Oct. 28, 1941. R. E. HERSEY 2,260,524

TELEPHONE SYSTEM

Filed June 4, 1937 2 Sheets-Sheet 1

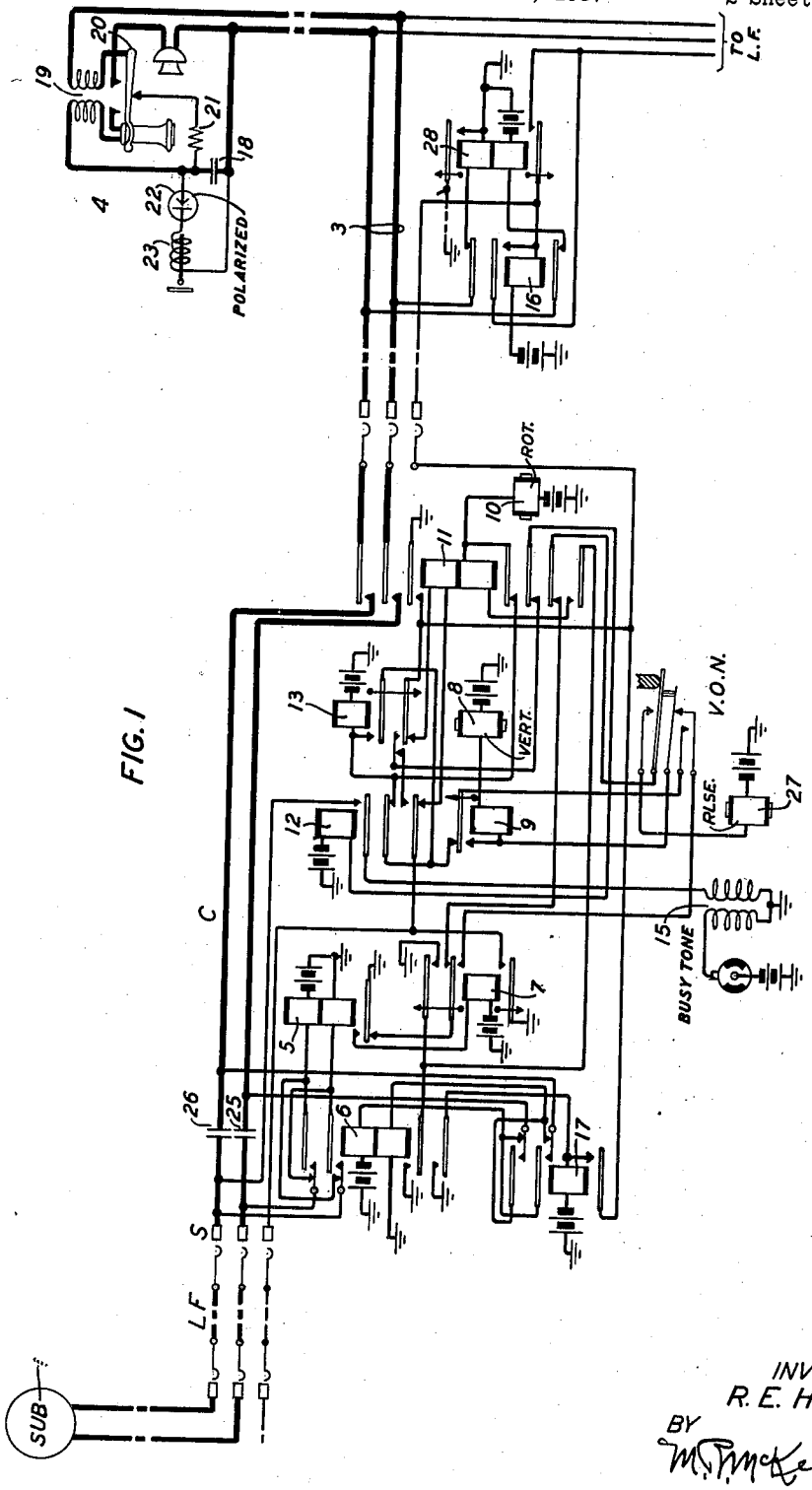

FIG. 1

INVENTOR
R. E. HERSEY
BY
M. P. McKenney
ATTORNEY

Oct. 28, 1941. R. E. HERSEY 2,260,524

TELEPHONE SYSTEM

Filed June 4, 1937 2 Sheets-Sheet 2

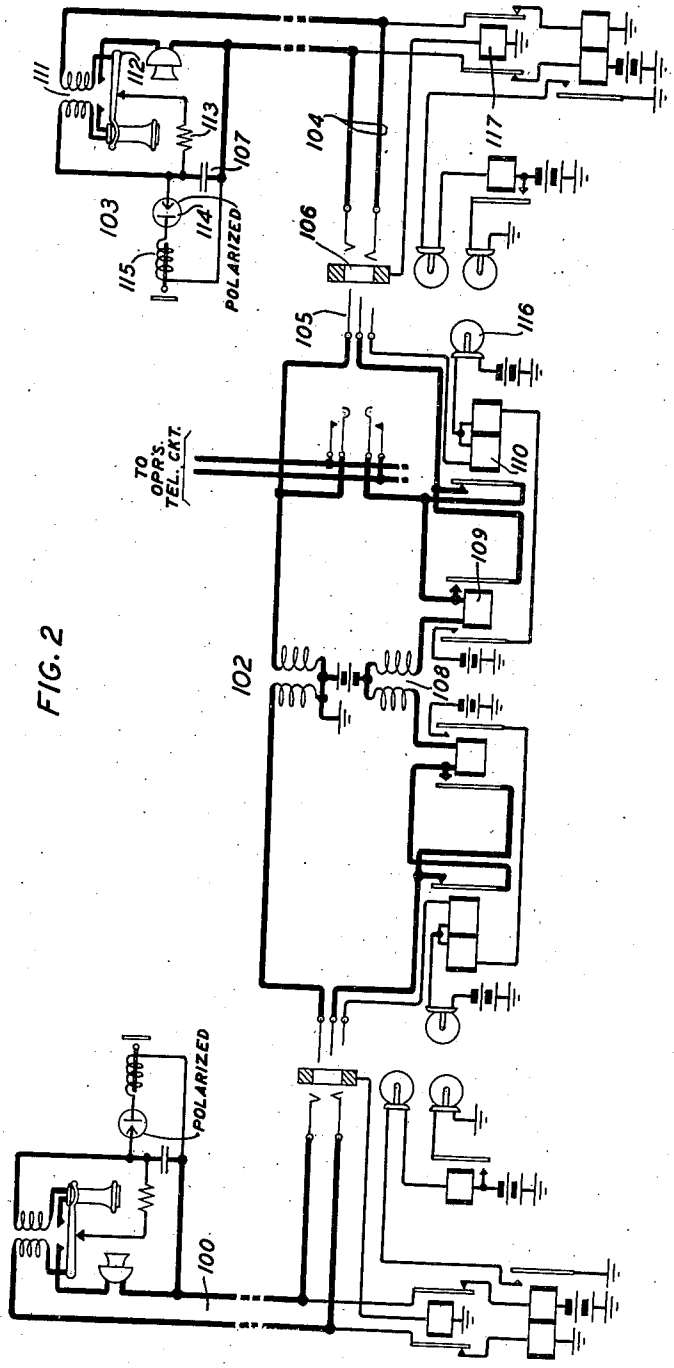

FIG. 2

INVENTOR
R. E. HERSEY
BY
W. P. McKenney
ATTORNEY

Patented Oct. 28, 1941 2,260,524

UNITED STATES PATENT OFFICE

2,260,524

TELEPHONE SYSTEM

Ralph E. Hersey, Madison, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 4, 1937, Serial No. 146,356

8 Claims. (Cl. 179—18)

The invention relates to telephone systems and particularly to improvements in signaling arrangements for such systems.

An object of the invention is to simplify and reduce the cost of the equipments for ringing subscribers on called lines.

Another object of the invention is to provide ringing means that does not require the usual ringing current supply nor ringing tripping equipment at the central office.

Heretofore systems have been provided in which ringing current applied at the central office causes the operation of ringing apparatus at a subscriber's station and when the subscriber answers the call by removing his receiver from the switchhook, a tripping relay at the central office is operated to discontinue the application of ringing current. In certain systems, for example in case of party line selective ringing systems, cold cathode gas-filled tubes of the trigger type have been used in the various subscribers' telephone sets. In these latter systems, a tube breaks down in response to ringing current to close a connection for a ringing circuit to ring a particular bell depending on the method of wiring.

A feature of the present invention is to provide a ringing and tripping arrangement for substation signaling in which the usual machine ringing equipment at the central office is eliminated and whereby a bell at the substation may be rung merely by closing the connection for the subscriber's line from the talking battery at the central office.

