May 20, 1941. J. A. KATER 2,242,397

TELEPHONE SYSTEM

Filed March 3, 1939 2 Sheets-Sheet 1

FIG. 1

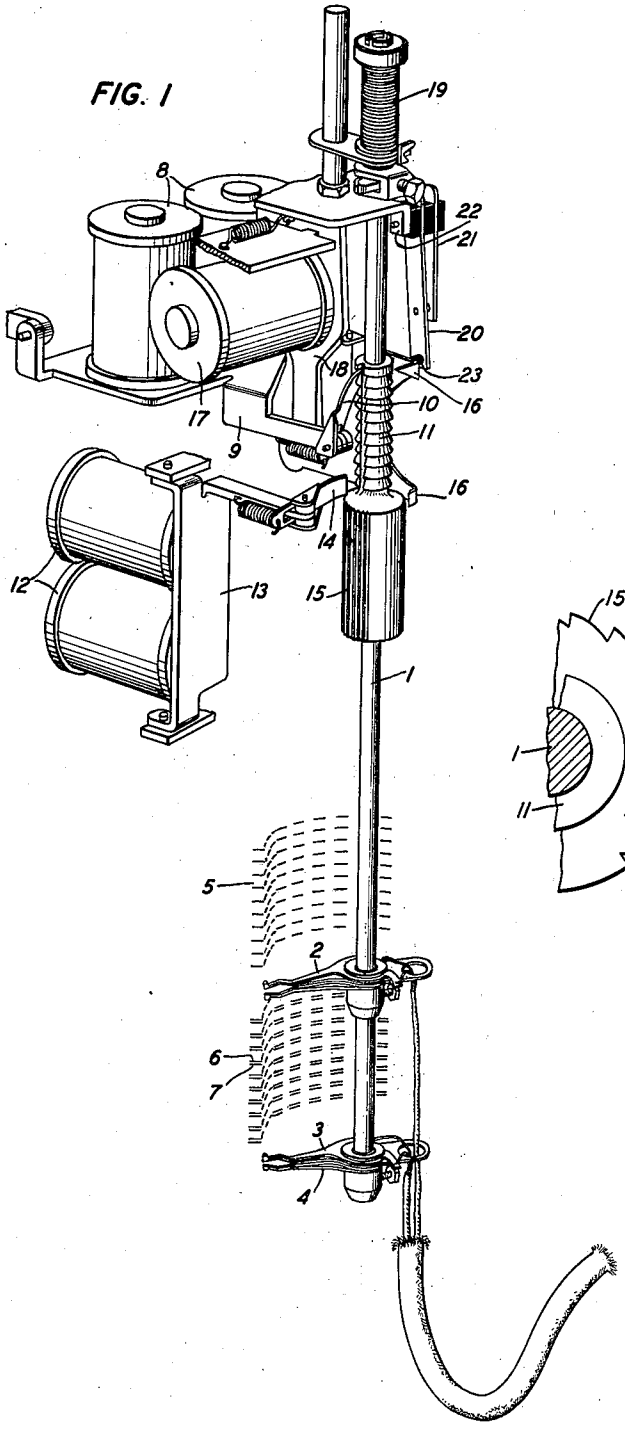

FIG. 2

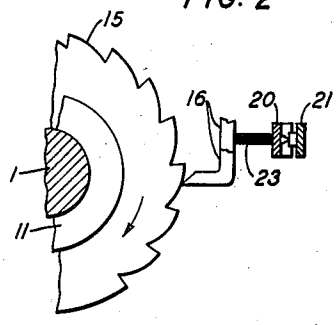

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FIG. 3

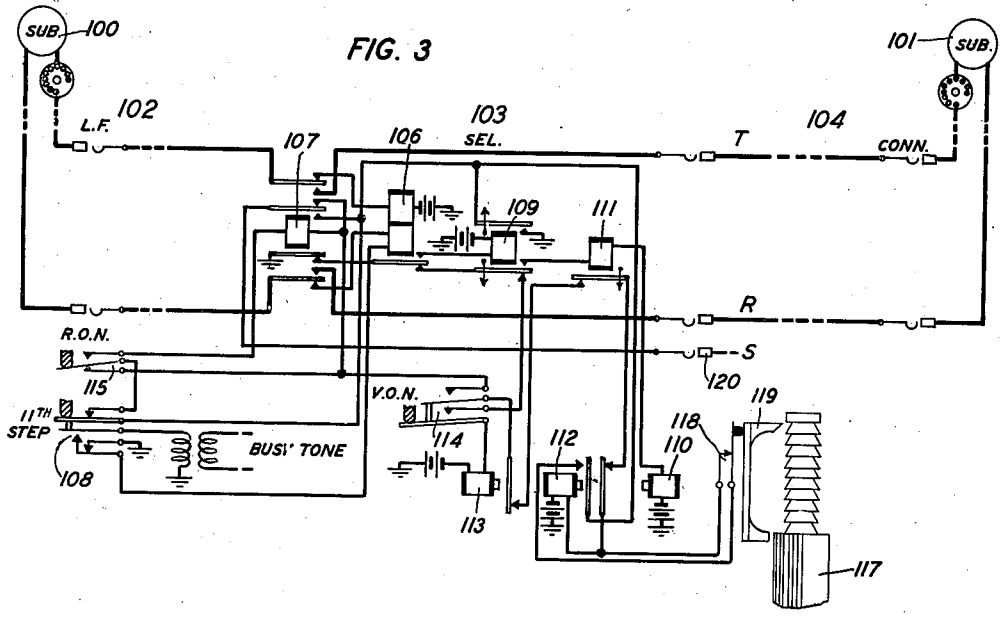
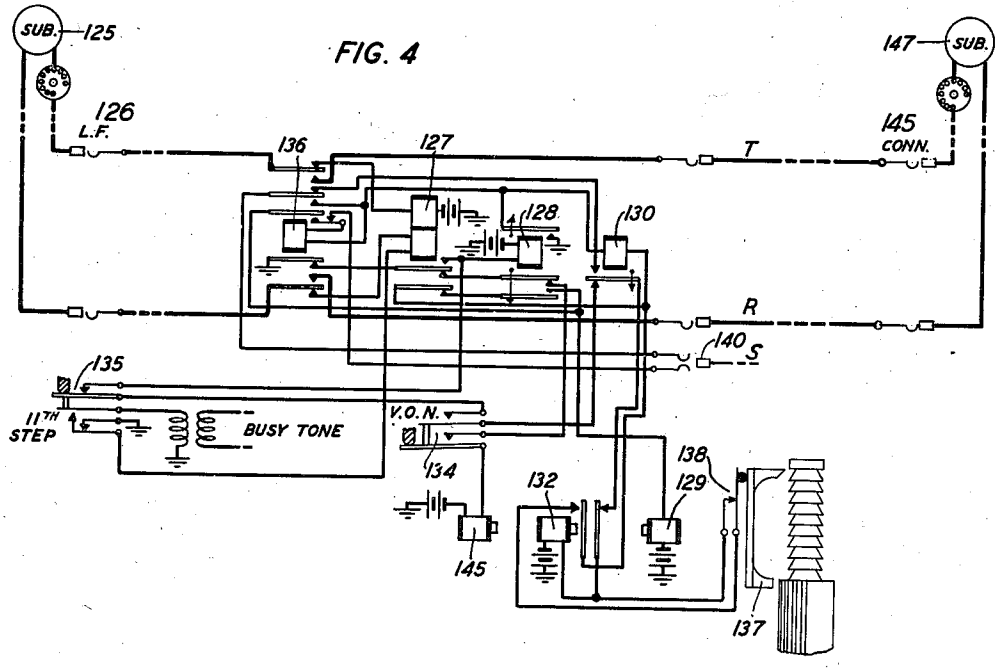


FIG. 4



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UNITED STATES PATENT OFFICE

2,242,397

TELEPHONE SYSTEM

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Application March 3, 1939, Serial No. 259,499

10 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to systems employing automatic switches of the step-by-step type.

An object of the invention is to provide circuit arrangements for step-by-step switches which are more reliable in operation and simpler in regard to the circuit-making equipments required.

