Oct. 18, 1938. C. W. HALLIGAN 2,133,814

TELEPHONE SYSTEM

Filed Dec. 22, 1937 2 Sheets-Sheet 1

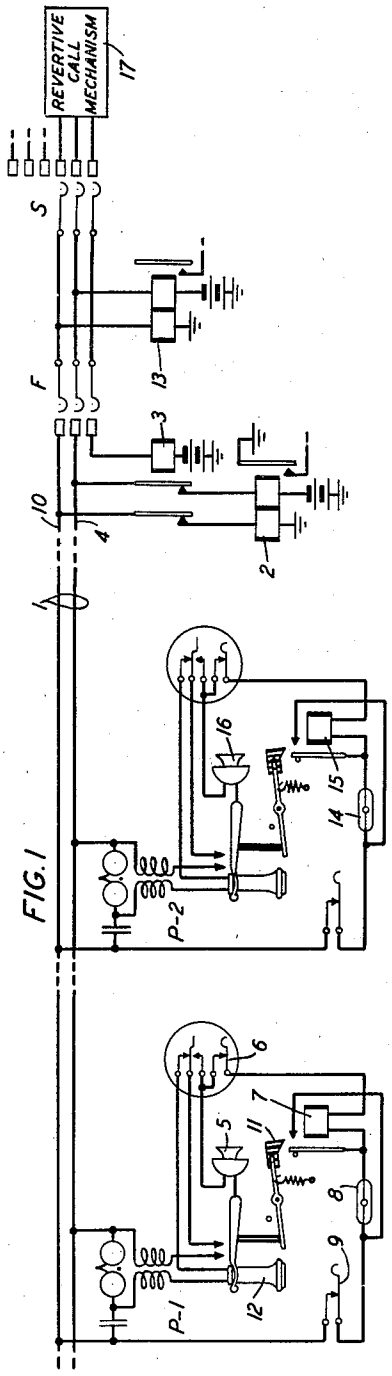

FIG. 1

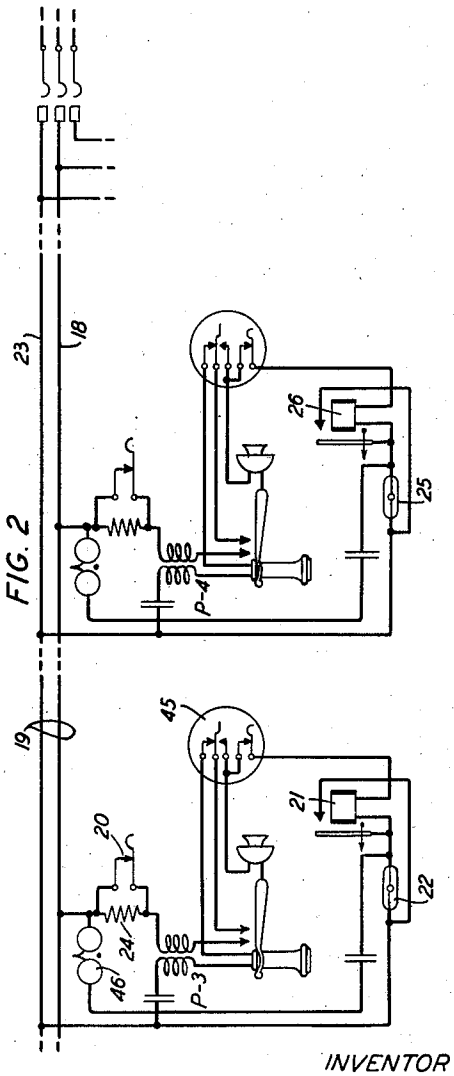

FIG. 2

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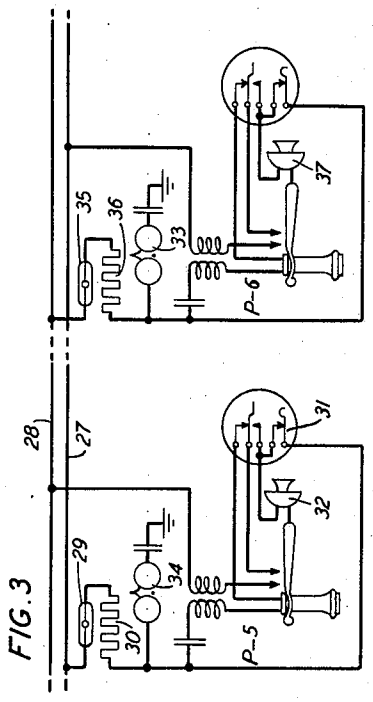

