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TELEPHONE SYSTEM

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2 Sheets-Sheet 1

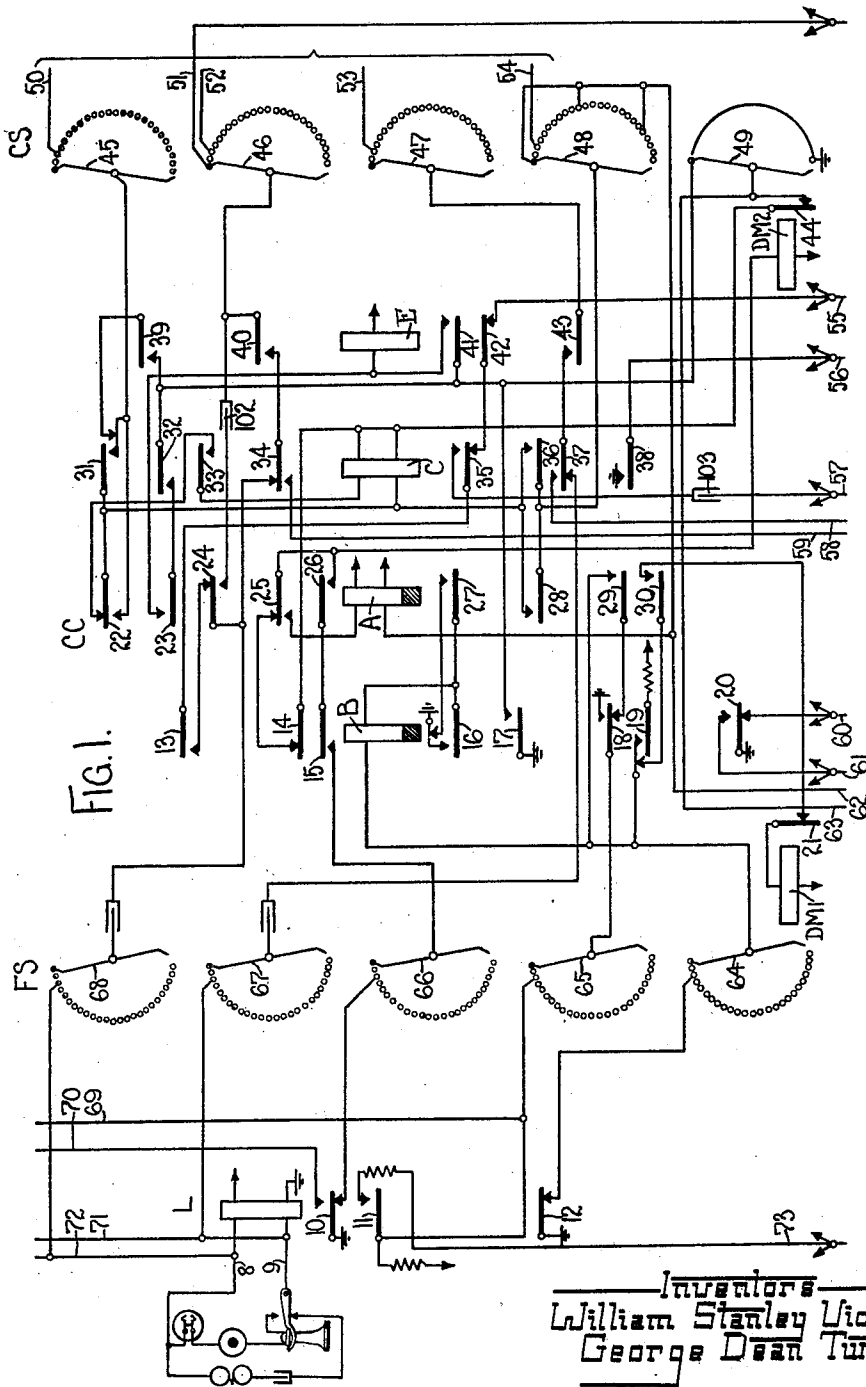


FIG. 1.

