March 24, 1942. R. S. WILBUR 2,277,191

COMBINED LINE AND CUT-OFF RELAY FOR TELEPHONE SYSTEMS

Filed Nov. 2, 1939

FIG. 1

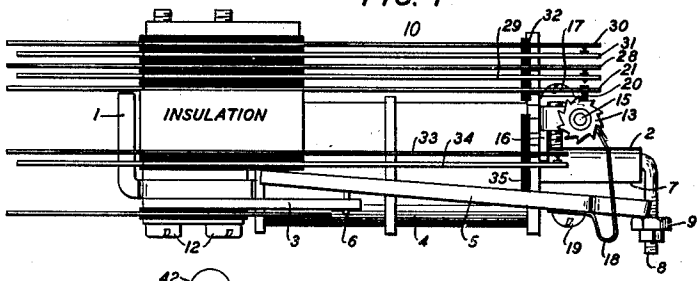


FIG. 2

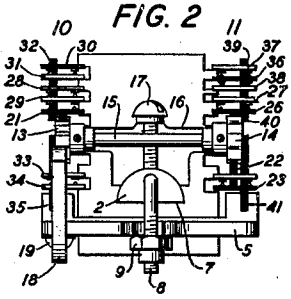


FIG. 3

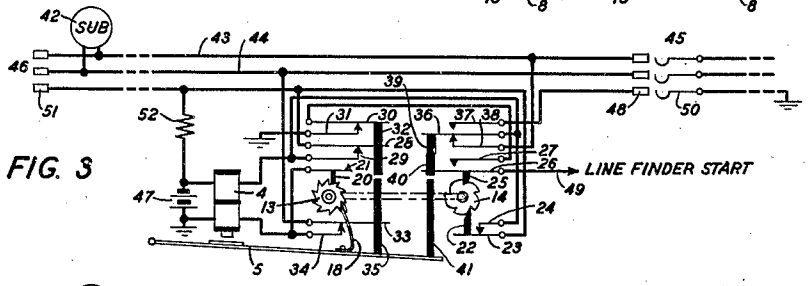


FIG. 4

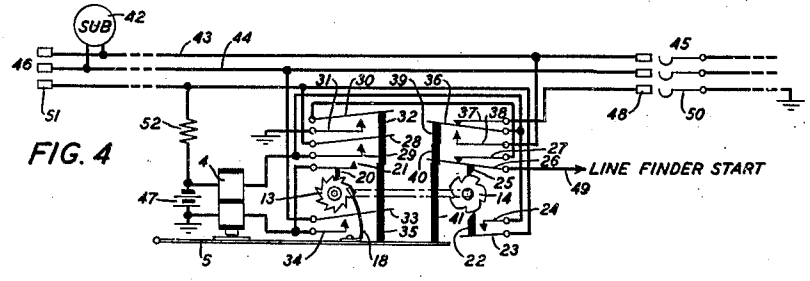


FIG. 5

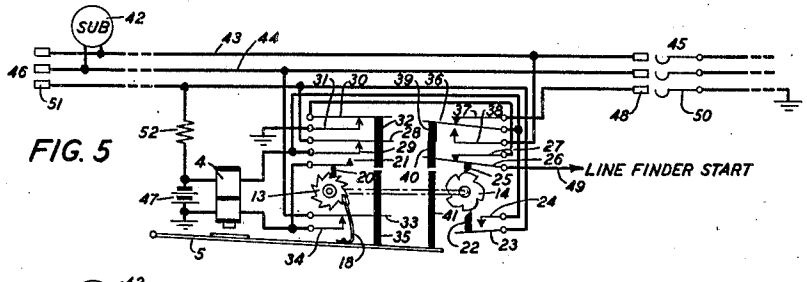
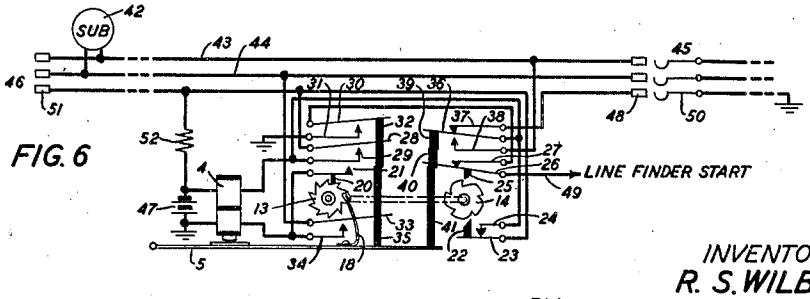


