(No Model.) 2 Sheets—Sheet 1.

G. A. CARDWELL.

AUTOMATIC TELEPHONE EXCHANGE.

No. 281,613. Patented July 17, 1883.

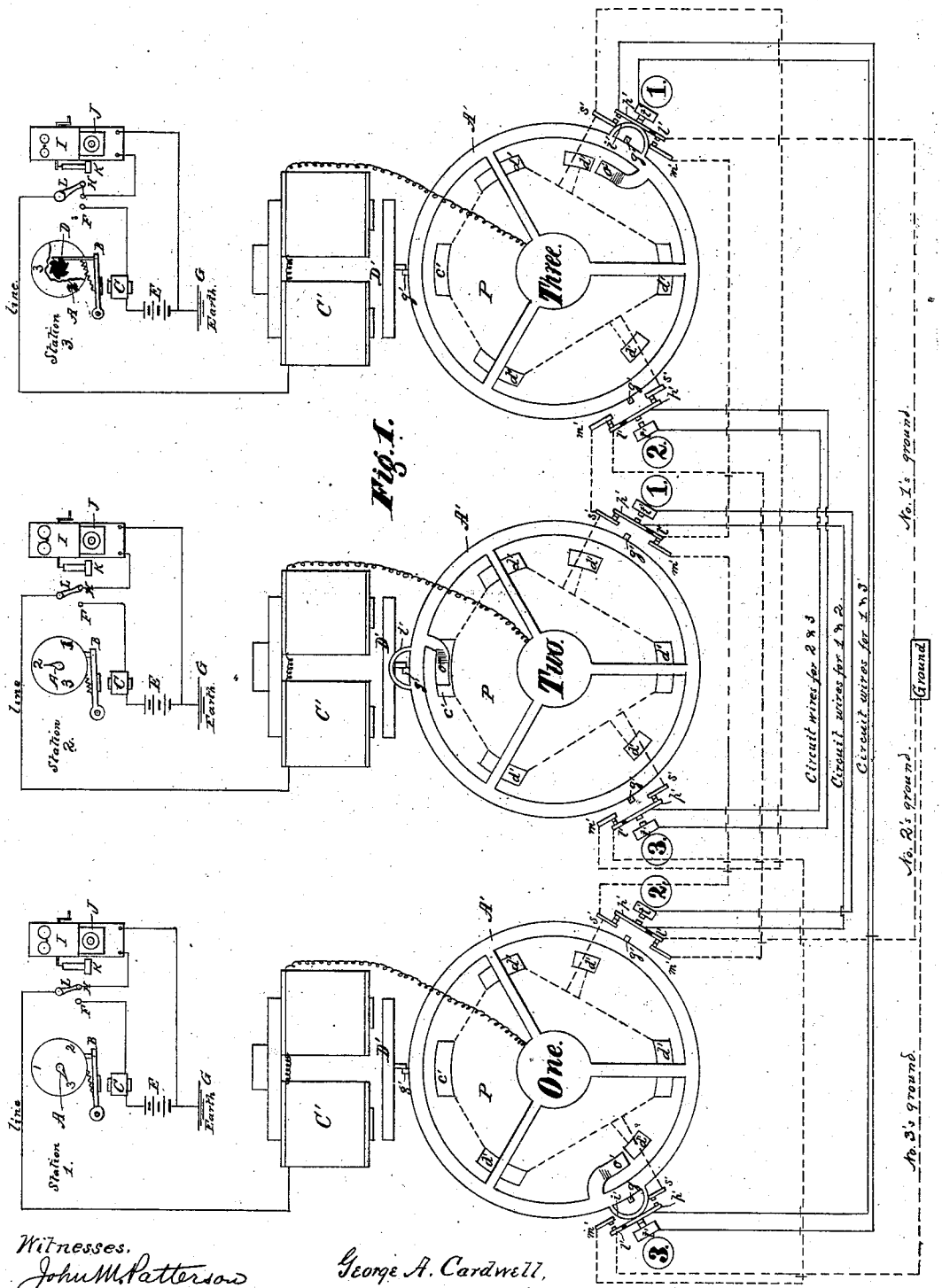

Fig. 1.

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Fig. 2.

