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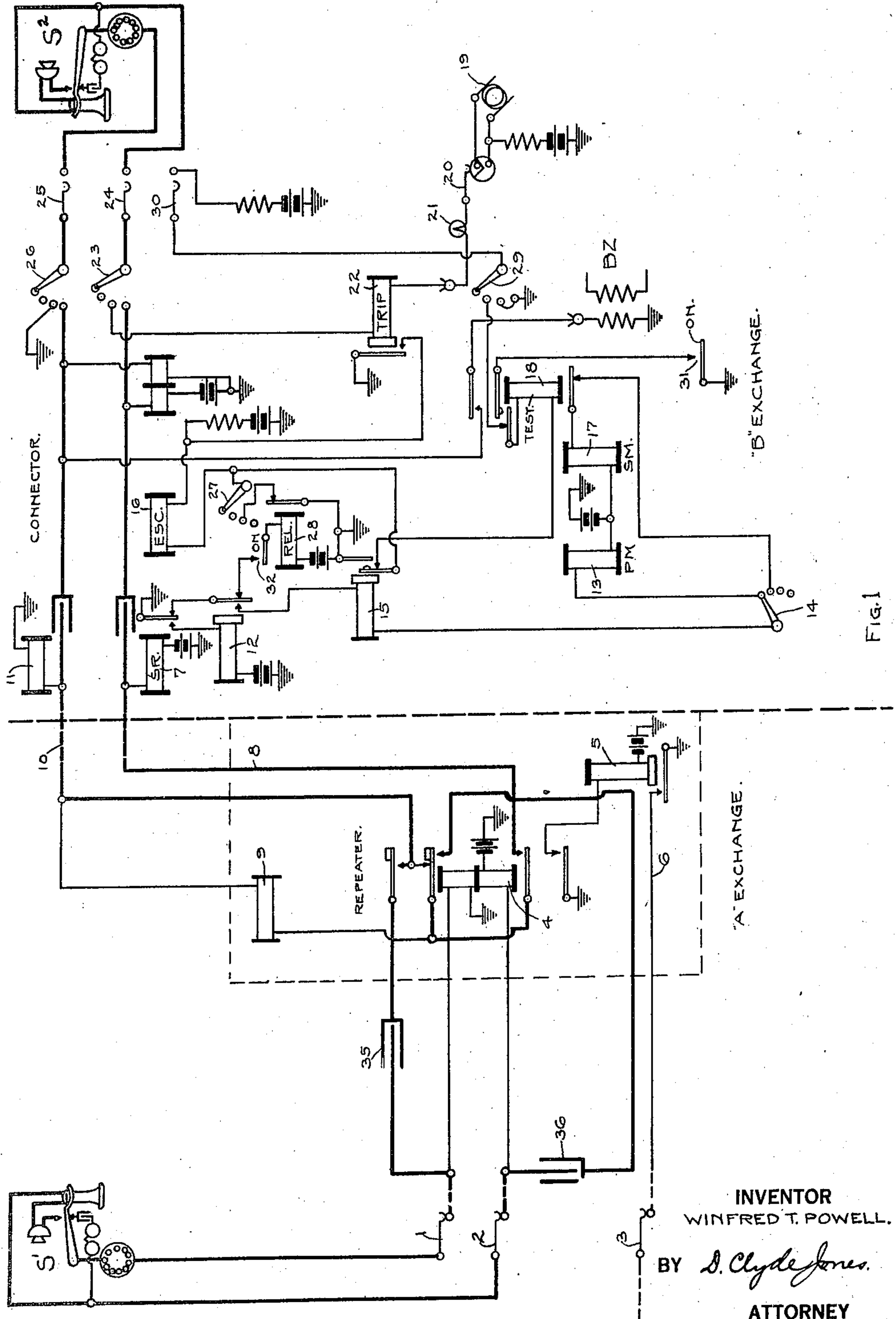
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1,515,360