FIG. 6



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COMBINED LINE AND CUTOFF RELAY FOR TELEPHONE SYSTEMS

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5 Claims. (Cl. 179—18)

This invention relates to telephone systems and more particularly to a combined line and cut-off relay structure applicable to a subscriber's line for replacing the usual individual line and cut-off relays and for performing all of the functions thereof. It is the object of the present invention to simplify and to reduce the cost of the individual relay equipment of subscribers' lines.

To attain this object a relay of a standard type, now used extensively in telephone systems, is modified by the addition of two cam wheels operable step by step by a pawl secured to the relay armature which cams are effective to control certain of the springs of the relay spring pile-ups, other springs of the pile-ups being operable by the armature in the usual manner, while still other springs are operable both in the usual manner and by the cam wheels. The cam wheels are secured to a shaft supported transversely of the front end of the relay core, one of the cam wheels having five teeth and the other ten teeth, the latter also serving as a ratchet wheel with which a pawl secured to the armature cooperates. The shaft is thus rotated one-tenth of a revolution upon each attraction of the armature.

In its normal condition, the windings of the relay are connected over normally closed contacts of certain of its springs to the tip and ring conductors of the line so that when the line loop is closed to initiate a call, the relay armature is attracted and through the pawl carried thereby starts to rotate the cam wheels. A tooth of the ten-toothed cam wheel in its half step position first operates certain contact springs to close a local operating circuit serially through both windings of the relay to insure a full attraction of the relay armature. In the fully attracted position of the armature, the local energizing circuit is opened, both windings are disconnected from the line loop and the five-toothed cam wheel operates springs to connect the tip winding of the relay to the sleeve terminal of the line and operates other contact springs to prepare a signaling circuit, which as illustrated may be the start circuit of a line finder.

With the energizing circuits of the relay now opened, the armature restores engaging contact springs to complete the line-finder start circuit or signaling circuit. The relay has now performed all of the functions normally performed by the usual line relay. When the started line finder finds the calling line, the relay is again energized by its tip winding over contact springs closed by the five-toothed cam wheel and attracts the armature to advance the shaft another step, the armature in its attracted position opening the start circuit and holding the contact springs closed whereby the tip winding remains connected to the sleeve terminal and is maintained energized until the connection is released. At this time, both windings of the relay are disconnected from the line loop. When the connection is released, the relay deenergizes and returns all contact springs to their normal condition. The relay has now performed the functions normally performed by the usual cut-off relay.

When the line is seized as a called line, as for example over a connector multiple, the tip winding thereof is energized over the connector sleeve terminal and the armature in passing to its fully attracted position advances the cam wheels, the ten-toothed cam wheel momentarily closing a local energizing circuit through both windings of the relay and the five-toothed cam wheel opening contact springs included in the energizing circuit through the tip winding. In its fully attracted position, the local energizing circuit is opened at other contact springs whereby the armature is restored and closes the line-finder start circuit. The energizing circuit through the tip winding of the relay is, however, immediately reclosed and the relay again attracts its armature advancing the shaft another step, thereby opening the start circuit. This momentary closure of the start circuit is not effective in this case to start a line finder since the line-finder start relay may be made slow to operate. The energizing circuit through the tip winding is now maintained over contact springs which were permitted to close by the second step taken by the five-toothed cam wheel and both windings are disconnected from the tip and ring conductors of the line loop. When the connection is released, the relay releases and restores all of its contact springs to their normal condition. Thus when the line is seized as a called line, the relay performs all of the functions performed by the usual cut-off relay.