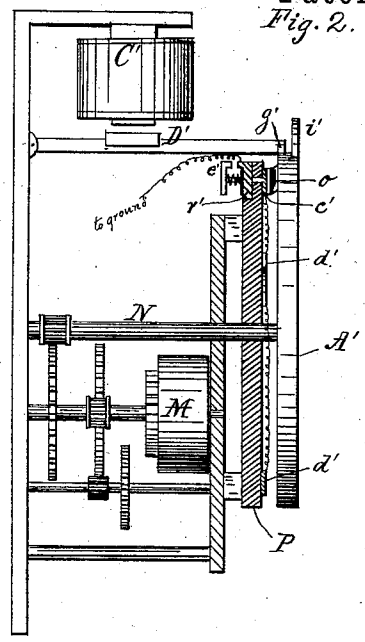
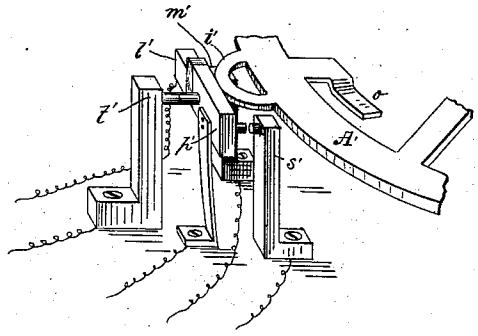


Fig. 3.



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UNITED STATES PATENT OFFICE.

GEORGE A. CARDWELL, OF BROOKLYN, NEW YORK, ASSIGNOR TO W. G. BUTTON, OF SAME PLACE.

AUTOMATIC TELEPHONE-EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 281,613, dated July 17, 1883.

Application filed July 7, 1882. Renewed June 25, 1883. (No model.)

To all whom it may concern:

Be it known that I, GEORGE A. CARDWELL, of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Automatic Telephone-Exchanges; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification, in which—

Figure 1 illustrates my system as applied to three subscribers and central-office apparatus suitable therefor. Fig. 2 is a partly-sectional side elevation of one of the individually-controlled motors at central office. Fig. 3 is a detached perspective illustrating the relative positions of the circuiting-wheel and a group of "coupling-switches."

The object of this invention is to provide a system of circuits and apparatus in a system of individual telephone-lines whereby the several subscribers themselves may, through the intervention of a central office, at will connect their respective lines with the lines of others, and communicate with such other subscribers without the assistance of operators at the central office, and so that such communicating-lines may be private and confined to two subscribers, or subject to connection by others, as desired at the time.

The installation of my invention requires a line from each subscriber to the central office or exchange, an earth or metallic return, means at the central office under the control individually of the subscribers for effecting the various combinations of lines, and devices at the subscribers' stations for bringing about the required operations.

The invention consists in the combination and arrangement of the various electrical and mechanical devices hereinafter fully described and claimed.

In entering upon the description of my invention I will suppose that a main or central office is already chosen, having individual lines radiating therefrom to the various subscribers; and for the sake of lucidity I will narrow the number of subscribers down to three, numbered accordingly.

Each subscriber has at his station a telephonic apparatus, comprising a transmitter, receiver, and magneto "call." In addition I provide him with an indicator whose face is a dial having numbers upon it corresponding to the various subscribers to the system, and an index-hand, which normally points to the number denoting the subscriber to whose station it belongs. This hand A is rotated by a spring-pawl, B, actuated by an electro-magnet, C; or it may be operated by a "deadbeat-escapement" similarly. Every time current is admitted to the magnet C pawl B draws the ratchet-wheel D around one space, and with it the hand A, two such spaces corresponding to one of the three lines, so that in the present instance the ratchet D has six teeth, as shown. A battery, E, is inserted in the circuit between the earth G and a two-point switch, F H. Point F is the terminal of the battery beyond the magnet C, and point H is the end of the local telephone-circuit, including the call I, transmitter J, and receiver K, the other side of such circuit going to ground G, as indicated. The switch-lever L is the terminal of the line leading to the central office, which is there normally grounded.

