Sept. 8, 1942. W. H. EDWARDS ET AL 2,295,171

TELEPHONE SYSTEM

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FIG. 1

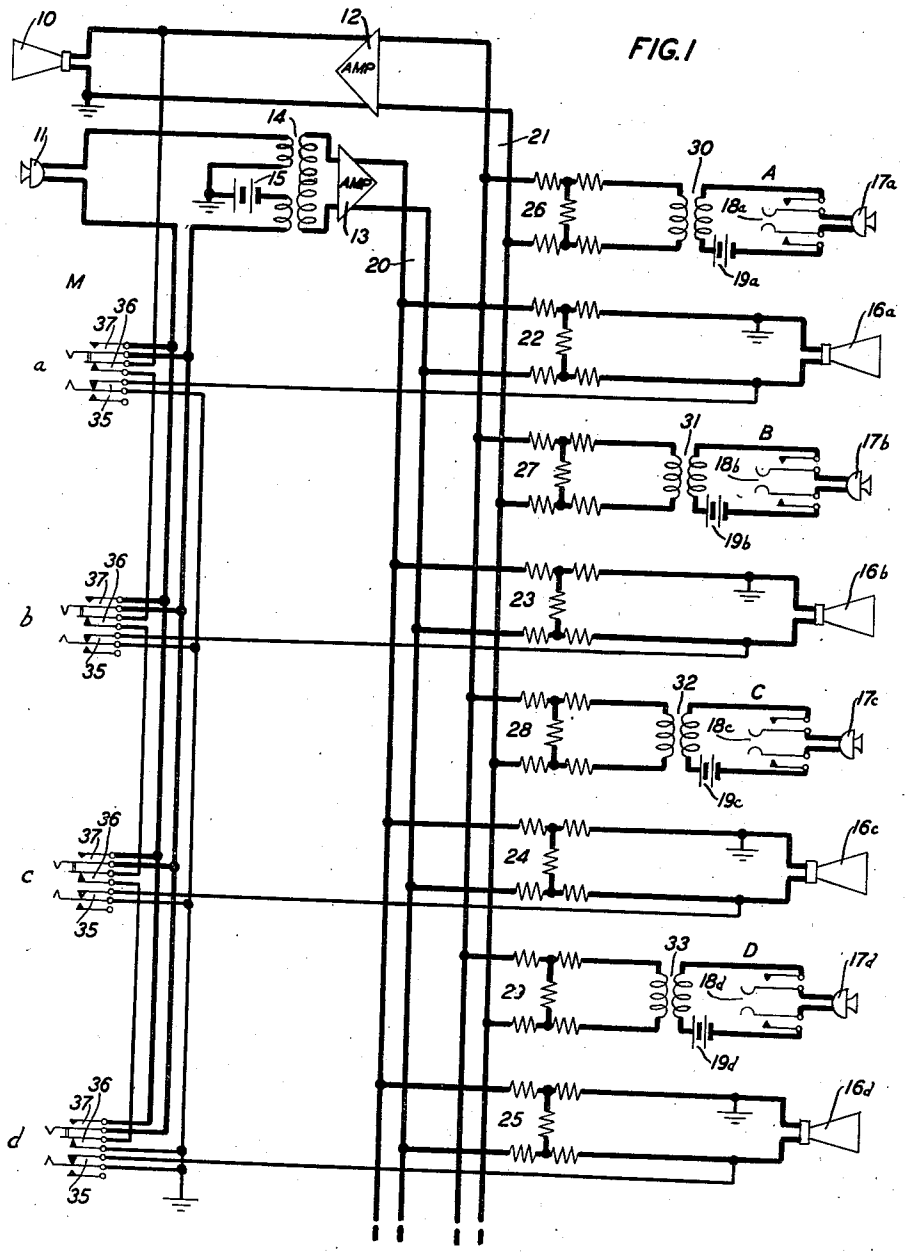

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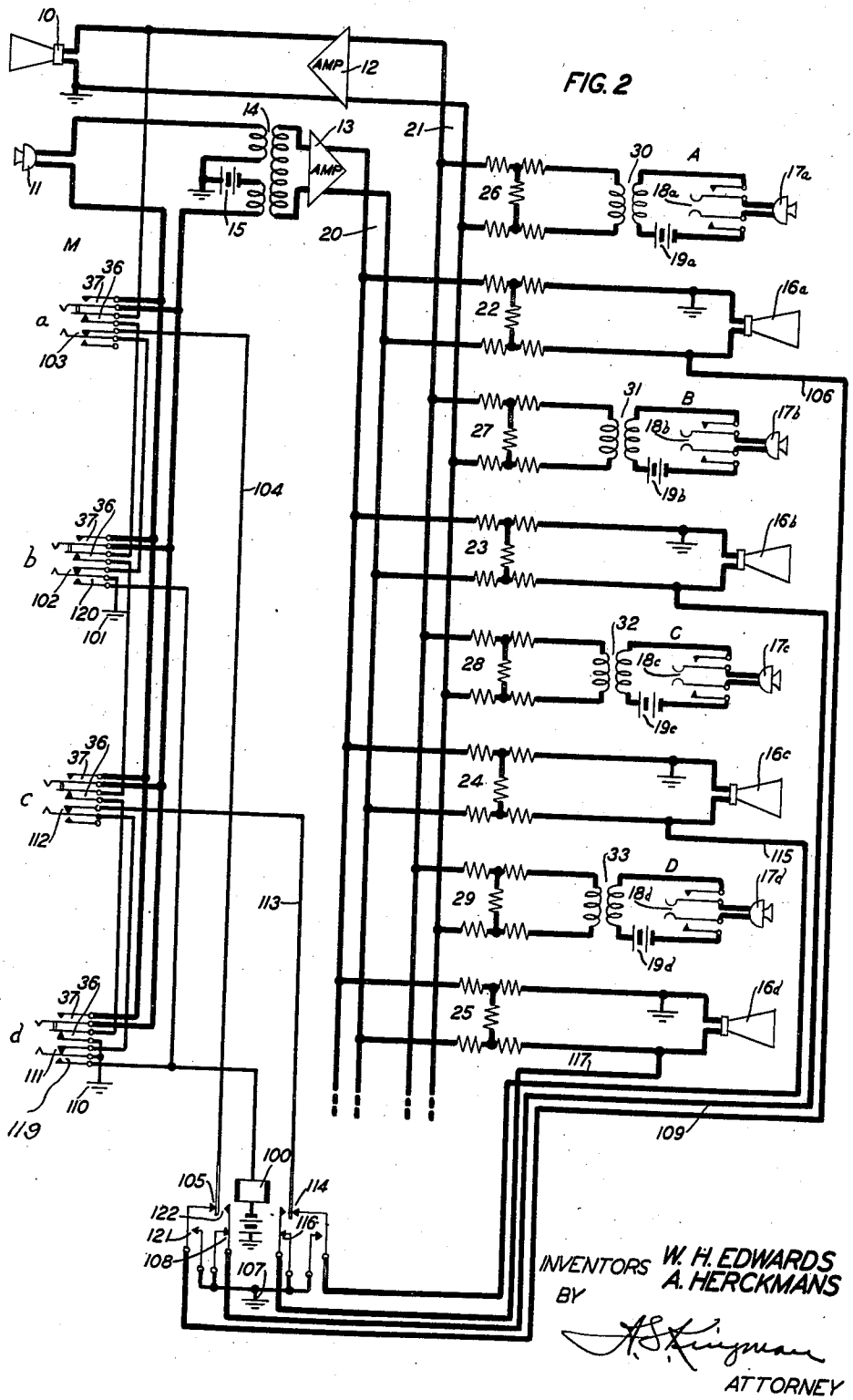
FIG. 2



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TELEPHONE SYSTEM

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14 Claims. (Cl. 179—36)

This invention relates to telephone systems and particularly to intercommunicating or conference systems of the type in which the origination of telephone calls between a master station and a plurality of subordinate stations is under the control of the subscriber at the master station.