FIG. 3

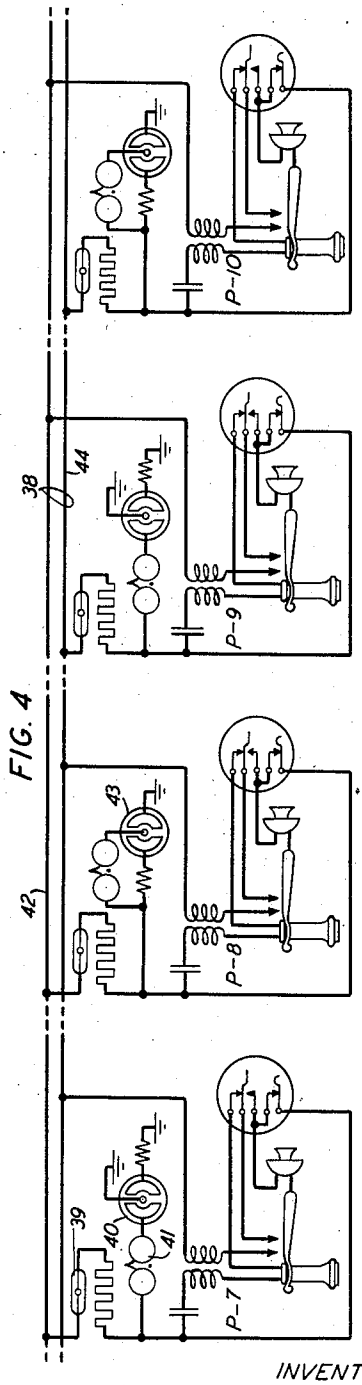

FIG. 4

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TELEPHONE SYSTEM

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Application December 22, 1937, Serial No. 181,084

7 Claims. (Cl. 179—17)

This invention relates to telephone systems and particularly to systems equipped with multi-station or party lines.

The objects of the invention are to improve the service on party lines by increasing the facility with which the party line subscribers may communicate with other lines or with each other without interference; to enable communications to be carried on in secret; and to simplify the equipment needed for the foregoing purposes.

Numerous forms of party line systems have been proposed heretofore in which the different parties on a line may communicate with each other in secret. Usually, however, these prior systems have required complicated mechanical devices at the substations.

According to a feature of the present invention these prior systems have been greatly simplified by the use of variable resistance elements at the substations which are capable of undergoing a large change in their resistance values to enable any substation to appropriate the line for its exclusive use provided the line is idle. Because of their normally high resistance, these elements serve to prevent the respective substations from seizing the line if the latter is already engaged. If the line is idle when a station calls, the application of the central-office battery potential to the resistance element at the station lowers its resistance, permitting sufficient current to flow through the station bridge circuit to operate a relay which latches in its operative condition and closes a short circuit around the resistance element. Because of this low-resistance bridge at the calling station the potential applied across the resistance element, at another station that may attempt to make a call, is insufficient to lower the resistance of that element to the point where the associated relay can operate. The resistance of the element of the second station remaining high, insufficient current flows through the talking set to permit the party to interfere with the line.

Another feature of the invention is a party-line system in which any one of the stations on the line may make a revertive call to a second station and condition the line in such a manner that the party at the called station may operatively associate his telephone instrument with the line. To do this the calling party seizes the line and operates the central office mechanism to cause ringing current to be applied to signal the party at the called station on the same line. The calling party then opens the low resistance bridge circuit at his station by means of a key or the switchhook contacts and thereby removes the shunt from the called station. When, therefore, the called party removes his receiver, the full battery potential is applied to the resistance element at his station, and the associated relay energizes and locks to condition the called station for conversation on the line. The party at the calling station has not lost control of the line by allowing the called party to enter thereon for the reason that the relay at the calling station is in its latched condition, short-circuiting the variable-resistance element. The calling party merely needs to remove his receiver after the called party has answered, and the two stations are then operatively connected to the line for conversation to the exclusion of all other stations on the line.

This and other features of the invention will be described more fully in detail in the following specification.

In the drawings accompanying the specification:

Fig. 1 shows a party line system in which the central office is equipped with line finder switches, selectors, and revertive call mechanisms;

Fig. 2 shows a modification of the station bridge circuits disclosed in Fig. 1;

Fig. 3 shows another form of the invention in which the variable-resistance elements are equipped with heating windings for changing their resistances; and

Fig. 4 illustrates a modification in which a party line is equipped with four stations.

