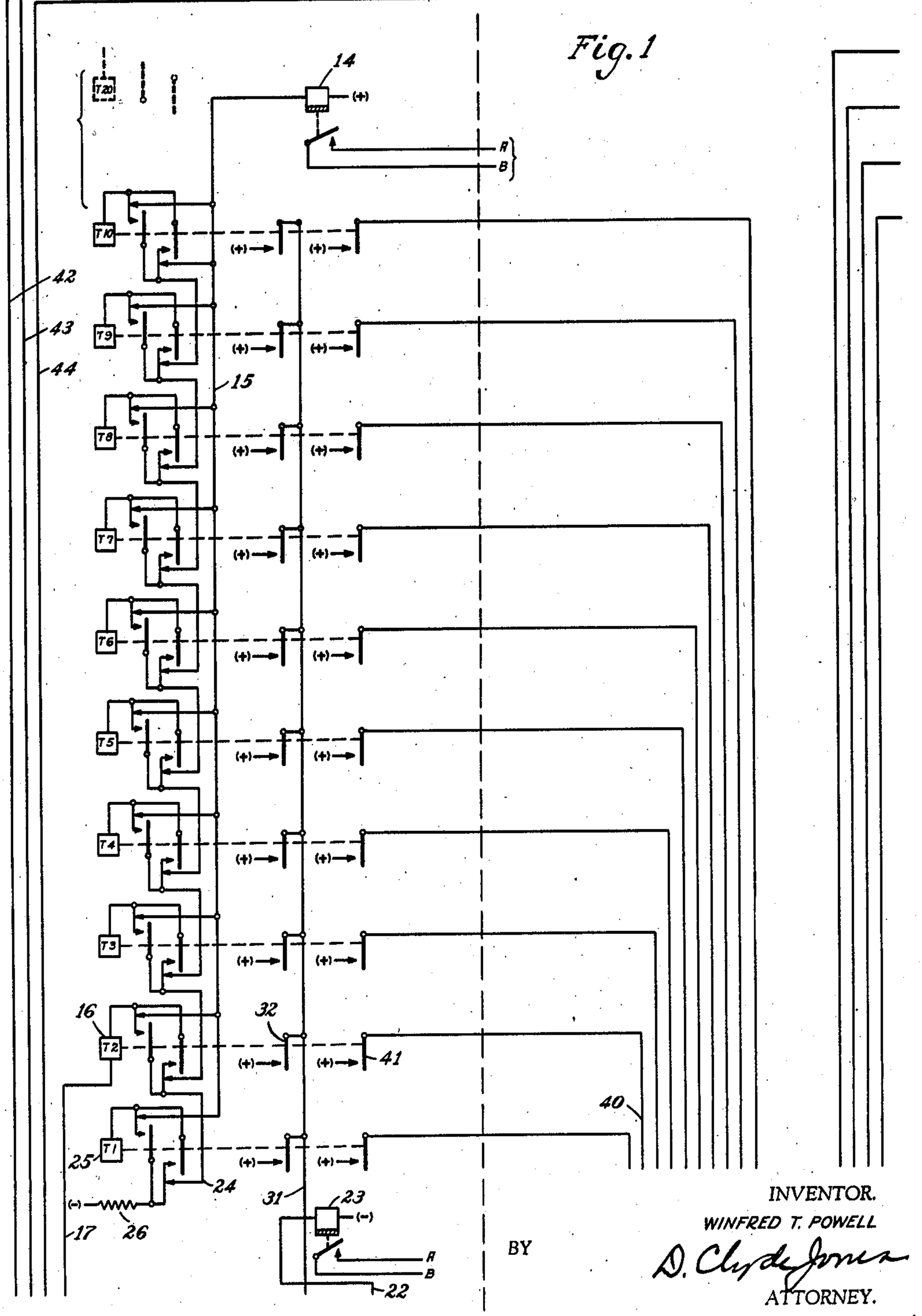
March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 1

Fig. 1



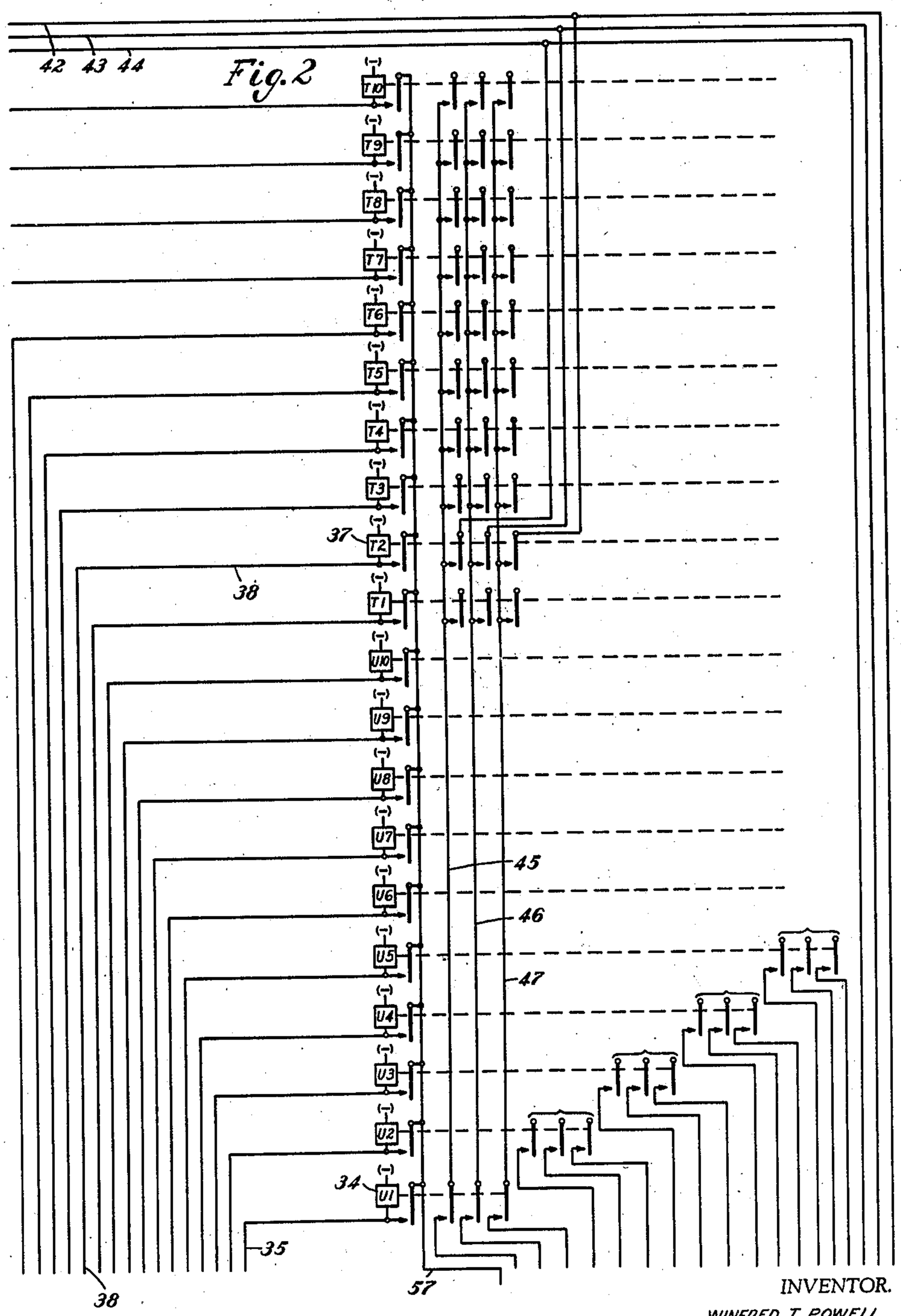
INVENTOR.
WINFRED T. POWELL
BY D. Clyde Jones
ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 2

Fig. 2



INVENTOR.
WINFRED T. POWELL

BY D. Clyde Jones

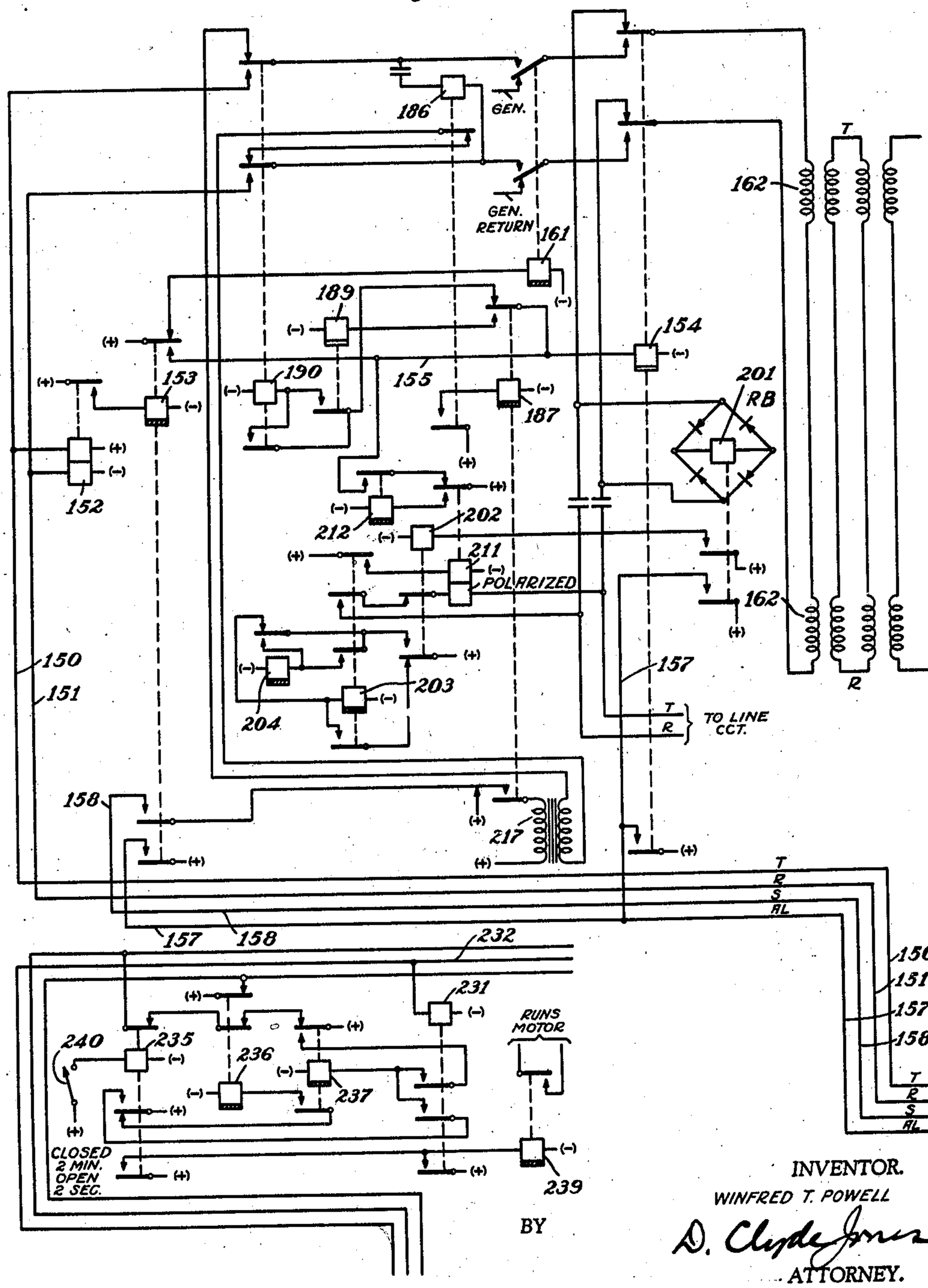
ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 3

Fig. 3



INVENTOR.