It is the object of this invention to provide an improved system of intercommunication for use between a master station and any or all of a plurality of subordinate stations.

This object is attained in accordance with a feature of the invention by the provision of a four-wire speech transmission path between the master station and each subordinate station and by the inclusion of a pair of centrally located one-way amplifiers therein, so arranged that one of the amplifiers serves to amplify the speech signals originated at all the subordinate stations and to impress them upon the receiver at the master station, and the other amplifier serves to amplify the speech signals originated at the master station and to impress them upon the receivers at the subordinate stations.

In accordance with a particular feature of the invention each subordinate station receiver is connected to the output terminals of a common amplifier by way of a resistance pad which renders it possible to disable the receivers without affecting the amplifier termination and without affecting the receivers which may be rendered effective for the reception of speech signals.

Another feature of the invention provides for the instantaneous establishment of a talking connection between the master station and any of a plurality of subordinate stations upon the initiation of a call at the master station. More specifically, the master station is equipped with switching means, which when operated to initiate a call to a subordinate station, functions to simultaneously condition the receivers, such as the loud-speakers disclosed, at the master and subordinate stations for the reception of speech signals and to complete an energizing circuit for the transmitter at the master station.

A further feature of the invention resides in the use, at the master station, of station selecting keys which may be operated individually or collectively, at the will of the master station subscriber to set up either a connection to an individual subordinate station or to establish a conference connection involving a plurality of subordinate stations.

These and other features of the invention will be recognized from the following detailed description made with reference to the accompanying drawings in which:

Fig. 1 is a circuit diagram illustrating a loud-speaker intercommunicating system involving features of this invention and in which an individual switching lead is required for each subordinate station; and

Fig. 2 is a circuit diagram similar to that of Fig. 1 and in which the number of switching leads is reduced by the use of a "gang" relay.

The following description is made with reference to Fig. 1 of the drawings. In this figure there are shown a master station M and four subordinate stations A, B, C and D, it being understood that the system may be extended to include a greater number of subordinate stations.

The master station M is equipped with a loud-speaker 10, a distant talking transmitter 11 and a set of four keys *a*, *b*, *c* and *d*. The four keys *a*, *b*, *c* and *d* correspond respectively to the subordinate stations A, B, C and D. At any convenient location, such as in the common portion of the circuit, there are two one-way amplifiers 12 and 13. The loud-speaker 10 is connected to the output terminals of amplifier 12 whereas the transmitter 11 is adapted to be connected to the input side of amplifier 13 by way of the repeating coil 14 when any one of the station selecting keys A, B, C or D is operated. The battery 15 is used to supply energy for the transmitter 11.

Each subordinate station is equipped with a loud-speaker, such as speaker 16_a at station A, a distant talking transmitter such as is shown at 17_a, and a key 18_a. The loud-speaker and transmitter are so mounted and of such types as to have a large coupling loss. Inasmuch as this is the only effective coupling in the system, this permits amplification sufficient to provide a satisfactory volume level at the loud-speaker. The keys such as 18_a, 18_b, 18_c and 18_d serve, when operated, to complete the transmitter connections to their respective batteries 19_a, 19_b, 19_c and 19_d. These batteries are shown for simplicity in the drawings as separate units. A common battery for all the subordinate stations may be employed if desirable.

