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First

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[54] INTERCOMMUNICATION SYSTEM FOR APARTMENT, OFFICE BUILDING AND THE LIKE

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[52] **U.S. Cl.** .....**179/37**, 179/1 H, 179/2 R

[51] **Int. Cl.** **H04m 9/00**

[58] **Field of Search** .....179/37, 18 AD, 2 R; 1/1 H, 1/2 A

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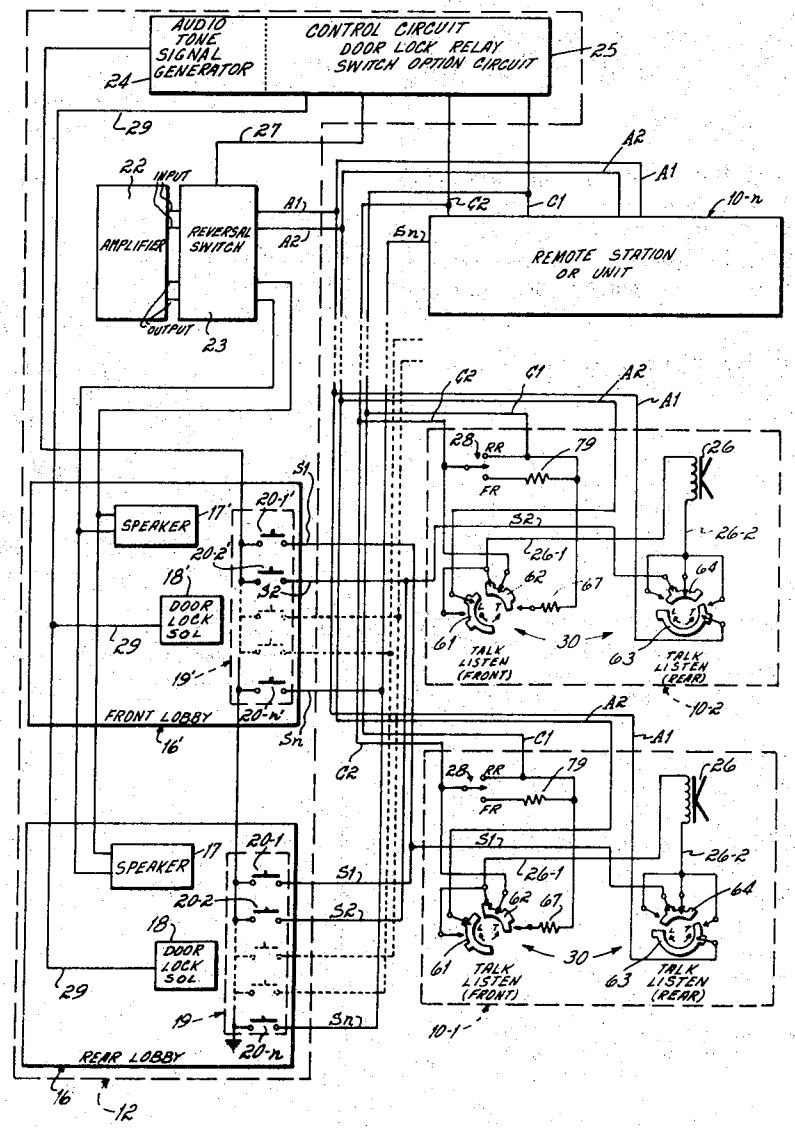
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[57] **ABSTRACT**

A two-way intercommunication system for selectively interconnecting a central station, such as an apartment or office lobby, with any one of a multiplicity of remote units, such as individual apartments or offices of a multi-unit building.

