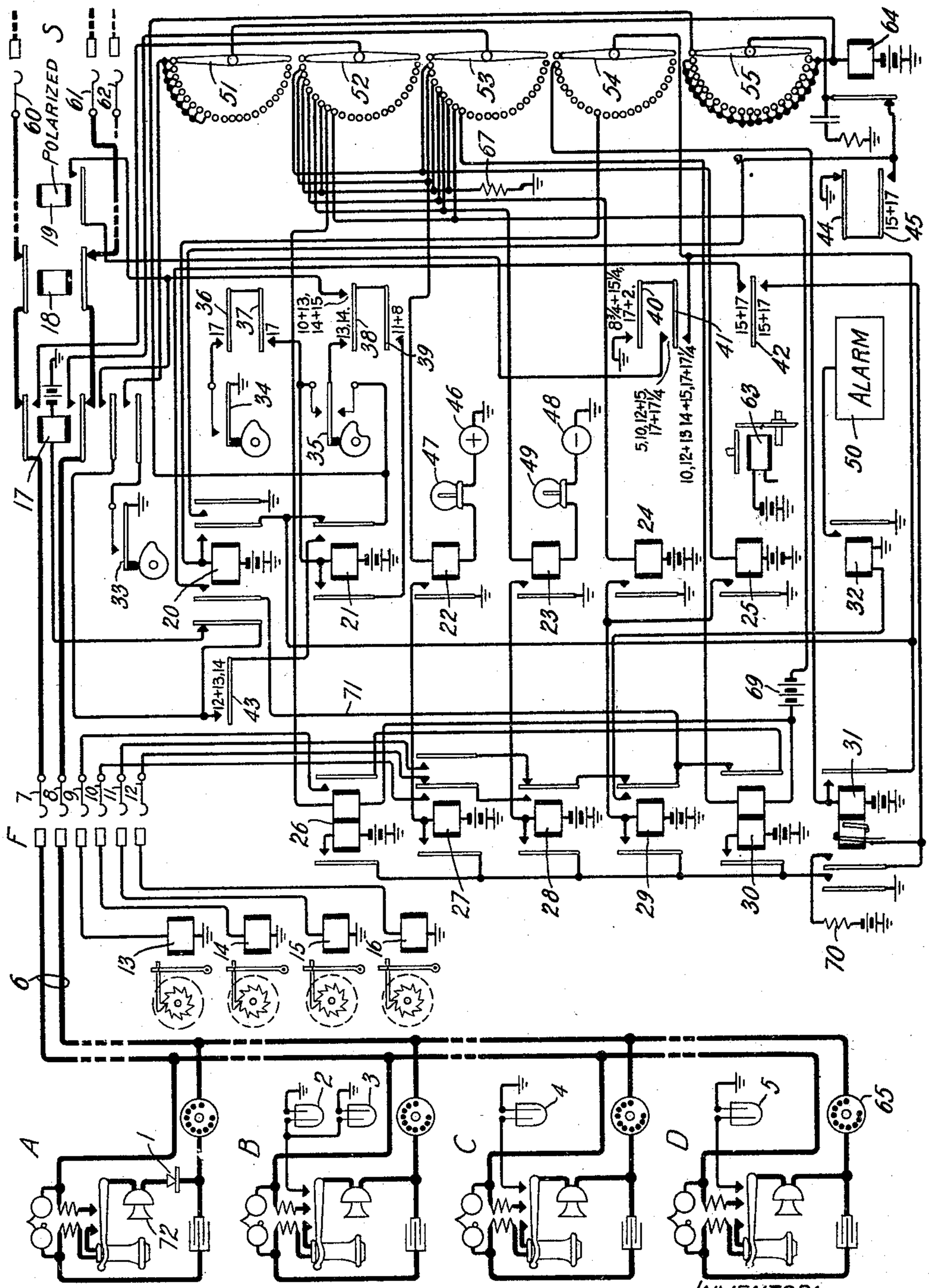
July 23, 1929. H. E. BRAGG 1,722,033

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 18, 1927



Patented July 23, 1929. 1,722,033

UNITED STATES PATENT OFFICE.

HERBERT E. BRAGG, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed October 18, 1927. Serial No. 226,849.

This invention relates to telephone exchange systems and particularly to message registration on party lines.

The object is to secure greater reliability in the tests made on party telephone lines to discriminate between the substations thereof.

A feature of the invention is a system in which one substation of a party line is distingushed from others by means of a device connected in the talking circuit at the substation and arranged to allow current to flow in one direction in a circuit including the line conductors in series, but to offer substantial resistance to flow in the opposite direction.

