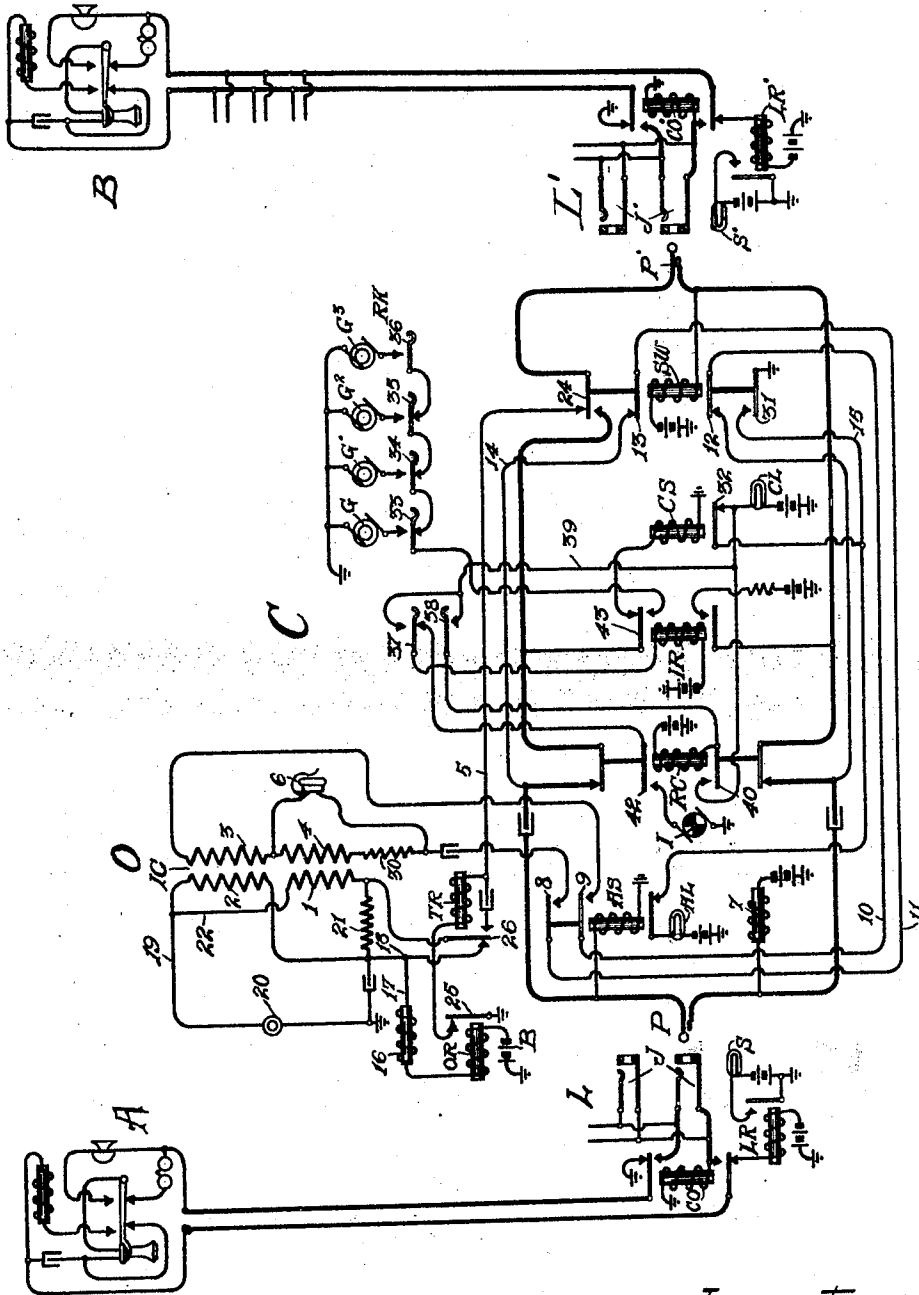


H. T. WHITE.
 OPERATOR'S CIRCUITS.
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UNITED STATES PATENT OFFICE.

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OPERATOR'S CIRCUITS.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, HAROLD T. WHITE, a citizen of the United States of America, residing in Kansas City, county of Wyandotte, and State of Kansas, have invented certain new and useful Improvements in Operators' Circuits, of which the following is a specification.

