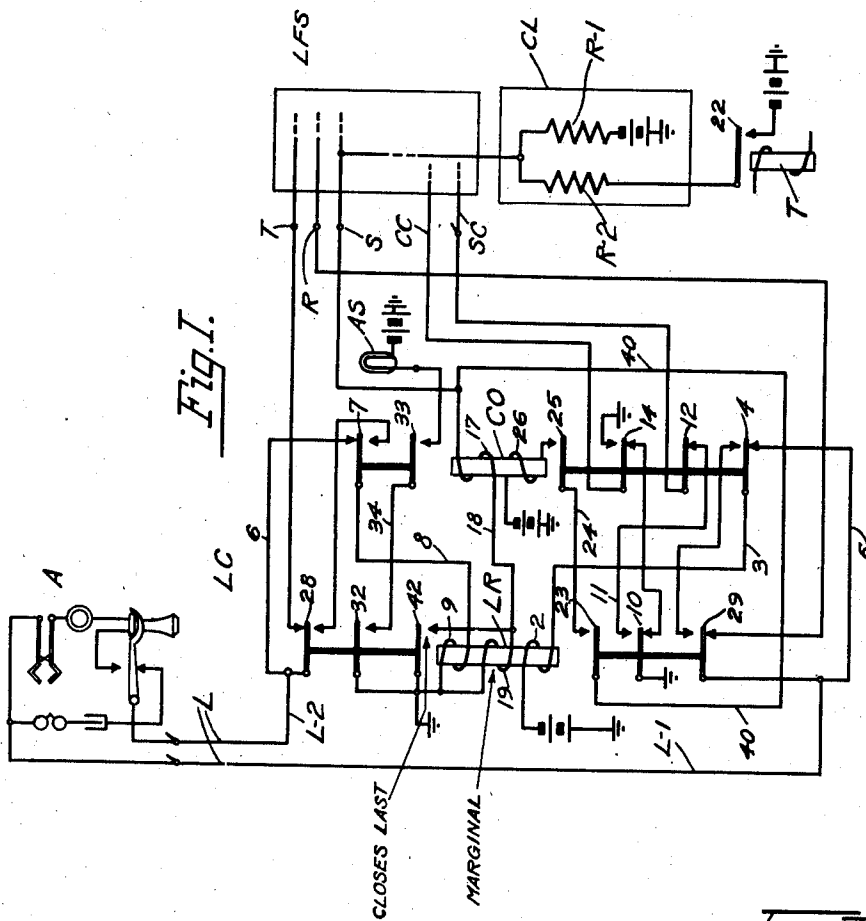
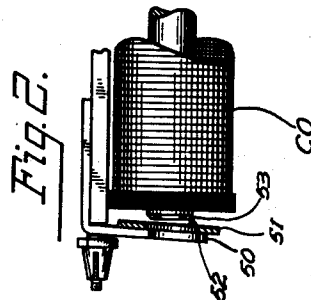


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TROUBLE CUTOFF SYSTEM
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TROUBLE CUTOFF SYSTEM

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8 Claims. (Cl. 179—18)

This invention relates to telephone systems, and more particularly to line circuits used therein.

The general object of the invention is the provision of a new and improved line circuit in which the number of relays is reduced to a minimum without a corresponding reduction in the number of functions performed thereby.

A specific object of the invention is the provision of an improved two-relay line circuit wherein the relays perform the usual line-relay and cutoff relay functions, and also serve to take over the function of a lockout relay to lock the associated line out of normal service, when the line is out of order, or when a revertive call has been made thereon.

A feature of the invention is that the line relay is restored in the usual manner when the associated cutoff relay operates upon an extension of the calling line, as by a finder, but may be reoperated with the cutoff relay operated, and the concurrent operation of the two relays causes the line to be locked out of normal service until the line is cleared.

