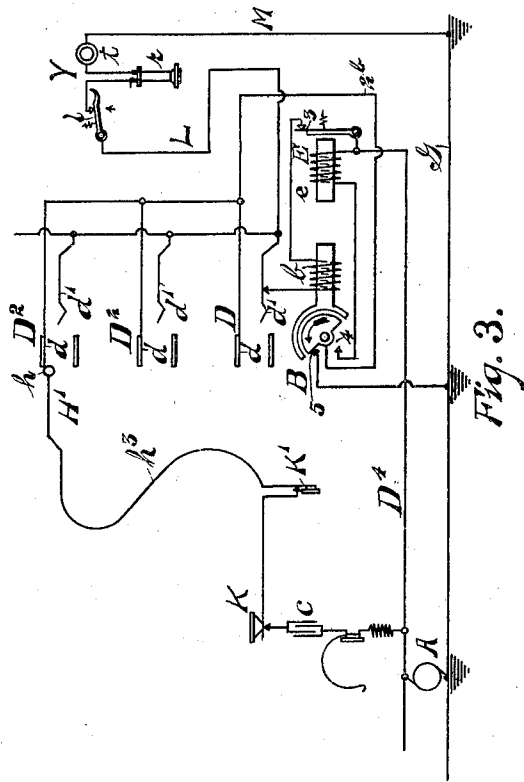
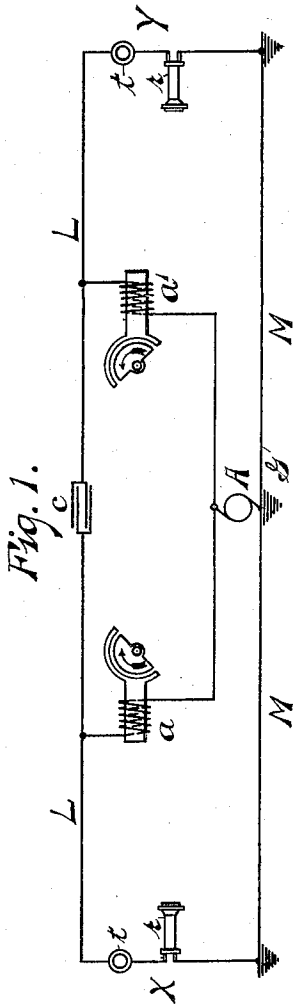


J. G. ROBERTS.
TELEPHONE SYSTEM.

APPLICATION FILED MAY 8, 1902.

4 SHEETS—SHEET 1.



Witnesses.
R. H. Burfield
F. J. Dommarque

Inventor:-
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by *Robert Lewis Ames*,
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4 SHEETS—SHEET 2.

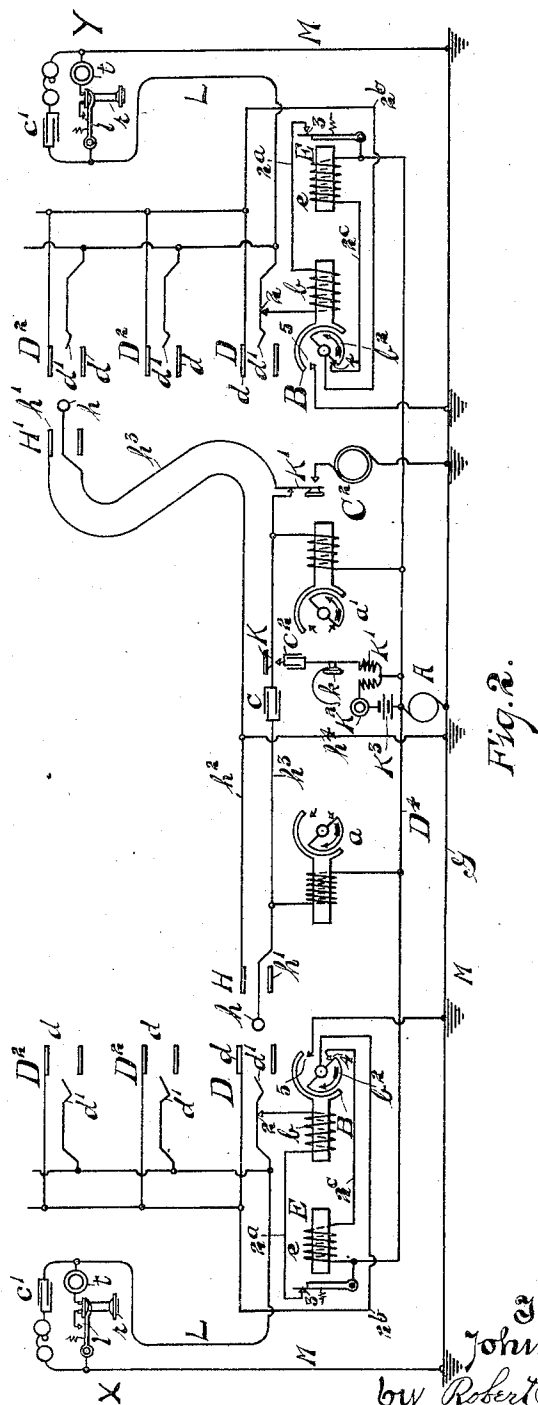


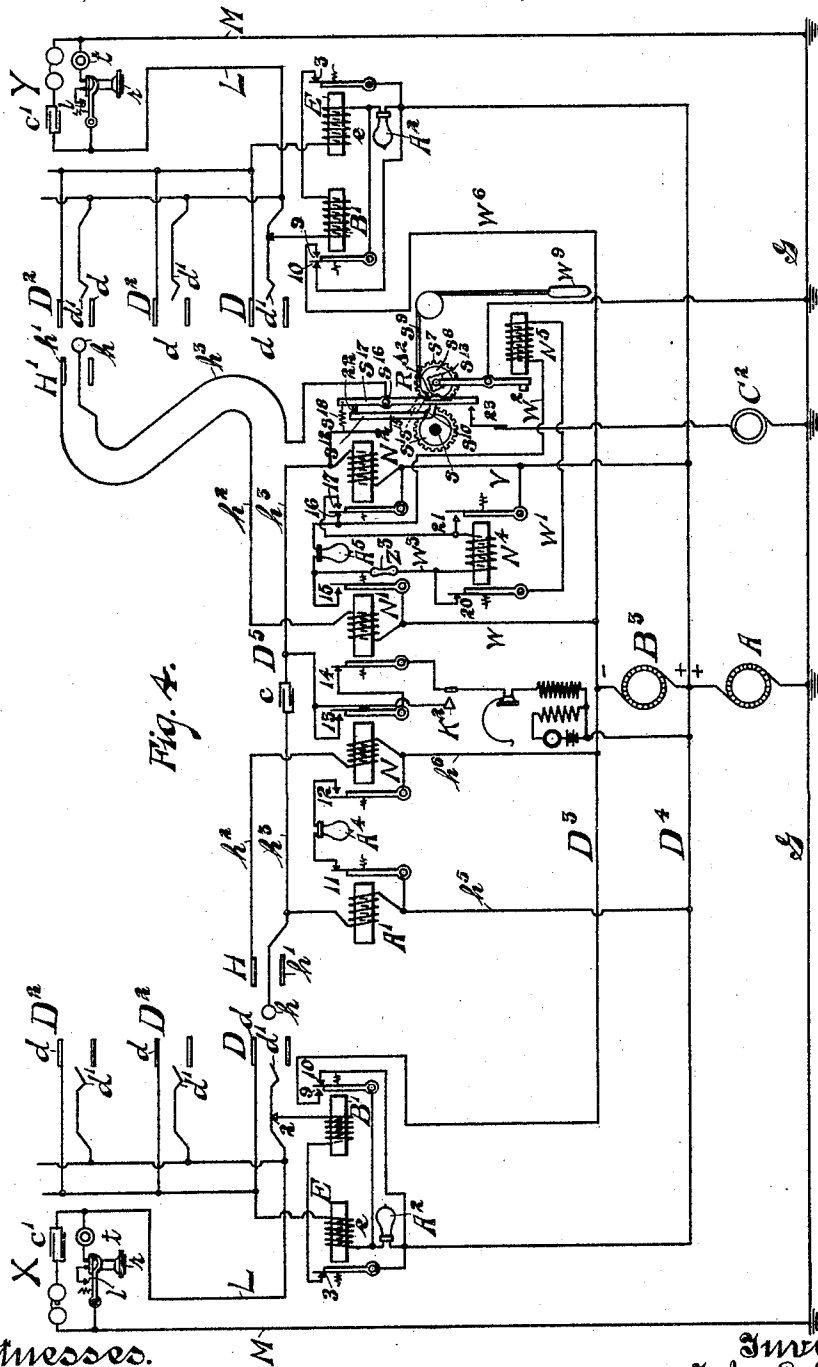
Fig. 2.

