

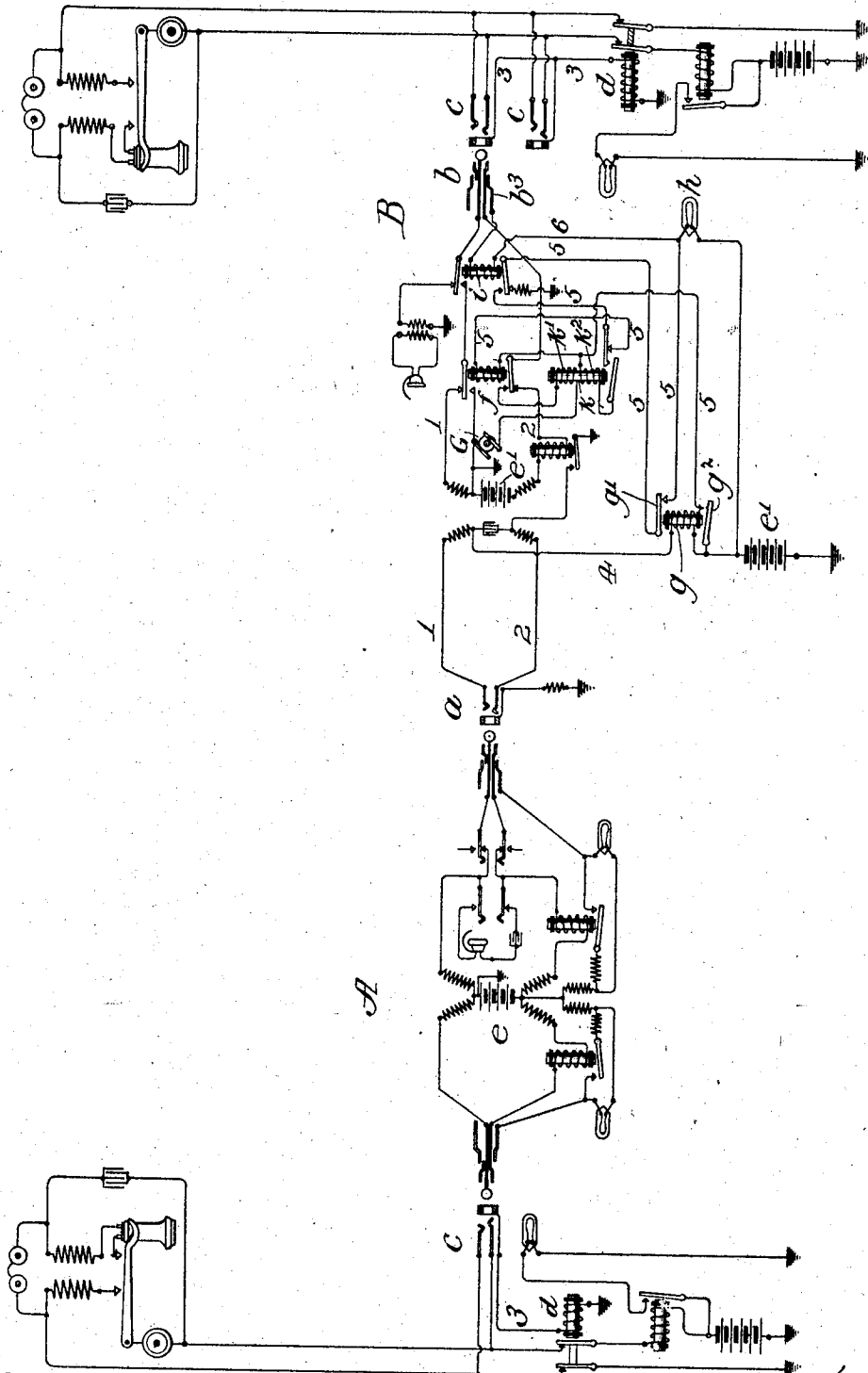
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C. A. CRAPO.  
TELEPHONE EXCHANGE TRUNK CIRCUIT APPARATUS.

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NO MODEL.



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# UNITED STATES PATENT OFFICE.

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## TELEPHONE-EXCHANGE TRUNK-CIRCUIT APPARATUS.

SPECIFICATION forming part of Letters Patent No. 772,871, dated October 18, 1904.

Application filed December 29, 1902. Serial No. 136,832. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES A. CRAPO, a citizen of the United States, residing at Denver, in the county of Arapahoe and State of Colorado, have invented a certain new and useful Improvement in Telephone-Exchange Trunk-Circuit Apparatus, of which the following is a full, clear, concise, and exact description.

