May 6, 1941. W. T. POWELL 2,241,158

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 21, 1939 9 Sheets-Sheet 1

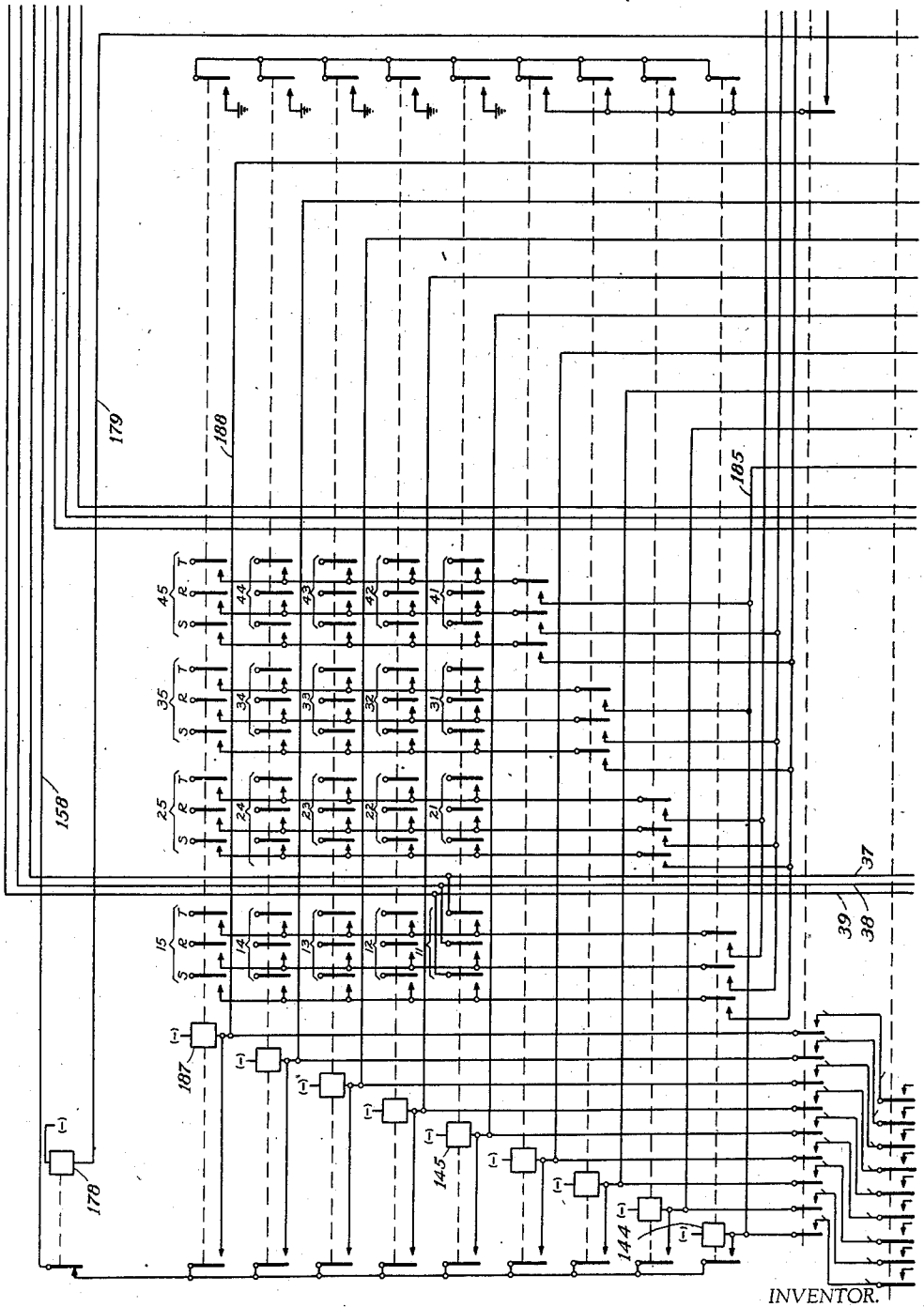


Fig. 1

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AUTOMATIC TELEPHONE SYSTEM

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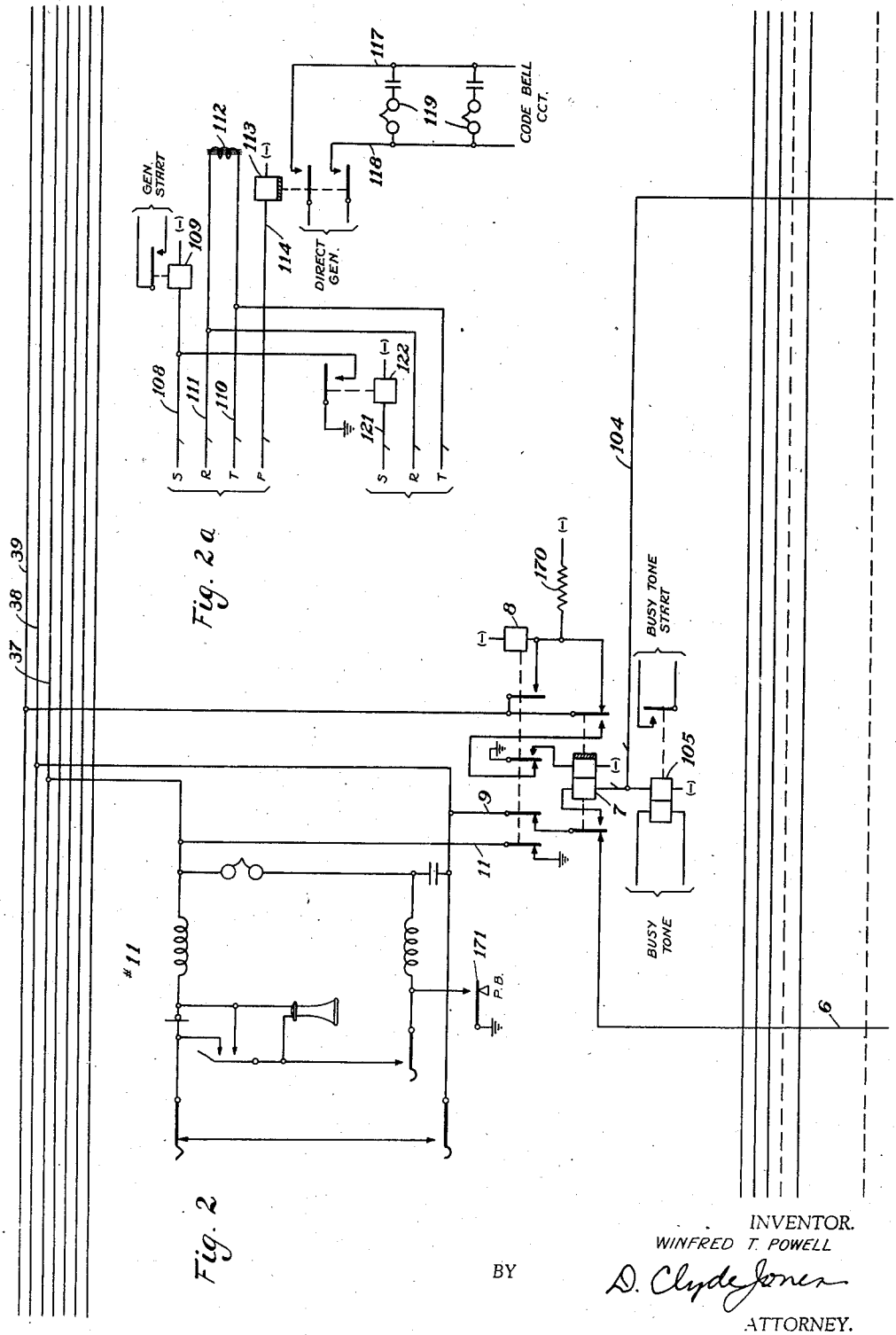


Fig. 2a

Fig. 2

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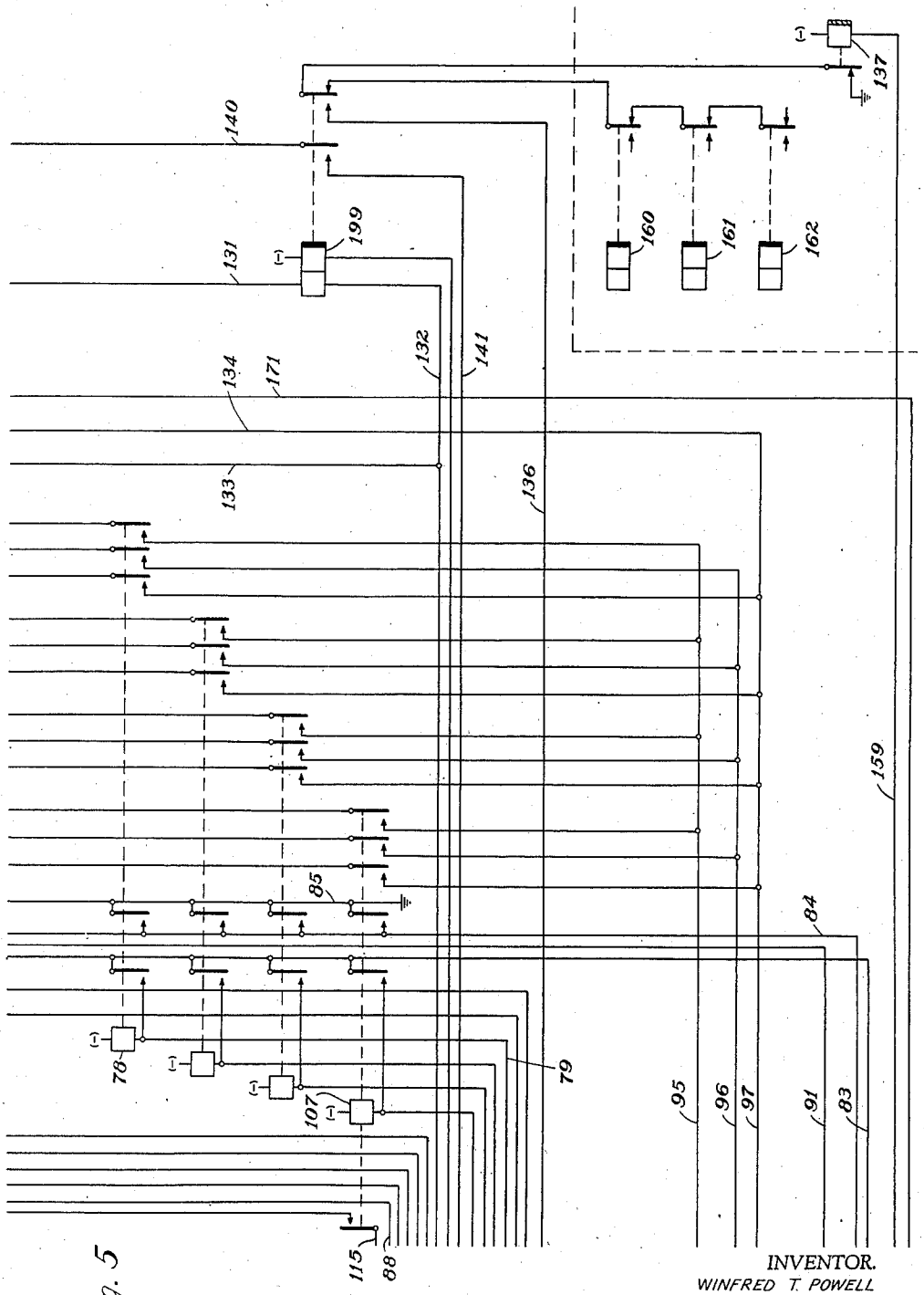