It is a special feature of the applicant's invention to employ a gas-filled tube at the substation for this purpose. This tube is in series with a bell winding and a resistance, and the tube and bell winding are shunted by a condenser. When a connection is established at the central office to this substation, the usual talking battery is applied on the line and the condenser is thereby charged until the tube breaks down, at which time the condenser discharges through the bell winding operating the bell, and the tube is then restored to normal. The condenser is then again charged and these operations are repeated. The bell will therefore be tapped intermittently at intervals depending on the characteristics of the condenser and the breakdown potential of the tube. When the subscriber answers by removing his receiver from the switchhook, the circuits for the bell and resistance are made inoperative. The arrangement is such that when the called subscriber restores his receiver on the switchhook the circuits for ringing the bell will not function as the talking battery connections have previously been reversed and are maintained reversed until the connection is released at the central office. The normal battery and ground connections for a subscriber's line through the usual line relay is of such polarity that the subscriber's bell will not ring. The discharge tube is for these purposes polarized to operate on currents in one direction only.

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

Fig. 1 shows the invention applied to an automatic step-by-step telephone system; and

Fig. 2 shows it applied to a manual telephone system.

Reference is now made to the drawings and particularly to Fig. 1, in which as much as is necessary to illustrate applicant's invention has been shown of an automatic step-by-step system. Any standard automatic system may be employed using a connector such as is illustrated at C in this drawing with the usual ringing source and tripping relay arrangement eliminated and otherwise arranged in accordance with the applicant's invention. A calling subscriber's line has been shown in diagrammatic form at 1 terminating in a line finder LF connected through any number of intermediate switches and a selector S having access to the connector C. This connector in turn has access to a subscriber's line 3 terminating in a called subscriber's substation apparatus 4 arranged in accordance with the applicant's invention.

A description will now be made of the operations when the substation 4 is called from the calling subscriber's line 1. The calling subscriber at 1 may connect through the line finder LF and intermediate switches to selector S which then finds the connector C in any manner well known in standard step-by-step systems. When the connector C has been found and connected to, a circuit is completed over the tip and ring conductors for the operation of relay 5 from battery and ground through the windings of this relay, contacts of relay 6, over the tip and ring conductors, back through the calling subscriber's loop. Relay 5 closes an obvious circuit for the operation of relay 7 which is slow in releasing and which remains operated during the dialing of the last two or tens and unit digits of the desired subscriber's line number by operation of relay 5 which now takes place. On the first release of relay 5 for the tens digit a circuit is completed for the operation of the vertical mag-

net 8 and relay 9 from battery through the winding of this magnet, winding of relay 9, vertical off-normal contacts VON, contacts of relays 7 and 5 to ground. This causes the vertical magnet 8 to operate the connector switch C to take one vertical step. On the second release of relay 5, the circuit for the vertical magnet extends through the vertical off-normal contacts VON and the armature and front contact of relay 9, which remains operated during the sending of the impulses of this digit, and the vertical magnet is operated to the desired level depending on the number of pulses received. At the end of this series of impulses relay 9, which is slow to release and remains operated during this series of impulses, will release and on the first impulse of the unit digit, a circuit will be completed for the rotary magnet 10 from battery through the winding of this magnet, contacts of relays 11, 12 and 9 and the vertical off-normal contacts VON, contacts of relays 7 and 5 to ground. It should be noted that a circuit is also completed for relay 13 from battery through the winding of this relay to ground at relay 5 over contacts of relays 12 and 9, contacts VON and contacts of relays 7 and 5. Relay 13 operates a locking circuit for itself through its lower inner armature and front contact, to relay 5 independent of the contacts of relay 12. Relay 13 is slow in releasing and remains operated during the dialing of the unit digit. The rotary magnet now advances the connector to the desired subscriber's line, in this case line 3. If the line is busy, there is a ground on the sleeve terminal which would cause the operation of relay 12 before relay 13 releases over a circuit from battery through the winding of relay 12, contacts of relays 11 and 13, over the sleeve circuit to ground. Relay 12 is locked in operated position on the release of relay 13 from battery through the winding of relay 12, contacts of relay 11, make-before-break contacts of relay 13, contacts of relay 12 to ground at the sleeve from the selector S, as is well known. Relay 12 applies busy tone from the source 15 over the tip conductor back to the calling subscriber's line at 1.