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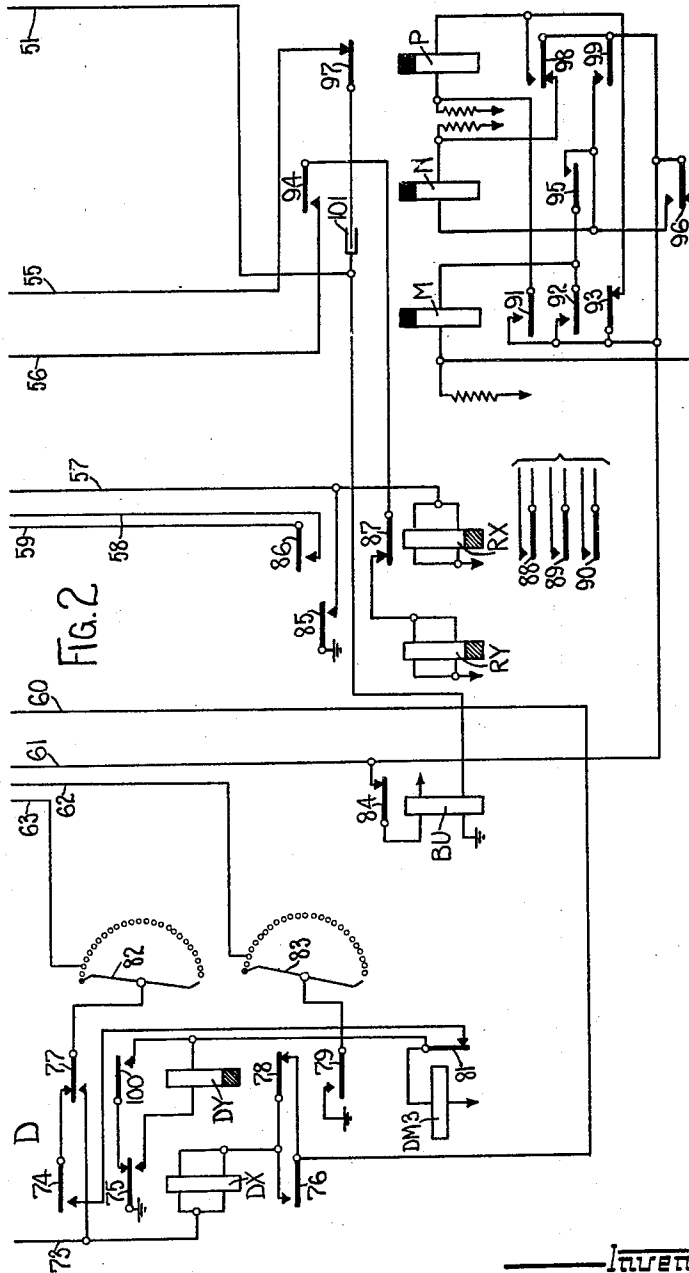
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2 Sheets-Sheet 2



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TELEPHONE SYSTEM

Application filed November 21, 1928, Serial No. 320,826, and in Great Britain December 9, 1927.

The present invention relates to automatic telephone systems and though a number of its features are of more general application, it can be employed to particular advantage in connection with small exchanges comprising comparatively few lines which are more-over all comparatively short. The main object of the invention is to reduce to a minimum the amount of equipment required in a small exchange system, for instance an isolated unit such as is generally known as P. A. X. This object is attained both by a reduction in the number of relays in the connecting equipment itself and also by a simplification of the arrangements for transmitting signalling currents of various kinds to the subscribers to indicate particular stages in the connection.

According to one feature of the invention, in a system employing finder switches and having subscribers' lines provided with line relays permanently connected thereto and an alternating current bell at the substation normally bridged across each line in series with a condenser, a wanted party is signalled by the intermittent short-circuiting of his line which causes his bell to be rung by condenser discharge.

According to another feature of the invention in a system employing finder switches and having subscribers' lines provided only with individual line relays which are permanently connected thereto the circuit for starting up a finder due to the energization of the line relay when the receiver is removed is rendered ineffective if the line is seized over a connector for an incoming call.

