

112A KEY EQUIPMENT
CONFERENCE CIRCUIT SD-69490-01 AND ALTERNATE
TERMINATION TRANSFER CIRCUIT SD-69492-01
DESCRIPTION OF OPERATION
FOR SAGE SYSTEMS

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1. GENERAL

1.01 The Alternate Termination Transfer Circuit (transfer circuit) and the Conference Circuit (conference circuit) described in this section were designed primarily for use in the SAGE system of air defense to permit dual use of a PBX trunk facility.

1.02 The transfer circuit provides means for preempting a PBX tie trunk facility between two Air Force locations and for transferring each end of the facility from its PBX termination to another operating location such as a command console at a Direction Center.

1.03 The conference circuit provides means for a controlling officer, by operation of a single key, to cause the transfer of up to 15 tie trunk facilities from their original terminations in a PBX to a conference bridge and amplifier circuit. Provision is made for retransfer of the tie trunk facilities to their original PBX terminations upon completion of the conference.

2. EQUIPMENT DESCRIPTION

2.01 The various components and apparatus which make up the transfer circuit and the

conference circuit are all mounted on 23-inch mounting plates. The mounting plates are normally installed on frames in a separate equipment room. The actual transfer and conference initiating keys can be mounted on a key telephone set, or a PBX switchboard, or at any attendant position.

3. FUNCTIONAL DESCRIPTION

A. General

3.01 The transfer circuit and the conference circuit were developed to ensure rapid and positive preemption of PBX-to-PBX tie trunks. The transfer circuit enables each end of a tie trunk to be transferred from its normal PBX termination to a position circuit associated with 112A key equipment, Switching System No. 302, or 1A1 key equipment. The conference circuit has many features similar to the transfer circuit and, in fact, makes use of the transfer circuit in performing its function. The conference circuit permits a maximum of 15 PBX tie trunk facilities to be preempted simultaneously and to be reconnected to a conference bridge at the originating location and to a maximum of 15 different operating positions at remote locations. The conference circuit does the preempting at the originating location while associated transfer circuits at the remote locations perform the transfer there.

B. Transfer Circuit

3.02 Fig. 1 is a simplified drawing illustrating the transfer circuit, associated circuits, and the interconnection between these circuits and the PBX tie trunk facility. This drawing shows transfer occurring on the 2-wire side of the

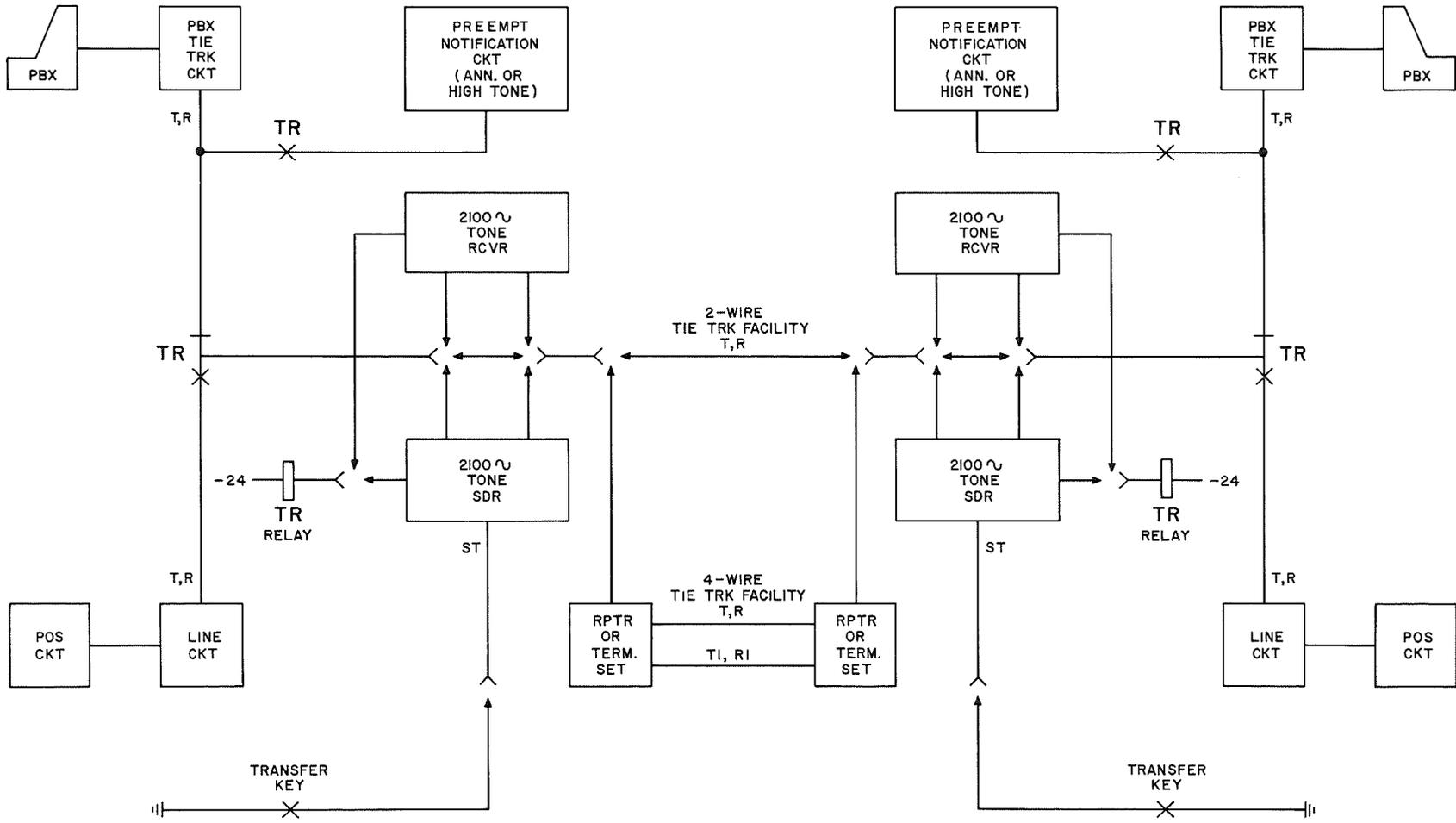


Fig. 1 — Alternate Termination Transfer Circuit — Block Diagram of Basic Connections to Associated Circuits

repeater or terminating set. If the preempted trunk is to be connected into a conference, transfer will occur on the 4-wire side of the repeater or terminating set.

3.03 As illustrated in Fig. 1, a 2100-cycle tone sender is connected to the tie trunk at the originating location and a 2100-cycle tone receiver is connected to the tie trunk at the remote location. If both the local and the remote locations can actuate a transfer, each location will have both a tone sender and a tone receiver. Transfer of the trunk facility is accomplished by furnishing a start signal to the local tone sender. The tone sender, in turn, applies a transfer signal to the local transfer circuit (to transfer the originating end of the trunk facility) and a 2100-cycle tone to the tone receiver at the remote location. The remote tone receiver accepts and amplifies the received tone and signals an associated transfer circuit to transfer the remote end of the trunk facility. Each disconnected PBX is notified of the transfer by a preempt signal which may be either a distinctive tone or a recorded announcement. Once the transfer has been effected, signaling and/or dialing may be accomplished in the normal manner over the tie trunk facility.

3.04 Transfer Origination (Fig. 2): To reduce the possibility of accidental transfer of a busy circuit, two key operations are necessary to preempt a tie trunk. Operation of the pickup (PU) or line key at the originating position connects the attendant to the tie trunk and permits monitoring and talking. If the attendant decides to seize the tie trunk, momentary operation of a nonlocking transfer key provides a start signal to the 2100-cycle tone sender. A relay in the tone sending circuit operates a W-Z relay combination in the transfer circuit. The W relay, when operated, enables the local TR relay to operate (which transfers the near end of the tie trunk facility) and starts a multivibrator in the tone sender. The 2100-cycle output of the tone sender oscillator is modulated by the multivibrator at five pulses per second with a 50:50 on and off time ratio. The W relay operates at the beginning of the tone sending interval; the Z relay is shunted until the end of the tone sending interval before it is permitted to operate. The tone sender connects 2100-cycle modulated tone over the preempted trunk facility to transfer the remote end.