WINFRED T. POWELL

BY D. Clyde Jones

ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 4

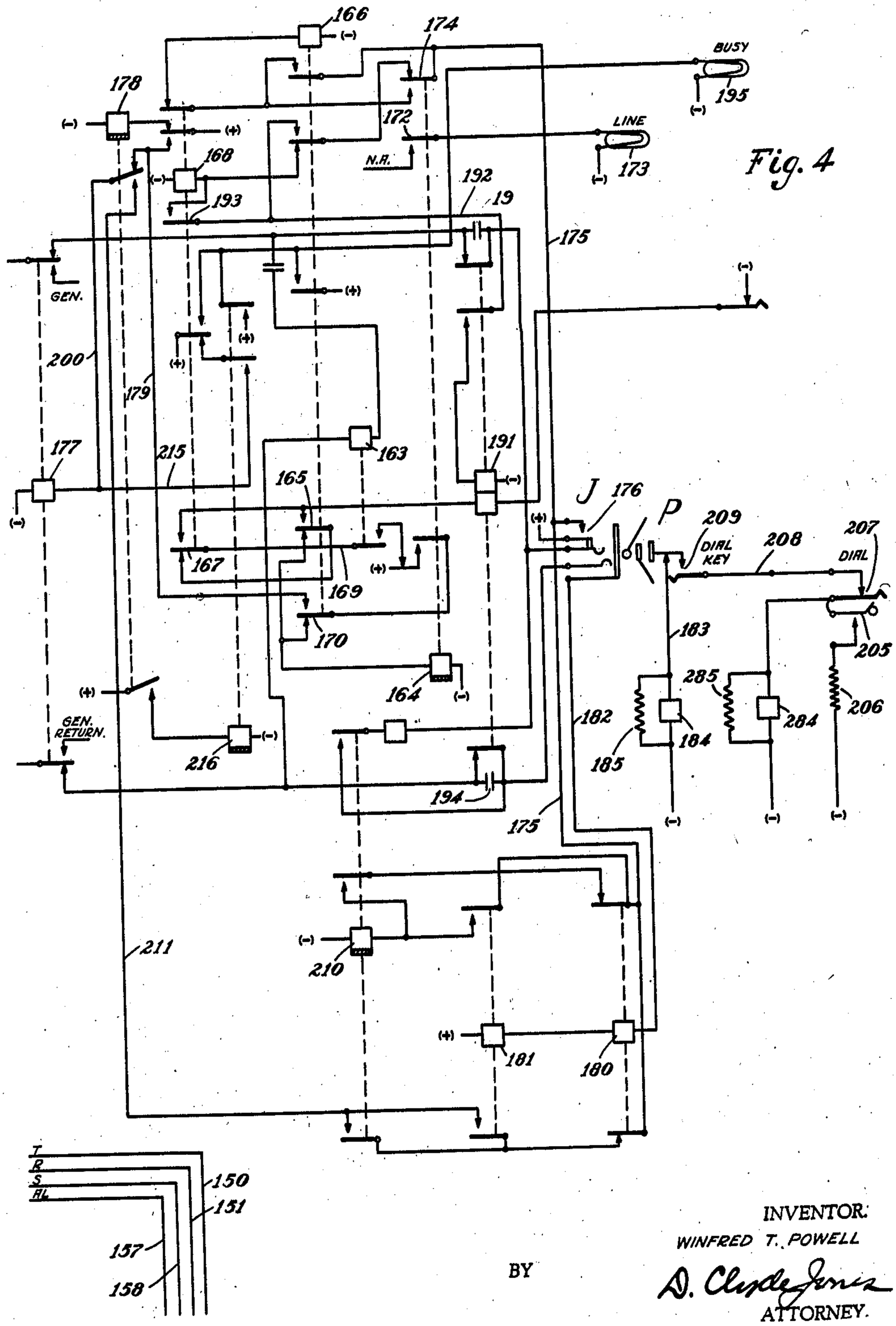


Fig. 4

INVENTOR.
WINFRED T. POWELL

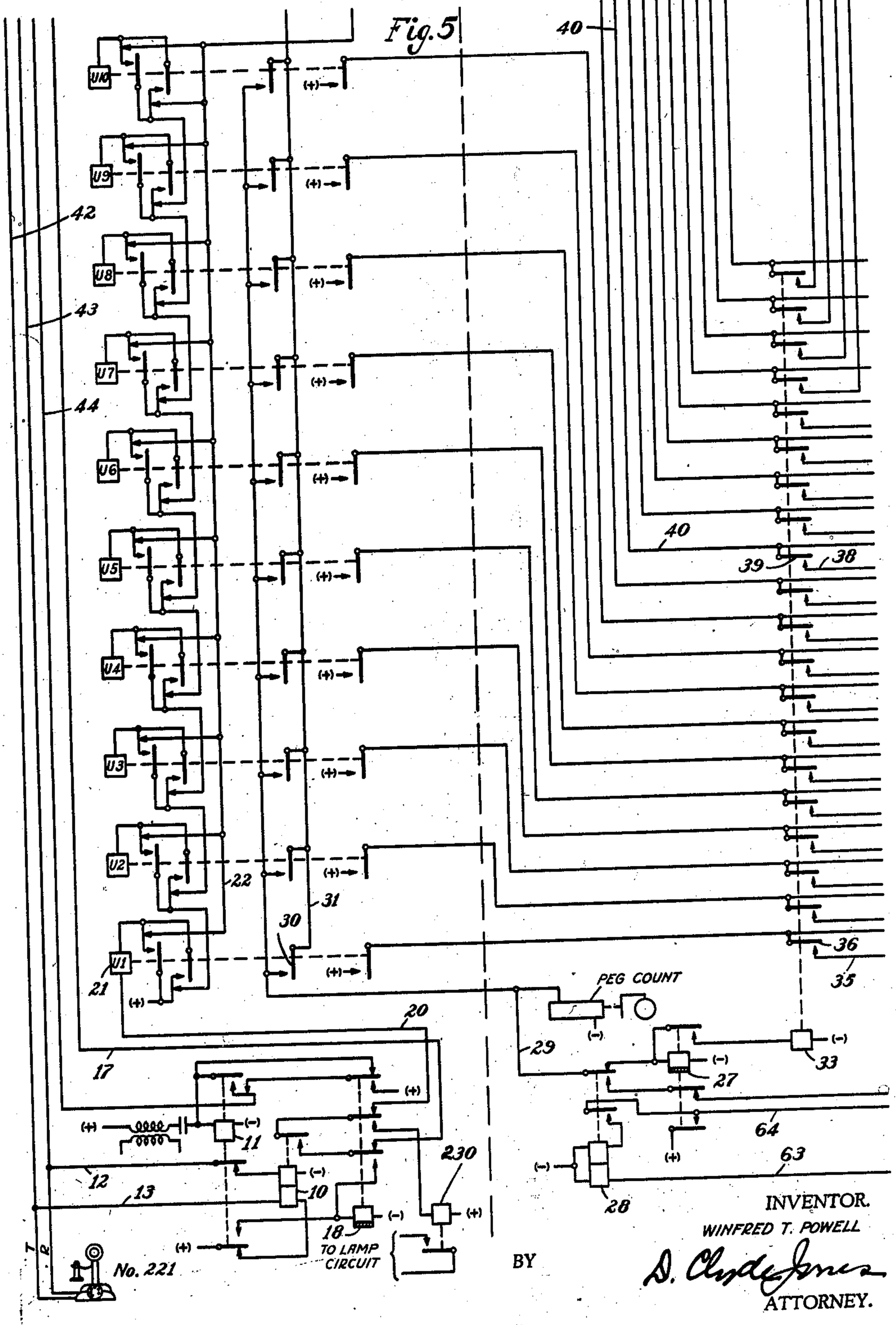
BY D. Clyde Jones
ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 5

Fig. 5



INVENTOR.
WINFRED T. POWELL

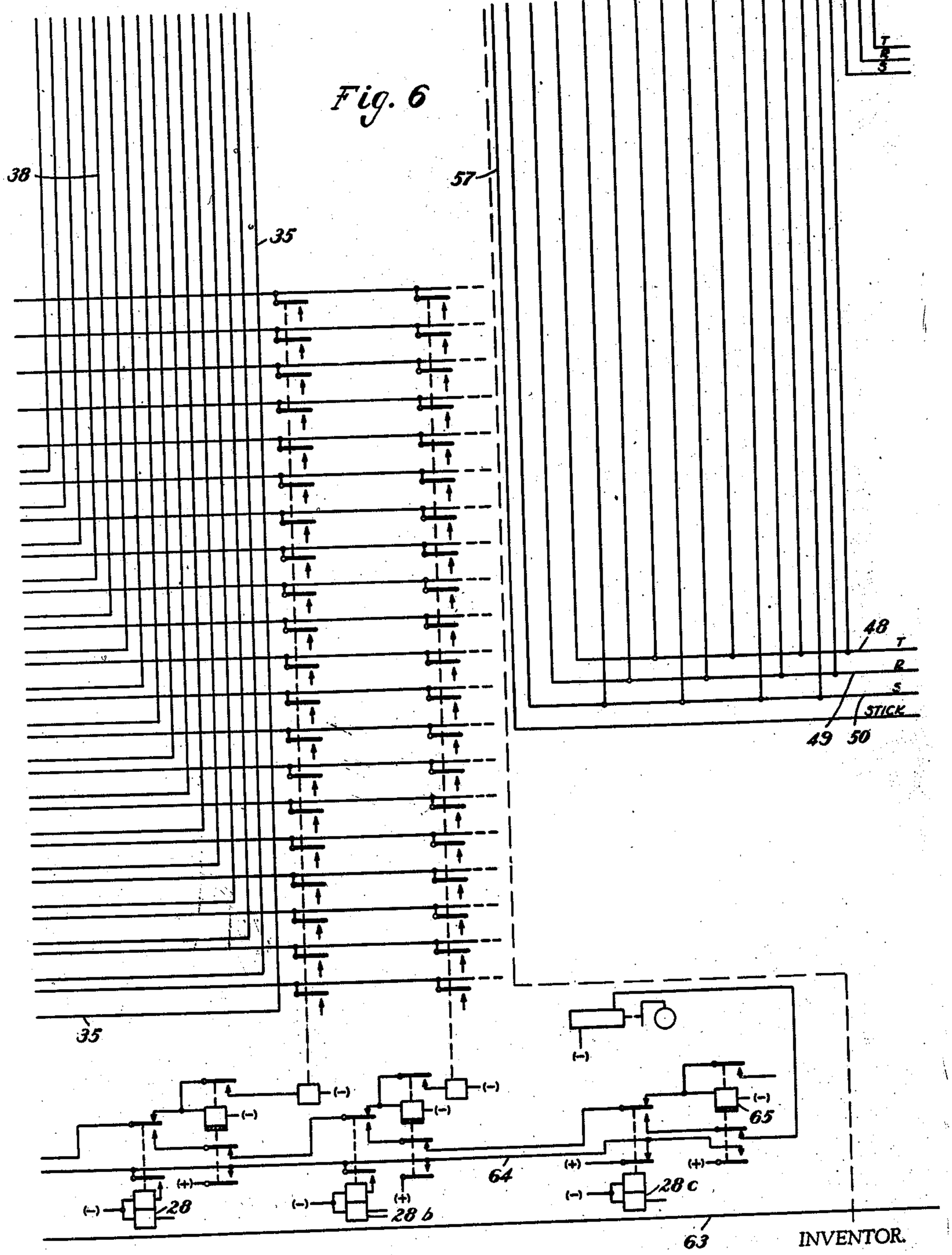
BY D. Clyde Jones
ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 6

