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TELEPHONE SYSTEM

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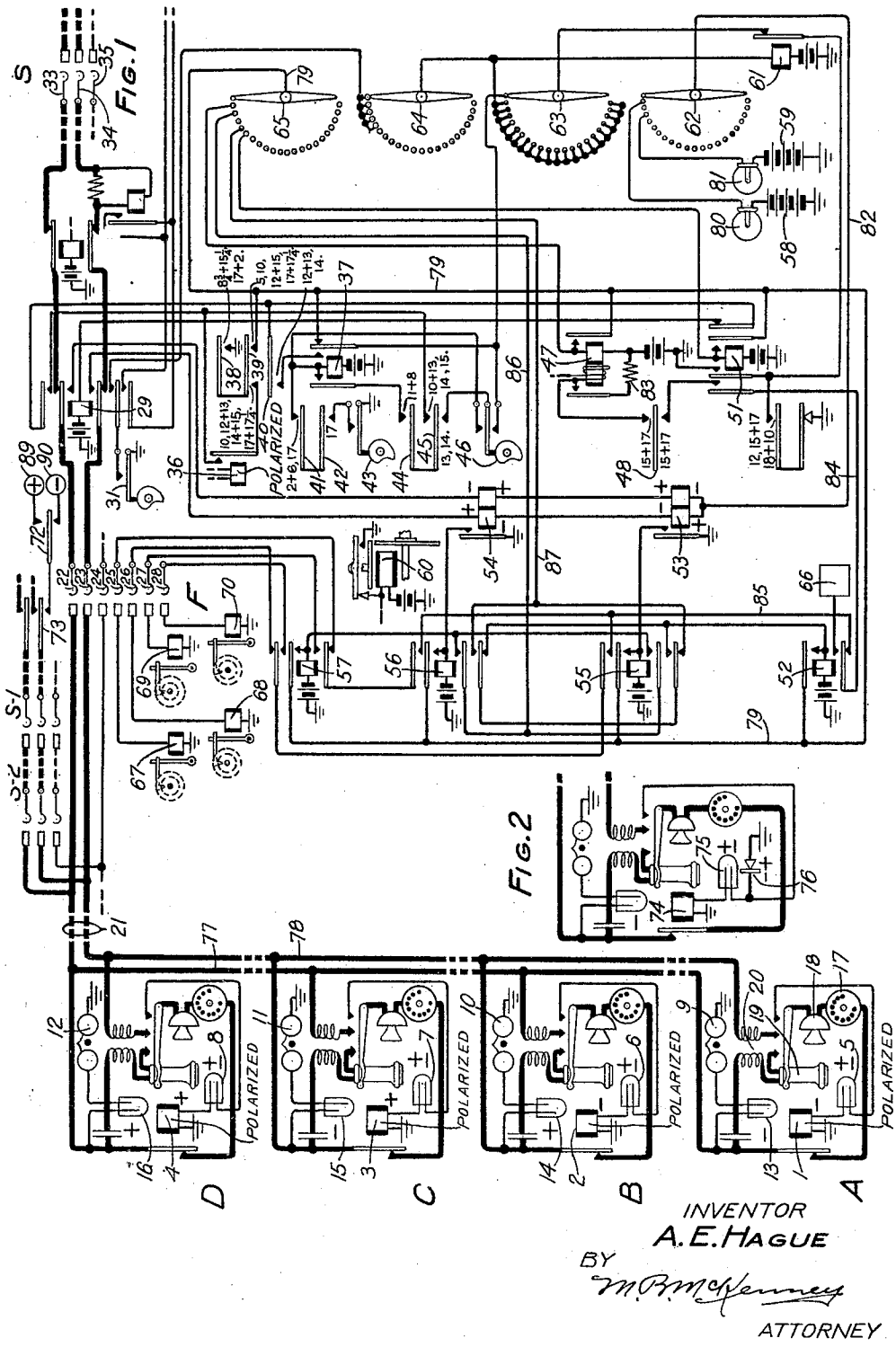

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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to means for identifying the calling stations on a party line.

