

Feb. 4, 1941.

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2,230,360

MULTIWAY TELEPHONE CIRCUIT

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2 Sheets-Sheet 1

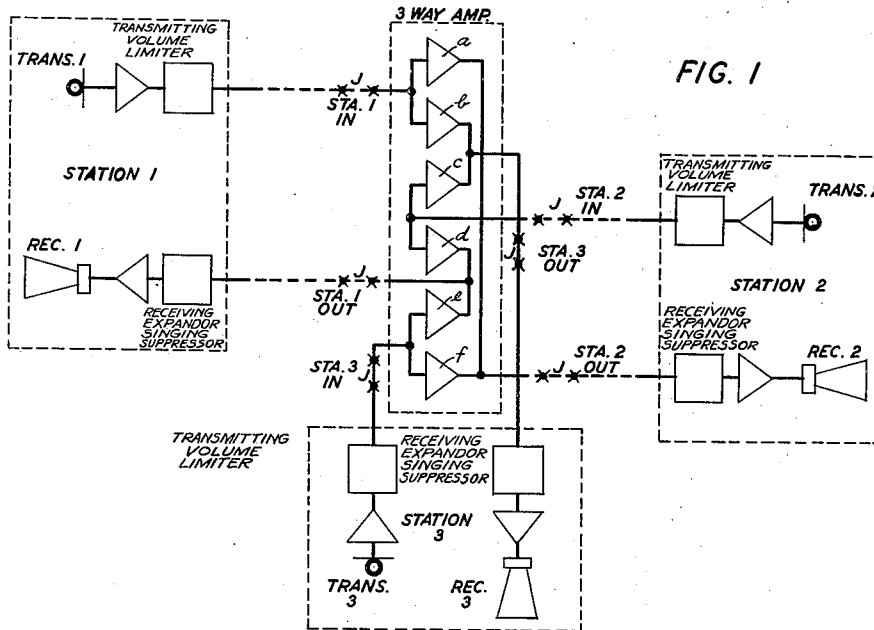


FIG. 1

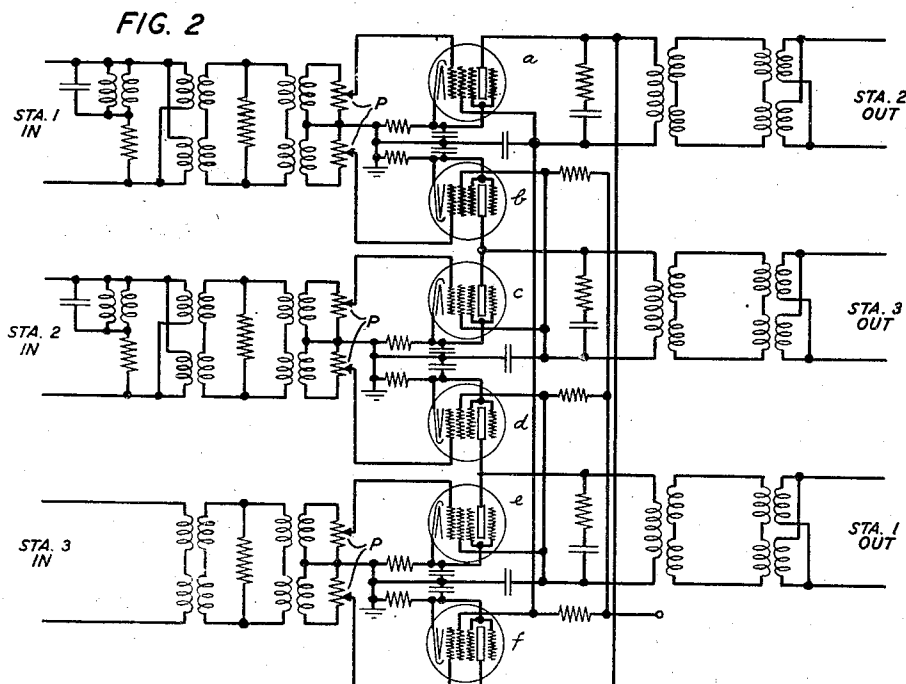


FIG. 2

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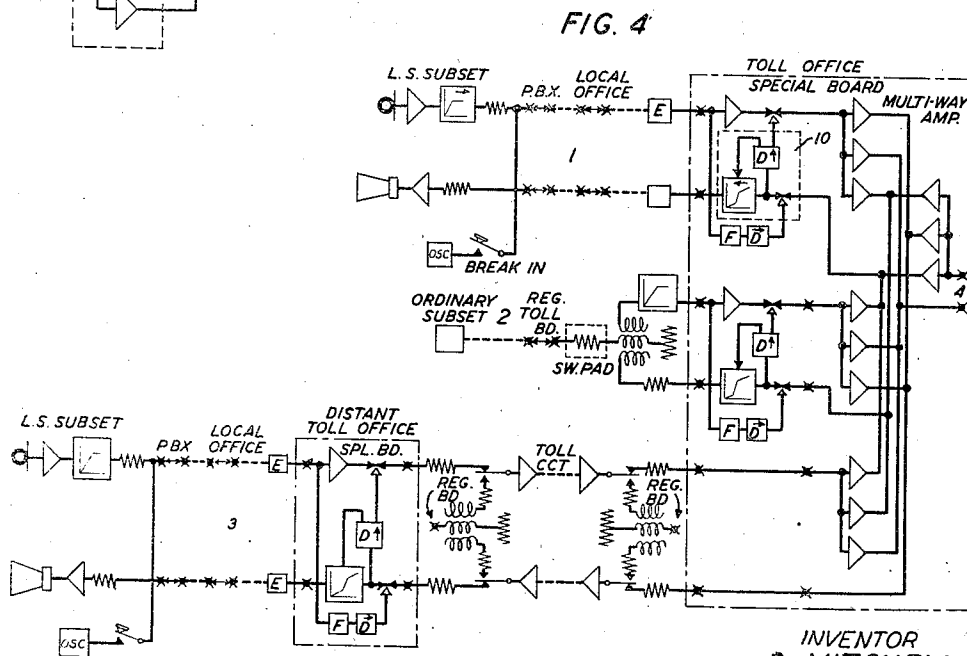
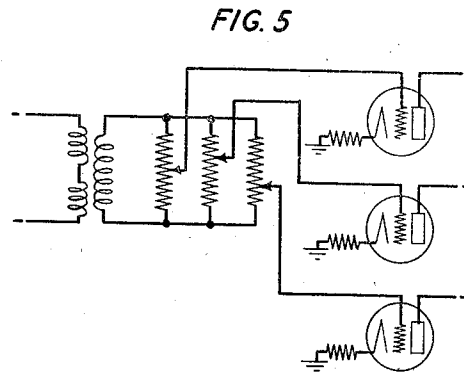
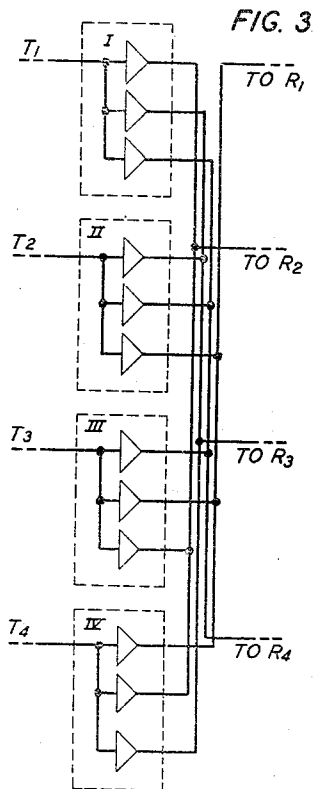
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MULTIWAY TELEPHONE CIRCUIT

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Application October 14, 1939, Serial No. 299,445

7 Claims. (Cl. 179-1)

This invention relates to multiway telephone circuits and more particularly to so-called conference circuits in which a plurality of speakers at different locations may be connected for a common conversation. It is particularly adapted to circuits using distant talking and listening telephone instruments at one or more of the subscribers' stations.

5 An object of the invention is to provide a system with amplifiers so associated as to give the necessary transmission of speech to the various terminal stations and further in the manner to avoid cross-coupling between the circuits.

