Jan. 9, 1940. C. W. HALLIGAN 2,186,242

TELEPHONE SYSTEM

Filed Oct. 1, 1937

FIG. 1

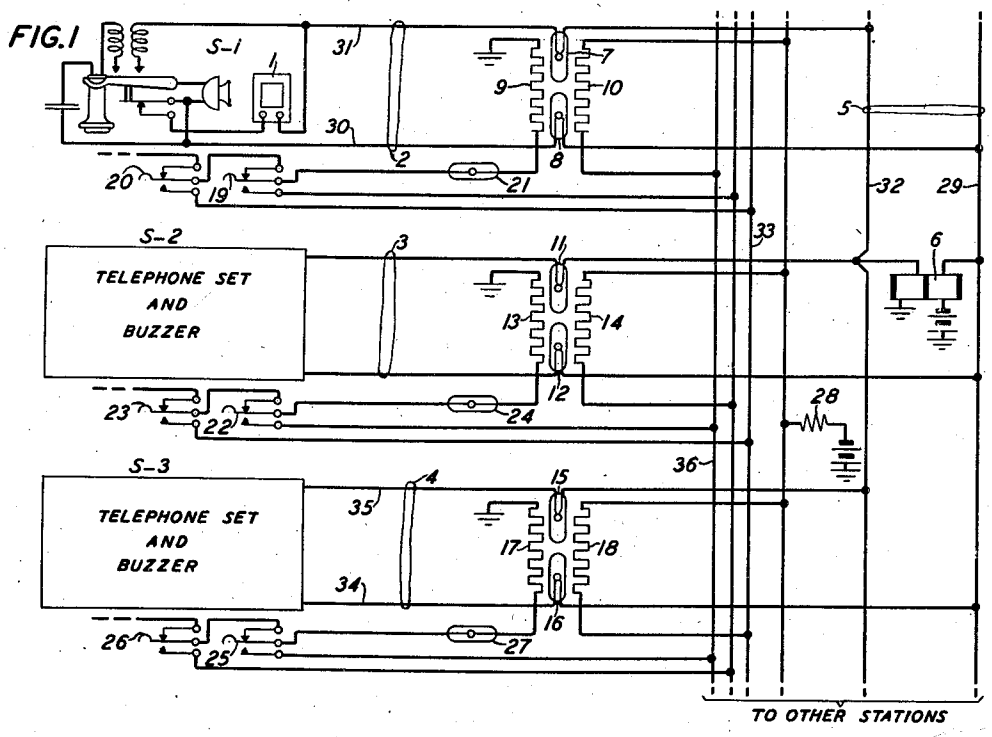


FIG. 2

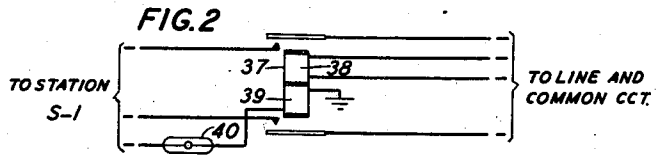
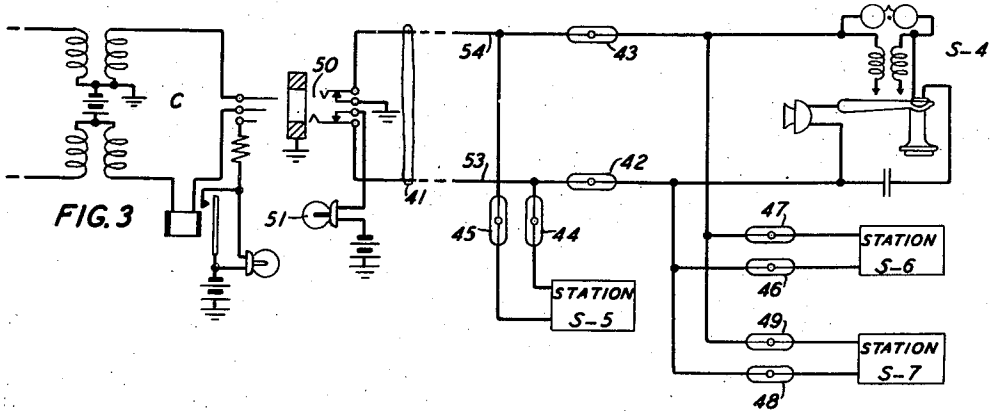


FIG. 3



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TELEPHONE SYSTEM

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8 Claims. (Cl. 179—31)

This invention relates to telephone systems and particularly to those in which conversational connections between lines or stations are established by automatic means.

