(No Model.) 2 Sheets—Sheet 1

W. DECKER.

AUTOMATIC TELEPHONE EXCHANGE.

No. 604,373. Patented May 24, 1898.

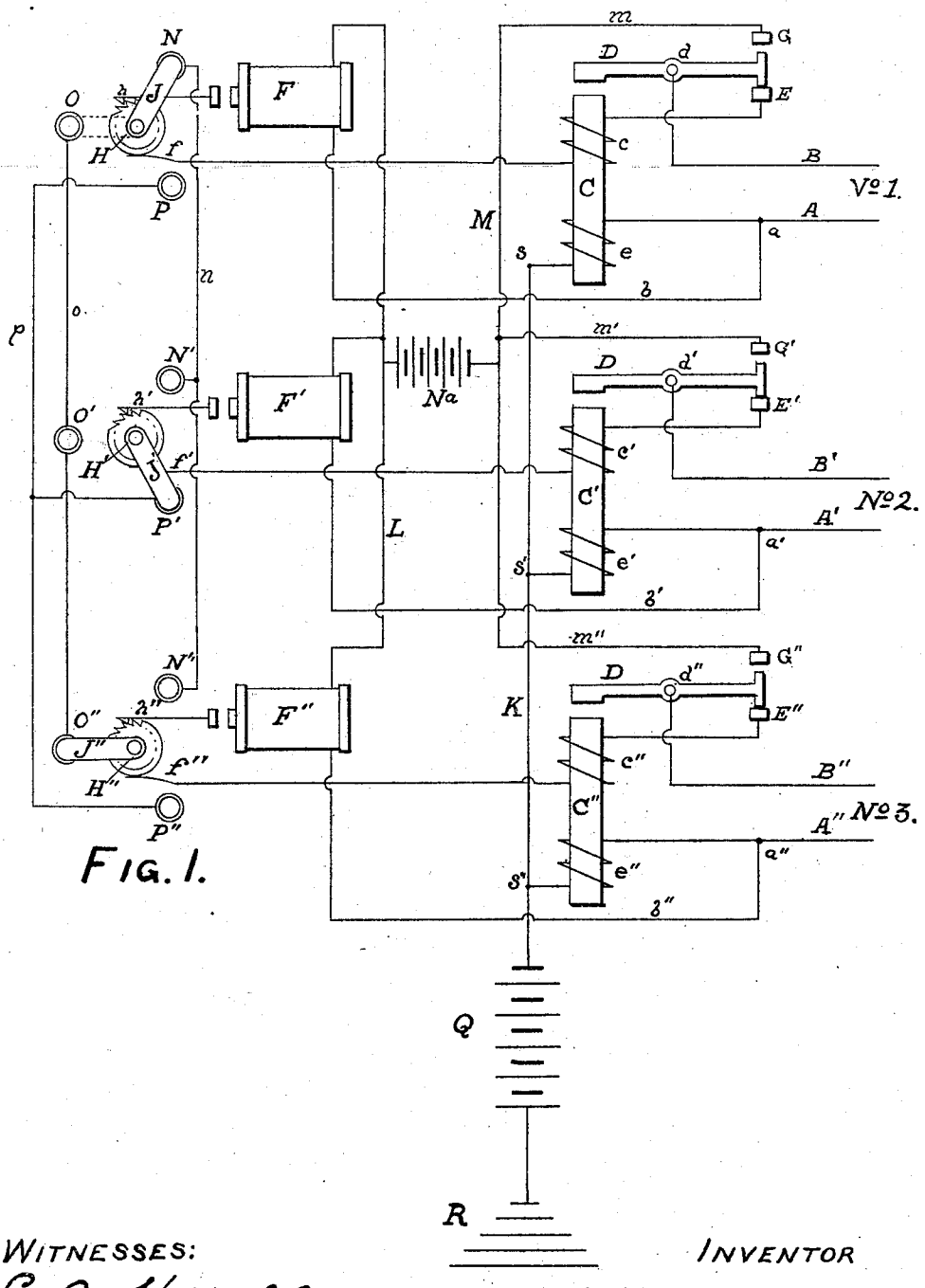

FIG. 1.

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(No Model.) 2 Sheets—Sheet 2.