The invention has been illustrated as applied to a central office system equipped with automatic switches for establishing connections between different lines in the system and also for establishing connections for revertive calls. It will be obvious, however, that the invention is not limited to automatic systems and that it could be applied as well to systems in which the connections are established by operators.

The variable-resistance elements used at the individual stations on the party lines are preferably made of some material having a high negative temperature coefficient of resistance. Such substances as boron and silver sulphide are suitable for this purpose. Since the resistance element is connected in the bridge circuit closed across the tip and ring conductors of the line by the switchhook contacts, when the party at the corresponding station removes his receiver to make a call, its normally-high resistance is sufficient to prevent the flow of enough current

through the bridge circuit to energize the station transmitter. Therefore, the telephone set at the station is normally disabled because of the high resistance of the resistor. If, however, the line is idle and there is no low resistance path across the conductors thereof at some other station, the closure of the bridge circuit at the calling station results in the application of substantially full central-battery potential across the resistance element. This potential causes some current to flow through the resistor, producing heat therein, resulting in an increase in the current flow, until in a short time the resistance of the element has undergone a large reduction in value. Thereupon full energizing current flows through the bridge circuit, and the station is operatively connected to the line. The subscriber may now proceed to operate his dial to obtain connection with other lines in the exchange or to cause the signaling of another station on his own line. As long as the low-resistance bridge is connected across the line at the calling station, no other station on the same line can operatively associate itself therewith. The reason is that substantially all of the voltage from the central office battery is consumed by the current flowing through the calling station loop, and the remaining voltage is insufficient to heat the resistance element at another station attempting later to appropriate the line.

For a better understanding of the invention detailed descriptions of the operation of the party-line systems illustrated in the several figures will follow. First assume that the party at station P—1 wishes to call another line in the exchange, and assume also that the party line 1 is idle at the time. When the calling subscriber removes his receiver from the switchhook, a circuit is closed from battery through the winding of line relay 2, back contact of cut-off relay 3 over the line conductor 4 through the induction coil and switchhook contacts at station P—1, transmitter 5, normally-closed dial contacts 6, through the winding of relay 7, resistor 8, key 9, and returning over the other conductor 10 through contacts of cut-off relay 3 and the left winding of line relay 2 to ground. After a short interval the resistance element 8 lowers its resistance, and enough current flows through the loop to operate the relay 7 and to energize the transmitter 5. The relay 7 in operating attracts its armature which is locked in the operated position by the latch 11 until the receiver 12 is replaced on the switchhook. The armature of relay 7 closes a short circuit around the resistor 8, thereby removing this element from the substation loop circuit.

The line relay 2 at the central office also operates and in the well-known manner causes an idle line finder F to seize the calling line 1 and extend the conductors thereof through to the windings of the impulse relay 13 associated with the selector S. The calling party now proceeds to operate his dial contact 6 to set the selector switch S and succeeding switches to extend the connection through to the line of the desired subscriber.

The party at station P—1 may carry on his conversation with the called subscriber free from any interruption from another party on the line 1 and also with the assurance that no other party on the line can listen to the conversation. Should another party on the line 1, such as the party at station P—2, remove his receiver from the switchhook while the line is engaged by the station P—1, the bridge at station P—2 is closed through the resistor 14, relay 15, transmitter 16 and the switchhook contacts in the manner already described in connection with station P—1. However, the resistor 14 is at its normal, high-resistance value, and the potential applied thereto is not sufficient to bring about a reduction in the resistance thereof. Accordingly, insufficient current flows through the bridge at station P—2 either to operate the relay 15 or to energize the transmitter 16. The party at station P—2, therefore, is effectively excluded from the line 1 during its use by station P—1. When the parties have finished their conversation, the subscriber at station P—1 replaces his receiver 12 on the switchhook, opening the switchhook contacts and tripping the latch element 11 to permit the restoration of the armature of relay 7. The opening of the line also causes the usual release of the automatic switches in the central office.