AUTOMATIC TELEPHONE REPEATER SYSTEM

Filed June 14, 1919

2 Sheets-Sheet 1



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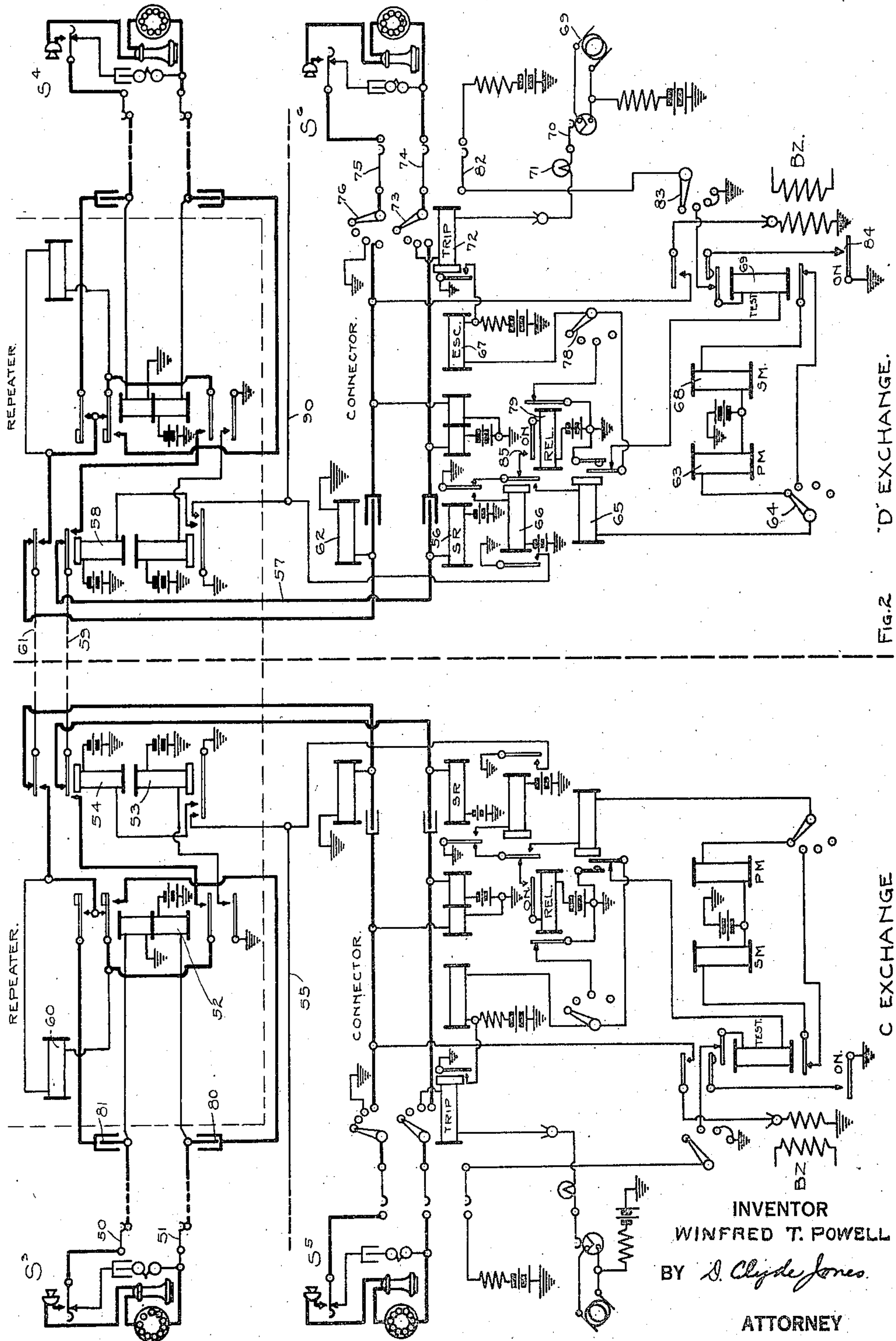
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UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

AUTOMATIC TELEPHONE REPEATER SYSTEM.