At the central office each subscriber has a separate device under his sole control as to its movements, but, as will be seen, in some degree subject to a change of conditions by the other subscribers. This central-office device consists, broadly, of a mechanical or secondary motor capable of rotating a wheel or hand, which constitutes a part of the subscriber's line, and effecting contact in turn with the lines of the other subscribers. For such motor I prefer a simple clock-work or train of wheels actuated by a spring; or, more particularly M, Fig. 2, is the motor, which, however, I do not limit to clock-work, as it may be substituted by any other which will fulfill the requirements. Upon the shaft N of the motor, but insulated therefrom, I mount the contact-wheel A′, upon whose periphery are a number of detents, *g′*. Above the motor M, I place an electro-magnet, C′, and under this a swinging armature, D′, which normally projects in the path of the detents *g′;* but when current energizes magnet C′ the armature D′ is drawn up, releasing the detent, and leaving the motor M

free to at once set the wheel A′ in rotation, which will continue until the armature D′ falls in front of a detent, *g*, and stops the rotation. Between the wheel A′ and motor M, I fix a stationary disk or ring of insulating material, P, and upon this I attach a plate, *c′*, which I call the "normal ground plate," and other plates, *d′*, all at a common distance from the center and electrically connected.

Upon the wheel A′ is an arm, *o*, which bears upon all the plates *c′ d′ d′* in succession when wheel A′ rotates. Each wheel A′ has at one point on its periphery a contact-arm, *i′*, which projects in a plane different from that of detents *g′*. In the present case there are three equidistant stopping-places around the circumference of wheel A′—one for each subscriber. At each of these a set of contacts are placed, as follows, so as to be operated by the contact-arm *i′* of the individual wheels A′: The contacts are set on an insulated base suitably arranged. A spring-plate, *p′*, projects in the path of arm *i*, so as to be pushed outward slightly when arm *i′* is passing it. Attached to spring *p′*, but insulated therefrom and in a plane not in the path of arm *i′*, is a contact, *l′*. A front contact, *s′*, is arranged in a fixed position, and a back contact, *t′*, likewise, so that normally the spring-plate *p′* rests against the contact *s′*, but when pushed out by arm *i′* it closes on contact *t′* and opens *s′*. A front fixed contact, *m′*, is placed also so that contact *l′* closes on it normally, but opens when *p′* moves outwardly. For the sake of brevity, I will call this group of contacts *l′ m′ p′ s′ t′* a "coupling-switch."

As stated, there is at the central office a motor M, circuiting-wheel A′, and magnet C′ for every subscriber, and around each of the wheels A′ are arranged, in the manner stated, as many coupling-switches as there are subscribers less one, the normal position of each wheel A′ not requiring any at that point. The circuiting-wheels belonging to the several subscribers are in the drawings marked with their respective numbers, "One," "Two," "Three," and the coupling-switches in figures corresponding, in order to simplify the description. At the central office the circuits are as follows, broken or dotted lines indicating grounding-circuits only:

Contacts *p′ t′* of switch "3" at circuit-wheel "One" are severally connected by two wires running directly to contacts *p′ t′* of switch "1" at wheel "Three." Contacts *p′ t′* of switch "2" at wheel "One" are similarly connected to contacts *p′ t′* of switch 1 at wheel "Two." Contact *p′ t′* of switch 3 at wheel "Two" are similarly connected to contacts *p′ t′* of switch 2 at wheel "Three." These are all circuit-wires, as distinguished from grounding-wires. For wheel "One," No. 1's normal grounding-wire starts from plate *c′* of that wheel, thence passes to contacts *m′ l′* of switch 1 at wheel "Two," thence to contacts *m′ l′* of switch 1 at wheel "Three," whence it goes directly to the general ground. For wheel "Two," No. 2's normal grounding-wire passes from plate *c′* of that wheel to contacts *m′ l′* of switch 2 at wheel "Three," thence to contacts *m′ l′* of switch 2 at wheel "One," whence it goes directly to ground. For wheel "Three," No. 3's normal grounding-wire passes from plate *c′* of that wheel to contacts *m′ l′* of switch 3 at wheel "Two," thence to contacts *m′ l′* of switch 3 at wheel "One," whence it goes directly to ground.

