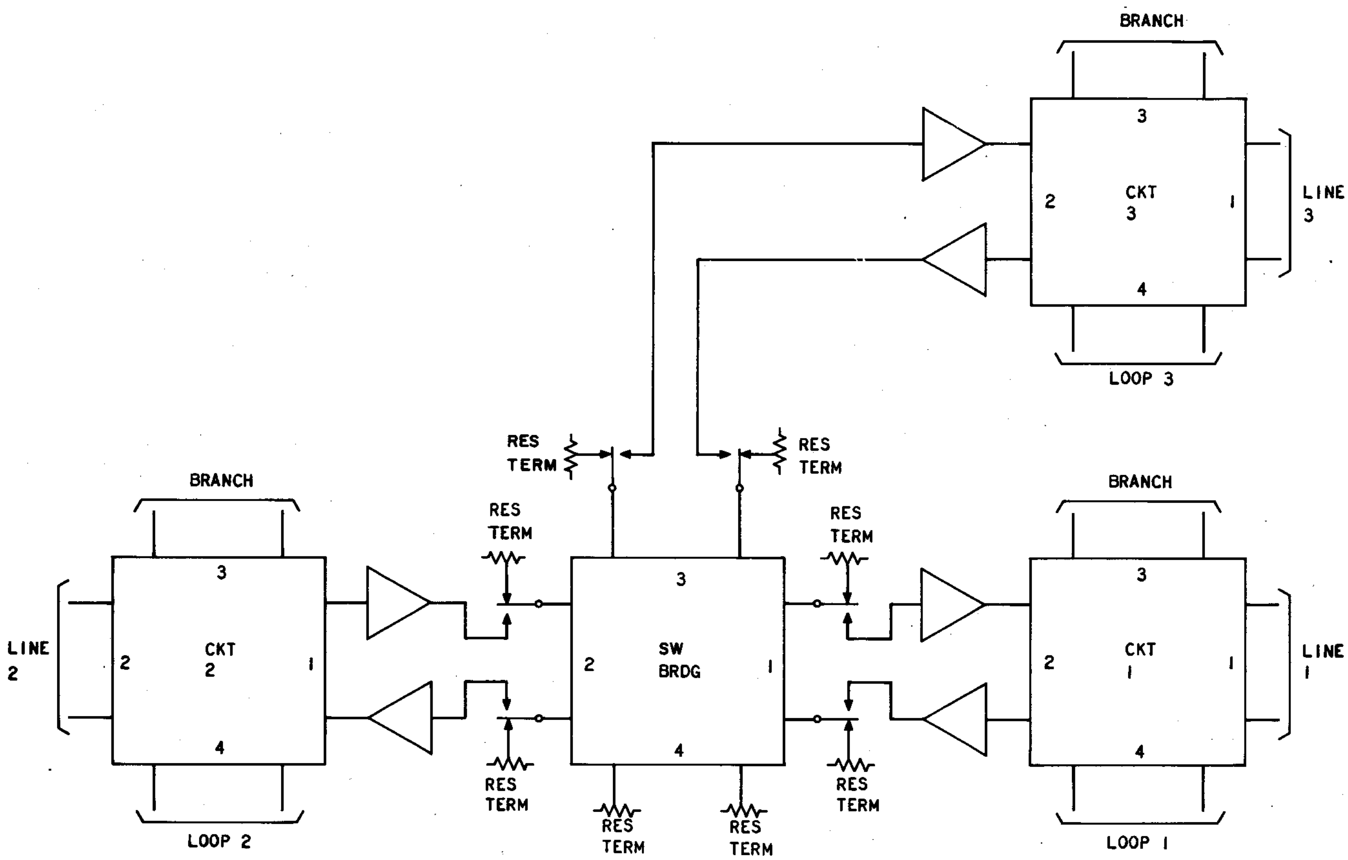


Fig. 20—Typical Switching Arrangement for Interconnecting Three Circuits in Any Combination

480-615-100	4-Wire Private Line Terminating Circuit—SD-69566-01	982-326-100	SS-1A Selective Signaling System—Description
332-434-100	4233A Network 4-Way Bridge Description	001-683-501 LL	Circuit Layout—Bridges Codes Description and 1000-Hz Losses
812-002-ZZZ	Private Line Service Terminations—Station Engineering Information	024-140-103	227-Type Amplifier Description

