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# T. C. WALES, JR. & H. M. CRANE.

## TELEPHONIC TRUNK CIRCUIT.

(Application filed Sept. 29, 1898.)

(No Model.)

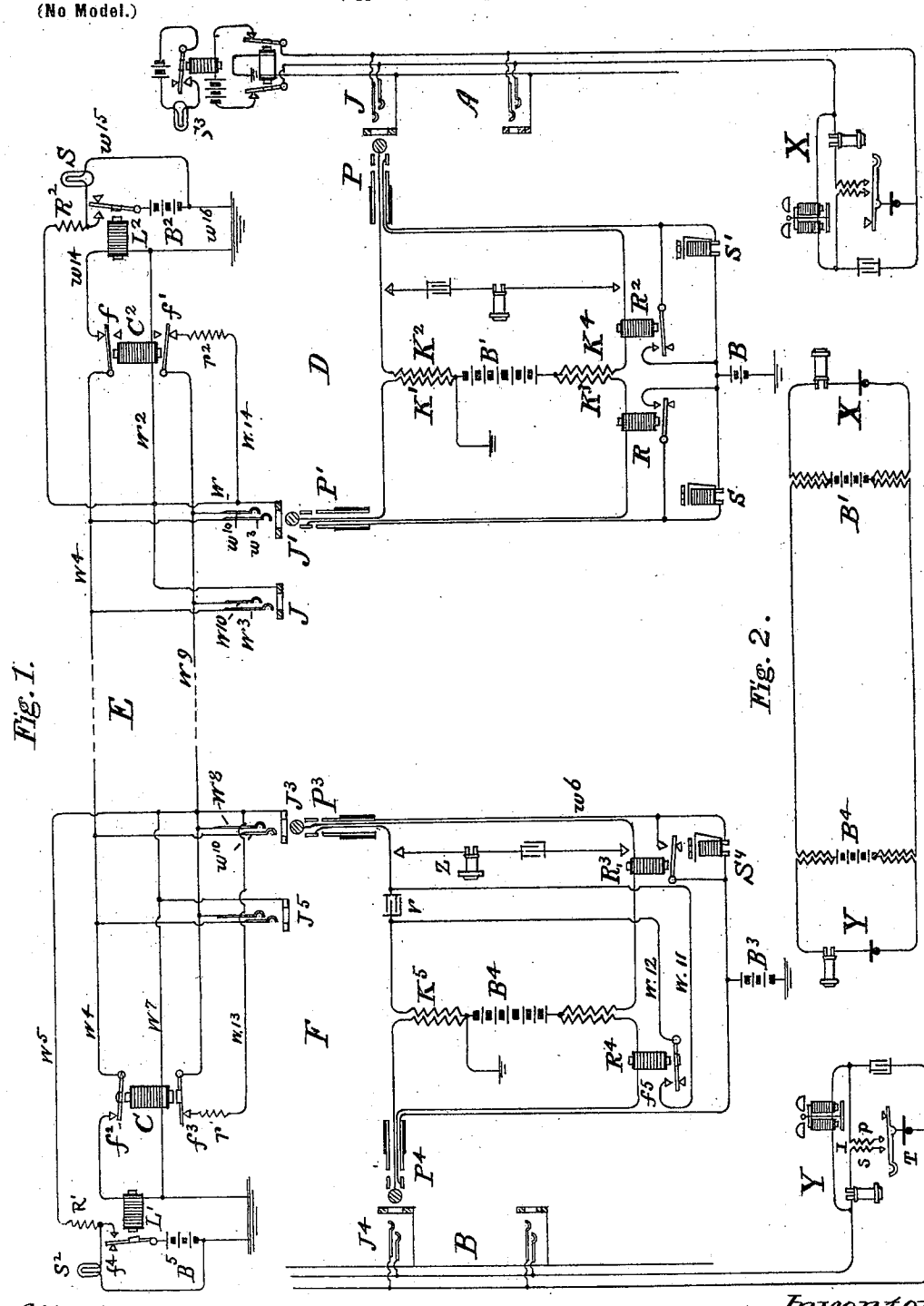


Fig. 1.

Fig. 2.

Attest.

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# UNITED STATES PATENT OFFICE.

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## TELEPHONIC TRUNK-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 623,583, dated April 25, 1899.

Application filed September 29, 1898. Serial No. 692,240. (No model.)