Witnesses.
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4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.

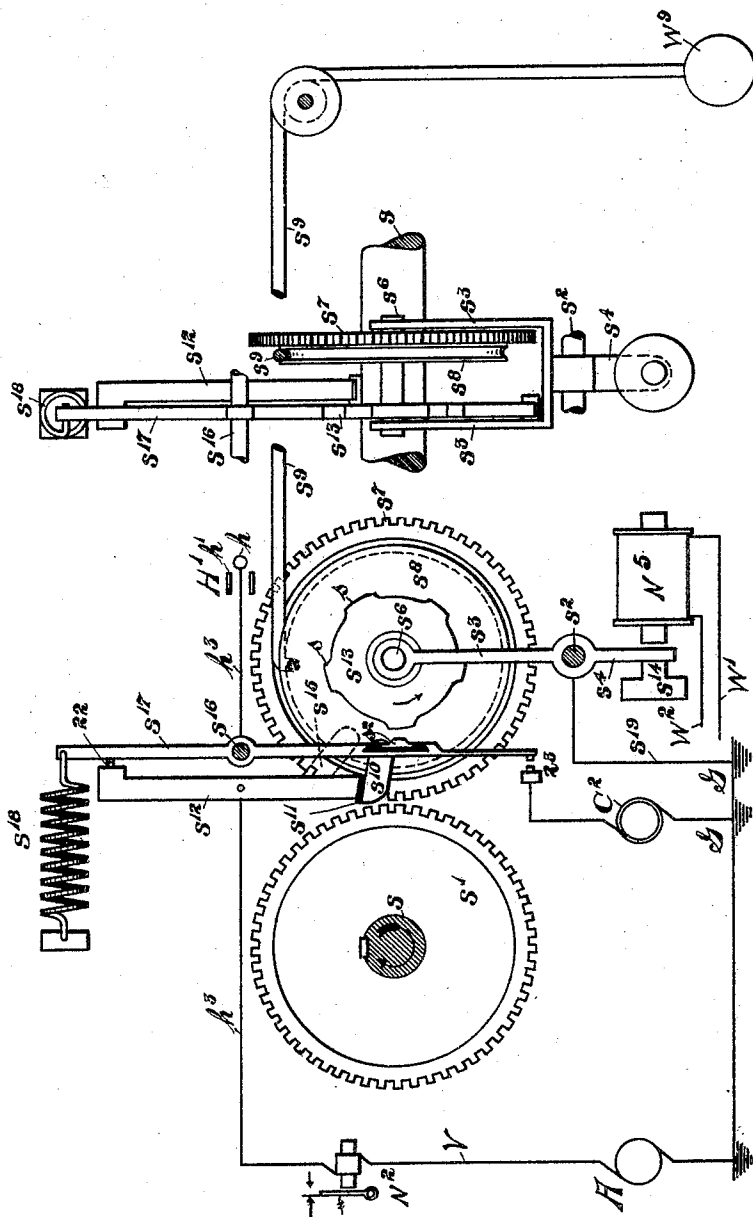


Fig. 6.

Witnesses.
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UNITED STATES PATENT OFFICE.

JOHN G. ROBERTS, OF EVANSTON, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 790,854, dated May 23, 1905.

Continuation of renewed application, Serial No. 48,590, filed February 23, 1901. This application filed May 8, 1902, Serial No. 106,400.

To all whom it may concern:

Be it known that I, JOHN G. ROBERTS, a citizen of the United States of America, and a resident of Evanston, county of Cook, and State of Illinois, have invented a certain new and useful Improvement in Telephone Systems, of which the following is a specification.

My invention relates to a central-office equipment in telephone-exchanges whereby substations may be connected together with the least possible work by the operator; and it consists in automatic means for switching the operator's set and the calling-generator on and off the circuit at the proper moments during the process of making a complete connection; also, in means for operating the signals for calling central and disconnecting and in certain other arrangements and combinations hereinafter specified.

The devices hereinafter described are applicable to central "energy systems" of the usual type, and while more particularly adapted to the system of circuits herein described are not necessarily limited thereto.

In the drawings, Figure 1 is a diagram of one form of my invention. Fig. 2 is a diagram of circuits of a multiple switchboard, showing two substations with lines to a signaling apparatus at the exchange and a cord-circuit with supervisory signals whereby an operator may connect the two substations together and disconnect them when the subscribers are through talking. Fig. 3 illustrates the busy-test circuit. Fig. 4 illustrates the circuits of a multiple switchboard, showing the two substations with connecting-lines, the signaling apparatus at the switchboard, a cord-circuit with supervisory signals, and relay-circuits whereby the switching necessary to enable the operator to listen in on the line and to connect the generator onto the line to call the subscriber are automatically made by putting up and taking down connections. Figs. 5 and 6 illustrate the ringing-machine used, Fig. 5 being a vertical elevation of the

same and Fig. 6 being the left-hand side view thereof.

Referring to Fig. 2, X and Y are subscribers' stations, each furnished with a condenser c' and call-bell permanently in circuit between the limbs of the line and a transmitter t and receiver r in a bridge of the line normally open at the switch-hook I. The two limbs M and L of these lines extend to the central office, where they are fitted with answering-jacks D and multiple jacks D², the limb L leading directly to the multiple-contact tip-springs d' of the several jacks, while the opposite limb M is connected with the common office ground or common office return G and with the grounded pole of the direct-current generator A, as shown. The tip-spring d' of the answering-jack is connected through a normal contact 2 with the winding b of the line visual signal B and thence by conductor 2^a with the back contact of the cut-off relay E, the armature of which relay is connected with lead D⁴, extending to the live pole of the generator A. The sleeve-contacts of the jacks are connected in multiple and by means of conductor 2^b with the axis of the rotary target b^2 of the line-signal B. The winding e of the cut-off relay E is connected by conductor 2^c with the normal contact 4 of the shutter or target b^2 , while its forward contact 5 is connected directly with ground, the common office-return, or with the line conductor M, as shown.