A specific feature of the arrangement is that the armature movement of the cutoff relay is sufficiently retarded that the time elapsing between the starting of the movement and the completion thereof is sufficient for the line relay to restore responsive to being cut off by the first part of the movement of the cutoff-relay armature, before the movement on the cutoff relay armature has been completed, whereby the two relays are not in a fully operated condition at the same time during the normal functioning of the system, and the special lockout condition can be impressed on the line circuit by a reoperation of the line relay over a local circuit at any time when the cutoff relay is fully operated.

The foregoing and other objects and features of the invention will become more apparent as the description progresses.

Referring now to the accompanying drawing, Figs. 1 and 2 show a sufficient amount of a telephone system embodying the features of the invention to enable the invention to be understood.

Fig. 1 illustrates a line circuit constructed in accordance with the features of the invention, in association with an automatic telephone line L having one or more substations thereon, and automatic switching equipment indicated by the rectangle LFS.

Fig. 2 illustrates a preferred construction of the armature portion of the cutoff relay CO of Fig. 1.

Referring now particularly to Fig. 1, the illus-

trated line circuit LC is individual to the telephone line L, having substation A thereon, and, if a party line, having other substations bridged across the talking conductors thereof. The line circuit LC includes line relay LR and cutoff relay CO, and has associated therewith the usual so-called tip, ring, and sleeve conductors T, R, and S, respectively.

The conductors T, R, and S of the line L and line circuit LC may be extended by switching equipment indicated by the rectangle LFS to other lines, as calls are made from the line L; and the equipment LFS may operate to extend connections to the line L, by way of the line circuit LC, over conductors T, R, and S.

A detail description of the operation of the improved line circuit follows:

An incoming call

When the line L is to be called, and conductors T, R, and S, associated therewith, are seized by the automatic switching equipment LFS, a battery potential may be placed on the sleeve lead S to guard the multiple of the called line against intrusion, thereby closing a circuit for the upper winding 17 of the cutoff relay CO in series with the middle winding 19 of the line relay LR. Cutoff relay CO is operated over this circuit, but line relay LR is not operated at this time because it is marginally adjusted with respect to the flow of current under the normal conditions through winding 19. Upon operating, cutoff relay 17 disconnects the upper and lower windings of line relay LR at armatures 4 and 7 from in bridge of the called line to clear the line for talking purposes.

When the connection is released, battery potential is removed from sleeve lead S, whereupon relay CO restores.

An outgoing call

When the subscriber at substation A removes the receiver to initiate a call, line relay LR operates over the following circuit: from battery through lower winding 2, conductor 3, back contact 4 of the cutoff relay CO, conductor 5, line conductor L—1, through the substation A back over line conductor L—2, conductor 6, back contact 1 of relay CO, and conductor 8, to ground through the winding 9 of relay LR. Line relay LR now operates over the calling line. At back contact 10 relay LR removes ground potential from marking conductor CC, individual to line circuit LC, thereby marking the line circuit as calling. At front contact 10, relay LR grounds

the finder-start conductor SC, by way of conductor 11, and through back contact 12 of relay CO.

The ground on the start conductor SC common to a group of line circuits may cause an idle line finder in the switching equipment LFS to search for the calling line. Any suitable type of automatic switching mechanism and control circuits may be used with this invention, but the specific circuit arrangement herein illustrated is especially adapted to operate in the telephone system described in the application of George R. Eaton, Serial No. 229,266, filed September 10, 1938.

The searching finder mechanism finds ground potential on all non-calling ones of the marking conductors, such as CC, for each such conductor is normally grounded, through a back contact (such as 14) of its associated cutoff relay and a back contact (such as 10) of its associated line relay.

When the calling line circuit LC is reached, the absence of ground on marking conductor CC permits the searching finder to stop and to seize the calling line. Upon the seizure of the calling line battery potential is applied to sleeve lead S to mark the line as busy. Cutoff relay CO is thereby operated over lead S.

A portion of the circuit connections for busy-ing the calling line is diagrammatically shown, including resistor R—1 in equipment CL.