*To all whom it may concern:*

Be it known that we, THOMAS C. WALES, Jr., residing at Newton, in the county of Middlesex, and HENRY MIDDLEBROOK CRANE, residing at Boston, in the county of Suffolk, State of Massachusetts, have invented certain Improvements in Telephonic Trunk-Circuits, of which the following is a specification.

This invention relates to trunk-circuits by means of which distant telephone substation-circuits which terminate at independent switchboards are connected with one another.

The trunk-circuit herein referred to is adapted for the interconnection of that type of substation-lines known in the art as "relay-circuits," in which a centralized source of current is employed by the substation both for signaling the central station and for energizing telephone-transmitters.

The present trunk-circuit is adapted for use in either direction—*i. e.*, it is symmetrical in arrangement and reversible or reciprocal in operation—and is therefore provided at each end with multiple switch connections and means actuated by the operation of any of the said switch connections for establishing a determinate electrical condition at the remaining switch connections at each end, and with means at each switch connection for testing the said electrical condition to ascertain at any switch connection at either end whether the trunk-circuit is or is not already in use.

The invention also relates to the associated automatic signals whereby the operators are instructed as to the condition and requirements of the circuit and its operation. To carry out the full operation of the invention, it is necessary to provide different forms of connecting cord-circuits at each trunk-terminal, one of which will be used by the "A" or calling operator in initiating a connection and the other to be used by the B or receiving operator in responding to a call.

In the drawings which accompany the specification, Figure 1 is a diagram illustrating the application of the invention and showing the trunk-circuit thereof in association with two substation-circuits connecting with two switchboards, and Fig. 2 is a diagram illustrative of the said trunk and substation circuits connected up as a conversation-circuit.

As the general arrangement of the relay-switchboard substation-circuits is now well known in the art, no extended description is necessary.

A and B are two substation-circuits extending from their respective substations X Y to two independent switchboards, (designated as D and F,) and E is the trunk-circuit extending between the said switchboards. The said substation-circuits have terminal jacks or switch-sockets on their respective switchboards; but the line or call-signal appliances of the circuit A only are shown. E is the said trunk-circuit, consisting of the conductors $w^4$ and $w^9$, extending from the armatures $f$ and $f'$ of the relay $C^2$ to the armatures $f^2$ and $f^3$ of the similar relay C at the opposite end. Normally each upper armature $f^2$ is connected through its back contact and a relay $L^2$ L′ to ground, and lower armature $f'$ is connected through a resistance $r^2$ with the test-rings of the line-jacks J J′, and also through resistance $R^2$ and a signal S to ground, while armature $f^3$ is connected through a resistance $r$ with the test-rings of line-jacks $J^3$ $J^5$, and also through resistance R′ and a signal $S^2$ to ground. The test-rings J J′ are also connected with the cut-off relay $C^2$ and to ground. The armature of the line-relay $L^2$ is, with a battery $B^2$, in a ground branch and adapted to light the signal S when attracted. The test-rings $J^3$ $J^5$ are also similarly connected with a cut-off relay C and to ground, and the armature of the line-relay L′ is, with a battery $B^5$, in a ground branch and adapted to light the signal $S^2$ when attracted.

The cord-circuit shown at central station D and termed herein the "answering-circuit" is a standard circuit used with switchboards of this type and is arranged differently from the cord-circuit shown at the central station F and designated as the "connecting cord-circuit," and the necessity therefor will be apparent. Consequently to insure that the circuit will be reversible or reciprocal the A operators at both central stations are provided with cord-circuits, as shown at the central

station D, and the B operators at the said stations are provided with cord-circuits, as shown in central station E.

The cord-circuit at D is provided with a battery B′, an induction-coil divided into four windings, two of which connect one pole of the battery with the tips of the plugs, while the other two connect the plug-sleeves and include in each side shunting-relays R $R^2$, respectively, and the test-ring plug-sleeves are connected with each other and are provided with disconnect-signals S and S′ and a ground branch including a battery B. Each signal is adapted to be shunted by the armature of the said relays. In the cord-circuit at F the sleeve-conductor of the plug $P^3$ is connected to the upper right-hand winding of the induction-coil and includes condenser *v*, which is adapted to be shunted by the armature $f^5$ of relay $R^4$ in the sleeve-conductor of the plug $P^4$. The tip of plug $P^3$ is connected with the lower right-hand winding of said coil, and the signal $S^4$ in the test-ring-sleeve conductor $w^6$ of the plug $P^3$ is arranged to be shunted by the relay $R^3$ in the tip-conductor of said plug.