Fig. 6



INVENTOR.
WINFRED T. POWELL

BY D. Clyde Jones

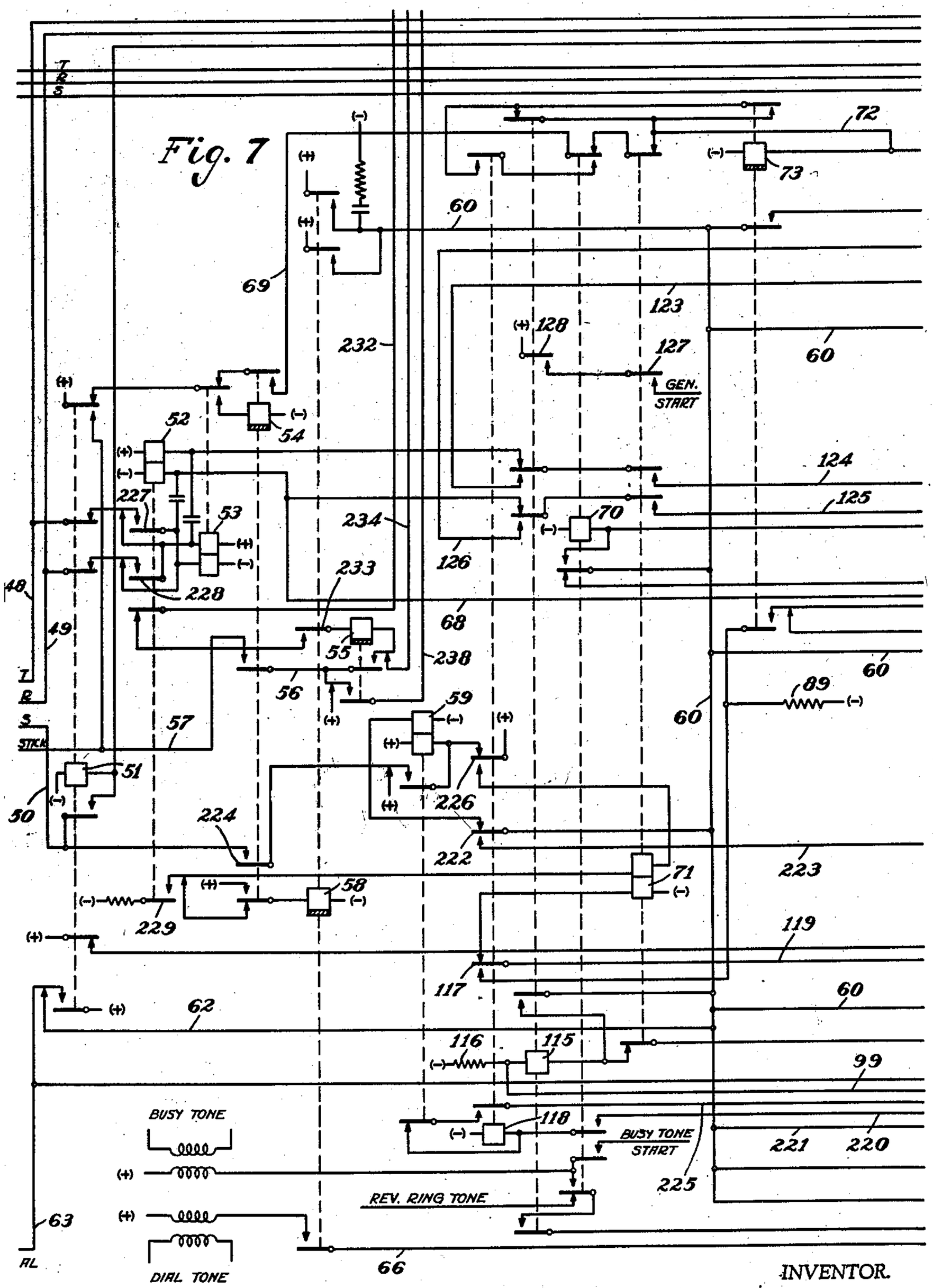
ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 7

Fig. 7



INVENTOR.
WINFRED T. POWELL

BY

D. Clyde Jones
ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 8

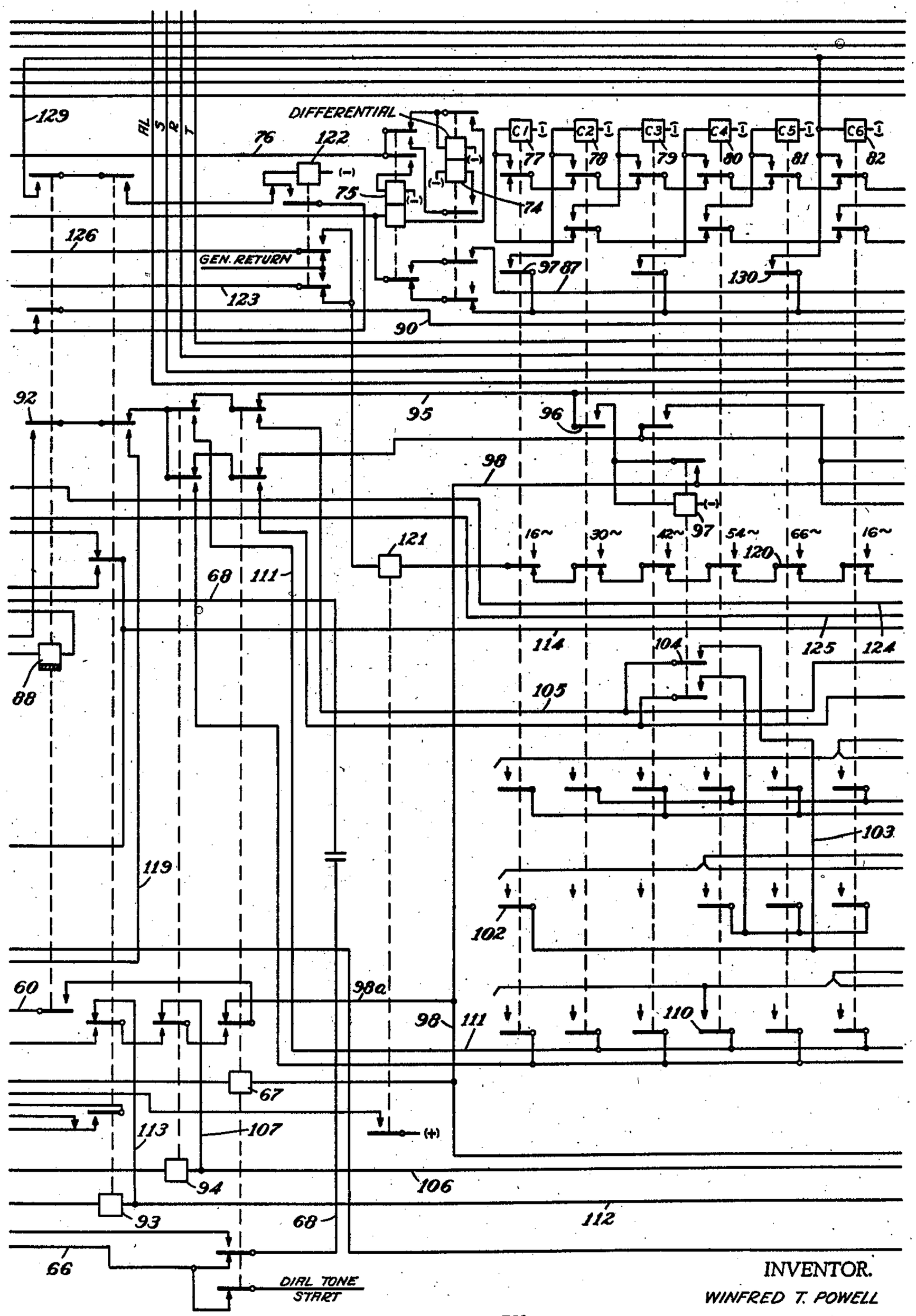


Fig. 8

INVENTOR.
WINFRED T. POWELL

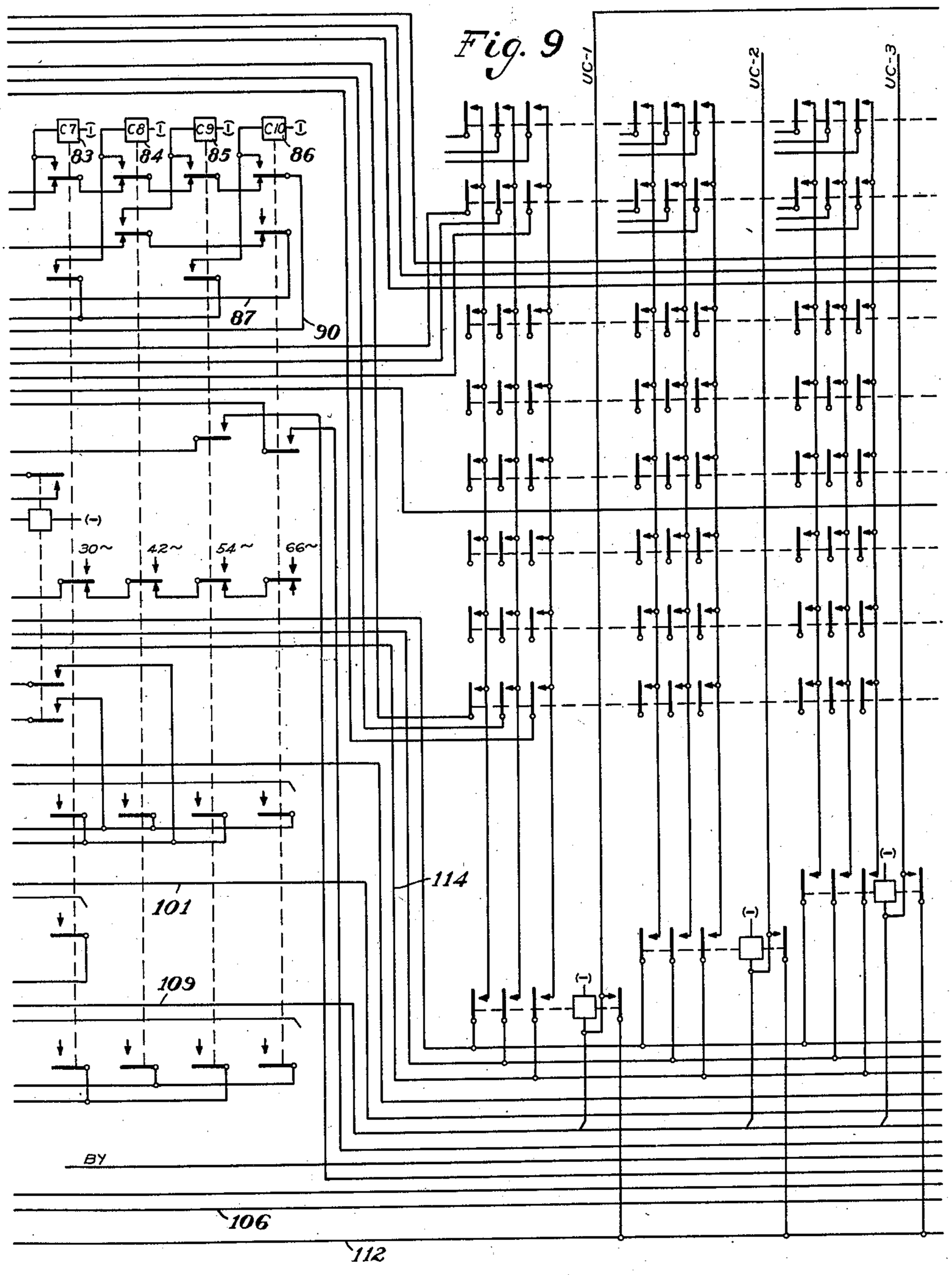
BY D. Clyde Jones
ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 9

Fig. 9



INVENTOR.
WINFRED T. POWELL

BY D. Clyde Jones
ATTORNEY.