My invention relates to trunk-line apparatus for telephone-exchanges.

It is a well-recognized requirement in modern telephone-exchanges that most, if not all, work incidental to the supervision of the connection should be done by the answering operator, while the trunking operator should be required merely to put up the connection upon order from the answering operator and take it down upon signal.

My invention has for its object, in general, to provide an improved organization or system in which an automatic ringing-key at the trunking-switchboard terminal of the line for signaling the called subscriber may be effectively controlled from the distant answering-switchboard.

More particularly my invention contemplates an arrangement whereby the ringing-key may be automatically actuated as a result of merely making connection with the trunk-line at both ends, and I further provide means whereby the answering operator may, if desired, resignal the called subscriber without requiring assistance from the trunking operator.

I will describe my invention particularly by reference to the accompanying drawing, which is a diagram illustrating two subscribers' lines extending from substations to different central offices A B, with a trunk-line extending between the two offices, with the connection-switches and accessory apparatus for uniting the two lines through the trunk-line and transmitting the incidental signals, the system being organized and equipped in accordance with my invention.

In the system illustrated the trunk-line extends in two metallic conductors 1 2 from a

spring-jack terminal *a* at the answering-switchboard A to a plug-terminal *b* at the trunking-board B. A subscriber's telephone-line is illustrated at each board provided with the usual spring-jack terminals *c c*, the substation apparatus of each line being of the usual type and including the usual gravity telephone-switch. At the switchboard each spring-jack is shown constructed with the usual long and short line springs, connected, respectively, with the line conductors of the telephone-line and a third contact or "testing," as it is generally called, which forms the normally open terminal of a local switchboard-conductor 3, which extends to earth through the usual cut-off relay *d*. The plug-terminals of the operator's cord-circuit at the answering-board and the plug-terminal of the trunk-line at the trunking-board are of the usual character adapted to cooperate with the spring-jacks of the type shown—that is to say, each plug has the usual tip, ring, and sleeve contacts which are adapted to register with the short and long line springs and the test-ring, respectively, of the spring-jack, into which the plug may be inserted. The operator's cord-circuit at the answering-board is of the usual type, which is well known in the art and which, being clearly illustrated by generally-accepted conventional symbols, does not require particular description. It will be noted that the grounded central battery *e* at the switchboard A is connected, as usual, in a bridge of the operator's plug-circuit between the windings of the repeating-coil with the grounded pole of said battery toward the tip-strand of the cord-circuit, so that when the connecting-plug is inserted in the spring-jack *a* the grounded limb of the plug-circuit will be connected to the conductor 1 of the trunk-line.

At the trunking-switchboard B the trunk-line is divided conductively by a repeating-coil in accordance with the usual practice, a battery *e'* being connected in a bridge between the two windings of said repeating-coil, which are conductively in circuit with the extensions

of line-wires 1 2, leading to the tip and ring contacts, respectively, of plug *b*. The pole of the battery which is connected to the tip-strand of the plug-circuit is grounded. I provide in association with the trunking operator's plug-circuit at the board B an electromagnetic ringing-key *f*, which may have two switch-levers or armatures controlling the continuity of conductors 1 2 between the battery *e*' and the plug. When the magnet of the ringing-key is excited, it attracts its armatures and breaks the circuit of conductors 1 2, connecting the ends or terminals thereof leading to the plug with the poles of a generator *G* of ringing-current, whereby the bell at the station of the called line with which the plug may be connected is rung. In the system shown ringing-current will be applied as long as the magnet *f* remains excited. The magnet of the ringing-key *f* is included in a divided branch of a local circuit 6 3, which is primarily established in registering contacts of the connection-switch or the plug *b* and the spring-jack *c* of the called line and is further controlled by a relay *g*, which is responsive to a switch at the distant answering-board. I have shown the magnet of relay *g* at the board B included in a conductor 4, extending from the free pole of grounded battery *e*' to the connection with the conductor 1 of the trunk-line leading to the switchboard A. It may here be remarked that for clearness of illustration I have shown two batteries, (each designated *e*;) but it is understood that these may be and preferably are one and the same central battery. In the system illustrated the ringing-key cannot be actuated until the trunk-plug is actually inserted in the spring-jack of the called line.