In the operation of the invention suppose that a subscriber at X wishes to be put in connection with a subscriber at Y. When the telephone at X is removed from its support, the line-signal $S^3$ is lighted, and in response to this the receiving operator, termed the "A" operator, inserts the plug P of a connecting or looping cord-circuit into a jack J, associated with the line of the calling substation, and ascertaining that substation Y is wanted touches the tip of the second plug P′ to the ring of a jack J′ of the selected trunk-circuit to ascertain whether it is already in use or not. Finding the circuit idle, the plug P′ is inserted into jack J′. The effect of this is to place a busy test upon the trunk-circuit and to operate the cut-off relay $C^2$. This is accomplished by a flow of current from battery B through signal S and rear sleeve of plug P′ of the answering and connecting cord-circuit, ring of jack J′, conductors *w* and $w^2$, and cut-off relay $C^2$ to ground. The cut-off relay $C^2$ by its operation opens the trunk-circuit by attracting the armatures *f* and *f*′, and the test-rings of all the jacks connected with the trunk-circuit at office D are raised to a potential above that of the earth. As a result of this the usual busy test will be obtained should any operator at station D touch her plug to any test-ring of the circuit. In addition to the operations described by the insertion of a plug P′ into jack J′ current also flows from battery B′, relay R, and front sleeve of plug P′ of the cord-circuit, spring $w^3$ of the jack, conductor $w^4$, armature $f^2$ of cut-off relay C and line-relay L′ at the second central station F. This current causes relay L′ to attract its armature and close the local circuit of signal-lamp $S^2$, which is placed before the connecting or B operator. When the armature of relay L′ is attracted to its front contact and the signal $S^2$ is lighted, current flows from the battery $B^5$ through resistance R′ to the wire $w^5$ and to the test-rings of the jacks $J^3$ and $J^5$, which are thus raised to a potential above that of the earth, and when a test is made with a calling-plug the usual "click" will be heard in the operator's telephone. Thus the trunk-circuit is made to test busy at all of the jacks at both of its terminals. In response to the operation of the signal $S^2$ the operator at station F inserts plug $P^3$ of the connecting cord-circuit into jack $J^3$ and learns from the A operator at station D the number of the called-for circuit. The insertion of this plug permits current to flow from battery $B^3$ through signal $S^4$, conductor $w^6$, and rear sleeve of plug $P^3$ of said cord-circuit, ring of jack $J^3$, conductor $w^7$, and cut-off relay C to ground. This current operates relay C, causing it to attract its armatures $f^2$ $f^3$ to open the main conductors $w^4$ and $w^9$ and to cut off the current from battery B′ at the station D, whereupon the armature of line-relay L′ returns to its normal position and the signal-lamp $S^2$ is extinguished. When the circuit is broken at $f^4$, the busy test already described is removed from the rings of the jacks at the station F as the battery $B^5$ is cut off; but current from battery $B^3$ flows, as described, to the said rings, and therefore there is no interruption of the busy test during the transfer from battery $B^2$ to battery $B^3$. In fact these batteries may be identical. This flow of current from the battery $B^3$ would cause the B operator's disconnect-signal $S^4$ to operate were the signal not short-circuited by the armature of the cord-circuit relay $R^3$, which is drawn up by the flow of current from battery $B^4$ through relay $R^3$, tip of plug $P^3$, lower spring $w^8$ of jack $J^3$, conductor $w^9$, spring $w^{10}$ of jack J′ at station D, tip of plug P′, and coil-winding K′ to ground. By operating the usual key the B operator is enabled to place the listening-telephone Z across the trunk-line circuit and to receive the number of the desired substation-line, whereupon she inserts plug $P^4$ into jack $J^4$ of this line and rings the bell at the substation in the usual manner. The subscriber at Y in answering removes the telephone from its hook-switch and bridges the transmitter T and the helices *s* and *p* of the induction-coil I across the line in series with the telephone. In this way a path of relatively low resistance is offered to the current which flows from battery $B^4$, relay $R^4$, ring or front sleeve of plug $P^4$, upper spring of jack $J^4$, through the substation-line and set, returning through lower spring of jack $J^4$, tip of plug $P^4$, and through the operator's cord-circuit induction-coil to the battery. This current operates relay $R^4$, which attracts its armature, thereby short-circuiting condenser *v*. The effect of this is to allow current to flow from battery B′ at station D through coil-winding $K^3$, cord-circuit relay R, ring of plug P′, upper spring $w^3$ of jack J′, conductor $w^4$, upper spring $w^{10}$ of jack $J^3$,