A further feature of the invention is that in a system employing finder switches and having subscribers' lines provided with line relays permanently connected thereto the continued operation of a finder switch is dependent upon the supply of guarding potential which is adapted to be connected up over one wiper due to the unoperated condition of the line relay if the line is non-calling or over another wiper from equipment temporarily associated with the line if it is already engaged in a completed connection.

In order that the invention may be fully

understood and readily carried into effect, by way of example a telephone system embodying the principles of the invention will now be described in detail with reference to the annexed drawings. Fig. 1 shows a subscriber's line relay L, which is individual to the particular subscriber, the connecting circuit CC with which is associated the finder switch FS which extends the calling subscriber to the connecting circuit CC, and the connector switch CS by means of which connections to a wanted subscriber are established. Fig. 2 shows the circuit of the distributor or allotter D, and the relays BU, RY and RX and M, N, and P, for supplying respectively busy tone, ringing and time periods to the exchange. For a proper understanding of the circuits Fig. 2 should be placed immediately below Fig. 1 with the corresponding conductors in alignment. It should be mentioned also that the substations are of the well-known type having the bell normally connected across the line in series with a condenser.

The setting up of a call on the apparatus shown will now be traced through in detail. When the subscriber to whose instrument conductors 8 and 9 extend lifts his receiver to originate a call, line relay L operates and at armature 10 earths the guarding conductor 70 extending to the banks of the connector switches such as CS, at armature 12 removes earth from the associated bank contacts of the finder switches such as FS and at armature 11 completes a circuit for relay DX over conductor 73, armature 78, conductor 60 and armature 20. Relay DX upon operating in this circuit completes a holding circuit for itself at armature 76, closes a point in the circuit of magnet DM3 at armature 74 and at armature 75 completes a circuit for relay DY which operates in series with the rotary magnet DM3, the magnet however not receiving sufficient current to energize it. Assuming the connecting circuit CC is idle at this time and has been preselected by the distributor D, earth is now extended from armature 79 over wiper 83 and bank contact, conductor 62, lower winding of relay A of the connecting circuit to battery. Relay A

operates, and at armature 27 prepares the circuit of relay B and at armatures 29 and 30 extends the circuit of the finder switch driving magnet DM1 to wiper 65 and 64 respectively of the finder switch. All contacts associated with non-calling lines in the bank of wiper 64 are earthed and all contacts associated with lines engaged on established connections in the bank of wiper 65 are earthed, so that the driving magnet will advance the wipers until they encounter the contacts associated with the calling line, relay B being held shunted by the driving earth till the contacts to which no earth is connected are reached. Relay B then operates in series with the magnet, and at armature 14 opens the homing circuit of the switch CS, at armature 15 prepares the impulsing circuit, at armatures 16 and 19 completes a holding circuit for itself, at armature 18 connects earth to wiper 65 and bank contact of the finder switch and hence to armature 11 of relay L and also to conductor 69 extending to the connector switch banks to guard the line from seizure by other calling subscribers, and at armature 17 connects earth over wiper 49 in normal position and wiper 82 to the left-hand terminal of relay DX. Relay DX is now shunted and releases allowing relay DY to release. Relay DY however, is fitted with a copper slug and is therefore slow to release, so that a momentary circuit is completed from earth over armatures 75 and 100 to the driving magnet DM3. This circuit is maintained during the releasing time of relay DY and when relay DY is fully restored is broken. The magnet therefore energizes momentarily and moves the wipers of the switch D to the next set of contacts in readiness for the next call. When wiper 82 advances the short-circuit on relay DX is removed so that if another line is calling at this time the next finder switch may be started up on the re-energization of relays DX and DY.

Relay B moreover at armature 20 connects earth to the common conductor 61 to start the busy tone relay BU and the interrupter relays M, N and P. It will be seen that the busy tone relay BU breaks its own circuit at armature 84, thus causing it to operate and release rapidly and by induction producing in its other winding a tone which is used for dialling indication and busy signal. At this stage the tone is passed from the lower winding of relay BU over conductor 51 and first bank contact and wiper 46 of the connector switch CS, condenser 102, armature 24 to the calling subscriber's line over the talk condenser and wiper 68 of the finder switch.