The contacts *s′* at the switches around wheel "One" are directly connected to the plates *c′ d′ d′* on the disk P of that wheel. Contacts *s′* around wheel "Two" are correspondingly connected to the plates *c′ d′ d′* belonging to wheel "Two." Contacts *s′* around wheel "Three" are correspondingly connected to plates *c′ d′ d′* belonging to wheel "Three."

The several arms *o′* on wheels A′ in passing over or resting upon plate *c′*, which is for the purpose made to yield slightly, force asunder the spring-contacts *e′ r′* behind the disks P, *e′* being electrically connected with *c′* and *r′* connected directly to the common ground in each instance. (See Fig. 2.) Each subscriber's line enters the central office and goes directly to the electro-magnet C′, controlling the motor of his circuiting-wheel A′, thence to his wheel A′, whence the circuit is diverted variously, according to the position of the wheel A′. Suppose, now, all the wheels A′ are in normal position, with arms *o′* resting upon plates *c′*, and contacts *e′ r′* broken. No. 3 desires to communicate with No. 1. No. 3 throws his two-point switch-lever L onto the point F, which at once introduces his battery to his line. If he has a ground, (as he should have at the central office, by reason of his arm *o′* resting upon plate *c′*, from which ground is made, as before stated, through the coupling-switches 3 at wheels "One" and "Two,") the fact that he has a circuit is at once announced by the magnet C attracting its armature B, which actuates the ratchet D by means of the spring-pawl and throws the hand around to 1 on the dial, thus showing that his wheel at central office is about to reach the coupling-switch 1. The instant the battery finds a closed circuit through central office, as stated, it energizes the electro-magnet C′ there, which attracts its armature D′, lifting it or its extension out of engagement with the detent, upon which the motor M starts moving and the wheel A′ rotates. As it moves the arm *o′* passes off the plate *c′*, and the circuit is thus broken, whereupon the magnets C′ and C let go their armatures; but wheel A continues to revolve until stopped by the next detent *g′* engaging the now released armature D′. Subscriber 3, after momentarily closing his lever L over on point F, restored it to point H just before the wheel "Three" stopped. At the instant the detent *g* stopped the wheel A′ its contact-arm *i* had reached and operated coupling-switch 1—*i. e.*, pushed out the contacts *p′ l′*, breaking the contact between *m′* and *l′*, *s′* and *p′*, and closing that between *p′* and *t′*. As No. 1's ground passed through *m′ l′* this is

broken. No. 3 has no ground of his own at the central office at this juncture, as his arm *o* does not rest on any ground plate on disk P; but he has now a ground through No. 1's line at No. 1's distant station, because his arm *i'* rests against *p'*, which is thus closed on *t'*, from which a direct wire goes to contact *p'* at coupling-switch 3 at wheel "One," such latter contact, *p'*, being closed on its front stop, *s'*. From the latter there could be two circuits. The current might pass from point *s'* at switch 2 of wheel "One" to ground by way of No. 1's ground, but, as stated, this has been broken. The other circuit is therefore to be taken. This goes from point *s'* at switch 3 up to plate *c'* of wheel "Three," whence it goes to arm *o'*, which rests upon it, thence by way of magnet *c'* out over No. 1's line, and to ground at No. 1's station. Then No. 3 operates his magneto-call and rings up No. 1. If the communication is not desired to be private no further operations are required before conversation.

As all the points *s'* around No. 1's wheel at central office are in circuit with *c'*, and all points *p'* are closed thereon, any other subscriber can get in on the line of No. 1 in the same manner as No. 3 did; but if such a possibility is to be prevented, as soon as No. 1 has been called he throws his battery onto line and causes his wheel "One" to rotate till its arm *i'* makes contact with point *p'* of switch 3. He then restores his lever L to point H and converses. The two positions now occupied by the respective circuiting-wheels "One" and "Three" are clearly shown in Fig. 1, upon examination of which it will be found that the lines Nos. 1 and 3 thus connected are absolutely isolated from and inaccessible to all other subscribers. As, under any circumstances, when the subscriber's battery is on his line, the continuity of that line depends upon the contact of arm *o'* at the central with either of the plates *c' d' d'* &c., the battery indicating-hand A on the local dial is moved around by a step-by-step movement, effected by the battery-circuit being alternately closed and opened by means of said arm *o'* and plates *c' d'*.