Application filed June 14, 1919. Serial No. 304,133.

To all whom it may concern:

Be it known that I, WINFRED T. POWELL, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Automatic Telephone Repeater Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems, and more particularly to automatic telephone systems.

In automatic telephone systems and particularly in multi-office systems using automatic switches which are operated by current impulses from a distant point, the length of the circuit over which the impulses are transmitted for controlling the automatic switches, becomes so great that the impulses must be repeated or relayed in order that they may be of sufficient intensity to control the automatic switches at a remote exchange.

Several arrangements have been proposed for relaying or repeating impulses in a system having operating conditions like those just described, but in each of these arrangements a plurality of controlling devices, such as relays, are necessary to repeat the impulses in the proper manner and subsequently to maintain a conversational circuit complete when all the impulses have been repeated by the device.

In accordance with the present invention it is proposed to employ an electromagnetic device having a plurality of elements certain of which are more sensitive than the others for repeating impulses in an automatic system.

Specifically stated, the invention resides in the use of a relay having fast and slow operating armatures for repeating current impulses from one conductor to another. This arrangement has been shown in connection with a so-called one-way trunk, and also with a so-called two-way trunk of an automatic telephone system.

Referring to the drawings Fig. 1 diagrammatically represents the invention applied to a one-way trunk in which that portion at the left of the dotted line schematically shows the arrangement of parts of the system at one exchange, and the portion

of the drawing at the right of the dotted line diagrammatically represents the arrangement of the circuits at a distant exchange.

Fig. 2 diagrammatically represents the invention applied to a two-way trunk in which the portion of the drawing shown at the left of the dotted line represents the incoming and outgoing apparatus connected to a trunk terminating at one exchange, while the portion of the drawing at the right of the dotted line represents the incoming and outgoing apparatus connected to the other end of said trunk where it terminates at a distant exchange. It will be understood that this disclosure is abbreviated in order that the showing and description of the invention need not be unduly complicated. It will, of course, be understood that when this invention is used in a system having a great many lines it will be necessary to employ one or more selectors of any well known type and employing well known circuits which may be inserted between the trunk selecting switch schematically shown, and the repeater at the first exchange and other selectors and operating circuits may be interposed between the repeater and the connector switch at the second exchange.

It is believed that the invention will best be understood by describing the method of establishing a connection from a calling to a called subscriber.

Referring to Fig. 1, when the calling subscriber S', whose line terminates at an exchange designated A, removes his receiver from its switchhook, a trunk selecting switch whose brushes are designated 1, 2 and 3 operates to extend the calling line to an idle trunk. This trunk may lead to a selector switch which may select other selecting switches which will extend the calling line to the repeater at the same exchange. As soon as the calling line is extended to the repeater, an electromagnet 4 is energized in a circuit extending from grounded battery, its lower winding, over the link circuits previously selected, brush 2 of the trunk selecting switch, through the calling subscriber's line and substation circuits, brush 1 of the trunk selecting switch, over the other side of the link circuits previously selected, upper winding of the relay 4, to ground. The re-

lay 4 is provided with a plurality of armatures; those which are weighted, do not respond to momentary energizations of the relay 4, whereas the other armatures operate
5 whenever the relay 4 is energized.