The objects of the invention are to minimize the amount of equipment needed to interconnect stations or lines selectively in the same system; to eliminate many of the moving parts heretofore employed for such purposes; to simplify the functions performed by the connecting equipment; and to secure other improvements in systems of this character.

It has been the practice in the past to effect conversational connections between the different parties on a multi-party line or between the individual stations in intercommunicating systems by means of connecting devices, such as automatic switches, relays, and manually operable keys. And in these prior systems, where it is desired to safeguard the established connections from intrusion by other stations, this is usually accomplished by relay circuit arrangements for excluding other stations or by some form of electromechanical lockout device.

According to the present invention advantages are secured over these prior arrangements by eliminating the connection-establishing switches and relays and by replacing them with simple resistor elements having the necessary resistance characteristics to isolate effectively each station from all other stations in the system and also to render any two stations, under the control of one of them, effective for conversation to the exclusion of all remaining stations. To this end the talking conductors of each station in the system are provided with variable-resistance elements, such as those having high negative temperature coefficients of resistance. The normal resistance of these elements is sufficiently high to prevent the flow of current from a common source over the talking conductors of the corresponding stations, although the common source may be connected in a permanent and continuous circuit to each of the stations. When, however, the temperature of the resistance elements associated with any particular station is increased, either by the application of external heat or by increasing the potential applied to the elements, their resistance is substantially decreased to permit the flow of talking current to such station. The party at any one of the stations may establish a talking condition between his station and the station of a particular party with whom he wants to converse, to the exclusion of all other stations, by means under his control, such as keys, whereby he may bring about a decrease in the resistance of the elements pertaining to his station and those pertaining to the called station, disabling at the same time the control of all remaining stations over the resistance elements associated with said remaining stations.

A feature of the invention is a multi-station system in which there is a mutually exclusive relationship between each station and one or more of the other stations, and in which certain stations are always subordinate to one of the other stations. According to this feature the several stations are permanently connected to the common line by means of talking branch circuits, each of which includes variable resistance elements in the talking conductors. These elements are so arranged that any one of the stations initiating a call causes its resistance elements to lower their resistance and render the station effective for conversation. Certain stations when thus seizing the line for their own individual use alter the potential of the line such that other stations attempting to call later are prevented from doing so because such subsequent calling stations do not receive sufficient current through their resistance elements to alter the resistance of these elements. Certain other stations, however, although mutually exclusive among themselves, are always subordinate to particular stations on the line. In other words, these subordinate stations may appropriate the line for use provided it is idle, but any one of the preferred stations may seize the line at any time, thereby excluding the subordinate station although it is using the line at the time.

The foregoing and other features of the invention will be described more fully in the following specification.

In the drawing which accompanies the specification:

Fig. 1 illustrates an intercommunicating system, including a number of stations and a common line circuit;

Fig. 2 shows a modified circuit for the individual stations shown in Fig. 1; and

Fig. 3 illustrates a multi-party line and an operator's cord circuit at the central office for making connections with said line.

In the systems illustrating the present invention the intercommunicating station lines and the multi-party stations are joined directly to the common line, over which talking current is supplied to the telephone instruments at the respective stations. To render the stations nor-

mally ineffective for conversation, variable-resistance elements are permanently connected to the talking conductors of each of the several stations. By selecting some material, such as boron or silver sulphide, having a high negative temperature coefficient of resistance, it is possible to substantially isolate each station from the common source of talking current, and, by properly designing these resistance elements, it is possible to bring about an extremely large reduction in the resistance values either by applying external heat to them or by raising the potential applied to the circuits in which these elements are used. The effects of this large reduction in resistance of the elements in any selected station line circuit is to change the line virtually from an open to a closed circuit condition. Moreover, the characteristics of these materials are such that the resistance elements may be so designed and arranged in the system that the large reduction in the resistance of the elements individual to a particular station lowers to such an extent the potential available for other stations that such other stations are disabled and are prevented from similarly lowering the resistance of their elements to render them effective for conversation.

