No. 832,443. PATENTED OCT. 2, 1906.

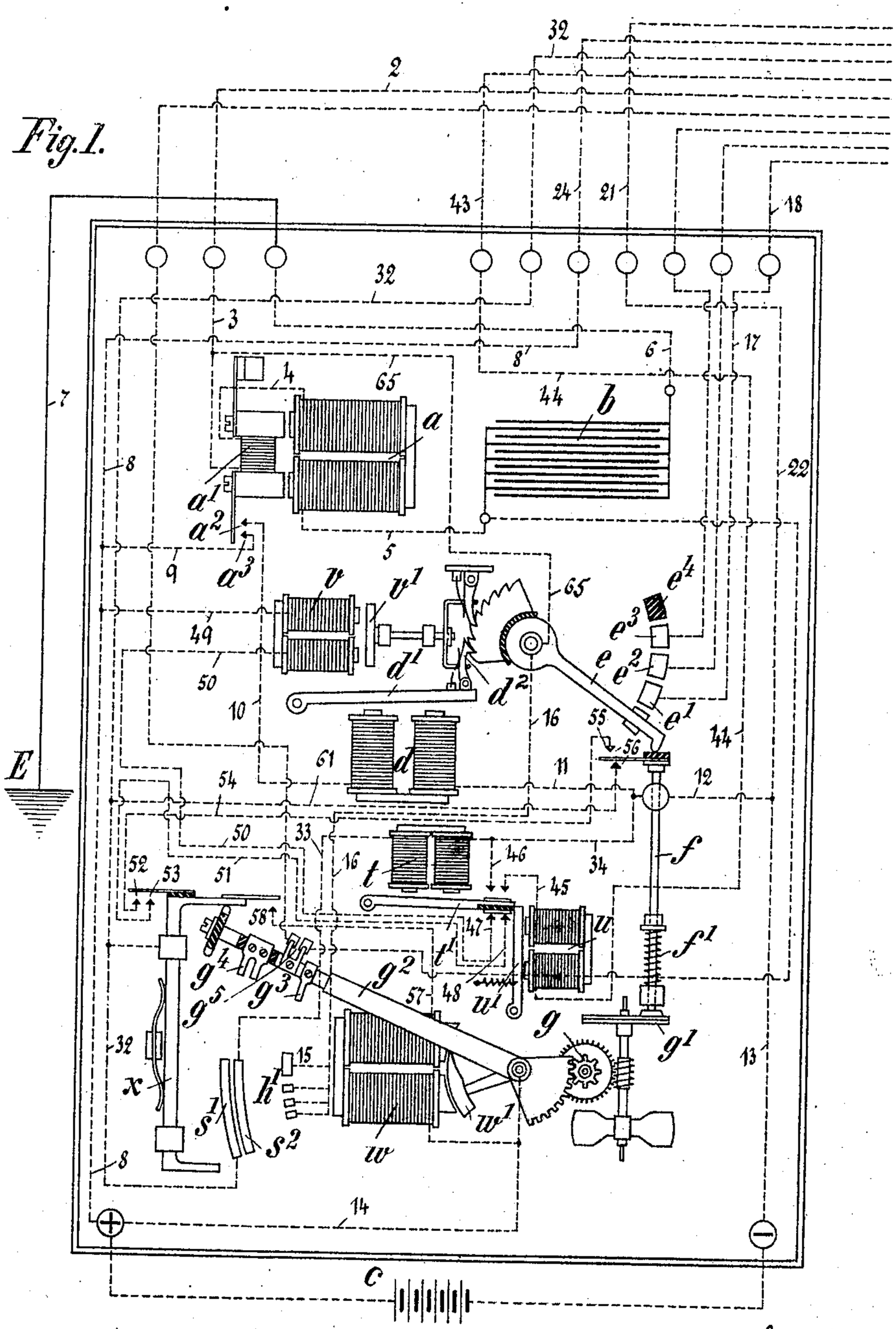
P. ARNHEIM.

TELEPHONE SYSTEM.