When the calling line is extended to the repeater as just described, the relay 4 attracts all of its armatures, but when the calling subscriber operates his sender or dial switch to interrupt the circuit just described,
10 all of the armatures of the relay 4 will be retracted. However, in response to each momentary closure of the signaling circuit through the dial switch, the relay 4 will attract its lower armatures, but its upper armatures will remain inactive. This condition of the upper armatures of relay 4 is effective to disconnect the trunk conductors 8 and 10 from the condensers 35 and 36, and to
20 short circuit the impedance coil 9 to prevent its interference with the operation of the switches at the distant exchange. As soon as the relay 4 has attracted its armatures, it closes a circuit at its lower-most armature
25 for energizing the slow releasing relay 5. This relay operates to apply a guarding potential to the test conductor 6 of the trunk circuit terminating at the repeater. Simultaneously with the first energization of the
30 relay 4, the stepping relay 7 of the numerical switch (assumed to be a connector switch in the present disclosure) at the exchange B is energized over a circuit extending from grounded battery, winding of the relay 7,
35 trunk conductor 8, inner lower front contact and armature, of relay 4, winding of the impedance coil 9, trunk conductor 10, winding of the impedance coil 11, to ground. The relay 7 is energized in this circuit and closes
40 a circuit for operating a slow-releasing relay 12.

In response to each interruption of the circuit extending from the calling substation to the repeater, the relay retracts its lower armatures and at its inner lower armature controls the operating circuit of the stepping
45 relay 7, while at its upper armature and back contact, the impedance coil 9 is short circuited. Thus it will be seen that the stepping relay 7 responds to the impulses repeated by the relay 4. With the relay 12 energized as the stepping relay 7 vibrates its armature in response to the repeated impulses which it may be assumed is the tens
50 series of impulses, an operating circuit is closed for the primary operating magnet 13 from grounded battery, winding of this magnet, side switch wiper 14 in its first position, winding of the slow-releasing relay
55 15, front contact and armature of relay 12, back contact and armature of the stepping relay 7, to ground. Under the control of the primary magnet, the brushes of the connector are advanced one step in the primary
60 direction in response to each impulse repeat-

ed to the stepping relay 7. The slow-releasing relay 15 is energized in the circuit just described and remains energized during the primary series of impulses transmitted to the switch. As long as the slow-releasing relay 15 is energized, a circuit is closed for the escape magnet 16 from grounded battery, resistance, winding of this magnet, continuity spring and armature of the relay 15, to ground. This circuit maintains the escape magnet 16 energized during the time that connector switch is completing its primary series of movements. At the close of the first series of impulses transmitted to this switch, stepping relay 7 will maintain its armature attracted for a relatively long interval, so that the energizing circuit of the slow-releasing relay 15 is broken permitting this relay to deenergize. When the slow-releasing relay 15 deenergizes, it interrupts the operating circuit for the escape magnet 16, previously described, and the escape magnet operates in the well known manner to move the side switch wipers into their second position.
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In response to the second or units series of impulses, the secondary magnet 17 is operated over a circuit traceable from grounded battery, winding of this magnet, lower armature and back contact of the test relay 18, side switch wiper 14 in its second position, slow-releasing relay 15, front contact and armature of the slow-releasing relay 12, back contact and armature of stepping relay 7, to ground. In response to the second series of impulses, the connector switch advances its brushes in a secondary direction to select the wanted line from the previously selected group. At the close of the units series of impulses, the connector switch is in operative relation to the terminals of the wanted line, and if this line is idle, the escape magnet which has been maintained energized through the armature of the slow-releasing relay 15, deenergizes and moves the side switch wipers into their third position. In this position signalling current is supplied to signal the wanted line from grounded battery, resistance, ringing generator 19, interrupter 20, lamp 21, ringing trip relay 22, side switch wiper 23 in its third position, connector brush 24, through the bell at the called substation S², connector brush 25, side switch wiper 26 in its third position, to ground. Also when the side switch wipers moved into their third position, the escape magnet was energized over a circuit now extended from grounded battery, resistance, winding of the escape magnet 16, side switch wiper 27 in its third position, back contact and armature of the release magnet 28, to ground. The trip relay 22 is marginal and does not operate until the wanted subscriber answers, whereupon it attracts its armature and short circuits the escape magnet 16.
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The escape magnet then moves its side switch wipers into the fourth or talking position. A guarding potential is supplied to the test terminal of the called line over side switch wiper 29 in its third and fourth positions, and test brush 30.