3.05 Tone Sender (Fig. 3) and Tone Receiver (Fig. 4): Pulsed 2100-cycle tone is the transfer originating signal; steady 2100-cycle tone is the transfer restoral or release signal. With distinctively different operate and release signals, a second operation of the transfer key releases the operated transfer circuit at the transferred end without reoperating the released transfer circuit at the opposite end; thus the two transfer circuits are restored to the same condition. A released transfer circuit causes the associated tone receiver to accept only pulsed tone, while an operated transfer circuit causes the receiver to accept only steady tone. The distinctive signals also provide a means for synchronizing the two ends of the circuit. Loss of synchronization might occur if power were interrupted at one end of the facility while it was in a transferred condition.

3.06 As stated in 3.04, operation of the transfer key provides the start signal to the 2100-cycle sender (see Fig. 3). The sender circuit locks to a timing circuit which controls the tone sending interval and connects tone to the trunk. The tone receiver (see Fig. 4) filters, amplifies, and rectifies the incoming tone. If the transfer circuit is idle, the tone receiver will accept only pulsed tone. If the transfer circuit is operated, the tone receiver will accept only steady tone.

3.07 The timing circuit in the 2100-cycle tone sender provides a tone sending interval of approximately 8 seconds. The interval is necessary to overcome a tone receiver delay of 1.5 to 4.0 seconds and to continue sending tone for a sufficient length of time to provide the proper time delay between operation of the W and Z relays. The time delay is used to hold the mechanical switching connection when high tone is used as a preempt warning signal. When the sender is used with the conference circuit, the tone sending interval must be long enough to overcome tone receiver delay and continue sending tone into monitor loudspeakers as an alerting signal. The time delay is incorporated into the tone receiver to prevent false operation from speech signals.

3.08 Preempt Notification (Fig. 5): In order to notify a tie trunk user that the trunk has been preempted for tactical use, a warning tone or recorded announcement is connected to the tie

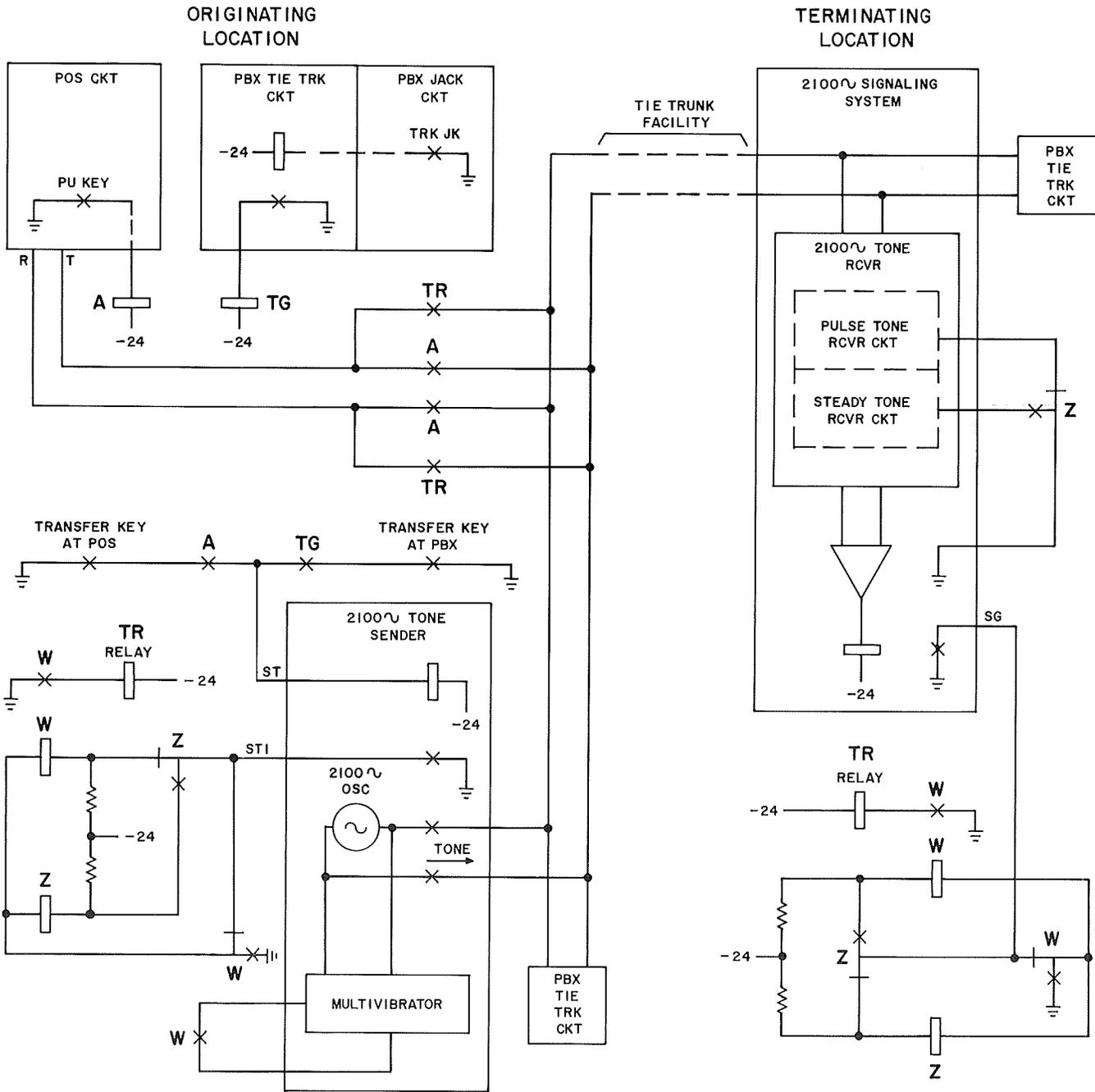


Fig. 2 — Transfer Origination — Simplified Diagram

trunk circuit toward the PBX. Abrupt preemption might drop the mechanical switching connection before the station user could identify the warning tone or announcement. To prevent this, the switching connection is held for a short time under control of the transfer circuit. When DX signaling is used, it is necessary to open the A1 and

B1 signaling leads. This holds a relay operated in the PBX tie trunk circuit and places the mechanical switching connection under control of the station. When E and M lead signaling is used, the E lead must be grounded to hold the connection. The E lead is grounded for an interval of time determined by the announcement counting

