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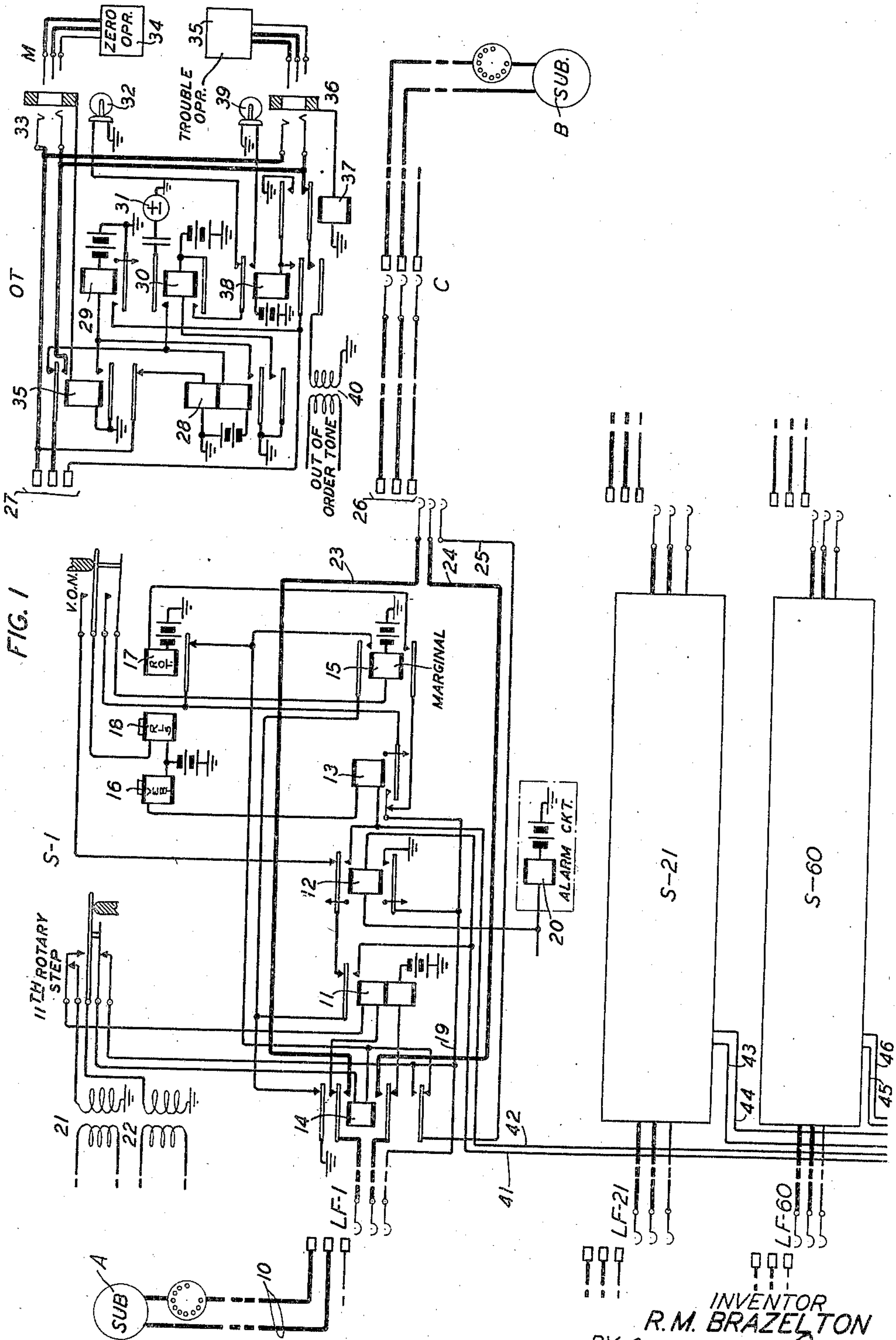
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2,143,971