March 30, 1943. W. T. POWELL 2,315,378

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 13, 1940 10 Sheets-Sheet 10

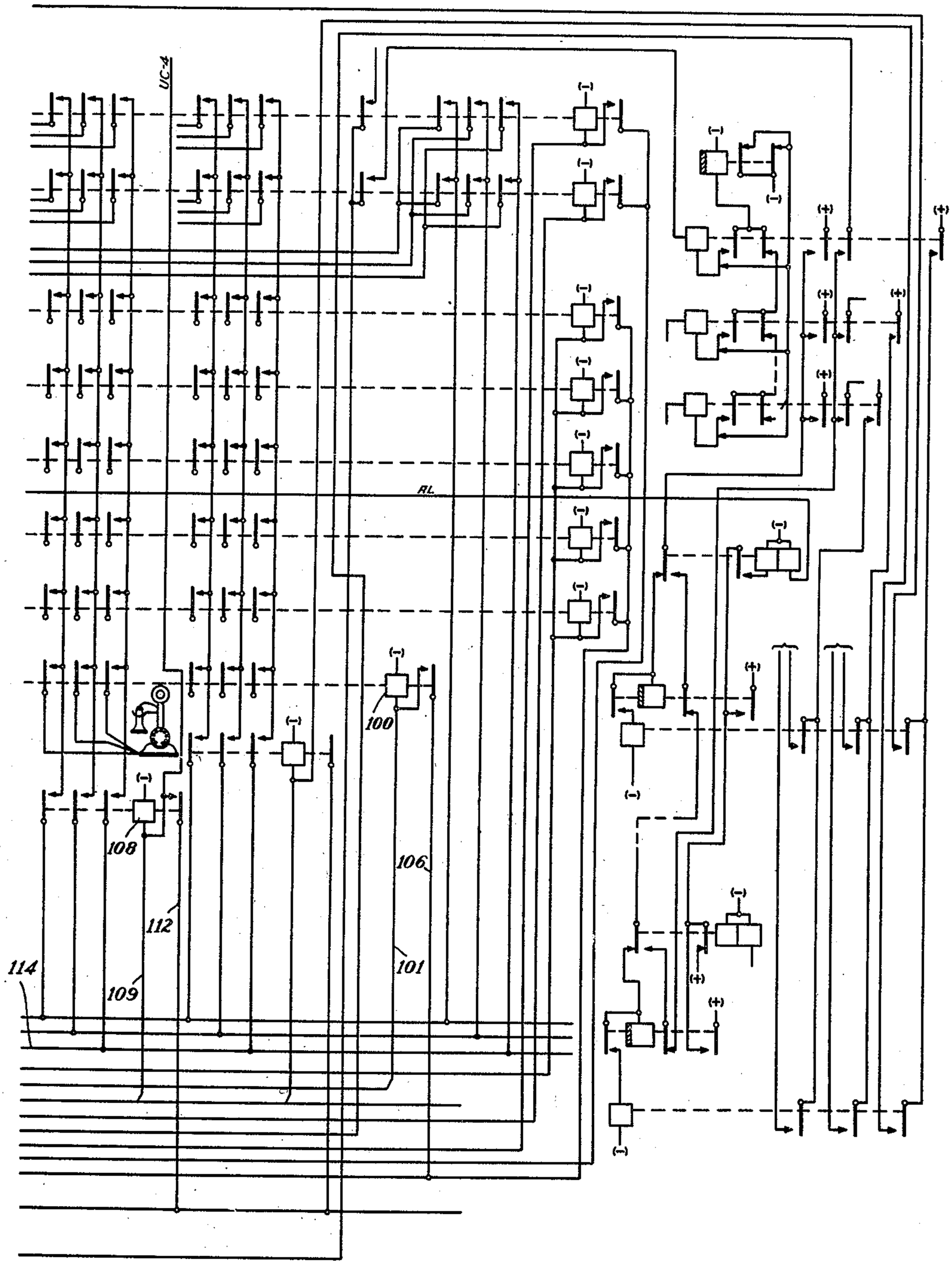


Fig. 10

INVENTOR.
WINFRED T. POWELL
BY D Clyde Jones
ATTORNEY.

Patented Mar. 30, 1943 2,315,378

UNITED STATES PATENT OFFICE

2,315,378

AUTOMATIC TELEPHONE SYSTEM

Winfred T. Powell, Rochester, N. Y., assignor to The Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y., a corporation of New York

Application September 13, 1940, Serial No. 356,623

6 Claims. (Cl. 179—17)

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

Present automatic telephone systems, are commonly so arranged that it is necessary for the calling party when calling another subscriber on his own line to dial a different number from that by which the wanted party thereon is usually called. Such an arrangement for handling revertive calls is confusing to the subscriber and results in many false calls.

In accordance with the present invention, a novel arrangement is provided wherein certain means discriminates between an ordinary busy line and a busy line due to a revertive call thereon while dialing the same called line number in the case of a revertive call as in the case of a normal call. This discriminating means in the first instance prevents the signalling of the busy wanted line but in the second instance permits the wanted subscriber, in the case of the revertive call, to be signalled during the period that the calling subscriber temporarily hangs up his receiver in accordance with instructions.

Another feature of the invention relates to an arrangement whereby a series of counting relays in addition to effecting the selecting operation of the connector also selectively controls the application of selective ringing current to the called subscriber's line.

Still a further feature of the invention relates to a novel arrangement for intercepting preliminary impulses.

The various features and advantages of the invention will appear from the detailed description and claims when taken with the drawings which diagrammatically represent the automatic telephone system of the present invention, when arranged with Figs. 1, 2, 3 and 4 in a horizontal row and with Figs. 5, 6, 7, 8, 9 and 10 arranged in a second horizontal row in the order named, the upper margins of Fig. 5 matching with the lower margin of Fig. 1. In Figs. 1 and 5 there is illustrated a calling telephone line and the lockout arrangement common to a group of telephone lines; Figs. 2 and 6 represent a group of finder relays for connecting a link circuit to a calling telephone line; Figs. 7, 8 and 9 illustrate a link circuit and the counting relays associated therewith; the righthand portion of Fig. 9 and Fig. 10 illustrate a relay connector for connecting a link to a wanted telephone line; Figs. 3 and 4 represent a trunking arrangement whereby a call may be extended to or received from a trunk connected to a distant office.

It is believed that the invention will best be understood by describing the operations involved in extending a telephone call from a calling subscriber's substation #221 to a called subscriber's substation #214. When the calling subscriber at substation #221 originates a call by removing his receiver from its switchhook, a circuit is completed for the line relay 10 from the negative pole of battery, upper winding of this relay, back contact and armature of the cutoff relay 11, upper side 12 of the calling subscriber's line thru the calling subscriber's substation network, lower side of the calling subscriber's line 13, lower winding of the relay 10, lower back contact and armature of the cutoff relay 11, to the positive pole of battery. In the form of the system herein disclosed, there is provided a lockout relay arrangement whereby only one calling subscriber at a time can extend his line to an idle link circuit. This locking relay arrangement comprises twenty tens lockout relays (of which only ten are completely illustrated, the twentieth tens relay being shown in dotted lines) and ten units lockout relays. When the line relay 10 is energized, a lockout circuit is completed from the negative pole of battery, resistance 26, continuity and back contact of relays T1 to T10 inclusive, conductor 15, back contact, continuity spring and winding of the second tens lockout relay 16, conductor 17, innermost back contact and armature of the slow releasing relay 13, armature and front contact of the line relay 10, middle armature and back contact of relay 18, conductor 20, the first units lockout relay 21, continuity spring and back contact of this relay, conductor 22, back contact and continuity spring of relays U10 to U1 inclusive, to the positive pole of battery. The tens lockout relay 16 and the units lockout relay 21 are operated over the above described circuit, each of which closes a locking circuit for itself and opens the operating circuit for the others in the corresponding group. Thus the tens relay 16 and the units relay 21 are locked operated until the calling line is extended to an idle link circuit. It will be understood that while the tens relay and the units relay are operated, no other tens or units relays can be operated, since their energizing circuits will be interrupted by the tens lockout relay and the units lockout relay then operated.

Alarm relay 14, which is normally energized except when a call is being extended by the lockout relays, functions when deenergized to close an alarm circuit. This alarm circuit becomes effective when the relay 14 is deenergized for a

period longer than that normally necessary to extend a calling line to a link. Alarm relay 23 functions in like manner in connection with the units lockout relays to close an alarm circuit when an operated one of these relays fails to release within a short interval of time.

As soon as the tens lockout relay 16 and the units lockout relay 21 have been energized and locked operated in the manner just described, the tens finder relay and the units finder relay of an allotted link circuit function to connect this allotted link to the calling line. Let it be assumed that the first link of this series is allotted for use and under this condition the slow releasing allotter relay 27 is operated from the negative pole of battery, winding of this relay, upper back contact and armature of the relay 28, conductor 29, front contact and armature 30 of the units lockout relay 21, conductor 31, armature 32 and front contact of the tens lockout relay 16, to the positive pole of battery. As soon as the allotter relay 27 operates, it closes an energizing circuit for the relay 33 from the negative pole of battery, winding of this relay, upper front contact and armature of the relay 27 and thence over conductor 29 and the remainder of the circuit just described, to the positive pole of battery at the armature 32 and front contact of the relay 16. When the relay 33 attracts its armatures it completes an energizing circuit from the negative pole of battery, units finder relay 34, conductor 35, front contact and armature 36 of the relay 33, outermost armature and front contact of units lockout relay 21, to the positive pole of battery. Relay 34 is energized in this circuit. Similarly, the #2 tens finder relay 37 is energized in a circuit traceable from the negative pole of battery, winding of this relay, conductor 38, front contact and armature 39 of relay 33, conductor 40, armature 41 and front contact of tens lockout relay 16 to the positive pole of battery. When the finder relays 34 and 37 are thus operated, the tip ring and sleeve conductors respectively designated 42, 43 and 44 are extended thru the armatures of the finder relay 37, conductors 45, 46 and 47, thence thru the armature and front contacts of the units finder relay 34 to the tip, ring and sleeve conductors 48, 49 and 50 of the selected link circuit. These tip and ring conductors 48 and 49 are thus connected in series with the calling line and thru the armatures and back contacts of the relay 51, the continuity springs and back contacts of the relay 52, thru the upper and lower windings in series of the battery feed and impulse relay 53, to the positive pole and the negative pole of battery, respectively. The impulse relay 53 is thus energized and completes a circuit from the negative pole of battery, winding of the slow release relay 54, front contact and armature of relay 53, uppermost back contact and armature of the relay 51, to the positive pole of battery. As soon as the slow releasing relay 54 is operated, it completes a locking circuit for the tens finder relay 37 and the units finder relay 34. This locking circuit is completed from the positive pole of battery, back contact and continuity spring of the relay 55, conductor 56, middle armature and front contact of relay 54, conductor 57, armature and front contact and winding of units finder relay 34 to the negative pole of battery and in multiple therewith thru the armature, front contact and winding of the tens finder relay 37 to the negative pole of battery. Also when the slow releasing relay 54 is operated, it closes an energizing circuit for the slow releasing relay 58 from the negative pole of battery, winding of this relay, lowermost armature and front contact of relay 54, to the positive pole of battery. Also as soon as the slow releasing relay 54 is energized, it applies busy potential to the sleeve conductor 50 of the link. This busy potential is applied from the positive pole of battery, back contact and continuity spring of the relay 59, middle armature and front contact of the relay 54, to the sleeve conductor 50 of the link. It will be understood that this busy potential prevents the calling line from being seized by any other line.

When the slow releasing relay 58 operates, it applies positive potential at its upper armatures and front contacts to the holding conductor 60 and thence thru a branch 62 of this conductor, back contact and continuity spring of the relay 51, conductor 63, lower winding of the allotter relay 28 to the negative pole of battery. The allotter relay 28 on operation closes a locking circuit for itself from the negative pole of battery, front contact and upper winding of this relay, conductor 64, back contact and armature of the relay 65, associated with the last allotter relay of the series, to the positive pole of battery. It will be appreciated that as a result of this last-described circuit, the allotter relay 28 of link #1 and similar allotter relays of the remaining links of the series will operate and remain locked until the last allotter relay of the series, namely relay 28c is energized, at which time the previously locked allotter relays of the series will release. This arrangement insures that the links are used in rotation.

Further, when the slow releasing relay 58 operates, it applies a dialing tone, from the dial tone source, front contact and armature of relay 58, conductor 66, inner back contact and armature of relay 67, conductor 68, lower winding of the battery feed relay 52, to the negative pole of battery. Dial tone current in this circuit is repeated over the link circuit in use and over the calling subscriber's line where it is heard as a dial tone in the receiver of the calling subscriber. This dial tone indicates to the calling subscriber that the apparatus is in readiness to receive the several series of code impulses corresponding to the called subscriber's substation.