The operator's cord-circuit is supplied with an answering-plug H and a calling-plug H', the tip-contacts h of which are connected together by the strand h^3 and the interposed condenser c , while the sleeve-contacts h' of the plugs are directly connected by strand h^2 , which in turn is connected with the grounded pole of the battery through conductor h^1 . A supervisory signal a , having a visual indicator, is associated with the answering-plug, and a similar signal a' is associated with plug H'. The windings of these signals are connected between the cord-strand h^3 on each side

of the condenser c and conductor D^4 , leading to the live pole of the generator A. A key K may be depressed to connect the operator's head-telephone h with the cord-circuit, a condenser c^2 and secondary winding of her induction-coil h' being included in series therewith between the strand h^3 at the right of condenser c and the lead D^4 . Current for the operator's transmitter h^2 and the primary winding of her induction-coil is preferably furnished by a battery h^3 in a local circuit. An alternating-current generator C^2 serves to call the subscribers from the central office, a key K' serving to connect the same with the cord-circuit.

The operation is as follows: The subscriber X in taking up his receiver closes the circuit of the line through the telephone instruments and permits current from the live pole of the generator A to flow over conductor D^4 , armature, and back contact 3 of cut-off relay E, conductor 2^a , winding b of line-relay B, contact 2, tip-spring d' of jack D, limb L of the telephone-line, through the telephone instruments at the substation and back to the central office over limb M to ground and dead pole of the generator A. The current in this path actuates line-signal B, which exposes its target to indicate a call. The armature b^2 of the signal B is normally in contact with a point at 4, as stated; but when the coil is energized it partially rotates and makes contact at 5. The sleeve d of the jack D is thus grounded through the line M or G when the signal on that line is displayed. The operator seeing the signal displayed answers the call by inserting the plug H in the jack D and depressing her key K to connect her telephone in circuit. The tip of the plug h when inserted in the jack lifts the spring d' from contact 2, thus opening the circuit of the signal B, whereupon it is automatically restored to the position shown. The sleeve h' of the plug H being grounded through the conductors h^2 and h^4 , the sleeve d is also grounded and a circuit is formed through the coil e of the cut-off relay E, said circuit being from the live pole of generator A, lead D^4 , winding e , conductor 2^c , contact 4 of line-signal B, the target b^2 of the signal, conductor 2^b , jack-contact d , strand h^2 , and branch h^4 to ground, and dead pole of the generator A. This circuit could not be made without opening contact 2 of the jack D after the signal is once displayed, for otherwise the contact in the signal B at 4 would be opened. After receiving her instructions the operator tests Y's line with the calling-plug H' in the manner hereinafter stated. If it is not busy, the plug is inserted in any one of the multiple jacks D^2 D^3 and the subscriber wanted is called by the generator C^2 in the usual way over a circuit from the live side of the generator C^2 , depressed key K' , tip-strand h^3 , tip-spring d' of the multiple jack D^2 , line-limb L, through the condenser c' , and the call-bell

at the subscriber's station Y, operating the said call-bell, and back over limb M to the central office and grounded pole of generator C^2 . The insertion of plug H' in the jack D^2 completes the circuit through the coil e of the cut-off relay E through the sleeve h' of the plug. The completion of this circuit energizes the winding of the relay E and causes it to attract its armature, thus breaking contact 3 and opening the circuit through the coil of the signal B. The current to charge the transmitters at stations X and Y is furnished from the generator A through the coils of supervisory signals a a' , which signals are displayed during the conversation and are restored when their circuits are opened by the receivers being placed back upon their hooks, the weight of the receiver breaking the contact in the substation, and thus opening the circuit. These circuits may be traced from the live side of the generator A, through signal a or a' to the tip of the corresponding plug, to jack-spring d' , to limb L of the telephone-lines, through transmitter and receiver contact l and the hook, and back on limb M to the grounded side of the generator A.

Inasmuch as the multiple jacks have precisely the same connections, the same circuit exists to substation Y as to substation X and is opened by placing the receiver on the hook, thus breaking contact l in the same manner. Thus it will be seen that the lifting of the receiver by the subscriber in the substation throws the signal at the central office corresponding to that line, providing a connection is not already made by a plug in any of the jacks of that line, and the insertion of the plug in the answering-jack restores the signal, but displays an operator's signal so long as the receiver is off from the hook. On ascertaining the number of the subscriber called for the operator inserts the connecting or calling plug of a pair into a multiple jack of the called line. The operator's signal belonging to the cord and of the pair thus engaged remains undisplayed until the subscriber called for answers by removing his receiver from its hook, it remaining displayed until the receiver is replaced upon the hook. The restoration of the receiver of either the called or calling subscriber to its hook breaks the circuit and restores the corresponding signal to its normal condition. It will be understood that an operator will not insert a connecting-plug in the multiple jack of a line at a time when the signal belonging to that line is displayed by the action of a calling subscriber, as she would be warned off the line by the "busy test," as hereinafter explained, unless she should choose to insert the plug for a purpose, also hereinafter explained, and wait for the "not-busy" signal when the wanted subscriber restores his receiver to its hook. During the interval occurring when a subscriber's signal is displayed, as assumed, the operator's act of placing a plug in the cor-

responding multiple jack would not restore the signal, because the circuit is at that time open to the coil of the cut-off relay E at contact 4. Fig. 1 shows in simple diagram this talking-circuit. The steady generator-current flows out to the substations from the live pole of generator A through the coils of the supervisory relays a and a' and serves to charge the transmitters at the substations for talking, the current finding its way back to the central office and opposite pole of the generator either over a ground-conductor or the line-limb M. The voice-currents travel over the outer rectangular path indicated, the condenser c permitting the passage thereof, while the coils a and a' have sufficient impedance or self-induction to prevent their passage. The condenser c , being opaque to steady current, renders the supervisory signals a and a' individual or selective in their operation.

Fig. 3 shows the test-circuit which would occur should the operator test Y's line at the moment Y was himself making a call for central and before the operator had answered. The operator's listening-key K is shown down, the tip of the calling-plug H' is just touching the sleeve d of the multiple jack D², and the signal B is displayed. The testing-circuit is closed from the live pole of generator A through the operator's instruments, the tip-strand h^3 , tip-contact h of the plug H', through the sleeve d of the jack D², over conductor 2^b, through the armature of the signal B, and the contact 5, made by the signal-armature, and thence to the grounded pole of the generator A. A surge of current through the operator's instrument to charge the condenser c will cause a click to be heard by the operator, warning her that the line is busy. The condenser c in the operator's circuit may be shunted by a high resistance to make this test plainly audible, although it is not absolutely necessary. The same test would occur to the operator if instead of the signal B being displayed another plug was inserted in another jack on the line, for the test-ring of the jack would then be connected to the ground or dead side of the generator by the sleeve-strand and conductor h^4 of that plug, as seen in Fig. 2. If the line is not in use, the operator will not get a click on testing the line, for with the signal B down and no other plug in a jack on the line neither the generator A nor any part of it is included in the test-circuit when an operator is making a test on the line, or, in other words, the test-rings of the jacks are not grounded.