The objects are to secure a positive and reliable test of a line to determine the calling party, to perform the test without impairing transmission and without interference with equipment not concerned therein, to simplify the equipment employed, and to otherwise improve systems of this character.

According to this invention, two of the four substations on a four-party line are equipped with polarized relays which respond to positive current and the other two with polarized relays which respond to negative current. These relays are connected to the line through non-directional discharge devices which are arranged to break down and permit current to flow when a certain potential is applied, regardless of its polarity. The relays on operating disconnect one side of the line from the test circuit so that the flow of current over the other side is sufficient to control devices at the central office to identify the calling station. The substation bells, which are arranged for selective ringing, are also connected in circuit with other discharge devices, which are arranged to permit current to flow only when subjected to a potential of a value higher than that required to cause the flow of current in the discharge devices in the test circuits. By this arrangement, the bells, which may be connected directly to the line without the use of ringing current responsive relays, are guarded against tapping when the identification test currents are applied to the line; by using polarized discharge devices for the bell circuits, selective ringing is secured; and by the use of the discharge devices for both test circuits and ringing circuits, the sub-stations are free from all ground or battery connections during conversation.

The invention is illustrated in the accompanying drawings in which Fig. 1 shows a party line terminating in a line finder switch together with means at the central office for performing the identification tests and for selectively operating the message registers. Fig. 2 shows a modification of a subscriber's substation.

The subscriber's line 21 has four substations, A, B, C and D. These stations are equipped respectively with polarized relays 1, 2, 3 and 4 and with space-discharge devices 5, 6, 7 and 8. At station A the relay 1 has one pole grounded and the other pole connected to the discharge device 5, which in turn is connected to a normally open contact on the receiver switchhook. With the receiver off the hook, the relay 1 is included in a circuit from ground through the discharge device 5 to both the tip and ring conductors of the line 21. The remaining relays 2, 3 and 4 and the corresponding discharge devices 6, 7 and 8 are similarly connected.

The space-discharge devices 5, 6, 7 and 8 are so arranged that they will not permit the flow of current unless potential of a given value is applied thereto. This potential may be substantially higher than that of the talking source; so that the ground connections at the relays are effectively disconnected from the line during conversation. Upon the application of potential of the necessary value, current is permitted to flow in either direction according to the polarity of the applied potential. Relays 1 and 2 are polarized in such a manner that they operate only in response to the flow of current caused by the application of the negative pole of the source to the conductors of line 21. Relays 3 and 4 are oppositely poled and will operate only when current of positive polarity is applied to the conductors of line 21.

The stations are also provided with individual call signal bells 9, 10, 11 and 12. Since it is desirable to furnish full-selective ringing for the stations on the party line, the respective signal bells are provided with individual directional current-discharge devices 13, 14, 15 and 16. These devices are similar to the other discharge devices above mentioned. They are, however, arranged to permit the flow of current only in one direction and are further arranged to permit the flow of current only when subjected to a potential which is substantially higher than the potential necessary to cause

the flow of current in said devices 5, 6, 7 and 8. The controlling devices 13, 14, 15 and 16 being unidirectional, it is possible to obtain full-selective signalling by connecting two of the bells to the tip side of the line and the other two to the ring side of the line. For example, the ringer 9 and discharge device 13 are connected to the tip conductor 77 and the same is true at sub-station D. The device 13, however, is so poled as to permit the flow of current only when the negative pole is connected to the tip side of the line, whereas the device 16 is poled to permit ringing current to flow only when the positive pole of the source is connected to the line. The same is true of stations B and C except that the ringers are connected to the ring side of the line. Inasmuch as the devices 13, 14, 15 and 16 will not permit current to flow to the respective ringers unless subjected to a potential which is substantially higher than that necessary to cause the flow of current through the devices 5, 6, 7 and 8, it follows that the application of test current to the line for identifying the calling stations does not interfere with the bells either at the calling station or at other stations; thus the annoyance of bell tapping is avoided.