APPLICATION FILED JUNE 25, 1902.

2 SHEETS—SHEET 1.

Fig. 1.



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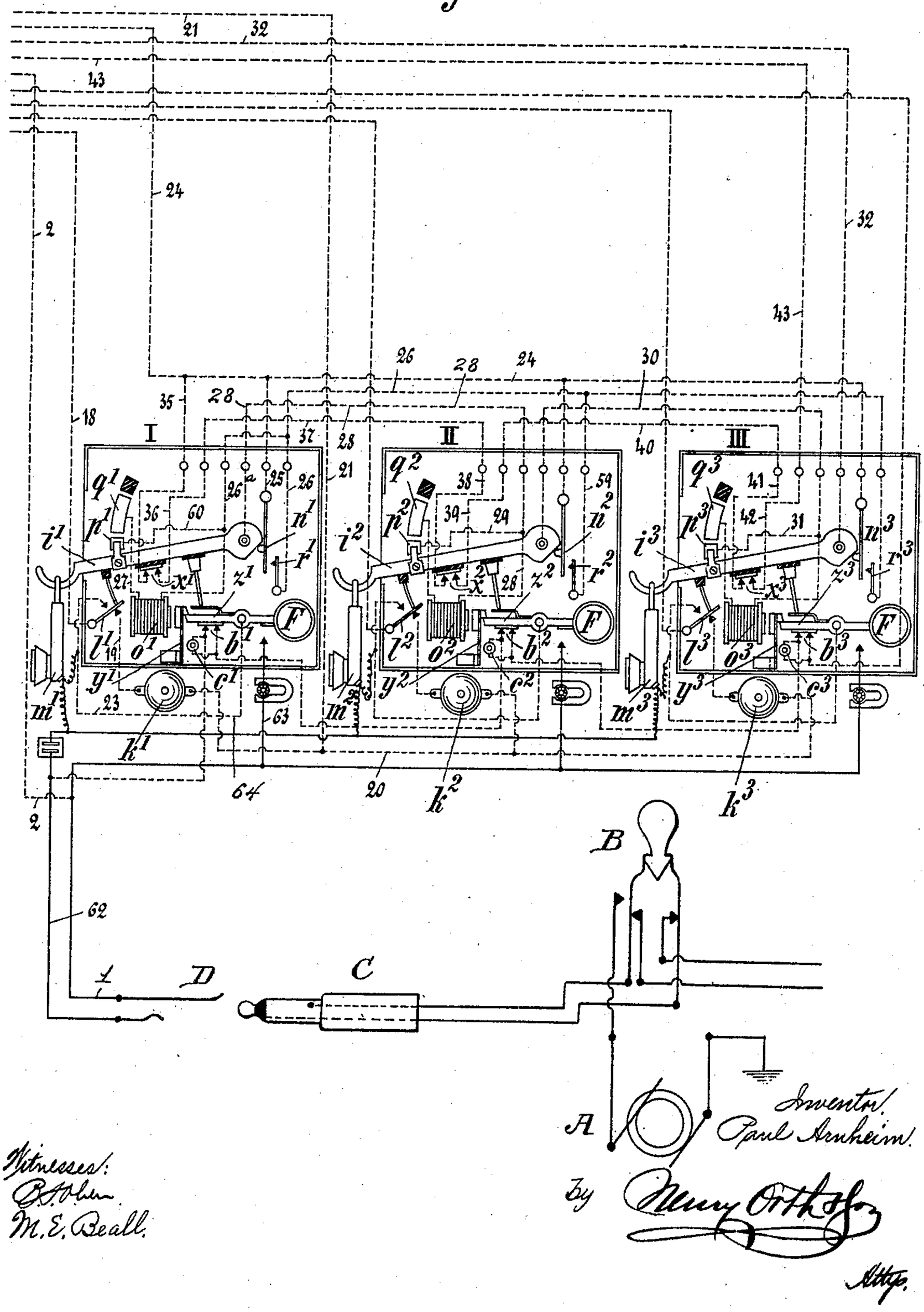
2 SHEETS—SHEET 2.