10 A further object is to devise a circuit in which adjustments may be made to bring about the same level of speech at all of the terminal stations. Another object is to provide a circuit free from hybrid coils, which coils, in general, require a very close balancing to avoid singing effects. Another object is to bring substantially all the essential amplifiers and adjustment elements of all the various circuits together at one point for better switching and better control of performance.

15 The invention will be better understood and still other objects and advantages will appear from the following specification and the accompanying drawings in which:

20 Fig. 1 is a simplified circuit drawing showing the invention in terms of a three-way conference system;

Fig. 2 is a more detailed drawing of the multiway amplifier;

25 Fig. 3 shows as implied circuit drawing similar to Fig. 1 but extended to a four-way conference system;

30 Fig. 4 is a more detailed showing of the circuit of Fig. 3 showing various additional features contributing to effective operation of the circuit as a whole; and

35 Fig. 5 shows a detail of a portion of the circuit of Fig. 2.

Referring more particularly to Fig. 1, there are shown three terminal stations, 1, 2 and 3, each comprising a transmitter and a loud-speaker serving as a receiver. These terminal stations are connected on a four-wire basis to an intermediate point including a three-way amplifier system.

40 The three-way amplifier circuit located at the intermediate point consists of a special connection of one-way amplifiers to provide the three-way amplifier which is permanently connected to the three remote stations in such manner as to provide two-way circuits between each station

and any of the other stations, the circuits possessing substantially no cross-coupling and avoiding the use of hybrid coils. More specifically, it will be observed that the intermediate amplifier station comprises six one-way amplifiers connected in a closed series circuit with successive amplifiers poled oppositely, the amplifiers being identified by the letters *a* to *f*. Signal from transmitter 1 is impressed on amplifiers *a* and *b*. The output of one of these is connected to the receiver at station 2 and the output of the other is connected to the receiver at station 3. Similarly, the transmitter of station 2 is connected to the inputs of amplifiers *c* and *d* and the transmitter of station 3 is connected to the inputs of amplifiers *e* and *f*. The outputs of the amplifiers *c* and *d* go, respectively, to the receivers of the stations 3 and 2 and those of the amplifiers *e* and *f* go, respectively, to the receivers of terminals 1 and 2. It will be observed that the circuit from transmitter 1 is completely isolated from the receiving circuit of station 1, making the cross-coupling so small as to be negligible. Likewise, there is complete isolation between the transmitter and receiver circuit in each of the other terminal stations.

While the details of the circuit at each terminal station may take on a variety of forms, it is desirable, in general, to include certain elements. Thus, at station 1 an amplifier is provided in the transmitting circuit. Also, there is included a transmitting volume limiter. In the receiving circuit there is also included an amplifier and a receiving expander singing suppressor. The details of this latter will be discussed below. While the terminal stations may be connected permanently to the appropriate leads at the intermediate amplifier station, it may be desirable in some cases to arrange for switching to any one of a plurality of subscriber stations other than those shown. Such provision may be made by the jacks *J* built in on some suitable switchboard.

The circuit of Fig. 1 is shown on a highly simplified basis in which two-wire circuits are represented by a single line. The details of a suitable amplifier are shown more fully in the circuit of Fig. 2, all lines here being shown on a two-wire basis. The elements constituting the vacuum tube circuit, such as the type of tube, biasing resistors, battery supply, transformers and retard coils, are those appropriate for the particular type of tubes used and need not be described here in detail.

In view of the fact that different terminal stations may be at widely different distances from

the intermediate amplifier station, it will be desirable to provide means by which the gain for the different stations shall be controlled. Provision for this is shown in Fig. 2 by the gain control potentiometers P. In some cases where one or more of the terminal stations are fairly close to the intermediate amplifier stations, the gain for those circuits will be relatively small and may, in fact, in some cases be a loss, this being permissible because of the individual amplifiers at the terminal stations. The adjustment of gain or loss to be associated with each terminal station is made at the intermediate point itself rather than at the terminal stations. The adjustments at the terminal stations are made initially and very rarely would require any further adjustments. In Fig. 2 the transmitting circuits are all shown at one side of the figure and the receiving circuits at the other side. It will be understood, however, that the proper terminals for an input and an output circuit belonging to one terminal station are brought together at the appropriate point.

