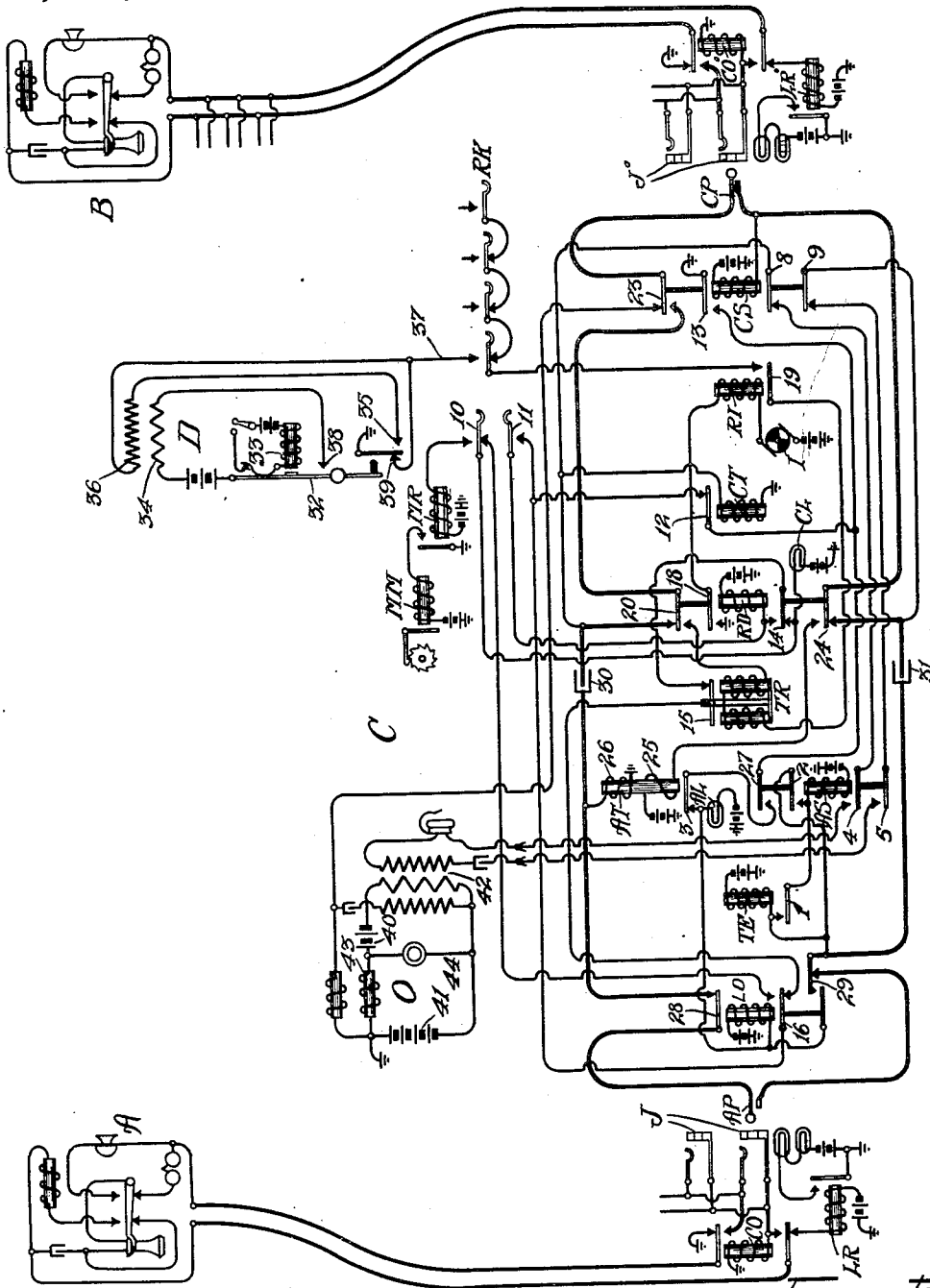


H. D. CURRIER.
TELEPHONE SYSTEM.
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UNITED STATES PATENT OFFICE.

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To all whom it may concern:

Be it known that I, HIRAM D. CURRIER, a citizen of the United States, residing in Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems, and has to do more particularly with improved and simplified circuit arrangements for link circuits, one of the features being an improved arrangement for automatically effecting the interruption of ringing current at the time of response. To this end I preferably employ a polarized trip relay connected in the ringing circuit which is preferably pulsating current, said relay being poled and adjusted so that the ringing impulses do not affect the control contact thereof, but a reversed flow in the relay occasioned by the removal of the called receiver, will operate its armature and thus actuate the ringing control contact. I have also provided an improved operator's telephone circuit which I have found adapted for operating over longer lines due to the use of a main battery and opposed battery cells, which latter cells take the place of a condenser.