The current controlling discharge devices shown at stations A, B, C and D may be of any suitable type such as the well-known current discharge tube comprising a glass container with enclosed electrodes and filled with any suitable gas. One form of directional tube is illustrated in the patent to F. Gray, No. 1,784,869, issued Dec. 16, 1930. Another is shown in the patent to Schroter No. 1605001, granted Nov. 2, 1926.

At the central office, the line terminates in the bank of a line finder switch F, which is diagrammatically illustrated by the brushes 22 to 28 inclusive and also terminates in the contact bank of a final selector switch S—2. The line finder F is directly connected to a selector switch S having the brushes 33, 34 and 35 and also illustrated in part diagrammatically. The line 21 may be seized as a called line over a connection extending through selector switches S—1 and S—2.

The line finder and selectors disclosed in this system may be of the panel type similar to the one described in the patent to Craft et al. No. 1123696, granted Jan. 5, 1915. Control and operating circuits for a selector switch of this character are shown and described in detail in the patent to Kopp No. 1,589,402, granted June 22, 1926, and also in the patent to Stearn et al. No. 1,395,977, granted November 1, 1921.

The stations A, B, C and D are provided at the central office with individual message registers 67, 68, 69 and 70 which are selectively operated to assess calls against the corresponding stations on the line. The registers are selected as the result of an identification test performed at some convenient time after the subscriber initiates the call. The test is made by means of the polarized differential relays 53 and 54 together with oppositely poled sources of test current 58 and 59. By means of the stepping switch shown at the right of the drawing, the sources 58 and 59 are connected in succession to a circuit which leads through both windings of the relays 53 and 54 and thence to the tip and ring conductors of the line. Being differential, the relays 53 and 54 will not operate so long as current of equal strength flows through both windings. When, however, the strength of current in one winding of either of these relays exceeds that in the other winding, the relay will or will not operate according to the direction of current flow. For instance, if the strength of current in the right winding of relay 53 exceeds that through the left winding and the polarity of the current is negative, relay 53 will operate. On the other hand, if the polarity is positive, the relay will not operate. It will operate, however, when positive current flowing through the left winding of the relay exceeds in strength the flow of current through the right winding. The same is true of relay 54 except that the polarity is reversed.

A detailed description will now be given, and for this purpose it will be assumed that the subscriber at station A initiates a call. In response to the initiation of the call, the line finder F operates to seize the calling line 21. Thereupon the subscriber manipulates his impulse transmitter 17 to set up the called designation in a register sender (not shown) at the central office. The register sender proceeds to control the selector switch S and succeeding switches to extend the connection to the called subscriber's line as is fully described in the above-mentioned patents to Kopp and to Stearn et al.

When the called subscriber answers, the direction of current flow over the trunk, with whose terminals the brushes 33, 34 and 35 of selector switch S are in contact, is reversed, thereby causing the operation of the polarized supervisory relay 36. At this time the sequence switch 60 has advanced to some position such as position 13 in which it remains during conversation. As soon after the relay 36 operates as the interrupter 46 closes its upper contact, a circuit is completed from battery, through the winding of relay 37, upper contacts of interrupter 46, contacts of sequence switch spring 45, contact of relay 36, left contact of sequence switch spring 39, contact of sequence switch spring 38 to ground. Relay 37 operates and locks through its left contacts, sequence switch spring 44, thence over sequence switch spring 45 to ground as above traced. As soon after relay 37 has operated as the interrupter 46 closes its lower contact, a circuit is completed from battery,

through the winding of relay 29, outer right contact of relay 51, contact of sequence switch spring 40, right front contact of relay 37, lower contacts of interrupter 46, sequence switch spring 45 to ground as above traced. Relay 29 operates and locks through its uppermost contact to ground at spring 38.