If the wanted line had been busy when the connector switch under consideration had completed its secondary movement, the escape magnet 16 instead of deenergizing would have been maintained energized through the continuity spring and contact of the slow-releasing relay 15, winding of the test relay 18, continuity spring and contact of this relay, side switch wiper 29 in its second position, connector test brush 30, through a multiple terminal of the wanted line and through a side switch wiper corresponding to wiper 29 in its third or fourth positions at the other connector switch which has seized the called line. The test relay 18 is energized in this circuit and closes a locking circuit for itself from grounded battery, resistance, winding of the escape magnet 16, continuity spring and contact of the slow-releasing relay 15, winding of the test relay 18, continuity spring and inner upper armature of the test relay, off normal contact 31, to ground. At the uppermost armature of the test relay 18 a busy tone is supplied to the calling line to inform the calling subscriber that the wanted line is busy.

When the calling subscriber replaces his receiver on the switchhook because the conversation has terminated or because he has received the busy tone, the relay 4 at the repeater deenergizes and opens the circuit for the stepping relay 7. When this takes place, the release relay 28 of the connector is operated over a circuit completed from grounded battery, its winding, off normal contact 32, back contact and armatures of relays 12 and 7 to ground. The release magnet 28 operates in the well known manner to restore the connector to normal position. Also, when the relay 4 deenergizes, the slow relay 5 controlled thereby, retracts its armature to remove the guarding potential from test conductor 6. The apparatus is now in normal condition.

Referring to Fig. 2, the type of repeater employed is similar to that shown in Fig. 1 and is used in an arrangement for two-way trunking, that is, each end of the trunk circuit is provided with apparatus for extending incoming and outgoing calls as desired.

A brief description of the method of setting up a telephone connection, it is believed, will best set forth the invention. When the calling subscriber at substation S³ initiates a call by removing his receiver from its switchhook, a trunk selecting switch, the brushes of which are shown at 50 and 51, operates to select a trunk lead-

ing in the direction of an idle impulse repeater through which the wanted line may be reached. The calling line may be extended through several link circuits and selectors depending on the size of the system until an impulse repeater, such as that shown at the upper left hand corner of Fig. 2, is reached. When this occurs, relay 52 is energized over a circuit extending from grounded battery, lower winding of the relay 52, through the link circuits over which the calling line has been extended, trunk selecting switch brush 51, through the calling subscriber's line and substation circuits, brush 50 of the trunk selecting switch, upper winding of relay 52, to ground. The relay 52 attracts its armatures, and at its lower-most armature and front contact closes a circuit for energizing the slow-releasing relay 53. As soon as relay 53 is energized, it completes a circuit for the slow-releasing relay 54, which disconnects the connector circuits at the C exchange from the selected trunk to the distant exchange designated D. Also at the lower armature and front contact of the relay 53, a guarding potential is applied to the test conductor 55 of the selected trunk. The apparatus is now in condition to receive and repeat impulses to the distant exchange at D. At the distant exchange the selected trunk may terminate in a selector switch which may operate to select another link circuit and selector to build up a connection to the connector switch shown at the lower right hand corner of Fig. 2.

It will be understood that the number of selector switches employed in establishing a connection will be dependent on the size of the system with which the present invention is employed, and it will further be understood that the number of selector switches may be increased or diminished without departing from the present invention.

Since it has been assumed that a connection has been established to the connector switch, it is necessary for the calling subscriber at station S³ to operate his dial switch to transmit impulses corresponding to the tens digit of the wanted number. In response to this series of impulses, the relay 52 at the repeater vibrates its lower armatures, but on the first deenergization of this relay its upper armatures are retracted, and since they are slow to operate are not attracted until the close of the tens series of impulses. As soon as the relay 52 was energized, it closed an operating circuit for the stepping relay 56, over conductor 57, inner back contact and armature of slow-releasing relay 58, trunk conductor 59, inner front contact and armature of the relay 54, inner lower front contact and armature of the relay 52, impedance coil 60,

inner upper front contact and armature of the relay 54, trunk conductor 61, upper armature and back contact of the relay 58, impedance coil 62, to ground. As soon as the stepping relay was energized, it closed a circuit for operating the slow-releasing relay 66 and this relay at its left hand armature applies a guarding potential to test conductor 90, to prevent the repeater at the distant exchange from being seized.