Heretofore circuit arrangements have been used for two-motion step-by-step switches in which contact springs are actuated by the movement of the so-called double dog at the beginning of the movement of the shaft and released at the end of the movement of the shaft to provide a holding circuit for the stepping magnets to insure that the magnets take a full step in switching arrangements where the stepping circuits for the magnets are controlled directly by dial pulses incoming over a line.

It is a feature of the present invention to provide circuit arrangements that include the use of contacts on the double dog and a stepping magnet having self-interrupting contacts to insure that a switch takes a full step each time it is operated by this magnet during the hunting-stepping movements of the switch.

In selector switching circuits heretofore used, a special relay is employed during the step-by-step hunting movement to control the rotor magnet operations when busy lines are encountered. It is another feature of the present invention to simplify such prior circuit arrangements for hunting by eliminating this special relay and delegating the function thereof to other elements employed in these circuits.

The invention has been illustrated in the accompanying drawings in which:

Fig. 1 shows in a somewhat diagrammatic form the main features of a standard step-by-step switch of the Strowger type on which contacts have been shown operated by a double dog;

Fig. 2 shows these contacts in more detail; and

Figs. 3 and 4 show automatic telephone systems of two different types with the selector circuit arrangements shown in detail to illustrate the application of the invention to such standard selector circuits.

Referring now to Figs. 1 and 2, Fig. 1 shows the usual operating shaft 1 having two sets of contact brushes 2, 3 and 4 operating on corresponding banks of terminals 5, 6 and 7, where terminals 5 are sleeve connections and 6 and 7 are respectively tip and ring connections. This shaft may be elevated by the vertical magnets 8 operating on armature 9 to cause the pawl 10 attached to this armature to engage the vertical ratchet 11 on the shaft. The usual rotary magnets 12 operate on armature 13 to cause pawl 14 attached thereto to engage the rotary ratchet 15 on the shaft to rotate the brushes to a desired set of terminals. The usual double dog 16 is provided to hold the shaft in actuated positions and the release magnet 17 may operate its armature 18 to engage the double dog to cause it to disengage the shaft to permit it to return to normal under tension of the usual spring arrangements 19. A set of contacts 20 and 21 are attached to the frame member 22 and the inner spring 20 thereof normally engages the double dog 15 through the insulation stud 23. When the double dog is raised to disengage a tooth when the shaft is either elevated or rotated, this spring 20 engages spring 21. When the double dog returns to rest on the next tooth, the connection between these contacts 20 and 21 is opened. Thus on each step of the switch the contacts 20 and 21 are momentarily closed, the closure taking place at the beginning of a step and the opening taking place at the end of the step. Advantage of this operation of the contacts 20 and 21 is taken in providing a circuit arrangement according to the applicant's invention to insure the switch to take full steps during its step-by-step hunting movement.

Fig. 3 shows an automatic telephone system disclosed diagrammatically except the selector circuit in which the applicant's application has been applied. A connection may be established from a subscriber 100 to a subscriber 101 in a well-known manner as far as the line finder 102 and connector 104 are concerned. If it is assumed that a connection has been established through a line finder 102, the closure of this connection causes relay 106 to operate over a circuit from battery through the upper winding of this relay, contacts of relay 107 over the subscriber's loop through the line finder, contacts of relay 107, lower winding of relay 106 to ground at the eleventh step contacts 108. Relay 106 closes an obvious circuit for the operation of relay 109. The subscriber then dials the first digit and on the first impulse relay 106 releases. This closes a circuit for the operation of a vertical magnet 110 and relay 111 from battery through the winding of this magnet, winding of relay 111, contacts of relays 109, 106 and 107 to ground. Relays 111 and 109 remain operated during the succeeding impulses. The vertical magnet 110 operating in response to these suc-

ceeding impulses steps the shaft of the switch to the desired level of bank contacts.