The brushes 62, 63, 64 and 65 of the stepping switch are now advanced by the alternate operation and release of the stepping magnet 61 to control the testing of the line 21. With the brushes in any one of positions 1 to 5 inclusive, position 1 being the normal position, a circuit is closed, after relay 29 is operated, through the winding of the magnet 61 each time the continuously driven interrupter 31 closes its contacts. This circuit may be traced from battery, through the winding of the magnet, brush 64, positions 1 to 5, middle lower contact of relay 29, contacts of interrupter 31 to ground. The release of the magnet 61 each time the circuit is opened at the contacts of the interrupter advances the brushes one step at a time from position 1 to position 6. After the brushes are advanced beyond position 5, the magnet 61 is no longer under the control of the interrupter 31.

With the stepping switch in position 2, a circuit is closed from battery, through the right winding of relay 47, brush 65, conductor 79, sequence switch springs 39 and 38 to ground. Relay 47 operates and locks through its winding and right contact to ground on conductor 79. Relay 47 prepares a circuit for operating the calling subscriber's message register after conversation has been completed.

With the stepping switch in position 2, a circuit is closed from the positive source of testing potential 58, resistance lamp 80, brush 62, conductor 82, through the windings of relays 53 and 54, inner upper and lower contacts of relay 29 to the tip and ring conductors 77 and 78 of the subscriber's line. The test circuit may be further traced over the tip conductor 77, through the armature of relay 1, impulse transmitter 17, talking transmitter 18, contacts of the switchhook, through the current controlling device 5, winding of relay 1 to ground. The circuit over the ring side of the line may be traced over conductor 78, through the right winding of induction coil 20, switchhook contacts, device 5, winding of relay 1 to ground. Due to the polarity of relay 1 the flow of current in this circuit does not cause the operation of the relay, and since current of equal intensity flows through both the right and left windings of relays 53 and 54, neither of these relays will operate.

No further operation takes place while the stepping switch is in position 3, but when the switch is advanced to position 4, the negative source of testing potential 59 is connected through resistance lamp 81 and brush 62 in position 4, over conductor 82, through the windings of relays 53 and 54 and thence over the subscriber's line and the relay 1 to ground. Due to the direction of current in this circuit, the relay 1 operates and opens its left contact to disconnect its winding from the tip conductor 77. This opens the circuits of the right windings of relays 53 and 54; whereupon the strength of the current predominates in the left windings. Therefore, the relay 54 attracts its armature, but relay 53 remains in its unoperated condition. Relay 54 closes an obvious circuit for relay 56, which locks through its inner upper contact to the grounded conductor 79.

No further operation takes place until the brushes of the stepping switch are advanced to position 6, at which time a circuit is closed from battery, through the winding of relay 51, brush 65, conductor 79 to ground. Relay 51 operates and locks to conductor 79. Relay 51 at its outer right back contact opens the circuit of relay 29 and this relay releases. The relay 51 in operating connects ground potential through its front contact and inner left armature, armature and contact of the stepping magnet 61, brush 63 in position 6 and through the winding of the stepping magnet 61 to battery. The operation of the magnet 61 opens its own operating circuit and advances the brushes to position 7. Since the terminals with which the brush 63 is associated are connected together, the switch continues to advance until it has reached its normal position 1. The apparatus remains in this condition during conversation.

When the called subscriber replaces his receiver on the switchhook, relay 36 releases, and sequence switch 60 is advanced from the talking position to some subsequent position such as position 17, to cause the operation of the message register of the calling party. The release of relay 36 opens the holding circuit of relay 37, and the latter relay releases. Relays 47, 51 and 56 are now held in a circuit through their windings and locking contacts over conductor 79, through the back contact and right-hand armature of relay 37, brush 63 in position 1, back contact of magnet 61, inner left contact of relay 51 to ground. While the sequence switch 60 is advancing from position 15 to position 17, a metering circuit is closed from battery through the resistance 83, left contact of relay 47, contacts of spring 48, outer left contact of relay 51, conductor 84, lower back contact of relay 52, conductor 85, uppermost contact of relay 56, lowermost contact of relay 57, brush 25, through the winding of message register 67 to ground. The register 67 operates and charges the call against the substation A. When sequence switch reaches position 17, and as soon thereafter as interrupter 43 closes its contacts, a circuit is completed from battery, through the winding of