Another feature of the invention is an arrangement at the central office for testing a calling party line by first connecting a source of potential in series with the line loop in one direction and then reversing the connection. The current flowing under these conditions is used to distinguish between substations and to cause selective operation of message registers.

The drawing shows the invention applied to a four-party line in an automatic telephone system. At the left of the drawing is shown a subscriber's line 6 having four substations A, B, C and D.

The substation A is provided with a device 1 which permits current to flow in one direction upon the application of relatively low potentials and substantially prevents the flow of current in the opposite direction. The device 1 is illustrated schematically and it is to be understood that any suitable device of this character may be used. For example, a rectifier of the type shown and described in the Journal of the American Institute of Electrical Engineers for March, 1927, page 215, may be employed.

The rectifier or uni-lateral device 1 is connected directly in series with the talking circuit as shown. The other three substations B, C and D are equipped with space discharge devices 2, 3, 4 and 5. The arrangement of these devices is such that for a given voltage current flows from one electrode to the other, but substantially no current will flow in the reverse direction. The station B is equipped with two of these devices oppositely connected so that current of one polarity will flow through one device to ground and current of the opposite polarity will flow through the other device to ground. Stations C and D are provided each with a single device, one of which is connected to permit current of one polarity to flow and the other to permit current of the opposite polarity to flow. These devices may be of the space discharge type, such as illustrated in the application of Gray, Serial No. 98,658, filed March 31, 1926.

At the central office the party line terminates in a line finder F illustrated diagrammatically by the brushes 7 to 12, inclusive. The line finder F is joined to a selector switch S having brushes 60, 61 and 62. The line finder and selector unit partially shown may be of substantially the same construction and operation as illustrated and described in detail in the patent to Kopp, No. 1,589,402, issued June 22, 1926. Control and operating circuits for a selector switch of this character are also shown in the patent to Stern et al., No. 1,395,977, issued November 1, 1921. The switches F and S may be of the panel type and the sequence switch 63 of the type illustrated in the Kopp and Stern patents.

The central office is also equipped with individual message registers for the different parties on the party line. The registers 13, 14, 15 and 16 are respectively individual to substations A, B, C and D.

The rotary stepping switch, shown at the right of the drawing, comprises the brushes 51 to 55, inclusive, and the stepping magnet 64. This switch serves as an auxiliary control device.

A detailed description will now be given, assuming that the party at substation D initiates a call. The initiation of the call causes the operation of line finder F to seize the subscriber's line 6. The calling subscriber thereupon manipulates his impulse transmitter 65 to set up the designation of the called line in the register sender (not shown) at the central office. Following this the sender controls the selector switch S and succeeding switches to extend the connection to the called subscriber's line.

When the called subscriber answers, the relay 19 operates in the usual manner and at this time the sequence switch 63 has advanced to some position, such as position 13. As soon, after the relay 19 operates, as the interrupter 35 closes its upper contact, a cir-

cuit is completed from battery, through the winding of relay 21, contact of said interrupter, contacts of sequence switch spring 38, contact of relay 19, through the sequence switch springs 41 and 40 to ground. Relay 21 operates and locks in the circuit from battery through its winding and contact, through sequence switch spring 39 and thence as above traced to ground.

As soon, after the relay 21 energizes, as the interrupter 35 closes its lower contact, a circuit is completed from battery through the winding of relay 17, outer left contact of relay 20, spring 43, front contact of relay 21, lower contact of interrupter 35 and thence to ground as above traced. Relay 17 operates locks through its middle lower contact and thence through the contacts of relay 19 to ground as previously traced.

The auxiliary stepping switch is now set in operation to make a test of the calling subscriber's line to determine which station has initiated the call. The circuit for operating the stepping switch leads from ground through the interrupter 33, lower contact of relay 17, wiper 51, winding of the stepping magnet 64 to battery. Magnet 64 energizes to step the wipers 51 to 55, inclusive, to their second position terminals.

In position 2 of the switch a preliminary test is made to determine if an accidental ground on the line initiated the operation of the central office equipment. This test is made by means of a circuit from the positive pole of grounded battery through the winding of relay 25, thence through wipers 52 and 53 in parallel through the front contacts of relay 17 to the tip and ring conductors of the subscriber's line. The call being a genuine one, no low resistance ground or foreign potential exists on either the tip or ring conductors of the line and relay 25 does not operate. The potential of the battery applied to the line in this test circuit is insufficient to cause current to flow through the space discharge tubes. While the stepping switch is in position 2, a circuit is completed from battery through the right winding of relay 31, wiper 54 to ground through the springs 41 and 40. Relay 31 operates and locks through its winding and right contact independently of the wiper 54.