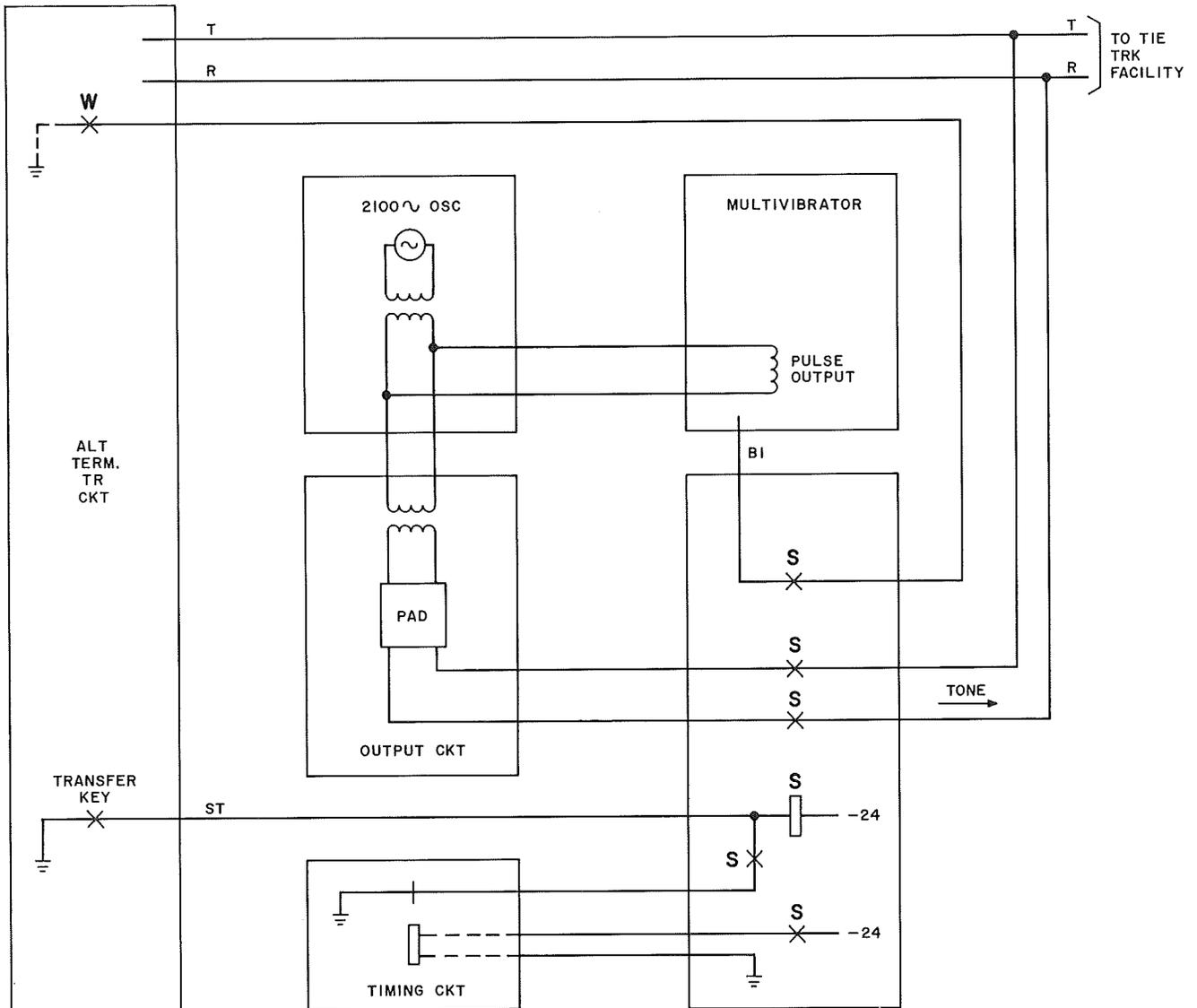


Fig. 3 — Tone Sender — Simplified Diagram

circuit, or the difference in time between operation of the W and Z relays. (The W and Z relays operate with a time difference corresponding to the tone sending interval at the originating location and corresponding to the tone sending interval, less tone receiver delay time, at the remote location.)

3.09 In order to ensure that the station user has a reasonable opportunity to hear a recorded announcement, the counting circuit permits two complete announcement cycles by holding the E lead grounded until the two announcement cycles have been completed. The counting circuit con-

sists of a 2-stage, 2-pulse counter circuit arranged to operate, at the completion of each announcement cycle, from a ground supplied by the announcement circuit on the LIM lead. The first cycle operates the CA and CB relays, while the second cycle operates the CC relay. The CC relay opens the start lead to the announcement circuit and drops the mechanical switching connection.

3.10 Transfer Origination from PBX (Fig. 6):

At times it may be necessary to originate a transfer from a station not equipped with a transfer key. In this case, the PBX switchboard may be given transfer capability. When a trans-

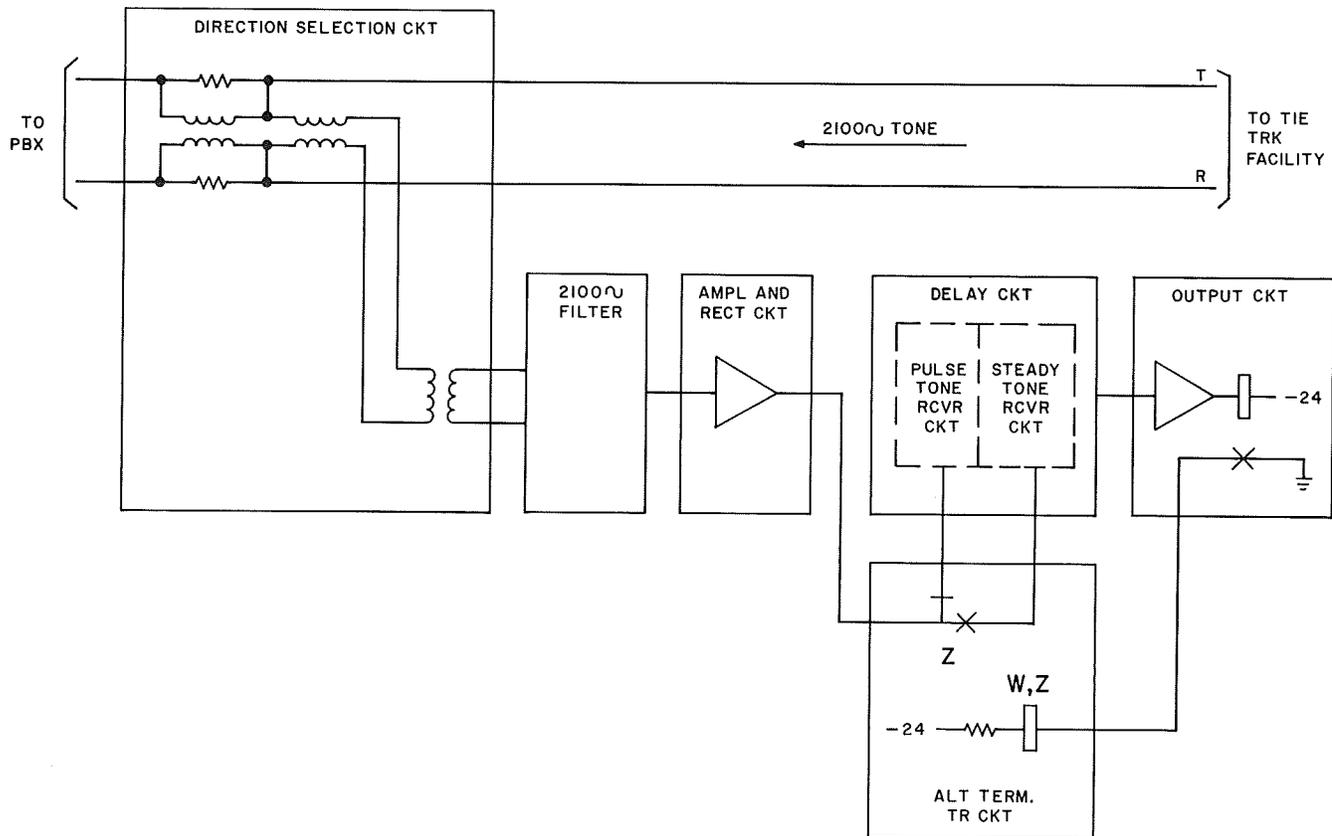


Fig. 4 — Tone Receiver — Simplified Diagram

fer is effected from the PBX, the switchboard attendant must insert a cord into the tie trunk jack and operate a nonlocking transfer key. As illustrated in Fig. 6, a PBX trunk jack detector relay operates when the cord is inserted in the trunk jack. If not locked out by a position circuit, which has priority, the trunk jack detector relay operates a PBX transfer memory circuit (TL relay). The memory circuit recognizes the transfer as originating from the switchboard and prevents transfer of the tie trunk facility from the PBX at the originating end. Only the distant end of the tie trunk facility is transferred to an operating position.