It has been assumed that the designation of the called subscriber's substation is #214, therefore the calling subscriber operates his dial sender to transmit two impulses corresponding to the hundreds digit of this line. In response to the first impulse, the impulse relay 53 will retract its armature momentarily. This completes a circuit from the positive pole of battery, uppermost armature and back contact of relay 51, armature and back contact of impulse relay 53, upper armature and front contact of slow releasing relay 54, conductor 69, armatures and back contacts of the busy relay 70 and the cut-in relay 71, conductor 72, winding of the slow releasing change-over relay 73 to the negative pole of battery. It will be understood that the change-over relay as well as the slow-releasing relay 54, fail to respond to the momentary operations of the impulse relay 53. When, however, at the conclusion of each series of impulses, the impulse relay is held operated for a considerable period of time, slow releasing change-over relay 73 will release. A second circuit in multiple with the energizing circuit of the change-over relay 73 is completed from the negative pole of battery, upper winding of the relay 74, uppermost back contact and armature of the relay 75, conductor

76 and thence over conductor 72 and the remainder of the circuit just described, to the positive pole of battery at the back contact and the armature of relay 51. Thus when the impulse relay 53 retracts its armature in response to the first impulse of the hundreds digit, the change-over relay 73 and the relay 74 are both energized. With the relay 74 energized, it closes a second circuit for itself which incidentally is ineffective at this time. This second circuit extends from the negative pole of battery, upper winding of the relay 74, its upper armature and front contact, lower winding of the relay 75, innermost lower front contact and armature of relay 73, and thence over the holding conductor 60 to the positive pole of battery at the front contact and armature of the relay 58. This last described circuit is ineffective as long as the armature of the impulse relay 53 is retracted in response to the first impulse, since there is positive potential present on the conductor 76 which serves to shunt out the lower winding of the relay 75. However, when the impulse relay 53 attracts its armature at the conclusion of the first impulse, this positive potential will be removed from the conductor 76, so that the relay 74 will be locked operated, and the relay 75 will be energized in the circuit which was previously described as ineffective. With relays 74 and 75 both operated, the number one counting relay 77 is operated from the negative pole of battery, winding of this relay, thru the back contacts and armatures of counting relays 78, 80, 82, 84 and 86, conductor 87, middle front contact and armature of relay 74, front contact and armature of relay 75, front contact and armature of change-over relay 73, holding conductor 60, to the positive pole of battery. It should be mentioned that as soon as the change-over relay 73 operates, it completes an operating circuit for the relay 88 from the negative pole of battery, resistor 89, lowermost armature and front contact of change-over relay 73, winding of the relay 88, holding conductor 60 to the positive pole of battery. As soon as the number one counting relay is energized, it closes a locking circuit for itself from the negative pole of battery, winding of this relay, its innermost front contact and armature, innermost back contacts and armatures of relays 77 to 86 inclusive, conductor 90, middle armature and front contact of relay 88 to the positive pole of battery over the holding conductor 60. When now the impulse relay 53 retracts its armature again in response to the second impulse of the hundred digit, the lower winding of the relay 74 is energized from the negative pole of battery, lower winding of this relay, its front contact and armature, uppermost front contact and armature of relay 75, conductors 76 and 72, back contacts and armatures of relays 71 and 70, conductor 69, front contact and armature of relay 54, back contact and armature of the impulse relay 53, back contact and armature of relay 51, to the positive pole of battery. At this time both the upper and lower windings of the relay 74 are energized and since this relay is differentially wound, it retracts its armatures. However, the relay 75 is maintained operated until the close of the second impulse, from the negative pole of battery thru its upper winding, front contact and armature to the positive pole of battery over conductors 76 and 72 as previously described. However at the close of the second impulse with the relays 74 and 75 deenergized and with the number one counting relay 77 operated, the number two counting relay 78 is energized from the negative pole of battery, winding of this relay, front contact and armature 91 of relay 77, back contacts and armatures of relays 74 and 75, front contact and armature of change-over relay 73, to positive potential on the holding conductor 60. The number two counting relay 78 locks itself operated from the negative pole of battery, winding of relay 78, its inner front contact and armature, innermost back contacts and armatures of relays 79 to 86 inclusive, conductor 90, middle armature and front contact of relay 88, to positive pole of battery over holding conductor 60.

At the conclusion of the hundreds series of impulses, the change-over relay 73 retracts its armatures and at its lowermost armature and continuity spring, it opens the original energizing circuit of the relay 88. However, the relay 88 is slow releasing and before it releases it completes a circuit for itself from the positive pole of battery on the holding conductor 60, winding of the relay 88, continuity spring and back contact of the change-over relay 73, front contact and armature 92 of relay 86, armatures and back contacts of the transfer relays 93, 94 and 67, conductor 95, armature 96 and front contact of the number two counting relay 78 (now energized), winding of the hundreds relay 97, to the negative pole of battery. Relay 88 as well as the relay 97 are energized in this circuit and the relay 97 closes a locking circuit for itself from the negative pole of battery, its winding, armature and front contact, conductor 98, winding of the relay 67, conductor 99, continuity spring and back contact of relay 51, branch 62 of the holding conductor 60, to the positive pole of battery. The transfer relay 67 is not energized in this circuit since it is shunted at this time by a branch circuit 98*a* of the conductor 98, back contact and armature of relay 67, front contact and lowermost armature of relay 88 to the holding conductor 60. The slow releasing relay 88 is shunted in a circuit from the holding conductor 60 through the winding of relay 88, back contact and continuity spring of the change-over relay 73, front contact and armature 92 of relay 88, armatures and back contacts of relays 93, 94 and 67, conductor 95, armature 96 and front contact of relay 78, armature and front contact of relay 97, conductors 98 and 98*a*, back contact and armature of relay 67, lower front contact and armature of relay 88 and thence to positive potential over the holding conductor 60. Shortly after the completion of this shunt circuit the relay 88 releases and at its lower armature and front contact it removes the previously described shunt circuit about the relay 67. Relay 67 then attracts its armatures. The apparatus is now in condition to receive the impulses corresponding to the tens digit which in the present instance is assumed to be "one."

In response to the single impulse of the tens series, the impulse relay 53 retracts its armature. When this takes place, the relay 74 is energized from the negative pole of battery, its winding, back contact and armature of the relay 75, conductors 76 and 72, back contacts and armatures of relays 71 and 70, conductor 69, front contact and armature of the relay 54, back contact and armature of the impulse relay 53, to the positive pole of battery at the back contact and armature of the relay 51. The change-over relay 73 is also energized in multiple with the last-mentioned circuit, as previously de-

scribed. As soon as the change-over relay operates, it closes an energizing circuit from the negative pole of battery, resistor 89, armature and front contact of the change-over relay 73, winding of the relay 88 to ground over the holding conductor 60. As soon as the relay 74 is energized in the manner described, it closes a circuit thru its upper winding, its armature and front contact, lower winding of the relay 75, front contact and armature of change-over relay 73 to ground over the holding conductor 60. This last-mentioned circuit is ineffective, since it is shunted by the original energizing circuit of relay 74, which circuit includes the conductor 76, as long as the impulse relay 53 retracts its armature in response to the single tens impulse. However, at the close of this impulse, impulse relay 53 attracts its armature and opens this shunt circuit, whereupon the mentioned circuit of relays 74 and 75, which had previously been ineffective, now holds the relay 74 operated and operates the relay 75. With relays 74 and 75 operated, an energizing circuit is closed for the number one counting relay 77 extending from the negative pole of battery, winding of this relay, back contacts and armatures of relays 78, 80, 82, 84, and 86, conductor 87, front contacts and armatures of relays 74 and 75, front contact and armature of the change-over relay 73 to the positive pole of battery over the holding conductor 60. It will be understood that the change-over relay, which is slow releasing, remains energized for a short interval but soon retracts its armatures after its energizing circuit is interrupted at the armature and back contact of the impulse relay 53, when this last-named relay attracts its armature at the conclusion of the tens series of impulses. The number one counting relay 77 when operated, closes a locking circuit for itself from the negative pole of battery, its winding, front contact and armature, back contacts and armatures of relays 78 to 86 inclusive, conductor 90, armature and front contact of relay 88, to the positive pole of battery over the holding conductor 60. It will be recalled that the relay 97 was operated and locked operated in response to the hundreds impulses. Now with the number one counting relay 77 operated and locked operated in response to the tens series of impulses, a circuit is completed for operating the tens relay 100 of the relay connector associated with the link in use. The relay 100 is energized in a circuit traceable from the negative pole of battery, winding of this relay, conductor 101, front contact and armature 102 of the counting relay 77, conductor 103, front contact and armature 104 of the relay 97, conductor 105, uppermost front contact and armature of relay 67, back contacts and armatures of relays 94 and 93, armature 92 and contact of relay 88, continuity spring and back contact of change-over relay 73, winding of the relay 88 to the positive pole of battery over the holding conductor 60. The tens connector relay 100, when operated, closes a locking circuit for itself from the negative pole of battery, winding of this relay, its front contact and armature, conductor 106, winding of the relay 94, to the positive pole of battery over the holding conductor 60. The relay 100 is locked operated in its circuit but the relay 94 does not operate at this time since it is shunted by a circuit extending from conductor 106 thence over conductor 107, inner back contact and armature of relay 94, front contact and armature of relay 67, front contact and armature of relay 88, conductor 60 to the positive pole of battery. It will be understood that this shunt circuit is effective as long as the relay 88 is operated. However, the slow releasing relay 88 is shunted at this time and shortly afterwards retracts its armatures. This shunt circuit may be traced from the positive pole of battery connected to the conductor 60, winding of the relay 88, back contact and continuity spring of the change-over relay 73, front contact and armature 92 of relay 88, armatures and back contacts of relays 93 and 94, armature and front contact of relay 67 to conductor 105, armature 104 and front contact of relay 97, conductor 103, armature and front contact of relay 77, conductor 101, front contact and armature of relay 100, conductor 106, winding of relay 94 and again to the positive potential connected to the holding conductor 60. A short interval after the relay 88 is thus short circuited it retracts its armatures and at its lower armature and front contact interrupts the shunt circuit that had previously existed about the winding of the switching relay 94. The switching relay 94 is now operated and attracts its armatures. Also as soon as the relay 88 deenergizes it opens the locking circuit including the conductor 90 which has been holding the counting relay 77 operated, thus this relay deenergizes and the apparatus is in condition to receive the impulses corresponding to the units digit of the wanted number.

It has been assumed that the units digit of the wanted number is 4 and therefore the calling subscriber operates his dial sender to transmit four impulses. In response to each of these impulses, the impulse relay 53 retracts its armature. On the first retraction of the armature of the impulse relay, the change-over relay 73 as well as the relay 74 are energized as previously described. When the change-over relay is thus operated it closes a circuit for again energizing the slow releasing relay 88. Also when the relay 74 is operated, it closes an ineffective circuit as before described thru the upper winding of relay 74, its armature and front contact, lower winding of relay 75, front contact and armature of relay 73 to positive potential over the holding conductor 60. Now, when the impulse relay 53 attracts its armature at the close of the first impulse, relay 74 will remain energized and relay 75 will be operated. Therefore, the number one counting relay 77 will be operated as before described from the negative pole of battery, winding of this relay, back contacts and armatures of relay 78, 80, 82, 84 and 86, conductor 87, front contacts and armatures of relays 74 and 75, front contact and armature of the change-over relay 73 to the positive pole of battery over the holding conductor 60. Relay 77, when operated, closes a locking circuit for itself thru its innermost front contact and armature and thence thru the back contacts and armatures of remaining counting relays, conductor 90, armature and front contact of relay 88, to the positive pole of battery over the holding conductor 60. In response to the second impulse of the units series, the lower winding of the relay 74 will be energized from the negative pole of battery, inner front contact and armature of the relay 74, upper front contact and armature of the relay 75, conductors 76 and 72 to the positive pole of battery thru the back contact and armature of the relay 53. It will be noted that the relay 74 is differentially wound and thus when both of its wind-

ings are energized, it will retract its armatures. At the upper armature and front contact of this relay, the energizing circuit thru the lower winding of the relay **75** is interrupted but relay **75** is now held operated through its upper winding, front contact and armature over conductor **76**. When the impulse relay **53** attracts its armature at the close of the second impulse of the units series, the locking circuit thru the upper winding, front contact and armature of the relay **75** is interrupted so that the relay **75** also retracts its armatures. When this takes place the number two counting relay is energized from the negative pole of battery, winding of this relay, front contact and armature **91** of relay **77**, back contacts and armatures of relays **74** and **75**, front contact and armature of change-over relay **73** to positive pole of battery over the holding conductor **60**. In response to the third impulse of the units series, relays **74** and **75** are operated as previously described, after which the number three counting relay **79** is energized from the negative pole of battery, winding of this relay, front contact and armature of relay **78**, back contact and armatures of relays **80**, **82**, **84** and **86**, conductor **87**, front contacts and armatures of relays **74** and **75**, front contact and armature of relay **73**, conductor **60** to the positive pole of battery. Relay **79** on operation closes a locking circuit for itself thru its front contact and armature, back contacts and armatures of relays **80** to **86** inclusive, conductor **90**, armature and front contact of relay **88** to the positive pole of battery over the holding conductor **60**. In response to the fourth impulse of the units series, the relay **74** will retract its armatures and when the impulse relay **53** attracts its armature at the conclusion of the fourth impulse, the relay **75** will also retract its armature. Thereupon the number four counting relay **80** is operated from the negative pole of battery, winding of this relay, front contact and armature of relay **79**, back contacts and armatures of relays **74** and **75**, front contact and armature of change-over relay **73** to the positive pole of battery on the holding conductor **60**. Relay **80** when operated, closes a locking circuit for itself through its own front contact and armature and thru the back contacts and armatures of the remaining counting relays of the series, conductor **90** to the positive pole of battery on holding conductor **60** through the armature and front contact of relay **88**, as previously described.