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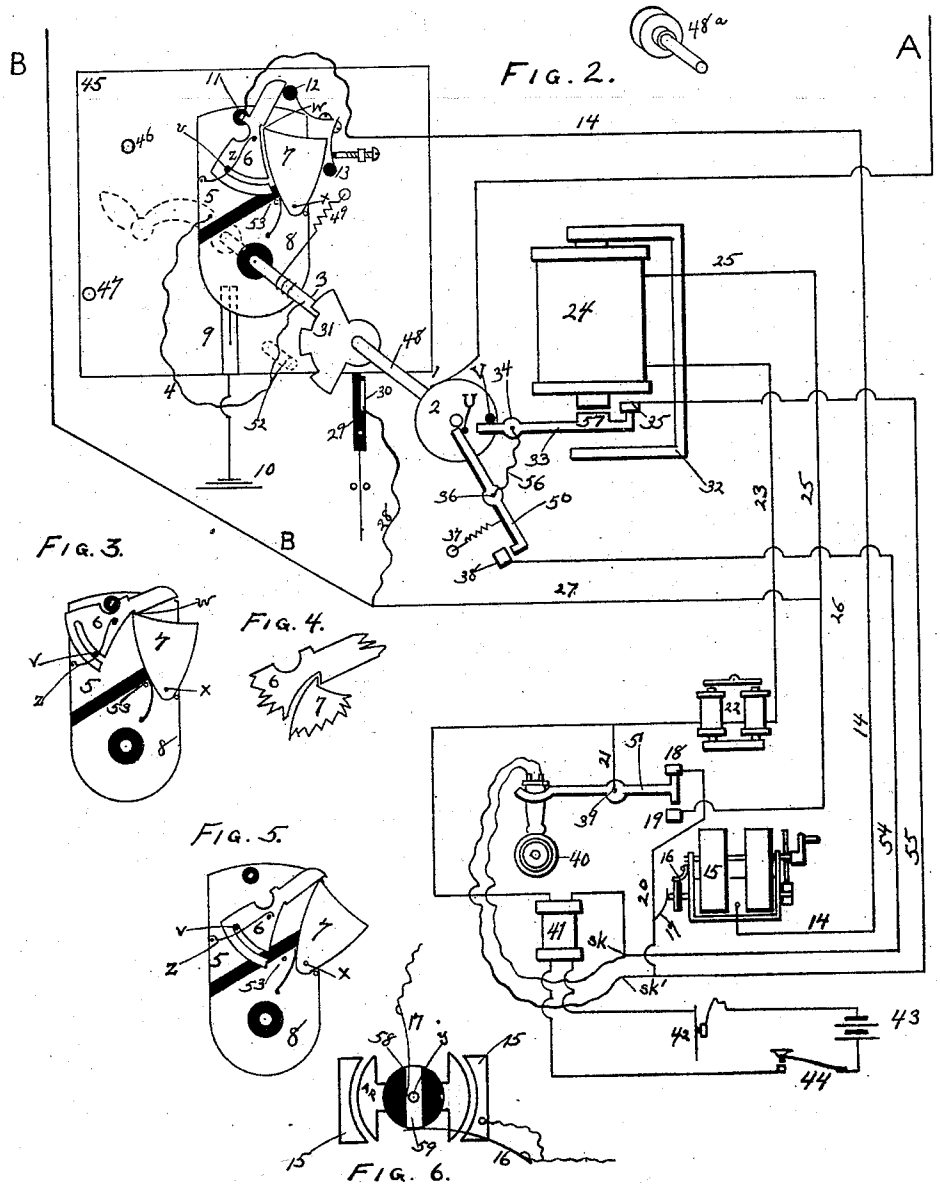

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AUTOMATIC TELEPHONE-EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 604,373, dated May 24, 1898.

Application filed March 25, 1895. Serial No. 543,122. (No model.)

To all whom it may concern:

Be it known that I, WARD DECKER, a citizen of the United States, residing at Owego, in the county of Tioga and State of New York, have invented a new and useful Automatic Telephone or other Electrical Exchange, of which the following is a specification.

My invention relates to an automatic telephone-exchange system and apparatus of that class in which electrical impulses are caused to operate a step-by-step movement to connect a terminal of one line to a terminal of another line.