3.11 Signaling Converter (Fig. 7): The problems inherent in transferring a PBX tie trunk to line circuits associated with a 112A, 302, or 1A1 position are compounded by the numerous types of line circuits which are used and the signaling incompatibility of many of these circuits with a PBX tie trunk circuit. Since signaling must take place in a normal manner after a trunk

has been preempted, various circuit configurations are required to ensure compatibility. Immediately after a transfer is initiated from a position, there is a period during which the 112A, 302, or 1A1 line circuit at the originating location is connected to the PBX tie trunk at the terminating location awaiting the operation of the remote tone receiver. This condition also exists when the transfer is originated at the PBX, in which case the PBX tie trunk is connected to a line circuit during the entire time the circuit is preempted.

3.12 If a transfer is initiated from a PBX and the distant line circuit is a 112A key equipment ringdown line circuit, a signaling converter must be connected into the circuit to provide signaling compatibility between the trunk circuit and the ringdown line circuit. The 112A ringdown line circuit is arranged for a timed spurt ringing signal. The signaling converter generates this ringing signal as follows (see Fig. 7): seizure of the tie trunk circuit transfers the M lead from ground to battery as a seizure signal to the distant

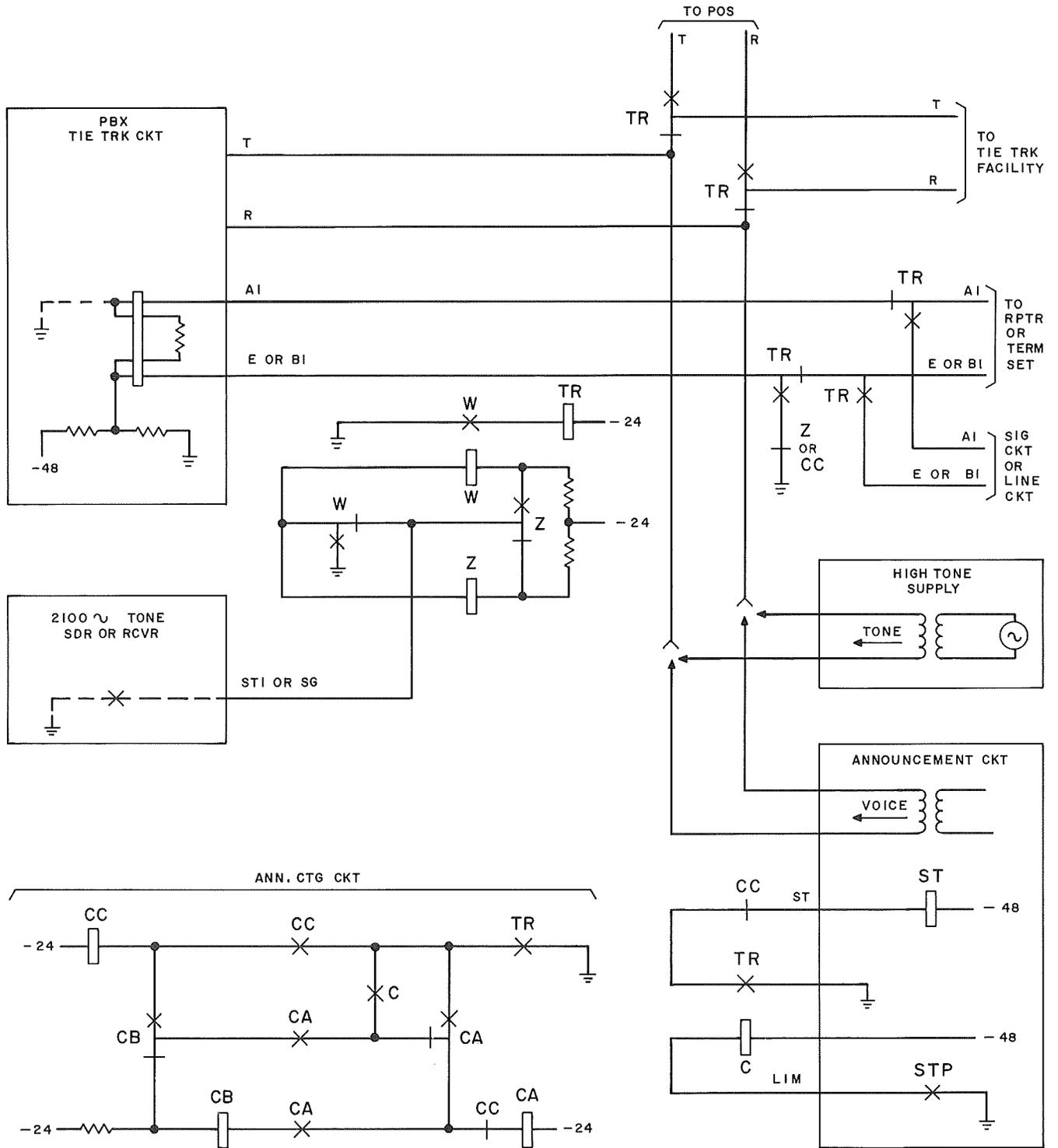


Fig. 5 — Preempt Notification — Simplified Diagram

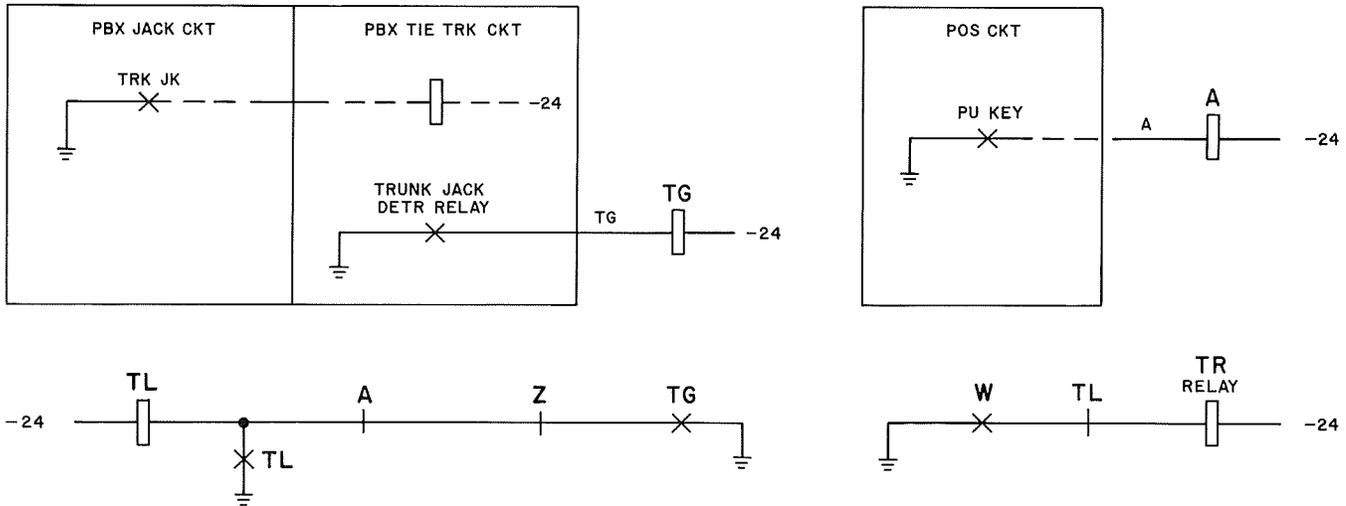


Fig. 6 — Transfer Origination from PBX — Simplified Diagram

tie trunk circuit. Operation of the transfer key operates the S relay in the 2100-cycle sender circuit. The operated S relay opens the operating path of the R relay in the signaling converter, connects ground to the E lead (via ES lead) to hold the local line circuit signaling relay operated, and connects battery to the M lead to maintain an idle circuit indication toward the distant line circuit. When the W relay operates (see Fig. 2), the TL relay operates and locks. The S relay releases at the completion of the tone sending interval and allows the R relay in the signaling converter to operate. The operation of the R relay applies ground to the M lead to signal the distant line circuit. At the end of a timed interval the M relay in the signaling converter will operate and reapply battery to the M lead. Operation of the M relay also applies ground, via the RA2 lead, to the tie trunk circuit. This satisfies answering supervision requirements of the PBX.