Fig. 4 is another diagram of circuits of a multiple switchboard and apparatus embodying the same principle and showing two substations with lines to the central office and signaling apparatus to the switchboard and a cord-circuit with supervisory signals and relay-circuits, whereby the switching necessary for the operator to listen in on the line and

for the generator to be connected to the line to call the subscriber are automatically made without any other operations than those of plugging into and taking the plug out of the jacks of the line.

The line-circuits and apparatus are substantially the same as those described in Fig. 2. The line-signal B, however, is replaced by a relay B', and the supervisory signals are replaced by relays A' and N². The talking-circuit in Fig. 4 is the same as that in Fig. 2 and Fig. 1. The line and supervisory signals in Fig. 4 are shown as incandescent lamps A², A³, A⁴, and A⁵, but may be of the needle, shutter, or any other type, as described. A is a generator to supply direct current to the relays B', B', and A', and N² and is of high enough electromotive force to supply current for the transmitters at the substations through the coils of the relays A' and N². B³ is also a direct-current generator to supply current to the coils of the cut-off relays E E, the starting-magnet N⁵ of the ringing-machine R, and the lamp-signals A² A³ A⁴ A⁵. The generator B³ is preferably of a lower electromotive force than generator A to save wire on the relays and make the resistance of these local circuits lower; but it is not necessarily a separate generator from A. In fact, generator B³ could be dispensed with and then the common generator line or lead D³ would be connected to or form a part of the ground-line G. It is convenient, however. Hence I have shown it in the diagram. This species of my invention in which I employ a single generator A is shown, described, and claimed by me in my divisional application, Serial No. 95,155, filed February 24, 1902. C³ is the alternating-current generator used for calling the subscribers to their telephones. R is the ringing-machine, which is shown in Figs. 5 and 6, and N, N', and N⁴ are relays, the functions of which will appear later in the description of the operation of the system.

Referring to Fig. 4, the operation of this system is as follows: X calls central by removing his receiver from its hook, thus closing his line at contact l through the coil of the line-relay B' and generator A at the switchboard, as before described, which relay in turn closes contact 9 through the line-signal A² and generator B³. The armature of relay B', which is normally on contact 10, connected with the common generator-wire D⁴, is now in connection through contact 9 with the common generator-wire D³. The jack-sleeves on that line are now all in condition to test busy—that is, in this construction the operator testing the line in any of its multiple jacks will get the busy-test "click" in her telephone. This arrangement for a test is the same as described in the circuit in Fig. 3, except that the test-rings are now connected with the negative pole of generator B³ instead of with ground, as in the former figure. The opera-

tor seeing the signal A^2 displayed inserts an answering-plug H of the cord-circuit in the answering-jack D of that line and in doing so opens the contact 2, restoring the relay B', thereby opening contact 9, restoring contact 10, and short-circuiting and extinguishing the line-signal A^2 . A circuit is now formed by the contact between the tip h of the plug H and the spring d' of the jack D from the generator A, through conductor h^5 , the coil of supervisory relay A', opening its normally closed contact 11 and tip-strand h^3 out over the limb L of the telephone-line to substation X, thence through the transmitter t and receiver r , back over limb M to ground G and generator A at the central office. A circuit is also formed from the generator B³ through conductor h^6 , the coil of the supervisory relay N closing both its normally open contacts 12 and 13 through strand h^2 and the contact between the sleeves h' of the plug H and d of the jack D, through the coil e of relay E, thus opening its normally closed contact 3, included in the normal circuit of relay B', thence around the shunt of the lamp A^2 , formed by the armature and contact 10 of line-relay B', and back on common wire D⁴ to the opposite pole of generator B³. The opening of the contact 11 prevents the supervisory signal A⁴ from being displayed, although the contact at 12 is made. The contact made at 13 switches the operator's head-phone circuit, one terminal of which is connected to lead D⁴ in the cord-circuit D⁵. The operator immediately answers the call in the usual way and receives her instructions from X. Learning that X wishes to talk to Y, the operator picks up the calling-plug H' and proceeds in the usual way to test Y's line by the jack D², which is the jack on Y's line that is within her reach. In touching the tip h of the plug H' to the sleeve d of the jack D² she will, if the line is not busy, hear no click in her ear, the sleeve of the jack being connected with the same pole of the generator, and therefore at the same potential as the tip of her plug, whereby no current can pass through her head-phone. She then plugs H' into jack D², the signal A⁵ being immediately displayed, as later explained, and remains so until Y answers the call or until the plug H' is removed from the jack D², as will be explained. At the moment the sleeve h' of the plug H' makes contact with the sleeve d of the jack D² a circuit from the negative pole of generator B³ is formed through wire W, the coil of supervisory relay N⁷ opening the normally closed contact 14, thus cutting out the operator's head-phone circuit and closing the normally open contact 15, thence through the cord-strand h^2 to plug H', then through the coil e of the cut-off relay E, opening its normally closed contact 3 in the circuit of the line-signal relay B', then through the shunt of lamp A², including the armature and the back con-

tact 10 of line-relay B', to the common wire D⁴, and back to the positive pole of generator B³. The closing of contact 15 forms a circuit from the generator B³ through contact 15, then through the signal A⁵ and causing it to be displayed, then through the normally closed contact 16 of the relay N², through the wire V and D⁴, back to B³. The relay N² remains inoperative on account of the condenser c' at Y's instrument, which opens the circuit at that point and the condenser c in strand h^2 . The closing of the contact 15 forms another circuit from the generator B³, following the same path as the other one to contact 15 and then through the wire W³, the normally closed contact 20 of the relay N⁴, the wire W', and through the coil of the magnet N⁵, starting the ringing mechanism R, as previously referred to and shown in detail in Figs. 5 and 6, then through the wire W² to contact 16 of relay N² and through wire V, back on common wire D⁴ to the other side of B³. As the cam S¹³ of the ringing mechanism revolves, as hereinafter explained, during the energization of the starting-relay N⁵ contact 23 is made and broken alternately, contact 22 being open when contact 23 is closed and closed when 23 is open. The alternating-current generator C² is consequently switched on and off Y's line at contact 23 and rings his bell accordingly through the condenser c' at the substation and the ringing-circuit being the same as that described in Fig. 2. As soon as Y removes his receiver from its hook to answer the call and if at that moment contact 22 is closed, or as soon thereafter as it is closed, current will pass from generator A, over wire V, through the coil of relay N², opening contact 16 and closing contact 17, then through contact 22 in R, then to the tip h of the plug H' and spring d' of the jack D² to limb L of the line, through the telephone instruments at Y, and back to the wire M and ground-wire G to the opposite side of generator A. The opening of contact 16 opens the circuit to and extinguishes the supervisory signal A⁵ and also opens the circuit of the coil of the controlling-magnet N⁵ of the ringing mechanism R, causing the gear S⁷ and cam S¹³ to revolve back to their normal position, as will be hereinafter explained. The contact 17, made by the armature of relay N², forms a circuit from generator B³ through contact 15, wire W³, the coil of relay N⁴, closing contact 21 and opening contact 20, then through contact 17 and back on wire V and common wire D⁴ to generator B³. The opening of contact 20 opens the circuit of current-supply to starting or ringing magnet N⁵, as well as does the open contact 16. The closing of contact 21 closes the circuit of current-supply to the coil of relay N⁴ in a parallel path to the contact at 17, so that the circuit through the coil of relay N⁴ is locked and cannot be opened again until the plug H' is removed from jack D²