Referring to the accompanying drawing for a better understanding of my invention, the system there illustrated comprises the telephones A and B terminating in a well-known form of line circuit including a line relay LR, cut-off relay CO and multiple jacks J. In the present form of my invention I employ a line signal for each line jack so that when a call is initiated the different signals are displayed and any one of a plurality of operators may seize the call to the exclusion of others. The cord circuit C includes an answering plug AP and calling plug CP connected by the heavily marked tip and sleeve talking conductors with interposed condensers 30 and 31. In answering a call the high resistance test relay TE is energized to connect an answering sleeve relay AS in circuit with the sleeve strand of the cord, and thus in series with the cut-off relay CO causing the energization of

both, followed by the operation of the answering tip relay AT which attracts its armature 3 and prevents the premature lighting of the answering supervisory lamp AL. A winding 25 of few turns is provided on the answering tip relay AT whereby when ringing current is applied to the called line, the calling subscriber is apprised of the fact by the induced current set up in the winding 26 of AT. This winding 25 is of such proportion as not to interfere with the proper operation of the tip relay AT.

The present form of my invention is preferably arranged for instantaneous disconnect and recall and to this end a link disconnect relay LD is provided which operates when the calling subscriber replaces his receiver and by the interruption of its normal contacts 28, 29 operatively disconnects the cord and line so that the calling subscriber may initiate a recall without awaiting the removal of the answering plug from the line jack.

In connection with the testing by relay TE when a calling line is seized by one operator, should a second operator insert an answering plug into another jack of this line, the test relay TE of this second cord will not energize due to the shunting effect of the comparatively low resistance relay AS of the first cord so that the operator at the second cord cannot communicate with the calling subscriber and knows that the call has been seized by another operator and therefore withdraws her plug.

I preferably have provided automatic listening in the present arrangement of my invention, this being effected through the action of the answering sleeve relay AS which connects the operator's telephone when the call is seized, and when the call is extended, the calling sleeve supervisory relay CS operates to again disconnect the operator's telephone O.

In extending a call to a wanted line the calling plug CP is inserted connecting calling sleeve relay CS and cut-off relay CO¹ in series and causing the energization of both. The operator then depresses the proper plunger of her ringing key RK to con-

nect ringing current from a pole changer D. The depression of any ringing plunger to its fully actuated position operates the common contacts 10, 11 whereby a meter relay MR and meter magnet MM are energized to record a connection. The closing of contact 11 operates the ringing disconnect relay RD to cause an intermittent energization of the ringing relay RI to intermittently connect ringing current to the called line. When the subscriber responds to the call the polarized trip relay TR is operated to cause a restoration of the disconnect relay RD thereby preventing further operations of the ringing relay and stopping the application of ringing current to the called line. The restoration of RD connects the tip relay CT in circuit with the called line causing its energization so that a subsequent de-energization thereof, when a called line receiver is replaced, will light the calling supervisory lamp CL.

For ringing purposes I employ pulsating current, this being taken from pole changers like D of different frequencies and preferably so arranged as to introduce a ground between each two impulses. By this arrangement ordinary polarized bells of corresponding frequencies may be used at the substations. The pole changer D includes a vibrating magnet 33 adapted to actuate a tuned reed 32 which when attracted closes a circuit through the primary winding 34 of a transformer and at the same time grounds a terminal of the secondary 36 by a contact 35 so that an impulse of current is induced in the secondary winding 36 and to the ringing conductor 37. As the tuned reed 32 moves away from the magnet, contacts 38 and 35 are broken followed immediately by the closure of contact 39 so that the ringing lead 37 is grounded and takes the discharge from the connected line and thus causes a movement of the armature of the substation bell opposite to that caused by the ringing impulse. Thus the bell armature is thus caused to vibrate. Of course, other methods of producing the pulsating current may be employed if desired.

The polarized trip relay TR is preferably included directly in the ringing circuit and is so poled that the current impulses from the ringing source do not cause an attraction of its armature 15. However, when a subscriber responds by removing his receiver the resulting direct current flow is in an opposite direction to the ringing impulses so that relay TR interrupts its contact 15 and thereby restores disconnect relay RD to prevent further application of ringing current.