The subscriber upon hearing the tone commences to dial the required number.

It will be convenient at this stage to consider the action of the interrupter relays M, N and P. The earth on common conductor 61 operates relay P over armature 93 and

relay P then operates relay N over armature 99, and at armature 98 provides a locking circuit for itself. Relay N closes a holding circuit for itself at armature 96 and at armature 95 completes the circuit for relay M to operate. Relay M locks itself up at armature 92 and at armature 91 shunts relay P which releases after a slight interval and shunts relay N. Relay N in turn releasing after an interval shunts relay M and the release of relay M in due course again completes the circuit for relay P when the above cycle is repeated. As the relays M, N and P are all slow to operate and slow to release, this operation is continued with perfect regularity, and the circuits requiring to be interrupted periodically are taken as shown over contacts of relays N and P.

Returning now to the operation of the connector circuit, when the subscriber operates his calling device he intermittently breaks the circuit of relay L which de-energizes correspondingly. The subscribers' numbers are arranged from 1 to 9, 01 to 09, and 001 to 004 and it will be assumed that a single figure number, say 2, is being called. Each time relay L restores an earth pulse is extended from armature 10, bank contact and wiper 66 of the finder switch FS, armatures 15 and 26 to the driving magnet DM2 of the connector switch and also over armature 25 to the upper winding of relay A so as to hold relay A energized during the train of impulses. It will be noted that after the distributor has stepped, and before impulsing has commenced, relay A is held from earth, armature 17, home position bank contact and wiper 49 of the connector switch, interrupter springs 44, lower winding of relay C, armature 28, wiper 48 and home position bank contact of connector switch, lower winding of relay A to battery. Relay C does not operate in this circuit. The wipers of the connector switch CS are advanced in accordance with the impulses from the calling device till they are resting on the contacts associated with the desired subscriber's line.

If the called subscriber is busy, earth will be encountered by wipers 45 and 48 from the conductors 50 and 54 corresponding respectively to conductors 69 and 70 of the calling subscriber's line circuit and relay C is unable to operate as it is short-circuited. Relay A restores after its slow releasing period and busy tone is now transmitted to the calling subscriber from the busy tone relay BU over condenser 101, interrupter armature 97, conductor 55, armatures 42, 35, 13 and 24, to the subscriber's line over the speech condenser and wiper 68 of the finder switch. The subscriber upon hearing the intermittent tone, will replace his receiver allowing the apparatus to restore to normal as will be described subsequently.

Assuming now that the wanted subscriber

is free, relay C will operate from earth on the homing plate and wiper 49, interrupter springs 44, lower winding of relay C, armature 22, wiper 45 and bank contact to battery on conductor 50, which is the called subscriber's equivalent of conductor 69. At armatures 31 and 36 respectively relay C completes locking and control circuits for itself, at armature 32 prepares a circuit for relay E and at armature 33 prepares a circuit for its second winding, both of the latter circuits becoming effective as soon as relay A releases and armatures 22 and 23 engage their back contacts. Relay C moreover at armature 35 completes the ringing tone circuit and at armature 38 connects earth to the common conductor 56 whence it is extended over armature 94, which as described previously is pulsing, armature 87, winding of relay RY to battery. Relay RY operates when its circuit is closed and at armature 85 operates relay RX which breaks the circuit of relay RY at armature 87. Relay RY releases and allows relay RX to release when the circuit of relay RY is again completed and the above sequence of operations will be repeated. It will be seen therefore that due to the design of relays RX and RY there is a comparatively rapid inter-operation between these relays during the time that relay N is operated and has closed its armature 94. The operation of relays C and E extended the called subscriber's line from wipers 46 and 47 of the connector switch CS over armatures 40 and 43, armatures 34 and 37, conductors 59 and 58 to armature 86 of relay RX and the rapid operations of relay RX cause the line to be short-circuited intermittently. This causes the called subscriber's line relay to energize and release rapidly and the resulting discharge from the condenser in the called substation circuit operates the bell. This ringing is divided up into suitable periods by the interrupting relay N, and an indication to the calling subscriber that ringing is taking place is provided over conductor 57 by way of condenser 103 and armatures 35, 13 and 24. It will be understood that armatures 88, 89 and 90 are associated with the other connecting circuits such as CC and perform functions similar to armature 86.