Fig. 2.



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TELEPHONE SYSTEM.

No. 832,443. Specification of Letters Patent. Patented Oct. 2, 1906.

Application filed June 25, 1902. Serial No. 113,143.

To all whom it may concern:

Be it known that I, PAUL ARNHEIM, a subject of the German Emperor, and a resident of Hamburg, in the German Empire, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

As is well known, commutator appliances have hitherto been constructed for several telephone stations or substations connected to a common lead or line wire, the arrangement being such that connection may be made between each substation and the central office or a branch of the same and also between two substations, the remaining substations being then cut out. The connection of the stations is effected by the aid of a third person at a special central office for the substations. The commutator apparatus which forms the subject of this invention also permits of effecting communication between every substation and the central office or a branch office of the same and between any two substations.

A construction form of the apparatus is illustrated in the accompanying drawings and its various functions are explained in the description which follows. This description also constitutes a clear explanation of the novelty and nature of the apparatus itself.

Figure 1 is a diagram showing the arrangement and construction of the commutator apparatus; and Fig. 2 is likewise a diagram showing three telephone-substations, their arrangement, and connection.

Similar symbols of reference refer to similar parts throughout the views.

1. Operation upon the calling up of a substation by the office and disconnection upon termination of the conversation.—The novel commutator apparatus comprises an alternating-current relay $a\ a'$, through which the office sends a number of current impulses corresponding to the number of the substation in order to ring up such substation. At the central station there is a suitable source of alternating current A, a ringing-key B, answering-plug C electrically connected to a similar connecting-plug, (not shown,) and the jack D one for each party-line, all of the usual construction. If, for example, it is desired to call substation No. 1, the office sends by means of an alternating-current generator A, ringing-key B, plug and jack, said generator being connected to earth, one electric impulse only through the following circuit: 1, 2, 3, a', 4, a, 5, condenser b, 6, 7, earth E. By means of this current the wire-wound armature a' is attracted by the magnet a and the circuit of an electric battery c is thereby closed at $a^2\ a^3$, the current taking the following path: $+c$, 8, 9, $a^3\ a^2$, 10, d, 11, 12, 13, $-c$. The electromagnet d attracts its armature d' and once only if but one electric impulse is sent through it. By this means a switch-lever e is displaced by one tooth by the intermediary of the draw-hook d^2—that is to say, this lever is brought upon the contact-stud e'. At the same time a rod f is released by the switch-lever e and displaced by a spring f' in such a manner that it no longer holds a friction-disk g' of the clockwork g. This clockwork then commences to run and causes the contact g^3 of its lever g^2 to come into contact with a contact-piece h'. The following call-circuit is thus formed: $+c$, 14, $g^2\ g^3$, h', 15, 16, e, e', 17, 18, l', 19, k', 20, 21, 22, 13, $-c$. The call-bell k' rings and the substation I is able to reply in the usual manner by removing the receiver m' from the hook i', whereupon the contact-spring l' is removed from the wire 19 and presses against the wire 23. The call-bell k' is then cut out and conversation can take place with a distant station over the line-wire 1, 2, 65, e, e', 17, 18, l', 23, m', 62.

By the unhooking of the receiver not only is the conversation-circuit formed as just described, but also the following disposition, which is necessary in order to cause the apparatus to resume the position of repose upon the termination of the conversation. Upon the oscillation of the receiver-hook i' contact is made between $n'\ r'$ and the following circuit thereby closed: $+c$, 8, 24, 25, n', r', 26, 26^a, o', 27, q', i', 28, 29, p^2, i^2, 30, 31, p^3, i^3, 32, s', g^4, s^2, 33, t, 34, 12, 13 $-c$. Of the coils of the magnets o' and t which are traversed by the current only the coil t is excited, as this latter is wound with a thinner wire than the coil o'. The armature t' is attracted and maintained in place by the armature u' of the other magnet u. If upon the termination of the conversation the receiver is again suspended upon the hook i', the following cir-