The invention having been described in a general manner, reference may now be had, for a more comprehensive understanding thereof, to the following detailed description taken in connection with the accompanying drawing in which:

Fig. 1 is a side elevational view of a relay in which the present invention is embodied;

Fig. 2 is a front elevational view of the relay;

Fig. 3 shows schematically a subscriber's line, a line finder having access thereto, the relay and

the circuits controlled thereby in their normal condition;

Fig. 4 illustrates the operated position of the relay and the condition of the circuits controlled thereby immediately following the initiation of a call on the subscriber's line and the closure of the line loop;

Fig. 5 illustrates the succeeding released position of the relay and the condition of the circuits controlled thereby at which time the line-finder start circuit is closed; and

Fig. 6 illustrates the succeeding operated position of the relay and the condition of the circuits controlled thereby at the time the line terminals are seized by the line finder.

The improved relay structure is of the general type disclosed in Patent 2,178,656, granted November 7, 1939 to P. W. Swenson and comprises a supporting bracket 1 to which the rear end of a forwardly extending core 2 and a hinge bracket 3 are suitably secured, a coil 4 having two windings surrounding the core 2, a U-shaped armature 5, the arms of which are pivoted by pins 6 on the arms of the hinge bracket 3 and the forward cross reach of which cooperates with the pole face 7 of the forward end of the cord 2, a back-stop screw 8 secured in the forward end of the core 2 having a back-stop nut 9 thereon for adjusting the normal air-gap between the armature and the pole face of the core, and two spring pile-ups 10 and 11, one on either side of the coil, insulatedly supported on and secured to the mounting bracket 1 by screws 12.

In accordance with the present invention, this relay structure has been modified by the addition of two cam wheels 13 and 14 secured respectively on the opposite ends of a shaft 15 which is rotatably mounted in a bracket 16 extending transversely across the forward end of the relay core and secured to the core 2 by the screw 17. The cam wheel 13, which is provided with ten teeth and serves also as a ratchet wheel by means of which both cam wheels may be rotated step by step under the control of spring pawl 18 secured to the end of the armature 5 by screw 19, cooperates with a stud 20 of insulating material secured to the contact spring 21. The cam wheel 14 has five teeth and cooperates with a stud 22 of insulating material secured to the contact spring 23 which passes freely through a hole in its mate spring 24. Normally the contacts of springs 23 and 24 are in engagement. Cam wheel 14 also cooperates with a stud 25 secured to the spring 26 which spring mates with a spring 27 and is normally out of contact therewith.

The active contact springs 28 and 30 are normally in engagement with their mate springs 29 and 31 and are interconnected by the stud 32 of insulating material staked thereto and passing freely through holes in springs 29 and 31. The active spring 33 is normally in engagement with its mate spring 34 and has staked thereto a stud 35 which passes freely through a hole in spring 34 into engagement with the inner surface of the end of armature 5. The upper end of stud 35 is positioned for engagement with the lower end of stud 32 so that when the armature is attracted, the stud 35 is moved to operate spring 33 and by its engagement with stud 32 also operates springs 28 and 30. The active contact spring 36 cooperates with a back contact spring 38 with which it is normally engaged and with a front contact spring 37 and has staked thereto an insulating stud 39 which extends freely through a hole in spring 38. Positioned immediately below the lower end of stud 39 is a stud 40 which is staked to spring 26 and passes freely through a hole in spring 27. A stud 41 is secured to the armature with its upper end positioned beneath the lower end of stud 40 whereby when the armature is attracted the stud 41 engages the stud 40 to operate spring 26 and stud 40 engages stud 39 to operate spring 36.