3.13 Trunk Make-Busy (Fig. 8): The transfer circuit places a busy condition on the trunk circuit toward the PBX to prevent seizure during the preempted period. High tone or a recorded announcement warns of the preemption and permits the station user to disconnect. Before a busy condition is placed on the trunk by the transfer circuit, approximately 50 milliseconds must elapse to ensure release of the mechanical switching connection when the station disconnects. The transfer circuit samples the B6 lead for ground, which is present when the trunk is busy. A slow release

relay in the tie trunk circuit provides the necessary delay in excess of 50 milliseconds. When ground is removed from the B6 lead by the tie trunk circuit, the fast operating MB relay quickly grounds the sleeve lead to make the trunk busy.

3.14 Transfer Restoral (Fig. 9): Restoral of a tie trunk facility to its PBX termination may be accomplished in two ways: by a second operation of the transfer key, or by an optional feature which provides restoral when the originating station disconnects. Fig. 9 shows how restoral occurs when a 112A or 302 position releases the pickup or line key, when a 1A1 key telephone set goes on-hook, or when an originating switchboard position removes the cord from the associated trunk jack. Hang-up restoral is restricted to the originating location to prevent interference with this feature by the terminating station or position. PBXs are always arranged for hang-up restoral to prevent leaving the circuit in a transferred condition if the PBX cord is removed from the trunk jack before the transfer key is operated for restoral.

C. Conference Circuit

3.15 General: The conference circuit permits a maximum of 16 PBX tie trunk facilities to be preempted simultaneously and enables the near end of each tie trunk to be connected into a conference bridge. The distant end of each tie trunk is preempted and connected into a position circuit

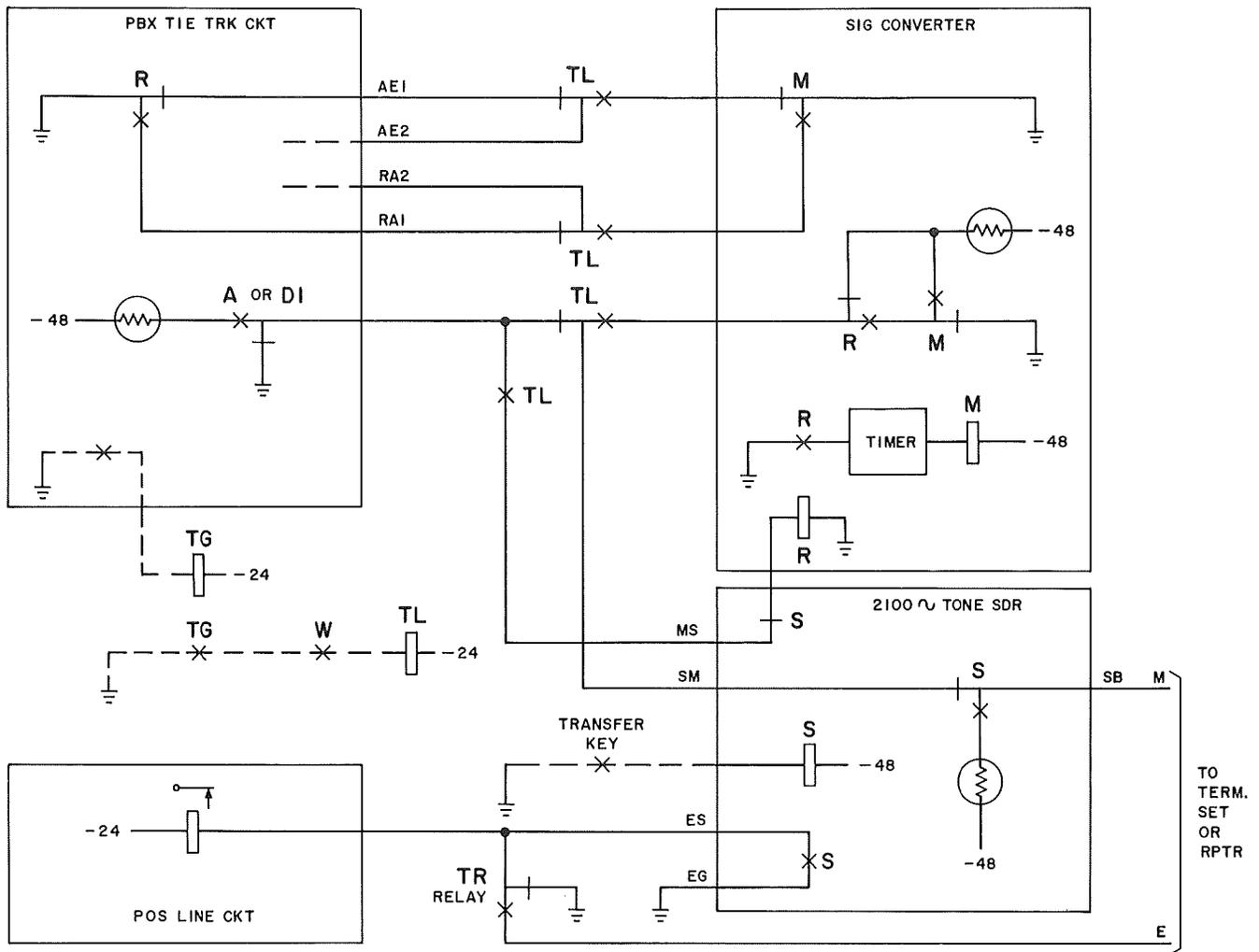


Fig. 7 — Signaling Converter Connections — Simplified Diagram

by the transfer circuit. The conference bridge, into which the tie trunks are connected at the originating end, consists of a conference amplifier and a low-impedance bus. Conferencing is accomplished on a 4-wire basis with each conferee connected to the bridge through isolating resistors. Since conferees may be connected to the conference over facilities with various losses, the conference circuit is arranged to provide additional loss with attenuation pads or additional gain through the use of amplifiers in the V4 repeater. A block diagram of the conference circuit and its connections to associated circuits is shown in Fig. 10.

3 16 Conference Origination (Fig. 11 and 12):

A conference is originated by operating a nonlocking conference key and a pickup or line key

associated with the conference circuit. (Origination from a PBX requires insertion of a cord into the trunk jack and operation of a transfer key.) The operation of two keys guards against inadvertent seizure of the conference. Seizure of the conference circuit starts the 2100-cycle tone sender. The sender operates the transfer relay in the conference circuit to preempt the near end of all tie trunk facilities to be conferenced and to connect power to the conference amplifier. As indicated in Fig. 12, one tone sender transmits 2100-cycle tone through the conference amplifier to all of the preempted trunks. All station users at the near end are warned of the preemption by high tone or a recorded announcement applied to all preempted tie trunk circuits.

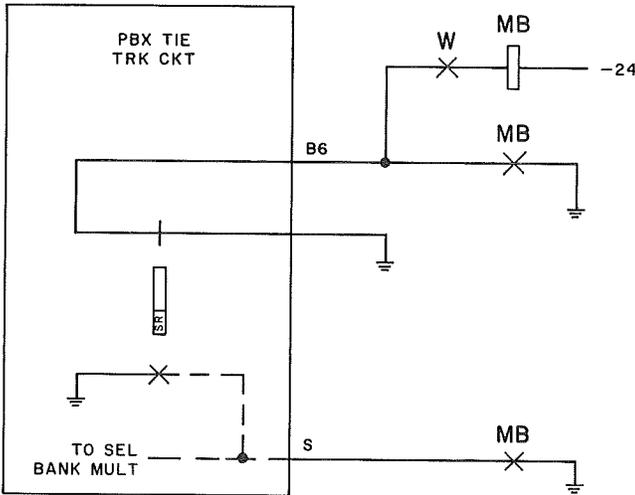


Fig. 8 — Make-Busy Circuit — Simplified Diagram

3.17 Once the conference key is operated, all conference keys are locked out and control is transferred to a release key. This prevents accidental release of the conference if a conference key is operated at another position at the originating location.

