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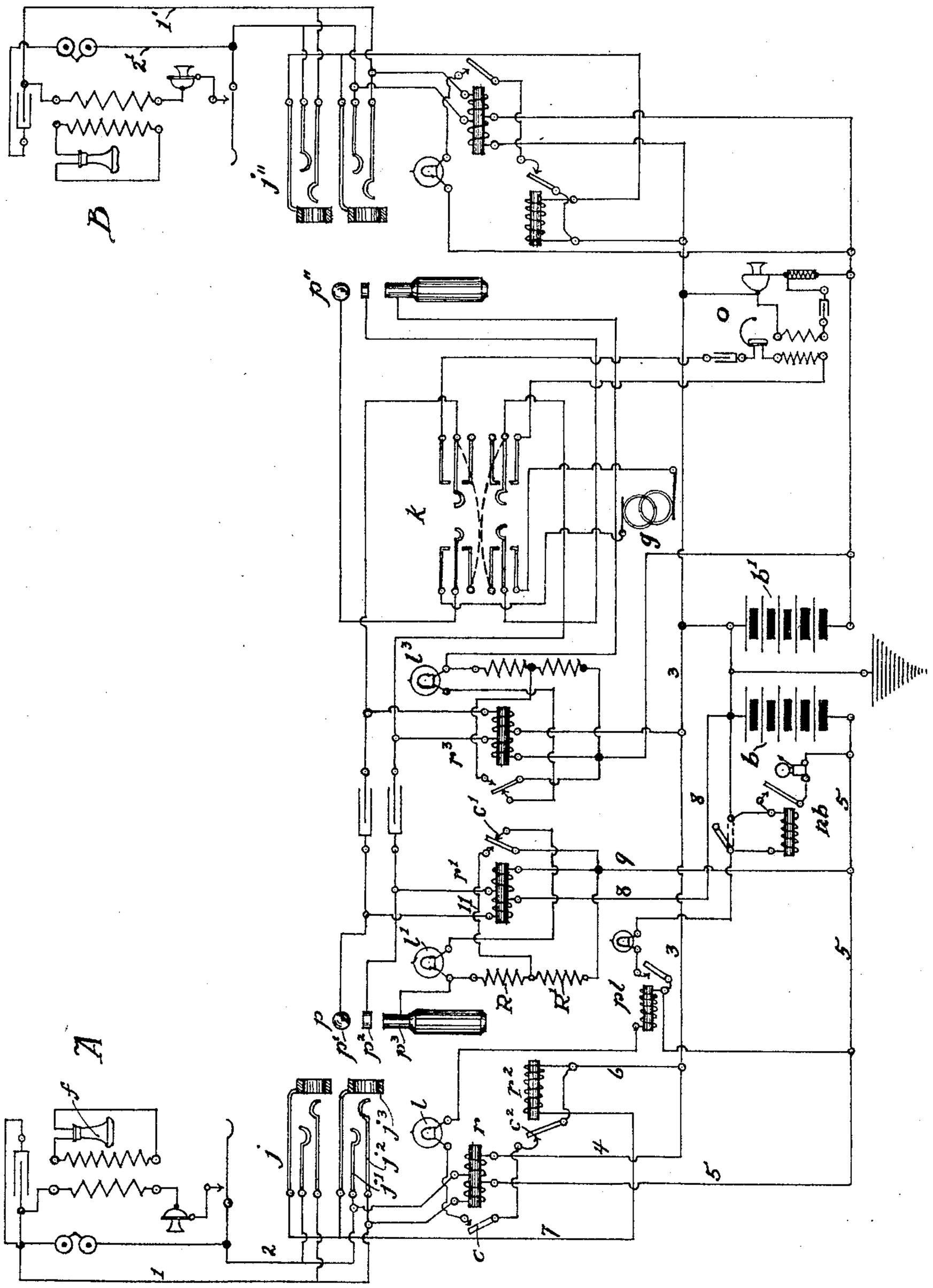
J. P. DOWNS.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED OCT. 23, 1902.

NO MODEL.



WITNESSES:

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No. 765,822. Patented July 26, 1904.

UNITED STATES PATENT OFFICE.

