(Model.)

4 Sheets—Sheet 1.

A. G. BELL.

Electric Call Bell.

No. 238,833. Patented March 15, 1881.

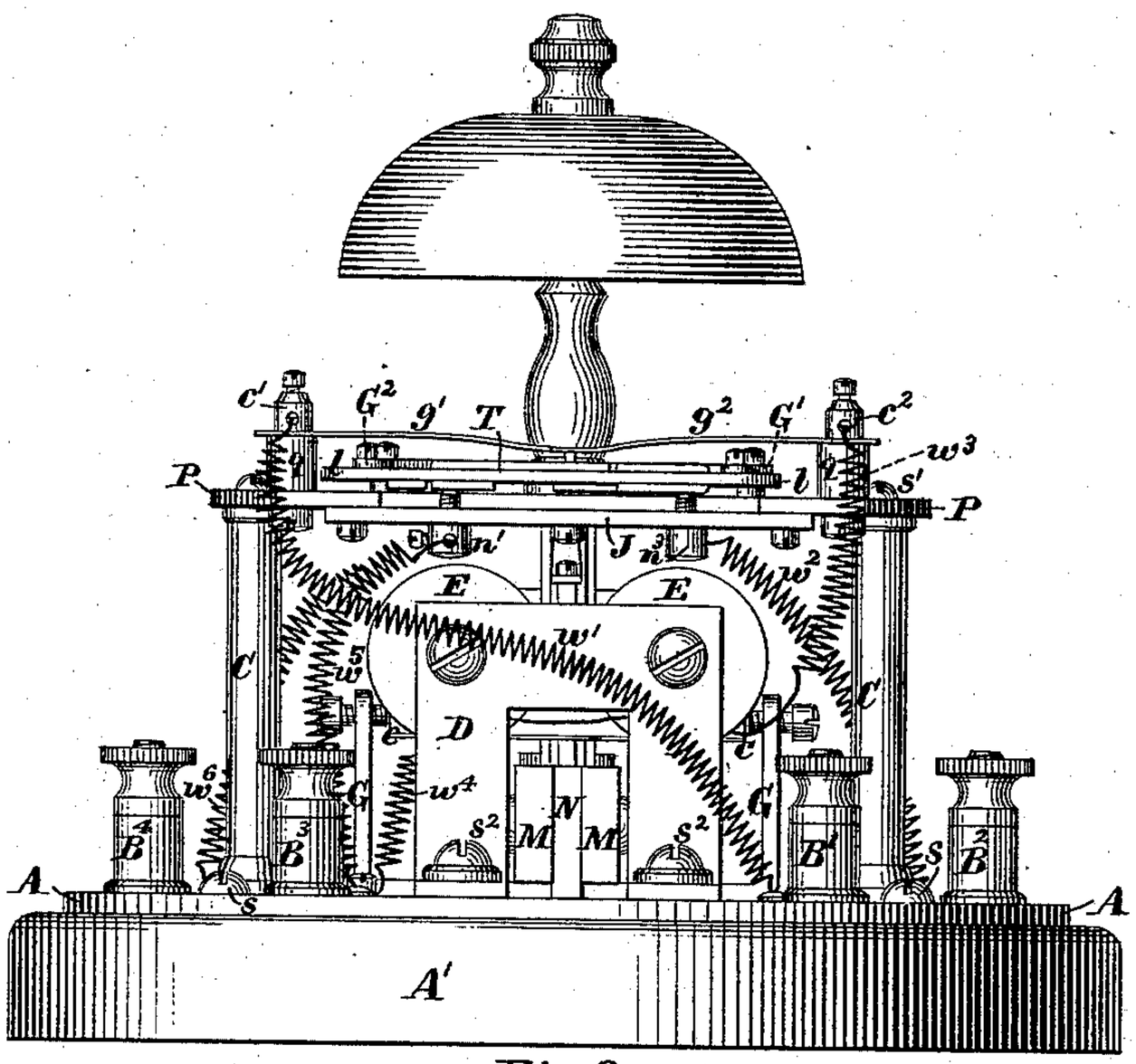


Fig. 2.