In response to each interruption of the calling subscriber's circuit at his dial switch, the relay 52 retracts its armatures and interrupts the energizing circuit just described of the stepping relay 56. It will thus be seen that the relay 52 repeats or relays each impulse from the dial switch to the stepping relay 56 at the distant exchange. In response to the vibration of the armature of the relay 56, an operating circuit is closed for the primary motor magnet 63, from grounded battery, winding of this magnet, side switch wiper 64 in its first position, winding of the slow-releasing relay 65, right hand front contact and armature of the slow-releasing relay 66, back contact and armature of the stepping relay 56, to ground.

In response to each impulse repeated to the relay 56, the primary motor magnet 63 advances the brushes of the connector switch in a primary direction to select the group of lines in which the wanted line terminates. At the close of the tens series of impulses, the escape magnet 67 which has been maintained energized during the transmission of this series of impulses over a circuit leading from grounded battery, resistance, winding of this magnet, continuity spring and armature of the slow-releasing relay 65, to ground, has its circuit opened at the slow-releasing relay 65 at the close of this series of impulses and moves the side switch wipers into their second position.

In response to the last or units series of impulses, the relay 52 at the repeater repeats impulses corresponding to the units digit of the wanted number, to the stepping relay 56. This relay 56 vibrates its armatures once for each impulse of the units digit. A circuit is completed for the secondary motor magnet 68 from grounded battery, winding of this magnet, lower armature and back contact of the test relay 69, side switch wiper 64 in its second position, winding of the slow-releasing relay 65 in series, right hand front contact and armature of the slow-releasing relay 66, back contact and armature of relay 56, to ground.

On the first energization of the relay 65, the escape magnet 67 is again energized in a circuit extending from grounded battery, resistance, winding of the escape magnet 67,

continuity spring and armature of the relay 65, to ground. The circuit of the escape magnet is maintained closed until the end of the units series of impulses, whereupon the escape magnet deenergizes if the wanted line is idle and moves the side switch wipers into their third position.

In this position of the side switch wipers, signaling current is applied to the called line from grounded battery, resistance, ringing generator 69, interrupter 70, lamp 71, ringing trip relay 72, side switch wiper 73 in its third position, connector brush 74, through the substation circuit and bell of the wanted station, connector brush 75, side switch wiper 76 in its third position, to ground.

As soon as the side switch wipers were moved into their third position, a circuit was also completed for the escape magnet from grounded battery, resistance, winding of this magnet, side switch wiper 78 in its third position, back contact and armature of the release magnet 79, to ground. The escape magnet is energized in this circuit and remains energized until the marginal trip relay 72 is operated when the called party responds, whereupon the escape magnet is short circuited at the armature of the trip relay 72 and moves its side switch wipers into their fourth or talking position.

It will be noted that during the transmission of the various series of impulses, that the slow acting armatures of the relay 52 remained inactive and were thus effective to disconnect the trunk conductors 59 and 61 from the condensers 80 and 81 and to short circuit the impedance coil 60 to prevent its interference with the operation of the switches at the distant exchange.

In the foregoing description it was assumed that the wanted line was idle. Let it be assumed that when the test brush 82 of the connector engaged the test terminal of the wanted line at the close of the units series of impulses, that a busy potential is found on its test terminal. Under this assumption, the escape magnet 67 instead of deenergizing as in the case of an idle line, is maintained energized in a circuit extending from grounded battery, resistance, winding of this magnet, continuity spring and contact at relay 65, winding of the test relay 69, continuity spring and contact of this relay, side switch wiper 83 in its second position, test brush 82, through a multiple test terminal of the wanted line, to ground, over a side switch wiper similar to 83, at the other connector switch.