The output terminals of amplifier 13 are connected to a speech channel 20, while the input terminals of amplifier 12 are associated with the speech channel 21. Each of the loud-speakers at the subordinate stations A, B, C and D is bridged across the speech channel 20, the connections being made by way of resistance pads 22, 23, 24 and 25, respectively. The transmitters 17_a, 17_b, 17_c and 17_d of subordinate stations A

B, C and D respectively, are each connected across the speech channel 21 by way of a resistance pad and a transformer. The resistance pads are identified by the numerals 26, 27, 28 and 29 while the transformers are indicated at 30, 31, 32 and 33. The resistance pads and the transformers may be located either at their respective stations or at a common point.

Each loud-speaker 16a, 16b, 16c, and 16d is normally disabled by being short-circuited, both sides of the input circuit thereto being grounded, one directly and the other through a normal contact 35 of their corresponding keys *a*, *b*, *c* and *d*

The input circuit to loud-speaker 10 at the master station is normally short-circuited, one conductor being connected directly to ground and the other connected to ground by way of the series-connected contacts 36 of keys *a*, *b*, *c* and *d*. The circuit for transmitter 11 at the master station M is normally opened and may be closed by way of contacts 37 of keys *a*, *b*, *c* or *d*.

The system disclosed in Fig. 1 operates in the following manner:

When the subscriber at master station M desires to converse with any of the subscribers at the subordinate stations A, B, C or D, the key corresponding to the desired subordinate station is actuated. Assuming the subscriber at subordinate station A is desired, the subscriber at master station M actuates key *a* which is individual to the station A. Key *a* at contacts 37, completes the energizing circuit for the transmitter 11 at the master station; at contacts 36, it removes the short circuit from the loud-speaker 10 and at contacts 35, it removes the short circuit from the loud-speaker 16a at subordinate station A. By speaking into the transmitter, the master subscriber may call the desired party at station A. The speech signals set up at the transmitter 11 are impressed on the amplifier 13 by means of the transformer 14; they are amplified at 13 and received at the loud speaker 16a at station A after traversing the speech channel 20 and the resistance pad 22. If it is necessary for the subscriber at station A to speak to the calling subscriber, the key 18a would be actuated to complete the energizing circuit for the transmitter 17a. Speech signals set up at the transmitter 17a are impressed on the amplifier 12 by means of the coupling transformer 30 and the resistance pad 26; they are amplified by the amplifier 12 and impressed on the loud-speaking receiver 10. At the termination of conversation, the keys *a* and 18a are restored to normal to restore the system to its normal unoperated condition.

Stations B, C and D may be signaled by the operation of keys *b*, *c* and *d* respectively. The functions performed by contacts 35, 36 and 37 of these keys are identical to those performed by correspondingly identified contacts of key *a*, just described.

Any number of the subordinate stations A, B, C and D may be simultaneously signaled by the simultaneous operation of the corresponding keys *a*, *b*, *c* and *d*. Thus, the subscriber at master station M may hold a conference with any number of, or with all of the subscribers at subordinate stations A, B, C and D. Due to the provision of the resistance pads in the transmitter circuit and in the loud-speaker circuit of each subordinate station which are connected at all times across the output of amplifier 13 and across the input of amplifier 12, the speech volume received at any station remains substantially unchanged regardless of how many stations are connected at one time.

Speech signals generated at each of the subordinate stations may be heard at each of the other subordinate stations, at a level slightly below that of speech from the master station. For example, speech signals set up at the transmitter 17a may be heard at station B; the path for such signals extending from transmitter 17a, transformer 30, resistance pad 26, channel 21, amplifier 12, loud-speaker 10, acoustical path to transmitter 11, repeating coil 14, amplifier 13, channel 20, resistance pad 23, to the loud-speaker 16b at subordinate station B. Similar paths may be traced from each of the transmitters 17b, 17c and 17d to the loud-speakers at the other subordinate stations. The amount the speech level is down under this condition compared to that of speech from the master station, is an amount equal to half the singing margin.

The system disclosed in Fig. 2 distinguishes from that shown in Fig. 1 only by the addition of a gang relay 100 which renders it possible to divide the subordinate stations into two groups and to decrease the number of conductors extending from the master station to the subordinate stations. Where it has been found convenient to do so, the apparatus shown in Fig. 2 which corresponds to similar apparatus disclosed in Fig. 1, has been assigned similar identification characters.