My invention relates to operators' telephone circuits, and more particularly to such circuits for use with cord circuits and trunk circuits.

The object of my invention is the production of a highly efficient balanced operator's telephone circuit, provided with a novel test circuit in which a minimum amount of apparatus is required.

Heretofore it has been necessary to associate two or more repeating coils with an operator's telephone circuit, where a test relay was provided, to secure the necessary test circuits and to reduce the side tone. One of the features of my invention is to provide an operator's telephone circuit having the above feature and to arrange this circuit so that only one repeating coil is necessary.

Another feature of my invention is the provision of a break contact for the test relay that removes a shunt from across a resistance adapted to be cut in series with one of the primary windings of the repeating coil to transmit the desired busy click to the operator's receiver when a busy line is tested. The provision of a break contact for the test relay produces a quicker test than can be obtained by de-energizing the test relay instead of energizing it. I also arrange the test relay in such a manner that a reverte test tone may be transmitted to the operator's receiver when the called party's substation is one connected to the calling subscriber's line.

A further feature of my invention is the connection of the operator's receiver in a Wheatstone bridge circuit to reduce the side tone.

The above features and others will be herein-after more fully set forth in the accompanying specification and in the appended claims.

For a better understanding of my invention, reference will be made to the accompanying drawing which illustrates my invention operating in connection with a tele-

phone exchange system which comprises a calling substation A and a called substation B connected via a cord circuit C. The substations A and B terminate respectively at the exchange in line circuits L and L¹. The line circuits L and L¹ comprise the usual line relays LR and LR¹, cut-off relays CO and CO¹, multiple jacks J and J¹, and the line signals S and S¹, respectively.

The cord circuit C for interconnecting the said substations as calling and called lines is provided with an answering plug P and a calling plug P¹, the said plugs P and P¹ being connected by the heavily marked conductors. The answering end of the cord circuit C is provided with an answering supervisory relay AS which is adapted, when the answering plug P is inserted into a jack J of a calling line, to automatically connect the operator's telephone set O in circuit with the cord conductors, and in addition, the said relay AS controls the lighting of the answering supervisory lamp AL. Associated with the calling end of the cord circuit C, I provide a switching relay SW, which relay is adapted to be energized, when a calling plug P¹ is inserted into the jack of a called idle line, to disconnect the operator's set O from the cord conductors of the said cord circuit C.

A party line ringing key RK is provided for connecting one of a plurality of generators G, G¹, G² and G³ to signal a subscriber at a called-for substation, and for controlling the circuit of a ringing control relay RC. The said relay RC in turn controls the circuit of an interrupter relay IR through the agency of a constantly rotating interrupter I, and operates to intermittently connect ringing current to signal the subscriber at the called-for substation. A calling supervisory relay CS is also provided and is adapted to be energized when a response is secured from the called substation to control the calling supervisory signal CL, and also operates to interrupt the circuit of the ringing control relay RC to disconnect the ringing current from the called substation.

