June 15, 1943. H. M. STOLLER 2,321,710

RELAY

Filed Sept. 26, 1941

FIG. 1

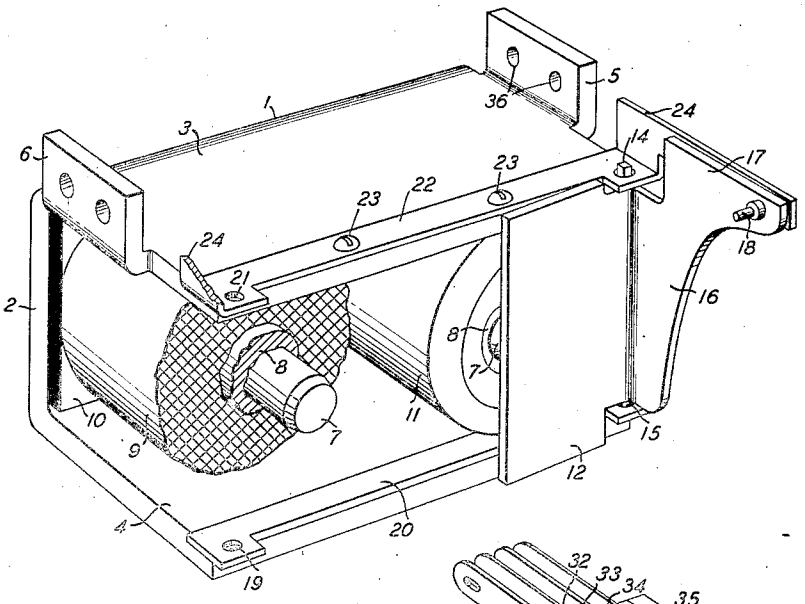


FIG. 2

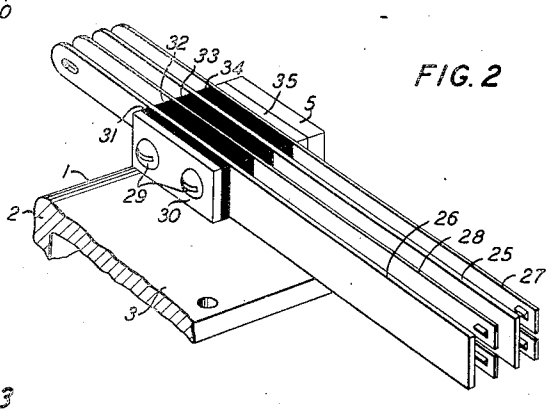
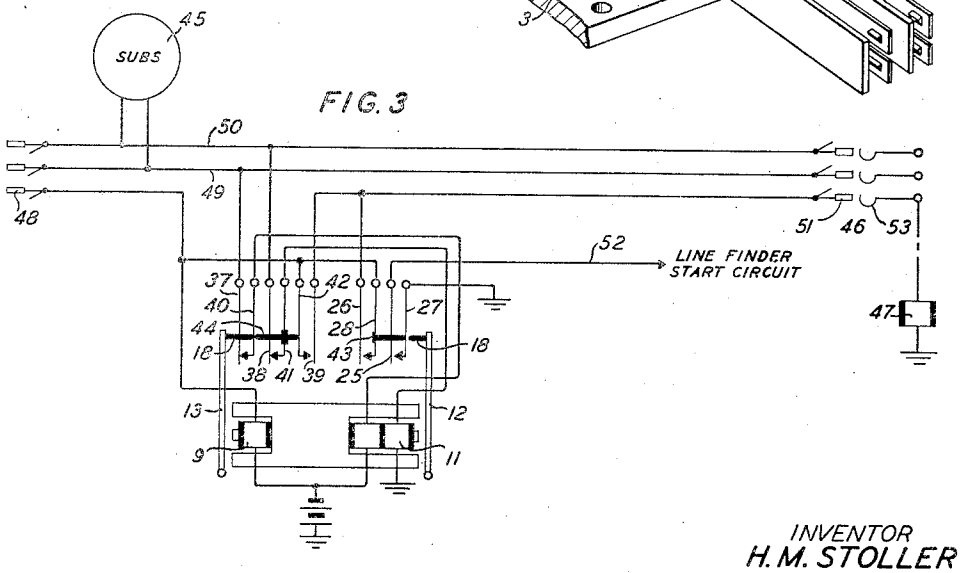


FIG. 3



INVENTOR
H. M. STOLLER
BY
P. C. Smith
ATTORNEY

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RELAY

Hugh M. Stoller, Mountain Lakes, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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5 Claims. (Cl. 179—18)

This invention relates to relays and more particularly to a combined line and cut-off relay assembly for use on subscribers' lines of telephone systems.