relay 37, springs 41 and 42, contacts of interrupter 43 to ground. Relay 37 operates and opens the holding circuit of relays 47, 51 and 56. Relay 37 may be held energized in the manner shown in detail in the above mentioned patent to Kopp to permit the release of relays 47, 51 and 56 as the sequence switch 60 advances to subsequent positions. From this point, the release of the line finder and selector switches takes place in any well-known manner such as explained in the above-noted patents to Kopp and Stearn et al.

Assume next that the call is initiated at substation B. In this case the relay 2, being polarized the same as relay 1, does not operate during the first part of the test when current of positive polarity is applied from the source 58. Accordingly, neither relay 53 nor relay 54 operates. In the second part of the test, relay 2 operates in response to current from the source 59 and in so doing disconnects its winding from the ring conductor 78. This deprives the left windings of test relays 53 and 54 of current; whereupon the relay 53 attracts its armature, and relay 54 retains its armature in its normal position. Relay 53 operates the relay 55 in an obvious circuit, and relay 55 locks to the conductor 79. When the sequence switch subsequently advances from position 15 to position 17, the metering circuit is completed over conductors 84 and 85, through the uppermost contact of relay 55, upper back contact of relay 57, brush 26 to the winding of message register 68 to ground, thus charging the call to station B.

Assume next that the call is initiated at substation C. In this case the polarity of relay 3 is opposite that of relays 1 and 2; accordingly relay 3 operates in response to the first part of the test when the positive source 58 is connected to the line. Relay 3 in operating disconnects its winding from the ring conductor, thus unbalancing the relays 53 and 54 and causing the operation of relay 54. Relay 54 causes the operation of relay 56 as above explained. When the stepping switch advances to position 3, a circuit is closed from battery, through the winding of relay 57, through the inner lower contact of relay 56, conductor 86, brush 65 to ground over conductor 79. Relay 57 operates and locks through its inner upper contact to the grounded conductor 79. When the negative source of potential 59 is connected to the line, relay 3, being of opposite polarity, does not operate, and neither relay 53 nor relay 54 attracts its armature. Subsequently when the sequence switch passes through positions 15 to 17, the metering circuit is completed over conductors 84 and 85, through the uppermost contact of relay 56, lower front contact of relay 57, brush 27, winding of message register 69 to ground, thus charging the call to substation C.

Assume finally that the call is initiated at substation D. Relay 4, being of the same polarity as relay 3, operates when the source 58 is connected to the line and in so doing disconnects its winding from the tip conductor of the line. This unbalances the test relays and causes the operation of relay 53. Relay 53 operates relay 55. In position 3 of the stepping switch, relay 57 is operated in a circuit through the inner lower front contact of relay 55 and thence over conductor 86 to ground as above traced. During the next part of the test, relay 4 does not operate, and neither relay 53 nor relay 54 attracts its armature. Subsequently when the sequence switch passes through positions 15 to 17, the metering circuit is closed over conductors 84 and 85, through the uppermost contact of relay 55, uppermost front contact of relay 57, brush 28, through the winding of register 70, thus charging the call to substation D.

In case subscribers at more than one of the stations attempt to originate a call at the same time, both testing relays 53 and 54 will operate as hereinbefore described causing the operation of relays 55 and 56. When the stepping switch reaches position 5, a circuit is closed from battery, through the winding of relay 52, lower front contact of relay 55, lower front contact of relay 56, conductor 87, brush 65 to the grounded conductor 79. Relay 52 operates in this circuit and locks through its front contact and upper armature to the grounded conductor 79. Relay 52 connects battery through the resistance 83, thence as traced over the conductor 84, through the armature and front contact of relay 52 to an alarm device 66. This arrangement prevents the operation of any of the message registers and also calls the attention of the unstandard condition to a trouble man. Should neither of the relays 53 and 54 operate during the test, both relays 55 and 56 would remain in their unoperated condition. Relay 52 is operated in this case by means of a circuit from battery, through its winding, through the lower-most back contacts of relays 56 and 55 to ground over conductor 87 to effect the alarm.