Fig. 5

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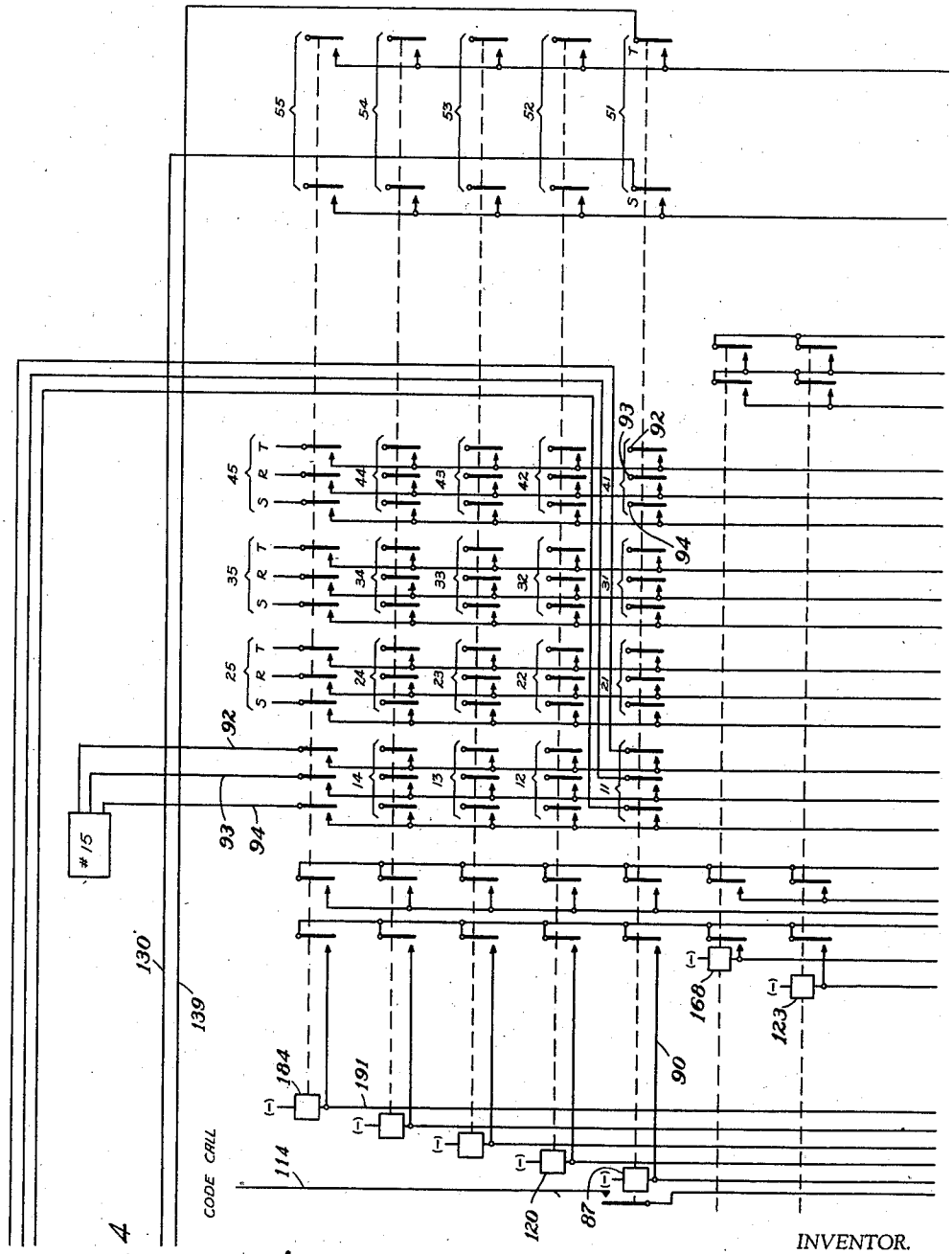


Fig. 4

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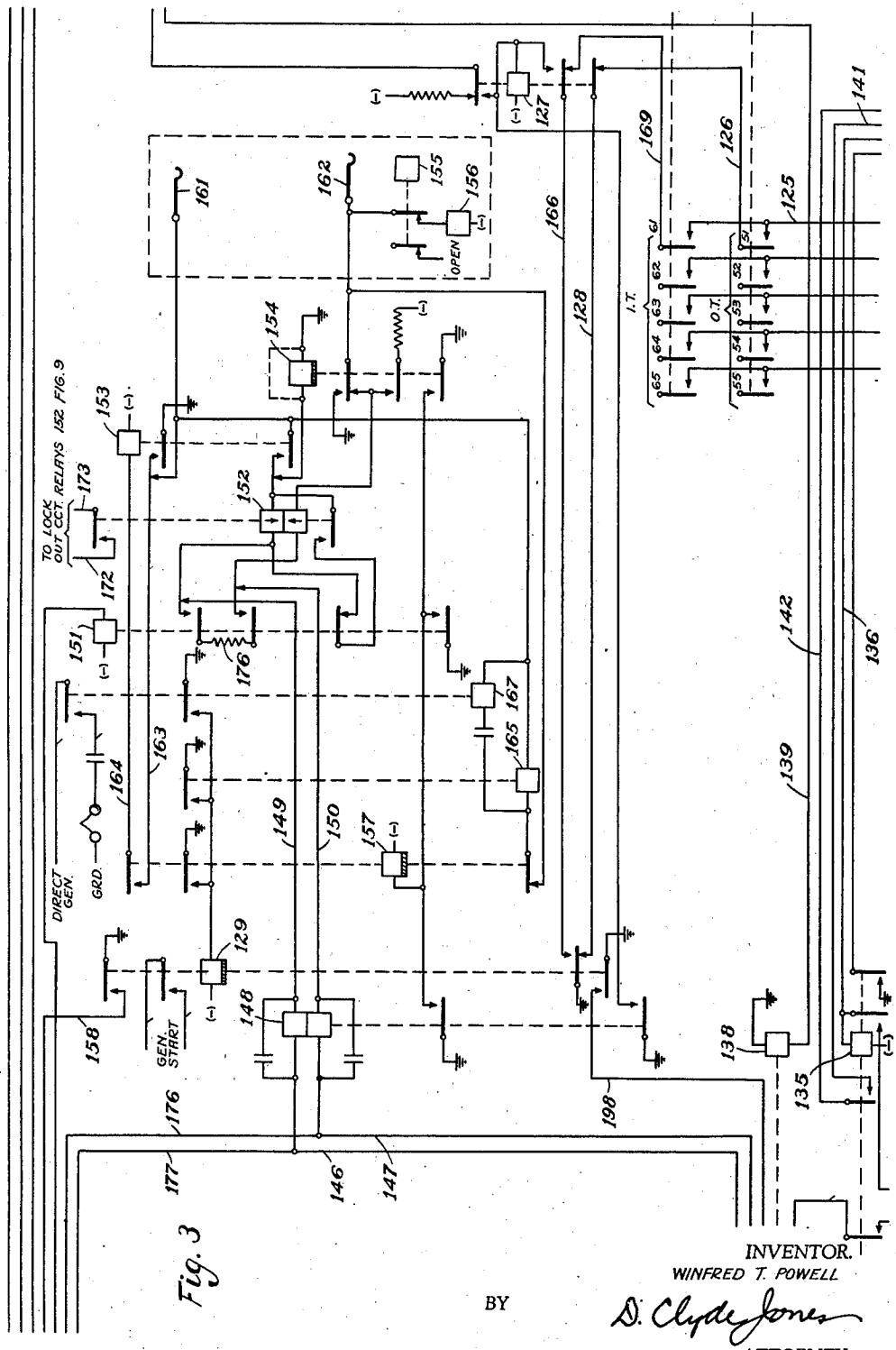


Fig. 3

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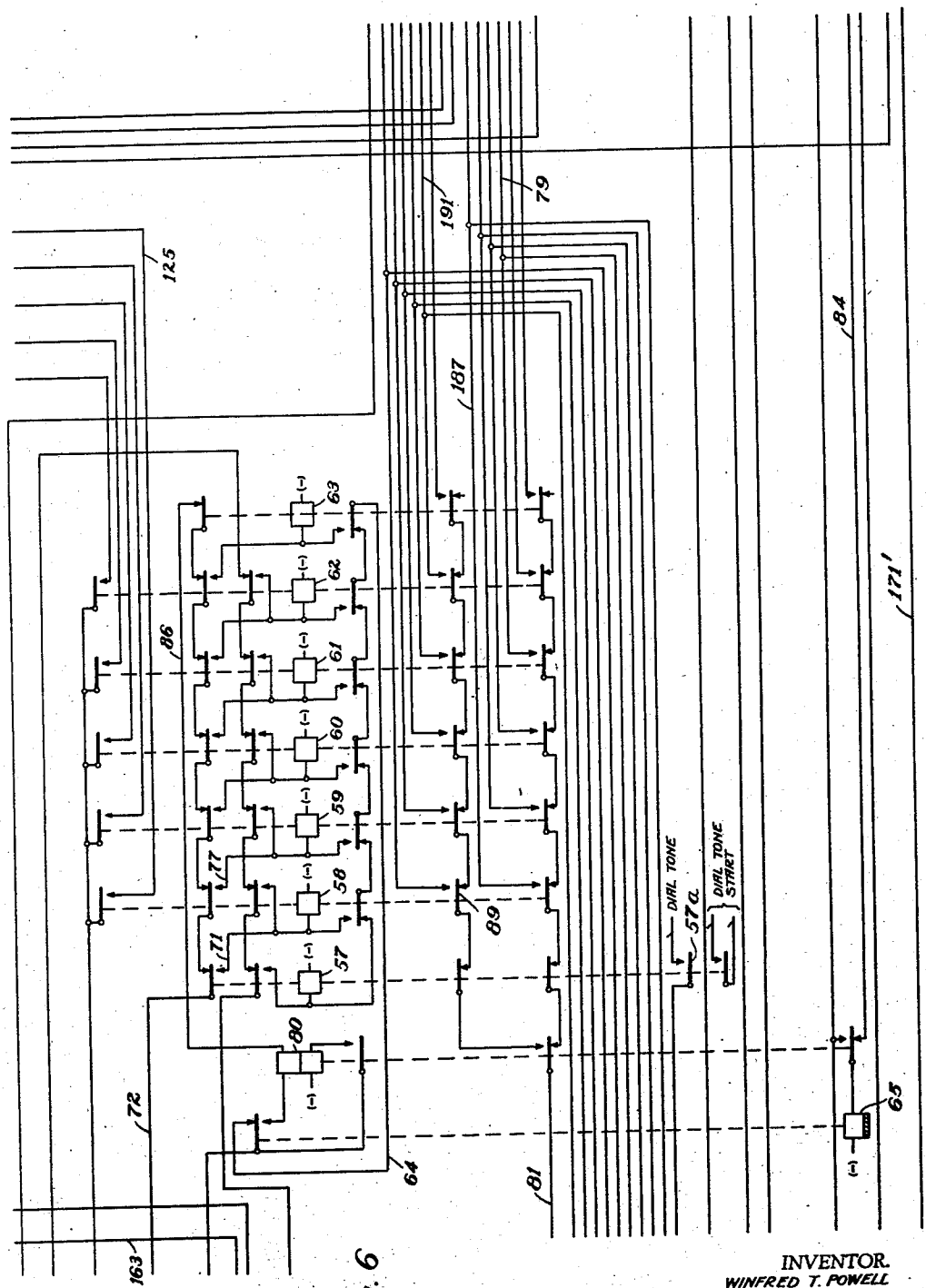