4 Claims, 3 Drawing Figures



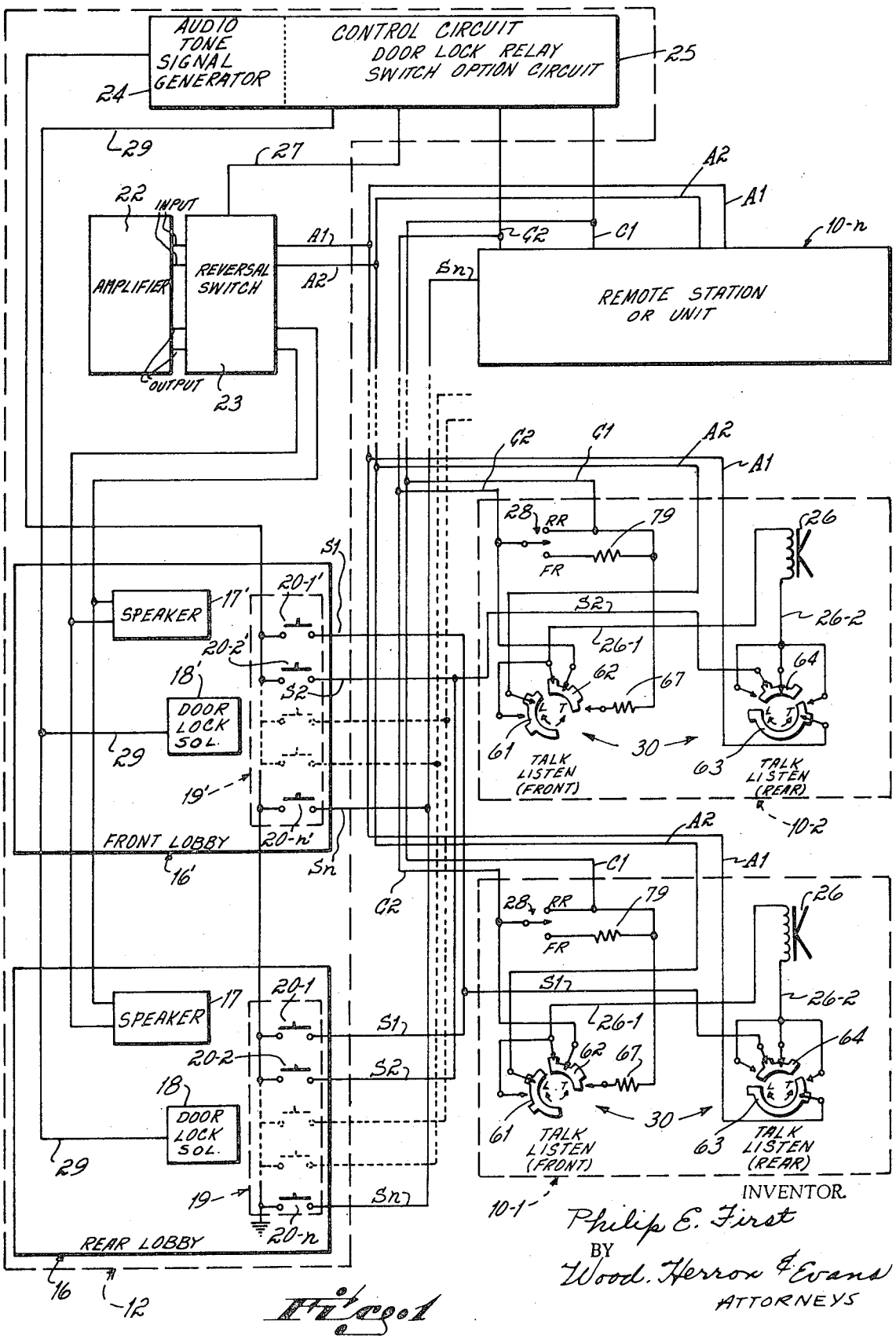


Fig. 1

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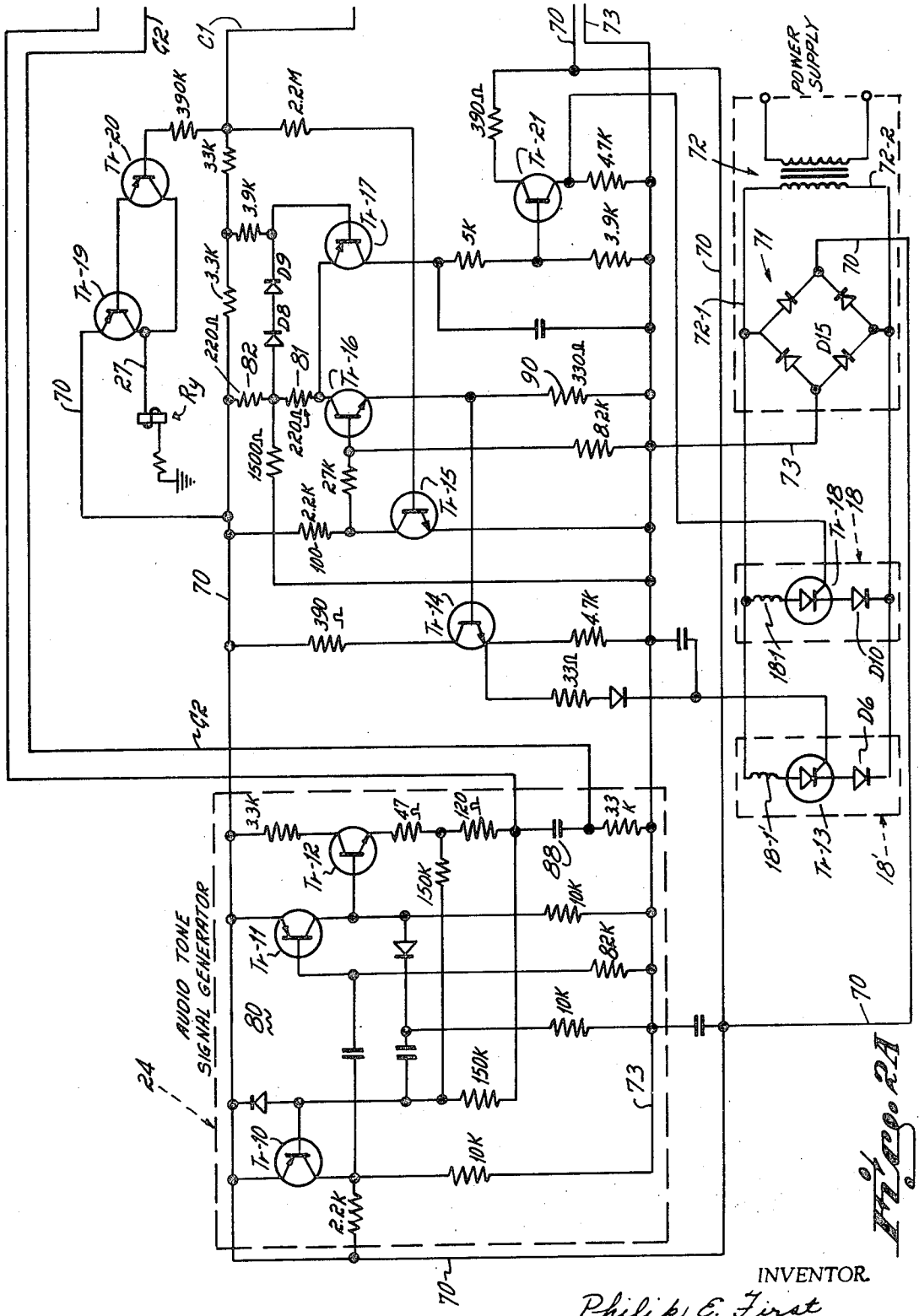
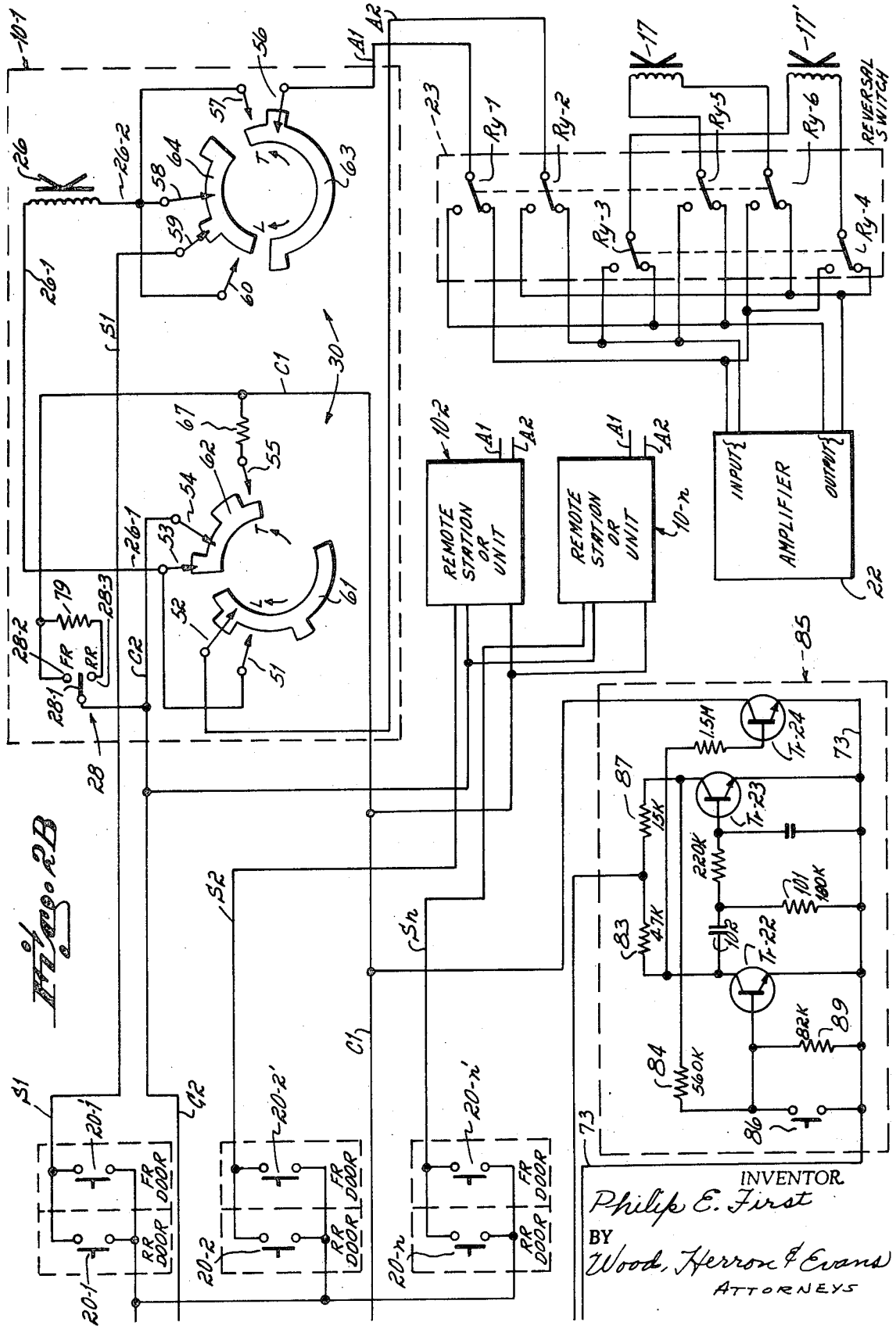


Fig. 2A

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REMOTE STATION OR UNIT
REMOTE STATION OR UNIT
AMPLIFIER
INPUTS
OUTPUTS
REVERSAL SWITCH
FR DOOR
RR DOOR
Tr-24
Tr-23
Tr-22
1.5M
15K
220K
100K
47K
82K
560K
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INTERCOMMUNICATION SYSTEM FOR APARTMENT, OFFICE BUILDING AND THE LIKE

This invention relates to intercommunication systems, and more particularly to intercommunication systems for facilitating two-way communication between a central station, such as the lobby of an apartment, office building or the like, and a selected one of a plurality of remote units, such as individual apartments or offices.