A detailed description will now be given of the systems illustrated in the drawing.

The intercommunicating system shown in Fig. 1 comprises a plurality of individual stations, including stations S—1, S—2 and S—3. Each station is equipped with any suitable telephone set and also with some form of signaling device, such as a buzzer 1. The several station lines or branches 2, 3, 4, etc., each of which comprises two continuous talking conductors, are connected directly to the corresponding conductors of the common current-supply circuit 5. Talking battery is supplied to the common circuit 5 through the windings of a choke coil 6.

Each of the talking conductors of each station line includes therein a variable-resistance element, and it will be noted that these resistors are the only elements in the talking conductors between the individual station and the common supply circuit 5. The elements 7 and 8 in the station line 2 are designed to alter their resistance when heated by either one of the heating windings 9 and 10. Both of these windings are arranged in close proximity to the resistors 7 and 8, and the heat produced by the energization of either winding alone is sufficient to lower the resistance of both elements 7 and 8 to the point where talking current flows freely from the common circuit 5 to the conductors of the station line 2. Similarly the station line 3 is equipped with variable-resistance elements 11 and 12 and with heating coils 13 and 14, and the station line 4 is equipped with variable-resistance elements 15 and 16 and with heat coils 17 and 18. And other stations in the system are similarly equipped.

The several stations are provided with selecting keys, each station having as many keys as there are other stations in the system. Station S—1 for example is provided with a key 19 for calling station S—2, with a key 20 for calling station S—3 and similarly with other keys for the remaining stations. The keys 19, 20, etc., at station S—1 are normally connected in series circuit including resistance element 21 and the heating coil 9. The element 21 is designed to offer a normal, high resistance to the flow of current therein and to lower its resistance when a sufficient voltage is applied thereto to cause heating current to flow through the element. In a similar manner station S—2 is equipped with keys 22, 23 for calling stations S—1 and S—3, respectively, and with the resistance element 24; and station S—3 is equipped with keys 25, 26 for calling stations S—1 and S—2 and with the resistance element 27.

Each of the heating coils 10, 14, 18, etc., has one of its terminals connected through a common resistance 28 to battery. The other terminal of coil 10 is connected to contacts of keys 22, 25, etc., at the remaining stations. Similarly, the other terminals of coils 14 and 18, individual to the station lines 3 and 4, are connected to the contacts of the selecting keys at the remaining stations.

To describe the operation of the intercommunicating system shown in Fig. 1, it will be assumed that the party at station S—1 wishes to converse with the party at station S—3. The party at station S—1 removes his receiver from the switchhook, opening the bridge which normally connects the buzzer 1 across the talking conductors and closing the two talking conductors in a loop including the telephone transmitter. A continuous circuit now exists from battery through the right winding of coil 6 over conductor 29 through the resistor 8, over talking conductor 30, through the switchhook contacts and transmitter, thence over talking conductor 31, resistor 7, and conductor 32, through the left winding of coil 6 to ground. The resistance of elements 7 and 8 is so high, however, that no appreciable current flows to the station S—1. Next, the calling party operates the key 20 to select the called station S—3. The closure of key 20 completes a circuit from ground through the heating coil 9 associated with the calling station line 2, resistance element 21, normal contacts of key 19, operated contact of key 20, conductor 33, through the heating coil 18 associated with the called station line 4, thence through the common resistance 28 to battery. The closure of this circuit applies a potential across the terminals of the resistance element 21. This potential causes a comparatively small current to flow through the element 21, gradually raising its temperature and lowering its resistance, permitting the current flow to increase until full heating current is flowing through the coils 9 and 18. The heat produced by coil 9 lowers the resistance of elements 7 and 8, permitting the full flow of current from the supply circuit 5 over the station line 2 to energize the transmitter at the station S—1. Likewise, the heat produced by coil 18 lowers the resistance elements 15 and 16 to permit the flow of current from the supply circuit 5 over the conductors 34 and 35 and through the buzzer at the called station S—3. The buzzer operates and attracts the attention of the party at station S—3. When the called party answers by removing his receiver from the switchhook, his buzzer is disconnected, and his transmitter is connected in a loop circuit and receives full energizing current from the common supply circuit 5. The parties at stations S—1 and S—3 may now converse with each other.