Fig. 6

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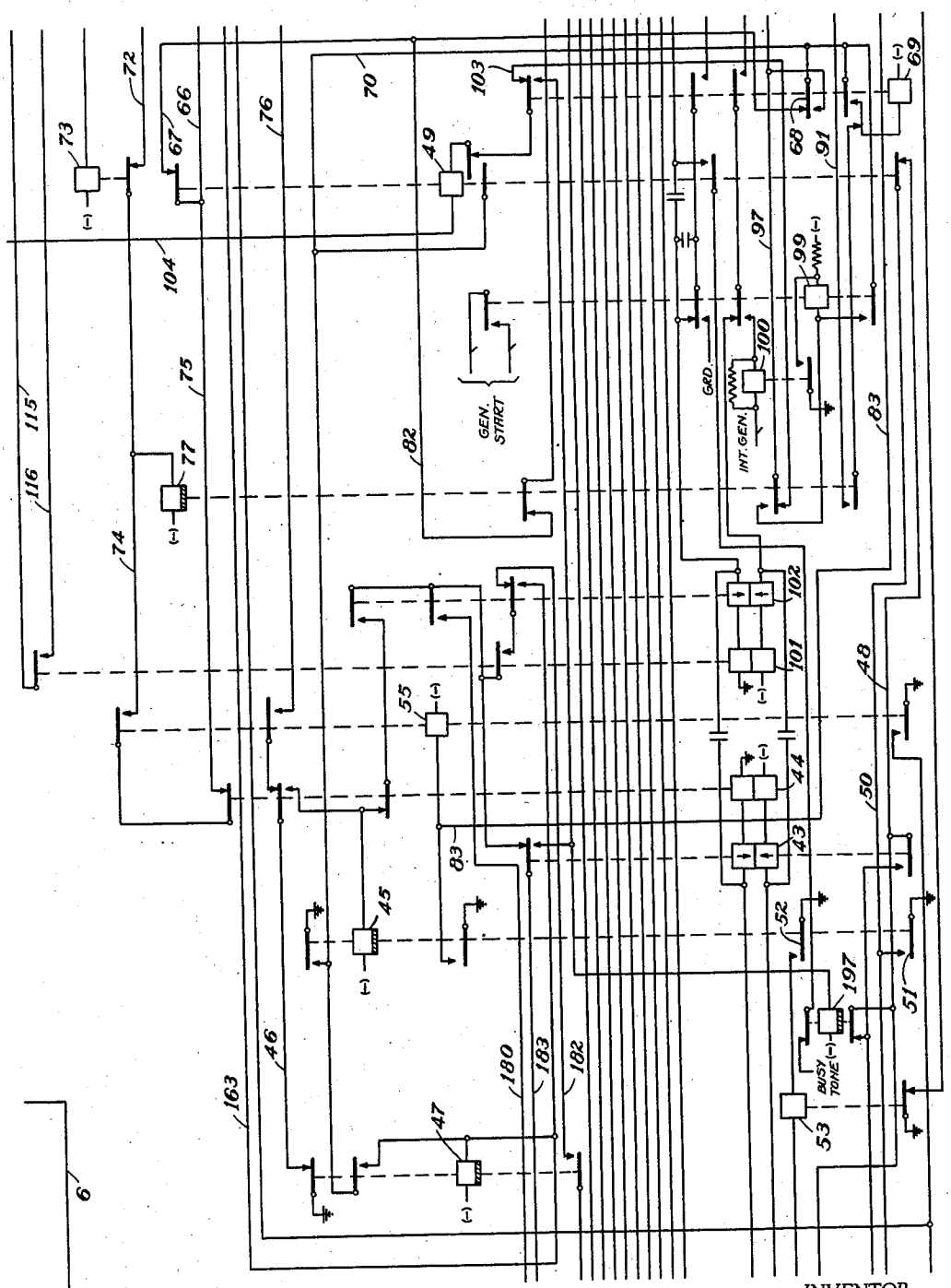


Fig. 7

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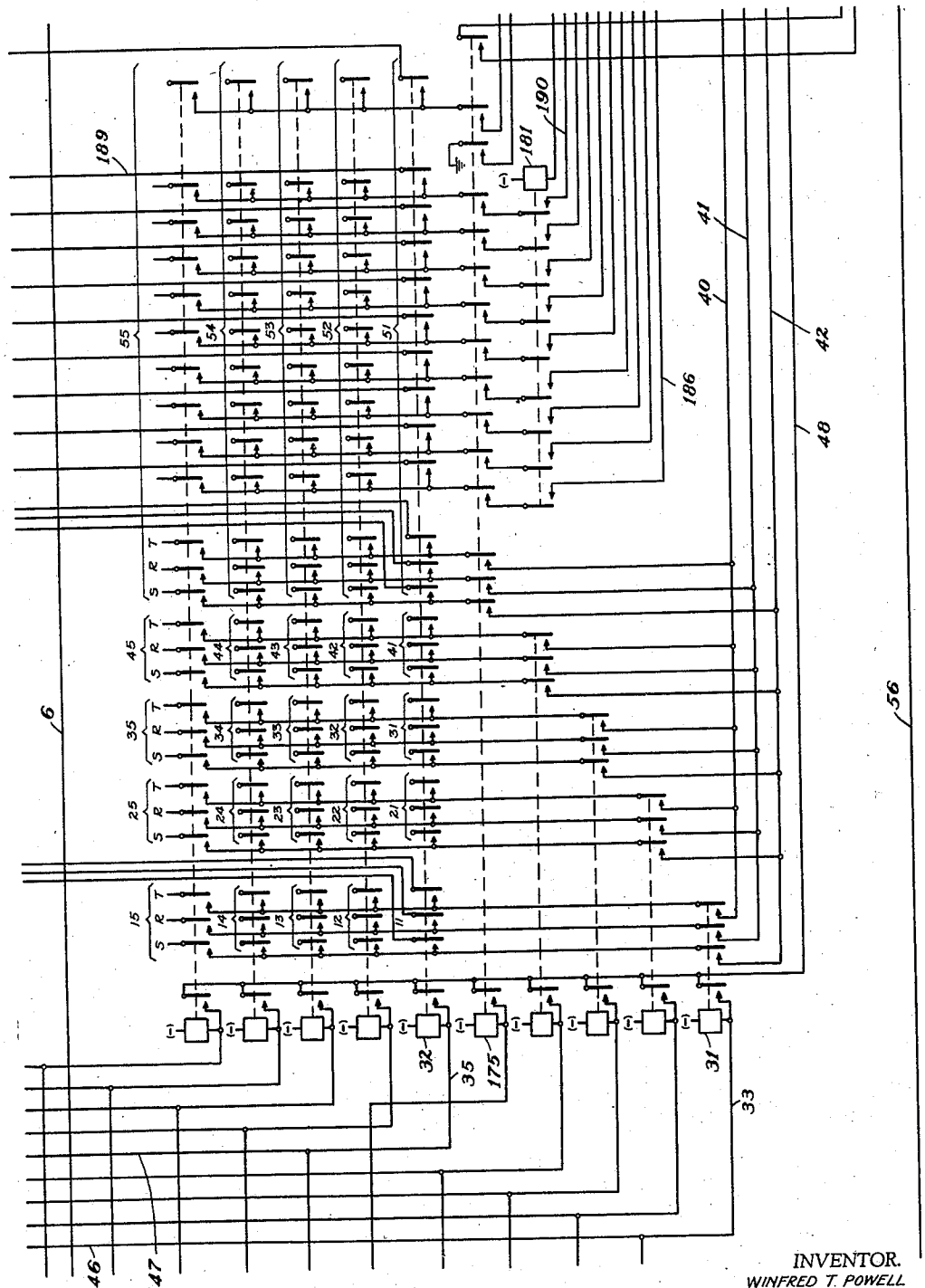


Fig. 8

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AUTOMATIC TELEPHONE SYSTEM

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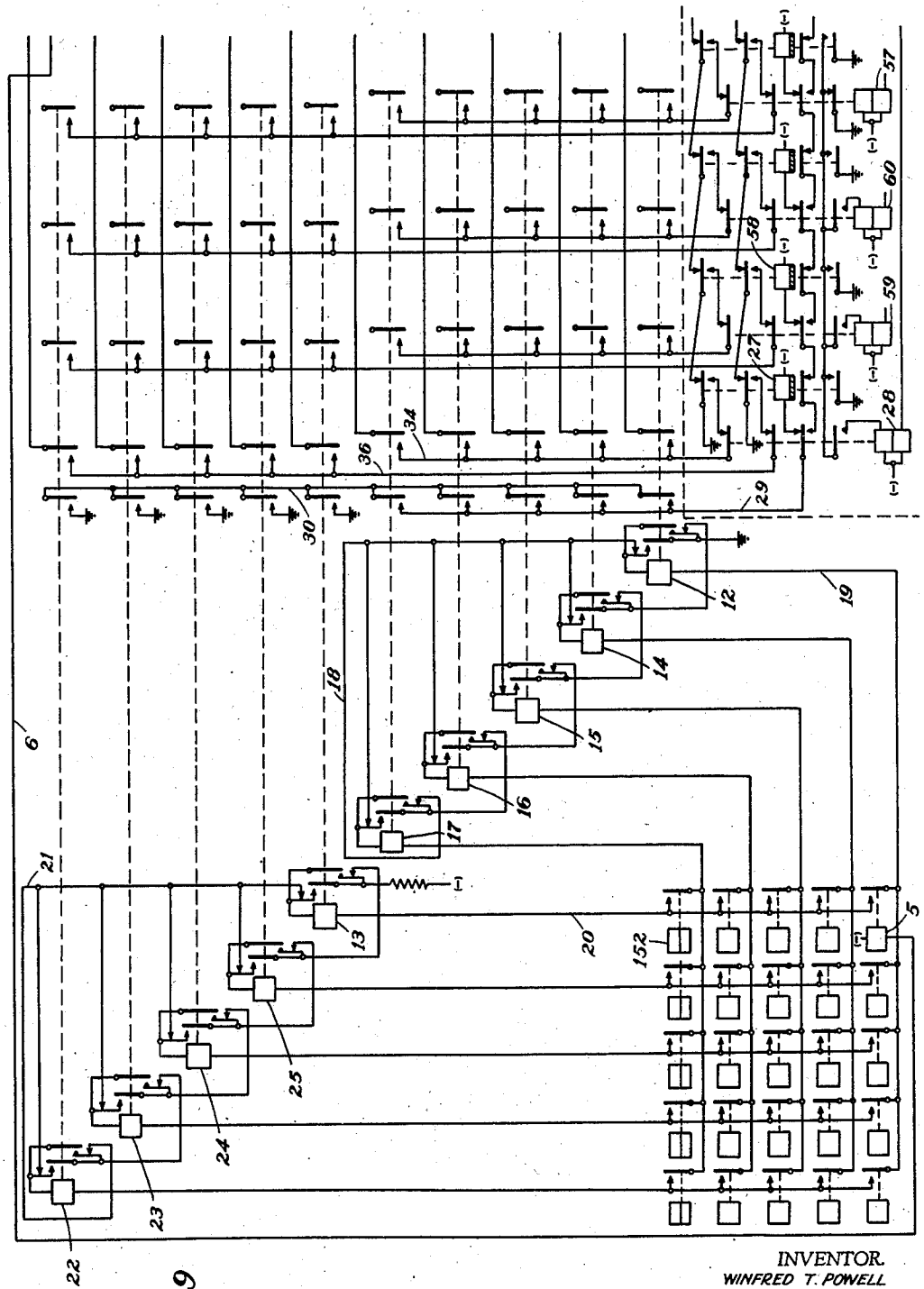


Fig. 9

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Patented May 6, 1941 2,241,158

UNITED STATES PATENT OFFICE

2,241,158

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 21, 1939, Serial No. 295,925

11 Claims. (Cl. 179—18)

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

In automatic telephone systems of the type in which relays are employed as switching means for completing a part or all of the telephone connections, provision must be made for completing trunk calls to and from a distant exchange. In such an arrangement provision must also be made at the local exchange for transferring a trunk call originating at a distant exchange from one substation at the local exchange to any other desired substation thereat, the trunk in use being held during the transfer operation. Provision must also be made for releasing a connection from a calling substation to a busy called substation while signalling the calling substation of the busy condition.

The present invention has for its purpose the improvement in such automatic telephone systems by the provision of novel circuit arrangements for meeting the above-mentioned conditions.

The drawings diagrammatically represent a telephone system when Figs. 1, 2, 3 and 4 are arranged end to end in order, reading from left to right, and when Fig. 5 is placed below Fig. 4 and with Figs. 5, 6, 7, 8 and 9 placed end to end and arranged to read from right to left.

In these drawings Fig. 2 represents a call substation and its telephone line, and

Fig. 2*a* represents a portion of the circuits employed in a code call arrangement;

Fig. 3 represents a portion of a trunk circuit which terminates at a distant exchange represented by the dotted rectangle;

Figs. 4 and 5 when taken together indicate a call substation at a telephone line as well as a relay connector and certain of the common equipment;

Fig. 6 represents a counting relay arrangement in which impulses dialed by the calling subscriber are counted and by which a relay connector is selectively operated;

Fig. 7 represents the major portion of a link connector utilized in extending a telephone connection;

Figs. 1 and 8 represent a relay finder arrangement for connecting the telephone lines to links and to trunk circuits; and

Fig. 9 represents a lock-out arrangement whereby originating calls are extended in sequence. This figure in the lower right hand corner thereof, also illustrates a relay allotter which functions to assign idle link circuits for use in sequence.

It is believed that the invention will best be understood by describing the operation of establishing a connection from a calling subscriber's line such as that designated #11 (Fig. 2) to a called subscriber's line herein designated #41. When the calling subscriber removes his receiver from the switchhook to initiate a call, a circuit is completed for the line relay 5 of this line. This circuit is traceable from the negative pole of battery, winding of the line relay 5 (Fig. 9), conductor 6, back contact and armature of relay 7, inner back contact and armature of the cutoff relay 8, telephone line conductor 9, thence through the calling substation circuits of the calling subscriber, telephone line conductor 11, outer armature and back contact and cutoff relay 8 to positive pole of battery. The line relay 5 when energized completes a lockout circuit whereby all of the remaining telephone lines of the group are disabled from making a connection until a link is extended to the calling telephone line and whereby a finder of the relay type extends a link to the calling subscriber's line. The operation of the relay type finder is completed in a very brief interval of time so that the locking out of the remaining lines of the group is not seriously objectionable. It will be appreciated that the lock-out arrangement is provided in order that two simultaneously originated calls will not be coupled to the same link.