Another feature of my invention resides in an improved operator's telephone O wherein no condenser is employed in the

primary circuit, but instead several cells of battery 40 preferably connected in series with the central exchange battery 41 and with like poles opposed. I also preferably employ an induction coil 42 of the so-called local battery or magneto type as this type of coil is of lower number of turns and resistance and thus lower impedance than the common battery coil. With an exchange battery 41 which varies between 20 and 28 volts, I have found that two dry cells 40 operate very effectively although I preferably employ counter E. M. F. cells at this point. An impedance coil 43 is also connected between the main battery 41 and the transmitter 44. With the operator's telephone O shown and described, I have found that the receiving and transmitting is several miles of cable better than with the usual condenser and common battery induction coil.

Having described in general the preferred arrangement of the circuits and apparatus employed in my invention, I will now describe more in detail its operation in establishing a connection between two telephone lines.

Assuming a subscriber at substation A has removed the receiver thereat to initiate a call, line relay LR is energized to light the associated line lamps. An operator therefore answers the call by inserting an answering plug AP into the jack of the calling line thereby connecting the high resistance test relay TE and cut-off relay CO in series, resulting in the energization of TE but preferably not CO. Relay TE therefore closes its alternate contact 1 connecting relay AS in circuit with the sleeve strand and thus in series with the cut-off relay causing the energization of both whereby alternate contact 2 of AS is closed connecting the winding of said relay AS directly to the sleeve strand independent of relay TE. Responsive to the closing of the alternate contacts of the cut-off relay, current flows over the line and through winding 26 of the answering tip relay AT to ground causing the energization of this relay so that the interruption of its normal contact 3 will prevent the lighting of supervisory lamp AL at this time. The closing of alternate contacts 4, 5 of AS connects the operator's telephone O through normal contacts 8, 9 in bridge of the talking conductors of the cord and therefore in circuit relation with the calling line.

The operator finding that the line of B is desired, and upon testing ascertains its idle condition, inserts calling plug CP in a jack J¹ thereof, thus connecting relays CS and CO¹ in series and causing the energization of both. The interruption of normal contacts 8, 9 of CS disconnects the opera-

tor's telephone from the cord and the closing of alternate contact 13 of CS establishes a circuit for calling supervisory lamp CL traced from ground through said alternate contact 13, normal contacts 12, 16, 15, 14, and lamp CL to battery.

The operator now depresses the proper ringing plunger thereby momentarily closing alternate contacts 10 and 11, while the plunger is in its fully depressed position, said contacts returning to the normal position upon restoration of the plunger to its intermediate or indicating position. The closing of alternate contact 11 establishes an energizing circuit for the ringing disconnect relay RD traced from battery through the winding thereof, alternate contact 11, normal contact 12 and alternate contact 13 to ground. Relay RD therefore closes its alternate contact 14 establishing a locking circuit for itself traced from battery through the winding thereof, alternate contact 14, normal contacts 15, 16, 12 and alternate contact 13 to ground.

It will be noted that at the time alternate contacts 10, 11 of the key are first closed and before relay RD energizes, the ground connection to armature contact 14 extends through alternate contact 10 and meter relay MR to battery so that said relay operates the meter magnet. Relay MR is of a slow restoring type so that although it receives but a short impulse of current this is sufficient to draw its armature up and maintain its attracted position long enough to operate the magnet MM and meter.

Referring again to relay RD, the interruption of normal contact 14 effaces lamp CL and the closing of alternate contact 13 establishes an intermittent energizing circuit for ringing relay RI so that current from connected pole changer D is periodically connected to the line over a circuit traced from ringing conductor 37, alternate contact 19, polarized trip relay TR, alternate contacts 20, 23, over the line and through the different substation bells (but ringing only that one tuned to correspond to the applied ringing current), returning over the sleeve strand and through winding CS and 25 of AT in multiple through battery to ground.

As previously referred to, pulsating current is produced at the pole changer D and this current is in a direction which will not operate the armature of the trip relay TR. As already referred to each impulse from the pole changer D is followed by a grounding of the ringing conductor 37 and of course a grounding of the connected line so that the condenser connected in series with the operated bell will discharge and restore the armature of the substation bell to be again operated by the next impulse

of ringing current. Although the path of discharge of current includes the winding of the trip relay, it does not effect the armature sufficiently to interrupt contact 15.

Upon response being received from the called substation and the removal of the receiver thereat from its switch-hook, a path for direct current through the trip relay TR is provided to cause the operation thereof, this circuit being traced from battery through winding 25 of AT and winding of CS in multiple over the called line returning over the tip strand, alternate contacts 23, 20, the winding of TR, alternate contact 19, the actuated ringing key contact, conductor 37 and contact 39 to ground. This current is in a direction to cause the operation of TR so that its contact 15 is interrupted to interrupt the locking circuit of the ringing disconnect relay RD whereby said relay restored interrupting the circuit of RI and preventing further application of ringing current. The closing of normal contact 20 of relay RD substitutes the calling tip relay CT for relay TR so that relay CT energizes by current over the called line interrupting its normal contact 12 which controls lamp CL.