The operating circuit for the cutoff relay CO is from battery through the resistor R—1, through the equipment LFS, sleeve conductor S, winding 17 of the relay CO, conductor 18, and the front contact 42 of line relay LR, to ground. When relay CO operates, it first opens its back contacts 4 and 7 to disconnect the line relay LR from the calling line. Line relay LR promptly restores before relay CO completes its operation. Upon restoring line relay LR, at contact 42, removes the shunt from around winding 19, in series with winding 17, the sleeve lead S, and resistor R—1. Because of the resistance value of resistor R—1, winding 19 of marginal relay LR is ineffective, due to insufficient current, to prevent the prompt restoration of relay LR.

Upon completing its operation, relay CO prepares a new connecting circuit for relay LR, through front contacts 1 and 4 of CO, through front contacts 28 and 29 of LR, but this circuit is not completed at this time, for relay LR restores, as described above, while the operation of relay CO is occurring. Additionally, at back contact 12, relay CO removes ground from the start conductor SC, while at front contact 14 it restores ground to the conductor CC, to mark the now-found line as non-calling to prevent further seizure by line-finder mechanism later searching for another calling line. The calling line having been extended, as described, the subscriber may now receive a suitable tone signifying that dialing of the desired number may be started in the usual manner.

The connection may be completed in the usual manner, and conversation may ensue as desired.

When the receiver is replaced, the well-known action of the automatic switching equipment LFS in releasing the connection opens the circuit over sleeve lead S of relay CO, allowing relay CO to restore, thus returning the line circuit LC to normal condition.

Trouble operation

Let it be assumed now that the conductors L—1 and L—2 are looped accidentally, such as by a

shorted condition on the line, as by an unnoticed accidental removal of the receiver, at substation A, for example. When this occurs line relay LR operates as described before, to cause the line circuit LC to be found and connected with by line-finder mechanism in the automatic switching mechanism LFS. As described, relay CO operates comparatively slowly when the line is found, and relay LR restores while this occurs (upon the opening of back contacts 4 and 7 and before front contacts 4 and 7 close). Since the presently noted extension of the line L is spurious, and not responsive to a regular call, on the line L, no dialing follows the extension.

In order to prevent one of the links in the equipment LFS from being needlessly tied up indefinitely by the abnormal condition, time equipment of the usual arrangement may be provided to temporarily operate timer relay T after a predetermined interval, provided no dialing occurs. When relay T operates, closure of contacts 22 places resistor R—2 in shunt of resistor R—1, thus increasing the current flow over sleeve lead S and through windings 17 and 19, in series, to ground. Relay LR now reoperates from the increased current flow through winding 19.

At armatures 28 and 29 line relay LR disconnects the conductors L—2 and L—1 from switch-board conductors T and R, and connects them to its own upper and lower windings 9 and 2, through front contacts 7 and 4 of the actuated relay CO. Relay LR is thus locked, through its own upper and lower windings, to the now-shortened, or loped, line L. At contact 23, line relay LR closes a locking circuit for the operated cutoff relay CO, from battery through winding 26, front contact 25, conductor 24, front contact 23, conductor 40, winding 17 of cutoff relay CO, conductor 18, front contact 42 of relay LR, to ground. Front contact 42 closes last. Therefore, the described lockout holding circuit for the line relay is closed at front contacts 28 and 29 before the contact 42 shunts the actuating winding 19.

Responsive to the disconnection of leads T and R at armatures 28 and 29, the seized link in equipment LFS may now clear out in the usual manner. Battery potential is now on sleeve lead S and its multiples to mark the line L as busy, being applied by way of locking winding 26 of relay CO, contacts 25 and 23, and conductor 40, to lead S.