The circuits of Figs. 1 and 2 are specific to a three-terminal conference circuit but the arrangement may be extended to a larger number of stations. This is shown, for example, in Fig. 3 where the circuit of Fig. 1 is extended to four-terminal stations. In this Fig. 3 it will be observed that there are twelve one-way amplifiers divided into four groups of three each. The input circuit of all the tubes in one group are connected to the transmitter of one terminal station as is shown by the connection of transmitter T_1 to the input of all the amplifiers in group I. The output terminals of the three amplifiers in group I are connected, respectively, to the receivers R_2 , R_3 and R_4 for stations 2, 3 and 4. A similar connection is made for each group. As a result, there will be, of course, a cross-connection between the output circuits of one amplifier in each group to an amplifier in each of the other groups except one. Such cross-connections, however, do not lead to any undesirable cross-coupling and the transmitter of any one terminal station is completely isolated from the receiving circuit of that station. While in Fig. 3 the transmitter and receiver for any one terminal are shown as separated, it will be understood that the lines are extended to bring the corresponding transmitter and receiver together at an appropriate point. It will be clear now that the principle of my invention may be extended to a still larger number of outlets. In general, if there are n outlets, then at the intermediate amplifying point there will be $n(n-1)$ tubes divided into n groups with $n-1$ tubes in each group.

Fig. 4 shows some of the details appropriate to a circuit of the form of Fig. 3. In this figure three terminal stations only are shown but a fourth may be added if desired. Also, to illustrate the flexibility of this system, one of the terminal stations is shown as a loud-speaker subset, a second is shown as an ordinary subset and a third is shown as a loud-speaker subset at the remote end of a toll circuit. The loud-speaking subset is shown as consisting of a microphone, suitable amplifier, a volume limiter and a pad in the transmitting side. In the receiving side there is a pad, an amplifier and a loud-speaker. The function of the pads is to pad out all the loops and trunks used for loud-speaker subsets to the same value of loss so that the loss to the toll office, where the special amplifier circuit is located,

is the same for all subscribers in that area. In general, the longest loop appearing in that office would have no pad.

In this circuit there is also shown an oscillator by which some frequency, preferably outside the normal voice band, may be sent and which can be operated by a key to allow the subscriber to break in when some other location is speaking. Further reference to this feature will be made below. The loud-speaker subset of circuit 1 is shown as connected to the subscriber private branch exchange. To make the proper connection, the local private branch exchange connects the loud-speaker set to two loops to the central office when it is desired to hold a loud-speaker conference.

At the toll office equalizers E are shown in both the transmitting and receiving trunk in order to equalize attenuation over a suitable range of frequencies. The loud-speaker subscriber is shown as being connected to the multiway amplifier through a special four-wire cord. This special cord preferably contains a singing suppressor of some suitable type. One type which is especially suitable is an expander type singing suppressor described in detail in my copending application Serial No. 255,233, filed February 8, 1939.

The ordinary telephone subset identified as circuit 2 is shown connected to the multiway amplifier through an expander type singing suppressor circuit of the same form as shown in connection with circuit 1. Such a suppressor is also necessary for circuit 2 since echoes returned because of the unbalance between the line and the network of the hybrid coil shown would otherwise falsely operate the receiving amplifier-detectors in the other expander singing suppressors. A volume limiter is included in the transmitting leg of this circuit 2 to allow the speech currents of the weak talkers to be sent out with sufficient gain so that they will operate the expander properly and to prevent loud talkers from overloading the line. The two-wire side of the hybrid coil is connected to a trunk in the regular toll switchboard. Thus, with my circuit either a local or distant ordinary subscriber may be connected in the conference circuit. Although not shown hereon, this ordinary subset could also be equipped with a break-in oscillator as described in connection with circuit 1.

The third terminal station identified as circuit 3 is connected through a four-wire cord to a toll circuit. This toll circuit may be arranged to be operated on a four-wire basis for loud-speaker use or on a two-wire basis through the regular switchboards when it is not needed for loud-speaker use. At the far end of the toll circuit another loud-speaking subset is shown connected in a similar manner through a four-wire cord.