After the subscribers have finished conversation they replace their receivers upon their respective switch-hooks, the restoration of the receiver at A being effective to restore relay AT so that its normal contact 3 is closed connecting ground from alternate contact 13 at CS through alternate contact 27, normal contact 3, lamp AL to battery, and the winding of LD to battery. The link disconnect relay LD therefore energizes, interrupting its normal contacts 28, 29 and thus operatively disconnecting the link and line A, causing the restoration of CO and again placing the line relay LR under line control whereby an immediate recall may be initiated if desired. Although the holding circuit for AS is interrupted by the interruption of normal contact 29 a substitute circuit is provided through alternate contact 29 to the grounded contact 3 so that the relay AS is maintained energized and by its contact 27 holds the circuit for relay LD and lamps AL, CL.

The restoration of the receiver at the called substation effects the restoration of calling tip relay CT whereby its normal contact 12 is closed establishing a circuit for the calling supervisory lamp CL traced from battery through said lamp, normal contact 10, alternate contact 16, normal contact 12 and alternate contact 13 to ground. The operator in response to these two lamps withdraws the plugs AP and CP from their respective jacks so that the restoration of CS interrupts alternate contact 13 and thereby causes the restoration of lamps AL, CL,

and relays AS, TE and LD, so that the link circuit is again at normal and available for other connections.

It will be noted that relay LD is a slow restoring type, this being to prevent the seizing of a recall by more than one link circuit. That is, assuming a connection is established between substations A and B and that after conversation the subscribers have replaced their receivers to bring about the lighting of lamps AL and CL and the energization of LD. Should the calling subscriber at A initiate a recall prior to the removal of plug AP, the associated line signals will of course be lighted and should another operator than the one which controls cord C seize this call, upon the withdrawal of plug CP of C the locking circuit for relays LD, TE and AS is interrupted at alternate contact 13 of CS. Now if relays LD, TE and AS were fast relays, and relay LD should restore prior to TE and AS it will be seen that due to the closing of normal contact 29 of LD, relay AS would remain locked up over the sleeve strand and therefore the operator of cord C would have her telephone connected to the calling line in multiple with the telephone of the other operator who has seized the recall. But due to the slowness of the relay LD, relays AS and TE will restore prior to LD, so that upon restoration of LD the associated relay TE will not again energize and therefore its relay AS also remains inert and the operator at C is prevented from coming in on the seized recall.

Although I have chosen a preferred embodiment for the purpose of illustrating my invention, I contemplate using it in other ways than that shown, and therefore I do not desire to be limited to the exact structure as shown and described, but aim to cover all that which comes within the spirit and scope of the appended claims.

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

1. A telephone system comprising telephone lines, a link circuit having called line terminals for connection to said lines as called lines, a source of pulsating current, a polarized relay, circuit connections for connecting said source of current and said relay in series circuit to a connected called line, said relay being so arranged as not to actuate its armature when so connected, means for establishing a reverse flow of current in said relay to cause the same to operatively energize and attract its armature, and circuit connections controlled by said armature when thus operated to disconnect said pulsating current from said terminals.

2. A telephone system comprising telephone lines, a link circuit having called line terminals for connection to said lines as

called lines, a source of pulsating current, a polarized relay, circuit connections for connecting said source and relay in circuit with said terminals and thus to a connected called line, said relay being poled with respect to said impulses so that its armature is not affected thereby, means for establishing a reverse flow of current in said relay to operate its armature, and circuit connections controlled by said armature when thus operated to disconnect said pulsating current from said terminals.

3. A telephone system comprising telephone lines, a link circuit having called line terminals for connection with said lines as called lines, a polarized relay, means for impressing a source of pulsating current through the winding of said relay upon said terminals and thus to a connected called line, polarized signal bells at said substation responsive to such application of current, a source of direct current, means whereby the removal of the receiver at a called substation connects said source of direct current in circuit with said relay to operate the armature thereof, contacts controlled by said armature, and circuit connections controlled by said contacts when thus operated for disconnecting said pulsating current from said terminals.

4. A telephone system comprising telephone lines, a link circuit having called line terminals for connection to said lines as called lines, a source of pulsating current, means for connecting said source to the link terminals and thus to a connected called line, a polarized relay connected directly in circuit with said source of current, all of the current applied to said line from said source of current passing through said relay but not effectively actuating its armature, a source of direct current, means controlled at a connected substation for establishing a flow of current through said relay from said last source to operate its armature, and circuit connections controlled by said armature when thus operated to disconnect said pulsating current from said terminals.