TELEPHONE SYSTEM

Filed March 27, 1937

2 Sheets-Sheet 1



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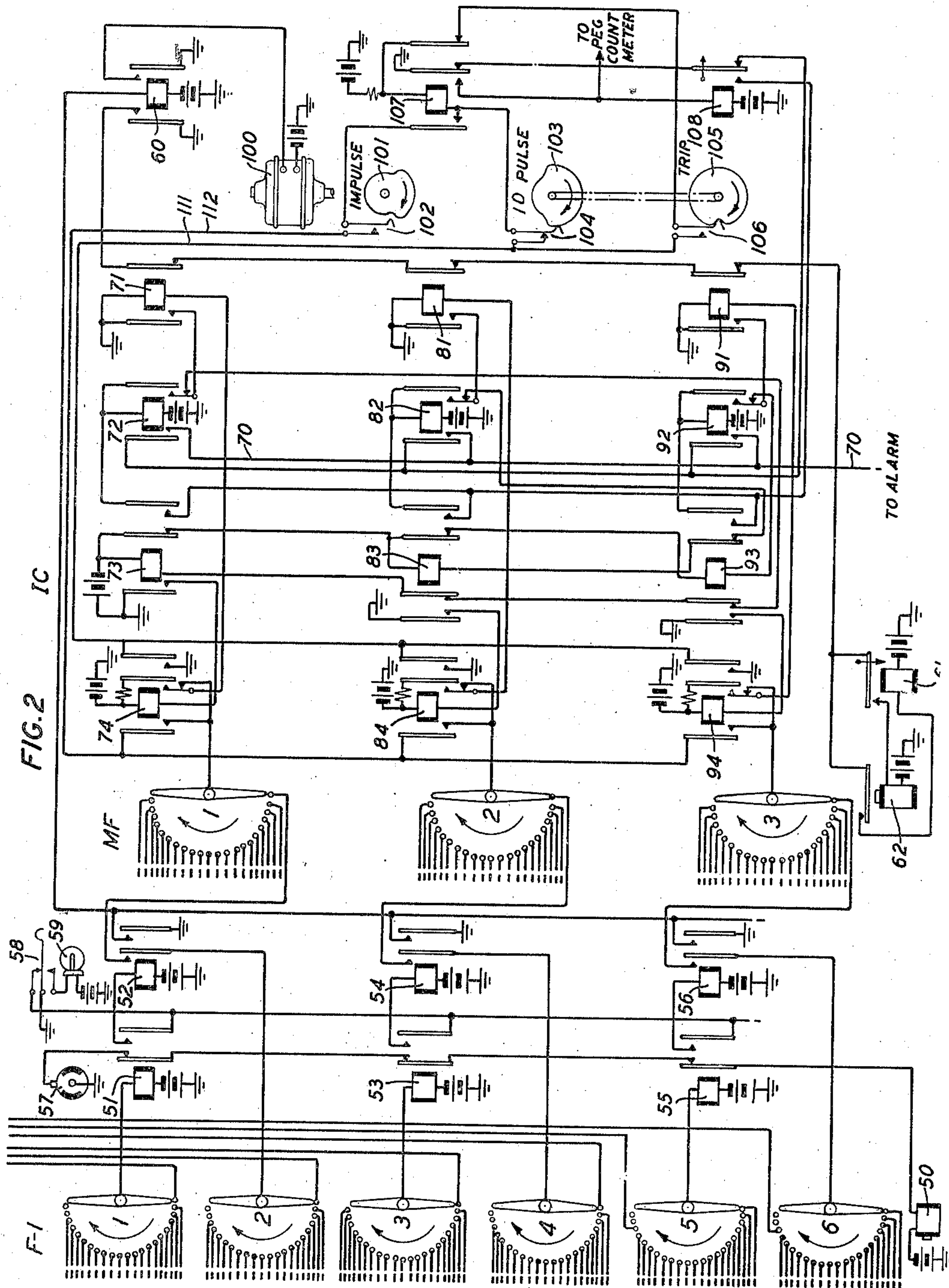
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TELEPHONE SYSTEM

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16 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems in which directly controlled electro-magnetic switches are used in establishing desired connections.

It is the object of the invention to improve the quality of the service rendered and moreover at the same time reduce the maintenance effort in automatic telephone systems of the type in which the switches are directly controlled by digit impulses from the calling station.