Having now described the structure of the improved relay, its application to a telephone system will be discussed. Referring first to Fig. 3, a subscriber's substation 42 is schematically disclosed which is connected over the tip line conductor 43 and the ring line conductor 44 to terminals appearing in the bank of a line finder 45, schematically illustrated by the set of brushes, and also to terminals of terminal set 46 of a connector bank. Normally the cam wheels and contact springs are in the condition illustrated in Fig. 3. It will now be assumed that the subscriber at substation 42 initiates a call by removing the receiver from the switchhook whereupon a circuit is established from ground through battery 47, the upper winding of relay coil 4 over spring 36 and its back contact spring 38, tip conductor 43 over the substation loop, ring conductor 44, spring 33 and its mate spring 34, through the lower winding of coil 4 to ground. The relay windings are thereby energized and attract the armature 5.

By the movement of the armature to its fully attracted position as disclosed in Fig. 4, the pawl 18 secured to the armature advances the ratchet wheel 13 one tooth or one step. At its half step position the stud 20 rides up upon the top of a tooth of the cam wheel and causes the engagement of spring 21 to which the stud is secured with spring 29 thereby establishing a local operating circuit for the windings of the relay extending from the ungrounded terminal of battery 47 through the upper winding of the coil 4 over springs 29 and 21 through the lower winding of the coil 4 to the grounded terminal of the battery. This circuit insures that the windings will be maintained energized until the armature is fully attracted since upon the movement of the armature, the stud 35 engaged thereby will open the line loop operating circuit for the relay windings by moving spring 33 out of engagement with spring 34.

When the armature reaches its fully attracted position as illustrated in Fig. 4, the stud 20 drops down into the depression between two teeth of cam wheel 13; the upper end of stud 35 is engaged against the lower end of stud 32 to move springs 28 and 30 out of engagement with their mate springs 29 and 31; a tooth of cam wheel 14 depresses stud 22 to move spring 23 out of engagement with spring 24 and a second tooth of cam wheel 14 raises stud 25 to engage spring 26 with spring 27 and the movement of spring 26 engages its stud 40 with stud 39 to disengage spring 36 from spring 38 and to engage it with spring 37. Upon the disengagement of springs 33 and 38, the previously traced connection of the upper winding of coil 4 to tip conductor 43 is opened and since the connection of the lower winding of coil 4 to ring conductor 44 was opened upon the disengagement of springs 33 and 34, both windings of the coil 4 are now disconnected from the line loop. Since also springs 21 and 29 are at this time out of engagement and the local energizing circuit through the relay windings is therefore opened, the relay releases its armature. With spring 36 now held in engagement with spring 37 by a tooth of cam wheel 14, the sleeve terminal

of the calling line is marked with battery potential to indicate to the line finders having access thereto that the line is in a calling condition. This potential is applied from battery 47 through the upper winding of coil 4 over springs 36 and 37 to terminal 48. Over springs 26 and 27 which are held in engagement by a tooth of cam wheel 14, the line-finder start circuit 49 is prepared.

Upon the release of the relay armature as just described, the cam wheels retain their previous settings but the armature permits springs 28, 30 and 33 to restore so that the circuit assumes the condition illustrated in Fig. 5. With spring 30 now in engagement with spring 31 and springs 26 and 27 still held in engagement by a tooth of cam wheel 14, the line-finder start circuit is completed from ground over springs 31 and 30 and over springs 27 and 26 whereupon in the well-known manner an idle line finder is started in search of the calling line. It will be assumed that the line finder indicated by the numeral 45 is started and that, therefore, when its test brush 50 encounters sleeve terminal 48 of the line a circuit is established from ground on brush 50 over terminal 48, springs 37 and 36, through the upper winding of coil 4 to battery, thereby causing the attraction of the relay armature to advance the cam wheels another step. The circuit now has assumed the condition illustrated in Fig. 6.