5. A telephone system including a called telephone line, a link circuit provided with a terminal for connection to said line, a source of pulsating current, a polarized relay, circuit connections for connecting said relay in series circuit with said source of current whereby all necessary current to signal the called substation passes through the winding of said relay and the said terminal to said line, and means controlled by the response of the called subscriber for operatively energizing said relay to disconnect said pulsating current from said terminal.

6. A telephone system including a called telephone line, a source of pulsating current, a polarized relay, circuit connections for connecting said source and relay in direct

series circuit with said called telephone line, said relay when so connected being irresponsive to said pulsating current, means controlled at the called substation for establishing a reversed flow of current through said relay whereby the armature of said relay is effectively operated, and circuit connections controlled by said relay to disconnect said pulsating current from said called line.

7. A telephone system including a telephone line, a source of pulsating current, a polarized relay, circuit connections for connecting said source and said relay to said line as a called line, an interrupter relay for intermittently operating said circuit, a source of direct current, and means controlled at the substation on said line for including said source of direct current in circuit with said relay whereby said relay operates its armature to open the circuit of said interrupter relay thereby preventing further application of ringing current to said line.

8. A telephone system including a called line, a source of pulsating current, a polarized relay, an interrupter relay for intermittently connecting said source and said relay to said called line, means for establishing a reverse flow of current in said polarized relay to operate its armature, and circuit connections controlled by said armature when thus operated to open the circuit of said interrupter relay thereby preventing further applications of ringing current to said called line.

9. A telephone system including a called telephone line, a source of ringing current, a polarized relay, circuit connections for connecting said source of current and said relay in circuit with the said called line, all of the current applied to said line to signal the substation thereon passing through the said relay, an interrupter for intermittently disconnecting said source of current from said line, and means controlled by the response of the called subscriber for operatively energizing the said relay to disconnect said signaling current from said line.

10. A telephone system including a called subscriber's line, a source of ringing current, a polarized relay, means for connecting both said source of current and said relay in series circuit with said called line, whereby all of the current applied to said line from said source passes through said relay without effectively operating the same, and substation controlled means for operatively energizing said relay to disconnect said current from said line.

11. A telephone system including a calling subscriber's line and a called subscriber's line, a source of ringing current, a polarized relay, means for connecting said source of current and said relay in circuit with said called line, said relay and said source of current being so connected that all

of the current applied to said line passes through said relay and said relay being so constructed that it does not actuate its armature when so connected, and means controlled at the calling substation for disconnecting said source of current from said called line.

12. A telephone system including a calling subscriber's line and a called subscriber's line, a source of ringing current, a polarized relay, means for connecting said source of current and said relay in circuit with said called line whereby the current applied to said line from said source of current passes through the winding of said relay, said relay being so constructed that it does not effectively actuate its armature when so connected, means controlled at the called substation for operatively energizing said relay to disconnect said source of current from said called line, and means controlled at the calling substation for disconnecting said source of current from said called line.

13. A telephone system including a calling and a called telephone line, a source of pulsating current, a polarized relay, circuit connections for connecting said source of current and said relay in circuit with said called line, said relay being so connected that all of the current applied to said called line from said source of current passes through the winding thereof, said relay being so constructed that its armature does not effectively respond when so connected, and means controlled over the calling line for disconnecting said source of current from said called line.

14. A telephone system including a calling and a called telephone line, a source of pulsating current, a polarized relay, circuit connections for connecting said source of current and said relay in circuit with said called line, all the current applied to said called line passing through said relay, the said relay being so constructed that it does not respond when connected in circuit with said source of current, means controlled over the called line for disconnecting said source of current therefrom, and means controlled over the calling line for disconnecting the source of current from the called line if the calling subscriber signals for disconnection before the called party answers.

15. A telephone system including a called subscriber's line, a source of signaling current and a polarized relay, a relay for including said source of current in circuit with said called line to operate the call bell at the substation on said line, said polarized relay being so connected that all the current applied to said line from said source of current passes through said relay, an interrupter relay for intermittently disconnecting said source of current from said line, an

additional source of current, and means responsive to the removal of the receiver at the called substation for including said additional source of current in circuit with
5 said polarized relay whereby said polarized relay is operatively energized to disconnect the said first source of current from said called line.

Signed by me at Chicago, county of Cook and State of Illinois, in the presence of two 10 witnesses.

HIRAM D. CURRIER.

Witnesses:

GEORGE E. MUELLER,
M. R. ROCHFORD.