The mentioned lock-out circuit is completed for the tens lock-out relay 12 and for the units lock-out relay 13. It will be appreciated that the tens lock-out relay 12 is common to all telephone lines of the group having the numeral one as a tens digit designation, whereas the units lock-out relay 13 is common to all telephone lines of the group having the numeral one as a units digit designation. The operating circuit for the units lock-out relay 13 and for the tens lock-out relay 12 is traceable from the positive pole of battery, continuity spring and back contact of the relay 12 and thence thru the corresponding continuity springs and back contacts of the remaining tens lock-out relays of this group, namely relays 14, 15, 16 and 17, conductor 18, inner back contact and continuity spring of the relay 12, winding of this relay, conductor 19, front contact and armature of line relay 5, conductor 20, winding of the units lock-out relay 13, its inner continuity spring and back contact, conductor 21, outer back contacts and

continuity springs of units lock-out relays 22, 23, 24, 25, 13 and resistance to the negative pole to the battery. The lock-out relays 12 and 13 are energized in this circuit and complete a locking circuit for themselves from the negative pole of battery, inner armature, front contact and winding of the units lock-out relay 13, conductor 20, front contact and armature of the line relay 5, winding of the tens lock-out relay 12, its inner front contact armature to the positive pole of the battery. While the tens lock-out relay 12 and the units lock-out relay 13 are thus held energized no other lock-out relays of the group can be energized since their energizing circuits are interrupted at the outer continuity springs and back contacts of the relays 12 and 13.

As soon as the lock-out relays 12 and 13 are energized, the relay 27 (Fig. 9) of a link allotter of the relay type is energized from the negative pole of battery, winding of the relay 27, back contact and armature of the relay 28, conductor 29, front contact and armature of the lock-out relay 12, conductor 30, armature and front contact of the relay 13, to the positive pole of battery. The allotter relay 27 when thus energized, completes circuits for operating the tens finder relay 31 (Fig. 8) and the units finder relay 32. The circuit for the relay 31 is traceable from the negative pole of battery, winding of the relay 31, conductor 33, armature and front contact of the relay 12, conductor 34, armature and back contact of the relay 28, uppermost front contact and armature of the relay 27 to the positive pole of battery. The units finder relay 32 has its circuit likewise traceable from the negative pole of battery, winding of the relay 32, conductor 35, armature and front contact of the units lock-out relay 13, conductor 36, armature and back contact of relay 38, inner front contact and armature of relay 27 to the positive pole of battery. With the tens finder relay 31 and the units finder relay 32 energized, the tip conductor 37, the ring conductor 38 and the sleeve conductor 39 are extended thru the contacts of the units finder relay 32 and the tens finder relay 31 to the corresponding conductors 40, 41 and 42 of the allotted trunk or link circuit. The extension of the calling line conductors 37 and 38 to the link conductors 40 and 41, completes a circuit including these conductors in series with the upper and lower windings of the differentially wound relay 43 (Fig. 7) and of the calling bridge relay 44 which also serves as an impulse relay. The relay 44 is energized in the circuit but the differentially wound relay 43 is not operated at this time. On the operation of the relay 44 the slow releasing relay 45 is energized from the negative pole of battery, winding of this relay, middle front contact and armature of the relay 44, conductor 46, back contact and armature of the trunk release relay 47 to the positive pole of battery. When the relay 45 is operated it closes an obvious operating circuit for the relay 55. Also as soon as slow releasing relay 45 is operated, it closes a locking circuit for the tens finder relay 31 and for the units finder relay 32 from the negative pole of battery, winding of these relays and thru their innermost front contacts and armatures and thence in multiple over the conductor 48, lowermost back contact and armature of the release relay 49, conductor 50, front contact and armature 51 of the relay 45, to the positive pole of battery. The operation of the relay 45, thru its armature 52 and front contact, connects the positive pole of battery through the winding of the relay 53, to the sleeve conductor 42 of the link. This sleeve conductor, on the operation of the relay finder is connected to the sleeve conductor 39 of the calling line and this last-named conductor is connected thru the right-hand armature and back contact of the relay 7 (Fig. 2), winding of the cutoff relay 8 to the negative pole of battery. The cutoff relay is thus energized and thru its innermost front contact and armature completes a locking circuit for itself independently of the control of the relay 7. The operation of the cutoff relay 8 also disconnects the line relay 5 from its related telephone line. Relay 5 thereupon releases and effects the release of the lock-out relays 12 and 13 so that they are again in readiness to cooperate in extending another telephone calling line to an allotted link circuit. Although the operations just described in extending a calling line to a link appear rather involved, they are effected in a matter of a fraction of a second. As soon as the cutoff relay operates, the slow releasing relay 7 is energized from the negative pole of battery, righthand winding of this relay, front contact and armature of cut-off relay 8 to the positive pole of battery.

It will be recalled that the relay 27 of the link allotter was operated following the initiation of the call to effect the operation of the tens finder relay 31 and the units finder relay 32 in order to connect the calling line to the link. On the operation of the relay 55, which was effected as soon as the slow releasing relay 45 was energized, a circuit was completed for operating the number one allotter relay 28. This circuit extends from the negative pole of battery, lower winding of relay 28, conductor 56, lower front contact and armature of relay 55 to the positive pole of battery. Relay 28 when thus operated is locked actuated in a circuit from the negative pole of battery, upper winding of this relay, its inner front contact and armature, back contact and armature of relay 57, which is the number 4 allotter relay of the series, to the positive pole of battery. Thus, on the next originating call, the relay 58 (Fig. 9) which is individual to the number two link will respond in a manner similar to the operation of the relay 27 which operated as previously described to extend the calling line to the number one link. It will be understood that the relays 59 and 60 will operate and lock in succession to allot the next link circuits in the group for connection to other telephone lines. However, when the relay 57 associated with the last link of the group is operated, it interrupts the locking circuits of the previously operated allotter relays so that they allot their individual link in succession.

As soon as the relay 45 was energized in response to the completion of the connection of the calling line to the allotted link circuit, the relay 57 (Fig. 6) associated with the counting relays of the connector was energized. The energizing circuit for the relay 57 is traceable from the negative pole of battery, winding of the relay 57, innermost lower back contacts and armatures of the counting relays 58 to 63 inclusive, conductor 64, upper armature and back contact of relay 65, conductor 66, upper armature and back contact of relay 49, conductor 67, back contact and armature 68 of relay 69, conductor 70, upper front contact and armature of relay 45 to the positive pole of battery. When the relay 57 is operated it applies a dial tone thru its front

contact and armature 57a and thru the calling ends of the selective link to the calling line.

Since the calling telephone line has been connected to an idle link circuit in the manner described and has received the dial tone, the calling subscriber operates his dial impulse sender to transmit several series of code impulses corresponding to the respective digits of the wanted party's line. Let it be assumed that the called subscriber's line is designated number 41. The calling subscriber first operates his impulse sender to transmit four impulses, that is, the line circuit will be interrupted four times and after a pause it will be interrupted once to transmit an impulse corresponding to the units digit one. In response to each of the four tens impulses, the calling bridge relay 44 releases and attracts its armature four times. However, the slow releasing relay 45 remains operated during the sending of this series of impulses.

When the impulse relay 44 releases in response to the first interruption of the line circuit corresponding to the first impulse of the tens digit, the relay 44 releases. This causes the energization of the number one counting relay 58, from the negative pole of battery, winding of this relay, conductor 71, uppermost front contact and armature of relay 57, conductor 72, armature and back contact of the pulse lock relay 73, conductor 74, uppermost front contact and armature of relay 55, uppermost armature and back contact of relay 44, conductor 75, upper armature and back contact of the release relay 49, conductor 67, back contact and armature 68 of the cut-in relay 69, conductor 70 to the positive pole of battery at the upper armature and front contact of relay 45. The number one counting relay when thus energized, closes a locking circuit for itself from the negative pole of battery, its winding, its innermost, lower front contact and armature and thru the innermost back contacts and armatures of the counting relays 59 to 63 inclusive, conductor 64, back contact and armature of relay 65, conductor 66, armature and back contact of relay 49, conductor 67, back contact and armature 68 of relay 69, conductor 70 to the positive pole of battery at the front contact and armature of relay 45. A locking circuit is also completed for the relay 57 from the negative pole of battery, winding of this relay, its inner front contact and armature, conductor 76, front contact and armature of relay 55, back contact and armature of relay 44, conductor 46, back contact and armature of slow releasing relay 47 to the positive pole of battery. When the impulse relay 44 operates after the first impulse just described, the relay 57 is released since its holding circuit is interrupted at the armature and back contact of the mentioned relay 44. The number one counting relay 58 however remains energized since its holdering circuit is independent of the relay 44.

When the impulse relay 44 is again deenergized in response to the second impulse of the tens digit, the number two counting relay 59 is energized from the negative pole of battery, winding of this relay, conductor 77, front contact and armature of relay 58, uppermost back contact and armature of relay 57, conductor 72, back contact and armature of relay 73, conductor 74, uppermost front contact and armature of relay 55, uppermost armature and back contact of relay 44, conductor 75, armature and back contact of relay 49, conductor 67, back contact and armature 68 of the cut-in relay 69, conductor 70, front contact and armature of relay 45 to the positive pole of battery. The number two counting relay 59, when thus energized, closes a locking circuit for itself from the negative pole of battery, winding of this relay, its innermost lower front contact and armature, innermost lower back contacts and armature of relays 60 to 63 inclusive, conductor 64, back contact and armature of relay 65, conductor 66, upper armature and back contact of relay 49, conductor 67, back contact and armature 68 of relay 69, conductor 70 to the positive pole of battery at the upper front contact and armature of relay 45. The locking circuit for the relay 58 is now interrupted at the innermost lower back contact and armature of the relay 59 but before the number one counting relay 58 releases, a substitute locking circuit is closed for itself from the negative pole of battery, winding of the relay 58, its innermost upper front contact and armature, inner back contact and armature of relay 57, conductor 76, front contact and armature of relay 55, back contact and armature of relay 44, conductor 46 to the positive pole of battery, at back contact and armature of the relay 47. This last-described circuit locks the number one counting relay in operated condition until the relay 44 is again energized at the conclusion of the number two impulse of the tens digit, at which time it releases.

In response to the third impulse of the tens digit, the number three counting relay 60 is operated and locked operated in the manner previously described while the number two counting relay will be held operated until the impulse relay 44 is again operated at the conclusion of the third impulse, at which time it releases. Similarly, in response to the fourth impulse, the number four counting relay 61 is energized and is locked operated over circuits similar to those already described. When the impulse relay 44 is operated at the conclusion of the fourth impulse, the number three counting relay 60 releases but the fourth counting relay 61 is maintained operated at this time. In the course of the transmission of the four impulses corresponding to the tens digit, the relays 57, 58, 59, 60 and 61 are operated and released in turn, with the exception of the number four counting relay 61 which is held operated until the tens connector relay is operated in the manner to be described. It will be noted that there are no time margins or marginal relay operations in this counting circuit since each relay is operated in turn in response to the transmission of each impulse from the dial sender at the subscriber's station and during the closed circuit intervals between impulses, a preceding counting relay of the series is released to close a break point in the operating circuit for the next counting relay in the series to be operated by the next impulse.

The change-over relay 77 is operated in response to the first impulse of the tens digit and owing to its slow releasing characteristics is maintained operated during the sending of the ten series of impulses. The circuit for thus operating change-over relay 77, extends from the negative pole of battery, winding of this relay, conductor 74, uppermost front contact and armature of relay 55, uppermost armature and back contact of the impulse relay 44, conductor 75, upper armature and back contact of relay 49, conductor 67, back contact and arma-

ture 68 of relay 69, conductor 70 to the positive pole of battery at the front contact and armature of relay 45. At the conclusion of the sending of the four impulses corresponding to the tens digit as a result of which the number four counting relay 61 has been operated and locked operated, the impulse relay 44 will be energized for a sufficient period so that the change-over relay 77 will release, its operating circuit being interrupted at the uppermost armature and back contact of the impulse relay 44.