cuit will be closed: $+c$, 8, 24, 35, x', 36, 37, 38, x^2, 39, 40, 41, x^3, 42, 43, 44, u, 45, 46, 34, 12, 13, $-c$. Owing to this, the electromagnet u attracts its armature u', the armature t' drops, contact between 45 and 46 is broken, whereby the electromagnet u is again cut out of circuit, while contact between 47 and 48 is closed, and the current thus sent through the following path: $+$ c, 8, 49, v, 50, 47, 48, 51, 53, 52, 54, 55, f, 12, 13, $-$ c. The two contacts 52 53 are closed by the falling of the rod x of the clockwork, and owing to the rising of the rod f it is in contact with 55. Owing to the formation of this circuit, the electromagnet v attracts its armature v', and thus releases the hook d^2 from engagement with the teeth of the switch-lever e, which then falls away from the contact-stud e'. The rod f leaves the contact 55 and presses against the contact 56. The following circuit then exists: $+$ c, 14, w, 57, 58, x, 32, 61, 56, f, 12, 13, $-$ c. The armature w' is attracted and the clockwork g rewound. By this means the rod x is raised, the contacts 52 and 53 and also 58 are again broken, and the electromagnet w again becomes dead. The clockwork g is not, however, able to run down so long as it is braked by the rod f.

2. Operation upon the calling up of a substation by the office and automatic disconnection when no answer is received.—The substation is called in the manner above described. Disconnection takes place, if no attention is paid to the call by the substation within, say, a minute and a half by the contacts 52 53 being closed by the running down of the clockwork, the contacts 47 48 remaining closed because the relay t has not been energized.

3. Operation upon the ringing up of substation by I the office, attempt to form connection by substation II before substation I has replied or while substation I is speaking.—Calling up is effected in the manner already described. In order that substation II may effect a connection, it is necessary that its magnet o^2 should be excited on the removal of its receiver m^2 from the hook i^2. This is not possible, however, as the switch-lever e in consequence of the calling up of station I has been brought upon the contact e' and the rod f displaced in such a manner that the negative pole of the battery c is cut out of the circuit by the interrupted contact 56. As soon as the call has been made the contacts s' g^4 a^2 are closed, and upon the removal of the receiver m^2 from the hook i^2 at substation II the current will take the following path: $+$ c, 8, 24, n^2, r^2, 59, 26, 60, p', i', 28, o^2, q^2, i^2, 30, 31, p^3, i^3, 32, s', g^4, s^2, 33, t, 34, 12, 13, $-$ c. As the electromagnets o^2 and t are arranged in series and the coils of the magnet t are wound with a thinner wire than the coils of the magnet o^2, only the magnet t is excited, and substation II cannot, therefore, communicate. The armature t' is attracted and maintained by the armature u'. As soon as the hook i^2 has again fallen the electromagnet u, as described under (1) is excited, the armature u' attracted, and the armature t' again released. If during the time in which substation II is attempting to communicate station I replies to the call which it has received before the hook i^2 has been depressed at substation II, the armature t' remains supported, because the magnet u cannot be excited, as the circuit is open at the contact x^2.

4. Operation upon the ringing up of the office by substation I and attempt to communicate by another station.—By the rising of the hook i' at substation I the following circuit is formed: $+c$, 8, 24, 25, n', r', 26, 26^a, o' q', i', 28, 29, p^2, i^2, 30, 31, p^3, i^3, 32, 61, 56, f, 12, 13, $-c$. The electromagnet o' is excited, whereby the armature y' is attracted and the drop-lever z' released, the fall of the indicator-disk F showing at the substation that the line is free. The substation is then connected through 1, 63, z', 23, m', 62 with the office. None of the other substations of the office-line wire 1–62 can now communicate, as the currents which are necessary in order to excite the magnets o^2 o^3 are interrupted, owing to the lifting of the hook i'.