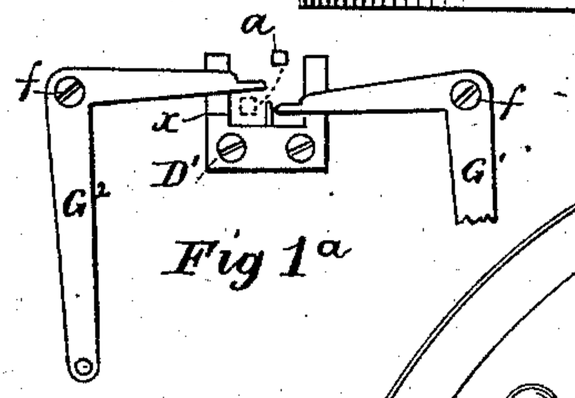


Fig 1a

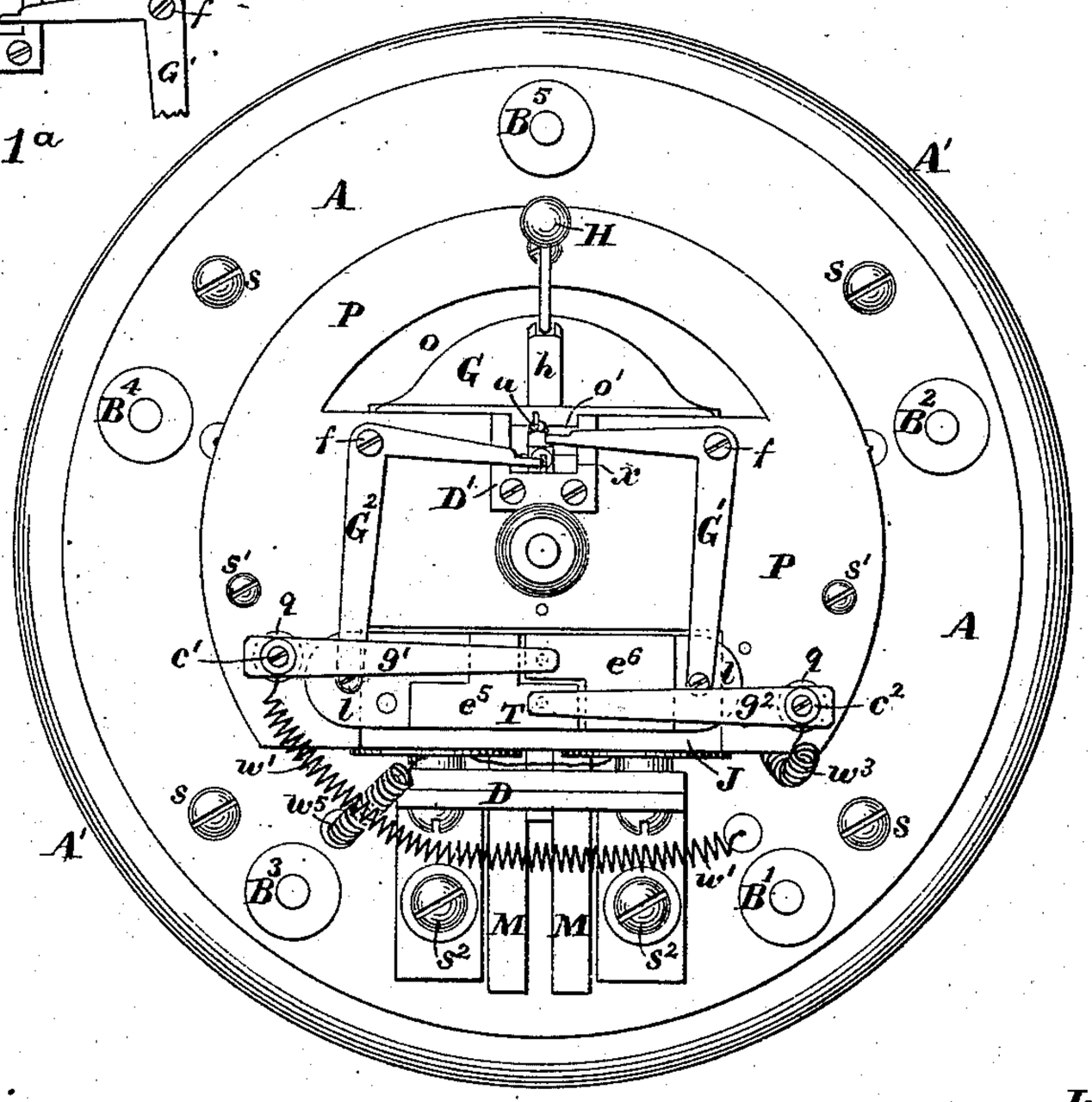


Fig. 1.