The various circuit-closing plates *d'* are set on the plate P at such intervals with reference to the switches 1, 2, 3, &c., that the arm *o'* will leave the plate *d'* before the arm *i'* makes the desired line.

While I have described a system in which the releasing of the motor at central office is effected by the momentary introduction of a current, by a slight modification it can be arranged so that the battery may hold the motor on closed circuit and release it by momentarily opening of the circuit. In case a subscriber has gone in search of another, his arm *o'* of course has broken his normal ground at plate *c'*, which may be called the "terminal" of his line. Should another subscriber now seek him, such other subscriber may get as far as the plate *c'* in the former's plate P, but cannot get on his line; hence it is necessary to give the latter a circuit, which I do by giving him a ground. For the instant the first subscriber starts from normal position and his arm *o'* leaves his plate *c'* the latter springs outwardly and establishes contact by its extension *e'* with the ground-contact *r*, behind the plate P, as shown at Fig. 2. This affords a circuit for another subscriber to use for returning to normal when he finds the sought line engaged or isolated.

I claim as my invention—

1. An automatic telephone-exchange for telephone-lines, comprising two or more independent lines, each provided with a mechanical motor at a central office, a wheel or hand operated by said motor, forming a part of said line, an electro-magnet in said line capable of starting and stopping said mechanical motor at certain determined points, and thus controlling the movement of said wheel, one or more contacts around the path of said wheel or hand and forming terminals of the other line or lines, a battery, and means at the subscribers' stations for starting and stopping said motor by the current from said battery.

2. In an automatic telephone-exchange, a series of independent mechanical motors, provided each with a rotating contact capable of successive connection with the terminals of other independent lines set in its path, in combination with means for electrically starting and stopping said motor from the distant subscriber's station, substantially as described.

3. In an automatic telephone-exchange, the combination of wheel A', having detents *g'*, with magnet C', armature D', and a motor, M, capable of mechanically rotating said wheel, substantially as described.

4. In an automatic telephone-exchange, the combination of the yielding plate *c'*, its back extension, *e'*, and ground-stop *r'*, with the rotating arm *o'*, forming a movable terminal of the individual line, substantially as described.

5. The combination of the battery E, an electro-magnetic indicator, A B C D, the line to central office, rotating terminal *o'* of said line, and the circuit-closing plates *d'*, substantially as described, whereby the movements of the wheel at central station are indicated to the subscriber.

6. In an automatic telephone-exchange, a rotating arm, in combination with a yielding contact-plate and a ground, said arm forming a movable terminal of an individual line, and making a normal ground for the subscriber at the central office, and said yielding contact-plate forming with said ground a possible ground or return circuit for another subscriber, substantially as described.

7. In an automatic telephone-exchange comprising a series of individual lines centering at a common office, a series of circuiting arms or wheels therein, each individually controlled through one of said lines, means for controlling the same, a series of switches around the path of each of said wheels or arms corresponding in number, and a ground for each line passing from its circuiting-wheel through one

switch in each of said series of switches, and so arranged, substantially as described, that the ground of a given line is broken when any of the circuiting-arms impinges on the switch belonging to such given line.

8. In an automatic telephone-exchange, the combination of a series of independently-controlled circuiting-wheels, A′, having arm *i*′, with a series of coupling-switches, 1 2, &c., around each wheel, and arranged to be operated by the impact of arm *i*′, said switches being arranged in pairs and connected substantially as described, whereby any two of the wheels A′ may be electrically connected, substantially as set forth.

9. The combination of the rotating arm *i*′ with the contacts *l*′, *m*′, *p*′, *s*′, and *t*′, when connected substantially as specified.

10. In an automatic telephone-exchange comprising a series of individual lines converging to a central office or exchange, and means for automatically connecting the said lines from the subscribers' distant stations, the combination therewith of devices, substantially as set forth, capable of automatically connecting or centering two or more of said lines upon any other line, whereby any number of the subscribers can center upon a given line for general conversation.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in presence of two witnesses.

GEORGE A. CARDWELL.

Witnesses:

WM. APGAR,

F. K. FITCH.