In automatic telephone systems in which registers are provided for receiving the directive impulses from calling stations it is usual to provide for automatically connecting a subscriber's line to an operator in case impulses are not received by the register within a predetermined interval of time, such as thirty seconds, after the register is connected to the line. By this arrangement, a large part of such cases are promptly disposed of and the lines restored to service by the operator without requiring any attention by the switch-room or test-room attendants; and it is necessary to trace the call and identify the calling line in comparatively few cases. Heretofore in systems in which registers are not provided and the switches are directly controlled by the impulses from calling stations, it is usual to provide a permanent signal alarm which is effective, a predetermined interval, such as twenty minutes, after a line is connected to a first selector and no directive impulses have been received, to summon a maintenance attendant who thereupon traces the call and frees the line-finder and selector switches from the line. According to this invention an arrangement is provided in an automatic telephone system in which the directive impulses from calling subscribers' stations are received by switches through which desired connections are established, for automatically connecting a calling line, from which no directive impulses are received within a predetermined interval, such as thirty seconds after the line is connected to a first selector, to an operator.

According to a feature of the invention, common timing and control equipment is provided for the first selector switches in an automatic telephone system, with means for automatically attaching the equipment to any first selector in the group upon its connection with a calling line, the control equipment being effective in case directive impulses are not received by the selector within a predetermined time thereafter to transmit impulses to the selector and operate the selector to connect the calling line over an idle trunk to an operator. The trunks thus employed

may be located on the tenth or "zero" level or on a level other than the "zero" level, if such other level is available. An additional feature is the provision of means for stopping the operation of the control equipment, in so far as its connection with a particular group of first selectors is concerned and in case permanent signal calls are routed to an operator over "zero" level trunks, whenever the maximum allowable number of trunks in the level have been seized and are being held on permanent signal calls.

These and other features of the invention will be better understood by considering the system which is shown schematically in the drawings which form a part of this specification, this system being one arranged in accordance with the invention. It is of course understood that the invention is not limited in its application to the particular system shown in the drawings, but may be applied to any automatic system not otherwise provided with means for automatically routing permanent signal calls to an operator.

Referring to the drawings:

Figure 1 shows an automatic telephone office comprising a calling subscriber's station A, a line-finder LF—1 and associated first selector switch S—1, other line-finders LF—21 and LF—60 and first selectors S—21 and S—60 in the same group, a connector switch C, a called subscriber's station B, a trunk OT and a manual switchboard M;

Fig. 2 shows a control circuit IC common to all of the first selectors in the office and shows a master-finder switch MF and one finder switch F—1 of a group of primary finders by which the control circuit IC is connected to the first selectors one at a time.

The line-finder, selector, and connector switches are of the well-known two-motion step-by-step type. Reference may be had to pages 53 to 65, inclusive, of the second edition of "Automatic Telephony" by Smith and Campbell for a description of the structure of such switches and their operation when used as selectors or connectors. The line-finder switches LF—1 LF—21 and LF—60 are each represented in the drawings by a set of brushes and a single set of terminals; reference may be had to Patent 1,799,654 granted to R. L. Stokely, April 7, 1931, for a description of the operation of a step-by-step switch when used as a line-finder. The selector S—1 is represented by its set of brushes and two sets of terminals 26 and 27, the other selectors S—21 and S—60 are represented by a set of brushes and a single set of terminals. The terminals 26 represent a level of

the bank giving access to succeeding selectors or connectors, as the case may be, and the terminals 27 represent the "zero" (tenth) level through which access is given to trunks leading to "zero" operator. The trunk OT terminates in an answering jack 33, and since in this case the same group of trunks is also used for permanent signal calls, the auxiliary jack 36 and associated relays 37 and 38 are provided for use and operation on such calls. The operation of the selector S—1 and operation of trunk OT are hereinafter described in detail.