The object of my invention is to provide a subscriber with a metallic circuit and enable him to bring the switching-magnets into the circuit for connecting purposes, after which he can remove them, leaving practically a clear line free from electromagnetic effects for telephoning or other purposes.

Another object of my invention is to provide practically a secret service and still leave the switchboard in such condition that three or more may converse at one time and be reasonably sure of not being overheard.

The nature of my invention and the preferable way to carry it into effect may best be explained and understood by reference to the accompanying drawings, in which the details, for clearness, are represented mostly in diagram.

Figure 1 represents the various connections and circuits at the central station for a three-subscriber exchange. Fig. 2 shows the mechanisms and connections of same and of the instruments at a subscriber's station and represents the mechanism at rest or at its normal position. Figs. 3, 4, and 5 represent details of the stopping-arm. Fig. 6 shows the short-circuiting device used on the magneto-generator.

In Fig. 1, Nos. 1, 2, and 3 represent metallic circuits from three substations. A, A′, and A″ are similar sides of each metallic circuit; B, B′, and B″ the opposite sides. As the connections are the same in each case, I will explain them for the present by reference only to No. 1.

The side A of the metallic circuit divides at *a*, the side *b* being normally open at the contact G through the switching-magnet F and battery N*a*. The main line A continues through the winding *e* on the electromagnet C to a connection at *s* with the wire K, to which the other wires A′ and A″ are connected at *s′* and *s″*, respectively, in the same manner. Wire K is also connected permanently through the battery Q to the ground R.

The side B of the metallic circuit is connected to the circuit-breaker D at *d* and normally completes its circuit through the contact E to the winding *c* of the electromagnet C and terminates in the movable arm J.

F is an electromagnet controlling the arm J by the ratchet-wheel H and pawl *h* and is connected, as before stated, through the common battery N*a* to the metallic circuit A B at *a* on one side and the contact G on the other.

N, O, and P are contact-points connected, respectively, to the dead wires or bars *n*, *o*, and *p*.

In operation, supposing the subscriber attached to No. 1 desires to be connected with the subscriber attached to No. 3, the following operations, which are automatic and are more fully described hereinafter, take place: No. 1's subscriber first breaks the metallic circuit, which was closed at his station, and then grounds line A. This completes the circuit through that line through winding *e* on electromagnet C to the wire K, through the battery Q back to earth at R, causing electromagnet C to attract its armature and break the connection of the line B to *c* at E and connect the line B to *m* at G. Now if the metallic circuit is alternately closed and opened at the subscriber's while line A is grounded the electromagnet F will be magnetized and demagnetized correspondingly through the following circuits: from A to *a*, through *b* and electromagnet F to common wire L, then through battery N*a* to common wire M, and through *m*, back contact G, (which is now closed,) circuit-breaker D to the side B of the metallic circuit. Supposing the necessary number of pulsations have been sent over the metallic circuit to move ratchet J around to the point O, as shown by the dotted lines, O is attached through bar *o* to O″, upon which No. 3's arm J″ normally stands. When the above pulsations have been sent and arm J rests on O, the subscriber breaks the ground-circuit and switches the metallic circuit through his telephone apparatus, as hereinafter ex-

plained. By breaking the ground-circuit electromagnet C is demagnetized and releases its armature, restoring the connection at E and breaking the connection at G. No. 1's subscriber will now be connected over a metallic circuit to No. 3's subscriber as follows: beginning at B, through the circuit-breaker D, contact E, winding *c*, wire *f*, arm J, contact-point O, bar *o*, contact-point O″, arm J″, wire *f*″, winding *c*″, contact-point E″, circuit-breaker D″, line-wire B″ to No. 3's subscriber, then back on line A″, winding *e*″, common wire K, through winding *e*, line-wire A to No. 1's subscriber, back over line-wire B to the place of starting.

As can be easily seen, the windings on the electromagnets C, C′, and C″ are so arranged that when currents are sent over the metallic circuits the sections *e*, *e*′, and *e*″ would magnetize the core but for the neutralizing effect of sections *c*, *c*′, and *c*″. Therefore as the cores C, C′, and C″ are never magnetized by currents over the metallic circuits no self-induction can take place in said electromagnets to affect such currents. Consequently telephone or other variable currents will not be retarded or otherwise affected in the metallic circuits.