In case, however, that the called line is idle, relay 13 will release after an interval and a circuit will be completed for the operation of relay 11 from battery, through the cut-off relay 16 over the sleeve circuit, contacts of relay 13, upper winding of relay 11, contacts of relay 12 to ground over the sleeve circuit from the selector S. Relay 11 is now locked through its lower winding from battery through the rotary magnet 10, lower winding of relay 11, its lower outer armature and front contact to ground at contacts of relay 7 thus putting the release of this connection under control of the calling subscriber's line. The resistance of the lower winding of relay 11 prevents the operation of the rotary magnet 10 at this time. Relay 11 in operating provides a ground for the sleeve circuit and cut-off relay 16 and is held operated by this ground over the sleeve. Relay 11 also closes at its two upper armatures and front contacts a connection for the tip and ring conductors to the called line 3 from battery and ground through the windings of relay 6 and contacts of relay 17. This causes the condenser 18 to be charged over a circuit from battery through the upper winding of relay 6, contacts of relays 17 and 11 over the ring conductor through the the right-hand winding of the repeating coil 19, contacts of the switchhook 20, resistance 21, condenser 18, over the tip conductor, contacts of relays 11 and 17, lower winding of relay 6 to ground. The condenser 18 is charged in accordance with the potential of the battery through the windings of relay 6 and at a speed depending on the characteristics of the condenser and the resistance 21. When charged to a value sufficient to break down the gas-filled tube 22, the condenser will discharge over a path from the lower side of the condenser 18, winding of the tap bell 23, tube 22, to the upper side of the condenser. The tap bell 23 will operate to actuate its plunger to give a single tap to its gong. The tube will then be restored to normal and the condenser 18 will again be charged by the battery and ground through the windings of relay 6 and when sufficiently charged cause the tube 22 to again break down to operate the tap bell 23 a second time. These operations are continued at a frequency determined by the characteristics of the resistance 21 and condenser 18 and the breakdown characteristics of the tube 22. The tap bell 23 will therefore continue to ring its gong until the subscriber answers by removing his receiver from the switchhook. In doing this the charging circuit through resistance 21 for the condenser 18 is opened and the condenser is short-circuited through the transmitter and consequently the ringing will cease. When the called subscriber at station 4 answers, relay 6 will operate and reverse the battery and ground through the winding of relay 5 over the tip and ring conductors to the calling subscriber's line as a supervisory signal and talking battery is now supplied for the calling subscriber's line through the winding of relay 5 and for the called subscriber's line through the winding of relay 6 and the talking connection over condensers 25 and 26.

When relay 6 operates it closes an obvious circuit for relay 17 which in operating locks itself to ground at relay 11 and reverses the battery and ground connection over the winding of relay 6 for the tip and ring conductors through the called line loop. The gas-filled tube 22 is polarized and will not break down with battery and ground reversed. The tap bell is therefore prevented from ringing when the called subscriber replaces his receiver on the switchhook. The calling subscriber when releasing causes the release of relay 5 which in turn releases relays 7, 11, 17 and 16. A circuit is then closed for release magnet 27 from battery winding of this magnet contact VON, contacts of relays 11, 7 and 5 to ground. It should be noted that when relay 11 releases the connection to the substation from battery and ground over relay 6 is opened so relay 17 may therefore be released to restore the polarity of the battery and ground to the tip and ring conductors for the next call. The polarity of the battery and ground through the line relay 28 over contacts of the cut-off relay 16 is such that it will not cause a breakdown of the tube 22.

Referring now to Fig. 2 in which the applicant's invention has been applied to a manual system, a connection may be established from a calling line 100 in the usual manner to a cord circuit 102 and the operator may then establish a connection to the subscriber at 103 over the line 104. In establishing this connection by inserting the plug 105 in the jack 106, a circuit is completed for the condenser 107 from battery through the lower right-hand winding of the repeating coil 108, winding of the supervisory

relay 109, contacts of relay 110, plug 105, jack 106, right-hand winding of repeating coil 111, switchhook 112, resistance 113, condenser 107, jack 106, plug 105, the upper right-hand winding of the repeating coil 108 to ground. This causes the condenser 107 to be charged and when sufficiently charged it causes the tube 114 to break down through the winding of the tap bell 115 which taps its gong once. These operations are then repeated until the subscriber at this station answers, when the ringing ceases and the talking circuit is completed. It should be observed that when the subscriber answered the supervisory relay 109 operates as usual to extinguish the lamp 116 which lighted in the usual manner, when plug 105 was inserted in jack 106 over the sleeve circuit which circuit also caused the operation of the cut-off relay 117. It should further be observed that the original circuit for lamp 116 extends through the left-hand winding of relay 110. This, however, did not cause relay 110 to operate. On the other hand, when relay 109 operates, the shunting circuit for lamp 116 extinguishes the lamp and now extends through both windings of relay 110 causing this relay to operate. The operation of relay 110 opens the ring conductor but by that time the operation of relay 109 has already provided a substitute connection for this conductor so at this time no disconnection takes place. However, when the subscriber at 103 replaces his receiver relay 109 releases which opens the ring conductor and consequently prevents battery and ground through the right-hand windings of the repeating coil 108 from charging the condenser 107 and start ringing of the bell 115 at this time, as relay 110 will be maintained operated over the sleeve circuit, through its left-hand winding to prevent the ring conductor from being closed by the contacts of this relay. The characteristics of relay 110 are such that it will not operate on current through its left-hand winding, but after once operated by current through both windings, current through the left-hand winding will maintain its operated. The supervisory lamp 116 now lights as a disconnect signal and the operator removes the plug 105 from jack 106, whereupon relays 110 and 117 are released and lamp 116 extinguished. Relay 117 restores the connection for the line 104 to battery and ground, through the windings of the line relay but the polarity of the battery and ground connection for this relay is such that the tube 114 will not operate.