When the subscriber's line 21 is called by a calling line, the connection is extended in any suitable manner over selector switches S—1 and S—2. Ringing current is applied from either of the sources 89 or 90, through contacts 72 and 73 to give selective ringing in the well-known manner. The potential of sources 89 and 90 is sufficient to cause flow of ringing current through the devices 13, 14, 15 and 16. For a detailed disclosure of one manner in which ringing current may be applied to the line, reference is made to the patent to Reeves No. 1218804, granted March 13, 1917.

The modification shown in Fig. 2 enables the use of a non-polarized relay 74 due to the employment of a unidirectional current controlling device 76. The device 76 is so poled

that it will permit the flow of current from the sides of the line directly to ground in shunt of the discharge device 75 and the relay 74 when the negative pole of the central office source is connected to the line. Thus the relay 74 is shunted and does not operate. On the other hand, if the positive source 58 is connected, current cannot flow through the device 76 and therefore will flow through the device 75 and relay 74 causing the operation of the relay. The unidirectional current controlling device 76 may be of any suitable type such as described in detail in the Journal of the American Institute of Electrical Engineers for March 1927, page 215.

While the invention has been illustrated in connection with a particular type of system, it is to be understood that it is not so limited but may be embodied in various kinds of systems.

What is claimed is:

1. In combination, a telephone line having a plurality of stations thereon, signal bells, one for each station, discharge devices, one in circuit with each bell and arranged to permit current to flow when subjected to a given potential, a relay at one station responsive to current of a given polarity, a relay at another station responsive to current of opposite polarity, and other discharge devices in circuit with said relays and arranged to permit current to flow when subjected to potential of a lower value than that which causes current to flow in said first mentioned devices.

2. In combination, a telephone line having two stations thereon, signal bells, one for each of said stations, current controlling devices, one in circuit with each bell and arranged to permit current to flow from the line to said bells when subjected to a potential of a given value, a relay at one station responsive to current of positive polarity, a relay at the other station responsive to current of negative polarity, and other current controlling devices, one in circuit with each of said relays arranged to permit current to flow from the line to said relays when subjected to potential of a lower value than that necessary to cause the flow of current in said first-mentioned devices.

3. In combination, a telephone line having two stations thereon, signal bells, one for each station, discharge devices, one in circuit with each bell, each of said devices arranged to permit a flow of current of a different polarity when subjected to potential of a given value, a relay at one station responsive to current of a given polarity, a relay at said other station responsive to current of a different polarity, and other discharge devices, one connected in circuit with each of said relays, said latter devices being arranged to permit current of either polarity to flow when subjected to a potential of a lower value than that which causes the flow of current in said first-mentioned devices.

4. The combination in a telephone system of a line having two stations thereon, signal bells, one at each station, current controlling devices, one in circuit with each bell and arranged to permit current to flow when subjected to a given potential, a relay at one station responsive to current of one polarity and serving when energized to disconnect one side of the line from the station, a relay at the other station responsive to current of a different polarity and serving when energized to disconnect the other side of the line from the station, test means responsive to current flowing over said line, and other current controlling devices, one in circuit with each of said relays and arranged to permit current to flow when subjected to potential of a lower value than that required for causing current to flow in said first-mentioned devices.