Assume next that the party at station P—1 wishes to converse with the party at station P—2 on the same line. He initiates the call in the manner above described, and the line is extended through to the first selector switch S. He then dials a code that causes the selector switch S to seize a revertive-call mechanism 17 in the central office. Thereafter he transmits a series of impulses to operate the mechanism 17 in such a manner that it will send ringing current in the proper code to signal the called party at station P—2. After he completes the dialing of the designation and the central office mechanism is prepared for ringing, the calling party operates the key 9 to open the bridge across the conductors of the line 1. In the well-known manner the mechanism 17 at the central office transmits ringing current back over the conductors of the line 1 to signal alternately the party at station P—2 and the calling party at station P—1. For example, a revertive ringing system of this general character is disclosed in the patent to Stokely, No. 1,647,256, granted November 1, 1927, and in the patent to Stokely, No. 1,695,828, granted December 18, 1928. The opening of the loop by means of the key 9 at the calling station serves two purposes. First, it removes the low-resistance bridge across the line which otherwise would cause the immediate tripping of the ringing-current mechanism at the central office. Second, it removes the shunt across the line 1 which otherwise would make it impossible for the called party at station P—2 to associate his station effectively with the line.

The called party at station P—2 on hearing his bell answers by removing his receiver to close the bridge circuit including the resistance element 14, the relay 15, and the transmitter 16. Since the bridge at the calling station is open at this time, the full voltage of the line is applied to the resistor 14, causing it to lower its resistance sufficiently to allow the relay 15 to operate and latch. Current flowing in this bridge circuit also causes the tripping of the ringing operation at the central office. Thus the station P—2 is operatively associated with the line, the resistance element 14 is short-circuited, and the transmitter 16 is fully energized. The calling party, noting that the ringing current has ceased, knows that the called party has answered. He then releases his key 9 to reclose the bridge at his station and render his telephone effective for conversation with the called party. Both stations are now in operative connection with

the line, and the parties thereat may converse with each other to the exclusion of any other stations on the line.

At the time the called party answers, the revertive-calling mechanism 17 is automatically released, and the relay 13 associated with the selector S is operated and held over the loop of the line 1. The selector S and the finder F remain in their operated condition, and talking current is supplied to the line 1 through the windings of relay 13.

At the end of conversation the parties replace their receivers on the switchhooks, releasing the respective relays 7 and 15 and also releasing the relay 13 in the selector S. The release of relay 13 brings about the release of selector S and line finder F.

In the modification shown in Fig. 2 it is unnecessary to utilize any mechanical latching devices for holding the relay at the substation during the interval the called party is gaining access to the line. Assume that the party at station P—3 initiates a call by removing his receiver from the switchhook. A circuit is thereby closed from the live pole of battery at the central office over conductor 18 of the line 19, through the closed contacts of key 20, thence through the switchhook contacts and transmitter, through the winding of relay 21, variable-resistance element 22 to the grounded pole of battery over the other conductor 23 of the line. If the line is idle, the voltage applied across the resistor 22 is sufficient to bring about a reduction in its resistance value, allowing the relay 21 to operate and the talking transmitter to become fully energized. Relay 21 short-circuits the resistor 22, and the bridge across the conductors 18 and 23 is now of a low-resistance value. The low resistance of this bridge at station P—3 deprives all other stations on the line from sufficient voltage to bring about a similar reduction in the resistance of the bridges at such other stations. The relay 21 is made slow to release to insure that it holds its contacts closed during the interruptions of the circuit when the subscriber operates the dial 45.

When, however, the party P—3 makes a revertive call for the purpose of conversing with the party at station P—4, the calling party at the proper time opens the key 20 in the bridge circuit. The key 20 in this case does not directly open the bridge circuit; instead it increases the resistance of the bridge circuit by including therein a resistance element 24. The resistance of element 24 is so chosen that it permits sufficient current to flow through the bridge at station P—3 to hold the relay 21 from releasing. The variable-resistance element 22, which is now in its high-resistance condition, is therefore prevented from reentering the bridge circuit during the time the key 20 is open. On the other hand the value of resistance 24 is high enough to prevent the bridge at station P—3 from effectively shunting the variable-resistance element 25 at the called station P—4 when the called party removes his receiver and closes his bridge circuit. Therefore, when the called party answers at station P—4, the element 25 lowers its resistance, and the bridge circuit, including the transmitter and the relay 26, is fully energized from the central office battery. Thereupon the ringing operation is terminated, and the calling party recloses the key 20 to short-circuit the resistance 24, permitting full energizing current to flow through the bridge at the calling station. While ringing current is being applied to line 19 to signal the called station P—4 and also to ring the bell 46 at the calling station, the element 22 at the calling station is maintained in its low-resistance condition by the passage of the ringing current therethrough. Hence relay 21 reoperates, in case it has released during ringing, as soon as ringing ceases and the central office battery is reconnected to the line. The parties may now converse with each other, and all other parties on the line are excluded.