Witnesses:
Philip Mauro
C. J. Hedrick

Inventor:
Alexander Graham Bell

(Model.) 4 Sheets—Sheet 2.

A. G. BELL.

Electric Call Bell.

No. 238,833. **Patented March 15, 1881.**

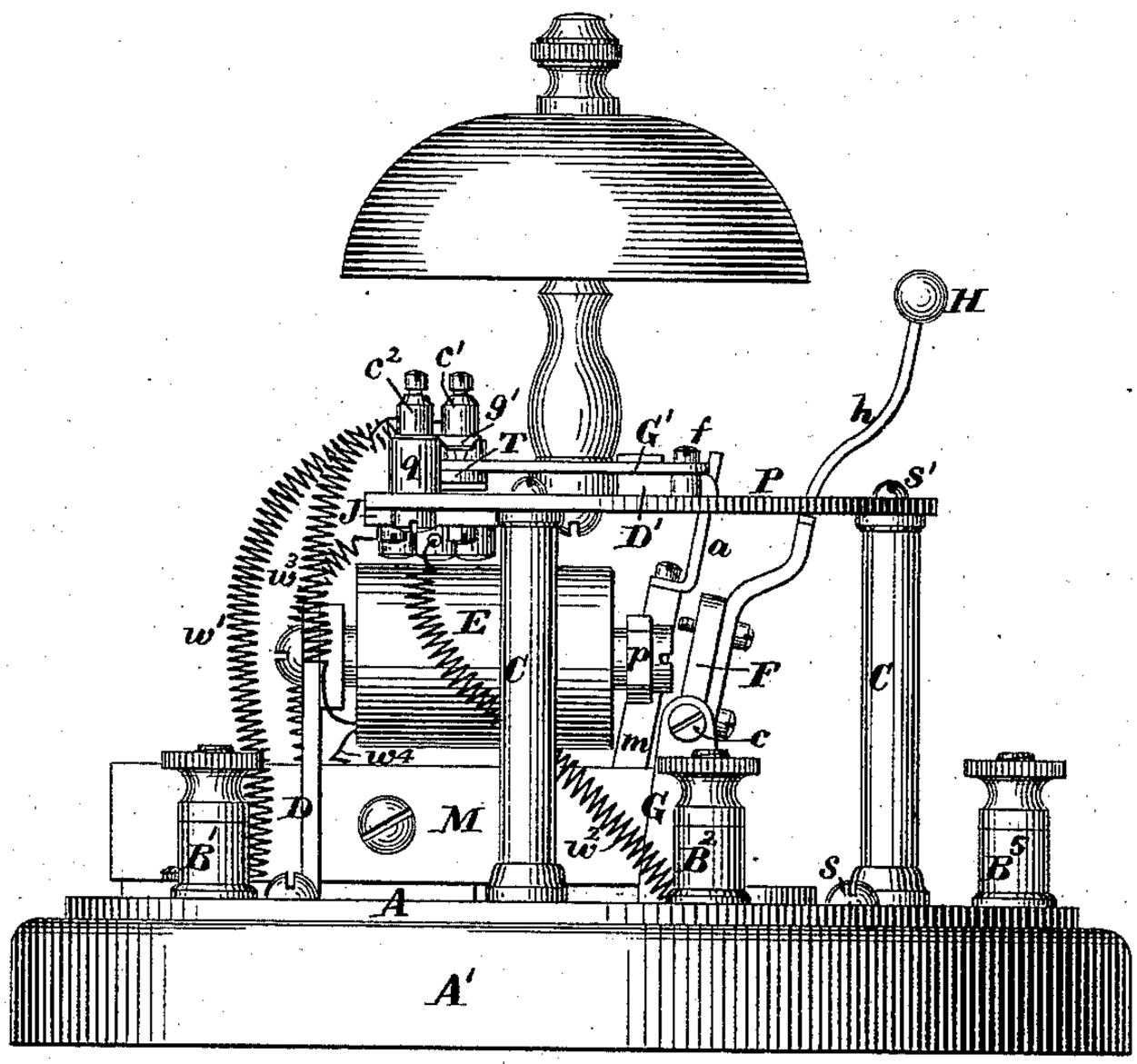


Fig. 3.