The closing of front contact 32 of relay LR and front contact 33 of relay CO, when both relays are energized due to trouble completes a circuit for a suitable alarm such as the visual alarm signal AS, from battery through the alarm signal AS, front contact 33 of relay CO, conductor 34, and front contact 32 of relay LR, to ground. This lighted signal AS indicates to any one inspecting the line equipment that the associated line is in locked-out condition.

The elimination of the abnormal conditions (the replacement of an accidentally removed receiver, or the clearing of a short circuit, as the case may be) allows the locked-out relay LR to restore. Relay LR opens the circuit of the alarm AS, at front contact 32, and at front contact 23 opens the holding circuit of relay CO. Relay CO restores, returning circuit LC to normal condition.

It will be understood, of course, that relay T, or similar other relay equipment may be arranged to reoperate upon the response of the called subscriber upon the calling when a revertive call

has been made, and the calling subscriber has temporarily hung up his receiver to allow the called substation to be signalled. Under this condition relay LR is reoperated, with relay CO operated; as before described, to place the circuit LC in locked-out condition for the duration of the ensuing conversation. The common equipment LFS is thus freed for other use during the reverte-call party-line conversation. The battery supply to the substations is through the line windings of relay LR in this case.

Since the line relay LR can be locked through its associated line loop through front contacts 4 and 7 of relay CO and its own front contacts 28 and 29, as described hereinbefore, it is necessary, as pointed out, to prevent such locking in the normal operation by retarding the speed of motion of the armature of the cutoff relay CO between the opening of back contacts 7 and 4, and the closing of the corresponding front contacts; so as to allow relay LR to restore before the cutoff relay completes its operation. Figure 2 shows a preferred way of insuring a retardation in the speed of movement of the armature 50 of relay CO.

To accomplish the retardation of speed of the armature movement of the cutoff relay CO, there is secured to the inner face of armature 50, an apertured copper disc 51. The apertured disc or annulus 51 is placed in the magnetic field of the energized core 53 when the armature 50 is attracted, and serves as a combined eddy-current damper and air-friction brake to retard the speed of the armature movement. The aperture 52 in the disc, slightly larger in diameter than the diameter of the relay core 53, together with the armature 50, acts as a dashpot to provide mechanical retarding means for the armature in its movement when attracted.

Thus, armature 50 (Fig. 2) of relay CO, in operating, opens its back contacts 4 and 7 (Fig. 1) and thereby the energizing circuit of relay LR, which latter relay promptly restores, opening its own front contacts 28 and 29 to prevent a locking circuit for the line relay. Due to the retardation in operating speed of the armature 50, the front contacts 4 and 7 of relay CO do not close until after the front contacts 28 and 29, of relay LR are opened. This provides for a positive restoration period for relay LR before the armature of relay CO completes its movement to fully actuated position, and thereby prevents relay LR from reoperating to lockout condition when a normal call is extended to the exchange from the substation A.

Although a preferred embodiment of the invention has been shown, particularly adapted to operate with a particular switching system, it is to be understood that the invention may be employed with other switching systems without departing from the true spirit and scope of the same as defined by the appended claims.

Having described my invention, what I claim is new and desire to secure by United States Letters Patent is:

1. In a telephone system wherein automatic switching equipment is provided in common for interconnecting telephone lines, a line circuit for the individual use of one of said telephone lines, said line circuit including a line relay operable over the associated line to indicate the origination of a call thereon, a cutoff relay associated with said line relay and operable to disconnect the line relay from the line to clear the line for talking purposes, means effective during the nor-

mal operation of the line and associated line circuit for insuring that said relays are not both in a fully operated position at the same time, means operable from the common switching equipment responsive to the line associated with said line circuit being out of order for operating said line relay over a local circuit during a time when the cutoff relay is fully operated, and contacts associated with said relays effective when both relays are operated fully at the same time to maintain both relays operated depending upon the flow of current over the associated line to lock the line out of normal service to thereby free the said common switching equipment for use in connection with the other lines.