When all the pulses of this digit have been transmitted, relay 111 releases and a circuit is completed for the rotary magnet 112 from battery through the winding of this magnet and its self-interrupting contacts, contacts of relay 111, contacts of the release magnet 113, vertical off-normal contacts 114, rotary off-normal contacts 115, eleventh step contacts 108 to ground at contacts of relay 109. This causes the rotary magnet to operate the shaft of the switch in a rotary direction to take one step. The energizing circuit is then opened at the rotary off-normal contacts 115 and this energizing circuit is also opened through the right-hand outer armature and back contact of the rotary magnet soon after it begins to operate. However, it should be noted at this time that the double dog 115 will be raised as it begins to ride over a tooth in the rotary ratchet 117 and thus closes a connection between the contacts 118 as described in connection with Figs. 1 and 2. The closure of this circuit provides a continued energizing and holding circuit for the rotary magnet 112 from battery through the winding of this magnet, contacts 118, the inner right-hand armature and front contact of magnet 112 to ground at contacts of relay 109. When the shaft has completed its step, the double dog 115 will be lowered into the next tooth of the ratchet 117 and thus open the connection through contacts 118 to release the rotary magnet 112. As the original energizing circuit for the rotary magnet 112 was opened by the operation of the rotary off-normal contacts 115, the rotary magnet will not take any further steps unless a busy sleeve terminal is encountered. If the connector circuit to which the brushes of the selector have been connected is busy, a ground will be supplied on the sleeve terminal such as 120. This causes the closure of a circuit for the rotary magnet 112 from battery through the winding of this magnet, the outer right-hand self-interrupting contacts, contacts of relay 111, contacts of the release magnet 113, vertical off-normal contacts 114, contacts of relay 107, sleeve brush and sleeve terminal 120 to ground. The rotary magnet will then take another step and will be maintained operated during this step by the contacts 118 again providing a holding circuit under control of the double dog 119 as hereinbefore described. These operations continue until an idle connector is encountered when no ground will be supplied on the terminal such as 120. This closes a circuit for the operation of relay 107 from battery, winding and contacts of the magnet 112, contacts of relay 111 and magnet 113, vertical off-normal contacts 114 through the terminal 120 and sleeve brush, upper armature and back contact of relay 107, winding of relay 107, rotary off-normal contacts 115, the eleventh step contacts 108 to ground at relay 109. This causes the operation of relay 107 which extends the tip and ring conductors over the upper and lower outer armatures and front contacts of this relay through to the idle connector which then operates in the usual manner to make this switch busy and apply a ground on the sleeve conductor. Relay 107 is thereby locked in operated condition from battery through the rotary magnet winding and its self-interrupting contacts, contacts of relay 111, contacts of release magnet 113, vertical off-normal contacts 114, winding of relay 107, rotary off-normal contacts 115, eleventh step contacts 108, inner upper armature and front contact of relay 107, the sleeve brush and sleeve terminal 120 to ground. The resistance of the winding of relay 107 prevents the rotary magnet 112 from operating in this circuit. The operation of relay 107 also releases relay 106 which in turn releases relay 109. The circuits are now in condition for transmission of the next digit which operates the connector 104 to extend the connection to the subscriber 101, which is then rung and when he answers the call talking between the two subscribers 100 and 101 may begin. When the connection is released the ground at the terminal 120 is removed and relay 107 releases which now causes the operation of release magnet 113 from battery through the winding of this magnet, vertical off-normal contacts 114, contact of relays 109, 106 and 107 to ground.

The circuit shown in Fig. 4 is similar to that shown in Fig. 3 except that the selector is of a somewhat different type. In this case when a calling subscriber 125 has established a connection through the line finder 126, relay 127 operates over a circuit similar to that described in connection with the operation of relay 106. Relay 127 closes an obvious circuit for the operation of relay 128 and the first digit may now be dialed. This causes the operation of the vertical magnet 129 and relay 130 from battery through the winding of this magnet, contacts of relays 128 and 127, winding of relay 130 to ground at relay 128. After the vertical magnet has operated the required number of steps, the relay 130 releases and closes a circuit for the rotary magnet 132 from battery through the winding of this magnet and its outer right-hand self-interrupting contacts, contacts of relay 130, vertical off-normal contacts 134, eleventh step contacts 135, contacts of relays 127 and 136 to ground. As the rotary magnet 132 operates, it opens its energizing circuit through its outer right-hand armature and back contact. On the rotation of the shaft the double dog 137 is raised to close a connection between the contacts 138 and these contacts close a holding circuit for the rotary magnet 132 from battery through the winding of this magnet, contacts 138, inner right-hand armature and front contact of the rotary magnet 132, winding of relay 130, contacts of relay 128 to ground. Relay 130 operates in this circuit and opens the original energizing circuit for the rotary magnet that extended through the outer right-hand armature and back contact of magnet 132 and the armature and back contact of relay 130. When the shaft has completed the step the double dog 137 returns to normal position in the next tooth on the rotary ratchet and opens the contacts 138 and thus causes the release of the rotary magnet 132. This insures the taking of a complete step by the shaft. Relay 130 is slow in releasing and remains operated for a short period after the step has been taken to determine whether or not the connector circuit on which the brushes of this selector have landed is busy. If it is busy a ground will be supplied on the sleeve terminal 140 and thus cause the rotary magnet 132 to be again energized over a circuit from battery through the winding of this magnet, the outer right-hand self-interrupting contacts, contacts of relays 130 and 136 over the upper sleeve brush to ground at the terminal 140. The rotary magnet in operating opens this