It is evident that the two windings on each magnet C, C′, and C″ consist of an approximately equal number of turns, and the preferable construction is to wind each leg of a U-shaped magnet with two windings, one over the other, and connect the outside one of one leg to the inside winding of the other leg, and vice versa.

It is also evident that my invention of using differential magnets, as described, may be used on different forms of exchanges or automatic switchboards; but the preferable form, partly described here, is more clearly shown and described in an application for Letters Patent of the United States dated May 14, 1894, Serial No. 511,085.

To explain how the subscriber's end is operated mechanically and automatically, I would refer to Fig. 2. A and B are the line-wires of a metallic circuit reaching to the central station, as described. As before stated, the first thing to be done is to ground wire A and then while grounded alternately open and close the circuit between A and B. The last-named operation may be performed by any device capable of alternately making and breaking the circuit, but preferably that one shown in my application Serial No. 511,085, and this one I have referred to and partly represented at 29, 30, and 31, and 45, 46, 47, and 48ª, and as it has been described in the above-mentioned application I will not describe it here in all its detail.

45 represents the back of a frame or board through which the shaft 48 projects and terminates in a handle, by which it can be turned. As this is supposed to be a transmitter on a three-subscriber exchange, only two others would need to be connected with, so that front board 45 is provided with two holes 46 and 47, in which pin 48ª may be inserted to stop the transmitter after it has sent the desired number of impulses. The circuit-breaker 31 and wheel 2 are rigidly attached and in electrical connection with the shaft.

8 is a conducting-plate fastened to the shaft, but insulated from it. Attached to this plate and in connection with it is the piece 7, hereinafter called the "trigger."

5 is a support for the arm 6 and is rigidly attached to plate 8, but insulated from it and connected to the shaft or frame by the wire 4. The trigger 7 never comes in contact with the plate 5.

6 is an arm for the purpose of stopping the transmitter at a desired point.

11 is a contact-point insulated from 5 and connected by wire 14 to the telephone apparatus. Plate 8 is in permanent connection with the ground 10 through the spring 9.

U and V are insulated points on the wheel 2 for the purpose of moving the arms 50 and 33, respectively.

24 is an electromagnet polarized by being in contact with the permanent magnet 32.

22, 40, 15, 51, 41, 42, 43, and 44 are the principal parts of the telephone apparatus.

49 represents a spring that returns all the mechanism to its normal position.

52 is a stop to prevent turning shaft 48 too far.

In operation, supposing this to be a subscriber connected to metallic circuit No. 1, Fig. 1, and that this subscriber wishes to connect himself with circuit No. 3. This, we will suppose, requires two impulses. It may be two sets of impulses, as Fig. 1 would show. The subscriber places pin 48ª in hole 46 in front board 45 and turns to his right the handle attached to shaft 48 as far as it will go or until stopped by stop 52. This causes all the mechanism attached to shaft 48 to move to the left, as viewed in the drawings, and as the pin 48ª projects through the hole 46 into the path of arm 6 arm 6 is pressed over out of the way, using the point *w* of the trigger as a fulcrum. This is shown clearly in Fig. 3. As the parts are moving in this direction the insulated portion of the lever 29 is acting as a catch to keep the mechanism from returning, if released by the hand, until the complete movement to the stop 52 is made, when lever 29 again points directly toward the shaft and the mechanism will return when released from the hand by the action of spring 49. It will be noticed that before starting arm 6 rests against a stop 12, which pushes the arm out of contact with the trigger, as that can go no farther than stop 53 and into contact with the point 11. In this condition the circuit may be traced from A to spring 1, wheel 2, shaft 48, wire 4, plate 5, arm 6, contact 11, wire 14, through short-circuited generator 15, spring 17, wire 20, contact 18, arm 51, wire 21, bells 22, wire 23,