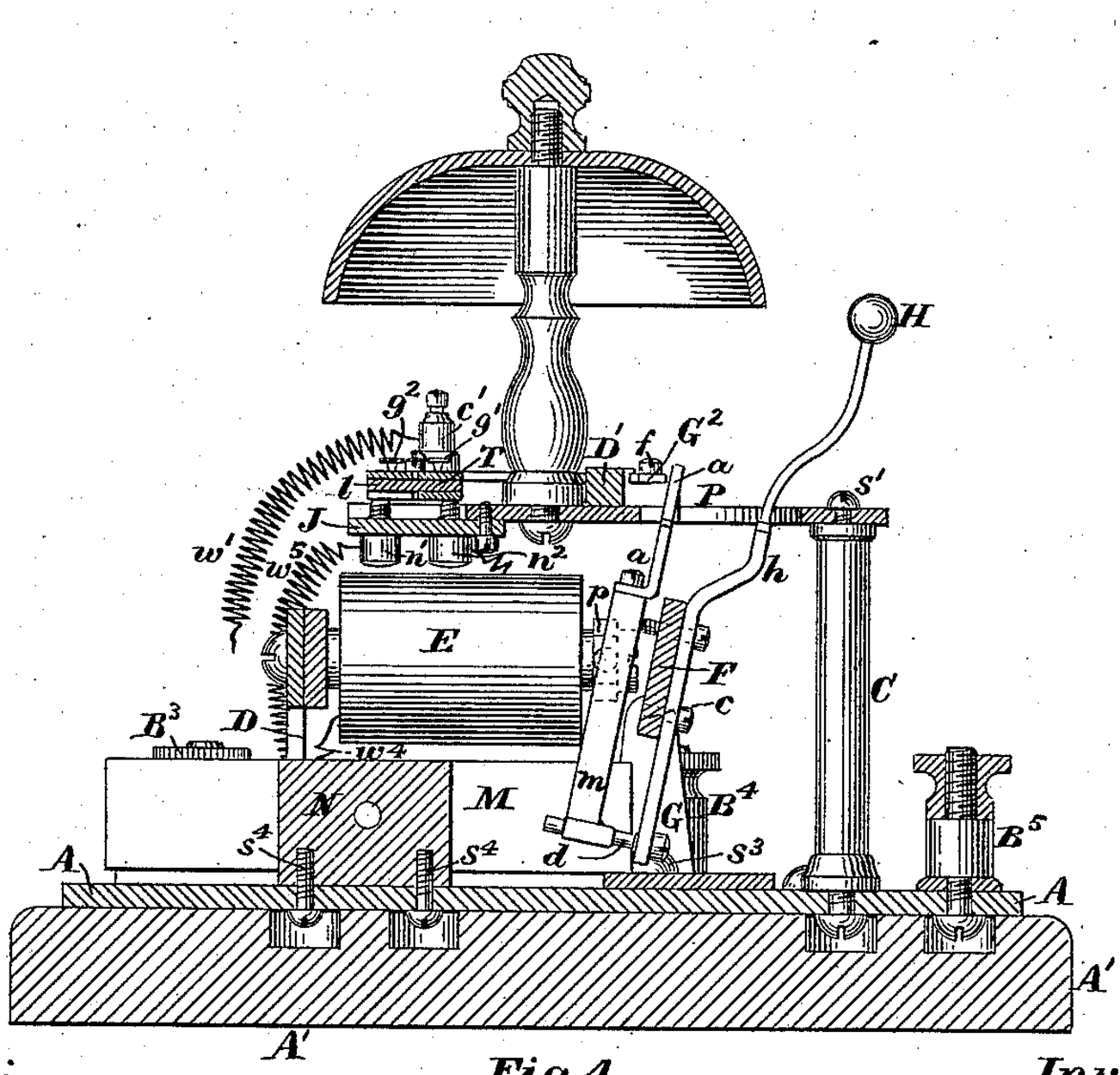


Fig. 4.

Witnesses:

Philip Mauro

C. J. Hedrick

Inventor:

Alexander Graham Bell

(Model.)

4 Sheets—Sheet 3.

A. G. BELL.

Electric Call Bell.

No. 238,833. **Patented March 15, 1881.**

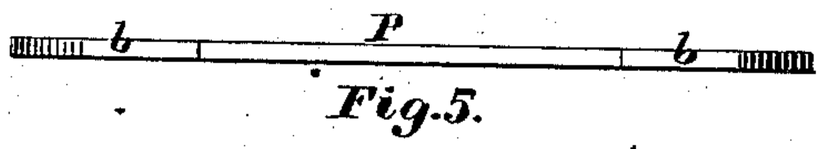


Fig. 5.