In telephone systems and particularly in systems of the step-by-step type, each subscriber's line is provided with a line relay and a cut-off relay, the two windings of the line relay being energizable in a circuit extending from the terminals of the central office battery over two pairs of normally closed contact springs comprising a part of the cut-off relay and the calling line loop when the calling subscriber closes the line loop at his substation to initiate a call. The line relay upon energizing is instrumental in closing two pairs of contact springs, over one pair of which a circuit is established to start an idle line finder in search of the calling line and over the other pair of which the winding of the cut-off relay is connected to the test or sleeve conductor of the calling line terminating in multiple bank terminals of all line finders having access to the calling line. When the started line finder finds the calling line and its test brush encounters the test multiple of such line, the circuit prepared by the operated line relay for the cut-off relay is completed and the cut-off relay operates to open its two pairs of normally closed contacts to thereby disconnect the windings of the line relay from the calling line loop. It also closes a third pair of contacts whereby the cut-off relay locks itself to the circuit completed over the test brush of the line finder and is thus maintained operated following the release of the line relay resulting from the disconnection of the windings thereof from the calling line loop.

Some suggestions have heretofore been made for combining line and cut-off relays into a single unit to effect savings in manufacturing and installation costs and to effect a saving in mounting space on the apparatus rack at the central office. Since several thousand of both line and cut-off relays are required each year, to meet the normal expansion of installed telephone offices and to meet the normal demand for new office installations, it is apparent that a relay structure that would perform all of the functions of both the usual line and cut-off relays in a reliable manner and which could be simplified to such an extent as to effect material manufacturing, installation and maintenance costs would be of great value.

It is therefore the object of the present invention to simplify the structural details of a combined line and cut-off relay assembly, to reduce thereby the cost of manufacture, installation and maintenance and to effect more reliable operation.

To attain this object and in accordance with one feature of the present invention, the magnetic circuit of the assembly comprises a channel-shaped field piece having two cores extending from the base of the channel forwardly between the flanges thereof upon one of which is supported a two-winding line relay coil and upon the other of which is supported a cut-off relay coil. To complete the magnetic circuit, two armatures are provided which are pivoted on axes extending at right angles to the flanges of the channel and which are attractable toward the forward edges of the channel flanges and toward the pole face ends of the cores. Supported on the upper flange of the field piece are two spring pile-ups associated respectively with the two armatures. For actuating the springs of the associated spring pile-up, each armature is provided with a forwardly extending arm having a spring operating stud of insulating material secured therein.

In accordance with a further feature of the invention, a short-circuited winding in the form of a copper sleeve surrounds each core and is interposed between the core and the coil supported on the core. The copper sleeve on the line relay core is provided to render the line relay slightly slow to release its armature to thereby insure that the cut-off relay will have sufficient time to close its holding circuit before the line relay releases its armature in response to the opening of the loop circuit over the subscriber's line by the attraction of the cut-off relay armature. The copper sleeve on the cut-off relay core permits the current to build up quickly in the test circuit established through the winding of the cut-off relay and the winding of the test relay of the line finder at the instant the line finder finds the terminals of the calling line. Heretofore the quick building up of current through the winding of the cut-off relay has been accomplished by the connection of a resistance of approximately 2800 ohms in shunt of the cut-off relay winding and by mounting such resistance as a non-inductive third winding of the line relay coil. The provision of the copper sleeve on the cut-off relay core permits the quick building up of current through the cut-off relay coil by inductive instead of conductive coupling and avoids the more expensive non-inductive winding and the consequent necessity for dissipating the heat therefrom. An additional

advantage attained by the omission of the shunt resistance is that all of the current then passes through the cut-off relay coil and the required ampere turns can be developed with a lower resistance, cheaper winding.