As soon as the change-over relay 77 releases, a circuit is completed for operating the fourth tens connector relay 78. Since the number four counting relay has been operated, the operating circuit for the connector relay 78 extends from the negative pole of battery, winding of this relay, conductor 79, lowermost front contact and armature of the number four counting relay 61, lowermost back contacts and armatures of the relays 60, 59, 58 and 57, back contact and armature of relay 80, conductor 81, armature and back contact of change-over relay 77, conductor 82, back contact and armature 68 of relay 69, conductor 70 to the positive pole of battery at the front contact and armature of relay 45. The connector relay 78 when thus operated closes a locking circuit for itself from the negative pole of battery, winding of this relay, its inner front contact and armature, conductor 83, inner front contact and armature of relay 45 to the positive pole of battery. Also as soon as the connector relay 78 is operated, a circuit is closed for the counting relay release relay 65 (Fig. 6). A circuit for operating this relay is traceable from the negative pole of battery, winding of this relay, armature and back contact of the transfer relay 80, conductor 84, front contact and armature of relay 78, conductor 85, to the positive pole of battery. The operation of the relay 65, at its armature and back contact, interrupts the previously described circuit which has been holding the number four counting relay 61 operated so that this counting relay now releases and the series of counting relays is in readiness for operation in counting the impulses corresponding to the units digit. The release of the number four counting relay 61 in the manner just described completes a circuit for operating the transfer relay 80. This circuit extends from the negative pole of battery, winding of the change-over relay 77, conductor 74, armature and back contact of relay 73, conductor 72, armatures and back contacts of relays 57 to 63 inclusive, conductor 86, upper winding of the transfer relay 80, front contact and armature of relay 65, conductor 66, armature and back contact of release relay 49, conductor 67, back contact and armature 68 of relay 69, conductor 70 to the positive pole of battery at front contact and armature of relay 45. Change-over relay 77 is also energized in this circuit with the transfer relay 80, but the operation of the change-over relay 77 performs no useful function at this time. The transfer relay 80 however, on operation, is locked operated from the negative pole of battery, lower winding of this relay, its front contact and armature, conductor 66, armature and back contact of relay 49, conductor 67 and thence over the remainder of the circuit previously described to the positive pole of battery at the front contact and armature of relay 45. As soon as the transfer relay 80 is operated, at its lowermost armature and back contact, it interrupts the energizing circuit for the relay 65 which releases. The release of the relay 65 interrupts the initial operating circuit for the transfer relay 80, which circuit extended thru its upper winding. However, the relay 80 is now locked operated thru its lower winding, but the change-over relay 77 releases. Also as soon as the relay 65 releases, a circuit is closed thru the back contacts and armatures of counting relays 58 to 63 inclusive, for operating the relay 57 which circuit is identical with that previously described as completed prior to the sending of the tens series of impulses. With the relay 57 again energized, the series of counting relays are in readiness to count the series of impulses corresponding to the units digit.

Since it has been assumed that the units digit is "one," the impulse sender at the calling subscriber's station transmits one impulse in response to which the impulse relay 44 retracts its armatures. When this takes place, the number one counting relay 58 is operated and locked operated over circuits identical with those previously described in connection with the counting of the tens digit series of impulses. It will be recalled that the operating circuit for the number one counting relay extends from the negative pole of battery, winding of this relay, conductor 71, front contact and armature of relay 57, conductor 72, back contact and armature of relay 73, front contact and armature of relay 55, armature and back contact of relay 44, conductor 75, armature and back contact of relay 49, conductor 67, back contact and armature 68 of relay 69, conductor 70, front contact and armature of relay 45 to positive pole of battery. The locking circuit for the number one counting relay 58 is completed from the negative pole of battery, winding of this relay, its lower front contact and armature and through the lower back contacts and armatures of relays 59, 60, 61, 62 and 63 and thence to the positive pole of battery over the conductor 64 as previously described.

With the number one counting relay 58 thus operated and change-over relay 77 released, a circuit is completed for the number "one" units connector relay 87, from the negative pole of battery, winding of the relay 87, conductor 88, front contact and armature 89 of relay 58, back contact and armature of relay 57, middle front contact and armature of the transfer relay 80 (now operated), conductor 81, armature and back contact of change-over relay 77, conductor 82, back contact and armature 68 of relay 69, conductor 70, front contact and armature of relay 45 to the positive pole of battery. Connector relay 87 when thus energized is locked operated from the negative pole of battery, winding of this relay, conductor 90, front contact and armature of relay 87, conductor 83, front contact and armature of relay 45 to the positive pole of battery. The release relay 65 is now operated, from the negative pole of battery, winding of this relay, armature and front contact of relay 80, conductor 91, front contact and armature of relay 87, conductor 85 to the positive pole of battery. As soon as the release relay 65 is operated it opens the locking circuits of the counting relays which have been operated, in this case the number one counting relay 58.

As soon as the tens connector relay 78 and the units connector relay 87 are operated, the called line #41 (Fig. 4) has its tip conductor 92, its ring conductor 93 and its sleeve conductor 94 extended thru the contacts of these relays to the corresponding tip, ring and sleeve conductors 95, 96 and 97 of the called end of the link circuit

which was seized by the calling telephone line.

The test of the called line #41 is now made. Let it be assumed that this line is idle at this time. Under this condition the change-over relay 77 (Fig. 7) is actuated from the negative pole of battery, winding of relay 77, conductor 74, armature and back contact of relay 73, conductor 72, armature and back contacts of relays 57 to 63 inclusive, conductor 86, upper winding of relay 80 (Fig. 6), front contact and armature of relay 65, now operated, conductor 66, armature and back contact of release relay 49, conductor 67, back contact and armature 68 of relay 69, conductor 70, front contact and armature of relay 45, to the positive pole of battery. The operation of the change-over relay 77 completes a circuit for operating the cut-in relay 69. This circuit extends from the negative pole of battery, winding of the relay 69, its continuity spring and back contact, armature and front contact of relay 77, conductor 91, front contact and armature of relay 87, conductor 85 to the positive pole of battery. The relay 69 when operated closes a locking circuit for itself thru its continuity spring and armature, conductor 70 to the positive pole of battery, at the armature and front contact of relay 45. The operation of the cut-in relay 69 interrupts the energizing circuits of the change-over relay 77 and of the transfer relay 80 which circuits, it will be recalled, extend thru the back contact and armature 68 of relay 69. The cut-off relay of the called line is operated over the sleeve conductor 94 of this line, sleeve conductor 97 of the called end of the link connected thereto, front contact and armature 68 of relay 69, conductor 70 to the positive pole of battery at the armature and front contact of relay 45. The positive battery thus applied to the sleeve conductors 97 and 99 provide a busy potential for rendering the called line busy.

It has been mentioned that the change-over relay 77 is slow-releasing and therefore before it retracts its armatures, a circuit is completed for the ringing relay 99, from the negative pole of battery, resistance, winding of this relay, front contact and middle armature of the change-over relay 77, sleeve conductor 97, which it will be recalled is now connected over conductor 70 to the positive pole of battery at the armature and front contact of relay 45. The ring relay 99 as soon as it is operated, closes a locking circuit for itself thru its lower front contact and armature, holding conductor 70 to the positive pole of battery at the armature and front contact of relay 45.

On the operation of the ringing relay 99, interrupted ringing current is applied to the tip and ring conductors 95 and 96 of the called end of the link circuit in use and thence to the corresponding conductors of the called line which include the ringer of the called line. The conductors 95 and 96 are connected to the ringing generator thru armatures and front contacts of the cut-in relay 69 and ringing relay 99. It will be understood that ringing circuit leading to the ringing generator (not shown) includes the ringing trip relay 100. Interrupted ringing current is applied to the ringer (not shown) at the called substation over the circuit just described, until the called party responds by removing his receiver from the switch hook. When this takes place the marginal trip relay 100 is operated and at its armature and front contact closes a shunt circuit about the ringing relay 99 causing this last-named relay to release and thereby disconnect the ringing current. Also when the ringing relay 99 releases, the battery feed relay 101 of the called end of the connection is connected in series with the differentially wound relay 102 to the tip and ring conductors 95 and 96 of the called end of the link.

The release of the telephone connection just completed is effected by the calling subscriber when he replaces his receiver on its switch hook. This act opens the line circuit at the switch hook contacts and thereby effects the release of the impulse relay 44 and in turn the slow releasing relay 45. It will be recalled that the relay 45 when operated applied the positive pole of battery to the holding conductor 70. Thus when the positive pole of battery is disconnected from the holding conductor 70, the tens connector relay 78, the units connector relay 87 and the tens finder relay 31 as well as the units finder relay 32 are released. The relay 45 also opens the sleeve conductor 42 of the calling line and therefore effects the release of the calling cut-off relay 8. Likewise, the release of the relay 45 effects the release of the relay 55 as well as the cut-off relay of the called line because the circuit of this last-mentioned relay which extends to the positive pole of battery over the sleeve conductor of this line, is interrupted at the front contact and armature of relay 45.

In the event that the called line was busy at the point in the operation when it was tested, then the positive pole of the battery would be connected to the sleeve conductor of that line either over a conductor similar to conductor 42, and calling end of the link to the positive pole of battery at the armature 52 and front contact of relay 45, or over a conductor similar to the sleeve conductor 97 of the called end of the link and thence over the holding conductor 70 to the positive pole of battery at the armature and front contact of relay 45. Referring back to the time when the units connector relay 87 was operated, a circuit is closed for operating the relay 49 of the link circuit. The operating circuit for the relay 49 extends from the positive pole of battery on the sleeve conductor of the called line which extended thru the armatures and contacts of the units connector relay 87 and the tens connector relay 78 to the sleeve conductor 97 of the link, armature and back contact of the change-over relay 77, conductor 103, back contact and armature of relay 69, back contact, continuity spring and winding of the release relay 49, conductor 104, winding of the busy relay 105 (Fig. 2) to the negative pole of battery. The busy relay 105 is operated and complets a circuit for starting a busy-tone device. The busy-tone current generated thereby is applied to the lefthand winding of the busy relay 105, and this current thus induced into the righthand winding of this relay is applied thru the lefthand winding of relay 7, front contact and armature of this relay, back contact and armature of the cut-off relay 8 and thence thru the calling subscriber's receiver at the calling station and then over the telephone line conductor 11 to the positive pole of battery at the armature and back contact of the cut-off relay 8.

It should be pointed out that the change-over relay 77 cannot be energized to initiate the selection of the called line now assumed to be busy, inasmuch as the change-over relay circuit is now open at the back contact and armature of the release relay 49. Since the change-over relay 77 cannot be operated under the conditions as-

sumed, the cut-in relay 69 and the ringing relay 99 will not be energized to effect the application of ringing current. It will be recalled that the holding circuits of the tens finder relay 31 and the units finder relay 32 include the conductors 48 and 50 which are normally connected in series thru the lowermost armature and back contact of relay 49. Therefore when the release relay 49 is energized the holding circuits for these finder relays are interrupted so that they release to disconnect the calling line from the selected link. The cutoff relay 8 (Fig. 2), of the calling line which was maintained operated over the sleeve conductor 39 of the calling line and the sleeve conductor 42 of the selected link also has its circuit interrupted when the finder relays disconnect the calling line from the link. In addition the disconnection of the link from the calling line interrupts the operating circuit of the impulse relay 44 which releases and in turn effects the release of the slow releasing relay 45. Relay 45 on deenergizing effects the release of the various operated relays of the link in the manner previously described.

When the cutoff relay 8 releases in the manner just mentioned, the calling line circuit including the conductor 9 is extended thru the armatures and back contacts of the cutoff relay 8, armature, front contact and lefthand winding of the relay 7 and thence thru the righthand winding of the busy relay 105 which is common to a group of lines. The busy relay 105 connects busy tone current to the calling line and the relay 7 remains operated to maintain the calling line disconnected from its line relay 5 so that this line relay cannot now connect the calling line to another link circuit. It will be appreciated that the cutoff relay 8 cannot be energized while the receiver at the calling substation is off of its switch hook since the initial operating circuit of the cutoff relay is maintained open at this time at the righthand armature and back contact of the relay 7. The energization of the busy relay 105 starts the busy tone machine and the busy tone current is applied to the calling line by being induced from the lefthand winding of the relay 105 into the righthand winding thereof to which winding the calling line is connected. When the calling subscriber replaces his receiver on its switchhook the telephone line circuit is opened whereupon the slow releasing relay 7 releases and all of the circuits employed in the telephone connection under consideration are restored to their normal condition.