circuit and the locking circuit through contacts 138 is again closed to maintain the magnet operated until the step is completed. If then an idle connector circuit is encountered, there will be no ground on terminal 140 which permits relay 136 to operate from battery, winding of magnet 132 and its outer right-hand armature and back contacts, contacts of relays 130 and 136, the upper and lower sleeve brushes through terminal 140, make-before break contacts of relay 136 through the winding of this relay to ground at contacts of relay 128. Relay 136 opens the circuit for the rotary magnet 132 to prevent it from taking another step and locks over a circuit from battery through the vertical magnet 129, upper inner armature and front contact of relay 136, winding of this relay to ground supplied immediately at contacts of relay 128 and later through the usual busy ground placed on the terminal 140 from the connector through the upper middle armature and front contact of relay 135. The resistance of this relay is sufficient to prevent the vertical magnet 129 from operating at this time. The operation of relay 136 causes the release of relays 127 and 128 and the circuits are now ready for the transmission of the remaining impulses to cause the connector 145 to extend the connection to the called subscriber 147 which is then rung and when he answers the connection is completed for talking. When the subscribers hang up, the ground on terminal 140 is removed causing the release of relay 136 which then closes the circuit for the release magnet 150 from battery through the winding of this magnet, vertical off-normal contacts 134, contacts of relays 128, 127 and 136 to ground causing the release of the switch.

What is claimed is:

1. The combination in a step-by-step switch having a brush shaft, a stepping magnet responsive to each of a series of energizations for imparting to said shaft a movement corresponding to one step, a circuit for energizing said magnet to initiate the step movement of the shaft, contact means controlled by the magnet for opening said circuit intermediate the beginning and end of the step movement, a second circuit for the magnet, and means operated by the movement of said shaft for closing said second circuit prior to the opening of said first circuit and for holding said second circuit closed until the shaft reaches the end of the step movement.

2. In combination in a step-by-step switch having a brush shaft, a stepping magnet responsive to each of a series of energizations for imparting to said shaft a movement corresponding to one step, a circuit for energizing said magnet to initiate the step movement of the shaft, contact means controlled by the magnet for opening said circuit intermediate the beginning and end of each step movement, a second circuit for said magnet, a pawl and ratchet mechanism for said shaft, and contact means controlled by said pawl and ratchet mechanism for closing said second circuit prior to the opening of said first circuit and for holding said second circuit closed until the shaft reaches the end of the step movement.

3. In combination in a step-by-step switch having a brush shaft, a stepping magnet for imparting to said shaft a movement corresponding to one step for each complete operation of said magnet, a set of contacts controlled by said magnet to open shortly after the magnet begins each step movement, a circuit extending through said contacts for energizing said magnet to initiate its operation, a second set of contacts controlled by said shaft to close shortly after said shaft begins to take a step movement and to open when it completes said step movement, and a circuit extending through said second set of contacts for energizing said magnet to complete its operation.

4. In a step-by-step switch, a shaft, a stepping mechanism for advancing said shaft in steps, a magnet for actuating said mechanism to advance said shaft one step for each energization of said magnet, a circuit for energizing the magnet to begin the stepping action of the shaft for its first step, a circuit for energizing the magnet to begin the stepping action of the shaft for succeeding steps, means for permanently disabling said first circuit after the first step movement and for closing said second circuit, a set of contacts, a mechanism controlled during the stepping actions of said shaft for closing said set of contacts as soon as a stepping action has begun and for opening said contacts as soon as a stepping action is completed, and a circuit controlled by said contacts for maintaining the energization of said magnet as long as said contacts are closed to insure the shaft taking a full step each time a stepping action has begun.