The expander singing suppressor circuit shown at 10 in Fig. 4, and which is described in detail in my copending application referred to above, allows the transmitting side of the circuit to be normally enabled. The gain of the transmitting limiter is normally at maximum value. In order to prevent singing, however, the gain of the expander in the receiving circuit is normally at a low value. With incoming messages the volume delivered by the expander circuit is increased by the action of the expander. At the same time the suppressor control operates and disables the transmitting side of the circuit. From this it will be seen that as long as speech is being re-

ceived and the expander is set to deliver large volumes, the transmitting circuit is disabled. It may occur at times, however, that it is desirable for a speaker at such a station to break in. To this end the oscillator referred to above is introduced and, as seen in circuit 1 of Fig. 4, when this oscillator circuit is closed the signal therefrom transmitted to the toll office passes through a filter F and a detector D to disable the receiving circuit. This causes the suppressor to release and allows the speech currents of the speaker at terminal 1 to get out and be heard by the other stations.

In the circuit of Fig. 2 a particular manner of connection from one transmitter to two amplifier tubes is shown. A modification of this arrangement appears in Fig. 5, the connection being adapted for groups of three amplifiers. In this figure the transformer from one transmitter feeds into a secondary circuit including three potentiometer resistances bridged in parallel. Separate and adjustable leads from each of these resistances serving as potentiometers lead to the respective grids of the group of amplifiers. Obviously, this circuit arrangement may be extended to a larger number of amplifiers or contracted to a smaller number.

What is claimed is:

1. A circuit for establishing two-way telephone communication between n telephone subscribers' stations, wherein n equals three or more, each having individual telephone transmitting and receiving apparatus, said circuit comprising an intermediate amplifier station having a plurality of one-way amplifiers, means connecting the transmitting apparatus of each subscriber station in parallel with the inputs of $n-1$ respectively different amplifiers at the intermediate station, and means connecting the receiving apparatus of each subscriber station in parallel with the outputs of different amplifiers at the intermediate station, the inputs of which are respectively connected to the transmitting apparatus of each of the other subscriber stations.

2. An arrangement for providing a two-way telephone conference connection between three telephone stations, each having individual telephone transmitting and receiving apparatus, comprising an intermediate amplifier station with six one-way amplifiers connected in a closed series circuit with successive amplifiers poled oppositely, means connecting the transmitting apparatus of each telephone station, respectively, in parallel to the inputs of a different pair of successive amplifiers in said series circuit, and means connecting the receiving apparatus of each telephone station, respectively, in parallel to the outputs of different pairs of successive

amplifiers in said series circuit, the inputs of the amplifiers in each of the latter pairs being respectively connected to the transmitting apparatus of each of the other telephone stations.

3. A circuit for establishing two-way telephone communication between n telephone subscribers' stations where n equals three or more, each having individual telephone transmitting and receiving apparatus, said circuit comprising an intermediate amplifier station having n groups of amplifiers with $n-1$ one-way amplifiers in each group and having their inputs in parallel, the input of each group being connected to the transmitter at one station, the outputs of any one group being connected separately, each to a receiver of the stations, other than the one connected to the input, each receiver being connected to one of the outputs in each group other than to the group to which its transmitter is connected.

4. In a multiway signaling system, a plurality of more than two terminal stations, a telephone transmitter and a telephone receiver at each station, a multiway amplifier station at an intermediate point comprising a plurality of one-way amplifiers, connections on a four-wire basis from each terminal station to the intermediate amplifier, each transmitter being connected in parallel to the input of a plurality of said one-way amplifiers, one for each of the receivers, and a connection from the output of each of the said last plurality of amplifiers to the said receivers, respectively.

5. The combination of claim 1, characterized by the fact that there are $n-1$ amplifier outputs connected to the receiving apparatus of each subscriber station, the outputs being from amplifiers not associated with the transmitting apparatus corresponding to a given receiving apparatus.

6. The combination of claim 1, characterized by the fact that the intermediate amplifier station is adapted for connection to different kinds of terminal stations and that there are means at the said intermediate station to compensate for the different characteristics and remoteness of the various terminal stations.

7. The combination of claim 1 characterized by the fact that there is a receiver singing suppressor for each terminal station, said suppressor normally disabling the circuit connected to the transmitting apparatus at a station when speech is being received, and characterized further by means whereby the suppressor for a given station may be disabled when the speaker at that station desires to break in.

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