It will be noted that the movement of the armature has now disengaged springs 28, 30 and 33 from their mate springs whereby the start circuit previously traced is opened at springs 30 and 31. In the half step position of cam wheel 13, springs 21 and 29 are momentarily engaged to close the local operating circuit through the windings of coil 4 as previously traced, but this circuit is not necessary at this time, since the upper winding of coil 4 is maintained steadily energized over the circuit previously traced to ground at the test brush 50. The second step advance of cam wheel 14 permits spring 23 to reengage spring 24 and moves its tooth from under the end of stud 25, but springs 26 and 36 are not permitted to restore since they are now held in their operated positions by stud 41 secured to the armature which is now positioned with its upper end in engagement with the lower end of stud 40. The relay armature is now maintained in its attracted position by the energization of the upper winding of coil 4 until the connection is released and ground is removed from the test brush 50. With the springs 33 and 34 disengaged and springs 35 and 38 also disengaged, both windings of the coil 4 are disconnected from the line conductors. When ground is disconnected from test brush 50, the upper winding of coil 4 becomes deenergized and the armature releases to restore the circuit to its normal position illustrated in Fig. 3.

Should the line be seized on an incoming call by the engagement of the brushes of a connector switch with the connector bank multiple terminal set 46 of the line and the line be at the time idle, the circuit will be in the condition illustrated in Fig. 3. A circuit will thereupon be established from ground in the connector switch over the sleeve terminal 51 through resistance 52 to battery and in parallel with resistance 52 over springs 28 and 29 or springs 23 and 24 and through the upper winding of coil 4 to battery, whereupon the relay armature will be attracted to advance the cam wheels one step and to move the springs into the position disclosed in Fig. 4. As previously described, in the half step position of cam wheel 13, the springs 21 and 29 are engaged to close the local operating circuit through the windings of coil 4 to insure that the armature will be fully attracted, since the armature in moving to its fully attracted position disengages springs 28 and 29 and the one step advance of cam wheel 14 disengages springs 23 and 24 and, therefore, opens the initial operating circuit through the upper winding of coil 4. When the armature reaches its fully attracted position with springs 28 and 29 disengaged and springs 23 and 24 disengaged, the upper winding of coil 4 becomes deenergized and the armature restores. The circuit is now in the condition illustrated in Fig. 5 in which the previously traced line-finder start circuit 49 is closed from ground over springs 31—30 and springs 27 and 26. This circuit is, however, only momentarily closed since the energizing circuit through the upper winding of coil 4 is immediately closed from ground in the connector switch over terminal 51 and springs 28 and 29 and the relay armature is again attracted to disengage springs 30 and 31 and to advance the cam wheels a second step. To insure that the line-finder start relay will not operate upon this momentary closure of the start circuit 49 to start a line finder which is not required on an incoming call, the start relay may be made slightly slow to operate.

The circuit is now in the condition illustrated in Fig. 6 and the relay is maintained operated until the connection is released by the energization of its upper winding from ground applied at the connector over terminal 51, springs 23 and 24 which engaged upon the second step advance of cam wheel 14, through the upper winding of coil 4. When the connection is released, the relay circuit restores to the condition illustrated in Fig. 3. Had the line been busy because of a call initiated therefrom, in which case the circuit would be in the condition illustrated in Fig. 6, the test brush of the connector switch would encounter busy ground on the test terminal 51 applied thereto over engaged springs 23 and 24, engaged springs 36 and 37, terminal 48 and brush 50 of the line finder.

While the invention has been disclosed in connection with a line circuit terminating in the bank of a line finder, it will be obvious that the line could be a line of a manual exchange system in which the circuit closed over the start conductor 49 could control the lighting of a line lamp and the relay would be responsive to the seizure of the line by an operator to extinguish such line lamp.