The finder switches such as F—1 are rotary step-by-step switches each comprising six brushes and terminal banks, there being twenty-two terminals in each bank only twenty of which are used in the arrangement shown. Each pair of brushes gives access to twenty first selectors, there being two conductors from each selector which conductors connect to like numbered terminals on two of the banks. For instance, conductors 41 and 42 from selector S—1 are connected to terminal 1 in each of banks 1 and 2 of switch F—1, conductors 43 and 44 from selector S—21 are connected to terminal 1 in banks 3 and 4, and conductors 45 and 46 from selector S—60 are connected to terminal 20 in banks 5 and 6. Thus each finder switch, such as F—1, gives access to a group of sixty first selectors. The master finder switch MF is also a 22-point rotary step-by-step switch, each of the three brushes and banks of which serves to connect the control circuit IC to 22 primary finders, thereby providing for the connection of the control circuit IC to a maximum of 1320 first selectors. It is, of course, understood that finder switches of other types and having a different number of brushes and banks and a different number of terminals in a bank may be provided, and thereby give access to whatever number of first selectors there may be in the office in question. The conductors 41, 43, 45, etc., are each connected to the front contact of the line relay of the associated selector; so that, when the line relay operates, it connects ground to this conductor; and, when the first dial impulse is received, the release of the line relay opens this connection. The other conductors such as 42, 44 and 46 are each connected through the winding of the change-over relay to the winding of the vertical stepping magnet of the associated first selector.

The primary finder switches such as F—1 are normally hunting for selectors which have been seized and not yet moved off normal. The circuit for operating the stepping magnet 50 of finder F—1 is traced through the back contacts of relays 55, 53 and 51 and through the 60 impulse-per-minute interrupter 57 to ground. When a finder switch such as F—1 finds the terminals of a selector which has been seized but not yet moved off normal the ground potential over the conductor such as 41 is effective to operate a relay such as relay 51, to stop the finder on these terminals, and to start the energization of a timing relay, such as relay 52, the operation of which requires an interval of from 30 to 60 seconds. If the selector is moved off normal before the expiration of this interval, the hunting operation of the finder switch is resumed; but if the selector is not moved off normal before this interval has expired the timing relay is operated and the master finder switch MF set in motion to connect the control circuit IC to the conductor such as 42 from the selector

in question. The control circuit IC is thereupon effective to transmit impulses over this conductor to operate the vertical-stepping magnet of this selector and raise the brushes to the "zero" level or to any other desired level. The impulses are created by the operation of an impulse mechanism comprising the motor 100, cams 101, 103 and 105, and contacts 102, 104 and 106. The "10 pulse" cam 103 and "trip" cam 105 are mounted on the same shaft to rotate together; but "impulse" cam 101 is geared to make eighteen or twenty revolutions to one revolution of cams 103 and 105, the contact 102 being closed ten times by cam 101 during the interval that contact 104 is closed by cam 103.

The operation of the finder switches and common timing and alarm mechanism will be further described by assuming the connection of the selector S—1 to a calling line. The receiver having been removed from the receiver hook at a calling station A and the line 10 having been connected by operation of the line-finder LF—1 through its brushes to the line relay 11 of the associated first selector S—1, relay 11 is energized. Relay 11 closes a circuit for operating release relay 12 and relay 12 connects ground to sleeve conductor 19 to hold the line-finder switch LF—1 and the cut-off relay (not shown) of line 10 in usual manner. Relay 20 of the common alarm circuit is energized in series with relay 12 and starts the operation of the usual timing equipment whereby a maintenance alarm will be given within an interval of about twenty to forty minutes. When relay 11 operates, the ground at the uppermost back contact of relay 14 is connected to conductor 41 and, as soon as brush 1 of finder switch F—1 encounters the terminal to which conductor 41 is connected, relay 51 operates thereby preventing the further operation of stepping magnet 50. Relay 51 closes a circuit for energizing the timing relay 52. Relay 52 is designed to operate within an interval of from thirty to sixty seconds after its operating circuit is closed; and, if the line relay of the selector releases (in response to the first dial impulse) prior to operation of relay 52, relay 51 releases and the hunting operation of the finder switch F—1 is resumed. In this case the selector S—1 responds to the dial impulses in usual manner to select a desired level of the bank and an idle set of terminals in the selected level. The call is thereafter completed through a connector switch such as C to a called line B in usual manner.