and by so doing opening the circuit through the coil of the relay N' , which opens its contact 15. If, however, Y does not answer the call, the ringing mechanism will be automatically released when the stop S^{10} , carried by the wheel S^8 , revolves around to point S^{15} and grounds the relay N^2 , as hereinafter described, the current passing from generator A through the coil of N^2 to strip S^{12} and from there to stop S^{15} and to ground-line G and back to A at the moment of contact between S^{12} and S^{15} . The result is the same as regards the operation of relay N^4 and magnet N^5 as would be had if Y had raised his receiver from the hook. The relay-armature of relay N^2 , having closed contact 17 for a moment, almost immediately falls back again, for contact s^{15} is instantly opened and the ground-line G connection removed by the ringing-machine revolving back to its normal position, the mechanism for accomplishing which will be fully described. The contact at 21, however, has been closed by this action of relay N^2 and contact 20 opened, so that current is securely cut off from the magnet-coil N^5 . Now assuming that Y had answered his call, as before mentioned, and is through talking, he replaces his receiver on its hook, thus opening the circuit through his telephone at the switch, current is cut off at that point from the relay N^2 , contact 17 is opened, and contact at 16 is closed and the signal A^5 is displayed to the operator through the same circuit as previously traced when plug H' is first inserted in jack D^2 , thus informing the operator that Y has replaced his receiver on the hook. For the same reason as before stated the opening of this contact 17 does not now cut off current from the coil of relay N^4 , because the parallel contact 21 remains closed and locks the circuit. In the same manner subscriber X on replacing his receiver on its hook opens the circuit through the coil of the supervisory relay A' , releasing its armature, closing its contact, and displaying the supervisory signal A^4 , current passing from generator B^3 , over wire h^6 , through contact 12, signal A^4 , the back contact of relay A' , and wire h^5 , back to common wire D^4 and generator B^3 . The two signals A^4 and A^5 being displayed, the operator knows that the conversation is terminated. It is then her duty to disconnect, which she does by removing plug H from jack D and plug H' from jack D^2 , which cuts off current from relay N, opening contact 12 and extinguishing the signal A^4 ; likewise from relay N' , closing contact 14 and opening contact 15. The opening of contact 15 cuts current off from and extinguishes the signal A^5 and also cuts off current from the coil of the relay N^4 , closing contact 20 and opening contact 21. Current is also cut off from relay E, which closes its contact 3, and the removal of the plug H closes the contact in the jack D. The disconnection

is now complete, current is cut off from all relay-coils and the ringing-coil, and all parts and contacts are in their normal positions.

To explain the busy test: Suppose the operator to be testing Y's line at jack D^2 with plug H' just after Y had raised his receiver from the hook and before Y's operator had answered the call. The operator would get a click in her ear from current from the generator B^3 passing through her head-phone, contacts 14 and 13 to D^5 , then through tip-strand h^3 and contact 22, thence to the tip of plug H' , to the sleeve d of jack D^2 , through the coil e of relay E to the armature of relay B' and its forward contact 9, and back through wire W^6 to common wire D^3 and to the other pole of generator B^3 . Now suppose Y had called central and Y's operator had answered the call by placing a plug in the answering-jack D, or supposing any operator on any board had placed a calling-plug in any other multiple jack, the sleeves of all the jacks on Y's line would be in connection with the common wire D^3 through the relay-coils, such as N or N' , of another cord-circuit corresponding to those shown in Fig. 4. Consequently an operator testing the line during that time will get a click in her ear from current passing through her head-phone from the generator B^3 in a similar manner to that described above.

Should the operator be unable to get Y to the phone, she will be made aware of the fact by the continual displaying of the signal A^5 . After waiting a reasonable length of time she will remove the calling-plug, thus switching into the circuit again her head-phone, and inform the calling subscriber X that she cannot get Y.

By the arrangement of circuits shown in Fig. 4 it is impossible for the operator to listen in on the circuit without removing the calling-plug and cutting off conversation between the connected subscribers. This insures absolute secrecy to the subscriber; but should it be desired to provide means for the operator to listen in on the circuit a switch or key K^2 can be provided within her reach for connecting the strand h^3 with her receiver.

A switch Z^3 is inserted in line W^3 , which can be opened and closed by the operator, as desired. By means of this simple switch device if the operator should desire to hold off the ringing-machine until some time after the connecting-plug is inserted it is only necessary to open the switch Z^3 during that time. This delay may be desired by an operator in case of an especially-urgent call, in which case though the wanted line was found busy the connecting-plug would be inserted and the answering-plug withdrawn until the supervisory signal associated with the connecting-plug was displayed, when the answering-plug would be reinserted in the jack of the calling-

line and the switch Z^3 closed. By the same device the machine may be started again after it has automatically come to a stop, as hereinbefore described, for the operator need only
 5 to open for a moment the switch Z^3 , thereby releasing the locking-relay N^4 , opening contact 21, and closing contact 20 and then closing the switch again, thus restoring the circuit through N^5 . The operator can ring the
 10 called subscriber again after the first revolution of the cam by removing the calling-plug and replacing it again in the jack to which it was connected; but should it be desired to provide means for her to start again the ringing
 15 mechanism R , after it has automatically come to a stop by the action of the relay N^4 without removing the plug it is only necessary to provide a switch by which the circuit to the coil N^4 may be opened, preferably by
 20 a button-switch shunting the coil of the relay N^4 , thus opening for a moment by a single pressure of the button the contact 15 and releasing the armature of the relay N^4 , closing the contact 20 in the circuit through the
 25 magnet N^5 , and starting again the ringing mechanism R , or, as explained above, the switch Z^3 may be employed.

In Figs. 5 and 6 the ringing mechanism is shown on an enlarged scale in two views.
 30 The mechanism is controlled entirely by the magnet N^5 starting when current is switched onto the coil of the magnet N^5 and stopping when current is cut off from it.

S is a shaft made to continuously turn with the uniform slow movement in the direction
 35 of the arrow.

S^1 is a gear-wheel with small teeth on its periphery keyed to shaft S , hence moving with it.