5. The combination in a telephone system of a line having two substations thereon, a signal bell at one station connected to one side of the line, a current controlling device in circuit with said signal bell and arranged to permit current of a given polarity to flow from the line to said bell when subjected to a given potential, a signal bell at the other station connected to the same side of the line, a current controlling device in circuit with said second bell and arranged to permit current of opposite polarity to flow from the line to the bell when subjected to a similar potential, relays, one for each of said stations, said relays being responsive to current of different polarities, and other current controlling devices, one in circuit with each of said relays and arranged to permit current to flow to said relays when subjected to potentials of a lower value than that which causes current to flow in said first-mentioned current controlling devices.

6. In a telephone system, a line having a plurality of stations thereon, signal bells, one for each of said stations, the bells at certain of said stations being connected to one side of the line and the bells at other of said stations to the other side of the line, discharge devices, one in circuit with each of said bells and arranged to permit the flow of current from the line to the bells when subjected to a given potential, polarized relays, one for each of said stations, certain of said relays responsive to current of one polarity and other of said relays to current of the opposite polarity, and other discharge devices connected in circuit with said relays and arranged to permit flow of current in said relays when subjected to potentials of a lower value than those applied to said first-mentioned devices.

7. In a telephone system, a telephone line having two stations thereon, signal bells, one at each station, discharge devices, one for each bell, circuits for connecting each of said

bells directly to a side of said line through the associated discharge device, said devices being arranged to permit flow of current to the bell when a definite potential is applied to the line, relays, one at each of said stations, other discharge devices, one for each of said relays and arranged to permit current to flow through said relays when subjected to potentials of a lower value than that which causes the flow of current in said first mentioned devices.

8. The combination in a telephone system of a line having two substations thereon, signal devices for calling the subscribers, one at each of said stations, directional space-discharge devices one for each of said signal devices, each device arranged to permit current of a given polarity to flow through the corresponding signal device when subjected to potential of a given value, relays, one at each of said stations, other space-discharge devices, one for each of said relays, each of said latter discharge devices arranged to permit current of either polarity to flow through the associated relay when subjected to potentials of a value different from that which causes the flow of current in said first-mentioned space-discharge devices.

9. The combination in a telephone system of a telephone line having a plurality of stations thereon, signal bells, one at each of said stations, current controlling devices, one connected in circuit with each of said bells, means for applying to said line signalling current of a given potential, said current controlling devices arranged to permit said current to flow to the bells to selectively operate the same, relays, one at each of said stations, and other current controlling devices, one for each of said relays and arranged to permit current to flow from said line to said relays when subjected to potential of a lower value than that required to cause the flow of current in said first-mentioned devices.

10. In combination, a telephone line having two stations thereon, signal bells, one for each station, current controlling devices, one in circuit with each of said bells and arranged to permit current to flow from the line to said bells when subjected to a given potential, testing devices, one at each of said stations, and other current controlling devices, one for each of said testing devices and arranged to permit current to flow from the line to said test devices when subjected to potential of a value lower than that necessary to cause flow of current in said first-mentioned current controlling devices.

11. In a telephone system, a telephone line having a plurality of stations thereon, message registers, one for each of said stations, signal bells, one for each of said stations, current discharge devices, one in circuit with each of said signal bells and arranged to permit signaling current to flow from the line to the associated bell when a given potential is applied thereto, testing devices, one at each of said sub-stations, other current discharge devices, one in circuit with each of said testing devices and arranged to permit current to flow from the line to said testing devices when subjected to potentials of a different value from that required to operate said signal bells, and means controlled by said testing devices for selectively operating said message registers.

12. In a telephone system, a telephone line having a plurality of stations thereon, signal bells, one for each station, certain of said bells being connected to one side of the line and the other of said bells to the other side of the line, space-discharge devices, one in circuit with each of said bells and arranged to permit signaling current to flow in said bells when subjected to a potential of a given value, testing devices, one for each of said stations, and other space-discharge devices, one in circuit with each of said testing devices and arranged to permit current to flow from the line to said testing devices when subjected to potential of a value different from that necessary to operate said first-mentioned discharge devices.

In witness whereof, I hereunto subscribe my name this 8th day of April, 1930.

ALFRED E. HAGUE.