If, however, the calling subscriber fails to dial, or if some trouble condition has given rise to the extension of the line 10 to the first selector S—1, relay 52 operates and closes a circuit for operating the start relay 60 of the control circuit IC. Relay 60, when operated, closes a circuit for motor 100 which drives the shaft of the impulse mechanism. If now the control circuit is not in use, a circuit is closed from battery through the winding of stepping relay 61, back contact of stepping magnet 62 of finder MF and through the back contacts of relays 91, 81 and 71 to ground at the front contact of start relay 60. Relay 61 connects the winding of magnet 62 to the same ground; when magnet 62 operates, it disconnects relay 61, and the release of relay 61 disconnects magnet 62 from this ground. Each operation and release of magnet 62 causes the advance of the brushes of switch MF one step, the alternate operation and release of relay 61 and magnet 62 continuing until one of relays 71, 81 and 91 is

operated. Assuming that brush 1 of switch MF encounters the terminal to which the inner front contact of relay 52 is connected, a circuit is closed from battery through the vertical-stepping magnet 16 of selector S—1, winding of relay 13, conductor 42, terminal and brush 2 of finder F—1, inner front contact of relay 52, terminal and brush 1 of switch MF, back contact of relay 74, and through the winding of relay 71 to ground. The current in this circuit is insufficient to cause operation of the vertical magnet 16 or change-over relay 13 of selector S—1 but is sufficient to operate relay 71 and thereby stop the advance of switch MF. Assuming that neither of relays 81 and 91 is at this time energized in a like circuit, the operation of relay 71 closes a circuit through back contacts of relays 72, 93, and 93 for operating relay 73. The operation of relay 73 prevents the operation of either relay 83 or 93 until the required operation of the selector, which is connected to relay 71, has been completed. Relay 73 also closes an obvious circuit for operating relay 74. Relay 74 opens the connection between conductor 42 and the winding of relay 71, connects this conductor through conductor 112 to the impulse contact 102 of cam 101, closes a holding circuit for relay 71 and connects ground through conductor 111 to the contacts 104 and 106 of cams 103 and 105. If, when relay 74 operates, the contact 106 of cam 105 is closed, relay 107 cannot operate since its winding is short-circuited by its own outer back contact and contact 106; but as soon thereafter as contact 106 is opened, relay 107 operates through contact 104. Relay 107 closes a circuit for operating relay 108. With relay 107 operated, the next succeeding ten closures of impulse contact 102 transmits a series of ten impulses to the vertical-stepping magnet 16 of selector S—1. This impulse circuit is traced from ground at the front contact of relay 74, over conductor 111, through contact 104, left front contact of relay 107, impulse contact 102, conductor 112, left front contact of relay 74, brush 1 and terminal of switch MF, inner front contact of relay 52, brush 2 and terminal of switch F—1, over conductor 42 to selector S—1, winding of relay 13, and through the winding of magnet 16 to battery. When the ten impulses have been transmitted contact 104 opens and relay 107 releases so that contact 102 is ineffective to transmit any more impulses over conductor 112. The release of relay 107 opens the operating circuit of relay 108; since relay 108 is slow in releasing a circuit is closed momentarily from ground at the inner back contact of relay 107, through the front contact of relay 108, right front contact of relay 73 and the winding of relay 72 to battery. Relay 72 operates and closes a locking circuit through its right front contact to ground at the front contact of relay 71. The operation of relay 72 causes the release of relay 73; the release of relay 73 causes the release of relay 74; the release of relay 74 causes the release of relay 71; and the release of relay 71 causes the release of relay 72. If, when relay 73 releases, either one of relays 81 or 91 is operated, the corresponding one of relays 83 and 93 is operated without further operation of switch MF. In this case the associated relays and impulse mechanism transmits impulses over conductor 112, and through the left front contact of relay 84 or relay 94, to operate that one of the first selectors to which this conductor is connected. If relay 72, 82 or 92 fails to release after relays 107 and 108 release, ground is connected through the inner back contact of

relay 107, back contact of relay 108 and left front contact of relay 72, 82 or 92, over conductor 70 to an alarm circuit.