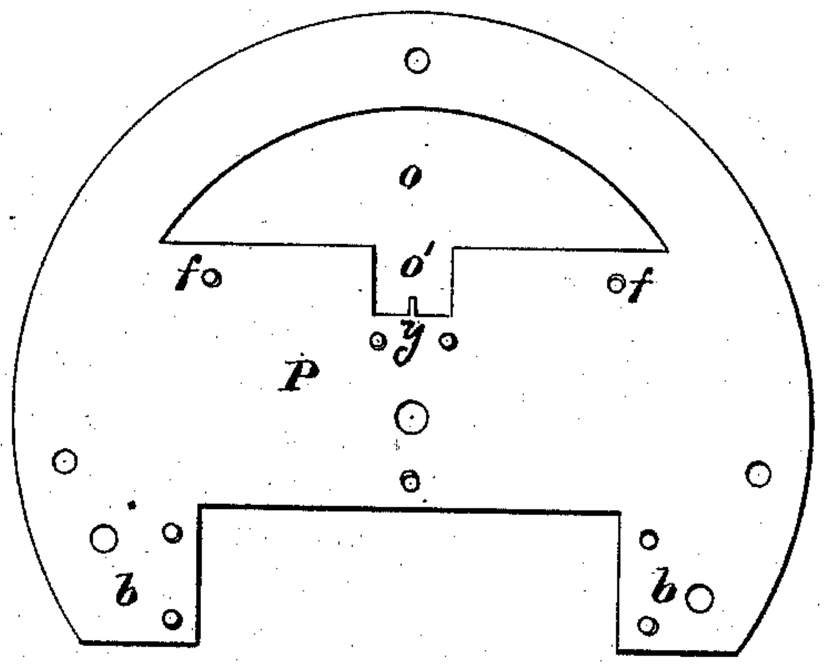


Fig. 6.

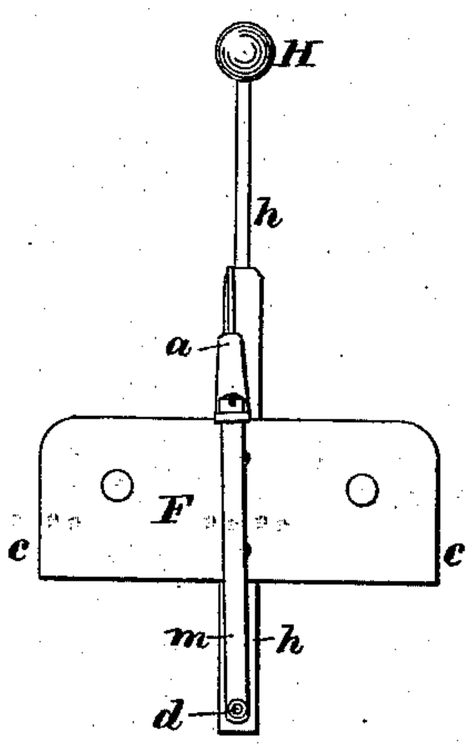


Fig. 7.

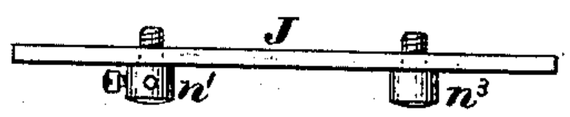


Fig. 8.

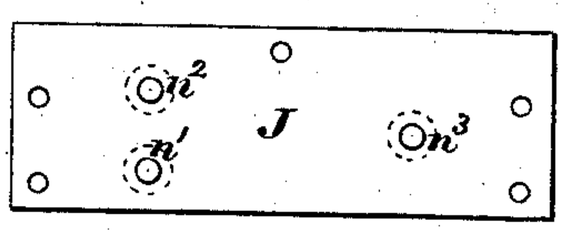


Fig. 9.

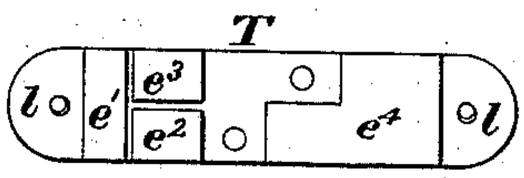


Fig. 10.