The operator's set O, as illustrated, comprises an induction coil IC built up of four windings, 1, 2, 3 and 4, and an operating relay OR which is energized when the plug of the operator's set O is inserted into the operator's jack. The said relay OR remains in its energized position until the plug is

withdrawn. The drawing does not show the plug for connecting the operator's receiver and transmitter with the coil IC and its associated mechanism, but this arrangement is well known and is in universal use. A test relay TR is also provided which is operated over a common test conductor 5 when a busy line is tested to produce a click in the operator's head receiver 6, and when an idle line is tested the relay TR does not energize but remains in its normal position. A make contact is provided for the test relay TR so that if the line tested is also the calling line and has a revertive tone connected to its test contact, this tone will be transmitted through the primary winding 1 of the induction coil IC and repeated into the operator's receiver 6. The primary windings 1 and 2 of the induction coil IC are connected in multiple between the opposite poles of battery B. As before mentioned, the normal contact 26 of relay TR closes a shunt about resistance 21 that is adapted to be connected in series with the primary winding 1 when the test relay TR is energized. The connecting of the resistance 21 in series with the primary winding 1 changes the flow of current there-through, thereby causing a click in the operator's receiver. A resistance 30 is connected in series with the secondary windings 3 and 4 and forms one arm of a Wheatstone bridge circuit. The windings 3 and 4 form other arms of the bridge and the circuit connecting wires extending out through contacts 8 and 9 of the relay AS form the fourth arm of said circuit. The receiver 6 is connected across this circuit having its one terminal connected between windings 3 and 4 and its other terminal connected between the resistance 30 and the resistance of said connecting conductors.

Having described in general the preferred arrangement of the circuits and apparatus employed in my invention, I will now describe it more in detail operating in connection with the exchange system as illustrated. Assuming now that the subscriber at the calling substation A removes his receiver to initiate a call, the closing of the switch hook contacts at the substation A brings about the energization of the line relay LR, and the actuation of the said relay LR brings about the lighting of the line signal S. The operator associated with the cord circuit C, noting the lighted line signal S, inserts the answering plug P of the cord circuit C into the answering jack J of the calling line, closing a series energizing circuit for the cut-off relay CO and impedance coil 7, traced from battery through the said coil 7, the sleeve contacts of the connected plug and jack, P and J, and through the winding of the cut-off relay CO to ground. The energization of the relay CO brings about the de-energization of the line relay LR. The relay LR

restoring effaces the signal S. The closing of alternate contacts of relay CO brings about the energization of the answering supervisory relay AS over a circuit traced from ground through the winding of the relay AS, tip contacts of the connected plug and jack, closed contact of the relay CO, through the substation A, back through sleeve contacts of the plug and jack, and through the winding of the impedance coil 7 to battery. The closing of alternate contacts 8 and 9 of relay AS connects the operator's set O to the cord conductors through the said contacts 8 and 9, conductors 10 and 11, normal contacts 12 and 13 of the switching relay SW, and conductors 14 and 15 to the respective cord conductors. The operator's plug being connected with its associated jack, a circuit is closed through relay OR over a circuit traced from battery through the winding of said relay, retardation coil 16, conductor 17, to the point 18 where the circuit divides, one path extending through winding 2 of the induction coil IC, conductor 19, and transmitter 20 to ground; the other path extending from the point 18, through normal contact 26 of relay TR, winding 1 of the induction coil IC, conductor 22, conductor 19, and transmitter 20 to ground.

The operator now inquires the wants of the calling subscriber A, and assuming that it is a subscriber at the substation B that is wanted, the operator then tests a multiple jack J¹ of the wanted line by placing the tip of the calling plug P¹ to the sleeve of a multiple jack J¹ of the wanted line to test the line as to its idle or busy condition. If the line being called is busy as a calling or a called line, the sleeve of the multiple jack of the line being called will be at a battery potential so that when the tip of the plug P¹ touches the sleeve of the jack J¹ a circuit is closed for the test relay TR associated with the operator's set O, traced from battery on the sleeve of the jack J¹ to the tip of the plug P¹, through normal contact 24 of the relay SW, test conductor 5, the winding of the relay TR, and alternate contact 25 of relay OR to ground. The relay TR upon energizing opens its normal contact 26, thereby removing the short-circuit or shunt from about the resistance winding 21, placing it in series with the primary winding 1 of coil IC. Between the interval that the operator touches the calling plug P¹ to the sleeve of the multiple jack J¹ of the called line and then removes it, the above operation takes place. The insertion of the resistance 21 in circuit with the winding 1 reduces the current flow through the said winding 1 of the induction coil, causing an impulse to be induced in the secondary windings of the induction coil, producing a click in the operator's head receiver, thus

notifying her of the busy condition of the wanted line. Owing to the fact that the relay TR energizes to connect the resistance 21 in series with the primary winding 1 instead of deenergizing to transmit the busy click to the operator's set, this test is made very rapidly and does not depend upon the length of time that the operator holds the tip of the calling plug against the jack of the called line.