Other features of the invention will be apparent from the detailed description taken in connection with the accompanying drawing in which:

Fig. 1 is a perspective view of a relay assembly in accordance with the present invention with the spring pile-ups, one armature and one backstop arm omitted and one of the relay coils shown partly in cross section to more clearly illustrate a novel feature of the invention;

Fig. 2 is a perspective view of the upper portion of the relay assembly illustrating the mounting of one of the spring pile-ups; and

Fig. 3 illustrates diagrammatically a circuit application of the improved relay assembly.

The relay assembly is provided with a channel-shaped field piece member 1 which is bent into the shape best disclosed in Fig. 1 from a blank punched from a sheet of magnetic iron. The member 1 has a base portion 2, an upper flange 3 and a lower flange 4. The upper flange 3 is provided with two portions 5 and 6 bent upwardly from its opposite ends to form brackets to which the spring pile-ups are secured. The base portion 2 of the field piece member 1 is provided with two holes (not shown) in which the rear ends of two cores 7 are secured. After the cores are secured in place, the forward edges of the flanges 3 and 4 and the forward ends of the cores 7 are ground or machined to be in good alignment.

Each core 7 is surrounded by a tubular copper sleeve 8 the rear end of which is knurled to hold the rear spoolhead of a coil, the core being knurled near the rear end thereof to hold the sleeve thereon. The coil 9 mounted on the left-hand core 7 as viewed in Fig. 1 is a cut-off relay coil having a single winding secured as by pyroxylin cement to the rear spoolhead 10 which may be of suitable insulating material, such as phenol fibre, and which may have two-winding terminal lugs (not shown) secured thereto in the usual manner and extending rearwardly through an opening provided therefor in the base 2 of the field piece member 1. The coil 11 mounted on the right-hand core 7 is a line relay coil having two equal windings secured to a rear spoolhead similar to the spoolhead 10 and having four-winding terminal lugs secured thereto and extending rearwardly through the opening in the base 2.

Associated with the forward ends of the core 7 are two armatures 12 and 13 stamped from magnetic iron. The armature 13 has been omitted from Fig. 1 to enable a clearer disclosure of the structural details of the cut-off relay coil 9. Each armature is provided at its upper and lower outside corners with cut-away portions to form two aligned and vertically extending pintles 14 and 15 and with an arm 16 extending forwardly at right angles therefrom to serve as a member for operating certain springs of an associated spring pile-up. The arm 16 has a portion 17 which extends above the plane of the upper flange 2 in the outer end of which is secured a spring operating stud 18 of insulating material, such as hard rubber. The two armatures 12 and 13 are similar except that they are reversely stamped and bent. The lower pintles 15 of the two armatures are seated in holes 19 in the forwardly extending arms of a U-shaped pivot plate 20 which may be welded or otherwise secured by its base to the inner face of the lower flange 4. In welding the plate 20 to the flange, the ends of its arms are permitted to extend sufficiently beyond the forward edge of the lower flange 4 so that when the pintles 15 of the armatures are inserted through the holes 19, they will be permitted to turn freely but will be held against undue separation from the edge of the lower flange. The upper pintles 14 of the two armatures are seated in holes 21 in the forwardly extending arms of an upper U-shaped pivot plate 22. The plate 22 is secured by its base to the outer face of the upper flange 3 by screws 23, in such a position that when the pintles 14 of the armatures are inserted through the holes 21, they will be permitted to turn freely but will be held against undue separation from the edge of the upper flange. The plate 22 is provided at each end thereof with a forwardly extending arm 24 bent to lie in a plane at right angles to the base portion of the plate and serving as a backstop for the associated armature.