5. Operation upon intercommunication between substations.—When substation I desires to communicate with substation II, said station I first of all places itself, in the manner above described, in communication with the office to which it expresses this desire. The office inserts one plug of the ringing-up system in the local latch of the corresponding line-wire (the usual testing being omitted) and sends two current pulsations into the wire by means of the call-push, thus setting lever e on contact e^2, as described. During this time the substation I will have pressed its push c' in order to make contact, as the relay a' a' is interrupted at b'. The hook i' is now raised and magnet o' has been energized to release the indicator F. The talking-circuit is then as follows: line 1, 63, z', 23, m', 62, for station I, and that for station II is line 1, 2, 3, 65, e, e^2, l^2, m^2, 62.

6. General.—In order to prevent the relay a a' from being again excited when once conversation has been commenced, the path for the current through the same is broken at the contact g^5 when the call originates with the office, and when the call originates with a substation at the contact b' b^2 b^3 of this latter.

It is of especial importance that, owing to the arrangement of the novel alternating-current relay a a' it is possible to use alternating currents for producing one or more current pulsations in the magnet d, which in combination with the clockwork g closes the call-circuit of one or other of the substations

according to the number of the current pulsations, because telephone-offices are usually arranged for working with alternating currents. The relay consists of an electromagnet *a* and an armature *a'*, which is wound with wire as well as the magnet. Alternating currents are sent through the windings of the magnet and of the armature in such a manner that the poles are constantly alternating in the armature also. The arrangement is such that the negative or positive pole of the magnet for the time being is opposite the positive or negative pole, respectively, of the armature. By the use of an armature having magnet-coils a more steady attraction is obtained than when a plain armature without coils is used, because the coils are so arranged that always unlike poles are opposite one another and a stronger attraction is effected. When the coils are connected in parallel, a displacement of phase takes place, due to the different self-induction of the stationary electromagnet-coil *a* and the movable electromagnet-coil *a'*. A further special feature of this installation consists in that the re-switching circuit for bringing the apparatus into the position of rest contains two electromagnets *t u* and two armatures *t' u'*, which alternately rest or bear against their magnets and release each other, respectively, in order to close and open the circuits necessary for the reswitching.

Finally, it may be stated that the present telephone system requires a battery of only weak elements, because the excitements of the electromagnets which follow one another directly are interrupted again immediately after their beginning.

Having thus fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination with a party-line, a source of current for the party-line and subscribers' stations connected to the line; of a central station, a switch to connect the subscriber called to line, means to send current to set the switch to connect the subscriber called and send current through the subscriber's signal, and means to simultaneously and automatically cut out all the calling-circuits of the other substations on the line, during the signaling by the central station.

2. The combination with a party-line, a local source of current for the entire party-line and subscribers' stations connected to the line; of a central station, means to send current from a source at the central office, an electrically-operated device to connect the subscriber called and send current through the subscriber's signal, means at each station to send a signal-current to the central station and means at each subscriber's station to close the talking-circuit to the line and simultaneously break the calling-circuit of all the other party-stations on the party-line, substantially as described.

3. The combination with a party-line and subscribers' stations, of a signaling-circuit normally open, electromagnetic mechanism to close the circuit, means to send a signal-current through the party-line to the central station, a magnetically-operated switch, means at the central station to send current through the subscriber's station to operate said switch, a local signal-circuit closed by said switch through the station called and means at the called station to break said local signal-circuit, substantially as described.

4. The combination with a party-line and subscribers' stations, of a signaling-circuit normally open, electromagnetic mechanism to close the circuit, means to send a signal-current to line, an automatic electrically-operated switch controlled by the current from the central station, a local circuit connected to the party-line by said switch to send a signal-current to the subscriber's station called and means controlled by the hook at the subscriber's station to close a branch local circuit to disconnect said switch, substantially as described.

5. The combination with a line and subscribers' stations; of a grounded magnet and its armature, a magnetically-operated switch to connect a station to line and included in a local circuit closed by said armature and clock-operated mechanism released by said switch to close a local circuit through the switch and signal at the station, substantially as described.