40 S^2 is a fixed point attached to the frame of the switchboard and upon which is fulcrumed a lever having two arms or forks $S^3 S^3$. Below the pin is a single arm S^4 , which is actuated by the electromagnet N^5 . Between the
 45 two prongs $S^3 S^3$ of the fork is a shaft or pin S^6 , which is free to turn on its axis. Upon the pin S^6 is mounted a gear-wheel S^7 , adapted to intermittently engage with the gear S^1 when moved transversely toward it sufficiently to
 50 permit the gear to engage therein. A pulley S^8 is rigidly attached to the gear-wheel S^7 and is controlled by a cord S^9 , passing over a pulley and held under tension by the weight
 55 W^9 . A stop S^{10} is rigidly attached to the pulley S^8 and rests normally against a rubber cushion S^{11} , the cushion forming the terminal of the lower end of a fixed strip S^{12} , and thus insulating the stop from the strip. A cam-wheel S^{13} is also rigidly fixed to the same shaft
 60 S^6 , and therefore turns with it. Upon the periphery of the cam-wheel are raised projections $s s$ —say five.

S^{14} is a stop against which the lower end of the fork, which is of iron, normally rests.

65 The core of the electromagnet N^5 when mag-

netized by the current attracts S^4 to it, thereby swinging the upper end of the fork carrying the wheel S^7 , the pulley-wheel S^8 , the cam-wheel S^{13} until the teeth of the wheel S^7 engage with the teeth of S^1 , compelling the pulley-wheel and cam to revolve in the direction
 70 of the arrow of the cam. This carries the stop S^{10} around to the position shown in dotted lines at S^{15} , where the end of the stop comes in contact with the fixed rod S^{12} and by
 75 virtue of the cord S^9 raises the weight W^9 . It is plain that on releasing the wheel S^7 from the wheel S^1 the pull of the weight will rotate the wheel S^7 and cam-wheel S^{13} in a contrary direction back to the position where it
 80 is shown in the drawings. Pivoted at S^{16} is another rod, S^{17} , the upper end of which is controlled by a spring S^{18} . The rod being of metal, it can make an electrical contact with the strip S^{12} at 22. The lower end of the rod
 85 S^{17} carries a plug s^2 , which is made of metal, but is insulated, as shown in the drawings, from the rod S^{17} . This plug is adapted to cut off any electrical contact with the projections of the cam-wheel S^{13} . The extreme lower
 90 end of the rod S^{17} also makes a contact, as 23, with one pole of generator C^2 . As the rod S^{17} oscillates contact 22 is broken just before 23 is made, oscillation being compelled, as already stated, by the projections on the cam-
 95 wheel S^{13} . When contact 23 is made, it sends the current of the ringing-generator to the pivot s^{16} , which is connected with the strand h^3 , which connects the tip h of the connecting-plug H^1 , and therefore when the raised
 100 portions of the cam S^{13} are brought far enough to the left by the pull of the magnet N^5 to engage with the projections s^2 on the swinging arm S^{17} during the revolution of the gear-wheel S^7 contact is made five times at 23 and
 105 broken as many times at 22; but during the intervals when the intermediate portions of the cam between the raised projections $s s$ are passing the piece s^2 contact at 22 is remade and broken at 23. During the time contact is
 110 made at 23 the current from the generator C^2 is sent out over the line through the tip-strand of the cord and the tip of the plug H^1 , which at that time is inserted in the jack of that line. Should the current in the coil of the electro-
 115 magnet N^5 be cut off during the partial revolution of the wheel S^7 , the armature S^4 will be released and the gear S^7 , by reason of the weight W , will be freed from wheel S^1 and will revolve backwardly until the stop S^{10} comes into
 120 contact with the rubber cushion S^{11} . Should the wheels remain in mesh until the stop S^{10} had turned around to the position shown by the dotted lines at S^{15} , it will be in electrical contact with the rod S^{12} and will serve to complete a circuit therefrom to ground through the wheel
 125 S^8 , axis or shaft S^6 , fork S^3 , and wire S^{10} , which will cause the supervisory relay N^2 to operate and in turn permit the system of relays to open the circuit supplying current
 130

to magnet N⁵, thus releasing the gear S⁷ and permitting it to revolve back to its normal position, as before. Should the calling subscriber remove his receiver from its hook during the time the generator is in the line, at which time the swinging arm S¹⁷ is lifted by one of the raised portions of the cam S¹³, the relay N² will remain inactive until a lower portion of the cam is reached by the lever, when it will immediately come into action by the making of the contact at 22 and the closed circuit at the instrument, whereupon the mechanism will be restored, as before.

By means of the five projections *s s* on the cam-wheel S¹³ five periodic rings will be made; but it is obvious that four, six, or any other number desired may be made or that they may be varied, as a series of very short rings, then a silence, then a repetition of the series of short rings. Should a receiver be taken off its hook while the depressed portion of the cam is opposite the piece *s*², the mechanism will be restored at once. Such a ringing device I term a "periodic" calling device, as distinguished from one adapted to ring the subscriber's bell continuously or one to ring it continuously for a certain length of time. It possesses many advantages over these latter. The continuous ringer is exceedingly annoying, while the single ringer often fails to give sufficient notice; but the periodic ringer with a time-limit apparatus answers all requirements. Commutators on the generator-shaft have been employed for breaking the call up into short rings; but these are objectionable in that a few seconds of time are liable to be lost before the subscriber's bell rings after the calling-plug is inserted in case the open-circuit part of the commutator is connected with the circuit at that time. With the rapidity of work now required in an exchange time even to the fraction of a second is precious and cannot afford to be lost. My invention prevents such loss of time and permits the use of a periodic ringer by connecting the generator with the line and operating the bell immediately upon the insertion of the plug. This feature I consider of value and importance and intend to broadly claim the same.

The supervisory relays shown in Fig. 4 are not by themselves claimed in this application, but are shown and described and generically and specifically claimed in my divisional application, Serial No. 95,155, filed February 24, 1902, before referred to, which is being withheld for the purpose of interference. In this application I intend to claim the other features of the invention.

No general description of the mode of operation as a whole is needed. It is obvious that many details can be altered without departing from my invention or varying its principle. Hence I do not wish to confine myself to exact details as shown.

What I claim is—

1. The combination with a pair of telephone-lines and means at the central office for uniting them, of a source of ringing-current and a ringing device for applying the same to the called line, an automatic time-limit apparatus to interrupt the circuit of said source of ringing-current after a predetermined time; and means controlled through the agency of a switch at one of the substations of the united lines for disconnecting the source of ringing-current, substantially as described.

2. The combination with a pair of telephone-lines and means at the central office for uniting them, of a source of ringing-current and an automatic ringing device for applying the same to the called line, an automatic time-limit apparatus to interrupt the circuit of said source of ringing-current after a predetermined time, and means controlled through the agency of a switch at one of the substations of the united lines for disconnecting the source of ringing-current, substantially as described.

3. In a telephone system, the combination with telephone-lines, of operators' connective means at the central office to connect said lines for conversation, a source of ringing-current, an automatic ringing device to connect the said generator to the called line, an automatic time-limit apparatus to disconnect said ringing-generator after a predetermined time, and means for automatically disconnecting said source when the called subscriber answers, substantially as described.

4. In a telephone system, the combination with subscribers' line-circuits, of a central office at which said lines terminate, operators' connective means at the central office to connect said circuits in pairs for conversational purposes, a calling device introduced into one of said circuits by the act of connecting said means thereto, an automatic time-limit apparatus for cutting off said device after a predetermined time, and an automatic cut-off device operative during said predetermined time by the response of the called subscriber to cut off said calling device, substantially as described.