ring-sleeve of plug $P^3$, conductor $w^{11}$, armature $f^5$ of relay $R^4$, conductor $w^{12}$, and coil-winding $K^5$ to ground. This current causes relay R at station D to operate, thereby short-circuiting signal S, which up to this time has displayed its shutter, owing to the flow of current from battery B through sleeve of plug P', ring of jack J', conductors $w$ and $w^2$, and cut-off relay $C^2$ to ground. If the present state of the main circuit is examined, it will be seen that so far as transmission is concerned the substations X and Y are connected by the simple circuit shown in Fig. 2. With regard to signaling it is evident that signal S' in the A operator's cord-circuit at station D is controlled by the switch-hook at substation X. Signal S of the said cord-circuit is immediately controlled by the relay R, which operates to short-circuit it, and relay R is in turn controlled by relay $R^4$ in the B operator's cord-circuit at station F, as has been previously described. Furthermore, relay $R^4$ is directly controlled by the hook-switch at substation Y, and thus the signal S is indirectly controlled by said substation. The arrangement for signaling brings the entire supervision of the connection under the care of the A operator at station D, where it should be. Upon the completion of conversation the telephones at the substations are replaced upon their hooks and the signals S' and S are respectively operated, thus informing the operator at station D of the termination of the conversation, upon which she withdraws plug P' from jack J'. This operation interrupts the flow of current through cut-off relay $C^2$, whose armatures then return to their normal position upon their back contacts. The withdrawal of the plug also causes a cessation of current, which up to this time has been flowing from battery $B^4$ through relay $R^3$, as hereinbefore mentioned, which short-circuits the signal $S^4$, and when the armature of said relay falls away the current from battery $B^3$ causes the signal to be lighted.

The busy test already described for the trunk-circuit at the station D depends upon the plug P' being in the jack J', and after the withdrawal of the plug the test is continued as follows: When the plug is withdrawn and the armatures $f$ and $f^2$ close upon their rear contacts, as stated, there exists a connection from battery $B^4$ at station F through relay $R^3$, tip of plug $P^3$, spring $w^8$ of jack $J^3$, conductor $w^9$, armature $f'$ of relay $C^2$ at station D, resistance $r^2$, conductor $w^{14}$ and $w$ to the test-rings of all the jacks of this trunk-circuit at station D, thence through resistance $R^2$, signal S to ground, and this busy test will remain upon all the test-rings at both stations D until the B operator at the latter station withdraws plug $P^3$ from jack $J^3$, which operation will restore the entire circuit to its normal position. As herein stated, these operations are reversible—*i. e.*, the call for a connection can be initiated from the central station F and the several operations be performed precisely as described of a call being received at the central station D, in which event, however, a cord connection of the character shown at switchboard D will be employed by the operator at F and one of the character shown at F by the operator at D.

We claim as our invention—

1. In a telephone switching system, the combination of a trunk-circuit extending between two multiple switchboards, adapted for reciprocal operation, and provided with multiple switch connections at each switchboard; means actuated by the operation of any of the said switch connections at either switchboard for establishing a determinate electrical condition at the remaining switch connections of both switchboards; and means at each switch connection of both switchboards for testing the said electrical condition; whereby it may be ascertained at any switch connection of the said trunk-circuit at either switchboard, whether the said trunk is or is not already employed at any other switch connection of the said two switchboards; substantially as set forth.

2. The combination substantially as hereinbefore described, of a reciprocally-operated interswitchboard telephone trunk-circuit provided with multiple switch connections upon the switchboards at both of its ends; with a busy-test system adapted to establish a special and abnormal electrical condition as long as the said trunk is switched at any one of its multiple connections, at either end thereof, in and upon the switch-sockets at all of the remaining switch connections of both switchboards.

3. In a telephone-exchange system, the combination of the herein-described reciprocally-operated trunk-circuit extending between two independent switchboards; two subscribers' circuits extending to the said switchboards respectively from different substations, where their electrical condition is controlled by a switch; a connecting switchboard-circuit at each switchboard uniting the said substation-circuits with the two ends of the said trunk respectively; a condenser in one branch of the switch-cord at one of the switchboards, and a shunt-circuit therefor; a relay in the other branch of the said switch-cord responsive to the operation of the substation-switch and controlling the continuity of the said shunt-circuit; and a signal in the cord-circuit at the other switchboard responsive to the shunting or unshunting of the said condenser; substantially as and for the purposes specified.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 12th day of September, 1898.

THOMAS C. WALES, JR.
HENRY MIDDLEBROOK CRANE.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.