Should one of the other parties, such as the party at station S—2, attempt to call the busy station S—1, he will be prevented from doing so by reason of the fact that there is insufficient potential available for lowering the resistance of the element 24. When the party at station S—2 closes the key 22 in his attempt to seize the sta-

tion S—1, a circuit is closed from ground through heating coil 13, resistor 24, operated contacts of key 22, conductor 36, heating coil 10 through common resistance 28 to battery. However, the flow of current through the common resistance 28 by way of heating coils 18 and 9 reduces the potential of the left-hand terminal of resistance 28 to the point where it is insufficient to cause the flow of energizing current through the resistance element 24 and coil 13 when the key 22 is closed. Consequently the closure of key 22 at the station S—2 is ineffective to lower the resistance of the elements 11 and 12, and the station S—2 remains excluded from the connection. In like manner, all other stations are disabled from establishing conversational connections either between themselves or with either of the engaged stations S—1 and S—3.

At the end of the conversation between the parties at stations S—1 and S—3 they replace their receivers on the switchhook and the calling party at station S—1 releases the selected key 19 to its normal position. Thereupon the resistance of elements 7, 8, 15, 16 and 21 restore to their normal high-resistance values, and the system is returned to the common use of all of the stations.

Fig. 2 illustrates a modified station line circuit in which the resistance elements 7 and 8 and the heating coils 9 and 10 of Fig. 1 are replaced by a relay 37 having two windings. The winding 38 replaces the heating coil 10 and serves when energized by the depression of a key at some other station to operate the relay and close the two talking conductors through to the called stations S—1. The second winding 39 replaces the heating coil 9 and serves when energized in series with the resistance element 40, by the depression of any selecting key at the calling station S—1, to operate the relay.

Fig. 3 of the drawing discloses a multi-party line 41 provided with four substations S—4, S—5, S—6 and S—7. The talking conductors of the several stations are isolated from each other and from the common line 41 by means of the variable-resistance elements 42, 43, 44, 45, 46, 47, 48 and 49, which are connected as shown. The line 41 terminates at the central office in a jack 50, and through the normal contacts of this jack the line conductors are connected to a signal lamp 51 and a source of current. The jack 50 appears at an operator's position, which is equipped with cord circuits, such as the cord C, for establishing connections between the line 41 and other lines in the exchange.

The resistance elements 43 to 49, inclusive, are designed to offer high resistance to the flow of current when the potentials applied thereto are below certain critical or required values. However, when sufficient potential is applied to these resistors, they rapidly lower their resistance and permit full current flow in the conductors to which they are connected.

Assuming that all stations on line 41 are in their normal condition, any one of these stations may seize the line by the mere act on the part of the party at the station of removing the receiver from the switchhook. Assume first that the party at station S—4 removes his receiver to make a call. The removal of the receiver closes a circuit from battery to the lamp 51, thence over conductor 53 through element 42 through the substation loop, element 43, conductor 54 through the contact of jack 50 to ground. Full potential being applied to the elements 42 and 43, they immediately lower their resistance and allow full energizing current to flow through the loop of the substation. Also the lamp 51 lights, and the operator replies to the call in the usual manner. While the line is thus in a calling condition, any one of the other stations S—5, S—6 and S—7 is excluded from the line by reason of the fact that a substantial part of the potential drop is consumed by the flow of current through the lamp 51, resistors 42 and 43 of the station S—4, and that remaining is insufficient to lower the resistance of any of the other resistance elements. Therefore, the resistance elements of stations S—5, S—6 and S—7 remain sufficiently high, even though the receiver at any one of these stations may be removed, to prevent enough current flow to enable any one of these parties either to listen or to interfere with the station S—4.