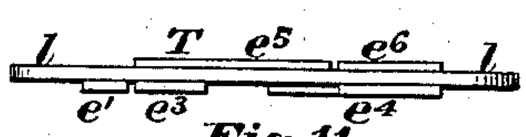


Fig. 11.

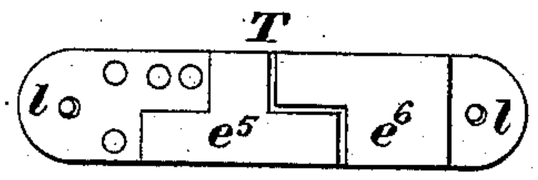


Fig. 12.

Witnesses:

Philip Mauro

C. J. Hedrick

Inventor:

Alexander Graham Bell

(Model.) 4 Sheets—Sheet 4.

A. G. BELL.

Electric Call Bell.

No. 238,833. **Patented March 15, 1881.**

Fig. 13.

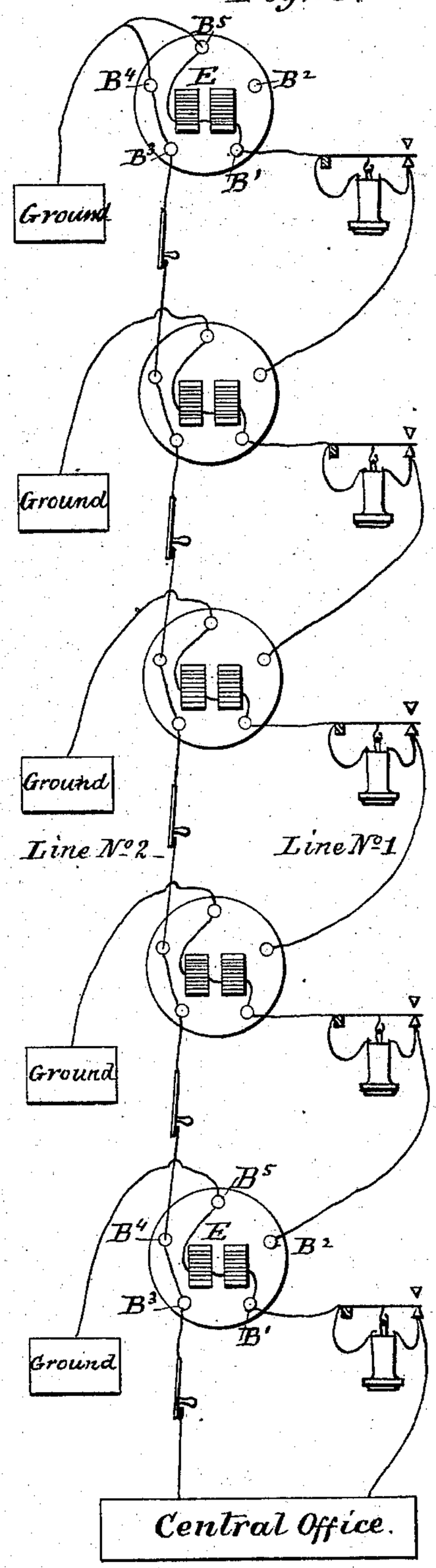
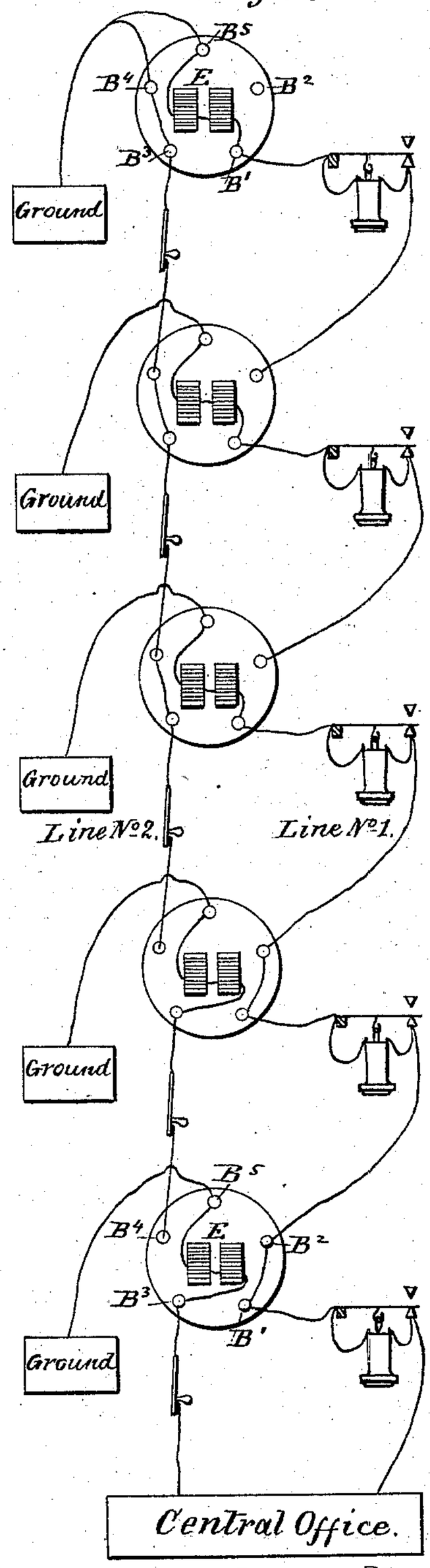