On the next closure and opening of the interrupter 33, the switch steps to its third position. In this position another test is made to determine which station originated the call. The circuit for this test may be traced from positive pole of the high potential source 46, lamp 47, relay 22, thence in parallel, through the wipers 52 and 53 and the contacts of relay 17, over the tip and ring conductors of the subscriber's line, through the switchhook contacts to the discharge device 5. It will be assumed that the polarity of the device 5 is such that it does not permit the flow of current in the circuit above traced. Accordingly, the relay 22 remains inert.

The stepping switch advances into position 4 where a circuit is completed from ground through the resistance 67, and thence in parallel through the wipers 52 and 53 to the tip and ring conductors of the line. This connection serves to discharge the subscriber's line before applying potential in the opposite direction.

In position 5 of the stepping switch a test circuit is closed from the negative pole of grounded battery, through the winding of relay 24, thence through the wipers 52 and 53 to the tip and ring conductors of the subscriber's line. If the line is still free from a low resistance ground connection, relay 24 remains inert.

In position 6 of the stepping switch, a test circuit is completed from the negative pole of the high potential source 48, lamp 49, winding of relay 23, wipers 52 and 53 in parallel, thence over the subscriber's line to the substation. In this case the potential is of the proper polarity to cause the flow of current in the circuit through the discharge tube 5. Current flowing in this circuit causes the operation of relay 23. Relay 23 in operating closes an obvious operating circuit for relay 28 which locks to the contact of relay 31.

In position 7 a circuit is completed from ground through the resistance 67 thence over the brushes 52 and 53 in parallel to the tip and ring conductors of the subscriber's line. This connection serves to discharge the line.

In position 8 of the control switch a circuit is completed from the positive pole of battery 69 through the right winding of relay 26, wiper 52, thence over the tip side of the line through the switchhook contacts of substation D and returning over the ring side of the line through wiper 53 to the negative pole of battery 69. Current flows in this circuit, operating the relay 26, which locks through its left winding. In position 9 of the control switch another circuit is completed from the negative pole of battery 69 through the wiper 52 and thence over the subscriber's circuit and returning through the wiper 53, right winding of relay 30 to the positive pole of battery 69. Relay 30 operates in this circuit and locks to ground.

The control switch advances into position 10 where the relay 20 is energized in a circuit from battery through its winding, wiper 54, thence through contacts 41 and 40 to ground. Relay 20 locks through its winding and inner right contact to ground independently of the wiper 54. Relay 20 releases the relay 17 which completes the tip and ring conductors through to the contacts of relay 18. The control switch continues to advance till it reaches its normal position. The operating circuit may now be traced from battery to the wind-

ing of magnet 64, wiper 55, contact of said magnet to ground at the front contact of relay 20. The magnet 64 interrupts its own circuit and steps the switch forward to its normal position.

At the end of conversation the called party replaces his receiver, resulting in the deenergization of relay 19. In the well known manner the sequence switch 63 moves from the talking position to a subsequent position, such as position 17 to prepare for metering. Relay 19 in releasing opens the circuit of relay 21 which also releases. Relay 20 is now held in a circuit from battery through its winding and inner right contact, back contact of relay 21, wiper 55, contact of magnet 64 to ground at the front contact of relay 20. Relay 31 is also held in a circuit from battery through its right winding and contact and thence through the back contact of relay 21 to ground as above traced.

When the sequence switch 63 moves from position 15 to position 17 a metering circuit is completed from battery through the resistance 70, inner left contact of relay 31, contacts of spring 42, inner left contact of relay 20, conductor 71, to the right back contact of relay 29, right front contact of relay 28, inner right back contact of relay 27, brush 12, through the winding of register 16 to ground. The register 16 operates and charges the call to the substation D. When the sequence switch 63 reaches position 17, and as soon thereafter as interrupter 34 closes, a circuit is completed from battery through the winding of relay 21, contacts 37 and 36 to ground at interrupter 34. Relay 21 operates and releases the relays 20 and 31.

From this point the release of the line finder and selector takes place in any well known manner such as explained in the patent to Kopp, No. 1,589,402, granted June 22, 1926.

Assume next that the call is initiated at the substation C. As in the previous case neither of the relays 24 and 25 operates. Since the polarity of the device 4 is opposite that of the device 5, current from the high potential source 46 is permitted to flow in the test circuit but not from the high potential source 48. Accordingly the relay 22 operates and relay 23 remains inert. Relay 22 closes an obvious operating circuit for relay 27. Relay 27 locks through its left contact. As before, the relays 26 and 30 both operate.