At the close of the units series of impulses when the impulse relay **53** holds its armature attracted, the change-over relay **73** deenergizes. Thereupon the units connector relay **108** is operated from the negative pole of battery, winding of this relay, conductor **109**, front contact and armature **110** of the number four counting relay **80**, conductor **111**, uppermost front contact and armature of relay **94**, back contact and armature of relay **93**, armature **92** and front contact of relay **88**, back contact and continuity spring of change-over relay **73**, winding of the slow releasing relay **88** to positive pole of battery over the holding conductor **60**. The connector relay **108** on operating, closes a locking circuit for itself from the negative pole of battery, winding of this relay, its front contact and armature, conductor **112**, winding of the relay **93**, to the positive pole of battery over the conductor **60**. The relay **93** is not operated at this time, since it is shunted by a circuit including conductor **112**, conductor **113**, back contact and armature of the relay **93**, front contacts and armatures of relays **94** and **67**, front contact and armature of relay **88**, to the holding conductor **60**. However, the slow releasing relay **88** is also short-circuited by the operation of the units connector, relay **108** and shortly afterwards retracts its armature so that the relay **93** will be operated. The mentioned short circuit for the relay **88** extends from the holding conductor **60**, winding of the relay **88**, back contact and continuity spring of the change-over relay **73**, front contact and armature **92** of relay **88**, back contact and armature of relay **93**, armature and front contact of relay **94**, conductor **111**, armature **110** and front contact of the counting relay **80**, conductor **109**, front contact and armature of relay **108**, conductor **112**, winding of relay **93** and again to the holding conductor **60**. Relay **88** thereupon releases and by so doing, removes the short circuit about the relay **93**, which then operates.

Since the connector relays **100** and **108** have been operated, the link circuit in use is connected to the tip ring and sleeve conductors of the called subscriber's line. The testing of this line now takes place. If this line is idle, positive potential will be absent from its sleeve conductor **114** and therefore the busy test relay **70** will not operate. Consequently, no busy tone will be transmitted to the calling subscriber and he will therefore know that he can now operate his dial sender to transmit impulses for selecting the proper ringing frequency to signal the desired calling substation on the telephone line to which his substation has been connected. It will be noted in the present arrangement, that provision is made for selectively signalling anyone of ten substations on a called telephone line. For this purpose five different ringing frequencies namely sixteen, thirty, forty-two, fifty-four and sixty-six cycle ringing current are provided. Let it be assumed that sixty-six cycle ringing current will signal the wanted substation. Therefore the calling subscriber operates his dial sender to transmit a series of five impulses to select that frequency. In response to the first impulse the changeover relay **73** is operated and remains operated during the series of impulses. Also in response to the five mentioned impulses, the counting relays for numbers 1 to 5 inclusive, designated **77** to **81**, inclusive, are first energized and then deenergized when the succeeding relay in the series operates. Consequently. only the #5 counting relay **81** remains operated. As soon as the change-over relay **73** is operated, it closes an energizing circuit for the relay **88** which circuit extends from the negative pole of battery, resistor **89**, armature and front contact of change-over relay **73**, winding of the relay **88** to the positive pole of battery over the holding conductor **60**. When the transfer relay **93** is operated as previously described, a circuit is closed for the ringing relay **115** from the negative pole of battery, resistor **116**, winding of the relay **115**, back contact and armature of the cut-in relay **71**, front contacts and armatures of relays **93**, **94** and **67**, front contact and armature of relay **88**, to the positive pole of battery over the holding conductor **60**. The ringing relay **115** when operated, closes a locking circuit for itself thru its innermost front contact and armature over the holding conductor **60** to the positive pole of battery. The ringing relay **115** when operated also closes at its uppermost armatures and front contacts break points in the link circuit. After the change-over relay releases but

before the slow releasing relay 88 deenergizes, a circuit is completed for operating the cut-in relay 71. This circuit is traceable from the negative pole of battery, lower winding of this relay, back contact and armature 117 of the relay 118, conductor 119, front contact and armature of relay 93, armature 92 and front contact of relay 88, back contact and continuity spring of change-over relay 73, winding of relay 88 over the holding conductor 60 to the positive pole of battery. With the cut-in relay 71 operated, a second pair of break points is closed in the link circuit. Since the counting relay 81 has been operated, 66 cycle ringing current is applied thru the front contact and armature 120 of relay 81, back contacts and armatures of relays 80, 79, 78 and 77, winding of the trip relay 121, back contact and armature of the reversing relay 122, conductor 123, front contacts and armatures of the ringing relay 115 and cut-in relay 71, tip conductor 124 of the link and thence over the tip conductor of the called telephone line, thru the substation ringer of the wanted substation, ring conductor of the called telephone line, ring conductor 125 of the link, front contacts and armatures of the cut-in relay 71, ringing relay 115, conductor 126, armature and back contact of relay 122, to the "generator return." It should be pointed out that the operation of the cut-in relay 71 and the ringing relay 115, closes a circuit thru their front contacts and armatures 127 and 128 for starting the ringing generator. It should be noted that in the present instance, the reversing relay 122 was not operated since the number of impulses in the ringing series of impulses was less than six. If however, the number of impulses in the ringing series was six or more, the reversing relay 122 would have been operated so that the ringing current would have been applied to the ring side of the line. This enables the ten different substations on a telephone line to be selectively signalled with the use of only five different cycles of ringing frequency, five connected between the tip line to ground and five connected from the ring side to ground. It will be appreciated that when the number of impulses in the ringing series is six or more, the reversing relay 122 will be operated from the negative pole of battery, its winding, continuity spring and back contact, front contact and armature of the transfer relay 93, armature and front contact of relay 88, conductor 129, front contact and armature 130 of the number five counting relay 81, back contacts and armatures of relays 74 and 75, inner front contact and armature of the change-over relay 73 and thence to the positive pole of battery over the holding conductor 60. Thus when any of the counting relays 82 to 86 inclusive are selected, the proper one of the five different cycles of ringing frequency will be selected, but in this instance the selected frequency will be applied to the ring side of the called telephone line.

When the subscriber at the called station responds by removing his receiver from its switchhook, the marginal trip relay 121 will be operated. At the armature and front contact of the trip relay, a shunt circuit is completed about the ringing relay 115 which deenergizes to close one pair of break points in the called end of the link circuit. The telephone connection is now completed, the talking battery being supplied to the calling party thru the windings of the impulse relay 53 and the talking battery being supplied to the called substation thru the windings of the relay 52.

At the conclusion of the conversation when the calling subscriber replaces his receiver on its switchhook, the impulse relay 53 will release. Shortly afterwards, the slow releasing relay 54 deenergizes and opens the circuit which has been holding the finder relays operated. Shortly after the release of relay 54, the slow releasing relay 58 deenergizes. When this relay releases, it removes positive potential from the holding conductor 60 so that all of the operated relays of the link circuit will be restored to normal.

Let it be assumed that the called telephone line was busy at the time when it was tested. Under this condition the busy relay 70 is energized from the negative pole of battery, winding of this relay, back contact and armature of the relay 93, sleeve conductor 114 to the positive pole of battery which is maintaining the called telephone line busy. Relay 70 when operated, locks itself operated thru innermost lower armature and front contact over the holding conductor 60. Also prior to the energization of the transfer relay 93, the relay 118 will be operated from the negative pole of battery, winding of this relay, armature and front contact of the busy relay 70, back contact and continuity spring of relay 93, to the positive pole of battery over the holding conductor 60. Relay 118 will be released when relay 93 opens the above described operating circuit. This is because the locking circuit for relay 118 is open at the lower back contact of relay 59. The operation of relay 59 will be described later.

Provision is made for releasing a link circuit in the event that a called subscriber on a revertive call does not answer or in the event that the calling subscriber does not hang up when the called subscriber replaces his receiver on the switchhook, which would otherwise hold the link circuit if the calling subscriber maliciously failed to hang up at the conclusion of the call with the intent of "tying up" the called subscriber's line. A timing circuit arrangement for effecting this result is shown at the bottom of Fig. 3 and at the lefthand portion of Fig. 7. In this timing arrangement, when the relay 52 (Fig. 7) is deenergized and the relay 53 energized, the timing relay 55 is energized in a circuit traceable from the negative pole of battery, winding of relay 231 (lower part of Fig. 3), conductor 232, armature and back contact of relay 52, front contact and armature 233 of relay 58, winding of slow releasing relay 55, its continuity spring and back contact, conductor 234, armature and back contact of relay 235, armature and back contact of slow releasing relay 236, back contact and armature of slow releasing relay 237 to the positive pole of battery. Relay 55 when thus operated, locks itself operated in series with the relay 231 over the conductor 232, winding of relay 55, its lower front contacts and armatures, conductor 238, back contact and armature 236 to the positive pole of battery. As soon as the relay 231 is energized, it closes an obvious energizing circuit for the slow releasing relay 239 and this relay at its armature and front contact, closes a circuit for the motor (not shown) which alternately opens and closes the contacts 240. These contacts are arranged to be closed for 2 minutes and opened for 2 seconds. As soon as contacts 240 are closed, an obvious circuit is completed for the relay 235. This relay at its lower armature and front contact completes a multiple circuit which maintains the slow releasing relay 239 operated so that the

motor will continue to run. Also when the relay 231 operates, it completes a circuit for operating the slow-releasing relay 237 from the negative pole of battery, winding of this relay, middle front contact and armature of relay 231, front contact and armature of relay 235 to the positive pole of battery. Relay 237 then locks itself operated thru the inner front contact and armature of relay 231. When the relay 235 deenergizes at the close of a 2 minute interval the relay 236 is energized in a circuit traceable from a negative pole of battery, winding of this relay, front contact and armature of relay 237, back contact and armature of relay 235 to the positive pole of battery. When the relay 236 operates, it opens at its uppermost armature and back contact a locking circuit which has been maintaining the relay 55 operated. The relay 55 then deenergizes to effect the release of the link. The deenergization of this locking circuit also removes positive battery from conductor 57 to effect the release of the tens and units finder relays of Fig. 2 for disconnecting the calling line from the link. This effects the release of cut-off relay 11, after which line relay 10 is operated by the closed circuit of the calling line. Relay 10 closes a circuit for locking relay 18, before this latter relay is released by its deenergization when relay 11 was released. With relays 10 and 18 energized, the circuit to the common lock-out relays is maintained open, thus preventing the seizure of a link until the calling party disconnects and again initiates a call.