What is claimed is:

1. A relay having a core, windings thereon, an armature cooperating with said core, sets of springs having contacts operable by said armature, a first energizing circuit for said windings extending over normally closed contacts of certain of said springs, means controlled by the first energization of said windings over said circuit to operate certain of said springs to disconnect said windings from said circuit and to connect one of said windings to a second operating circuit, means operative upon the deenergization of said windings to operate certain of said springs to close a signaling circuit and means operative upon the reenergization of said one winding over said second operating circuit to operate certain of said springs to open said signaling circuit, said winding becoming deenergized upon the subsequent opening of said second operating circuit to restore all springs to

their normal condition whereby said windings are reconnected to said first operating circuit.

2. A combined line and cut-off relay having a core, windings thereon, an armature cooperating with said core, sets of springs having contacts operable by said armature, means controlled by a first energization of both windings over a line loop to operate certain of said springs to disconnect said windings from said loop, to momentarily connect said windings in a local operating circuit, to prepare a signaling circuit and to prepare a second operating circuit through one of said windings, means operative in response to the deenergization of said windings upon the opening of said local operating circuit to operate certain of said springs to close said signaling circuit and means operable upon the reenergization of said one winding over said second operating circuit to operate certain of said springs to open said signaling circuit, said one winding becoming deenergized upon the opening of said second operating circuit to restore all springs to their normal condition whereby said windings become reconnected to the line loop.

3. A combined line and cut-off relay having a core, windings thereon, an armature cooperating with said core, first sets of contact springs operable by said armature over which said windings are normally connected to a line loop, a rotatable shaft having cam wheels thereon, a pawl secured to said armature whereby said shaft is advanced step by step upon successive actuations of said armature, a second set of contact springs momentarily operable during the first step advance of one of said cam wheels by the attraction of said armature in response to the closure of the line loop to close a local energizing circuit for said windings, a third set of contact springs operable by the first step advance of said other cam wheel for preparing a signaling circuit, said armature in its fully attracted position operating said first sets of springs to disconnect said windings from said line loop whereby upon the opening of said momentarily operated second set of springs said windings are deenergized to release said armature, a fourth set of contact springs closable upon the release of said armature to close said prepared signaling circuit and a second operating circuit for one of said windings prepared over one of said first sets of springs by the first step advance of said other cam wheel whereby upon the closure of said second circuit and the attraction of said armature said cam wheels are advanced a second step, said fourth set of springs are opened to disrupt said signaling circuit and one of said first sets of springs is held operated to maintain said second operating circuit closed.

4. A combined line and cut-off relay having a core, windings thereon, an armature cooperating with said core, sets of springs having contacts operable by said armature, said windings being normally connected to a line loop over certain of said springs and one winding being normally connected to a second operating circuit over other of said springs, means controlled by a first energization of said one winding over said second operating circuit to operate certain of said springs to disconnect said windings from the line loop and from said second operating circuit whereby said one winding becomes deenergized to operate other of said springs to reconnect said one winding to said second operating circuit whereupon said one winding again becomes energized to operate springs whereby it is maintained energized so long as said second operating circuit is maintained closed.

5. A combined line and cut-off relay having a core, windings thereon, an armature cooperating with said core, first sets of contact springs operable by said armature over which said windings are normally connected to a line loop, an operating circuit for one winding of said relay extending in parallel over second and third sets of contact springs, a rotatable shaft having a cam wheel thereon, a pawl secured to said armature whereby said shaft is advanced step by step upon successive attractions of said armature and means for closing said operating circuit whereby said armature is attracted to open said first sets of springs to disconnect said windings from the line loop, to open said second set of contact springs and to advance said cam wheel one step to open said third set of springs, said winding thereupon deenergizing to release said armature whereby said second set of springs is reclosed to reestablish said operating circuit whereupon said armature is reattracted to advance said cam wheel a second step to reclose said third set of springs, said operating circuit then remaining closed until opened by said means.

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