It has been common in systems heretofore to provide a conductor leading from the free pole of a battery, such as the battery *e*', to the sleeve-contact of the trunk-plug to supply current to the cut-off relay of the line with which connection is made, a signal-lamp also being included in that portion of the circuit which is associated with the plug. In my system I may retain this conductor and the signal-lamp *h* therein and include the magnet of the ringing-key *f* in a shunt 5 around said signal-lamp. It has also been customary to provide a relay *i* in the portion 6 of the local circuit which is established by the plug, this relay serving normally to connect the tip of the plug with the winding of the operator's telephone induction-coil for the purpose of making the busy test, the induction-coil winding being automatically cut off by the relay *i* when the magnet thereof is excited by the completion of the local circuit 6 3. In the system shown this relay is retained and is provided with an armature controlling a normally open break in the shunt-circuit 5 about the lamp *h*, said armature being also arranged to normally complete a path to ground from

said lamp-signal, which path is further controlled by a normally open contact *g*' of relay *g*.

In order that the ringing-current may be automatically cut off when the called subscriber answers, I control the application of ringing-current by means of a magnet which is responsive to the telephone-switch at the called station. In the system illustrated this office is performed by the disconnect-magnet *k*, which is provided with a winding *k*' in the path of current from generator *G* to the called line, and a self-exciting winding *k*". When the magnet of relay *k* is excited, its switch-contacts are arranged to cut out the winding of the ringing-key magnet *f* and substitute in its place in circuit 5 the self-exciting winding *k*" of the relay *k*.

Normally the circuit conditions are as shown in the diagram. When the trunk operator at board B receives a call for a trunk connection, she may, in accordance with the usual practice, tell the answering operator over an order-wire which trunk to use in extending the connection. The A operator will then insert her calling-plug into the spring-jack *a* of the trunk so designated, and as soon as she does so the relay *g* will be excited by current from battery *e*' in the branch 4 through the line conductor 1 of the trunk-line and thence to earth by way of the tip-strand of the operator's cord-circuit at board A. The relay *g* being excited will pull up its armature *g*' *g*", whereupon the signal-lamp *h* at the trunking-board will be lighted by current passing from battery *e*' through said lamp to earth by way of the armature *g*' of relay *g* and the normally closed contact of relay *i*. The trunking operator at the B switchboard being thus assured by the lighting of lamp *h* that the answering operator has plugged into the right trunk-line jack will insert the trunk-plug *b* into the spring-jack of the line wanted, having received the number of this line by order-wire from the answering operator. Having thus put up the connection, the work of the trunking operator is finished until the connection is to be taken down again, since by means of my invention the bell at the substation of the line with which connection is made will be automatically rung until the called party responds. The insertion of the trunking-plug *b* into the spring-jack of a line completes the local circuit 6 3, whereupon relay *i* is excited, as usual, and draws up its armatures, completing the shunt-circuit 5, which includes the winding *f*' of the automatic ringing-key. Current from generator *G* is thus applied by said ringing-key through the winding *k*' of the disconnect-relay *k*, to the called line. The winding *k*', however, does not receive sufficient current to energize the relay until the called subscriber answers, because of the high resistance of the signal-bell at the substation. When the substation-

switch is closed, however, increased current flows through the winding  $k'$ , whereby the relay  $k$  is excited and draws up its armature, cutting out from the circuit the winding of magnet  $f$  and substituting its own locking-winding  $k^2$ . The ringing-key magnet being deenergized will reestablish the talking-circuit, so that conversation may be had over the trunk-line, and said ringing-key magnet will be permanently locked out irrespective of further changes in the electrical condition of the called line, but subject, however, to being reset from the answering-switchboard. If it should be desired, for example, to send a "recall-signal"—that is, to signal the called subscriber a second time after he has once responded and then hung up his telephone—such second signal may be sent from the answering-switchboard without calling upon the trunking operator for assistance. The answering operator is provided with the usual supervisory signals, which inform her of the condition of the connected lines, and if she wishes to send a second signal after the called party has hung up his telephone she may do so by simply withdrawing her calling-plug from the trunk-line spring-jack  $a$ , or in any other way breaking the circuit which energizes relay  $g$ , and then reestablishing that circuit to again excite the relay. When the relay  $g$  becomes deenergized under the conditions above named, it will break the circuit of the locking-winding  $k^2$ , whereby the disconnect-relay will be restored to its normal condition, in which the ringing-key magnet  $f$  is included in a local circuit in place of the locking-winding  $k^2$ . When relay  $g$  again becomes energized, the ringing-key magnet  $f$  will therefore be again excited, as before explained.

It will be apparent that the invention herein set forth may be embodied in systems which may differ in many respects from that shown in the drawing, and the claims should be understood accordingly.

I claim—

1. The combination with a telephone trunk-line and connection-switches at each terminal for uniting the trunk-line with other lines, of an electromagnetic ringing-key for the trunk-line at one end thereof, a local circuit for said ringing-key, and means controlled through the joint action of the connection-switches at both ends of the trunk-line for closing said local circuit, whereby the ringing-key is automatically actuated when connection is made at both ends of the trunk-line.