The utility of intercommunication systems which permit two-way communication between a central station, such as the lobby of an apartment or office building, and a plurality of remote stations, such as the individual apartments or offices of the building, is now well established and accepted. Such systems permit the tenant of an office or apartment to converse with a prospective visitor prior to permitting the visitor to enter the apartment or office, as the case may be. Such preliminary conversation provides the tenant with an opportunity to screen or interview the prospective visitor, and if so desired to deny entry. In certain instances, for example in the case of door-to-door salesmen, a housewife who normally would be too embarrassed to dismiss a salesman to whom she has opened the door without first subjecting herself to his sale appeal, finds it remarkably less embarrassing and significantly more convenient when using an intercommunication system to summarily dismiss the same salesman without a hearing. This the housewife does in the privacy and security of her apartment knowing the salesman will never be nearer than a distant lobby.

From the standpoint of personal security, the preliminary screening of visitors afforded by intercommunication systems of the type to which this invention is directed permits a housewife to safely deny entry to a potential assailant who, in the absence of such screening, may easily have gained entry when the housewife unwittingly opened the door in response to what she believes is an innocent knock or ring of the doorbell.

Finally, intercommunication systems for an apartment or office building are desirable from the standpoint of convenience alone. For example, a dairy products deliveryman can conveniently inquire of his customer as to the customer's specific need for dairy products on a given day. This avoids trecking to the apartment, which may be on the 15th or 18th floor of a multi-story apartment building, only to learn that the tenant/customer desires some unusual dairy product which is not normally carried by the deliveryman, but is inventoried in his truck.

In designing an intercommunication system, a number of factors must be considered if the ultimate cost of the system is to be kept within the reasonable bounds necessary for commercial acceptance. Illustrative of such factors is the complexity of the remote station unit. If the remote unit is unnecessarily complex, the total cost of the system may be excessive, it being realized any excess in cost of a remote unit due to unnecessary complexity is multiplied by the number of units, apartments, offices, or the like in the building. For example, if in a 200-unit apartment building the remote unit requires an unnecessary relay, the cost added to the system is not just the cost of one relay, but rather 200 relays since there are 200 apartments in the building. Due to this multiplication factor, it is therefore essential that the complexity of the remote unit be kept low if system cost is to be minimized.

Another important factor cost-wise is the number of individual wires which are required to interconnect the central station with the various remote units. If multiple independent wires are required between the central station and each remote unit, the total number of independent wires in the system becomes excessively large, the excessiveness being influenced by the multiplication factor noted above, namely, the number of apartments or offices in the building. Excessive wiring is costly for two reasons, namely, the wire itself is expensive as is the electrician's labor required to install it.

Another, and equally important, factor in the commercial acceptance of an intercommunication system is its convenience and ease of use by the tenant. Such systems should have remote units with a minimum number of controls, which controls are also easily understood and used. It must be remembered that the average user is often a woman who does not have a high level of mechanical aptitude or familiarity with technical subject matter.

It has been an objective of this invention to provide a two-way intercommunication system for apartments, office buildings, and the like which is relatively simple and inexpensive in design, and which can be conveniently used by mechanically unskilled personnel. This objective has been accomplished in accordance with certain principles of this invention by providing a system in which all stations, both central and remote, have a two-way speaker and are connected in parallel to a pair of common audio lines and a pair of common control lines. In addition to the two audio lines and two control lines which are common to all stations, a plurality of wires corresponding in number to the number of remote units connect the central station with individual ones of the remote stations. At the central station an audio amplifier is provided in combination with amplification direction reverser which is responsive to the control lines for reversing, under the control of the remote stations, the connection of the amplifier in the audio lines to thereby facilitate, on an alternate basis, communications to and from the remote stations. Also at the central station is a signal generator, such as an audio frequency tone generator, and a plurality of call switches corresponding in number to the number of remote units. The call switches selectively interconnect the output of the tone generator to the remote units via the individual remote unit signal lines. At the remote station, in addition to the two-way speaker, is a three-state or condition switch. In the first, or standby, condition the switch connects the remote speaker between its respective signal line and one of the common control lines to facilitate initiation of an audible signal at a called remote station in response to actuation in the lobby of that station's call switch. In a second condition of the remote station switch, termed the talk position, the remote speaker is connected across the audio lines to facilitate communication from the remote station to the central station via the audio lines and the amplifier which is normally connected to amplify communications originating at the called station. In the third, or listening, position of the remote switch, the remote station speaker is connected across the audio lines and additionally a control signal is placed on control lines to

actuate the amplification direction reverser to reverse the amplifier connections and permit amplification of signals originating at the central station.

The system of this invention has a number of novel and unobvious features. For example, by virtue of using control lines and audio lines which are common to each station, remote and central, the number of independent wires required is kept to a minimum regardless of the number of remote units in the system. In fact, the number of independent wires for a building having n remote stations is equal to $n+4$. Also, since the remote station requires only a two-way speaker and a switch, the materials cost of the system, which is directly related to the cost of a single remote unit by the number of units in the building, is kept to a minimum. Finally, since the remote unit switch in the standby or normal condition connects the speaker to the signal line, a call can be initiated from the lobby without any required cooperation or participation by the party being called.

These and other advantages and objectives will become more readily apparent from a detailed description of the invention taken in conjunction with the drawings in which:

FIG. 1 is a schematic circuit in block diagram format of a preferred embodiment of an intercommunication system incorporating the principles of this invention;

FIGS. 2A and 2B combined is a detailed circuit diagram of the preferred embodiment of FIG. 1.

With reference to FIG. 1, the preferred embodiment is seen to include a plurality of identical remote stations or units **10-1**, **10-2**,...**10-*n***, and a central station or unit **12** to which each of the remote units **10-1**, **10-2**,...**10-*n*** can be selectively interconnected for two-way communication. The remote units **10-1**, **10-2**,...**10-*n*** preferably are located in different apartments or offices of a multi-apartment or multi-office building, while the central unit **12** is located in the lobby or other common area of the building. In the preferred embodiment the central unit **12** includes two identical stations **16** and **16'** each of which has a two-way speaker **17**, **17'**, a door unlocking mechanism **18**, **18'**, and a call panel **19**, **19'**. The speakers **17**, **17'** of the stations **16**, **16'** can be selectively interconnected for two-way communication with similar two-way speakers, to be described, in the remote units **10-1**, **10-2**,...**10-*n***. The door unlocking mechanisms **18**, **18'** of stations **16**, **16'** are associated with normally locked doors which are designed to be under the control of door switches, to be described, associated with each remote unit **10-1**, **10-2**,...**10-*n***. The call panels **19**, **19'** facilitate selective signalling from the stations **16**, **16'** to the various remote units **10-1**, **10-2**,...**10-*n*** for the purpose of initiating a communication between one of the central stations **16** or **16'** and a selected remote unit. For this purpose, each of the call panels **19**, **19'** include a plurality of switches **20-1**, **20-2**,...**20-*n*** and **20-1'**, **20-2'**,...**20-*n'***, respectively, corresponding in number to the number of remote units **10-1**, **10-2**,...**10-*n***, and which when activated, result in the production at the corresponding remote unit of an appropriate signal such as an audible tone.