In the modification illustrated in Fig. 3 of the drawings all relays and latching devices are dispensed with, and the ringing current source from the central office is utilized for the purpose of maintaining the bridge circuit at the calling station under the control of the calling party and for lowering the resistance of the bridge at the called station to associate the called station with the line in response to the acts of the calling party in making a revertive call. In this arrangement the variable-resistance elements are provided with heating windings which are arranged in proximity to the elements to transmit heat thereto when current flows in the circuits including the windings. These resistance elements in addition to being included in the bridge circuit across the conductors of the line are also included in the circuits over which ringing current is transmitted from the central office to the subscribers' bells.

Assume that the party at station P—5 in Fig. 3 wishes to make a call. When he removes his receiver from the switchhook, a circuit is completed from the live pole of the central-office battery over conductor 27 of the line through the variable-resistance element 29, through the heating winding 30 associated with said element, contacts of the dial 31, transmitter 32, switchhook contacts through the induction coil and returning over conductor 28 to the grounded pole of battery. If the line is idle and is free from shunts at other stations, the voltage applied across the resistor 29 and its heating winding 30 causes enough current to flow therethrough to lower the resistance of the element 29. The resistance of the bridge circuit being reduced to its low value, the station P—5 now has control of the line, and all other stations are excluded by the shunt of the bridge circuit at the calling station.

If the party at station P—5 wishes to call station P—6 on the same line, he dials the proper code to seize a revertive-calling mechanism at the central office and to set the same for ringing the bell 33 at the called station and the bell 34 at his own station. The calling party replaces his receiver on the switchhook, opening the bridge circuit at his station. As is well known in the art, and as disclosed in the above-mentioned patents to Stokely, the act of replacing the calling party's receiver may serve to start the code ringing mechanism in its ringing operation. The variable-resistance element 29 is designed to maintain its low resistance value for an appreciable interval after the current through its circuit ceases to flow. The element 29 therefore remains at a low-resistance value during the brief interval that its circuit is opened between the time that the bridge circuit is severed at the switchhook contacts and the time that ringing current begins to flow over the line to the bell 34 of the calling station. When ringing current is applied over the conductor 27 of the line, it flows through the element 29 and its heating

winding 30 and through the bell 34 to ground. This ringing current, which is applied at intervals, serves to maintain the resistance element in its low-resistance condition. Similarly the application of ringing current over the conductor 28 from the central office flows through the resistance element 35 and its heating winding 36 and the ringer 33 at the called station P—6 to ground. Thus the called party is signaled by his bell 33, and the resistance element 35 is heated sufficiently to lower its resistance value. When therefore the called party answers by removing his receiver, the bridge circuit is closed through the element 35 and the transmitter 37, and current from the central-office battery flows through this bridge circuit. Current flowing through the bridge circuit at the called station trips the ringing mechanism and holds the resistance element at its low-resistance value, rendering the called station P—6 effective for conversation on the line. As soon as the calling party at station P—5 notes the discontinuance of the ringing operation, he removes his receiver to close his bridge circuit before the resistor 29 has restored to its high-resistance value. The reclosure of the bridge at the calling station permits current from the central office battery to flow through said bridge in sufficient volume to maintain it in its low-resistance condition. At the end of conversation the parties replace their receivers, and the line is restored to the common use of all parties thereon.

The arrangement disclosed in Fig. 4 is similar to that of Fig. 3, except that the line 38 is equipped with four stations, and these stations are provided for full-selective ringing. The station P—7 is provided with the variable-resistance element 39 in the bridge circuit and also with a three-element discharge tube 40 connected in circuit with the ringer 41 such that the ringer is operated selectively when ringing current of one polarity is applied to the tip conductor 42 of the line. The station P—8 is similar to station P—7, except that the discharge tube 43 is so connected that the ringer responds to ringing current of the opposite polarity on the tip conductor of the line. Stations P—9 and P—10 are similar to stations P—7 and P—8, except that their ringing circuits are connected to the ring conductor 44 of the line.

What is claimed is:

1. The combination in a telephone system of a line having a plurality of stations thereon, each station equipped with a normally-open bridge circuit connected across the conductors of said line and including a transmitter and a variable resistance element, a source of potential connected to said line, means at a calling one of said stations for closing the bridge circuit thereat in series with said source, the resistance element at the calling station responding to said potential source to lower the resistance of said bridge and allow energizing current to flow through said transmitter, said low-resistance calling bridge serving as a shunt to prevent any other station from lowering the resistance of its bridge and operatively associating its transmitter with the line, and means controlled by the calling party for removing the shunting effect of his low-resistance bridge to enable a second station to operatively connect itself to the line and for thereafter reestablishing said low-resistance bridge at the calling station.