3.18 **Transfer at Remote Conference Location (Fig. 13):** At remote locations a transfer circuit and a 2100-cycle tone receiver are connected to each trunk facility. When the tone receiver detects incoming 2100-cycle tone it actuates the transfer circuit, which in turn transfers the tie trunk facilities to conferencing positions. Since the tone sending interval exceeds the delay time of the tone receivers, the remaining time is used for 2100-cycle pulsed tone signaling. Pulsed tone indicates a conference is being originated, while steady tone signifies the conference is being terminated. The signaling tones are applied through monitoring loudspeakers at each conferencing position. The volume on the loudspeakers may be varied but cannot be reduced to the point that signals become inaudible.

3.19 **Push-to-Talk:** Push-to-talk operation is used by each conferee. Operation of a pickup or line key associated with the conference circuit disconnects, or attenuates, the monitoring loudspeaker and connects the position to the conference through the attendant telephone circuit, or 1A1 key telephone set. The attendant is always connected to the conference, either through the

position telephone circuit or the monitoring loudspeaker. Fig. 12 and 13 illustrate the push-to-talk feature. Operation of a push-to-talk key transfers the attendant telephone circuit from the receive pair to the transmit pair of the 4-wire trunk and connects a terminating resistor across the receive pair. The originating conference position may be provided with transmitter cutoff of all other conferees.

3.20 **Conference Connection Through PBX (Fig. 14):** It may be necessary to connect a station without the push-to-talk feature into a conference.

To accomplish this, the PBX at the originating location may be given a conference key and arranged for conference capability. A transmit amplifier and a receive amplifier are connected between the PBX position and the conference bridge to provide gain and isolation between transmit and receive loops. The transmit amplifier is a compression amplifier and overcomes loss in the local line facility, PBX cord circuit, and 4-wire terminating set.

3.21 Since the conference circuit does not provide supervisory signals to the PBX operator, a voice operated switch circuit and a timing

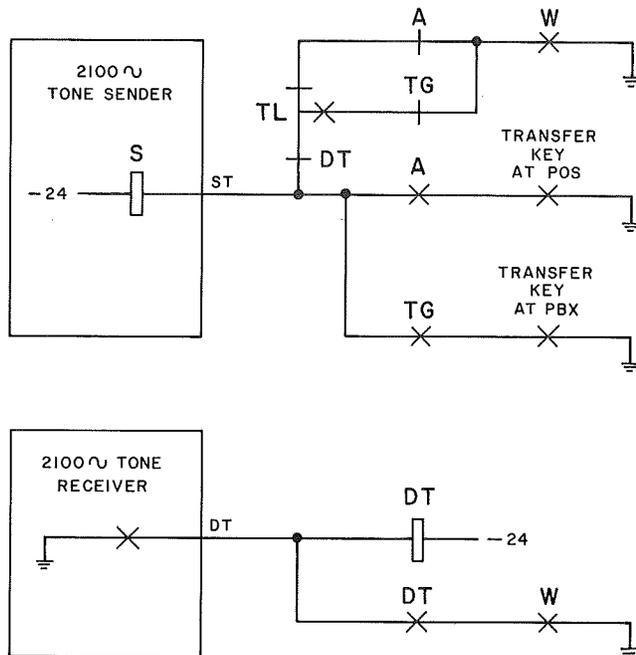


Fig. 9 — Transfer Restoral — Simplified Diagram

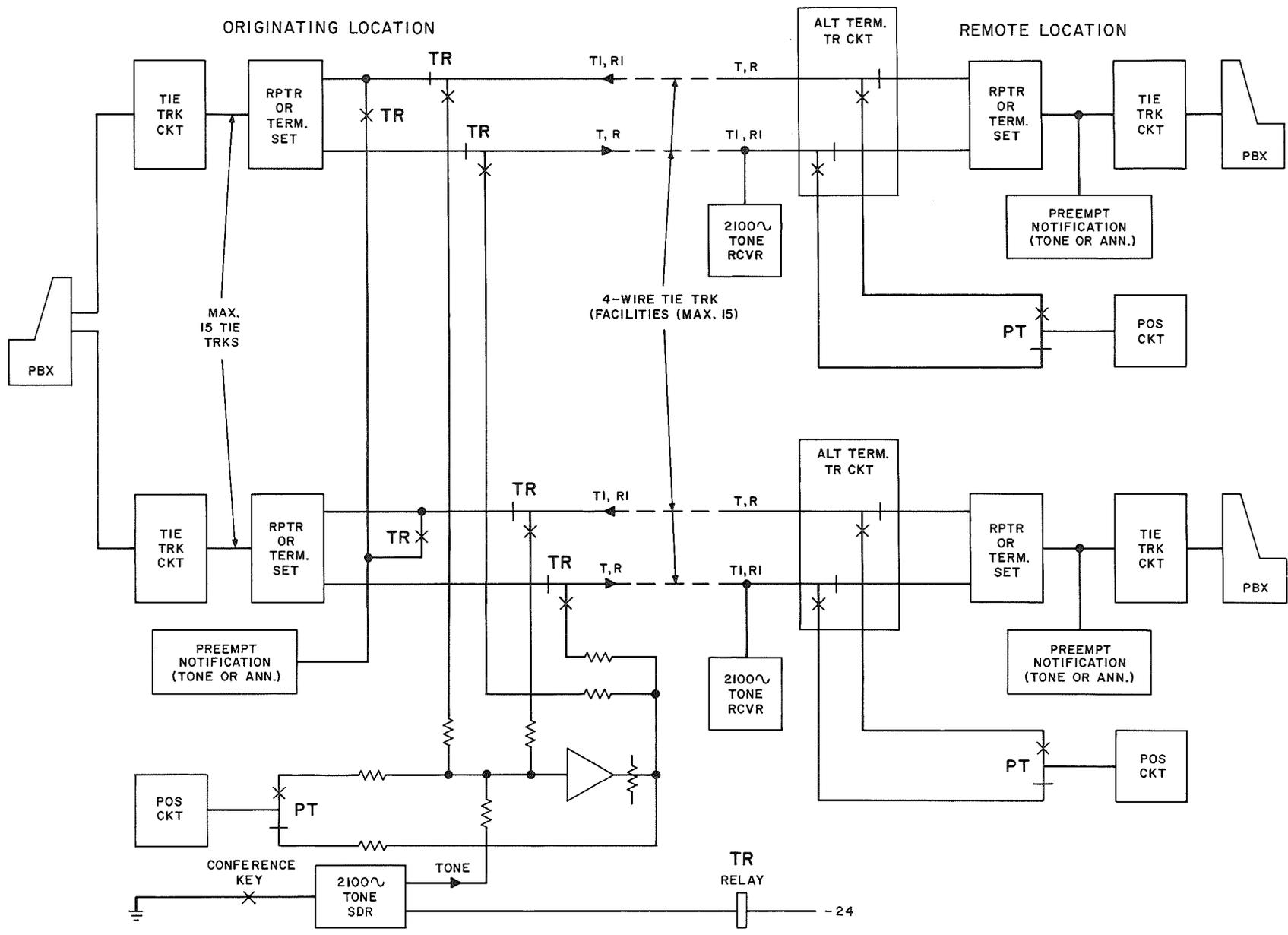


Fig. 10 — Conference Circuit — Block Diagram of Basic Connections to Associated Circuits