6. The combination with a line and subscribers' stations; of a grounded magnet and its armature, a magnetically-operated switch to connect a station to line and included in a local circuit closed by said armature, a magnetically-wound clock-operated mechanism released by said switch and included in a branch local circuit and means at the station to send a current through the branch local circuit to rewind the clock mechanism, substantially as described.

7. The combination with a line and subscribers' stations; of a grounded magnet and its armature both wound and connected in series, a magnetically-operated switch to connect a station to line and included in a local circuit closed by said armature, a magnetically-operated switch-releasing device included in a branch local circuit, a magnetically-wound clock-operated mechanism included in a second branch circuit to close a local circuit through said switch and signal at the called station, a hook at the station and means included in a circuit closed by said hook to send current through the branch local circuit to release the switch and close the clock-winding circuit to rewind the clock, substantially as described.

8. The combination with a line and subscribers' stations; of a grounded magnet and its armature, a magnetically-operated switch to connect a station to line and included in a local circuit closed by said armature, a magnetically-operated switch-releasing device included in a branch local circuit, a magnetically-wound clock-operated mechanism included in a second branch circuit, a contact-arm actuated by the clock mechanism, a sliding contact operated by said arm, a magnetically-operated circuit-closer, said arm closing a signal-circuit to the station, a hook at the station to close a circuit to actuate the circuit-closer, thereby closing the local circuit through switch-releasing device, said switch closing the winding-circuit to move the arm against the sliding contact and bring all parts back to normal position, substantially as and for the purposes set forth.

9. The combination with a line and subscribers' stations connected thereto; of a hook at each station to close a local circuit through the remaining stations and a magnet at the calling-station, a contact released by said magnet to connect the talking-circuit to line and cut out the remaining stations, a switch-lever, and operating mechanism positioned from the line to connect the called station to line and send a local signal-current to the called station, and a circuit closed by the calling-station to return the switch-lever and operating mechanism to normal position, substantially as described.

10. The combination with a party-line and subscribers' stations connected thereto, of a signaling-circuit at each station normally open, a local circuit for all of the stations on the line, electromagnetic mechanism to close the circuit, a hook at each station to close the local circuit through the electromagnetic mechanism and thereby close the signaling-circuit to line, an electromagnetically-operated switch controlled by current from the line to connect the talking-circuits of the respective stations to line and a branch local circuit closed by the hook to return said switch to normal position, substantially as described.

11. The combination with a party-line and subscribers' stations, a grounded electromagnet and its wound armature, a local circuit closed by the armature, an electromagnetically-operated switch in said local circuit to connect a subscriber's station to line, a magnetically-wound clock mechanism, a contact-arm g^2 operated by the clock mechanism, a brake for the clock mechanism released by said switch, a branch local circuit closed by the arm g^2 through the subscriber's signal, a second branch local circuit closed by the hook at the subscriber's station through all of the stations on the party-line, a magnet in said circuit, its armature and a third branch circuit closed thereby, a spring-retracted armature to lock the last-mentioned one to close the circuit, a third branch circuit closed by the hook, an electromagnet in said circuit to move the spring-retracted armature to open the third circuit and close a fourth circuit, an electrically-operated switch-releasing mechanism in the fourth circuit, thereby releasing the switch to move the brake, a clock-winding circuit closed by the brake, said clock-winding circuit broken by the arm g^2 when the clock is wound, substantially as described.

12. The combination with a party-line, a source of current for the party-line, and subscribers' stations connected to the line; of a central station and a source of signaling-current thereat, means common to all the substations on the party-line to automatically prevent other substations on the line to signal the central station, and means at each substation to cut out the calling-circuits of all the other substations on the line when a substation is signaling the central station, substantially as described.

13. The combination with a party-line, a source of current for the party-line, and subscribers' stations connected to the line; of a central station, a source of signaling-current thereat, means common to all the substations on the party-line to automatically prevent other substations on the line to signal the central station, means at each subscriber's station to cut out the calling-circuits of all the other substations on the line when a substation is signaling the central station, and means at each substation to temporarily permit signal-current to be sent from the central station to the other substations on the line, substantially as described.

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