What is claimed is:

1. In a telephone system, a central office, a subscriber's station, a line connecting said office and station, a source of talking current connectable to said line at said central office, a ringer at said station having a winding and circuit means at said station including a gas-filled discharge tube connected to said winding and operative in response to the continuous flow of current from said source over said line for producing an intermittent current through said winding for the corresponding intermittent operation of said ringer.

2. In a telephone system, a central office, a subscriber's station, a line connecting said office and station, a source of talking current connectable to said line at said central office, a ringer having a winding at said station, circuit means at said station connected to said winding and said line and including a network and a gas-filled discharge tube operative in response to the continuous flow of current from said source when said source is connected to the line for producing an intermittent current through said winding to operate the ringer at intervals.

3. In a telephone system, a central office, a subscriber's station, a line connecting said office and station, a source of talking current connectable to said line at said central office, a condenser and a resistance in a series connection in said line at said station, a gas-filled discharge tube having a definite breakdown potential and a direct current ringer in a circuit in shunt of said condenser, said condenser, resistance, tube and ringer being so adjusted that on the connection of the talking battery to the line at the central office the tube is caused to discharge at intervals for the operation of the ringer once for each discharge.

4. In a telephone system, a central office, a subscriber's station, a line connecting said office and station, a source of talking current connectable to said line at said central office, a condenser and a resistance in a series connection in said line at said station, a gas-filled discharge tube having a definite breakdown potential and a direct current ringer in a circuit in shunt of said condenser, said condenser, resistance, tube and ringer being so adjusted that on the connection of the talking battery to the line at the central office the tube is caused to discharge at intervals for the operation of the ringer once for each discharge, and means for disabling the circuit for the discharge tube in response to the subscriber removing his receiver from its switchhook.

5. In a telephone system, a central office, a subscriber's station, a line connecting said office and station, a source of talking current connectable to said line at said central office, a condenser and a resistance in a series connection in said line at said station, a gas-filled discharge tube having a definite breakdown potential and a direct current ringer in a circuit in shunt of said condenser, said condenser, resistance, tube and ringer being so adjusted that on the connection of the talking battery to the line at the central office the tube is caused to discharge at intervals for the operation of the ringer once for each discharge, and means responsive to the subscriber removing his receiver from its switchhook for opening the connection for the resistance and short-circuiting the discharge tube, the ringer and the condenser.

6. In a telephone system, a central office, a subscriber's station, a line comprising two line conductors connecting said office and station, a source of talking current connectable to said line at said central office, a ringer at said station comprising a winding, a plunger and a gong, the plunger being operated to strike the gong each time the winding is energized, a gas-filled discharge tube, and a condenser at said station, a circuit means for normally connecting said winding and said discharge tube in series across the two conductors of said line and the condenser in shunt of said winding and discharge tube, said winding, tube and condenser being responsive to continuous flow of current from said source for alternately charging the condenser and discharging it across said tube in said winding to energize said winding to intermittently operate the armature to strike the gong.

7. In a telephone system, a central office, a subscriber's station, a line connecting said office

and station, a source of talking current connectable to said line at said central office, a ringer comprising a gong, an armature and an operating winding, a condenser charged in response to the continuous flow of current in said line, and means effective at intervals for discharging said condenser through said winding to deliver thereto impulses of current to operate said armature.

8. In a telephone system, a central office, a telephone station, a line connecting said central office and station, a source of direct current connectable to said line at said central office, a signal device at said station responsive to repeated impulses of current, and means separate from said signal device and including a storage condenser and a space discharge tube operative in response to the continuous flow in said line of current from said direct current source for measuring predetermined intervals of time and for delivering an operating impulse to said signal device for each measured interval.

RALPH E. HERSEY.