In accordance with a preferred form, the identical central stations **16** and **16'** are located in the rear lobby and front lobby, respectively, of the building in which the remote units **10-1**, **10-2**,...**10-*n*** are located. In such case, the door unlocking mechanisms **18** and **18'** control normally locked doors between the rear and front lobbies, respectively, and the interior of the building wherein the remote units **10-1**, **10-2**,...**10-*n*** are located.

The central station **12**, in addition to the rear and front lobby stations **16** and **16'**, also includes an amplifier **22**, a reversal switch **23**, an audio tone signal generator **24**, and a control circuit **25**. The amplifier, reversal switch, signal generator and control circuit may be physically located in either the front or rear lobby, or elsewhere in the building. The amplifier **22** provides amplification of two-way communications between the rear and front lobby speakers **17** and **17'**, respectively, and the speakers of the remote stations **10-1**, **10-2**,...**10-*n***. The reversal switch **23** controls the amplification direction, that is, whether communications from, or to, the central station are amplified. The signal generator **24** generates an audio frequency tone which can be transmitted to one or more of the remote units **10-1**, **10-2**,...**10-*n*** under the control of the switches **20-1**, **20-2**,...**20-*n*** and **20-1'**, **20-2'**,...**20-*n'*** of the respective call panels **19** and **19'**. The control circuit **25** includes the requisite circuitry, to be described in detail, for facilitating the signalling, communicating, door unlocking, and other control functions of the system.

The remote units **10-1**, **10-2**,...**10-*n***, which as indicated are structurally and operationally identical, each include a two-way speaker **26**, a three-position manually operated door switch **28**, and a three-position manually operated talk/listen switch **30**. The remote speaker **26** facilitates two-way communication between its respective remote unit **10-1**, **10-2**,...**10-*n*** and the rear and/or front lobby speaker **17**, **17'**. The three-position door switch **28** facilitates control from its respective remote unit **10-1**, **10-2**,...**10-*n*** of the door unlocking mechanisms **18**, **18'**, facilitating unlocking by personnel at the remote units of the doors in the front and rear lobbies which permit access to the interior of the building in which the remote units are located. The talk/listen switch **30** permits personnel at the remote units **10-1**, **10-2**,...**10-*n*** to control the central station reversal switch **23** and thereby select the direction of permissible communication between the rear and front lobby speakers **17**, **17'** and the remote speakers **26**. When switch **30** is in the "talk" position the central station amplifier **22** amplifies speech from the remote unit **10** to the central unit **12**, and when in the "listen" position amplifies speech from the central unit **12** to the remote unit **10**. The talk/listen switch **30** has a third and normal, or standby position in which it connects the remote speaker **26** in a manner such that it will audibly reproduce a tone signal generated by the tone signal generator **24** should the remote unit be signalled from one or the other of the lobby call panels **19**, **19'**.

Interconnecting the central station **12** and the remote units **10-1**, **10-2**,...**10-*n*** are two audio lines A1 and A2. Audio lines A1 and A2 are common to each remote unit **10-1**, **10-2**,...**10-*n*** and each of the lobby speakers **17** and **17'**. Stated differently, the remote units **10-1**, **10-2**,...**10-*n*** and the rear and front lobby speakers **17**, **17'** are connected in parallel to the audio lines A1 and A2. The amplifier **22** is connected in audio lines A1 and A2 via the reversal switch **23**, and, depending on whether the talk/listen switch **30** of a remote unit **10-1**, **10-2**, ...**10-*n*** is in its talk or listen

position, amplifies speech to or from the central station 12, respectively.

Also interconnecting the remote units 10-1, 10-2,...10-*n* are control lines C1 and C2. The control lines C1 and C2, like the audio lines A1 and A2, are common to each of the remote units 10-1, 10-2,...10-*n*. Control lines C1 and C2 are also connected to the control circuit 25. Thus, the remote units 10-1, 10-2,...10-*n* and the control circuit 25 connect in parallel to the control lines C1 and C2. The control lines are responsive to the position of the remote unit talk/listen switch 30 for controlling via control circuit 25 the condition of the reversal switch 23 and hence the direction of speech amplifier 22.

In addition to the audio lines A1 and A2 and the control lines C1 and C2 there are n signal lines S1, S2,...S*n*. The signal lines S1, S2,...S*n* are respectively unique to the remote units 10-1, 10-2,...10-*n*, that is, each remote unit has its own individual signal line. Each signal line S1, S2,...S*n* is connected to the tone signal generator 24 via its respectively associated front lobby call panel switch 20-1', 20-2',...20-*n*' and its respectively associated rear lobby call panel switch 20-1, 20-2,...20-*n*. With the signal lines S1, S2,...S*n* so connected, the audible tone generated by generator 24 can be selectively transmitted to any one of the remote units 10-1, 10-2,...10-*n* by activation of the respectively associated front lobby call panel switches 20-1', 20-2',...20-*n*', or the respectively associated rear lobby call panel switch 20-1, 20-2,...20-*n*.

In operation, when a party in the front or rear lobby, herein termed the "calling party" desires to communicate with personnel at one of the remote units 10-1, 10-2,...10-*n*, herein termed the "called party," the individual in the lobby activates the switch 20-1, 20-2,...20-*n* corresponding to the desired remote unit, if in the rear lobby, or the switch 20-1', 20-2',...20-*n*' if in the front lobby. For example, if the calling party in the front lobby wishes to communicate with remote unit 10-1 the calling party depresses switch 20-1' of front lobby call panel 19'. Depression of this switch interconnects the tone signal generator 24 and signal line S1 of remote unit 10-1, in turn causing an audio signal to be transmitted to speaker 26 of remote unit 10-1. Since talk/listen switch 30 of remote unit 10-1 is in its standby position, that is, is connected to switch line S1 on which the audio signal is transmitted, the tone is audibly reproduced by speaker 26 of called party unit 10-1. An audible signal is not reproduced by speakers 26 of the other remote units 10-2,...10-*n*, notwithstanding that they are connected to their signal lines S2,...S*n* through their talk/listen switches 30 which are in standby position, because the lobby call switches 20-2, 20-2',...20-*n*, 20-*n*' associated with these remote units have not been activated by the calling party to connect the signal generator 24 to their respective signal lines S2,...S*n*.

The audible signal produced by speaker 26 of called remote unit 10-1 signals personnel at this remote unit that a caller is in either the front or rear lobby station 16', 16. At this point, since the talk/listen switch 30 of called remote unit 10-1 is in the standby position, the remote speaker 26 is not connected to the common audio lines A1 and A2 and the calling party in the front lobby unit 16' is unable to hear conversation originating in called remote unit 10-1. If the called party in remote unit 10-1 desires to speak with the calling party in front lobby station 16', the called party places switch 30 in the talk position. With switch 30 in the talk position, remote speaker 26 is disconnected from signal line S1 and instead is connected across the audio lines A1 and A2. Additionally, lines C1 and C2 are open-circuited when the talk/listen switch 30 is in the talk position. This is sensed by control circuit 25 to cause reversal switch 23 connect the amplifier 22 such that its input is connected to the remote speaker 26 via lines A1 and A2 and its output is connected to the lobby speakers 17, 17'.