5. The combination with a pair of telephone-lines, of a cord-circuit for uniting them, a source of ringing-current and an automatic device adapted to connect said source with the called line, a relay associated with said cord-circuit and adapted to respond to current flowing from a portion of the talking-circuit thereof, said relay when energized being adapted to disconnect said source of ringing-current from the called line, and an automatic time-limit apparatus for interrupting the flow of ringing-current after a predetermined time, substantially as described.

6. In a telephone system, a telephone-line, operators' connective means, a calling-generator adapted to be connected with the line when a connection is established therewith, a

relay for disconnecting said generator adapted to be operated over the telephone-line when the called subscriber responds and a time-limit apparatus adapted to close another circuit through said relay after a predetermined time to disconnect said generator.

7. In a telephone system, a telephone-line, operators' connective means, a calling-generator adapted to be connected with the line by the act of connecting said means therewith, a relay for disconnecting said generator adapted to be operated over the telephone-line when the called subscriber responds and a time-limit apparatus adapted to close another circuit through said relay after a predetermined time to disconnect said generator, substantially as described.

8. The combination with a pair of telephone-lines and means at the central office for uniting them, of a source of ringing-current and a ringing device for applying the same to the called line, means controlled through the agency of a switch at the called station for disconnecting the source of ringing-current, an automatic time-limit apparatus to interrupt the flow of ringing-current to said line after a predetermined time, and a supervisory signal associated with the called line to indicate the condition of said line, substantially as described.

9. The combination with a pair of telephone-lines and means at the central office for uniting them, of a source of ringing-current and an automatic ringing device for applying the same to the called line, means controlled through the agency of a switch at the called station for disconnecting the source of ringing-current, an automatic time-limit apparatus to interrupt the flow of ringing-current to said line after a predetermined time, and a supervisory signal associated with the called line to indicate the condition of said line, substantially as described.

10. The combination with a pair of telephone-lines, and a cord-circuit at the central office for uniting them, of a central source of current associated with the cord-circuit, a supervisory relay associated with the calling end of the cord-circuit and a signal controlled thereby, said relay being adapted to respond to current in the cord-circuit, a source of ringing-current and an automatic device for connecting the same with the called line, a switch at the called substation to permit the flow of current in the line to actuate said relay to disconnect said source of ringing-current, and a time-limit apparatus to interrupt the flow of the ringing-current after a predetermined time, substantially as described.

11. The combination with a pair of telephone-lines, of an operator's cord-connector at the central office to unite said lines for conversational purposes, a central source of current associated with said cord-circuit and lines and adapted to send current over the lines for talk-

ing purposes, supervisory relays and signals associated with the answering and calling ends of said cord-circuit, the said relays being adapted to respond respectively to current in the corresponding ends of the cord-circuit, a source of ringing-current and an automatic device for connecting the same with the called line upon the connection of the cord-circuit therewith, an automatic time-limit apparatus at the central office to interrupt the flow of current from said source of ringing-current after a predetermined time, and means controlled by the supervisory relay associated with the called line and the switch at the called substation for disconnecting said ringing source during said predetermined time, substantially as described.

12. The combination with a pair of telephone-lines, of an operator's cord-connector at the central office to unite said lines for conversational purposes, a central source of current associated with said cord-circuit and lines and adapted to send current over the lines for talking purposes, supervisory relays and signals associated with the answering and calling ends of said cord-circuit, the said relays being adapted to respond respectively to current in the corresponding ends of the cord-circuit, a source of ringing-current and an automatic device for connecting the same with the called line, upon the connection of the cord-circuit therewith, an automatic time-limit apparatus at the central office to interrupt the flow of current from said source of ringing-current after a predetermined time, and means controlled by one of the said supervisory relays together with the switch at the corresponding substation for disconnecting said ringing source, substantially as described.

13. The combination with a telephone-line, of an operator's plug, a ringing-generator adapted to be connected with the line when the plug is connected therewith, means for automatically disconnecting said generator within a predetermined time, and further means for again connecting it with the line without the withdrawal of the plug, substantially as described.

14. The combination with a telephone-line, of an operator's plug, a ringing-generator adapted to be connected with the line by the act of connecting the plug therewith, means for automatically disconnecting said generator within a predetermined time, and further means for again connecting it with the line without the withdrawal of the plug, substantially as described.

15. In a telephone system, the combination with subscribers' lines, of a central office at which such lines terminate, operators' connective means at the central office to connect said lines in pairs for conversational purposes, an operator's telephone introduced into said connective means by the act of connecting said means to a line, a calling device, and

means to cut off said operator's telephone and introduce the said device into the other line of the pair by the act of connecting said connective means therewith, substantially as described.

16. In a telephone system, the combination with subscribers' lines, of a central office at which said lines terminate, operators' connective means at the central office to connect said lines in pairs for conversational purposes, an operator's telephone and a calling device, means to introduce said telephone into said connective means and thereby into one of the lines of a pair by the act of connecting said connective means thereto and for cutting off said telephone and introducing the calling device into the other of said lines by the act of connecting said means therewith, and means for cutting off said calling device after a predetermined time, substantially as described.

17. In a telephone system, the combination with subscribers' lines, of a central office at which said lines terminate, operators' connective means at the central office to connect said lines in pairs for conversational purposes, an operator's telephone and a calling device, means to introduce said telephone into one of the lines of a pair by the act of connecting said connective means thereto and for cutting off said telephone and introducing the calling device into the other of said lines by the act of connecting said means therewith, an automatic time-limit apparatus for cutting off said device after a predetermined time, and an automatic cut-off device operative during said predetermined time by the response of the subscriber to cut off said calling device and time-limit apparatus, substantially as described.

18. In a telephone system, the combination with subscribers' line-circuits, of a central office at which said lines terminate, an operator's cord-circuit at the central office having an answering and a connecting plug, an operator's telephone, means to automatically connect said telephone with the cord-circuit upon the insertion of the answering-plug into a calling-subscriber's line, a calling device, automatic means to disconnect said telephone from and connect said calling device to, the cord-circuit upon the insertion of the connecting-plug into a called-subscriber's line, means to cut off said device after a predetermined time, and further means to automatically cut off said calling device upon the response of the subscriber.

19. In a telephone system, the combination with line-circuits, of a central office, operators' connective means at the central office to connect said circuits in pairs for conversational purposes, and a periodic calling device introduced into one of said circuits by the act of connecting said means thereto, and adapted to immediately and invariably send ringing-

current over said line, substantially as described.

20. In a telephone system, the combination with subscribers' lines, of a central office at which said lines terminate, an operator's cord-circuit at the central office to variously connect said lines in pairs for conversational purposes and having a calling-plug, a periodic calling device introduced into said cord-circuit by the insertion of the calling-plug into the subscriber's line, said device being adapted to immediately and invariably send ringing-current over said line, and means to automatically disconnect said device from the cord-circuit upon the response of the called subscriber, substantially as described.