A spring pile-up is secured to each of the upwardly extending brackets 5 and 6 of the member 1. The spring pile-up associated with the line relay armature 12 comprises two fixed springs 25 and 26 and two cooperating, movable or armature springs 27 and 28. These springs are clamped to the bracket 5 by screws 29 which extend through aligned holes in an outer clamping plate 30, in the springs, in the spacers 31, 32, 33 and 34 of insulating material, such as phenol fibre, which are interposed between the springs and between the outer spring 26 and the outer clamping plate 30, in the metal spacer 35 and into threaded holes 36 in the bracket 5. The pairs of springs 25 and 27 and 26 and 28 have their cooperating contacts normally disengaged. The screws 29 where they extend through holes in the springs may be insulated therefrom by the usual sleeves of insulating material which surround the shanks of the screws. The other spring pile-up associated with the cut-off relay armature 13 comprises three fixed springs 37, 38 and 39 and three associated movable or armature springs 40, 41 and 42 as disclosed in Fig. 3. These springs are insulatedly secured to the bracket 6 in the same manner as the springs of the other pile-up. The pairs of springs 37 and 40 and 38 and 41 have their cooperating contacts normally engaged and the pair of springs 39 and 42 have their cooperating contacts normally disengaged. Each spring terminates at its rear end in a soldering terminal to enable external wiring conductors to be connected therewith and each movable or armature spring has its contact end bifurcated with a contact welded to each section thus formed, the pair of contacts on each spring cooperating with a pair of contacts welded to the associated fixed spring.

As best disclosed in Fig. 3, the insulating stud 18 secured to the arm of the line relay armature 12, engages against the outer face of the armature spring 27. Aligned with this stud and secured to the other armature spring 28 as by ring staking, is an insulating stud 43 which extends freely through a hole in the fixed spring 25 with its outer end engaged against the spring 27. Thus by the attraction of the armature 12 associated with the line relay coil 11, the studs 18 and 43 cause the movement of the armature springs 27 and 28 to engage their contacts with the contacts of the associated fixed springs 25 and 26.

The insulating stud 18 secured to the arm of the cut-off relay armature 13, passes freely through a hole in the fixed spring 37 with its free end engaged against the outer face of the armature spring 40. Aligned with the stud 18 and ring staked or otherwise secured to the armature spring 41 is an insulating stud 44, the outer end of which passes freely through a hole in the fixed spring 38 into engagement with the inner face of armature spring 40 and the other end of which is engaged against the outer face of the armature spring 42. Thus by the attraction of the armature 13 associated with the cut-off relay coil 9, the studs 18 and 44 cause the movement of the armature springs 40 and 41 to disengage their contacts from the contacts of the associated fixed springs 37 and 38 and to engage the contacts of armature spring 42 with the contacts of fixed spring 39. The armature springs are all so pretensioned that through the insulating studs 18, 43 and 44, they normally press the arms of the two armatures 12 and 13 against the backstop arms 24 in which position, the inner edges of the armatures are separated from the front edges of the flanges 3 and 4 by suitable air-gaps.

Fig. 3 illustrates the application of the improved relay assembly to a subscriber's line of a dial switching system served by a line finder. In this figure, the relay assembly has been schematically disclosed to better illustrate its operation. A subscriber's substation is illustrated by the circle 45, the line finder by the brush set 46 and the test relay of the line finder by the rectangle 47. In the installation of the relay assembly, two terminals of the line relay coil 11 are connected respectively to the battery and ground busbars of the central office battery and the other two terminals are connected to the armature springs 40 and 41. One terminal of the cut-off relay coil 9 is connected to the battery bus-bar and the other terminal is connected to the two armature springs 28 and 42 and to the sleeve multiples 48 of the subscriber's line appearing in the banks of all connector switches having access to such line. The springs 37 and 38 are connected to the ring and tip conductors 49 and 50 of the line, the springs 26 and 39 are connected to the sleeve or test multiples 51 of the line in the banks of all line-finder switches having access to such line, such for example as the switch 46, and the springs 25 and 27 are connected to the line-finder start circuit 52 and to ground respectively.