It has been mentioned that the short-circuit on the called subscriber's line operates his line relay intermittently and this accordingly connects earth to the conductor 54, which corresponds to conductor 70. This earth shunts relay C but at the same time makes it slow to release and as the operations of relay L are rapid during the ringing periods, relay C does not restore. When however, the called subscriber lifts his receiver to reply to the call, the line relay remains operated and maintains the shunt on relay C which therefore releases, thereby removing earth from the common conductor 56 at armature 38 and at armatures 37 and 34 completing the talking circuit for

the subscribers to converse. The calling and called subscribers receive talking battery through the windings of their respective line relays, such as L for the calling subscriber, which are permanently connected to the lines.

Earth is maintained on conductor 50 after relay C releases from armature 17 over armatures 39, normally closed springs controlled by armature 31 and wiper 45, and on conductor 54 from contacts corresponding to 10 of the called subscriber's line relay, thus preventing the called subscriber's line being taken by another calling party. During the ringing of the called subscriber's bell, earth is connected to wiper 45 through the upper low resistance winding of relay C over armatures 33, 22 and 31 thus guarding the line during the ringing of the wanted subscriber and preventing the starting up of a finder switch due to the operation of the line relay since the battery connection associated with the armature such as armature 11 is thereby rendered ineffective for producing the operation of the relay DX.

At the conclusion of the conversation, the release of the equipment takes place when relay L of the calling line restores and extends earth from armature 12 over the bank contact and wiper 64 of the finder switch to relay B, thus shunting relay B and causing it to release. The release of relay B removes earth from the common conductor 61 to allow the tone and interrupter relays to restore, opens the circuit of relay E at armature 17, and at armature 14 completes the homing circuit for the driving magnet DM2 of the connector switch. Earth on the homing plate is extended over wiper 49, interrupter springs 44, armatures 14 and 25, winding of the magnet DM2 to battery and energizes the magnet which moves the wipers to home position where earth is no longer encountered and therefore no further rotation can take place. As long as the connector switch is off-normal earth from the homing plate is extended to conductor 63 and this guards the connector in the distributor bank till the switch has reached its home position.

It will be noticed that the earth to operate relay DX at the commencement of a call is obtained from resting contacts 20 of the relays B of the connector circuits to the common conductor 60. If therefore, a subscriber endeavours to make a call when all the connector circuits are in use, he cannot operate relay DX and must then wait until a connector circuit becomes free when he will receive dial tone as usual.

When a subscriber calls another subscriber who has a two or three figure number, the dialling of the initial digit 0 moves the connector switch ten steps and it will be seen from the wiring of the bank 48 of the connector switch that relay A is held operated over the eleventh contact in the bank of wiper 48, thus preventing relays C and E

from switching to start the ringing. The subscriber then dials the next digit and the connector switch is advanced further and when it stops, unless the digit is 0, relays C and E will operate and ring the wanted subscriber as already described. If the second digit dialled is also 0, the connector switch again reaches a contact on which relay A is held and the dialling of the third digit then enables the wanted subscriber's line to be reached. No subscribers' lines are connected to contacts 11 and 21 of the connector switch.

What we claim as new and desire to secure by Letters Patent is:—

1. In a telephone system, subscribers' lines each having a line relay permanently connected thereto, a bell and a condenser normally bridged in series across each line at the subscriber's station, a connector having access to said lines, and means for intermittently short-circuiting a line with which said connector is connected whereby the bell at the subscriber's station is rung by the discharge of the associated condenser.

2. In a telephone system, a subscriber's line, a line relay permanently connected thereto and energized on both incoming and outgoing calls, finder switches having access to said line, a start relay common to said finders, a circuit for said start relay closed by the energization of said line relay, and means for rendering said circuit ineffective in case the line relay is energized due to an incoming call.