21. In a telephonic system, the combination with line-circuits, of a central office at which said circuits terminate, operators' connective means at the central office to interconnect the line-circuits in pairs for conversational purposes, a periodic calling device introduced into one of said circuits by the act of connecting said means therewith, said device being adapted to immediately and invariably send ringing-current over said line, and an automatic time-limit apparatus for cutting off said calling device after a predetermined time, substantially as described.

22. In a telephone system, the combination with subscribers' lines, of a central office at which said lines terminate, operators' connective means at the central office to interconnect said lines for conversational purposes, a periodic calling device introduced into one of said lines by the act of connecting said means therewith and adapted to immediately and invariably send ringing-current over said line, and means to automatically disconnect said device when the subscriber responds, substantially as described.

23. In a telephone system, the combination with subscribers' line-circuits, of a central office at which said lines terminate, operators' connective means at the central office to connect said circuits in pairs for conversational purposes, a periodic calling device introduced into one of said circuits by the act of connecting said means thereto and adapted to immediately and invariably send ringing-current thereover, an automatic time-limit apparatus for cutting off said device after a predetermined time, and an automatic cut-off device operative during said predetermined time by the response of the called subscriber to cut off said calling device, substantially as described.

24. In a telephone system, the combination with subscribers' lines, of a central office at which such lines terminate, operators' connective means at the central office to connect said lines in pairs for conversational purposes, an operator's telephone introduced into one of the lines by the act of connecting said means thereto, a periodic calling device, and means

to cut off said operator's telephone and introduce the said device into the other line of the pair by the act of connecting said connective means therewith, said device being adapted to immediately and invariably send ringing-current over said line, substantially as described.

25. In a telephone system, the combination with subscribers' lines, of a central office at which said lines terminate, operators' connective means at the central office to connect said lines in pairs for conversational purposes, an operator's telephone and a periodic calling device, means to introduce said telephone into one of the lines of a pair by the act of connecting said connective means thereto and for cutting off said telephone and introducing the calling device into the other of said lines by the act of connecting said means therewith, said device being adapted to immediately and invariably send ringing-current over said line, and means for cutting off said calling device after a predetermined time, substantially as described.

26. In a telephone system, the combination with subscribers' lines, of a central office at which said lines terminate, operators' connective means at the central office to connect said lines in pairs for conversational purposes, an operator's telephone and a periodic calling device, means to introduce said telephone into one of the lines of a pair by the act of connecting said connective means thereto and for cutting off said telephone and introducing the calling device into the other of said lines by the act of connecting said means therewith, said device being adapted to immediately and invariably send ringing-current over said line, and means to automatically disconnect said calling device by the response of the subscriber, substantially as described.

27. In a telephone system, the combination with subscribers' lines, of a central office at which said lines terminate, operators' connective means at the central office to connect said lines in pairs for conversational purposes, an operator's telephone and a periodic calling device, means to introduce said telephone into one of the lines of a pair by the act of connecting said connective means thereto and for cutting off said telephone and introducing the calling device into the other of said lines by the act of connecting said means therewith, said device being adapted to immediately and invariably send ringing-current over said line, an automatic time-limit apparatus for cutting off said device after a predetermined time, and an automatic cut-off device operative during said predetermined time by the response of the subscriber to cut off said calling device and time-limit apparatus, substantially as described.

28. In a telephone system, the combination with line-circuits, of a central office at which said circuits terminate, operators' connective

means at the central office to interconnect the line-circuits in pairs for conversational purposes, a periodic calling device introduced into one of said circuits by the act of connecting said means therewith, an automatic time-limit apparatus for cutting off said calling device after a predetermined time, and a supervisory signal at the central office to indicate the response of the called subscriber, substantially as described.

29. In a telephone system, the combination with line-circuits, of a central office at which said circuits terminate, operators' connective means at the central office to interconnect the line-circuits in pairs for conversational purposes, a periodic calling device introduced into one of said circuits by the act of connecting said means therewith, said device being adapted to immediately and invariably send ringing-current over said line, means to automatically disconnect said device when the subscriber responds, and a supervisory signal associated with the operators' means to indicate the condition of the telephone at the called substation, substantially as described.

30. In a telephone system, the combination with line-circuits, of a central office at which said circuits terminate, operators' connective means at the central office to interconnect the line-circuits in pairs for conversational purposes, a periodic calling device introduced into one of said circuits by the act of connecting said means therewith, an automatic time-limit apparatus for cutting off said calling device after a predetermined time, means operative during such predetermined time to automatically disconnect said device upon the subscriber's response, and a supervisory signal associated with the said operators' means to indicate the condition of the telephone at the substation, substantially as described.

31. In a telephone system, the combination with a plurality of telephone-lines, of a cord-circuit at the central office to connect the lines together for conversation, a relay associated with each end of the cord-circuit and independently actuated, one of said relays serving to connect the operator's telephone with the cord-circuit when connection is established with the calling subscriber, and the other to disconnect the said telephone when connection is established with the called subscriber, substantially as described.

32. In a telephone system, the combination with a plurality of telephone-lines, of a cord-circuit at the central office to connect the lines together for conversation, supervisory relays associated with the cord-circuit and controlling supervisory signals, and an operator's telephone having its connection with the said cord-circuit controlled by said relays, substantially as described.

33. In a telephone system, the combination with telephone-lines, of a cord-circuit to es-

5 establish connections for conversation with said lines, an operator's telephone associated with the cord-circuit, a supervisory-signal-controlling electromagnet associated with the cord-circuit, means to connect said telephone with the cord-circuit to enable the operator to converse with a calling subscriber, and means controlled by said electromagnet to automatically disconnect said telephone from the cord-circuit during connection with a called subscriber's line, substantially as described.

10 34. In a telephone system, the combination with telephone-lines, of a cord-circuit to establish connections with said lines for conversation, an operator's telephone associated with the cord-circuit, a supervisory-signal-controlling electromagnet also associated with said cord-circuit, and means controlled by said electromagnet for automatically connecting said telephone with the cord-circuit when connection is established thereby with a telephone-line, substantially as described.

15 35. In a telephone system, the combination with telephone-lines, of a cord-circuit to establish connections with said lines for conversation, a supervisory-signal-controlling electromagnet associated with each end of the cord-circuit and adapted to be independently operated by current in connection with the respective lines with which the cord-circuit

may be connected, an operator's telephone associated with the cord-circuit, and having its connection therewith established by the electromagnet associated with the answering end thereof and its disconnection therefrom accomplished by the electromagnet associated with the calling end, substantially as described.

20 36. In a telephone system, the combination with telephone-lines, of a cord-circuit to establish connections therewith for conversation, a supervisory relay associated with each end of the cord-circuit actuated in connection with the line with which connection is established, an operator's telephone having its circuit completed through alternate contacts of the relay associated with the answering end of the cord-circuit and normal contacts of the relay associated with the calling end thereof, whereby the telephone is normally disconnected from the cord-circuit but when connection is established with the calling-line it is connected therewith and again disconnected during conversation, substantially as described.

25 Signed by me at Chicago, county of Cook, State of Illinois, this 5th day of May, 1902. 55

JOHN G. ROBERTS.

Witnesses:

ELLA EDLER,

ROBERT LEWIS AMES.