With the relay assembly thus connected, when the subscriber at substation 45 removes his receiver from the switchhook to initiate a call, a circuit is established from ground through the right winding of line relay coil 11, over the normally closed contacts of springs 38 and 41, tip conductor 50 of the calling line, over the line loop through the substation 45, and thence returning over the ring conductor 49, over the normally closed contacts of springs 37 and 40 to battery through the left winding of line relay coil 11. Coil 11 thus becomes energized to attract the associated armature 12 to thereby move armature springs 27 and 28 to engage their contacts with the contacts of the fixed springs 25 and 26, respectively. The engagement of the contacts of springs 25 and 27 closes the line-finder start circuit 52 to start an idle line finder in search of the calling line and the engagement of the contacts of springs 26 and 28 prepares an operating circuit for the cut-off relay coil 9 which may be traced from battery through such coil, over the contacts of springs 28 and 26 to the sleeve or test terminal 51 thereby placing potential on such terminal and the multiples thereof to indicate to a started line finder that the line is in a calling condition.

It will be assumed that the line finder indicated by the brush set 46 is started to hunt for the terminals of the calling line. As soon as the test brush 53 engages the test terminal 51 of the line, the previously traced circuit through the cut-off relay coil 9 is completed through the winding of the line-finder test relay 47 to ground. Coil 9 thereupon energizes, the copper sleeve 8 on its core permitting a quick build-up of current through its winding whereby the test relay 47 is enabled to operate quickly. With the coil 9 energized, the associated armature 13 is attracted to disengage the contacts of springs 40 and 41 from the contacts of springs 37 and 38, respectively, to thereby disconnect the windings of the line relay coil 11 from the calling line loop and to engage the contacts of spring 42 with the contacts of spring 39. With the contacts of these latter springs now engaged, a holding circuit for the cut-off relay coil is established from battery through such coil over the contacts of springs 42 and 39, test terminal 51, brush 53, to ground at the line finder to hold the cut-off relay energized after its initial operating circuit is opened at the contacts of springs 26 and 28 by the retraction of the line relay armature 12. Since the core of the line relay is provided with a copper sleeve, the retraction of the line relay armature, whereby the contacts of springs 26 and 28 become opened, is delayed for a sufficient interval to insure that the holding circuit for the cut-off relay coil 9 has been established by the engagement of the contacts of springs 39 and 42. Cut-off relay coil 9 is now maintained energized over its holding circuit until the line finder becomes released following the restoration of the receiver to the switchhook at the calling line substation.

While the relay assembly has been disclosed as applied to a subscriber's line terminating in the bank of a line finder, it will be apparent that a change in the arrangement of the springs of the spring pile-ups would enable the relay to be used in other types of dial switching or manual systems.

What is claimed is:

1. In combination, a line relay having a magnetic circuit including a core and an armature attractable thereto, contact springs operable by said armature and a cut-off relay having a magnetic circuit including a core and an armature attractable thereto, contact springs operable by said armature, and a copper sleeve on the cut-off relay core to enable a quick build-up of current in the cut-off relay coil.

2. A combined line and cut-off relay assembly comprising a field piece, two cores secured thereto, a line relay coil supported on one of said cores, a cut-off relay coil supported on the other of said cores, armatures attractable to the ends of the respective cores, contact springs supported on said field piece, certain of which springs are operable by the cut-off relay armature and others of which are operable by the line relay armature and a copper sleeve on the cut-off relay core to enable a quick build-up of current in the cut-off relay coil.

3. A combined line and cut-off relay assembly comprising a channel-shaped field piece, two cores secured to the base thereof and extending forwardly between the flanges thereof, a line relay coil supported on one of said cores, a cut-

off relay coil supported on the other of said cores, armatures attractable to the forward pole-piece edges of the flanges of said channel and to the ends of the respective cores, contact springs supported on one of said flanges, certain of which springs are operable by the cut-off relay armature and others of which are operable by the line relay armature and a copper sleeve on the cut-off relay core to enable a quick build-up of current in the cut-off relay coil.

4. A relay having a magnetic circuit including a core and an armature attractable thereto, contact springs operable by said armature, an operating coil supported on said core and energizable in a circuit including another relay and a copper sleeve on said core interposed between said core and said coil to provide a quick build-up of current in the circuit of said coil.

5. A relay having a magnetic circuit including a core and an armature attractable thereto, contact springs operable by said armature, an operating coil supported on said core and energizable by the entire current applied thereto over a circuit including another relay and a copper sleeve on said core interposed between said core and said coil to provide a quick build-up of current in the circuit of said coil.

HUGH M. STOLLER.