In a similar manner the station S—5 may initiate a call and exclude all of the remaining three stations S—4, S—6 and S—7. Likewise, stations S—6 and S—7 are mutually exclusive. When station S—5 initiates a call, current flows over the conductor 53 through the resistance element 42, through the resistance element 46, loop of station S—6, resistance elements 47 and 43 and thence to ground. The full potential of the battery is sufficient to lower the resistance of all four elements 42, 43, 46 and 47, enabling the station S—6 to seize the line for conversation. And the same is true when the station S—7 initiates a call. However, should the party at station S—4 remove his receiver while either station S—6 or S—7 is in a condition for conversation, the shunt at the station S—4 lowers the potential across the branch extending to the station S—6 and S—7. Therefore, the calling station S—6 or S—7 is automatically excluded and disabled from further conversation by the preferred station S—4. The station S—5, being connected in parallel relation with stations S—6 and S—7 cannot take control of a connection already established by either of the stations S—6 and S—7.

What is claimed is:

1. The combination in a telephone system of a telephone station, a source for supplying talking current to said station, two talking conductors permanently joining said source to said station, elements in said talking conductors having a normal resistance sufficiently high to prevent the flow of talking current to said station, and means effective upon the initiation of a call at said station for lowering the resistance of said elements to permit talking current to flow to said station.

2. The combination in a telephone system of a plurality of stations, each equipped with a telephone, a source of current common to said stations for supplying energy to said telephones, each station provided with a continuous and permanent talking circuit extending therefrom to said common source of current, means under the sole control of the party at each station for opening and closing the talking circuit of said station, and control elements in said talking circuits for controlling the amount of current flowing from said source to the respective stations.

3. The combination in a telephone system of a plurality of stations, each equipped with a telephone, a source of current common to said stations for supplying energy to said telephones, each station provided with an unbroken talking

path extending therefrom to said common source of current, variable-resistance elements in said talking circuits having normal resistance values sufficiently high to prevent the flow of current from said source to the respective stations, and selective means for lowering the resistance of the elements in the talking circuit of a particular station to enable current to flow from the common source to said station.

4. The combination in a telephone system of a plurality of stations, each equipped with a telephone, a source of current common to said stations for supplying energy to said telephones, each station provided with an unbroken talking path extending therefrom to said common source of current, variable-resistance elements in said talking circuits having normal resistance values sufficiently high to prevent the flow of current from said source to the respective stations, and selective means controlled by the party at any one of said stations for causing a reduction in the resistance of the elements in the talking circuit of such station to enable the flow of current in said talking circuit from said common source.

5. In a telephone system, a plurality of stations, a source common to said stations for supplying talking current thereto, each station equipped with a talking circuit comprising two conductors extending therefrom to said source of current, variable-resistance elements included respectively in the talking circuits of said stations and serving normally to prevent the flow of current from said source to said stations, and selective means controlled by the party at any one of said stations for altering the resistance of the elements associated with his station and with any one of the stations he desires to call to enable the flow of energizing current from said source both to his station and to the called station.

6. In a telephone system, a line, a plurality of stations, talking branches one for each station permanently connected to said line and extending in a continuous path to the respective stations, variable-resistance elements in said branches, a common source of talking current, and means for applying said source to the line to vary the resistance of said elements and allow current to flow to any station that is in a calling condition to the exclusion of other stations that are not in a calling condition and to allow current to flow to a particular calling station to the exclusion of a particular other station that is already in a calling condition.

7. In a telephone system, a line, a plurality of stations, each having unbroken talking conductors permanently connected between the station and said line, variable-resistance elements, one for each of said talking circuits, a common source of talking current, means for applying said source to lower the resistance of the element associated with any calling station to the exclusion of another of said calling stations if the latter is in a non-calling condition and for applying said source to lower the resistance of the element associated with a particular calling line station to the exclusion of a particular other station whether or not the latter is in a calling condition.

8. In a telephone system, a line, a plurality of stations, each having a talking branch permanently connected to said line and extending without interruption to the corresponding station, thermo-sensitive resistance elements in each of said branches having normal resistances sufficiently high to prevent the flow of current over the line to the corresponding station, a source of current common to said stations for heating the elements in any one of said branches, circuit means under the control of a calling one of said stations for causing heating current to flow from said source to selectively heat the resistance elements in the corresponding branch, said elements automatically lowering their resistances to permit the flow of energizing current from said source over the line to the calling station, and means common to said stations effective to reduce the heating current available from said source to a value insufficient to lower the resistance of the elements associated with a second station in the event said second station subsequently attempts to seize said line.

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