TO CONNECT	TO	OPERATE
CIRCUIT 1	SW BRDG 1	SL1-1
CIRCUIT 1	SW BRDG 2	SL1-2
CIRCUIT 2	SW BRDG 1	SL2-1
CIRCUIT 2	SW BRDG 2	SL2-2
CIRCUIT 3	SW BRDG 1	SL3-1
CIRCUIT 3	SW BRDG 2	SL3-2
CIRCUIT 4	SW BRDG 1	SL4-1
CIRCUIT 4	SW BRDG 2	SL4-2

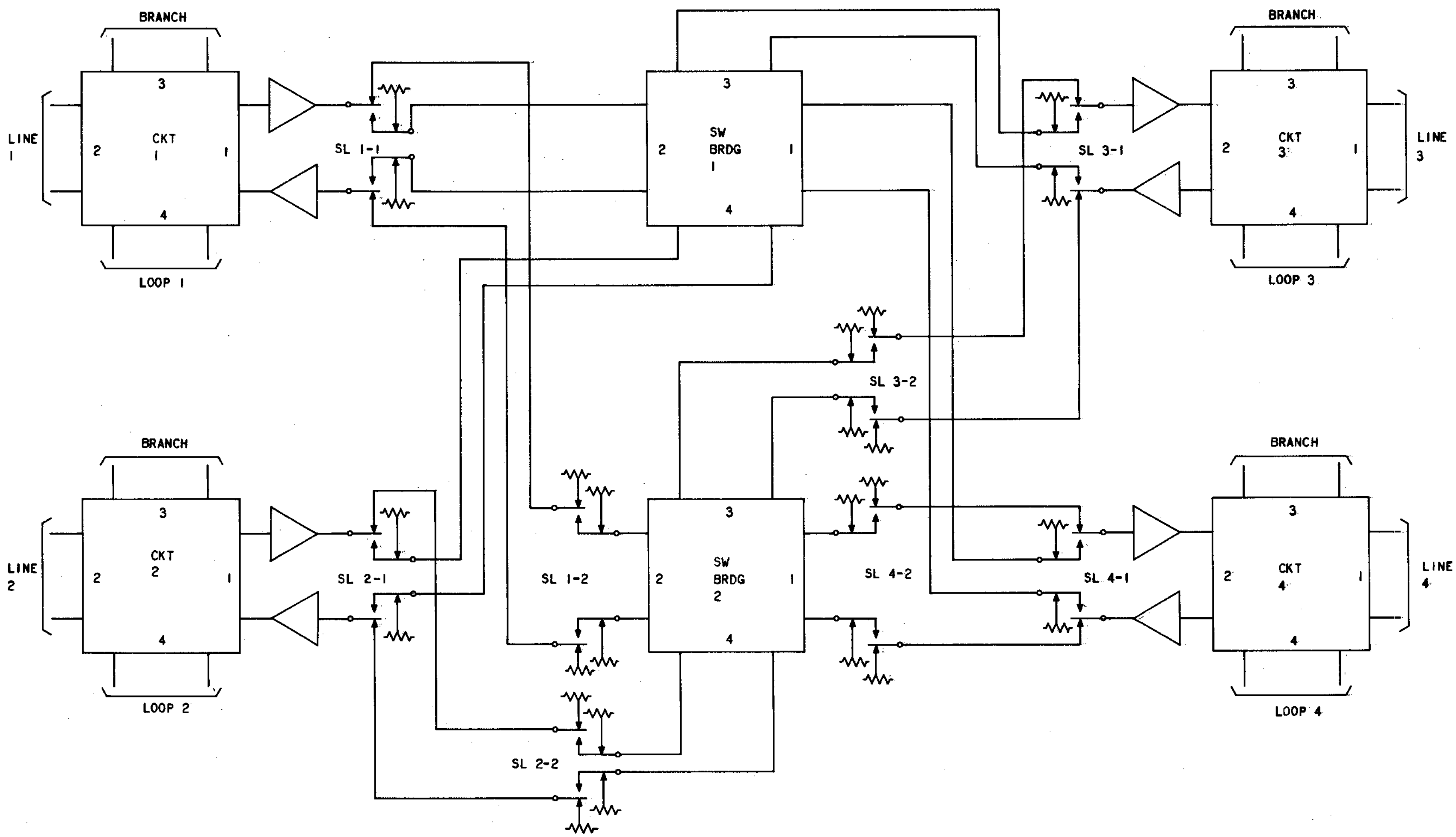


Fig. 21—Typical Switching Arrangement for Interconnecting Four Circuits in Any Combination