When the called party in remote unit 10-1 desires to stop talking, and start listening in anticipation of hearing conversation originated by the calling party in the lobby, the talk/listen switch 30 is placed in the listen position. In this position the remote speaker 26 is connected to the audio lines A1 and A2. Additionally, a predetermined impedance is placed across control lines C1 and C2 which is sensed by the control circuit 25 to modify via line 27 the reversal switch 23 and in turn switch the input of the amplifier 22 to the central station speakers 17, 17' and the amplifier output to the remote speaker 26. The calling party in the front lobby is now free to speak into the speaker 17', which speech is then amplified by amplifier 22 and transmitted to the remote unit 10-1 via lines A1 and A2 where it is transduced by speaker 26 which, because switch 30 has been placed in the listen position, is connected to audio lines A1 and A2.

When the called party again wishes to talk, switch 30 is placed in the talk position. In the talk position, the remote speaker 26 is connected to audio lines A1 and A2 and the predetermined impedance associated with the talk switch position, e.g., an open circuit, is placed across control lines C1 and C2 with the result that the control circuit 25 causes, via line 27, the reversal switch 23 to reverse the input and output of the amplifier 22 to facilitate amplification of speech from the remote unit and transmission thereof to the lobby speakers 17, 17'.

Should the called party in remote unit 10-1 desire to unlock the door connecting the front lobby and the interior of the building in which the remote unit 10-1 is located, the door unlock switch 28 is switched from a normal or "standby" position to a "front door" position. This is effective to place a predetermined impedance across control lines C1 and C2, in turn causing the control circuit 25 to generate a signal on line 29 which activates the door unlocking mechanism 18' of the front lobby to unlock the door. Were the calling party to be located in the rear lobby 16, the called party would place the door switch 28 in a "rear door" position, placing a different predetermined impedance across control lines C1 and C2 which in turn causes the control circuit 25 to activate door unlocking mechanism 18 associated with the rear lobby door.

When the called party desires to terminate all conversation, the talk/listen switch 30 is placed in the standby position which removes speaker 26 from audio lines A1 and A2. This prevents the calling party from either listening to conversation originating at the called station, or from speaking to the called station.

The remote units 10-1, 10-2,...10-*n* are each structurally and operationally identical, and therefore only remote unit 10-1 is described in detail. As can best be seen in FIG. 2B, the unit 10-1 includes the two-way speaker 26 which, when spoken into, transduces the speech to an electrical signal on its output lines 26-1 and 26-2 for transmission via audio lines A1 and A2 to the central unit speakers 17, 17'. The two-way speaker 26, when input with a speech-carrying electrical signal on lines 26-1 and 26-2 from the central unit 12 via audio lines A1 and A2, transduces the speech signal to an audible output. Two-way speakers of the foregoing type are of conventional and well known construction, and hence are not described in detail herein. Suitable two-way speakers are commercially available from Nutone Division, Scovill Mfg. Co.

The two-way speaker 26 of unit 10-1 is alternately connectable between signal line S1 and control line C2, and between audio lines A1 and A2 via the talk/listen switch 30. The switch 30 has a first set of stationary contacts 51–55 and a second set of stationary contacts 56–60. Cooperating with contacts 51–55 are two rotatable conductive segments 61 and 62, while associated with stationary contacts 56–60 are two rotatable conductive segments 63 and 64. Segments 61 and 62 are ganged with segments 63 and 64 such that when a rotatable switch actuator (not shown) is rotated either counterclockwise or clockwise, the segments 61–64 rotate counterclockwise or clockwise, respectively.

The talk/listen switch 30 of remote unit 10-1, and hence the rotatable conductive segments 61–64, have three conditions or positions. A first, or standby position is the normal condition, and is shown in FIG. 2B. In this position contacts 53 and 54 are bridged by conductive segment 62, while contacts 58 and 59 are bridged by conductive segment 64. With these contacts bridged, lines 26-1 and 26-2 of two-way speaker 26 are connected across signal line S1 and control line C2. With speaker 26 connected across lines S1 and C2, a tone from the tone signal generator 24 can be transmitted to the speaker 26 of remote unit 10-1 if either the rear lobby panel switch 20-1 or the front lobby panel switch 20-1' is activated by a calling party seeking to initiate a communication with remote unit 10-1. Since remote units 10-2...10-*n* are connected in parallel with remote unit 10-1 to control line C2 and individually to their respective signal lines S2...S*n*, the speakers 26 of remote unit 10-2,...10-*n* are, when their respective switches 30 are in the standby position, connected to the tone signal generator 24 via lines C2 and their respective signal lines S2,...S*n* such that a tone can be transmitted to the remote unit 10-2,...10-*n* upon activation of the front or rear lobby switches 20-2,20-2',...20-*n*, 20-*n*', respectively.

When switch 30 is in its standby position, control line C1, and audio lines A1 and A2 are open-circuited.

The switch 30, in addition to the standby position described above, also has a talk position. In the talk position, segments 61–64 are rotated counterclockwise such that contacts 51 and 52 are bridged by conductive segment 61 while contacts 56 and 57 are bridged by conductive segment 63. With these contacts bridged, speaker lines 26-1 and 26-2 of speaker 26 in remote unit 10-1 are connected to output lines A2 and A1, respectively. Lines A1 and A2 are in turn connected to the input of amplifier 22 via normally closed contacts Ry-1 and Ry-2 of a control relay Ry to be described, relay contacts Ry-1 and Ry-2 forming part of the reverser switch 23. The output of the amplifier 22 is connected in parallel to the front and rear lobby two-way speakers 17' and 17 via normally closed relay contacts Ry-3, Ry-4 and Ry-5, Ry-6, respectively, of relay Ry, contacts Ry-3 to Ry-6 also forming part of the reverser switch 23. With switch 30 of unit 10-1 in the talk position, lines S1, C1 and C2 are open-circuited.

Thus, with the talk/listen switch 30 of remote unit 10-1 in the talk position, speaker 26 of remote unit 10-1 is connected via audio lines A1 and A2 and the reverser switch 23 to the input of the amplifier 22 while front and rear lobby speakers 17' and 17 are connected to the output of the amplifier 22 via switch reverser 23, thereby establishing an audio path from the speaker of remote unit 10-1 through the amplifier 22 to the rear and front lobby speakers 17 and 17'. The speakers 26 of remote unit 10-2,...10-*n*, as long as their respective talk/listen switches are in the standby position are not connected to the input of amplifier 22 via audio lines A1 and A2 and the reverser switch 23. Accordingly, only speech input to speaker 26 of remote unit 10-1, whose talk/listen switch 30 is in the talk position, will be transmitted to the input of the amplifier and following amplification therein to the front and rear lobby speakers 17' and 17.

The talk/listen switch 30 of remote unit 10-1 also has a listen position. In the listen position, conductive segments 61–64 are rotated clockwise. With these conductive segments so rotated, stationary contacts 51 and 52 are bridged by segment 61; contacts 54 and 55 are bridged by conductive segment 62; contacts 56 and 60 are bridged by conductive segment 63; and contact 59 which connects to signal line S1 is not bridged to another contact. With contact 59 not bridged, line S1 is open-circuited. The bridging of contacts 51, 52 by segment 61, and bridging of contacts 56 and 60 by segment 63 connects speaker lines 26-1 and 26-2 of speaker 26 of remote unit 10-1 to audio lines A2 and A1, respectively. The bridging of contacts 54 and 55 by segment 62 connects a predetermined impedance 67 between control lines C1 and C2. The presence of impedance 67 across control lines C1 and C2 is effective to turn on control circuit transistors Tr-20 and Tr-19 connected in a Darlington circuit configuration, which in turn energize relay Ry via line 27, transferring relay contacts Ry-1 to Ry-6 of reverser switch 23 from the position shown in FIG. 2B. With the relay contacts Ry-1 to Ry-6 transferred the speaker 26 of remote unit 10-1, which is connected to lines A1 and A2 via switch 30 when in its listen position, is connected to the output of amplifier 22 while the front and rear lobby speakers 17' and 17 are connected to the input of amplifier 22. Thus, the placement of impedance 67 across control lines C1 and C2, when the switch 30 of remote unit 10-1 is in the listen position, is effective to energize relay Ry and transfer the contacts Ry-1 to Ry-6 of reverser switch 23, thereby effectively connecting lobby speakers 17 and 17' to the input of amplifier 22 and speaker 26 of remote unit 10-1 to the output of amplifier 22.