The first impulse transmitted from the impulse control equipment IC over conductor 42 to selector S—1 operates relay 13 and magnet 16. Relay 13 is slow in releasing and remains operated while magnet 16 responds to the succeeding impulses in the series. Each operation of magnet 16 raises the brushes one step; and, assuming that ten impulses are received, the brushes are raised to the tenth level. When the shaft and brushes are moved out of normal position, the vertical off-normal springs VON are actuated, closing a circuit for operating relay 15, this circuit is traced from battery through the winding of relay 15, lower contact of the VON springs, front contact of relay 13 to ground at the lower front contact of relay 12. Relay 15 closes a holding circuit which includes the back contact of rotary-stepping magnet 17, its own upper front contact, and the uppermost back contact of relay 14. When relay 13 releases after all of the impulses in the series have been received from control equipment IC, a circuit is closed for operating the rotary-stepping magnet 17; this circuit includes the lower front contact of relay 15, the back contact of relay 13 and the lower front contact of relay 12. Magnet 17 operates advancing the brushes into engagement with the first set of terminals in the tenth level (or other selected level if trunks to a trouble operator are connected to some other level of the bank). The operation of magnet 17 causes the release of relay 15; and the release of relay 15 causes the release of magnet 17. If the trunk connected to the first set of terminals is idle, the cut-through relay 14 is operated when magnet 17 releases; the operating circuit is traced from battery through the winding of relay 15, lower contract of springs VON, back contact of magnet 17, winding of relay 14, lower contact of the "11th rotary step" springs, to ground at the lower front contact of relay 12. Being marginal, relay 15 does not operate in series with relay 14. If, however, the first trunk is busy, the lower brush of switch S—1 encounters a ground potential which short-circuits the winding of relay 14, thereby causing the reoperation of relay 15 instead of the operation of relay 14. Relay 15 again closes the circuit for operating magnet 17 and the brushes are advanced to the next set of terminals, the above-described cycle of operation of relay 15 and magnet 17 being repeated until an idle trunk is found at which time relay 14 operates. The operation of relay 14 disconnects relay 11 from line 10 and extends the connection from line 10, through the inner front contacts of relay 14 over conductors 23 and 24 and the upper brushes of switch S—1 to the windings of line relay 28 of the selected trunk OT. Relay 11 releases and relay 28 operates. Relay 28 closes a circuit for operating slow-to-release relay 29. Relay 29 connects ground to the lower terminal of set 27, thence through the lower brush of switch S—1, conductor 25 and lowermost front contact of relay 14 to sleeve conductor 19 to hold relay 14 operated and to hold the line-finder switch LF—1 in usual manner. The release of relay 11 causes the release of relay 12; but being slow in releasing relay 12 does not open its lower front contact until after relay 29 has connected ground potential to conductor 19. The operation of relay 28 also closes a circuit for operating relay 30. Relay 30 closes a circuit for lighting the an-

swering lamp 32 at the "zero" operator's position and connects the ringing source 31 to the lower talking conductor of the trunk, an audible signal being thereby transmitted to the calling station to indicate that an operator is being signaled. When an operator answers the call by inserting a plug in answering jack 33, relay 35 is operated through the sleeve of the plug. Relay 35 disconnects relay 28 thereby causing the release of relays 28 and 30, but relay 29 is held to ground at the front contact of relay 35. The answering operator then requests the calling subscriber to replace the receiver; if the call cannot thus be dismissed, a plug is inserted in the jack 36 to which trunk OT is connected at a trouble operator's position thereby causing operation of relay 37. The "zero" operator's cord is thereupon disconnected from jack 33 so that relay 35 releases and relays 28, 29 and 30 reoperate. Relay 37 closes a circuit for operating relay 38 and relay 38 locks under control of relay 29. With relay 38 operated, a circuit is closed for lighting lamp 39 at the trouble position. The plug may then be removed from jack 36 releasing relay 37. Since relay 38 is held operated under control of relays 28 and 29, lamp 39 remains lighted and the out-of-order tone source 40 is connected to one of the talking conductors. If then the calling subscriber replaces the receiver (or the trouble condition is removed), relay 28 releases thereby causing the release of relays 28, 30 and 38; and lamp 39 is extinguished. The release of relay 29 disconnects ground potential from the sleeve terminal thereby causing the release of relay 14 of selector S-1 and the return of the switches S-1 and LF-1 to normal in usual manner.