3. In a telephone system, a subscriber's line, a line relay permanently connected thereto and energized on both incoming and outgoing calls, a start relay, means for energizing said start relay when said line relay is operated on an outgoing call, and means for short-circuiting said start relay when said line relay is operated on an incoming call.

4. In a telephone system, a connector, a called line having a line relay permanently connected thereto, means for operating said connector to seize said line, means including said relay for signalling the subscriber on said line, means controlled by the connector for busying said line during the signalling period, and means controlled by said line relay for busying said line after the called subscriber has answered.

5. In a telephone system, subscribers' lines, automatic switching mechanism for enabling a calling line to be extended to a called line, means for signalling the called line, a circuit for guarding the called line against seizure during the signalling period, and a second circuit for guarding the called line against seizure after the called party has answered.

6. In a telephone system, a calling line and a called line, automatic switching mechanism for enabling said calling line to establish a connection to said called line, and two busy circuits for guarding the called line against

seizure effective at different times after the connection to the called line has been completed.

7. In a telephone system, subscribers' lines, a finder switch having access to said lines, means for starting said switch responsive to a call, a circuit completed over one wiper of said switch for causing the switch to pass over lines which are not calling or being called, and a second circuit completed over a second wiper of said switch for causing the switch to pass over lines which are already engaged in a completed connection.

8. In a telephone system, means for completing connections between calling and called lines, a battery, and a line relay associated with each line through which current from said battery is supplied to the line for talking and signalling purposes.

9. In a telephone system, subscribers' lines each having a line relay permanently connected thereto, a plurality of line finders, a relay in each of said finders, a distributor for preselecting an idle finder, means responsive to the initiation of a call over one of said lines for energizing the relay in the preselected finder over a wiper of said distributor, means responsive to the operation of said relay for operating said finder to connect with the calling line, and means for maintaining said relay energized by impulses transmitted from the line relay of the calling line over a wiper of said finder after the finder has come to rest.

10. In a telephone system, subscribers' lines each having a line relay permanently connected thereto, a bell and a condenser normally bridged in series across each line at the subscriber's station, a connector having access to said lines, means for intermittently short-circuiting a line with which said connector is connected whereby the line relay of said line is intermittently operated and the bell at the subscriber's station is rung by the discharge of the associated condenser, a ring control relay in said connector, and means controlled by said line relay for short-circuiting said ring control relay.

11. In a telephone system, subscribers' lines, a finder switch having access to said lines, means for starting said switch responsive to the initiation of a call, and two testing circuits extending over two separate wipers of said switch for causing said switch to pass over non-calling lines, said circuits simultaneously testing for absence of ground potential.

12. In a telephone system, a subscriber's line, a line relay associated with said line and energized on both incoming and outgoing calls, automatic switching apparatus, means for extending said line to said automatic switching apparatus when said line relay is energized on an outgoing call, and means for rendering said first means ineffective in case

said line relay is energized on an incoming call.

13. In a telephone system, subscribers' lines, a finder switch having access to said
5 lines, means for starting said switch responsive to the initiation of a call over one of said lines, a pair of talking conductors in said switch, and two testing circuits extending over two separate wipers of said switch in-
10 dependent of said talking conductors, said testing circuits effective simultaneously to cause said switch to pass over non-calling lines.

14. In a rotary hunting switch, an operating magnet, a relay, a circuit including said
15 magnet and said relay in series, two test wipers connected in multiple to said circuit at the junction between said magnet and said relay for intermittently operating said mag-
20 net and maintaining a shunt around said relay as long as either of said wipers encounters ground potential, said relay operating in series with said magnet to stop said switch as soon as neither of said wipers encounters
25 ground potential.

In testimony whereof I, the said WILLIAM STANLEY VICK have signed my name at Liverpool, England, this 26th day of October, 1928.

30 WILLIAM STANLEY VICK.

In testimony whereof I, the said GEORGE DEAN TURTON have signed my name at London, England, this 24th day of October, 1928.

35 GEO. DEAN TURTON.

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