2. The combination in a telephone system of a line having a plurality of stations thereon, each station having a normally-open bridge circuit including a transmitter therein, a source of potential and means for connecting the same to said line, variable-resistance elements in the bridge circuits at said stations, each of these elements having a high-resistance value when current is not flowing through the corresponding bridge circuit, means at any calling one of said stations for closing the bridge circuit thereat across the conductors of said line, the resistance element at the calling station responding to the potential of said source to lower its resistance value and allow energizing current to flow through the bridge circuit, means responsive to the flow of energizing current in said bridge circuit for maintaining the station operatively associated with said line independently of said resistance element, and means controlled at the will of the party at the calling station for enabling the party at a second station on said line to operatively associate his station with the line.

3. The combination in a telephone system of a line having a plurality of stations thereon, bridge circuits for said stations having transmitters therein, each bridge circuit having a normally-high resistance for maintaining it operatively disassociated from said line, a source of potential and means for connecting the same to said line, variable-resistance elements in said bridge circuits, means for applying said potential source to the resistance element at a calling station to lower the resistance of the corresponding bridge and operatively associate the station with said line, the low-resistance bridge circuit at the calling station serving as a shunt on all other stations to prevent anyone from becoming operatively associated with the line, and means controlled at the will of the party at the calling station for removing the shunting effect of his low-resistance bridge to permit a desired one of the other stations to become operatively associated with said line.

4. The combination in a telephone system of a line having a plurality of stations thereon, each station equipped with a normally-open bridge circuit, a source of potential and means for connecting the same to said line, variable-resistance elements, one included in each of said bridge circuits, means at a calling station for closing the bridge circuit thereat to apply the potential of said source to the resistance element in said bridge, said element responding to said potential to lower its resistance value and decrease correspondingly the resistance of said bridge, the low-resistance bridge serving as a shunt to prevent any other station from lowering the resistance of its bridge, and means controlled by the calling party for removing the shunting effect of said low-resistance bridge to permit a second station to reduce the resistance value of its bridge when closed and for thereafter reestablishing the shunting effect of the bridge at the calling station.

5. The combination in a telephone system of a line having a plurality of stations thereon, each station equipped with a normally-open bridge circuit including a transmitter and a variable-resistance element, each station also equipped with a signaling device, each of said elements having a normally-high resistance to maintain the corresponding bridge circuit at a high-resistance value, a source of potential and means for connecting the same to said line, means controlled by the party at a calling station for closing the bridge circuit to apply said source of po-

tential to the variable-resistance element in said bridge, said element responding to the applied potential to lower its resistance and permit energizing current to flow through the bridge, the low-resistance bridge at the calling station serving to shunt the other stations on the line, a source of signaling current, and means controlled by the calling party for causing the application of said signaling current to the line to operate the signaling device at a called station and to cause a reduction of the resistance of the bridge circuit at the called station by applying potential to the variable-resistance element in said last-mentioned bridge.

6. The combination in a telephone system of a line having a plurality of stations thereon, each station having a normally-open bridge circuit including a variable-resistance element therein, each station also equipped with a signaling device, a source of potential and means for connecting the same to said line, means controlled by a calling party for closing the bridge circuit at his station to apply the potential of said source to the variable-resistance element in the corresponding bridge circuit, said element responding to the applied potential by lowering its resistance, the low-resistance bridge of the calling station serving to shunt the other stations on the line, a source of signaling current, means for applying said signaling current to the line to operate the signaling device at a called station and to lower the resistance of the resistance element in the bridge at said called station, and circuit means for applying current from said ringing source to the resistance element at the calling station to maintain the same in a low-resistance condition.

7. The combination in a telephone system of a line having a plurality of stations thereon, each station equipped with a normally-open bridge circuit connected across the conductors of said line and including a transmitter and a variable-resistance element, a source of potential connected to said line, means at a calling one of said stations for closing the bridge circuit thereat in series with said source, the resistance element at the calling station responding to said potential source to lower the resistance of said bridge and allow energizing current to flow through said transmitter, said low-resistance calling bridge serving as a shunt to prevent any other station from lowering the resistance of its bridge and operatively associating its transmitter with the line, and means controlled by the calling party for lowering the resistance of the bridge at a second station to enable the second station to operatively connect itself to the line without losing control of the bridge at said calling station.

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