5. In a step-by-step switch, a shaft, a stepping mechanism for advancing said shaft in steps, a magnet for actuating said mechanism to advance said shaft one step for each energization of said magnet, a circuit for energizing the magnet to initiate the step movement of the shaft, means controlled by said magnet for opening said circuit soon after each step movement has begun, a set of contacts, a mechanism controlled during each step movement of said shaft for closing said set of contacts as soon as a step movement begins and for opening said contacts as soon as a step movement is completed, and a circuit for maintaining said magnet energized as long as said contacts are closed to insure the shaft taking a full step each time a step movement has begun.

6. In a step-by-step switch, a magnet for advancing the switch step by step, a circuit for energizing the magnet to begin the stepping action of the switch for each step, contacts controlled by said magnet to open said circuit, contacts controlled by said switch to close as soon as a stepping action has begun and to open when a stepping action is completed, and a second circuit controlled by said latter contacts for maintaining the energization of said magnet as long as said latter contacts are closed to insure the switch taking the complete steps.

7. In a telephone system, a step-by-step switch comprising sets of terminals arranged in a bank, a set of brushes movable by said switch to engage the terminals in said bank in succession, lines connected to said sets of terminals, a magnet, a first circuit for beginning the energization of said magnet for the taking of a first step to cause the brushes to connect to the first set of terminals and its associated line, means for disabling said circuit shortly after the switch begins to take said first step, a second circuit for beginning the energization of said magnet for the taking of additional steps operative if succeeding sets of terminals are busy, a third circuit operative if a set of terminals to which the brushes have been advanced are idle for disabling said second circuit and a fourth circuit controlled by the movement of the switch for

maintaining the magnet energized until the switch has completed each step.

8. In a telephone system, a step-by-step switch, a magnet, means responsive to each operation of said magnet for moving said switch one step, a first circuit for energizing said magnet, means for closing said circuit once, means for opening said first circuit shortly after the magnet starts to operate, a second energizing circuit for said magnet, means for repeatedly closing said second circuit each time the switch has taken a step and the magnet is released and for opening said second circuit shortly after the magnet starts to operate, a third energizing circuit for said magnet and means for closing said third circuit each time shortly after the switch starts to move and opening said third circuit when the switch has been moved a step to insure the complete operation of the magnet to make the switch take complete steps.

9. In combination, in a step-by-step switch, having a brush shaft, a stepping magnet for imparting to said shaft a movement corresponding to one step for each complete operation of said magnet, a first circuit for energizing said magnet for taking a first step only, off-normal contacts for opening said circuit in response to the taking of the first step by said switch, a second circuit for energizing said magnet for the taking of succeeding steps, a pair of contacts controlled by the energization of the magnet to open said two circuits shortly after the energization of the magnet begins, a second pair of contacts controlled by the energization of said magnet, a third pair of contacts controlled by said switch to close as soon as the stepping action has begun and to open when a stepping action is completed and a third circuit controlled by said second and third pair of contacts for maintaining the energization of the magnet as long as said last-mentioned pair of contacts are closed.

10. In a step-by-step switch, a shaft a stepping mechanism for advancing said shaft in steps, a magnet for actuating said mechanism to advance the shaft one step for each energization of said magnet, a circuit for energizing the magnet to begin the stepping action of the shaft for its first step, a circuit for energizing the magnet to begin the stepping action of the shaft for succeeding steps, means for permanently disabling said first circuit after the first step movement and for closing said second circuit, means controlled by said magnet for opening said second circuit soon after the second and each succeeding step movement has begun, a set of contacts, a mechannism controlled during the stepping action of said shaft for closing said set of contacts as soon as the stepping action has begun and for opening said contacts as soon as the stepping action is completed, and a circuit controlled by said contacts for maintaining the energization of said magnet as long as said contacts are closed to insure the shaft taking a full step each time a stepping action has begun.

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