Control circuit Darlington transistors Tr-19 and Tr-20, which sense the presence of impedance 67 across lines C1 and C2 in the listen mode of switch 30 of remote unit 10 to reverse the input and output connections of amplifier 22 relative to the remote speaker 26 of unit 10-1 and the lobby speakers 17, 17', are connected such that the emitter of transistor Tr-19 is connected to a positive bus 70 supplied from the positive output terminal of a four diode bridge rectifier 71, the input terminals of which are connected across the secondary winding of a transformer 72 which steps down the voltage of a conventional 120 volt a.c. supply. The base circuit of Darlington transistor Tr-20 is connected to control line C1. In the absence of impedance 67 across control lines C1 and C2, i.e., when switch 30 of unit 10-1 is not in the listen mode,Darlington transistors Tr-19 and Tr-20 are non-conductive, rendering relay Ry de-energized. With relay Ry de-energized, relay contacts Ry-1 to Ry-6 are in the position shown in FIG. 2B, causing the reversal switch 23 to connect the input of amplifier 22 to remote speaker 26 of unit 10-1 and the output of amplifier 22 to lobby speakers 17, 17'. However, when talk/listen switch 30 of unit 10-1 is placed in the listen position and impedance 67 is connected across control lines C1 and C2, the potential of control line C1 and hence of the base of Darlington transistor Tr-20, is lowered relative to the positive bus 70 connected to the emitter of Darlington transistor Tr-19 due to the voltage drop across impedance 67. This lowering of the potential of the base of Darlington transistor Tr-20 relative to the emitter of Darlington transistor Tr-19 switches the Darlington transistors Tr-20 and Tr-19 to a conductive state energizing the relay Ry. Energization of Relay Ry transfers relay contacts Ry-1 to Ry-6 from the position shown in FIG. 2B, causing lobby speakers 17, 17' to connect to the input of amplifier 22 and remote speaker 26 of unit 10-1 to connect to the output of amplifier 22. As long as the talk/listen switches 30 of remote unit 10-2,...10-*n* remain in the standby position, speech into lobby speakers 17, 17' which are connected to the input of amplifier 22 is not transmitted to the remote speakers 26 of remote units 10-2,...10-*n*, notwithstanding that the audio lines A1 and A2 are connected to the output of amplifier 22 by virtue of placement of talk/listen switch 30 of remote unit 10-1 in the standby position. This lack of transmission of the speech from lobby speakers 17, 17' to the speaker 26 of remote unit 10-2,...10-...*10-n* occurs because the talk/listen switches 30 of remote unit 10-2,...10-*n*, presumed to be in the standby condition, do not connect the speakers 26 of remote units 10-2,...10-*n* to the audio lines A1 and A2 as is necessary for a transmission of speech from the lobby speakers 17, 17' via the amplifier 22.

Switches 30 of remote units 10-2,...10-*n* function in a manner similar to that of switch 30 of unit 10-1.

The door control switch 28 of remote unit 10-1 includes a contact 28-1 movable to an inactive or standby position (shown in FIG. 2), a lower or rear door position in which it contacts stationary contact 28-3 and an upper or front door position in which it contacts stationary contact 28-2. In the lower or rear door position of door control switch 28, a predetermined impedance 79 is connected across control lines C1 and C2. This impedance 79 across control lines C1 and C2 sufficiently lowers the voltage input to the base circuit of a control circuit transistor Tr-17 which is normally biased to be nonconductive, causing transistor Tr-17 to be switched to its conductive state. Transistor Tr-16 remains nonconductive. The voltage on line C1, while low enough to switch transistor Tr-17 to a conductive state, is not low enough to switch normally conducting transistor Tr-15 to a nonconducting state. With transistor Tr-15 conductive, transistor Tr-16 remains nonconductive due to the voltage drop across resistor 100 connected to the base circuit of transistor Tr-16.

The conduction of transistor Tr-17 biases into conduction a normally nonconductive transistor Tr-21, which has its emitter-collector path connected between the positive bus 70 and the control electrode of a silicon control rectifier (SCR) Tr-18. With transistor Tr-21 conductive, the positive potential from the bus 70 is applied via the emitter-collector transistor path of conducting transistor 21 to the control electrode of SCR Tr-18 to render this SCR conductive. The conduction of SCR Tr-18 energizes a normally de-energized rear door lock solenoid 18-1 of door unlocking mechanism 18, to unlock the door in the rear lobby which interconnects the rear lobby and the interior of the building in which the remote units 10-1, 10-2,...10-*n* are located. The rear door locking solenoid 18-1 and the SCR Tr-18 are connected across the secondary winding of step-down transformer 72. SCR Tr-18 and the rear door locking solenoid 18-1 remain energized, permitting the door in the rear lobby to be opened, as long as movable contact 28-1 is in its lower or rear door position contacting stationary contact 28-3 to place impedance 79 between control lines C1 and C2. Door switches 28 of remote units 10-2,...10*n*, like switch 28 of remote unit 10-1, unlocks the door in the rear lobby when placed in the lower or rear door unlock position.

When the movable contact 28-1 of door switch 28 of remote unit 10-1 is placed in its upper or front door position to contact stationary contact 28-2, a predetermined impedance, in this case a short-circuit, is placed across control lines C1 and C2. The short-circuiting of control line C1 and C2 lowers the potential of control line C1, and hence of the base of a transistor Tr-15 which is normally biased to be conductive, to a degree sufficient to turn transistor Tr-15 off. The rendering of transistor Tr-15 nonconductive raises its collector potential to approximately the potential of positive bus 70. The increased voltage level at the collector of nonconducting transistor Tr-15 is resistably coupled to the base circuit of normally nonconducting transistor Tr-16, driving this latter transistor to a conductive state. The conduction of transistor Tr-16 increases the voltage drop across resistors 81 and 82 in its emitter-collector path, to positively maintain transistor Tr-17, which is normally nonconductive, in a nonconductive state.

The conduction of transistor Tr-16 is also effective, due to the increased voltage drop across a resistor 90 connected between its emitter and negative bus 73, to bias normally nonconducting transistor Tr-14 to a conductive state. Transistor Tr-14 has its emitter-collector path connected between the positive bus 70 and the control electrodes of SCR Tr-13. When transistor Tr-14 is rendered conductive, positive bias is applied to the control electrode of SCR Tr-13 rendering this SCR

conductive. Conduction of SCR Tr-13 energizes the front door locking solenoid 18-1' of front door unlocking mechanism 18', permitting the door in the front lobby, which interconnects the lobby and the interior of the building where remote units 10-1, 10-2,...10-*n* are located, to be opened. The SCR Tr-13 and series connected front door locking solenoid 18-1', which are connected across the secondary winding of step-down transformer 72, remain energized, permitting the door in the front lobby to be opened as long as the door switch 28 of unit 10-1 is in its upper or front door position to short-circuit control lines C1 and C2.