Revertive call

In the event that the called line is found busy at the time of the busy test, due to the fact that the calling line and the called line are one and the same, in other words, a revertive call, provision is made in the present system for handling such a call. It will be remembered that at the time the busy test is made, the busy test relay 70 is operated and thru its innermost, lower front contact and armature, it closes a locking circuit for itself over the locking conductor 60. It will further be remembered that this test of the busy line is effected before the transfer relay 93 (Fig. 9) is energized. During this interval the relay 118 will be operated from the negative pole of battery, winding of relay 118, front contact of relay 70, conductor 220, back contact and continuity spring of relay 93, branch conductor 221 and the holding conductor 60 to the positive pole of battery. The operation of relay 118 at its armature 222 and back contact, interrupts the circuit thru the upper winding of relay 59 which has previously maintained this relay energized. With the armature 222 and the front contact of relay 118 closed, a circuit is completed from the positive pole of battery, holding conductor 60, armature 222 and front contact of relay 118, branch conductor 223, sleeve conductor 114 of the link which is now connected to the sleeve conductor of the called line thru the operation of the connector relays. Since the sleeve conductor 114 is connected to the sleeve conductor of the called line, it will also be connected to the sleeve conductor of the calling line inasmuch as they are branches of the same conductor, thence thru the sleeve conductor which is extended by the finder relays to the sleeve conductor 50 of the link in use, armature 224 and front contact of relay 54, continuity spring and armature of relay 59, lower winding of this relay to the positive pole of battery. Thus the lower winding of the relay 59 is included in a shunt circuit and since the circuit thru its upper winding has been interrupted, this relay releases. When now the transfer relay 93 is operated as previously described, the relay 118 will have a locking circuit completed for itself from the negative pole of battery, winding of this relay, lowermost back contact and armature of relay 59, front contact and armature of relay 118, conductor 225, front contact and continuity spring of relay 93, branch conductor 221 and holding conductor 60 to the positive pole of battery. It will be noted that at the time of the operation of the relay 118, the normal energizing circuit for the cut-in relay 71 is interrupted at the back contact and armature 117 of the relay 118. Thus ringing current is not applied to the called line at this time. However, the calling subscriber who is making a revertive call is instructed in the directions of his telephone directory or otherwise, that when he receives a busy signal on the occasion of calling a subscriber on his own line, he shall replace his receiver on its switchhook for an interval long enough to permit signalling current to be applied to the called line to signal the called subscriber. Thus when the calling subscriber hangs up, the impulse relay 53 will be deenergized and shortly thereafter the slow releasing relay 54 will release. The release of the relay 54 interrupts the holding conductor 57 which has maintained the finder switching relays of the link operated, so that these relays are restored but the calling line connection to the link in use is not interrupted since it is now by way of the connector relays. When the slow releasing relay 54 releases, a circuit is completed for the upper winding of the cut-in relay 71. This circuit is traceable from the positive pole of battery, armature 226 and front contact of relay 118, upper winding of the relay 71, continuity spring and back contact of the relay 52, lowermost back contact and armature of relay 54, winding of the slow releasing relay 58, to the negative pole of battery. Thus when the relay 54 releases, the cut-in relay 71 is operated and the slow releasing relay 58 is continued operated to maintain, at its upper armatures and front contacts, positive potential on the holding conductor 60. With the cut-in relay 71 operated break points are closed in the link conductor 124 and 125 so that the selected ringing current is applied over this end of the link to the called subscriber's line. When the calling or called party responds, the trip relay 121 is energized as previously described and completes a circuit including the conductor 99 which shunts the ringing relay 115. The release of the relay 115 closes another pair of break points in the link conductors 124 and 125 and at the same time disconnects ringing current from the link circuit. On the response of the called subscriber, the relay 52 (Fig. 7) is energized and its continuity spring and back contact interrupts the circuit which has been maintaining the cut-in relay 71 and the slow releasing relay 58 energized. When the relay 58 releases, it interrupts at its uppermost armatures and front contacts the holding conductor 60 so that the apparatus associated with the link in use is restored. Thus the common equipment employed thus far in the connection including the finder relays of the link as well as the link and the connector relays are restored to normal. On the release of the link from this connection, the cutoff relay 11 of the

calling subscriber (Fig. 6), which is also common to the line of the called subscriber, deenergizes and talking battery is then supplied for this revertive call line thru the windings of the line relay 10. It should be noted that after the link circuit is released as above set forth, a second link circuit is not connected to the calling line. It will be seen that while the cutoff relay 11 is energized, the slow releasing relay 18 is operated from the negative pole of battery, winding of this relay, front contact and armature of cut-off relay 11 to the positive pole of battery. When however, the cut-off relay 11 is released in the manner just described, the line relay 10 will again be operated thru the called subscriber's substation. With the line relay 10 operated the slow releasing relay 18 is maintained operated from the negative pole of battery, winding of this relay, its innermost front contact and armature, front contact and armature of line relay 10, middle armature and front contact of slow releasing relay 18, winding of the relay 230 to the positive pole of battery. Relay 230 closes a lamp circuit indicating that a revertive call is in process so that in the event that the lamp circuit is lighted for an abnormal period, an attendant can investigate to find out whether or not the system is functioning properly. It will be recalled that the inner and middle armatures and back contacts of relay 18, controls the lockout circuit which includes the tens relay 16 and the units relay 21. These relays when operated control the association of a link circuit with the calling line and since this lockout circuit is interrupted during a revertive call, no link circuit is associated with this line.

On the conclusion of this revertive call when both subscriber's replace their receivers, the line relay 10 will deenergize and the equipment that has been used in this call will all be restored to normal in readiness for a succeeding call.

Call from dial office to distant manual office

Referring to Fig. 3, when the connector relays of a link in use, select a two-way trunk circuit, a circuit is closed from the calling line and this link across the conductors 150 and 151 to operate the relay 152. This relay closes an obvious circuit for operating the relay 153. Relay 153 completes a circuit for operating the relay 154 from the negative pole of battery, winding of this relay, conductor 155, front contact and armature of relay 153 to the positive pole of battery. Relay 153 on operation also applies positive battery to the allotter conductor 157 for making this trunk busy and also applies positive battery to the sleeve conductor 158 of the trunk for operating relay 51 (Fig. 8), of the link. Furthermore, the operation of relay 153 at its upper armature and back contact opens the circuit of the normally energizing ringing relay 161, to permit this slow releasing relay to deenergize but not until the slow releasing relay 154 is operated. The joint action of relays 154 and 161 applies an impulse of ringing current to the primary windings of the repeating coil 162 for the purpose of applying a short impulse of ringing current over the two sides of the trunk leading to the distant manual office. This impulse of alternating current is effective to operate the alternating current relay 163 (Fig. 4) which closes a circuit for operating the relay 164. This circuit is traceable from the negative pole of battery, winding of the slow releasing relay 164, back contact and armature 165 of relay 166, back contact and armature 167 of relay 168, conductor 169, armature and front contact of relay 163, back contact and continuity spring of relay 164 to the positive pole of battery. Relay 164 on operating closes a locking circuit for itself independent of the control of the alternating current relay 163. This circuit extends from the negative pole of battery, winding of relay 164, back contact and armature 170 of relay 166, armature and continuity spring of relay 164 to the positive pole of battery. Relay 164 when operated, closes a circuit at its front contact and armature 172 for lighting the incoming or line lamp 173 which indicates to the manual operator at the distant manual office that a call is awaiting extension on this trunk. At the close of the impulse of alternating current, the alternating current relay 163 releases but the slow releasing relay 164 has been operated and locked as previously described. When the operator answers by inserting an answering plug P into the jack J of the trunk on which the call is waiting extension, relay 166 is energized in a circuit from the negative pole of battery, winding of this relay, uppermost contact and armature of relay 168, back contact and armature 174 of relay 164, conductor 175, jack contacts 176 (now closed), to the positive pole of battery. Relay 166 when operated, closes a locking circuit for itself from the negative pole of battery, its winding, uppermost back contact and armature of relay 168, innermost contact and armature of relay 166, to the positive pole of battery over conductor 175 as previously described. The operation of relay 166 opens the locking circuit for the slow releasing relay 164, which circuit is now interrupted at the back contact and armature 170 of relay 166. Since the relay 164 is slow releasing, there will be a short interval during which an impulse of alternating current is transmitted back to the trunk to operate alternating current relay 186 (Fig. 3). This is effected by the operation of the relay 177 which is energized in a circuit closed from the negative pole of battery, winding of this relay, armature and front contact of the ringing relay 178, conductor 179, front contact and armature 170 of relay 166, armature and front contact of relay 164 to the positive pole of battery. When after a short interval the slow releasing relay 164 releases, it interrupts the circuit just described and relay 177 releases. Also the release of the relay 164 opens the previously described circuit for the line lamp 173 which is thus extinguished. On the insertion of the plug P into the jack J, the relay 180 is energized from the positive pole of battery, winding of the marginal relay 181, winding of the relay 180, conductor 182, sleeve contacts of the jack and plug, conductor 183, through the coil 184 and resistor 185 in multiple, to the negative pole of battery. However, the operation of the relay 180 at this time performs no function on this class of call, since the marginal relay 181 does not operate in series with the resistance of the coil 184 and the resistor 185.

The operation of the alternating current relay 186 in response to the impulse of alternating current transmitted back over the trunk in the manner just described, effects the operation of the slow releasing relay 187 in an obvious circuit. The energization of relay 187 completes an energizing circuit for the relay 189 in multiple with the slow releasing relay 154. This circuit extends from the negative pole of battery, wind-

ing of the relay 189, front contact and armature of relay 187, conductor 155, armature and front contact of relay 153, to the positive pole of battery.

At the termination of this impulse of alternating current, the relays 186, 187 and 189 release in sequence. When the relay 187 releases, the relay 190 is operated in a circuit from the negative pole of battery, winding of this relay, inner front contact and armature of relay 189, back contact and armature of relay 187, conductor 155, front contact and armature of relay 153 to the positive pole of battery. Relay 190 when thus operated, closes a locking circuit for itself through its lower front contact and armature, back contact and armature of relay 187 and thence to the positive pole of battery as previously described. Thus the relay 190 remains energized after the relay 189 deenergizes.

The manual operator is now connected to the calling party and after obtaining the number of the wanted party extends the connection to the wanted line in the usual manner by signalling the subscriber thereon (by means not shown), after which conversation takes place. At the conclusion of the conversation when the calling subscriber hangs up, the relays 152, 153 and 154 release in sequence. The release of relay 153 opens the circuit including the sleeve conductor 158 of the link circuit in use which operation is effective to release the cut off relay 11 of the calling line, as well as the relay 51 of the link. The release of relay 51 effects the release of the tens and units finder relays. As soon as the relay 153 deenergizes, it closes a circuit for again operating the ringing relay 161. As soon as this ringing relay operates and before the switching relay 154 releases, an impulse of alternating current is transmitted forward over the trunk as a disconnect signal. This impulse of alternating current causes the relay 163 (Fig. 4) to operate and release. The operation of the relay 163 completes an operating circuit for the relay 191 extending from the negative pole of battery at the common coin box tone key 192, lower winding of relay 191, front contact and armature 165 of relay 166, back contact and armature 167 of relay 168, armature and front contact of relay 163, back contact and continuity spring of relay 164 to the positive pole of battery. Relay 191 on operation closes a locking circuit for itself from the negative pole of battery through its upper winding, its inner front contact and armature, conductor 192, armature 193 and front contact of relay 168, back contact and armature of relay 166, back contact and armature 174 of relay 164, conductor 175, jack contacts 176, to the positive pole of battery. The operation of the relay 191 includes condensers 194 and 195 in the conductors leading to the repeating coil circuit which is effective to release the supervisory relay (not shown) of the cord circuit at the manual office, for giving the operator disconnect supervision. When the operator disconnects by removing the plug P from the jack J, relays 166, 191 and 180 release. The busy lamp 195 continues to be lighted as long as this trunk is in use, since its circuit is closed when the operator answers but is opened by the release of relay 166 when the operator disconnects.