The metering circuit may be traced as explained, over contactor 71 through the right back contacts of relays 29 and 28, outer right front contact of relay 27, brush 11 to the winding of register 15 to ground. The register 15 operates, charging the call to substation C.

If the call is originated at station B both relays 22 and 23 operate causing the energization of relays 27 and 28. Also the relays 26 and 30 are both energized. The metering circuit in this case leads over the conductor 71, right back contact of relay 29, right front contacts of relays 28 and 27, brush 10 through the winding of register 14 to ground. The register 14 charges the call to substation B.

Assume next that the call is originated at the substation A. In this case the closure of the high potential test circuit is ineffective to operate either of the relays 22 or 23 since the substation is free from ground connections. When the control switch reaches position 8, however, the circuit previously traced from the positive pole of battery 69 extends over the tip conductor of the subscriber's line through the switchhook contacts, talking transmitter 72, through the device 1 and returning over the ring side of the line to the opposite pole of battery 69. It is assumed that device 1 is so connected as to permit current to flow in this direction. Accordingly the relay 26 operates and locks. Later, in position 9 of the control switch, the circuit is closed to apply the battery 69 in the opposite direction to the subscriber's line. The device 1 being asymmetrical will not permit current to flow in this direction. Accordingly the relay 30 remains inert in this case. The metering circuit may now be traced from conductor 71, through the contact of relay 30, contact of relay 26, brush 9, through the winding of the register 13 to ground.

By employing a directional device at the substation A which permits currents of low potential to flow through the talking circuit in one direction and not in the other, a positive test is obtained for the fourth substation on the party line. Although connected directly to the talking circuit the directional device 1 offers practically no interference with the conversational current.

Should a low resistance ground connection be applied to the line, it will be detected by the operation of one or both of the relays 24 and 25. Either one of these relays closes an obvious circuit for relay 29. In this instance the metering circuit leads over conductor 71 through the front contact of relay 29 and the winding of relays 32 to ground. Relay 32 closes a circuit to the alarm device 50 to notify the attendant that trouble exists on the line.

While the invention has been illustrated as applied to a system employing a certain type of selective switch it is to be understood that it is not so limited but may be embodied in various types of systems. Furthermore any discriminating type of directional device may be employed for the substations B, C and D on the party line.

What is claimed is:

1. The combination in a telephone system of a subscriber's line, a test circuit including the two sides of said line in series, and a device at the subscriber's station allow-

ing current to flow in one direction in said circuit and resisting the flow of current in the other direction.

2. The combination in a telephone system of a subscriber's line, a test circuit including the two sides of said line in series, and a device in the talking circuit at the subscriber's station arranged to permit the flow of current in one direction in said test circuit and to resist flow in the opposite direction.

3. The combination in a telephone system of a subscriber's line, a test circuit including the two sides of said line in series, a device at the substation arranged to pass current in one direction in said test circuit and to oppose the flow of current in the other direction, a register, and means responsive to current flow in the test circuit for controlling said register.

4. In a telephone system, a party line, means for distinguishing one substation on the line from another comprising a test circuit including both sides of the line in series and a device at the substation arranged to pass current in one direction in the test circuit and to oppose current flow in the other direction, means individual to each substation, and means responsive to current flow in the test circuit for selectively operating said individual means.

5. In a telephone system, a line having a plurality of substations, means controlled by the switchhook at any one of said substations for closing a circuit including the two sides of the line in series, and a current controlling device at one of the substations for allowing current to flow in one direction in said circuit and resisting flow in the other direction.

6. In a telephone system, a line having a plurality of substations thereon, an asymmetric current controlling device at each of two substations, one of said devices included in the talking circuit, the other device excluded from the talking circuit, and test circuits including said devices for distinguishing one substation from another.

7. In combination, a party line, an asymmetric current controlling device at each of two substations on said line, a test circuit including one of said devices and the two sides of the line in series, a second test circuit including the other device and both sides of the line in parallel, message registers, and means controlled by current flowing in said test circuits for selectively operating said registers.

8. In combination, a central office, a party line, a test circuit including both sides of the line in series, a source of potential at said office, means for connecting said source in said circuit in one direction, means for reversing the connection of said source, and a device included in the test circuit at one of the substations for permitting current to flow in one direction in said circuit and resisting flow in the opposite direction.

In witness whereof, I hereunto subscribe my name this 17 day of October A. D., 1927.

HERBERT E. BRAGG.