2. The combination with a telephone trunk-line extending from an answering-switchboard to a trunking-switchboard, and connection-switches at each board for connecting the trunk-line to other lines, of an electromagnetic ringing-key at the trunking-switchboard in a local circuit established through the agency of the corresponding connection-

switch, a relay  $g$  controlling said local circuit, and means for exciting said relay controlled through the agency of a switch at the answering-switchboard.

3. The combination with a calling and a called telephone-line terminating on different switchboards, and a trunk-line extending between said switchboards, a source of calling-current, an electrically-actuated key associated with the trunk-line and adapted when operated to apply calling-current to the called line, connection-switches at both ends of the trunk-line for uniting the trunk-line with the calling and called telephone-lines, and means made operative by the closure of both said connection-switches for energizing the aforesaid electrically-actuated key.

4. The combination with a telephone trunk-line extending from an answering-board to a trunking-board, and means at the trunking-board for connecting the trunk-line with a subscriber's line, of a source of calling-current, an electrically-actuated key controlling the application of said calling-current to the trunk-line, means made operative in completing connection with the trunk-line at both ends thereof to energize said calling-key, and electromagnetic mechanism controlled through the agency of the substation telephone-switch for deenergizing said key to disconnect the source of calling-current from the line.

5. The combination with a telephone trunk-line and connection-switches at each end for connecting the same to other lines, of an electromagnetic ringing-key at the trunking end, a trunk-line relay at the same end and means for exciting said relay controlled by a switch at the other end, a local circuit for the said ringing-key, controlled jointly by the connection-switch at the corresponding end of the line and the said trunk-line relay, a disconnecting-relay for the ringing-key, responsive to the electrical condition of the called line, and a self-locking circuit for said disconnecting-relay, controlled by said trunk-line relay.

6. The combination with a telephone trunk-line extending from an answering-switchboard to a trunking-board, a called subscriber's line also terminating at the trunking-board, and a connection-switch for uniting the lines, of a source of calling-current and a key adapted to apply said current to the called line, a switch at the called substation, a magnet at the trunking-board responsive to said switch, mechanism controlled by said magnet for cutting off the source of calling-current, a locking-circuit for said magnet, a relay controlling the flow of current through said locking-circuit, and a switch at the distant answering-board to which said relay is responsive; whereby the called station may be resgnaled from the answering-switchboard.

7. The combination with a telephone trunk-  
 line and connection-switches at each end for  
 connecting the trunk-line with other lines, of  
 a source of calling-current at the trunking  
 5 end of the trunk, an electromagnetic ringing-  
 key for connecting said source of calling-cur-  
 rent with the line, an actuating-circuit for  
 said key completed through the joint agency  
 of the connection-switches at both ends of  
 10 the trunk, a disconnecting device for deener-  
 gizing said ringing-key to disconnect the  
 source of calling-current from the line, said  
 device being responsive to the electrical con-  
 dition of the called line, and means controlled  
 15 through the agency of the connection-switch  
 at the other end of the trunk for reversing  
 said disconnecting device, whereby calling-  
 current may be reapplied to the called line.

8. The combination with a telephone trunk-  
 20 line extending from an answering to a trunk-  
 ing switchboard, of other lines terminating  
 at each switchboard, a connection-switch at  
 each end of the trunk-line for uniting it to  
 the other lines, a source of calling-current at  
 25 the trunking-board, an electromagnetic key  
 controlling the connection of said source of  
 calling-current with the called line, a trunk-

line relay associated with the trunk at the  
 trunking-board, an actuating-circuit for said  
 relay controlled in the connection-switch at 30  
 the answering-board, an actuating-circuit for  
 said ringing-key controlled jointly by the  
 trunk-relay and the connection-switch at the  
 trunking-board, a disconnect-relay for the  
 ringing-key responsive to the electrical con- 35  
 dition of the called line, said relay also con-  
 trolling the actuating-circuit of the ringing-  
 key and operating to deprive the said key of  
 current, a locking-circuit for said disconnect-  
 relay completed in contacts of the same and 40  
 adapted to maintain the disconnection of call-  
 ing-current from the line after the response  
 of the called subscriber, and contacts of the  
 trunk-relay controlling said locking-circuit,  
 whereby the ringing-key may be actuated to 45  
 reapply calling-current to the line.

In witness whereof I hereunto subscribe  
 my name this 21st day of November, A. D.  
 1902.

CHARLES A. CRAPO.

Witnesses:

HARRY A. RHODES,  
 N. O. PIERCE.