Assuming that the line tested is busy, the operator notifies the calling subscriber of the busy condition of the line, and the said calling subscriber then replaces his receiver upon the switch hook, opening the circuit of the relay AS. The operator withdraws the answering plug P from its connected answering jack J, opening the series energizing circuit of the relay CO and the impedance coil 7. All the apparatus used in the connection thus far is now restored to normal, and is available for use in establishing other connections.

Assuming that the operator tests the multiple jack of a called line that is idle, the placing of the tip on the plug P¹ against the jack J¹ does not affect the test relay TR, as the sleeve of the jack J¹ is at a ground potential and no energizing circuit for relay TR is closed. The winding 21 thus remains shunted and the operator receiving no click knows that the line is idle and inserts the calling plug P¹ into a multiple jack J¹ of the wanted line. A circuit including switching relay SW and the cut-off relay CO¹ is therefore established, causing the energization of these relays whereby the operation of CO¹ extends a connection from the plug P¹ to the substation B and removes the normal control of its line relay LR¹. Responsive to the energization of the relay SW, its alternate contact 31 is closed to establish a circuit for the calling supervisory signal CL, traced from battery through the said lamp, normal contact 32 of relay CS and alternate contact 31 of relay SW to ground. The opening of the normal contacts 12 and 13 of relay SW disconnects the operator's set O from the cord conductors, and the interruption of normal contact 24 of relay SW disconnects the test conductor 5. The operator now depresses the proper ringing key plunger, 33, 34, 35 or 36, to its fully depressed position, closing the end spring contacts 37 and 38. The closing of alternate contact 38 establishes an energizing circuit for the ringing control relay RC, traced from battery through the winding of relay RC, alternate contact 38, conductor 39, normal contact 32 of relay CS, to ground at alternate contact 31 of relay SW. Upon the energization of the relay RC, its alternate contact 40 is closed, establishing a locking circuit for itself traced from battery through the winding of the said relay RC, said alter-

nate contact 40, normal contact 32 of relay CS, to ground at alternate contact 31. The closing of alternate contact 42 of relay RC establishes an intermittent energizing circuit for the interrupter relay IR, traced from battery through the winding of the relay IR, normal contact 37 of the end springs, alternate contact 42 of relay RC, and through the constantly rotating interrupter I to ground. The relay IR is therefore alternately energized and de-energized, alternately connecting the ringing current and the supervisory relay CS in bridge of the called line.

Upon a response being secured from the called subscriber, upon the following de-energization of interrupter relay IR, a circuit for the calling supervisory relay CS is established, traced from ground through the winding of CS, normal contact 43 of relay IR, alternate contact 24 of relay SW, over the called line, returning through the winding of the switching relay SW to battery. Relay CS thereupon energizes, interrupting its normal contact 32, whereby the supervisory signal CL is effaced, and the holding circuit of the ringing control relay RC is interrupted. The relay RC thereupon restores, interrupting the operating circuit of the interrupter relay IR, at contact 42.

If the called line tested had been the calling line and a cord circuit had been used for establishing the connection that connects a tone test to the answering jack of the line, then when the tip of the calling plug was brought into engagement with a multiple jack of the line, the relay TR would have been energized as before mentioned, and the tone test would have been connected through alternate contact 26 of relay TR and through the primary winding of the induction coil IC to ground, causing the tone to be induced in the secondary windings of the induction coil to the operator's receiver.