The present system is arranged so that a party at any station of the system can establish code call conditions whereby signals such as bells or lights or both may be operated according to predetermined codes in order to locate various persons in a plant where the system may be used. In effecting the code operation of the system, a party desiring to initiate code call signals, is instructed to dial a predetermined number. In the system herein disclosed the predetermined number is assumed to be #11. It will be understood that the use of #11 for the code call prevents the use of this number for a subscriber's line. The subscriber, after removing his receiver from the switchhook and after receiving the dial tone indicating that his line has been connected to an idle link circuit, first operates his dial sender to transmit one impulse corresponding to the tens digit and subsequently another impulse corresponding to the units digit of the predetermined number. In response to the single tens digit impulse, the system operates as previously described to effect the operation of the number one counting relay 58. At the end of the tens series of impulses the number one tens connector relay 107 is operated and locked operated in a manner similar to that already described. In response to the single units impulse the number one counting relay 58 is again operated and in this instance is effective to complete a circuit as previously described for operating the number one units connector relay 87. The energization of these last-mentioned connector relays extends the link circuit, which is connected to the calling line, to the code call unit shown in Fig. 2*a*. The positive pole of battery is connected at this time to the sleeve conductor 108 of the code call unit, which conductor includes the winding of the start relay 109 and is connected to the negative pole of battery. The start relay 109 at its front contact and armature completes a circuit for starting the code call current generator (not shown). It will be noted that the tip conductor 110 and the ring conductor 111 of the code calling network are connected thru the impedance coil 112 so that this closed circuit across these conductors actuates the trip relay 100 to prevent ringing current from the link being applied to the code call network. If the calling party does not hear a busy tone signal in his telephone receiver at this time, he knows that the code call is idle, and he then proceeds to dial the code of impulses assigned to the party wanted. For example, he may dial the digit two twice in order to give two short rings or he may dial O twice to give two long rings. Of course it will be understood that various codes of long and short impulses may be assigned for use in signalling various parties. The core call impulse circuit extends from the negative pole of battery, winding of the relay 113, conductor 114, front contact and armature of the units connector relay 87, front contact and armature of the tens connector relay 107, conductor 115, uppermost armature and front contact of relay 101, conductor 116, back contacts and armatures of the counting relays 62 to 57 inclusive, conductor 76, front contact and armature of relay 55, back contact and armature of the relay impulse 44, conductor 46, back contact and armature of the trunk release relay 47, to the positive pole of battery. Thus on each deenergization of the impulse relay 44 in response to each of the code impulses transmitted by the calling subscriber, an impulse is transmitted over the last-described circuit to the pulse relay 113. It will be noted that the relay 113 is slow releasing and will remain operated during a series of properly timed impulses. Thus it will remain operated for a comparatively long interval of time when the #0 digit is dialed and will remain operated for a comparatively short interval of time when the digit two is dialed. The operation of the relay 113 applies generator current thru its armatures and front contacts to the conductors 117 and 118 across which the code call signals such as 119 are connected in multiple. Thus the signals herein shown illustrated as bells ring the predetermined code at their various locations. When the wanted party hears his code on the common code bells 119 he answers by dialing a predetermined number, e. g. the number 12. The party answering, of course, goes to the nearest telephone and removes the receiver from the switchhook thereat, which results in connecting this line to a second link circuit. The desired party thereupon sends im-

pulses according to the number 12 which, of course, operates first the number one counting relay associated with the link circuit connected to his line and the operation of this relay effects the energization of a number one tens connector relay similar to **107**. In response to the units digit #2 the counting relay **59** is likewise operated in the manner already described. The operation of this counting relay causes the operation of a number two units connector relay similar to **120**. The operation of the mentioned tens and unit connector relays extends the line #12 to the link circuit that has been used by the calling party. As soon as this connection has been established positive potential on the sleeve conductor **121** energizes the make busy relay **122** which relay at its armature and front contact connects the positive pole of battery to the sleeve conductor **108** connected to the link used by the calling telephone line, thereby maintaining the code call number busy until both parties to the connection have replaced their receivers on the switchhooks. The tip and ring conductors at the calling end of the link used by the answering party are thus connected to the tip and ring conductors of the calling end of the link used by the calling party because these are common to the code call circuit.

Thus a talking connection is established between the calling and the called parties. The release of the connection used by the calling party releases the link and the other apparatus used by him and a link and apparatus used by the answering party is similarly released when the answering party hangs up. The release of both of these connections restores the code call apparatus to normal condition.

In accordance with the present invention it is proposed to provide for trunk call connections from the present system either to a distant manual telephone office or to a distant automatic telephone office by means of two-way trunks between the present system and a central office of either of the mentioned types. The telephone lines in the present system may be arranged to have restricted or unrestricted connection to the mentioned trunks, that is certain of the telephone lines can obtain connection to these trunks while other lines of the system are so arranged that they cannot be connected to said trunks. Let it be assumed that a calling party on a telephone line arranged for unrestricted service, desires connection to a trunk leading to a distant office. This subscriber is instructed to dial a predetermined number, for example, #55, to select the first idle trunk leading to the central office (Fig. 3). However, in the case of incoming calls from the distant central office, the central office operator plugs into an idle trunk and ringing current applied to this trunk is effective to operate one or more bells in the present automatic exchange. Any person hearing these bells can answer the incoming trunk call by removing the receiver from the switchhook of any telephone line in the system and dialing a predetermined number, for example, the #66.

Let it be assumed that it is desired to initiate a call from an unrestricted telephone line in the system to a distant exchange. The subscriber does this by removing his receiver from its switchhook and as soon as he hears the dial tone he dials the predetermined trunk number **55**. On removing the receiver from the switchhook, the apparatus operates to extend the calling line to an idle link circuit thru the operation of a tens finder relay and a units finder relay in a manner previously described in extending a call between local subscribers. As soon as the link is connected to the calling line, the dial tone is applied to this line and the subscriber operates his dial sender to transmit five tens impulses. In response to these five impulses the counting relays are operated in a manner already described to energize the #5 counting relay **62**. In response to the operation of this relay the tens connector relay **123** is operated in manner similar to that already described. The calling subscriber then transmits five units impulses corresponding to the units digit of the predetermined number **55**. In this instance the counting relays of the selected link will attempt to count the five units impulse of the second or units digit but the counting will be stopped and the corresponding counting relay will be locked operated at the first idle trunk in the group of five trunks leading to the distant office. In other words if trunk number one is idle, only one of the five units impulses will be effective to operate the counting relays and the remaining four impulses will be ineffective. However, if trunk number 5 is the first idle trunk then all of the five impulses of the units digit will be counted and the number 5 counting relay **62** will be operated and locked. If all five trunks of the group are busy then all of the five units impulses will be counted but a busy circuit will function to signal the calling party that all of the trunks in the group are busy.

Let it be assumed that the trunk illustrated in the drawings (Fig. 3) is the number one trunk and that this trunk is idle. Under this condition when the subscriber transmits five impulses of the units digit the impulse relay **44** will release five times after which it will remain energized. The first release of the relay **44** in response to the first impulse is effective to operate the number one counting relay **58** at which time the relay **57** releases when the relay **44** operates at the end of the first impulse. Since the trunk number one is assumed to be idle the relay **73** is now operated from the negative pole of battery, winding of relay **73**, armature and front contact of the number one counting relay **58**, conductor **125**, front contact and armature of the tens connector relay **123**, conductor **126**, back contact and armature of the make busy relay **127**, conductor **128**, back contact and armature of the slow releasing relay **129** (Fig. 3) to the positive pole of battery. This operation of the relay **73** opens the circuit including the conductor **72** so that the remaining counting relays of the series will not be operated in response to impulses, that is the remaining four impulses are of no effect. In the event that the first four trunks of the group of five trunks are busy, the relays similar to **129** thereof will be energized so that no circuit will be completed for operating the relay **73**. When however, the fifth units impulse is recorded on the number five counting relay **62**, the relay **73** will be operated in a circuit similar to that described but in this instance will be complete from the back contact and armature of a relay similar to **129** at the fifth trunk of the group.

Since it has been assumed that the first trunk is idle and only one units impulse effectively registered, the units connector relay **87** will be operated over a circuit as described so that the trunk #1 will be selected although the number **55** has been dialed. At the conclusion of the operation of the counting relays, the release relay **65** is operated over the conductor **91**, its cir-

cuit being completed at the front contact and armature of the connector relay 87. With the relay 65 energized, the operated counting relay, in this instance the number one counting relay 58, is released since its holding circuit is interrupted at the armature and back contacts of relay 65. The change-over relay 77 is now operated from the negative pole of battery, winding of this relay, armature and back contact of the relay 73, conductor 72, armatures and back contacts of relays 57 to 63 inclusive, conductor 86, upper winding of the relay 80, front contact and armature of release relay 65, conductor 66, armature and back contact of relay 49, conductor 67, back contact and armature 68 of relay 69 and thence over the holding conductor 70 to the positive pole of battery at the front contact and armature of relay 45. When the change-over relay 77 operates, cut-in relay 69 and the ringing relay 99 are operated as previously described. A circuit is now completed from the negative pole of battery, resistance, back contact and armature of the make busy relay 127 (Fig. 3), conductor 130, armature and front contact of the units connector relay 87, conductor 131, lefthand winding of the relay 199, conductors 132 and 133, front contact and armature of the number five tens connector relay 123, conductor 134 and conductor 97, front contact and armature of relay 69 and thence over the conductor 70 to the positive pole of battery at the front contact and armature of relay 45. Relay 199 operates and in turn operates the finder marking relay 135 (Fig. 3). This circuit extends from the negative pole of battery, winding of the relay 135, conductor 136, front contact and armature of the relay 199, armature and back contact of the relay 137 which is common to the group of trunks, to the positive pole of battery. With the finder marking relay 135 operated the trunk marking relay 138 is energized in a circuit from the positive pole of battery, winding of this relay, conductor 139, armature and front contact of the units connector relay 87, conductor 140, armature and front contact of relay 199, conductor 141, front contact and armature of relay 135, conductor 142, righthand winding of the relay 199 to the negative pole of battery. This circuit operates the trunk marking relay 138 and holds the relay 199 operated.

At this time the tens finder relay 144 (Fig. 1) and the units finder relay 145 of the number one trunk are operated to connect this trunk to the calling line number 11. Relay 144 is operated in a circuit from the negative pole of battery, winding of this relay, armature and front contact of the trunk marking relay 138, armature and front contact of the finder marking relay 135, conductor 146, and 33, front contact and armature of tens finder relay 31, conductor 48, back contact and armature of the release relay 49, conductor 50, front contact and armature 51 of the slow releasing relay 45 of the link. Similarly the units finder relay 145 is energized in a circuit from the negative pole of battery, winding of this relay, armature and front contacts of relays 138 and 135, conductors 147 and 35, front contact and armature of units finder relay 32 and thence over conductor 48 and the remainder of the circuit already described to the positive pole of battery at the front contact and armature 51 of relay 45. The operation of the tens and units finder relays 144 and 145 extends the tip, ring and sleeve conductors 37, 38 and 39 of the subscriber's line #11 to the tip, ring and sleeve conductors 146, 147 and 198 of the trunk, thence thru both windings in series of the relay 148 (Fig. 3) of the trunk, conductors 149 and 150, back contacts and continuity springs of the holding relay 151 thru both windings in series of the differentially wound relay 152 from whence one side of the circuit is extended thru the continuity spring and back contact of the relay 153, winding of the relay 154 to the positive pole of battery. The other side of this circuit is extended from the lower winding of the differential relay 152, back contact and inner armature of relay 154, trunk line conductor to the distant office, armature and back contact of the cut-off relay 155 associated with the operator's trunk circuit, winding of the line relay 156 also associated with the trunk circuit, to the negative pole of battery. Differential relay 152 does not operate at this time but the line relay 156 operates to signal the operator who plugs in an idle cord circuit to the related trunk. The relay 148 is also energized in this circuit and at its inner front contact and armature it completes a circuit for operating the slow releasing relay 157. The relay 157 at its inner upper front contact and armature completes an operating circuit for the slow releasing relay 129. Relay 129 on operating, completes a circuit from the positive pole of battery, its armature and front contact, conductor 158, armature and back contact of relay 178, armature and front contact of the tens finder relay 144 and winding of this relay to the negative pole of battery and in multiple therewith thru the armature, front contact and winding of the units finder relay 145 to the negative pole of battery. These last-described circuits function to lock the finder relays in operated condition.