2. In a telephone system wherein the subscriber lines are provided respectively with individual line circuits, and wherein each line circuit includes a line relay operable over the associated line to indicate that the line is in calling condition, and wherein there is a cutoff relay associated with the line relay and operable when the line has been connected with as a called line or has been extended as a calling line, to disconnect the associated line relay from the calling line and thereby permit it to restore, means for insuring that the completion of the operation of the cutoff relay occurs sufficiently later than the partial operation thereof that the line relay restores upon being disconnected responsive to the partial operation of the cutoff relay and before the cutoff relay is completely operated, and means effective, when it is desired to lock the associated subscriber line out of service until it is cleared, for reoperating the line relay over a local circuit while the cutoff relay is operated, said relays cooperating when both are fully operated at the same time to lock the line out of normal service.

3. In a telephone system, a line relay individual to a subscriber line, and means for operating said line relay over said line responsive to the removal of the receiver thereon to indicate a calling condition on the line, switching means effective to extend a connection from said line, a cutoff relay associated with said line relay and means for operating it over the extended connection to disconnect said line relay, said line relay restoring when disconnected, the said disconnection and restoration of said line relay occurring responsive to a partial operation of said cutoff relay, said cutoff relay subsequently operating fully after the line relay has restored, means operable over the extended connection in the event that the line relay operation occurred initially as a result of an unintended closure of the circuit therefor over the subscriber line for reoperating said line relay over a local circuit, and circuit connections controlled by said relays jointly to maintain both relays operated under control of the calling line so long as the unintended or abnormal condition remains thereon.

4. In a telephone system wherein line circuits are provided individual respectively to subscriber lines, each said line circuit including a line relay operable over the associated line when calling to indicate the calling condition thereof, each such circuit including a cutoff relay operable to disconnect the line when connection has been made thereto as a called line or when the line has been extended as a calling line, means associated with said cutoff relay for insuring that the associated line relay restores when the cutoff relay operates to disconnect the line relay when the line has been extended as a calling line, and means operable over the extended connection for reoperat-

ing the line relay while the cutoff relay is operated, and circuit connections controlled jointly by said relays for opening the said extended connection and for maintaining both relays operated under the control of the associated line so long as a circuit for the line relay remains established thereover.

5. In a switching system wherein switching equipment is provided in common for a number of lines to effect desired interconnections thereof, each said line having a line circuit associated therewith including a line relay operable over the associated line when there is a calling condition thereon, each line circuit including a cutoff relay for disconnecting and restoring the associated line relay, means associated with the cutoff relay for insuring that the line relay restores when the cutoff relay operates, and before the operation of the cutoff relay is completed, means effective under predetermined conditions for reoperating the line relay over a local circuit after it has been disconnected and restored by the operation of the cutoff relay, and circuit connections controlled jointly by said relays when both of them are in operated condition at the same time for holding both relays operated so long as a circuit remains established for the line relay over the associated line, said means including contacts on both of said relays for reconnecting the line relay to the line when both relays are fully operated.

6. In a line circuit, a line relay operable over an associated line, a cutoff relay for disconnecting the line relay when operated, contacts on both relays for reconnecting the line relay when both relays are operated at the same time, means associated with the cutoff relay for insuring that the line relay restores during the operation of the cutoff relay and thus does not become reconnected as a result simply of the operation of the cutoff relay, and means subsequently effective under predetermined conditions for operating the line relay locally to secure its reconnection to the line when the cutoff relay fully operated.

7. In a telephone system, a line circuit including a line relay and a cutoff relay, said relays being operable separately to perform their respective line-relay and cutoff-relay functions, and means for causing both said relays to be brought into operated position at the same time to act jointly to lock the associated line out of service.

8. In a telephone system, a line circuit including a line relay and a cutoff relay separately operable to perform their respective separate functions, one function of the cutoff relay being to disconnect the line relay from the associated line responsive to movement of the armature thereof when the relay is energized, and means including contact means controlled by a further movement of said armature in the same direction for reconnecting said line relay.

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