Door switches 28 of remote units 10-2,...10-*n*, like door switch 28 of remote unit 10-1, unlocks the door in the front lobby when placed in the upper or front door unlock position.

When switch 28 is placed in its lower or rear door position, placing impedance 79 across control lines C1 and C2, the potential at control line C1 is not dropped sufficiently to render normally conducting transistor Tr-15 nonconductive and in turn switch on transistor Tr-14 and trigger SCR Tr-13 and energize the front door locking solenoid 18-1'. However, the lower potential of control line C1 due to the placement of impedance 79 across lines C1 and C2 when the door switch 28 is placed in its lower or rear door position is sufficient to switch normally nonconducting transistor Tr-17 to its conductive state and in turn switch on transistor Tr-21 and trigger SCR Tr-18 to energize rear door locking solenoid 18-1. Transistor Tr-16, which is responsive to transistor Tr-15, is prevented from being rendered conductive to trigger SCR Tr-13 via transistor Tr-14 and energize front door locking solenoid 18-1', when switch 28 is in the rear door position, by virtue of the fact that the voltage on control line C1 is not sufficiently low to switch off normally conductive transistor Tr-15 and in turn switch on normally nonconductive transistor Tr-16. Similarly, when transistor Tr-16 is rendered conductive via transistor Tr-15 in response to placement of door switch 28 in the upper or front door position, the voltage drop across transistors 81 and 82 is sufficient to prevent normally nonconducting transistor 17 from being rendered conductive, in turn preventing switching of transistor Tr-21, energization of SCR Tr-18 and rear door locking solenoid 18-1.

Resistor 90 in the emitter circuit of transistor TR-16 to have an emitter-collector current approximately 10 times greater than the emitter-collector current of transistor Tr-17. Thus, conduction of transistor Tr-16 has a significant effect on the emitter voltage of transistor Tr-17, while conduction of Tr-17 has little effect on the collector voltage of transistor Tr-16.

When switch 28 is placed in its upper position and control lines C1 and C2 are short-circuited, both transistors Tr-16 and Tr-17 tend to turn on. However, transistor Tr-17 is prevented from turning on because the forward bias of transistor Tr-17 is prevented from rising above approximately 1.2v by diodes D8 and D9, and further because the heavy conduction of transistor Tr-16 causes a large voltage drop across resistors 81 and 82 which drives the emitter voltage of transistor Tr-17 more negative than its base voltage to effectively reverse bias it.

The one signal generator 24 includes an astable multivibrator or oscillator 80 having transistors Tr-10 and Tr-11. The emitter-collector paths of transistors Tr-10 and Tr-11 are connected between the positive bus 70, and the negative bus 73 which is connected to the negative output of rectifier 71. The base circuits of transistors Tr-10 and Tr-11 are interconnected with the collector circuits of transistors Tr-11 and Tr-10, respectively, in a well known manner to provide, when a capacitor 88 in the base circuit of transistor Tr-10 is shunted, in a manner to be described, free-running, or astable, multivibrator operation. Circuit parameters of oscillator 80 are selected to provide audio frequency operation. The output of the astable multivibrator 80 is taken at the collector of transistor Tr-11 and is connected to the base of a switching transistor Tr-12 for alternately driving transistor Tr-12 into conduction and nonconduction at a frequency corresponding to the audio frequency of the multivibrator 80. Switching transistor Tr-12 is connected between the positive bus 70 and the signal lines S1, S2 ... S-*n* via the respective front and rear lobby switches 20-1, 20-1'; 20-2, 20-2';...20-*n*, 20-*n*'.

In operation, when a calling party at the central station 12, for example at the front lobby 16', desires to initiate a call to a remote unit, such as unit 10-1, the front lobby panel switch 20-1' associated with remote unit 10-1 is actuated. This shunts the capacitor 88 via a circuit which includes a switch 20-1', and signal line S1, talk/listen switch 30 in standby position, and the remote speaker 26 of called unit 10-1. Completion of this capacitor shunting circuit initiates oscillation of the multivibrator 80 which in turn alternately switches transistor Tr-12 on and off. Since the multivibrator frequency is in the audio range, transistor Tr-12 is switched on and off at an audio frequency. As transistor Tr-12 is switched on and off at audio frequency, current flows through the remote speaker unit 26 of unit 10-1 via actuated lobby call switch 20-1', lines S1 and C2 and talk/listen switch 30 of unit 10-1. This current flow is transduced by speaker 26, producing an audible tone having a frequency equal to that of the operating frequency of multivibrator 80. The audible tone at the called station 10-1 continues until the front (or rear) lobby panel switch 20-1' (or 20-1) is de-actuated, or until the called party switches the talk/listen switch 30 from the standby position, in which the speaker 26 is connected across lines S1 and C2, to either the talk or listen position in which the speaker 26 is not connected across lines S1 and C2, but rather across the audio liens A1 and A2.

Under certain circumstances it is desirable if the door in the front and/or rear lobby controlled by unlocking mechanisms 18 and 18' can be opened from the lobby. This is in contrast to provision for opening the lobby doors controlled by locking mechanisms 18 and 18' from the various remote units 10-1, 10-2 . . .10*n* under the control of the door switches 28. To facilitate unlocking the lobby door of, for example, the front lobby, a switch-operated circuit 85 is provided. The circuit 85 includes a normally nonconducting transistor Tr-24 having an emitter-collector path connected between negative bus 73 and control line C1. It will be recalled from the description of the operation of door switch 28 that when door switch contact 28-1 is in its upper or front door position contacting stationary contact 28-2, transistors Tr-15, Tr-16, Tr-14, and SCR

Tr-13 switch to energize the front door locking solenoid 18-1' due to the lowering of the potential of control lines C1. Transistor Tr-24 which as indicated is normally nonconducting, when rendered conductive in a manner to be described, also lowers the potential of control line C1, to switch transistors Tr-15, Tr-16, Tr-14 and SCR Tr-13 and energize front door locking solenoid 18-1'.

Switching of normally nonconducting transistor Tr-24 from the off state to the on state, to energize locking solenoid 18-1' and unlock the front door, is effected through a manually operated switch 86 which may be, for example, a key operated switch located in the front lobby and which upon insertion of the key completes a circuit between its normally open contacts. Upon closure of key operated switch 86, resistor 89 is short-circuited and the base of normally conductive transistor Tr-22 is brought to the potential of line 73 to which the emitter of transistor Tr-22 is connected, causing this transistor to cease conduction. With transistor Tr-22 off, resistor 101 and capacitor 102 is no longer short-circuited, and current flows through resistor 101 and capacitor 102 via resistor 83. The voltage drop across resistor 101 switches normally nonconductive transistor Tr-23 on. With transistor Tr-23 on, its collector voltage, which is now at the potential of line 73, maintains transistor Tr-22 off via resistor 84. Nonconduction of transistor Tr-22 also switches on normally nonconducting transistor Tr-24 whose base is resistively coupled to the collector of transistor Tr-22. Conduction of transistor Tr-24 connects line C1 to line 73, effectively short-circuiting lines C1 and C2. With lines C1 and C2 short-circuited, SCR Tr-13 is energized to energize the front door solenoid 18-1' and open the front door in much the same manner as when door switch 28 is placed in its upper or front door position.