coil 24, wire 25, wire 27 to the other side of the metallic circuit B. When the movement to the left started, arm 6, relieved from pressure against stop 12 by the action of spring *z*, presses against trigger 7 and, catching it at *w*, holds it, by this means also upholding itself, trigger 7 being held in position long enough by spring-stop 13 to enable this to be done. At the same time contact between arm 6 and point 11 is broken. Therefore line A, connecting through the shaft and wire 4, is grounded by arm 6 being in contact with trigger 7, attached to ground-plate 8, and the telephone apparatus is left open-circuited at 11. Upon releasing the handle of shaft 48 the mechanism begins to travel back toward the right by action of the spring 49. Retarding-wheels are used in practice to reduce speed of mechanism in this direction. Strip 30 on lever 29 makes a contact on the first raised portion of segment 31 when arm 6 approaches hole 47 and makes a contact with the second raised portion as it approaches hole 46. These makes and breaks, as can easily be seen, occur directly across the metallic circuit from B to A. When arm 6 reaches hole 46, it encounters the pin 48^a, inserted in the said hole. This stops all the parts, leaves lever 29 with its notched insulated edge in contact with the lower corner of the middle raised portion of 31, and therefore on open circuit. Arm 6 is again pressed against contact-point 11, bringing the telephone apparatus again in circuit after breaking the ground connection of line A at trigger 7. Two impulses have been sent over the metallic circuit while one side A was grounded. The ground has been broken and the metallic circuit No. 1, as has been shown, connected with a similar metallic circuit at the central station. The telephone call-bells may now be rung over these metallic circuits. In my other application before referred to I use one of the dead-bars shown in Fig. 1 at *o* permanently connected to the ground. In the system here represented this grounded bar is used more particularly for a testing-circuit, as one may connect the free end of B at J, Fig. 1, with the grounded bar, thus closing the metallic circuit through the differential coils of electromagnet C, after which the call-bells may be rung and other operations take place to ascertain the condition of the lines, apparatus, &c., without being connected to another circuit.

When arm 6 struck pin 48^a in hole 46, as before stated, it released trigger 7, which by action of a spring then fell forward toward the right. After conversation has been finished the pin is withdrawn from hole 46, allowing arm 6 to fall against and in contact with trigger 7, as shown in Fig. 5, grounding line A again, and strip 30 on lever 29 sends another impulse over the metallic circuit, which resets the switching mechanism at the central station by moving the arm J around to its original position. Arm 7 strikes stop 13 and is forced back, throwing arm 6 up, which now uses *v* for a fulcrum, until it is caught by stop 12, and everything stands as before the operation began.

When the first movement of the subscriber's mechanism was made, pin U on wheel 2 left lever 50 and spring 37 drew the lever against contact-point 38, by so doing completing a short circuit around the telephone-receiver, beginning at *sk* over wire 54, contact 38, lever 50, wire 56, lever 33, contact 35, line 55 to *sk'*. This is maintained until generator 15 is made to ring through the bells 22 and coil 24. When that happens, electromagnet 24 will by one direction of the current become demagnetized, when the lower pole of permanent magnet 32 will immediately attract the armature 57 and hold it, breaking the short circuit at 35 and leaving the telephone in condition to be used. When wheel 2 is restored to its normal position, stop V restores the armature to its upper position and closes contact 35, while stop U opens the short circuit at 38 for the purpose of leaving the telephone in readiness for use when called by other parties. By these methods a subscriber cannot listen to another's conversation without first ringing and giving warning.

The object of having arm 6 fall forward in the position shown in Fig. 5 is to get it out of the way of the pin 48^a, supposing that a subscriber held the handle and set the pin a hole or two in advance, so that by calling one subscriber and ringing off the short circuit he could stop the mechanism again before the short circuit was reset and listen to other subscribers. This is prevented, as the arm cannot catch another pin until after coming to its normal position and being reset, which act also necessarily resets the short-circuiting device. The polarized electromagnet being connected into the circuit next to the call-bells 22 is thrown out of the talking-circuit when using the latter by the lever 51.