The test relay 69 is energized in this circuit and completes a locking circuit for itself through its continuity spring and inner upper armature, off normal spring 84, to ground. At the upper-most armature of

the test relay 69, a busy tone is applied to the calling line from the busy tone device BZ.

When at the close of the conversation or in response to the busy tone the called subscriber at station S³ replaces his receiver on its switchhook, the relay 52 deenergizes and thereby opens the operating circuit of the stepping relay 56. This relay deenergizes and in turn causes the deenergization of the slow-releasing relay 66. A circuit is thus completed for the release magnet 79 from grounded battery, off normal contact 85, back contacts and armatures of slow-releasing relay 66, and stepping relay 56 to ground. The release magnet 79 is energized and operates to restore the apparatus of the connector switch to normal position. As soon as the relay 52 deenergized, it opened the holding circuit of the slow-releasing relay 53, and this relay deenergized to remove the busy potential from the test conductor 55. Relay 54 also deenergized at this time to connect trunk conductors 59 and 61 to the connector switch shown at the lower left hand corner of Fig. 2. The release of the trunk selecting switch indicated at 50 and 51 may also be operated by the removal of ground from the test conductor 55.

A call may similarly be established from substation S⁴ as a calling station to the substation S³ as a called station, but it is not believed necessary to repeat the method of establishing a call between these last two mentioned substations since it is identical with the method of establishing a call between the substation S³ and S⁴ as previously described.

What I claim is:

1. In a telephone exchange system, a switch, conductors extending to said switch, a second switch, a pair of talking conductors extending from said first switch to said second switch, said last mentioned conductors having break points operating magnets at said second switch controlled by impulses repeated to said last mentioned conductors, means for transmitting impulses to said first switch, and a single relay for repeating said impulses to and for controlling the break points of said last mentioned conductors.

2. In a telephone system, telephone lines, means for transmitting impulses over said telephone lines, talking conductors including automatic switches and trunks for interconnecting said lines, said talking conductors being divided into sections by condensers and a relay having armatures for repeating impulses around certain of said condensers to certain of said automatic switches

and for preventing said last mentioned condensers from interfering with said impulses.

3. In a telephone system, telephone lines, means for transmitting impulses over said telephone lines, talking conductors including automatic switches and trunks for interconnecting said telephone lines, said talking conductors being divided into sections by condensers and a relay having armatures for repeating impulses around certain of said condensers to certain of said automatic switches and for opening the conductors including said last mentioned condensers to prevent interfering with said impulses.

4. In a telephone system, telephone lines, means for transmitting impulses over two sides of said telephone lines in series, talking conductors including automatic switches and trunks for interconnecting said lines, said talking conductors being divided into sections by condensers and a relay for repeating impulses around certain of said condensers for operating certain of said switches, said relay being provided with slow operating parts to prevent the condenser discharge from interfering with said impulses.

5. In a telephone system, telephone lines, means for transmitting impulses over said telephone lines, talking conductors including automatic switches and trunks for interconnecting said lines, said talking conductors being divided into sections by condensers and a relay having a plurality of slow operating elements and a fast operating element, the two conductors of said talking circuit extending through said slow operating elements, an impulse repeating circuit around certain of said condensers extending through said fast operating element, and means responsive to control over said impulse circuit for variably operating certain of said switches.

6. In a telephone system, telephone lines, means for transmitting impulses over said telephone lines, talking conductors including automatic switches and trunks for interconnecting said lines, said talking conductors being divided conductively into sections by condensers, and a relay having an element slow to respond and another element rapid in responding to the energization of said relay, said last mentioned element operating to repeat impulses about certain of said condensers to control the operation of certain of said switches and said slow operating element functioning to control a break point in said talking circuit.

In witness whereof, I hereunto subscribe my name this 12th day of June A. D. 1919.

WINFRED T. POWELL.