In the showing of Fig. 2, subordinate stations A and C constitute one group of stations, while stations B and D make up the second group. As in the case of Fig. 1, the loud-speakers 16a, 16b, 16c and 16d at the subordinate stations A, B, C and D respectively, are normally short-circuited. The short circuit for speaker 16a may be traced from ground at 101, normal contact 102 of key *b* at the master station M, contact 103 of key *a*, conductor 104, left armature and contact 105 of relay 100, conductor 106, one side of the loud-speaker 16a to ground on the other side of the speaker 16a. The short circuit for speaker 16b extends from ground 107, contact 108 of relay 100, conductor 109, one side of the speaker 16b to ground on the other side of speaker 16b. The short circuit for speaker 16c extends from ground 110, contacts 111 of key *d*, contacts 112 of key *c*, conductor 113, right armature and contact 114, of relay 100, conductor 115, one side of speaker 16c to ground on the other side of speaker 16c. The short circuit for speaker 16d extends from ground 107, contact 116 of relay 100, conductor 117, one side of speaker 16d to ground on the other side of speaker 16d.

Contacts 36 and 37 of keys *a*, *b*, *c* and *d* perform the same functions as similarly identified contacts of the keys of Fig. 1. Contacts 118 and 119 of keys *b* and *d* serve to control the operation of relay 100 over obvious circuits.

Subordinate station A is signaled by the actuation of key *a* at the master station M. When key *a* is operated, contacts 37 and 36 thereof function to complete the battery supply to transmitter 11 and remove the short circuit from loud-speaker 10 respectively. The normal short-circuiting path for loudspeaker 16a, previously traced, is opened at contact 103 of key *a*. The subscriber at the master station M may now speak to the subscriber at subordinate station A. The subscriber at subordinate station A, should it be found necessary to speak to the calling sub-

scriber, may do so by actuating key 18a. The speech signal transmission paths are identical to those traced in the description of operation of the system shown in Fig. 1.

To communicate with subordinate station B, the subscriber at master station M actuates key *b*. Contacts 37 and 36 of key *b* perform functions which are now apparent. At contact 120, the key *b* completes an obvious operating circuit for gang relay 100. At contact 102, it removes ground from conductor 106 which is included in the normal short circuit of loud-speaker 16a; this ground however, is replaced as will be described presently. When relay 100 operates, it closes its contact 121 to connect ground 107 to conductor 106 thereby maintaining the loud-speaker 16a short-circuited. At contact 108 the normal short-circuiting path for speaker 16b is opened, to condition the speaker 16b for operation. Though the conductor 109, included in the short circuit of speaker 16b, is connected to conductor 104 by way of relay contacts 122, the speaker 16b is still prepared for operation since the ground connection to conductor 104 is opened at contacts 102 of key *b*. Conversation between stations M and B is carried on in the same manner as between stations M and A described above. It will be noted that the short-circuited condition of loud-speakers 16*c* and 16*d* is maintained when relay 100 operates in response to the operation of key *b*.

It is believed unnecessary to describe in detail the setting up of connections between master station M and subordinate stations C and D since such should now be apparent. Suffice it to say that key *c* is used to select station C and functions to open the normal short-circuiting path for speaker 16c at contacts 112, and that key *d* is operated to select station D. Key *d* performs the same functions as key *b* and when relay 100 operates as a consequence of the operation of key *d* the speakers 16a, 16b and 16c are maintained short-circuited.