JOHN P. DOWNS, OF CLEVELAND, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO JOHN F. McDONNELL, OF CLEVELAND, OHIO.

TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 765,822, dated July 26, 1904.

Application filed October 23, 1902. Serial No. 128,421. (No model.)

To all whom it may concern:

Be it known that I, JOHN P. DOWNS, a citizen of the United States of America, and a resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Telephone-Exchange Systems, (Case No. 3,) of which the following is a specification.

My invention relates to improvements in telephone-exchange systems, and has for its object the provision in a common battery system of means for very materially reducing the click in the calling-subscriber's receiver, for rendering the system more economical in the consumption of battery-current, for obtaining positive action of the relays in the cord-circuit, for securing perfect balance in the several circuits, and for adapting said system for use in connection with party-lines and common return-circuits. These results I attain, respectively, by maintaining closed the battery-circuit when once established through the subscriber's telephone set and shunting into circuit the additional apparatus necessary, opening instead of shunting the supervisory-lamp circuit, and making the relay-windings relatively high and proportioning and connecting said windings upon both sides of the line.

A system embodying my invention will be explained in connection with the accompanying drawing, diagrammatically setting it forth and forming a part of this specification, which will make my invention perfectly clear.

In said drawing or diagram, A and B will readily be recognized as representing, respectively, the calling and the called subscribers' stations, adapted to be connected over the line conductors 1 2 1′ 2′ and through the cord-circuit, diagrammatically representing the central office or exchange apparatus. Line conductors 1 2 of the calling subscriber terminate in the springs j' j^2 of the multiple jacks j, between which are connected the divided windings of the line-relay r, controlling its signal-lamp l. The said relay is wound to be of relatively high resistance, the windings thereof being equally divided, as indicated, and connected upon either side of the circuit. The same conditions obtain with respect to the supervisory relay r' in the cord-circuit, the windings thereof being of lower resistance, however. It will be observed that the connection of the cord-circuit, including said relay r' in the subscriber's circuit, may be secured through the insertion of the plug without opening the battery-circuit when once established through the subscriber's station, said cord-circuit merely being bridged into circuit with the subscriber's set, thereby obviating practically all of the undesirable click in his receiver. Lamp l' of said supervisory relay is connected in shunt relation with divided resistances R R′, which connection through the lamp is adapted to be broken upon the energization of said relay, resistance R′ being simultaneously shunted.

I have diagrammatically shown also the operator's set o, her ringing and listening key k, the lamp-relay r^2, the pilot-lamp and relay pl and the night-bell and its relay nb, all of which are of the usual type and will require no extended description herein. Battery b is designed to supply current for the answering side of the cord-circuit and the calling subscriber, while battery b' serves the opposite side of the circuit.

When the subscriber A removes his receiver f from its hook to call subscriber B, we will assume, circuit will be closed from the positive side of the battery through conductors 3 4, one half of the winding of relay r, conductor 2, through the subscriber's instrument, conductor 1, the other half of the winding of said relay, and conductor 5 to the opposite pole of the battery. This energizes the line-relay, closing the lamp-circuit at its contact c, which lamp being at once illuminated is observed by the operator, who inserts her answering-plug p in the jack of subscriber A.

The circuit through the supervisory relay r', controlling the lamp l', will at once be closed in turn through the tip and sleeve p' p^2 by contacting with the corresponding springs j' j^2. Current immediately flows through the divided windings of this relay, which causes it to open the normally closed lamp-circuit at c', thereby extinguishing the supervisory

lamp l'. Tracing again from the positive pole of battery b, current passes over conductor 8 to one half of the winding of relay r', the tip of the plug, conductor 2, through the subscriber's instrument, conductor 1, sleeve p^2, the other half of the relay-winding, conductors 9 5, to the opposite pole of the battery. At the same time the lamp-relay r^2 is energized to open the circuit of signal-lamp l at contact c^2, its circuit being from the positive pole of battery b, conductors 3 and 6, through the windings of relay r^2, conductor 7, test-thimble and test-ring j^3 p^3, resistance R, and in multiple through resistance R′ and conductor 11, conductors 9 and 5 to the negative pole of said battery.