Transistor Tr-24 remains conductive until capacitor 102 of R-C timer network 101, 102 changes. When this occurs, current ceases to flow through resistor 101, causing the voltage drop thereacross to go to zero, which in turn switches transistor Tr-23 to its normal nonconductive state. With transistor Tr-23 nonconductive and its collector at a high potential, transistor Tr-22 is switched to its normally conductive state. Conduction of transistor Tr-22 via its lowered collector voltage switches transistor Tr-24 off, causing front door SCR Tr-13 to cease conduction, in turn de-energizing front door solenoid 18-1' which locks the front door. Thus, momentary actuation of switch 86 unlocks the front door for a predetermined interval established by the R-C constant of resistor-capacitor network 101, 102.

In the preferred embodiment a single transformer 72 is used to provide both AC power for SCR Tr-13 and SCR Tr-18, as well as DC power via rectifier 71 for the remainder of the control circuitry. By virtue of rectifier diode D15 which is connected between negative bus 73 and line 72-2 constituting one side of the secondary winding of transformer 72, the potential of line 73 exceeds the potential of line 72-2 when line 72-2 is negative with respect to line 73 by an amount equal to the voltage drop across diode D15. Since the control electrode of SCR Tr-13 is coupled to negative bus 73, this SCR would tend to be falsely triggered and rendered conductive when line 72-1 is positive, by virtue of the fact that the potential of line 73 is above that of line 72-2, line 72-1 also constituting the anode voltage of the SCR Tr-13.

To avoid false triggering of SCR Tr-13 when line 72-1 is positive, and still permit use of a single transformer for SCR and control circuit power, a diode D6 is connected between the cathode of SCR Tr-13 and line 72-2 which constitutes the other side of the secondary winding of transformer 72. Since the voltage drop across diode D6 equals the voltage drop across diode D15, the cathode of SCR transistor Tr-13, when line 72-2 is negative, is above the voltage of line 72-2 by an amount equal to the amount by which the voltage of line 73 exceeds the voltage on line 72-2. By raising the cathode voltage of SCR Tr-13 by an amount equal to that which the SCR control electrode is raised due to the drop across diode D15, the voltage between the control electrode and the cathode of SCR Tr-13 is restored to that at which it would be were diode D15 not connected between line 72-2 and 73, thus preventing the possibility of false triggering of SCR Tr-13 when line 72-1 is positive. In a similar fashion, false triggering of SCR Tr-18 is prevented when line 72-1 is positive by providing diode D10 between line 72-2 and the cathode of SCR Tr-18. Diode D10 compensates for the voltage drop across rectifier diode D15 which tends to reduce the voltage between the control electrodes of SCR Tr-18 and its cathode.

Having described the invention, I claim:

1. An intercommunication system comprising:

n remote stations each having a two-way speaker,

a central station having a two-way speaker,

first and second audio lines each permanently and directly connected to each of said *n* remote stations and to said central station two-way speaker,

audio frequency signal generator means,

n signal lines each permanently and directly connected between said signal generator means and a different one of said *n* remote stations,

n call switches at said central station, each of said switches corresponding to a different one of said *n* remote stations for transmitting an audio frequency signal between said signal generator means and a selected remote station via the signal line connected to the selected remote station,

first and second control lines each permanently and directly connected to each of said *n* remote stations and said central station,

audio frequency amplifier means connected in said audio lines,

amplifier control means connected to said amplifier and between said control lines and responsive to a control signal on said control lines from said remote stations for amplifying, on an alternative basis, communications on said audio lines in one direction from said remote stations and in another direction from said central station,

n switch means respectively at different ones of said remote stations, each of said switches normally connecting its respective two-way speaker between its respective signal line and one of said control lines to facilitate, without manipulation of its remote station switch means, audible reproduction of an audio frequency signal transmitted from said signal generator means to said remote station

over said respective signal line and said one control line in response to activation from said central station of the call switch corresponding to said remote station, said n switch means each having a second condition in which its respective two-way speaker is connected between said audio lines, and said n switches each having a third condition in which its respective two-way speaker is connected between said audio lines and in which a control signal is placed on said control lines to cause said amplifier control means to alter the direction of amplification of said amplifier.

2. The system of claim 1 further including a DC power supply,

wherein said n call switches are connected in different ones of said *n* signal lines,

and wherein said signal generator means includes

a. a transistor switch having its emitter-collector path in series with said power supply, said series connected power supply and emitter-collector path being connected between said *n* call switches and said one control line, and

b. an audio frequency oscillator having its output connected to the base of said transistor for switching said transistor at said audio frequency to apply an audio frequency signal to the signal line of a called station via an activated call switch.

3. A remote intercommunication unit for use in an intercommunication system having first and second audio frequency communication lines between which a central station two-way speaker is connected, first and second control lines to which control means for an amplifier in said audio frequency lines is responsive for reversing the direction of amplification when an impedance is connected across said control lines, and a signal line connected to an audio frequency signal generator, said unit comprising:

first and second audio communication terminals permanently and directly connectable to said first and second communication lines,

first and second control terminals permanently and directly connectable to said control lines,

a signal terminal connectable to said signal line,

a two-way speaker,

an impedance element,

a three-condition switch having

a. a normal condition in which said speaker is connected between only said signal terminal and said first control terminal,

b. a second condition in which said speaker is connected between only said audio communication terminals, and said impedance element is connected between only said control terminals for activating said amplifier control means to reverse the direction of amplification, and

c. a third condition in which said speaker is connected between only said audio-communication terminals, and said impedance is disconnected from between said control terminals.

4. An intercommunication system comprising:

n remote stations each having a two-way speaker,

a central station having a two-way speaker,

first and second audio lines each permanently and directly connected to each of said *n* remote stations and to said central station two-way speaker,

audio frequency signal generator means,

n signal lines each permanently and directly connected between said signal generator means and a different one of said *n* remote stations,

n call switches at said central station, each of said switches corresponding to a different one of said *n* remote stations for transmitting an audio frequency signal between said signal generator means and a selected remote station via the signal line connected to the selected remote station,

first and second control lines each permanently and directly connected to each of said *n* remote stations and said central station,

audio frequency amplifier means connected in said audio lines,

amplifier control means connected to said amplifier and between said control lines and responsive to a control signal on said control lines from said remote stations for amplifying, on an alternative basis, communications on said audio lines in one direction from said remote stations and in another direction from said central station,

n switch means respectively at different ones of said remote stations, each of said switches normally connecting its respective two-way speaker between its respective signal line and one of said control lines to facilitate, without manipulation of its remote station switch means, audible reproduction of an audio frequency signal transmitted from said signal generator means to said remote station over said respective signal line and said one control line in response to activation from said central station of the call switch corresponding to said remote station, said n switch means each having a second condition in which its respective two-way speaker is connected between said audio lines, and said n switches each having a third condition in which its respective two-way speaker is connected between said audio lines and in which a control signal is placed on said control lines to cause said amplifier control means to alter the direction of amplification of said amplifier,

a transformer having a primary winding and a secondary winding with two terminals,

a full wave diode bridge rectifier having a pair of input terminals connected between said secondary winding terminals and a pair of output terminals,

a circuit element operative to control a mechanism,

an SCR having an anode, a cathode, and a control electrode,

an SCR control circuit connected across said bridge output terminals and responsive to said control lines for generating a trigger signal for said SCR control electrode in response to a mechanism control signal on said control lines, and

a compensating diode connected in series with said SCR and said circuit element between said SCR cathode and secondary winding to increase the voltage between said SCR control electrode and said SCR cathode an amount equal to the voltage drop across the bridge rectifier diode whose cathode is connected to the cathode of said compensating diode, and thereby prevent false triggering of said SCR when said SCR is forward biased by said secondary winding.

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