With the arrangement shown in Fig. 2, all the stations of either group may be selected for simultaneous conversation. More specifically, when keys *a* and *c* are actuated, the subordinate stations A and C are connected with the master station for conference purposes, and when keys *b* and *d* are operated, the stations B and D are selected. It is believed obvious from preceding descriptions that when keys *a* and *c* are operated the short circuits are removed from loudspeakers 16a and 16c at stations A and C and those about speakers 16b and 16d at stations B and D are maintained. Similarly, when keys *b* and *d* are actuated, relay 100 operates to remove the short circuits from speakers 16b and 16d at stations B and D and to maintain the speakers 16a and 16c at stations A and C shorted.

The speech transmission paths between the several stations connected for conference purposes are identical with those described in connection with Fig. 1.

If it is not desirable, under some circumstances to use loud-speaker and transmitter arrangements which have a large coupling loss to provide margin against singing, the amplifiers 12 and 13 may include voice operated features to introduce losses at the proper time in either or both circuits to compensate for this.

What is claimed is:

1. In a loud-speaking telephone intercommunicating system, a master station having a telephone set comprising a normally disabled loud-speaker and a transmitter, a subordinate station including a normally disabled loud-speaker, an intercommunicating line interconnecting said stations, and means at said master station for simultaneously enabling the loud-speaker at each of said stations and for effectively connecting the transmitter at said master station to said intercommunicating line.

2. In a loud-speaking telephone intercommunicating system, a master station having a telephone set comprising a normally disabled loud-speaker and a transmitter, means for energizing said transmitter, a subordinate station having a normally disabled loud-speaker, an intercommunicating line interconnecting said stations, and means for effectively connecting said loud-speakers and said transmitter to said line, said means comprising a switch at said master station and contacts controlled thereby for enabling each of the loud-speakers and for connecting said energizing means to the said transmitter.

3. In a loud-speaking telephone intercommunicating system, a master station, a subordinate station, an intercommunicating line interconnecting said stations, a telephone set at each of said stations for use in communicating over said line, each set comprising a normally disabled loud-speaker and a transmitter normally disconnected from said line, a switch at said master station for enabling the loud-speaker at each of said stations and for connecting the transmitter at the master station to said line, and switching means at said subordinate station for connecting the transmitter thereat to said line.

4. In a loud-speaking telephone intercommunicating system, a master station, a plurality of subordinate stations, an intercommunicating line interconnecting said master station and said subordinate stations, a telephone set at each of said stations for use in communicating over said line, each set comprising a normally disabled loud-speaker and a transmitter normally disconnected from said line, switching means at said master station for enabling the loud-speaker at said master station and the loud-speakers at each of said subordinate stations and for effectively connecting the transmitter at the master station to the intercommunicating line, and switching means at each of said subordinate stations for effectively connecting the transmitter thereat to said line.

5. In a loud-speaking telephone intercommunicating system, a master station, a subordinate station, a telephone set at each of said stations comprising a normally disabled loud-speaker and a transmitter, a speech channel interconnecting said stations including an amplifier having output terminals connected to the loud-speaker at said master station, a second speech channel interconnecting said stations including an amplifier having input terminals adapted to be connected to the transmitter at said master station, switching means at said subordinate station for connecting the transmitter thereat to said first speech channel, and means comprising a switch at said master station for enabling the loud-speaker at each of said stations and for connecting the transmitter at the master station to said second speech channel.

6. In a loud-speaking telephone intercommunicating system, a master station, a subordinate station, a pair of one-way speech channels interconnecting said stations, a normally disabled loud-speaker at said master station associated with one end of one of said speech channels, a normally disabled loud-speaker at said subordi-

nate station associated with one end of the other of said speech channels and a distant talking transmitter at the master station adapted to be connected to the other end of said other speech channel, a switch at said master station, and means including contacts of said switch for simultaneously enabling the loud-speakers at both said stations and for effectively connecting the distant talking transmitter at said master station to one end of said other speech channel.