The lamps l and l', connected, respectively, to line-relay and to the cord-circuit relay, are maintained upon open circuit until the connection is to be taken down, thereby effecting a saving over the common practice of shunting out said lamps.

Having answered the call and learned the desired number, the operator tests the wanted line-jack to ascertain if that line is busy. This test is made in the usual manner by applying the tip of the calling-plug p'' to the thimble of the jack j'', the listening-key k being thrown into a listening position, so that the operator's set is connected across the cord-circuit and is connected on one side to the tip. If the line is in use and a plug is already inserted in one of the multiple jacks thereof, the potential of the jack-thimbles will be different from normal relatively to the plug-tip and receiver because of the connection established from the jack-thimble j^3 through the ring p^3, lamp l', and resistances R R′, or R alone, through conductor 9 to the other battery-bus. By this variation of potential and the flow or lack of flow of current through the operator's receiver the line is tested. The current-flow to produce the "click" for line-testing requires to be carefully graduated for two reasons: First, a variable resistance in the called circuit, which would produce a variable potential difference, would at times permit an explosive and very annoying click in the operator's receiver, and, second, any sudden rush of current through a new path of low resistance or self-induction would cause a very disagreeable explosive sound in the receiver of the subscriber, this being audible also to the correspondent with whom he may be already conversing.

An important part of my invention relates to the means for controlling the flow of test-current. My object is to properly control and regulate the resistance of the path of supply of test-current to the test-thimble under all conditions. This I attain in the following manner: The relay r', through its armature and the contact c', controls the direct circuit of the lamp l'. It cannot control the continuity of the shunt around this lamp containing the two resistance-coils R R′. It does, however, close a shunt about coil R′ by way of wire 11 when the direct lamp-circuit is broken. It will be observed that when the lamp is illuminated two parallel paths are closed from conductor 9 to the sleeve p^3 of the plug, one by way of the armature and the contact c' to and through the lamp, the other by way of coils R′ and R around the lamp. The resistances of the coils and the lamp being thus in parallel, a path of much lower joint resistance is presented than would exist through either of them alone. If now the lamp-circuit be broken, but one path remains, and the resistance between the battery and the plug-sleeve is increased. I prevent this by dividing this remaining resistance between the two coils and shunting out one of them when the lamp-circuit is broken. Thus I still maintain one portion of the resistance of the coils, which replaces the joint resistance, the latter being maintained only when the lamp is burning. Of course it is to be understood that the resistance of the lamp need not be exactly equal to the resistance of the coils; but the relative proportions of the resistances are to be adjusted in accordance with well-known laws to attain the desired result of regulation.

In addition to the feature of regulating the resistance of the test-circuit it is to be noted that another important end is served by my compensating arrangement, which is to regulate the current-flow through the relay r^2. This is the cut-off relay for the line-signal and requires a certain amount of current for its operation. To greatly reduce this current would widen the margin of operation beyond a reasonable limit of efficiency, although the relay might continue to hold up, because with its armature up it is working under conditions of maximum pull. In order to secure positive action, however, current regulation is required.

Connection with the B subscriber is obtained in the usual manner by inserting the calling-plug p'' in B's jack j'', the opposite side of the cord-circuit preferably being arranged in the same manner as the answering side, which has just been described. The ringing and listening key k, the signaling-generator g, and the operator's set o are sufficiently indicated to avoid the necessity for further description or reference to their use. Conversation being concluded between A and B, the subscribers will hang up their receivers, thus opening the circuits at their respective stations, whereupon the supervisory relays r' r^3 will be deënergized, and the controlled lamps l' l^3 will be illuminated by current flowing from batteries b and b', and the operator thus being signaled will take down the connection.

From the foregoing it will be seen that the objects of my invention are attained in a simple and practical manner, thereby materially

improving the service of a common or central battery telephone system.

By maintaining intact the circuit originally established between the central office and the subscriber's station and simply bridging the cord-circuit upon his line the marked annoyance of a sharp click or series of clicks in the calling-subscriber's receiver is done away with.

The relays in the cord-circuit are wound sufficiently high to insure their positive action, and the windings are divided and connected to balance the respective circuits, whereby my improved system is adapted for use as well upon common-return and party-line circuits. Moreover, quite a saving in battery-current is effected by opening the lamp-circuits, as is accomplished in the system described, instead of providing paths of low resistance to shunt out the lamps.