Referring back to the point in the description where the relay 135 (Fig. 3) of the link operated, it closes a circuit from the positive pole of battery, front contact of relay 135, conductor 159 and winding of the relay 137 (Fig. 5), to the negative pole of battery. Relay 137 is thus operated and at its armature and back contact removes positive battery potential from the relays such as 199, 160, 161 and 162 to prevent the operation of other finder marking relays such as 135, at the same time in the event that several trunk calls are initiated simultaneously. Trunk release relay 47 (Fig. 7) is now operated from the negative pole of battery, winding of this relay, conductor 163, front contacts and armatures of finder marking relay 135 and of trunk marking relay 138 as well as of the tens finder relay 144 and the units finder relay 145, to the positive pole of battery. Trunk release relay 47 when operated locks itself in this condition thru its inner front contact and armature, front contact and armature of relay 45, to the positive pole of battery. However, the operation of the trunk release relay, at its uppermost armature and back contact, interrupts the energizing circuit including the conductor 46 leading to the slow releasing relay 45. When the relay 45 releases, it removes the positive potential which has been holding the relays 31, 32 (Fig. 8) of the finder and relays 55, and 53 of the link, tens connector relay 123 and the units connector relay 87, as well as the cut-in relay 69, the ringing relay 99 and the finder marking relay 135, thus all of these relays also release. Trunk release relay 47 also releases because its holding circuit is opened at the relay 45. The release of the finder relays 31 and 32 disconnects the link in use, from the calling line

and thus the impulse relay 44 releases. Relays 138 and 199 are also released by the release of the mentioned finder relays. When the finder marking relay 135 releases it also effects the release of the common relay 137 to permit another trunk operation similar to that described.

It will be recalled that when the calling line was extended to the trunk the line relay 156 (Fig. 3) at the distant operator's position was operated, the operation of this relay signalled the operator at the distant office indicating that she should connect a cord circuit to this trunk. When the operator answers this call by plugging her cord circuit into the trunk jack, the contacts of which are designated 161 and 162, the cut-off relay 155 of this trunk is operated in the well-known manner to disconnect the line relay 156 and to extinguish the trunk signal (not shown). Current from the cord circuit (not shown) at the central office is now applied to the tip contact 161 of the plug, back contact and continuity spring of the relay 153, conductor 163, front contact and armature of relay 157, conductor 164, winding of the relay 153 to the negative pole of battery. Relay 153 is thus operated and its continuity spring and armature completes a locking circuit for itself independent of the battery supply at the operator's cord circuit. With the relay 153 operated it interrupts the circuit of the relay 154 which releases.

From the foregoing it will be seen that the link circuit originally connected to the calling line to establish this connection is released and that the calling line is connected directly thru the contacts and armatures of the finder relays 144 and 145 to the trunk circuit leading to the central office.

When the subscriber at the local station designated #11 terminates the connection by replacing his receiver on its switchhook, the tip and ring conductors leading to the central office are opened and this effects the release of the relay 148 of the local trunk circuit. This gives the central office operator disconnect supervision, also the release of the relay 148 causes the slow releasing relay 157 to deenergize. Relay 157 on releasing, opens the locking circuit of the relay 153 and connects the high resistance relay 165 across the trunk. Thus relay 153 releases and relay 165 operates. When the relay 165 operates, it closes a circuit for holding the slow releasing relay 129 before it has had time to release, following the release of the relay 157. Since relay 129 is thus held operated, the trunk still tests busy and the cut-off relay 8 of the local line #11 is still held operated. The operated make busy relay 127 (Fig. 3) keeps this trunk busy by disconnecting the negative pole of battery at its back contact and armature. It will be understood that the make busy relay 127 is locked operated thru its inner front contact and armature, conductor 166, front contact and armature of relay 129 to the positive pole of battery. When the central office operator disconnects by removing the plug of her cord circuit from the jack which includes the contacts 161 and 162, the trunk circuit is opened which allows the high resistance relay 165 to release. This relay in turn effects the release of slow releasing relay 129 and relay 129 then effects the release of the tens finder relay 31, the units finder relay 32 and the make busy relay 127. The tip and ring conductors of the local line #11 are now opened because the finder relays 144 and 145 of the trunk are released.

In the case of a call originated at the distant central office and intended for a subscriber at the local automatic exchange, the operator at the central office plugs her cord circuit into the trunk jack of the first idle circuit leading to the local automatic exchange. As a result of plugging into this trunk jack, battery connected at the cord circuit taken for use is applied across the trunk conductors for operating the high resistance relay 165. When the operator applies ringing current to the trunk to signal the local automatic exchange, this alternating ringing current operates the relay 167. The slow releasing relay 129 is operated as a result of the operation of either of these last-mentioned relays. The relay 129 makes this trunk busy to outgoing calls because it removes positive potential from the conductor 128. However, this trunk is selectable at the local exchange by the local substation which is assigned to answer such incoming calls. This trunk is rendered selectable because the relay 129 applies positive battery, at its armature and front contact, to the conductor 166 which it will be noted is extended thru the inner armature and back contact of the make busy relay 127. The operation of relay 167 by the ringing current intermittently connects local uninterrupted generator current to the common bell circuit for signalling the attendant who is assigned to answer incoming calls.

The party at the local automatic exchange who is responsible for answering calls from a distant office now removes the receiver from the switchhook and operates the dial sender at the substation to transmit impulses corresponding to #66. The removal of the receiver from the switchhook causes the telephone line of this assigned party to be selected by the first idle link circuit. On the completion of this connection of the link to the mentioned line, a dial tone informs the party that he can proceed with dialing the number 66. In response to the six impulses corresponding to the tens digit #6 the counting relays 58 to 62 inclusive are operated and released while the number 6 counting relay 63 is operated and is maintained operated at this time. The operation of the number 6 counting relay 63 causes the operation of the number 6 tens connector relay 168 (Fig. 4). At the close of the tens series of impulses and after the operation of the tens connector relay 168, the counting relays are restored to their normal position as previously described, in readiness to receive the impulses corresponding to the units digit of the number 66. In response to these units impulses the number one counting relay 58 is operated and as soon as this takes place the relay 73 is operated from the negative pole of battery, winding of this relay, front contact and armature of the counting relay 58, conductor 125, front contact and armature of the tens connector relay 168, conductor 169, back contact and armature of the make busy relay 127, conductor 166, front contact and armature of the relay 129 (now energized) at the incoming trunk, to the positive pole of battery. The relay 73, when operated, at its armature and back contact interrupts the circuit for operating any of the remaining counting relays of the series so that only the number one counting relay 58 is operated. The remaining five units impulses are ineffective since the number one trunk is selected. If however, the number one trunk was busy and trunk number two was idle two units impulses would have been counted. The

circuits then function in the previously described manner, for selecting this trunk after which the trunk connects itself to the calling line by way of its finder relays and the link is released. Supervision and release operations are now controlled in the manner described for an outgoing trunk call.

The above description relates to a local telephone line which is equipped for non-restricted service, that is, it can make calls over a trunk to a distant exchange. It will be noted that in the case of such a line equipped for unrestricted service, the relay 53 of the link is operated over the sleeve circuit 42 including the calling subscriber's cut off relay 8. In the case of such a line the cut off relay 8 is connected in multiple with a resistance 170 to the negative pole of battery so that the relay 53 will operate. However, in the case of a line which is denied trunk service, the cut off relay 8 is not connected in multiple with the high resistance such as 170 (Fig. 2). In the case of such a line which is equipped for only limited service, the marginal relay 53 of the selected link will not operate. In such a case when the trunk number 66 is dialed, positive battery at the armature and back contact of relay 53 is extended over conductor 171', armature and front contact of the tens connector relay 168, conductor 134 to the sleeve conductor 97 of the link. Thus when change-over relay 77 releases at the close of the series of impulses, the circuit including conductor 97 is extended, thru the armature and back contact of relay 77, conductor 103, back contact and armature of the cut-in relay 69, back contact, continuity spring and winding of the release relay 49, conductor 104, winding of the busy relay 105. The release relay 49 is energized in series with the busy relay 105. Release relay 49 when operated effects the disconnection of the calling line from the link which it has seized. The calling line is now connected to the winding of its associated relay 7, and busy tone is supplied to this line until release, as previously described.

Provision is made in the present system so that either an outgoing trunk call or an incoming trunk call can be transferred by certain of the substations of the local automatic exchange to other local lines. In order to effect such transfer the local substation must be provided with a push button such as 171 enabling one side of the calling line to be connected to ground. For convenience in describing the operation of this transfer feature, it will be assumed that the calling line number 11 is connected to a central office trunk which connection has been completed in the manner already described. It will further be assumed that the party connected to the trunk circuit at the distant exchange finds that his connection should be transferred to line number 15. It will be remembered that with the line number 11 connected to the first trunk, namely trunk number 51, tens finder relay 144 and the units finder relay 145 will be operated. Also the relays 148, 157, 129, 153 and 127 of the trunk will be operated in the manner already described. Each of the trunk conductors to the distant office will be energized thru the plug contacts 161 and 162. However, at this time the relays 154 and 165 are not energized. Now when the subscriber at substation number 11, receives the information that the party on the distant end of the trunk should have the call transferred to line number 15 at the local exchange, the party at station number 11 operates the push button 171 momentarily and then dials the number 15. The actuation of this bush button grounds one side of the telephone line circuit which is effective to unbalance the differential relay 152 of the trunk so that this relay operates. When the relay 152 operates it closes a short circuit across its upper winding so that when once energized, it will remain operated even though the push button 171 is released. The upper contact and armature of the differential relay 152 connects the conductors 172 to 173 leading to the lockout circuit for the several lines. By this arrangement, the differential relay 152 acts in the same manner as a line relay of the telephone lines, and thus causes the operation of the tens lock-out relay 17 and the units lock-out relay 13. These two lock-out relays when operated, cause the allotter repeater relay such as 58 of the first idle link, to be operated which is assumed to be link number 2. The operation of the relay 58 causes the tens finder relay 175 and the units finder relay such as 32 of the second link to operate to connect the tip, ring and sleeve conductors of trunk number 51 to the tip, ring and sleeve conductors of link #2. The impulse relay similar to 44 of link #2 is energized over the tip and ring conductors of the calling line circuit. Relay 44 in turn causes relays similar to 45 and 55 of this link to be operated. On the operation of the relay 45, relay 151 of the trunk is operated, because the sleeve conductor of the trunk is connected to positive battery at link number 2 and is extended thru the finder relays and thence by the sleeve conductor of the trunk to the winding of the holding relay 151. Relay 151 at its make before break contacts connects a resistance coil 176 across the trunk conductors leading to the central office, for the purpose of holding this trunk and for providing supervision. If the push button 171 has been released by this time, then the opening of the back contact and armature of the holding relay 151 establishes a balanced circuit through the windings of the differential relay 152 for causing this relay to release. When the relay 152 is thus released it opens the operating circuit of the tens lock-out relay 17 and the units lock-out relay 13. However, the trunk is still held because the holding relay 151 is still operated. The conductors 176 and 177 leading from the relay 148 of the trunk are extended thru the units finder relay such as 32 and a tens finder relay such as 175, to the corresponding tip and ring conductors 40 and 41 of the second link, which last-named conductors are connected in series thru the upper and lower windings of the differential relay 43 and the impulse relay 44 respectively to the negative and positive poles of battery. The party at station number 11 now dials the number 15 corresponding to the number of the substation to which the call is to be transferred. In response to each of the series of impulses corresponding to the digits of the number 15, the impulse relay 44 successively operates the counting relays so that the tens connector relay 107 and the units connector relay 184 are operated to connect the line of substation number 15 to this second link. Ringing current is then supplied to the telephone line number 15 and when the subscriber thereat answers by removing his receiver from its switchhook, the ringing current is disconnected and the subscriber at station number 15 is in telephonic connection with the subscriber at station number 11. This last-named subscriber advises the subscriber at

station number 15 that a call is waiting him on the trunk. This latter subscriber then operates his push button similar to that shown at 171 to ground one side of the telephone connection. This operation is effective to unbalance the differentially wound relay 102 of the second link causing this relay to operate. When relay 102 is operated, a circuit is completed for operating the trunk release relay 47. This circuit is traceable from the negative pole of battery, winding of relay 47, front contact and armature of the relay 102, front contact and armature of the relay 101 (now operated) back contact and armature of the differential relay 43, conductor 183, front contact and armature of a tens finder relay similar to 175 which relay has cooperated in connecting line number 11 to line number 15. Trunk release 47 when operated locks itself in this condition at the innermost front contact and armature of relay 45, to the positive pole of battery. The release relay 178 of the trunk is now energized from the negative pole of battery, winding of this relay, conductor 179, armature and front contact of the units finder relay such as 32, armature and front contact of a tens finder relay similar to 175, conductor 180, front contact and armature of differential relay 102, back contact and armature of differential relay 43, conductor 183, front contact and armature of a relay similar to 175 to the positive pole of battery. The operation of the relay 178 opens the locking circuits for the finder relays 144 and 145 of the trunk circuit so that the telephone line number 11 is disconnected from the trunk and is transferred back to its own line circuit. It will be recalled that at this time the relay 7 is locked-energized in series with telephone line number 11. Since the cutoff relay 8 has been released by the disconnection of the line number 11 from the mentioned trunk, relay 7 while thus operated, maintains busy potential over the sleeve conductor 39 to maintain this line busy until the subscriber thereat replaces his receiver on its switchhook. As soon as the relay 7 is operated it applies a busy tone to the telephone line number 11 which continues to sound in the receiver at substation number 11 until the subscriber thereat replaces his receiver on the switchhook at which time the circuit of relay 7 is opened. This is effective to remove the busy potential from the sleeve conductor 39 and also disconnects the busy tone current from this line. As soon as the telephone line number 11 is disconnected from the mentioned trunk by the operation of the release relay 178, the relay 148 of the trunk circuit deenergizes but the slow releasing relay 157 of this trunk has a substitute circuit completed for itself at this time at the front contact and armature of relay 151. Also when the release relay 178 energizes it disconnects the telephone line number 11 from the calling end of the second link circuit so that the impulse relay 44 thereof deenergizes.