After the subscribers have finished conversation, they will replace their receivers upon their respective switch hooks, whereby the circuits of the answering supervisory relay AS and the calling supervisory relay CS are interrupted, causing the restoration of the said relays and lighting the answering supervisory lamp AL and the calling supervisory lamp CL. The operator noting the lighted signals, withdraws the plugs P and P¹ from the connected jacks J and J¹ and thereby brings about the restoration of the apparatus employed in establishing the connection.

In an operator's set in which a test relay is employed, a secondary induction coil is most commonly used to reduce side tone, but with the arrangement as shown and described I do away with this second coil and use the balancing winding 30 to form one of the legs of the bridge in combination with

the windings 3 and 4 of the induction coil IC and the resistance of the operator's cord conductors, thus simplifying the operator's set to a great extent.

5 It is to be understood that I do not wish to be limited to the exact matter shown, as various other arrangements may readily suggest themselves to one skilled in the art. Therefore, I desire to cover all such changes
10 and modifications as come within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent is:

1. An operator's telephone circuit including an induction coil provided with a pair of primary windings, a test relay, a resistance normally short-circuited but adapted to be placed in circuit with one of said primary windings only, and means for energizing said test relay to place said resistance in series with said winding to cause a change in the current flow through said winding whereby a signal is transmitted to the operator's receiver.

2. An operator's telephone circuit including an induction coil provided with a primary winding, a resistance coil adapted to be connected in circuit with said primary winding, a test relay provided with contacts normally shunting said resistance coil, and means for energizing said test relay whereby the shunt from around said resistance coil will be opened and the current flow of said primary winding reduced to indicate to the operator that a busy line has been tested.

3. An operator's telephone circuit including an induction coil provided with a primary winding and a secondary winding, a resistance coil in series circuit with said primary winding, a test relay provided with contacts normally closing a shunt around said resistance coil, said test relay being adapted to be operated when a busy called line is tested to remove the shunt from around said resistance coil to change the flow of current through said primary winding thereby inducing an impulse of current in said secondary winding to indicate to the operator that the called line tested is busy.

4. An operator's telephone circuit including an induction coil provided with a pair of primary windings connected in multiple, a resistance coil, a test relay, contacts controlled by said test relay for connecting said resistance coil in circuit with one of the said primary windings to change the current flow therethrough, and an operator's receiver affected by the change of current flow through said primary winding.

5. An operator's telephone circuit including an induction coil provided with a pair of primary windings and a pair of secondary windings, said primary windings being normally connected in multiple with the opposite poles of a battery, a subscriber's tele-

phone line, a test relay adapted to be connected to the jack of a busy telephone line, a resistance coil, and contacts controlled by said test relay for placing said resistance coil in series with one of said primary windings whereby the current flow through said primary windings will be reduced and an impulse will be induced in said secondary windings to transmit to the operator the busy condition of said telephone line.

6. A telephone system including an operator's telephone circuit provided with an induction coil having primary and secondary windings, a subscriber's telephone line provided with a jack at the central exchange, an operator's cord circuit, means for connecting said operator's telephone circuit to said cord circuit, a test relay for said operator's telephone circuit adapted to be energized when the calling plug of said cord circuit is applied to said jack if said subscriber's telephone line is busy, a normally short-circuited resistance in circuit with the primary winding of said induction coil, and contacts controlled by said test relay for removing the shunt circuit from around said resistance, whereby the current flow through said primary winding is changed to transmit to the operator the busy condition of said subscriber's line.

7. A telephone system including subscribers' telephone lines, a cord circuit for interconnecting said lines, an operator's telephone circuit provided with an induction coil automatic means for connecting said operator's telephone circuit to said cord circuit, a test relay for said operator's circuit adapted to be energized when the calling plug of said cord circuit is applied to the jack of a busy one of said subscriber's telephone lines, a normally shunted resistance included in series circuit with a primary winding of said induction coil, and means controlled by said test relay for removing the shunt from about said resistance to change the current flow in said primary winding, thereby notifying the operator that the tested called line is busy.