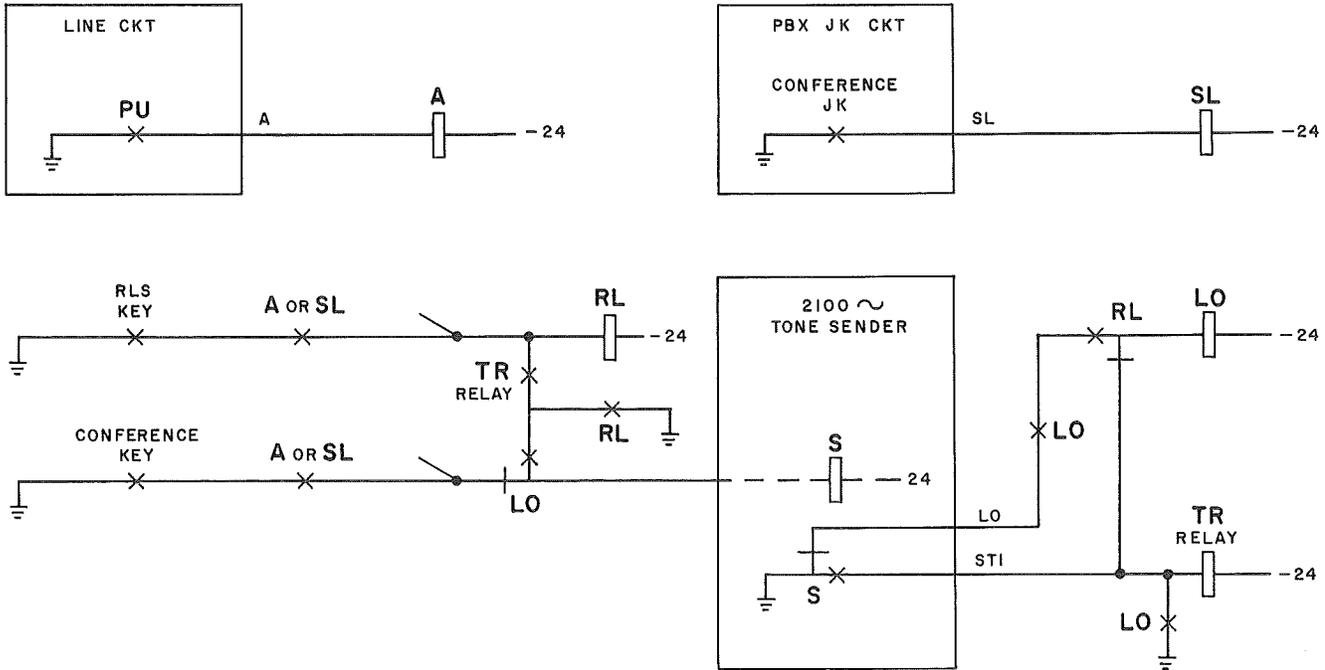


Fig. 11 — Conference Origination and Release Circuit — Simplified Diagram

circuit are connected to the conference at the PBX position for this purpose. Voice signals from the conference operate the voice switch relay and hold it operated during the conference. When a lull occurs in the conversation or the conference is terminated, the voice switch relay releases and furnishes a start signal to the timing circuit. If conversation is not resumed within a preset interval, the timing circuit grounds the sleeve lead and the PBX operator receives a disconnect signal. The attendant monitors the conference and removes the cord when assured the conference is ended.

3.22 Conference Release (Fig. 11): Release of the conference circuit and the restoration of all conferenced tie trunks to their original PBX terminations is accomplished by operating a release key at the originating location. As in the case of conference origination, a pickup key must be operated or a cord inserted into the PBX conference jack to activate the release key. Operation of the release key operates a common release relay,

which in turn starts the 2100-cycle tone sender. The conference circuit disables the multivibrator portion of the tone sender, which results in a steady tone output. The steady tone is applied over all the conferenced tie trunks to operate the tone receivers at remote locations. The receivers furnish signals to associated transfer circuits and all tie trunks are restored to their original PBX termination.

4. REFERENCES (NOT ATTACHED)

4.01 The following drawings provide additional information.

- SD-69490-01 — Conference Circuit
- SD-69492-01 — Alternate Termination Transfer Circuit
- SD-69501-01 — AC-DC Audible Ringing Circuit
- SD-69512-01 — 7B Timer
- SD-69514-01 — Signaling Converter
- SD-69517-01 — 2100-Cycle Signaling System

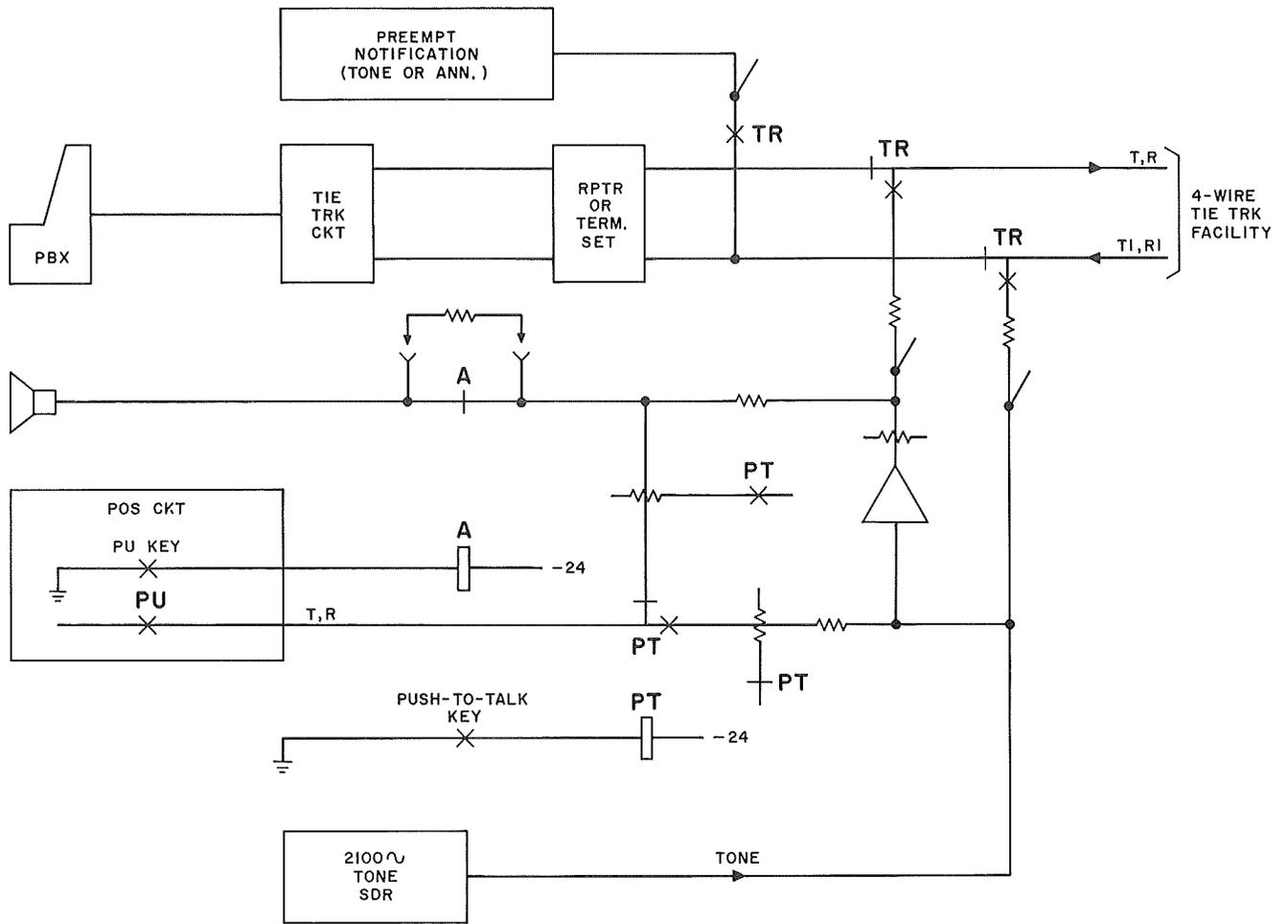


Fig. 12 — Transfer of Tie Trunk to Conference Bridge at Conference Originating Location — Simplified Diagram