When the push button similar to 171 at substation number 15 is operated and then released, the differential relay 102 of the second link retracts its armatures thereby closing a circuit for operating the transfer relay 181 of this link. A circuit for operating the relay 181 (Fig. 8) extends from the negative pole of battery, winding of this relay, armature and front contact of relay 47, conductor 182, back contact and armature of relay 102, front contact and armature of relay 101, back contact and armature of differential relay 43, conductor 183, front contact and armature of a tens finder relay similar to 175 to the positive pole of battery. It will be recalled that when telephone line number 15 was selected by substation number 11, a tens connector relay similar to 107 and a units connector relay similar to 184 was operated. Corresponding finder relays 144 and 187 of the two-way trunk are now operated to extend this trunk to telephone line number 15. The circuit for operating the tens finder relay 144 of the trunk is traceable from the negative pole of battery, winding of this relay, conductor 185, armature and front contact of relay of a units finder relay such as 32, armature and front contact of a tens finder relay such as 175, armature and front contact of transfer relay 181, conductor 186, conductor 187, inner front contact and armature of tens connector relay 107, conductor 83, front contact and armature of slow releasing relay 45 to the positive pole of battery. The number 5 units finder relay 187 is also energized from the negative battery, winding of this relay, conductors 188 and 189, armatures and front contacts of relays 32 and 175, armature and front contact of transfer relay 181, conductor 190, conductor 191, front contact and armature of the number 5 units connector relay 184, conductor 83 to the positive pole of battery at the front contact and armature of slow releasing relay 45. The finder relays 144 and 187 when thus operated are held locked over a circuit including the conductor 158 which extends to positive battery at the front contact and armature of relay 129. This selection and operation of the trunk finder relays is of course made before the finder relays of the link and the transfer relay 181 release.

Also when the push button similar to 171 at substation number 15 is released, the release of the differential relay 102 effects the release of the slow releasing relays similar to 45 and 55 at the second link because one circuit of relay 45 is opened at a front contact and armature of the differential relay 102. The other branch operating circuit of the slow releasing relay 45 is opened at the back contact and armature of trunk release relay 47 since this relay is now operated. The release of relay 45 effects the release of relay 55. The relays 175, 32, 107 and 184 of the second link are released by the release of relay 45 at the second link. The relay 47 also deenergizes because its locking circuit is opened at the relay 45. However, relay 47 is slow releasing. Relay 181 is also released when the relay 47 deenergizes. The holding relay 151 of the trunk circuit is released because the relay 45 removes positive potential from the sleeve conductor leading to this ground. The trunk circuit is now connected to line number 15 and since the holding relay 151 is released, line number 15 is in telephone connection with the trunk. Line number 15 is thus in control of the release and of the supervision of the trunk circuit in the manner previously described to telephone line number 11.

A further feature of this invention enables the transfer operation to be effected among a series of telephone lines in succession provided each of these lines has a push button similar to 171 and a ground connection at its substation. The repeated transfer among the series of telephone lines in succession is effected in exactly the same manner as already described since the transfer of the trunk from a first line such as line number 11 to a second line such as number 15 places line number 15 in exactly the same condition as

was line number 11 so that the subscriber at line number 15 can push the button such as 171 and dial another number to effect the transfer to another line. The subscriber at this last-mentioned line can effect a further transfer by operating the push button at his substation and dialing a number still different to a telephone line.

In accordance with an additional feature of this invention there is provided an arrangement whereby the answering party can release the link to which he is connected and can reconnect his telephone line to the trunk. This is useful in the case where a local answering station dials the number of another telephone line but finds that this line is either busy or does not answer. The party at the local station then simply operates the push button such as 171 again which is effective to operate the differential relay such as 43 of the link to which he is connected. The operation of the relay such as 43 is effective only after a number has been dialed to operate the release relay 49 of the link and this relay opens the sleeve conductor of the link only when it is connected to a trunk. The circuit for operating the release relay 49 (Fig. 7) extends from positive battery, armature and front contact of relay 175 (Fig. 8), conductor 183, armature and front contact of relay 43, front contact and armature of the cut-in relay 69, back contact, continuity spring and winding of relay 49, conductor 104 and thence to negative battery thru the righthand winding of busy relay 105. The release relay 49 opens the holding circuit including the conductors 48 and 50 which circuit has been holding operated the finder relays which were operated to connect the second link to the trunk. However, the opening of the holding circuit does not take place until the differential relay 43 retracts its armature when the push button 171 is released. The release of the finder relays restores the second link circuit to normal and disconnects telephone line number 11 from this link circuit. The release of these finder relays also opens the circuit to the holding relay 151 of the trunk which relay releases. Line number 11 is now reconnected to the trunk circuit and the local subscriber now advises the distant party that the wanted party is not available. The connection can be released as just described or another local station may be dialed in search of the wanted party, all of which operations take place in the manner already described.

The present system is so arranged that on an ordinary call to a busy line, the link is released and the calling line is rendered busy till the subscribed thereat hangs up. This condition however, does not exist when a call is transferred to a busy line because it must be possible for the calling party to reconnect with the trunk in use. When a telephone line attempts to transfer a call to a busy line, the release relay 49 of the link in use will be operated and locked-operated. This prevents the change-over relay 77 from operating. Under this condition the operation of the release relay 49 does not effect the release of the cut-off relay 8 of the calling line because of the holding circuit provided by the extreme right-hand contact of relay 195 and the back contact of busy relay 197. Busy tone is applied to the calling line thru a back contact of the busy relay 197 and a front contact of release relay 49. Now when the transfer button switch 171 is operated, differential relay such as 43 attracts its armatures to close an operating circuit for the relay 197 which is completed over conductor to positive battery at relay 175. When the button such as 171 is released relay 43 releases but before the slow releasing relay 197 releases, the holding circuit for the finder relays is open and they release. This releases the relay 151 of the trunk and the calling line is transferred back to this trunk circuit.

What I claim is:

1. The method of connecting a telephone line to an idle trunk of a series of trunks which comprises transmitting thru said line a series of impulses at least equal in number to the number of trunks in said series, each of said impulses corresponding to a different trunk, utilizing said impulses in succession to effect the testing of the selectability of said series of trunks in succession, seizing the first selectable trunk in the series in response to said testing, and rendering the impulses corresponding to the remaining trunks of the series ineffective.

2. The method of connecting a telephone and its telephone line to one trunk of a series of trunks on which trunk, an incoming call is awaiting extension, which method comprises signalling in the range of said telephone and thru said trunk that a call on said trunk is awaiting extention, transmitting thru said telephone line on noting said signal, a series of impulses equal in number to the number of trunks in said series, utilizing said impulses in succession to effect the testing of certain of said trunks of the series in succession until said trunk is found, seizing said trunk in response to said testing, and rendering the impulses corresponding to the remaining trunks of the series ineffective.

3. The method of connecting a telephone and its telephone line to one trunk of a series of trunks, on which trunk an incoming call is awaiting extension and subsequently connecting a second telephone and its line to said trunk and releasing the first mentioned telephone line therefrom, which method comprises signalling in the range of said telephone and thru said trunk while a call on said trunk is awaiting extension, transmitting thru said telephone line on noting said signal, a series of impulses equal in number to the number of trunks in said series, utilizing said impulses in succession to effect the testing of certain of said trunks of the series in succession until said trunk is found, seizing said trunk in response to said testing, rendering the impulses corresponding to the remaining trunks of the series ineffective, ascertaining over said first telephone line and said trunk that a second telephone and its telephone line are wanted, and transferring the telephone connection between said trunk and said first-mentioned telephone line from said trunk to said second telephone line.

4. In a telephone system, a plurality of telephone lines, a trunk line, means including link circuits for interconnecting said telephone lines and said trunk, means for rendering telephone lines in use busy, means for releasing the connection from a calling telephone line to a busy called telephone line, means including a relay individual to said calling telephone line for applying a busy signal thereto in response to the releasing of the connection to said called telephone line, means including a link circuit for transferring a connection from one called telephone line to a second telephone line, and means associated with said last-mentioned link and responsive to the busy condition of said second telephone line for

applying a busy signal to said called telephone line.

5. In a telephone system, a telephone line, a series of trunks, means including a connector for seizing a selectable trunk of the series and for connecting said trunk to said telephone line, means associated with said telephone line for generating a series of impulses at least equal in number to the total number of trunks in the series, means in said connector for counting the number of trunk impulses generated and for testing the selectability of said trunks in succession, and means for disabling the counting of said impulses when a selectable trunk in the series is found.

6. In a telephone system, a telephone line, a series of trunks, means including a link and a connector for seizing a selectable trunk of the series and for connecting said trunk to said telephone line, means associated with said telephone lines for generating a series of impulses at least equal in number to the total number of trunks in the series, means in said connector for counting the number of trunk impulses generated and for testing the selectability of said trunks in succession, means for disabling the counting of said impulses when a selectable trunk in the series is found, and means for connecting the selected trunk to said telephone line independently of said link and for releasing said link for immediate use.

7. In a telephone system, a telephone line, a series of trunks, means associated with said telephone line for generating a series of trunk impulses at least equal in number to the total number of trunks in the series, means including a connector for counting the number of impulses generated and for testing the selectability of said trunks in succession, means for disabling the counting of said impulses when a selectable trunk in the series is found, means including said connector for seizing said selectable trunk and for connecting said trunk to said telephone line, and means responsive to the connection of said trunk to said telephone line for releasing said connector.

8. In a telephone system, a telephone line, a series of trunks, means associated with said telephone line for generating a series of trunk impulses at least equal in number to the total number of trunks in the series, means including a connector for counting the number of impulses generated and for testing the selectability of said trunks in succession, means for disabling the counting of said impulses when a selectable trunk in the series is found, means including said connector for seizing said selectable trunk and for connecting said trunk to said telephone line, means responsive to the connection of said trunk to said telephone line for releasing said connector, and means responsive to the busy condition of all of said trunks for applying a busy signal to said telephone line.

9. In a telephone system, telephone lines, a trunk circuit, means for rendering said telephone lines idle or busy, a link circuit common to all of said telephone lines, means including said link circuit for selectively connecting one of said telephone lines to another of said telephone lines or to said trunk circuit, means responsive to the connection of said one line to said trunk circuit for establishing a by-pass connection said one line to said trunk independently of said link, and means responsive to an attempted connection from said one line to another busy line for releasing said link for immediate use.

10. In a telephone system, a telephone line, a plurality of trunk lines, a trunk finder of the all relay type associated with each trunk line, and means for automatically operating the trunk finder of a trunk line in use on an incoming call or the trunk finder of an idle one of said trunk lines in response to a local party dialling two different predetermined code numbers, one for incoming trunk calls and the other for outgoing trunk calls.

11. In a telephone system, a telephone line, a plurality of trunk lines, a trunk finder of the all relay type associated with each trunk line, means for automatically operating the trunk finder of a trunk line in use on an incoming call or the trunk finder of an idle one of said trunk lines in response to a local party dialling two different predetermined code numbers, one for incoming trunk calls and the other for outgoing trunk calls, and means for selectively registering different combinations of impulses for either of said code numbers in accordance with the busy or idle condition of one of said trunk lines.

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