By means of the lamps such as 39 of the trunks in the group with OT, the trouble operator knows how many of the trunks in this group are being held on permanent signal calls; and, if this number of trunks leaves only enough trunks for use on "zero" operator calls, the key 53, associated with primary finders having access to the first selectors to the banks of which this group of trunks is multiplied, is operated thereby stopping the operation of these primary finders so that no more permanent signal calls can be automatically extended to an operator. If a selector is seized and no dial impulses are received and the primary finder having access thereto has been stopped by operation of the key such as 53, the permanent signal alarm relay 20 is operated and an alarm actuated after an interval of from 20 to 40 minutes has elapsed.

What is claimed is:

1. In a telephone system comprising lines and selector switches and means for automatically connecting calling lines to said selectors, switching means for finding a selector to which a calling line is connected, and control means individual to said switching means, said control means rendered effective a predetermined interval of time following the finding of such a selector for automatically causing the selective operation of said selector.

2. In a telephone system comprising selectors and means for automatically connecting calling lines to said selectors, an impulse mechanism common to said selectors, finder switches for use in connecting said mechanism to any one of said selectors, means effective a predetermined interval of time after a calling line is connected to one of said selectors for completing the connection between said selector and said impulse mechanism,

and means comprising said impulse mechanism and a stepping magnet of said selector for advancing the brushes of said selector to select a desired group of terminals in the bank of said selector.

3. In a telephone system comprising lines and selectors and means responsive to the origination of a call for extending the calling line to an idle one of said selectors, a finder switch, a plurality of said selectors being connected to terminals in the bank of said finder switch, means for advancing the brushes of said switch, means for stopping the advance of the finder switch as soon as its brushes encounter the terminals of a selector to which a calling line is connected and which has not yet been selectively operated, an impulse mechanism, means effective a predetermined interval of time after the advance of said switch is stopped for connecting said impulse mechanism to said selector, and means comprising said impulse mechanism and a stepping magnet of said selector for operating said selector to select a desired group of terminals in the bank of said selector.

4. In a telephone system comprising lines and selectors and means responsive to the origination of a call for extending the calling line to an idle one of said selectors, primary finder switches, a different group of said selectors being connected to terminals in the bank of each of said finder switches, means for advancing the brushes of said switches, means for stopping the advance of a finder switch when its brushes engage the terminals of a selector to which a calling line is connected and which has not been selectively operated, an impulse mechanism common to all of said finder switches, means operative a predetermined interval of time after the advance of one of said primary finders is stopped and comprising a master finder switch for connecting said impulse mechanism to the selector with whose terminals the brushes of said one of the primary finders are in engagement, and means comprising said impulse mechanism and a stepping magnet of said selector for selectively operating said selector.

5. In a telephone system according to claim 2, means effective upon completion of said selective operation of the selector for disconnecting said impulse mechanism from the selector.

6. In a telephone system according to claim 3, means effective upon completion of said selective operation of the selector for disconnecting said impulse mechanism from the selector, the advance of said finder switch being thereupon resumed.

7. In a telephone system comprising lines and selectors and means for automatically connecting calling lines to selectors, primary finder switches each having a plurality of sets of brushes, each of said selectors being connected to terminals accessible to one of said sets of brushes, means for advancing the brushes of said finder switches, a control relay and a timing relay for each of said sets of brushes, means for stopping the advance of any one of said finder switches when one of its sets of brushes engages the terminals of a selector to which a calling line is connected and which is awaiting selective operation, said stopping means including the control relay of whichever set of brushes engages the terminals of such a selector, a master finder switch having a plurality of brushes, a contact on each of said timing relays for connecting the associated brush

of a primary finder switch to a different terminal accessible to one of the brushes of said master finder switch, means for starting the operation of said master finder switch whenever one of said control relays operates to stop the advance of a primary finder switch, said starting means including the timing relay associated with said one of the control relays, means for stopping the operation of said master finder switch when one of its brushes engages the terminal to which the contact of said timing relay is connected, said stopping means including a relay individual to said one of the brushes of the master finder switch, an impulse mechanism, relay means individual to each of the brushes of said master finder switch for operatively and separately connecting said impulse mechanism to the brushes of the master finder switch, and means including said impulse mechanism, a brush of said master finder switch, the contact of one of said timing relays, a brush of a primary finder switch and the operating magnet of a selector which is awaiting selective operation for advancing the brushes of said selector to select a desired group of terminals.