To short-circuit the generator while standing idle, I use the device shown in Fig. 6. With strong field-magnets 15 the armature AR assumes the position shown. 58 is a circular piece of insulating material, across which is fastened the conducting-strip 59, to which Y the armature terminal is attached, the other terminal being fastened to the frame 15. Also fastened to the frame is the spring 16, and when the armature is in the position shown it is short-circuited through the spring 16 and strip 59. When the armature is running, no current is generated at the time of short circuit. The operation of this device may be rendered more certain by weighting the wheel running the armature or arranging a spring to stop the armature on the short-circuiting device.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a system of electrical intercommunication a short-circuited telephone-receiver, a

circuit-breaker for breaking the short circuit, an electromagnet for operating the circuit-breaker, all in combination with a calling-generator connected with said electromagnet, whereby the short circuit is broken on operating the calling-generator.

2. In a system of electrical intercommunication, the combination of a calling-generator, a short-circuited telephone-receiver, a polarized electromagnet in circuit with the calling-generator for the purpose of breaking the short circuit on operating the generator.

3. In an automatic telephone or other electrical exchange, the combination of a calling-generator, a telephone-receiver, a short circuit around the latter adapted to be opened and closed by the armature of a polarized electromagnet in circuit with, and operated by, the calling-generator.

4. In an automatic telephone or other electrical exchange an armature free to move between two points, a polarized electromagnet on one side of said armature normally holding it against one point, means for releasing the armature from the influence of the electromagnet, all in combination with a permanent magnet on the other side of said armature of such strength as to draw the armature against the other point and hold it there despite further action of the electromagnet.

5. In a system of electrical intercommunication a short-circuited telephone-receiver, an electromagnet in circuit with the calling-generator for breaking the short circuit on operating the generator, all in combination with a switch for throwing the electromagnet out of circuit when the latter circuit is used for telephonic purposes.

6. In an automatic telephone or other electrical exchange, a short-circuited telephone-receiver, a polarized electromagnet for breaking the short circuit, a switch for throwing the polarized electromagnet out of the telephone-circuit and means for automatically restoring the short circuit.

7. In an automatic telephone or other electrical exchange system differential magnets included in but inoperative over a metallic circuit, an electromagnetic switching device for connecting said metallic circuit with other circuits, means for operating said differential magnets over one side of the metallic circuit and suitable return, a switch controlled by the differential magnets and adapted to bring the electromagnetic switching device into the metallic circuit, all in combination with suitable means for operating the last-named switching device over the metallic circuit.

8. In an automatic telephone or other electrical exchange system, a metallic circuit with one side grounded, a switch-operating magnet in the metallic circuit and a switch-operating magnet in the grounded circuit for throwing the aforesaid magnet into action.

9. In an automatic telephone or other electrical exchange system comprising metallic circuits converging at a central station and one side of each metallic circuit permanently connected together and to a common ground or return at said central station, electromagnets adapted to be operated over one side of the metallic circuit to bring into the metallic circuit a second set of electromagnets, operating the last-named magnets over the metallic circuit to connect the free side of said metallic circuit with the free side or sides of other metallic circuits, substantially as described.

10. A system of electrical intercommunication consisting of metallic circuits extending from substations to a central station; one side of each metallic circuit being connected at the central station through one half of a differential electromagnet to the corresponding side of all the other metallic circuits and also through a battery or other source of electricity to a return-circuit; the other side of each metallic circuit at the central station being connected through a circuit-breaker operated by said differential electromagnet, and through the remaining half of said differential electromagnet and terminating in a switch; mechanism at the respective substations and central station whereby a current may be sent over one side of a metallic circuit and half of the differential magnet, thereby operating the circuit-breaker and breaking the circuit on the other side and at the same time bringing into the metallic circuit another electromagnet together with a battery or other source of electricity, whereby, by means of the second electromagnet and currents sent over the metallic circuit the said metallic circuit may, by the switch before mentioned be placed in electrical connection with one or more other metallic circuits, and by breaking the circuit of the first-named current restore the other side of the differential magnet to the metallic circuit and remove the switching-magnet.

11. In an automatic telephone or other electrical exchange, a transmitting instrument for operating the central-station switchboard consisting of the combination of a backward-and-forward-moving intermittent circuit-breaker 31, the trigger 7, arm 6 and pin 48^a substantially as shown and described.

12. In an automatic telephone or other electrical exchange, a transmitting instrument for operating the central-station switchboard consisting of the rotary axle 48, the plates 8 and 5, arm 6, trigger 7 and contact 11 all in combination with the stops 12 and 13 substantially as shown and described.

WARD DECKER.

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