7. In a loud-speaking telephone intercommunicating system, a master station, a subordinate station, an intercommunicating line interconnecting said stations, a telephone set at said master station comprising a normally disabled loud-speaker and a normally deenergized transmitter, a telephone set at said subordinate station comprising a normally disabled loud-speaker and a normally deenergized transmitter, switching means for simultaneously enabling the loud-speaker at each of said stations and for energizing the transmitter at said master station, and switching means at said subordinate station for energizing the transmitter thereat.

8. In a loud-speaking telephone intercommunicating system, a master station having a telephone set including a normally disabled loud-speaker, a subordinate station including a normally disabled loud-speaker, and means at said master station for simultaneously enabling the loud-speaker at each of said stations.

9. In a loud-speaking telephone intercommunicating system, a master station having a transmitter, means for energizing said transmitter, a subordinate station having a normally disabled loud-speaker, an intercommunicating line interconnecting said stations, and means for effectively connecting the master station transmitter and the subordinate station loud-speaker to said line, said means comprising a switch at said master station and contacts controlled thereby for enabling the subordinate station loud-speaker and for connecting said energizing means to the master station transmitter.

10. In a telephone intercommunicating system, a master station, a plurality of subordinate stations, an intercommunicating line interconnecting said master station and said subordinate stations, a telephone set at each of said stations for use in communicating over said line, each set comprising a normally disabled receiver and a transmitter normally disconnected from said line, switching means at said master station for enabling the receivers at all of said stations and for effectively connecting the transmitter at the master station to the intercommunicating line, and switching means at each subordinate station for effectively connecting the transmitter thereat to said line.

11. In a telephone conference or intercommunicating system, a master station, a plurality of subordinate stations, an intercommunicating line interconnecting said master station and said subordinate stations, means for establishing a conference connection over said line involving said master station and any number of said subordinate stations, and means permanently included in the circuit to each subordinate station for presenting the same approximate impedance to the intercommunicating line and from the line to ground regardless of the number of subordinate stations involved in the conference connection.

12. In a telephone intercommunicating system, a master station, a plurality of subordinate stations, an intercommunicating line interconnecting said master station and said subordinate stations, a telephone set at each of said stations, each set comprising a receiver and a transmitter normally disconnected from said line, short-circuiting means for the master station receiver, control conductors from the master station to each subordinate station which normally short-circuit the receiver at each of said subordinate stations, switching means at said master station for opening the short circuit from the receiver of each of said subordinate stations and from the receiver at said master station, and for effectively connecting the transmitter at the master station to the intercommunicating line, and switching means at each of said subordinate stations for effectively connecting the transmitter thereat to said line.

13. In a telephone intercommunicating system, a master station, a plurality of subordinate stations, an intercommunicating line interconnecting said master station and said subordinate stations, a telephone set at each of said stations, each set comprising a receiver and a transmitter normally disconnected from said line, short-circuiting means for the master station receiver, control conductors from the master station to each subordinate station circuit which normally short-circuit the receiver at each subordinate station, networks associated with each subordinate station for preventing the short circuit of said receivers from appreciably affecting the impedance termination of the intercommunicating line, switching means at said master station for opening the short circuit from the receiver at each of said subordinate stations and from the receiver at said master station, and for effectively connecting the transmitter at the master station to the intercommunicating line, and switching means at each of said subordinate stations for effectively connecting the transmitter thereat to said line.

14. In a loud-speaking telephone conference and intercommunicating system, a master station, a plurality of subordinate stations, an intercommunicating line, a telephone set at each of said stations comprising a normally disabled loud-speaker and a transmitter, switching means at said master station for effectively connecting and disconnecting the telephone set thereat to said line and for simultaneously selectively enabling the loud-speakers at each of or at a combination of said subordinate stations, impedance means associated with each of said subordinate stations permanently included in circuit between the intercommunicating line and the telephone set at each of said subordinate stations, whereby said subordinate stations present the same impedance to the intercommunicating line whether or not the loud-speaker thereat is enabled, and switching means at each of the subordinate stations for effectively connecting its corresponding transmitter to the line.

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