8. In a telephone system comprising lines and selectors and means for connecting calling lines to said selectors, an impulse mechanism common to said selectors, a finder switch for use in connecting said impulse mechanism to any one of a plurality of said selectors, means for advancing the brushes of said finder switch, means for stopping the advance of said finder switch when it engages the terminals of a selector to which a calling line is connected and which is awaiting selective operation, means effective within a predetermined interval of time after such a selector is found for completing the connection between said selector and said impulse mechanism, a group of trunks connected to one of the groups of terminals in the banks of each of said plurality of selectors, means comprising said impulse mechanism and an operating magnet of said selector for advancing the brushes of said selector to said group of trunks, and means in said selector for automatically selecting an idle one of said trunks.

9. In a telephone system according to claim 8, a manual switchboard, an answering jack and a trouble jack at said switchboard, both of said jacks being connected to said selected trunk, an answering lamp and means effective upon seizure of said trunk for lighting said lamp, a trouble lamp, and means including said trouble jack for lighting said trouble lamp in place of said answering lamp.

10. In a telephone system comprising lines and selectors and means responsive to the origination of a call for extending the calling line to an idle one of said selectors, a finder switch, a plurality of said selectors being connected to terminals in the bank of said finder switch, means for advancing the brushes of said switch, means for stopping the advance of the finder switch as soon as its brushes encounter the terminals of a selector to which a calling line is connected and which has not yet been selectively operated, an impulse

mechanism, means effective a predetermined interval of time after the advance of said switch is stopped for completing a connection between said impulse mechanism and said selector, a manual switchboard, a group of trunks leading from the banks of said plurality of selectors to said switchboard, means comprising said impulse mechanism and a stepping magnet of said selector for operating said selector to select said group of trunks, and means for automatically operating said selector to seize an idle one of said trunks.

11. In a telephone system comprising lines and selectors and means responsive to the origination of a call for extending the calling line to an idle one of said selectors, primary finder switches, a different group of said selectors being connected to terminals in the bank of each of said finder switches, means for advancing the brushes of said switches, means for stopping the advance of a finder switch when its brushes engage the terminals of a selector to which a calling line is connected and which has not been selectively operated, an impulse mechanism common to all of said finder switches, means operative a predetermined interval of time after the advance of one of said primary finders is stopped and comprising a master finder switch for connecting said impulse mechanism to the selector with whose terminals the brushes of said one of the primary finders are in engagement, a manual switchboard, groups of trunks leading from the banks of said selectors to said switchboard, the trunks in each of said groups being connected to the banks of the selectors in one or more of said groups of selectors, means comprising said impulse mechanism and a stepping magnet of said selector for operating said selector to select said group of trunks, and means for automatically operating said selector to seize an idle one of said trunks.

12. In a telephone system according to claim 2, keys, the operation of each key being effective to prevent the operation of one or more but not all of said finder switches.

13. In a telephone system according to claim 3, a key, and contact means controlled by said key for stopping the operation of said finder switch.

14. In a telephone system according to claim 8, a key, and contact means controlled by said key for stopping the operation of said finder switch.

15. In a telephone system according to claim 11, keys, one for each of said groups of trunks, and contact means controlled by each of said keys for preventing the operation of the finder switch or switches, having access to the selectors in whose banks the trunks of any group are connected.

16. In a telephone system comprising lines and selector switches and means for automatically connecting calling lines to said selectors, said selectors being controlled directly over calling lines, switching means for finding a selector to which a calling line is connected, and control means rendered effective a predetermined interval of time following the finding of such a selector for automatically causing the selective operation of said selector.

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