Having now described a system equipped in accordance with my invention, I claim as new, and desire to secure by Letters Patent, the following:

1. In a telephone-exchange system, a subscriber's station and a central station with a line-circuit interconnecting them, multiple jacks for said line at the central station, and an operator's cord-circuits having terminal plugs for testing and interconnecting the line-jacks, a source of supply of test-current and a connection therefrom to each cord-circuit, a resistance device in said connection adapted to be operatively affected by the condition of the subscriber's substation apparatus, together with a reciprocally-variable balancing resistance adapted to regulate the potential of the jack test-terminals during connection of a plug therewith under all conditions of the external circuit, substantially as described.

2. In a telephone-exchange system, a subscriber's station, a central station, and a circuit interconnecting them, terminal jacks for the line at the central station, each jack having a test thimble or contact, operator's cord-circuits and terminal-plugs adapted to coöperate with the line-jacks for testing and interconnection, a common source of test-current, an operator's telephone and connections therefor to the testing-terminals of the plugs and to the source, connections from the test-battery to the cord-circuits and responsive devices connected therein, and connections to the jack-thimbles, together with a variable-resistance device and means whereby said device and thereby the resistance of said connections may be regulated to regulate thereby the potential difference for testing, under all conditions of the external circuit, substantially as described.

3. In a telephone-exchange system, a multiple switchboard, multiple jacks thereon, plugs having testing-tips and sleeves coöperating with said jacks, a test-battery and an operator's telephone, a connection from said test-battery to the ring of each plug, a variable-resistance device included in said connection controlled by the subscriber, and means to compensate for the variations in resistance to regulate the potential on the plug-ring, substantially as described.

4. In a telephone-exchange system, a subscriber's station, a central station, and a line-circuit interconnecting them, a common battery at the central office, a line-relay and connections therefor to battery and to line, a line-signal and a local circuit therefor controlled at one point by said relay, a cut-off relay and its armature controlling said local circuit at a second point, a circuit for said cut-off relay including contacts of a jack-plug, a supervisory signal included in said circuit, together with a regulable resistance device whereby the resistance of the circuit may be regulated under all conditions of operation of said supervisory signal, substantially as described.

5. In a telephone-exchange system, a subscriber's line and a terminal jack therefor at a central station, plugs and a cord-circuit for interconnecting lines, a common battery for the lines, a relay connected to each line and a local circuit containing a line-signal controlled by said relay, a cut-off relay also controlling said local circuit, a local circuit for the cut-off relay including contacts closed on the plug and jack during connection, a supervisory relay connected between the battery and the cord-circuit, a supervisory signal in a local circuit controlled thereby, said circuit constituting a portion of the cut-off-relay circuit referred to, together with a regulable resistance device in said circuit actuated in the use of the apparatus of the system to regulate the resistance and thereby regulate the flow of current in the cut-off-relay circuit, regardless of the condition of the supervisory signal, substantially as described.

6. In a telephone-exchange system, subscribers' stations, a central station, and metallic line-circuits between them, a common battery for the lines, a relay for each line having its windings divided and permanently connected to the two sides of line, connections from the battery including it between the relay-windings, a local circuit and a signal for each line-relay, connected to the same battery, said line-relay controlling said local circuit only, a cut-off relay controlling each local circuit, also connected to said battery, and a circuit, and a supervisory signal therein, closed in making connection with line, to and through the cut-off relay, substantially as described.

7. In a telephone-exchange system, a subscriber's station, a central station, and a line-circuit interconnecting them, a relay permanently connected to said line at the central station, and a local circuit, with a signal therein, controlled by the relay, a cut-off relay also controlling the local circuit, a supervisory signal, a circuit therefor and variable com-

pensating resistance therein, to regulate the circuit resistance in all conditions of the supervisory signal, a common battery, and means operable in making connection with the line, to connect the battery and the supervisory-signal circuit with the cut-off relay, substantially as described.

Signed at Cleveland, this 18th day of October, 1902, in the presence of two subscribing witnesses.

JOHN P. DOWNS.

Witnesses:
C. H. PORTLE,
ALBERT LYNN LAWRENCE.