Call from the manual office to the dial office

On the initiation of a call from the manual office to the dial office, the operator inserts a calling plug similar to P into the jack J. This causes the relay 180 to be energized in series with the marginal relay 181 as previously described. However, the marginal relay 181 does not operate at this time. The relay 168 (Fig. 4) is next energized from the negative pole of battery, winding of this relay, back contact and armature of relay 166, back contact and armature 174 of relay 164, conductor 175, jack contacts 176 to the positive pole of battery. The operation of relay 168 causes the slow-operate and slow-release ringing relay 178 to release and in the interval before the relay 178 releases, the relay 177 is operated from the negative pole of battery, winding of this relay, conductor 200, armature and front contact of relay 178, front contact and armature of relay 168 to the positive pole of battery. With the relay 177 operated, at its front contacts and armatures, it applies generator current to the trunk for operating the relay 201 through the rectifying bridge network RB (Fig. 3). Relay 201 completes a circuit for operating the relay 202 in a circuit from the negative pole of battery, winding of this relay, inner front contact and armature of relay 201 to the positive pole of battery. In addition, the relay 201 applies positive potential to the allotter conductor 157 which makes the calling end of the trunk busy. Relay 202 completes a circuit for operating the slow releasing relay 203 which circuit is traceable from the negative pole of battery, winding of this relay, back contact and armature of slow releasing relay 204, front contact and armature of relay 202 to the positive pole of battery. Relay 203 on operating, closes a break point in a locking circuit for itself thru its lower innermost front contact and armature, back contact and armature of relay 202 (when this relay releases) to the positive pole of battery. On the operation of the relay 203, the slow releasing relay 204 is operated in a circuit extending from the negative pole of battery, front contact and armature of relay 203, front contact and armature of relay 202 to the positive pole of battery. Relay 204 locks itself operated at the armature and front contact of relay 202. When the impulse of alternating current terminates, relays 201 and 202 deenergize. Relay 202 on releasing, closes the previously mentioned locking circuit for the relay 203. Relay 204 now has its energizing circuit interrupted at the lowermost front contact and armature of relay 202. With the relay 202 deenergized and with relay 203 operated, a circuit is closed across the tip and ring conductors of the incoming line circuit. This causes an idle link circuit to connect with the line circuit now in use. When this connection is effected the operator can then proceed to dial the required number. With the dial off-normal contacts 205 (Fig. 4) closed, the negative pole of battery is connected thru the low resistance coil 206, off normal contacts 205 and impulse contacts 207 of the dial, conductor 208, contacts of the dial key 209, sleeve contacts of the plug P and jack J, conductor 182, winding of relay 180 and marginal relay 181, to the positive pole of battery. The marginal relay 181 is operated in this circuit. When the operator actuates the dial, the circuit last described is opened at the dial impulse springs 207 a number of times corresponding to the number dialed. At each interruption of the impulse circuit, caused by the dial operation, the relays 180 and 181 are released and again energized after the interruptions. At the end of the dialing operation, the marginal relay 181 does not energize

because the dial off normal contacts 205 opens the circuit thru the low resistance coil 206 leaving a high resistance circuit including coils 284 and 285, completed thru the mentioned sleeve contacts. When the relay 181 is thus intermittently energized, it extends a circuit for the slow releasing relay 210 from the negative pole of battery, winding of this relay, front contact and armature of relay 181, conductor 175, jack contacts 176 to the positive pole of battery. This circuit holds the slow releasing relay 210 operated during the series of impulses. However, the relay 210 is released during the interval between each series of impulses. In response to each dial impulse, the relay 177 (Fig. 4) is energized in a circuit extending from the negative pole of battery, winding of this relay, conductor 200, armature and back contact of the ringing relay 178, conductor 211, lower front contact and armature of relay 210, back contact and armature of relay 180, conductor 175, jack contacts 176 to the positive pole of battery. Therefore, an impulse of alternating current is applied at the front contacts and armatures of relay 177 at each interruption of the impulse circuit at the dial impulse springs, which impulse of alternating current is transmitted over the trunk leading to the dial office. Since the slow releasing relay 154 (Fig. 3) is deenergized at this time, these impulses of current are applied to the rectifying bridge R—B which operates to apply pulsating current corresponding to these impulses to the relay 201. It will be appreciated that these pulsations in this rectified current are sufficiently smooth to operate the relay 201 without chatter and also permit this relay to release at the end of each impulse period. Relay 201 (Fig. 3) and relay 180 (Fig. 4) therefore follow the impulses corresponding to the number designation of the wanted subscriber in the dial office. The relay 202 at its back contact controls the impulse circuit leading to the link which was selected. This supplies impulses to the link in accordance with the impulses received over the trunk circuit. When the link has been connected to the line of the wanted subscriber this line is tested for its busy or idle condition and if found idle, ringing current is applied thereto in the manner previously described. When the called subscriber answers, the polarized relay 211 (Fig. 3) is energized to close an obvious circuit for the slow releasing relay 212.

When the called subscriber hangs up, relays 211 and 212 are released in sequence. During the time interval required for the relay 212 to release, a circuit is extended for operating the slow releasing switching relay 154. This circuit is completed from the negative pole of battery, winding of this relay, conductor 155, front contact and armature of slow releasing relay 212, back contact and armature of relay 211 to the positive pole of battery. However, when relay 212 releases the switching relay 154 will also release. But during the interval when relay 154 is energized, alternating current is extended thru the front contacts and armatures of relay 161, front contacts and armatures of relay 154 to the windings of repeating coil 162 and thence by induction over the trunk to give a disconnect signal. The impulse of alternating current actuates the alternating current relay 163 (Fig. 4). Since relay 168 is energized at this time, the relay 191 is energized from the negative pole of battery, common coin box tone key 192, lower winding of relay 191, front contact and armature 167 of relay 168, armature and front contact of relay 163, back contact and continuity spring of relay 164 to the positive pole of battery. Relay 191 locks itself operated and connects the condensers 194 and 195 in series with the talking conductors of the cord circuit in use. This effects the release of the supervisory relay (not shown) of the cord circuit in use, for giving the operator disconnect supervision.

The release of the connection from the manual office to the dial office is indicated by an extra long impulse of alternating current applied to the trunk circuit. This is accomplished by the release of the relay 168 when the operator removes the plug P from the jack J.

It will be recalled that the relay 168 has been maintained energized in a circuit extending from the negative pole of battery, winding of this relay, back contact and armature of relay 166, back contact and armature 174 of relay 164, conductor 175, jack contacts 176 to the positive pole of battery. When the operator releases the connection by removing the plug P from the jack J, contacts 176 are opened. On the release of the relay 168, the slow-to-operate ringing relay 178 is energized at the back contact and armature of relay 168, and the relay 177 is now operated from the negative pole of battery, winding of this relay, conductor 215, front contact and armature of slow releasing relay 216, back contact and armature of relay 168 to the positive pole of battery. It will be understood that when the slow to operate ringing relay 178 is energized, it opens the operating circuit of the slow releasing relay 216. In this interval when relay 178 is operating and relay 216 is releasing, the relay 177 is operated as described for an extra long interval due to the delayed action of relays 178 and 216. The operation of relay 177 applies alternating current over the trunk. In response to this impulse, the rectifying bridge RB functions to operate the relay 201. Relay 201 at its inner front contact and armature, completes a circuit which operates the relay 202. When relay 202 operates, it opens its lowermost armature and back contact and thereby interrupts the locking circuit of the slow releasing relay 203. At the close of the impulse of alternating current, relays 201 and 202 release in sequence and with the relay 202 deenergized the locking circuit of the slow releasing relay 203 is opened so that this relay deenergizes. Relay 202 was therefore energized for an extra long time interval as described for releasing the connection to the dial office by holding the line circuit open for an extra long period of time.

Coin box tone

If a subscriber's line equipped with a coin box selects a trunk leading to the manual office (Fig. 3), an impulse of coin box tone current is applied to this trunk when the operator answers. The operator can also apply ringing current (by means not shown) back over the trunk while operating the common coin box key 192 for again causing coin box tone to be momentarily applied to the trunk. In this way an indication is given to the distant operator when the calling substation is equipped with a coin box.

This coin box tone is applied to the trunk at the time that the operator answers and during the time that the relay 166 (Fig. 3) is released and the relay 187 is operated. It will be understood that a station equipped with a tone box has a coin box tone connection made to the

sleeve conductor of its line circuit. This sleeve conductor is connected to positive battery as long as the relay 187 is deenergized. However, when the relay 187 is energized in response to the impulse of alternating current which is sent back over the trunk when the operator answers, positive battery on the sleeve conductor is removed and the sleeve conductor is connected to positive battery thru the primary winding of the induction coil 217. The coin box tone is induced into the secondary winding of the coil 217 and is applied to the trunk thru the back contact and armature of relay 186, back contacts and armatures of relay 190, back contacts and armatures of ringing relay 161, front contacts and armatures of relay 154. The operator hears this impulse of special tone and knows that the calling line is provided with a coin box. In the event that the operator desires to check the calling line to find out whether or not it is equipped with a coin box, she operates the ringing key (not shown) for an instant to ring back over the trunk, at the same time operating the common coin box tone key 192. The operation of the key 192 opens the energizing circuit of the relay 191 so that this relay will not be operated when relay 163 (Fig. 4) is energized by the ringing current sent back over the trunk. However, the alternating current relay 186 (Fig. 3) is energized by the ringing current sent back over the trunk to operate the relay 187. When however, the relay 186 releases at the time that the application of ringing current is discontinued until the relay 187 releases, the tone is applied to the trunk as previously described.

What I claim is:

1. In a telephone system, a plurality of telephone lines certain of which are multi-party lines, each telephone line having a calling sleeve conductor and a called sleeve conductor, means including link circuits for interconnecting said lines, means for rendering busy, telephone lines in use, testing means for determining the busy or idle condition of a called telephone line, a discriminating relay individual to each of certain of said link circuits, means for normally operating the discriminating relay of a link circuit in response to the selection of said link circuit for use, a circuit for shunting said discriminating relay of a link circuit connected to a party line in the case of a revertive call thereon, said last-mentioned circuit including the calling and the called sleeve conductors of said last-mentioned party line, and signalling means controlled by said discriminating relay.

2. In a telephone system, a plurality of telephone lines, certain of which are multi-party lines, means including link circuits for interconnecting said telephone lines, means for rendering busy, telephone lines in use, a governing relay controlled over a calling telephone line and a link circuit connected thereto, a busy test relay associated with said link circuit, said busy test relay being energized on the test of a busy called line, a revertive busy test relay energized for a short period thru contacts of said busy test relay, means responsive to a revertive call condition for energizing said revertive busy test relay for a longer period, a cut-in relay controlling in part the application of signalling current to a called telephone line, a circuit for said cut-in relay normally completed thru back contacts of said revertive busy test relay, and a second circuit for said cut-in relay completed at a front contact and armature of said revertive busy test relay as well as at normally closed contacts of said governing relay, said second circuit controlling the signalling of a multi-party telephone line in the case of a revertive call thereon.

3. In a telephone system, a plurality of telephone lines, certain of said telephone lines being each provided with a plurality of substations, the substations of a telephone line being selectively responsive to signalling current of different characteristics, sources of signalling current of different characteristics, selectively operable switching means for interconnecting said telephone lines, means including a series of counting relays directively controlled over a calling telephone line for operating said switching means to select a wanted telephone line, said counting relays having front and back contacts, signalling means selectively controlled by said counting relays for signalling a wanted substation on a wanted telephone line, said signalling means including a circuit extending thru a front contact of one of said counting relays and thru back contacts of earlier counting relays in the series and connecting a selected source of signalling current to said wanted telephone line.

4. In a telephone system, a multi-party telephone line, other telephone lines, means including link circuits for interconnecting said telephone lines, testing means including a sleeve conductor associated with each link circuit for testing the idle or busy condition of any of said telephone lines when a link circuit is connected to a telephone line being called, means for signalling called telephone lines, said testing means normally serving to prevent said signalling means from signalling a busy called telephone line, and a device connectible to the sleeve conductor of said link circuit for discriminating between a busy condition due to one telephone line calling another telephone line and a busy condition of a called telephone line, due to a party thereon calling said line, said discriminating means enabling a calling party to signal a called party under the last-mentioned busy condition.

5. In a telephone system, telephone lines including a multi-party telephone line, each of said telephone lines being provided with a sleeve conductor, means including link circuits for interconnecting said telephone lines, testing means associated with each link circuit for testing the idle or busy condition of any of said telephone lines when a given link is connected to a telephone line being called, means for signalling called telephone lines, said testing means normally serving to prevent said signalling means from signalling a busy called telephone line, and a relay selectively controlled over the sleeve conductor of a called telephone line for discriminating between a busy condition due to one telephone line calling another telephone line and a busy condition of a called telephone line, due to a party thereon calling said line, said discriminating means enabling a calling party to signal a called party under the last-mentioned busy condition.

6. In a telephone system, a multi-party telephone line, other telephone lines, means including link circuits for interconnecting telephone lines, each link circuit comprising a transmission channel and a testing channel electrically isolated from said transmission channel, testing means associated with each link circuit and including the testing channel thereof for test-

ing the idle or busy condition of any of said telephone lines when a certain link circuit is connected to a telephone line being called, means for signalling call telephone lines, said testing means normally serving to prevent said signalling means from signalling a busy called telephone line, and means including the testing channel of said certain link circuit for discriminating between a busy condition due to one telephone line calling another telephone line and a busy condition of a called telephone line due to a party thereon calling said line, said discriminating means enabling a calling party to signal a called party under the last-mentioned busy condition.

WINFRED T. POWELL.