8. An operator's telephone circuit including an induction coil provided with a primary winding, a test conductor, a test relay connected in circuit with said test conductor, and contacts controlled by said test relay for connecting said test conductor in circuit with said primary winding of said induction coil.

9. An operator's telephone circuit including an induction coil, a test conductor, a test relay connected in circuit with said test conductor, a resistance coil, and contacts controlled by said test relay for connecting said resistance in series with a primary winding of said induction coil and for connecting said test conductor in circuit with said primary winding.

10. An operator's telephone circuit including an induction coil provided with a pair of primary windings normally connected in parallel, a test relay, a resistance adapted to be placed in circuit with one of said primary windings, and means for energizing said test relay to place said resistance in series with said primary winding, thereby causing a change in the current flow through said primary winding.

11. An operator's telephone circuit including an indication coil provided with a primary winding, a test relay individual to the operator's telephone circuit, a pair of normally closed contacts for said test relay, and means for operating said test relay to open said normally closed contacts, thereby changing the current flow through said primary winding to transmit a signal to the operator.

12. An operator's telephone circuit including a receiver and an induction coil provided with a primary winding, a test relay, a pair of normally closed contacts for said test relay controlling a circuit through said primary winding, and means for energizing said test relay when a busy called line is tested to cause said relay to open its normally closed contacts to transmit an audible signal to the operator's receiver.

13. An operator's telephone circuit including an induction coil provided with a pair of primary windings, a resistance coil normally in circuit with said primary windings, a second resistance coil, and means for connecting said second resistance coil in circuit with one of said primary windings to cause a change in current flow through said primary winding to transmit a signal to the operator.

14. An operator's telephone circuit including an induction coil provided with a primary winding, a resistance coil normally in circuit with said primary winding, a second resistance coil, and a test relay for connecting said second resistance coil in circuit with said primary winding to cause a change in the current flow through said primary winding.

15. An operator's telephone circuit including an induction coil provided with a pair of primary windings, a resistance coil connected in circuit with said primary windings, a test relay, and means for energizing said test relay to connect a second resistance in circuit with one only of said primary windings.

16. An operator's telephone circuit including an induction coil provided with a pair of primary windings connected in multiple, a resistance connected in circuit with said primary windings, a second resistance, and means for connecting said second resistance in circuit with one only of said primary windings.

17. An operator's telephone circuit including an induction coil having a primary winding, a normally shunted resistance connected in circuit with said primary winding, a test relay connected to a test conductor, and means for energizing said test relay to remove said shunt from about said resistance and to connect said primary winding to said test conductor.

18. An operator's telephone circuit including an induction coil provided with a pair of primary windings connected in multiple, a test relay connected to a test conductor, and means for energizing said test relay to connect one of said primary windings to said test conductor.

19. An operator's telephone circuit including an induction coil having a pair of primary windings and a pair of secondary windings, a resistance coil adapted to be connected in circuit with a primary winding of said induction coil but normally shunted therefrom, a test relay, and means for energizing said test relay when a busy line is tested to remove said shunt from about said resistance thereby placing said resistance in series with said primary winding.

20. An operator's telephone circuit including an induction coil having a pair of primary windings and a pair of secondary windings, a resistance coil adapted to be connected in circuit with a primary winding of said induction coil but normally shunted therefrom, a test relay, and means for energizing said test relay when a busy line is tested to remove said shunt from about said resistance thereby placing said resistance in series with said primary winding, thus changing the current flow through said primary winding and inducing an impulse of current in said secondary windings to transmit a signal to the operator.

Signed by me at Kansas City, in the county of Jackson and State of Missouri, this 21 day of August, 1917.

HAROLD T. WHITE.