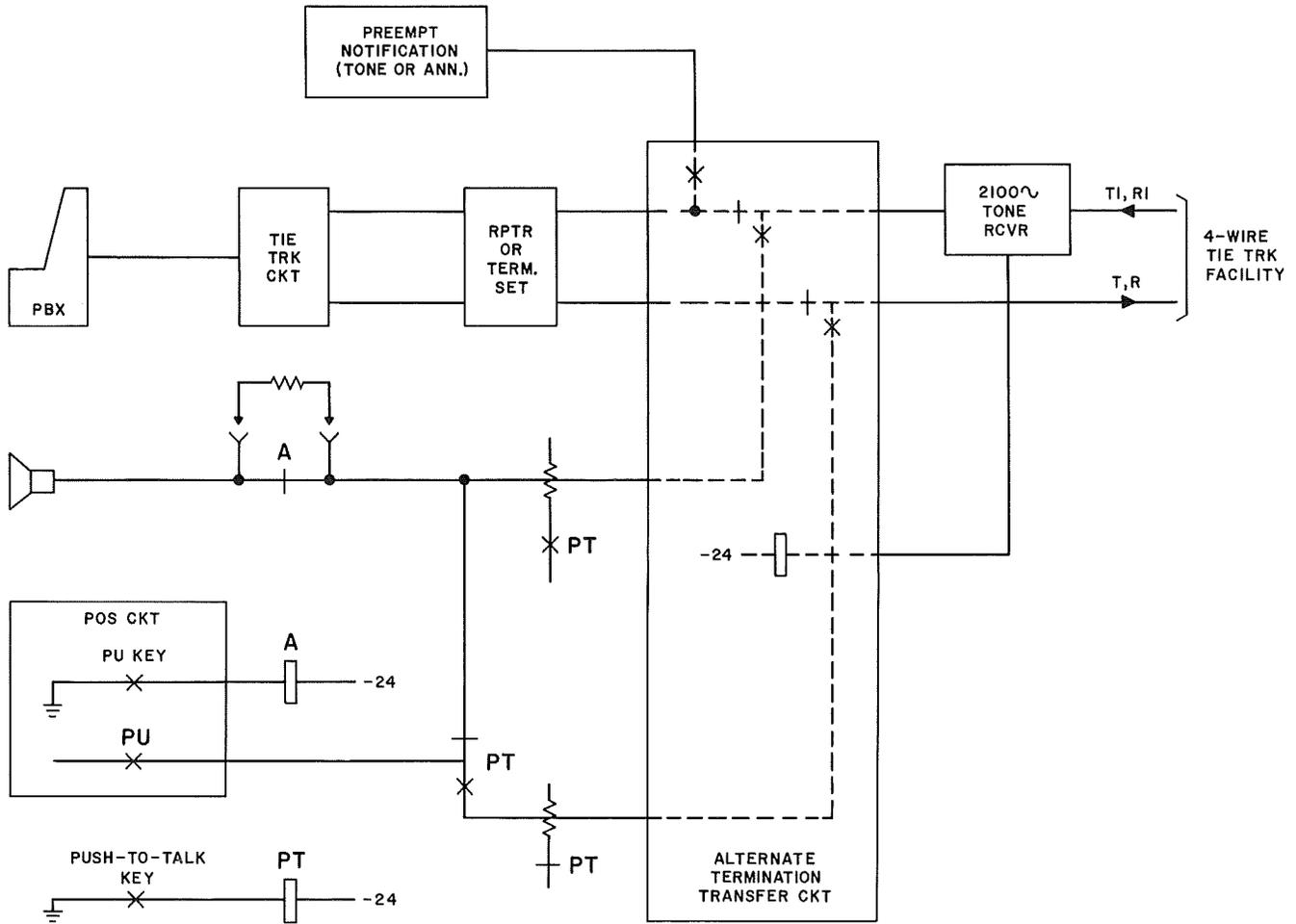


Fig. 13 — Transfer of Tie Trunk to Position Circuit at Remote Conference Location — Simplified Diagram

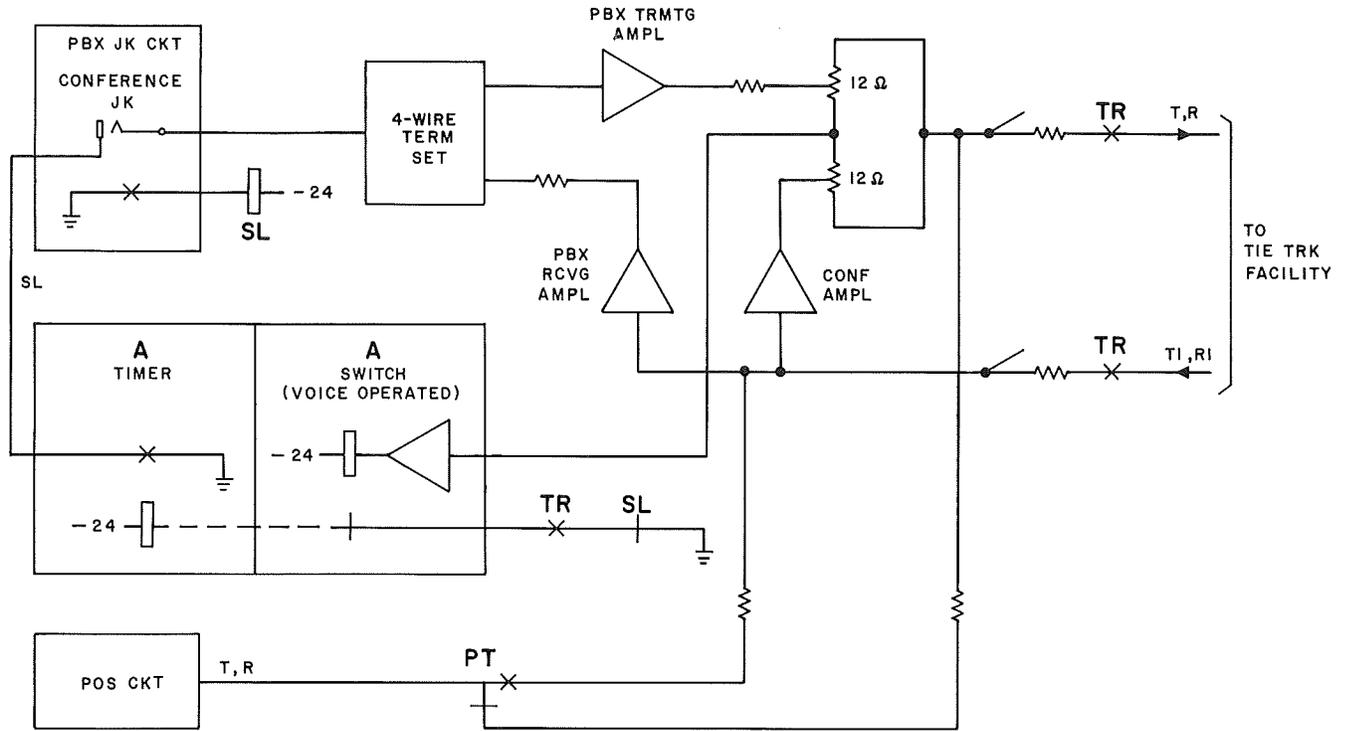


Fig. 14 — Conference Connection Through PBX — Simplified Diagram