Fig. 14.



Witnesses:

Philip Mauro.

C. J. Hedrick

Inventor:

Alexander Graham Bell

UNITED STATES PATENT OFFICE.

ALEXANDER G. BELL, OF WASHINGTON, DISTRICT OF COLUMBIA.

ELECTRIC CALL-BELL.

SPECIFICATION forming part of Letters Patent No. 238,833, dated March 15, 1881.

Application filed March 13, 1880. (Model.)

To all whom it may concern:

Be it known that I, ALEXANDER GRAHAM BELL, of Washington, District of Columbia, have invented a new and useful Improvement in Electric Bell-Calls, of which the following is a specification.

This invention relates to call-bells or signaling apparatus for use in electrical or telephone systems, so that an operator at one station can call or signal any one of a series of stations without disturbing the others.

Heretofore various apparatus have been devised for this purpose, the particular construction of which need not be here set forth. In such apparatus as in the ordinary system in which all the bells are rung at the same time, the electro-magnet for operating the switch mechanism, or an alarm at each station, remains always in circuit, thus causing great resistance. This high resistance, which is very objectionable for obvious reasons, can by the present invention be avoided, for although an electro-magnet, switch, or signaling apparatus is located at each station only one instrument at a time is in circuit. This result is accomplished by means of electro-magnetic switches, which, operating successively, cut out their magnets and complete the line to the next station. To receive the switch-magnets as they are cut out a second line is used, by the passage of currents over which the magnets can be returned to first line. In the normal condition of the system the second line is completed through all the stations to ground, and can be used by the way-stations or subscribers to call the terminal station or central office. It is also sometimes used by the central office for calling a subscriber. Line No. 1 is normally divided into sections, each grounded at the end farthest from the central office through the magnet of the switch or signaling-instrument, and disconnected from the adjoining section on either side. The first section is connected with the central office. Telephone communication is had through line No. 1.

The electro-magnetic switches best adapted for use as indicated operate to cut out their own magnets by the passage of a current through the coils of the latter and by the forward movement of the armatures, and in order that the effect of the current used for operating one switch may not extend to the others, the adjoining or alternate switches are adapted to be shifted by currents of opposite polarity.

In connection with electro-magnetic switches as described bells are used, the hammers of which are or may be operated by the same magnets that operate the switches. To do this effectively the bells are adapted to be set for ringing by a single rapid reversal of polarity of the current. The particular means adapted for this purpose are an improved form of switch, and also other parts and combinations of devices comprised in the present invention will be hereinafter more fully set forth.

In the drawings, Figure 1 is a plan, and Fig. 2 a rear elevation, of an electrical-bell instrument adapted for the working of the principal feature of my invention, and embodying some of its minor details. Fig. 3 is a side elevation, and Fig. 4 a sectional elevation, of the same. Fig. 1ª is a detail plan view of a small portion of the apparatus. Figs. 5 to 12, inclusive, are views, in detail, of certain parts or pieces used in the construction of said instrument, as will be more particularly pointed out. Figs. 13 and 14 are diagrams used in explanation of my said invention.

A is a metallic bed-plate, secured to a wooden table, A′, by screws *s*.

P is a metallic plate, secured by screws *s′* to the tops of three posts, C, which are fastened to the bed-plate, as shown. For convenience this plate P is of peculiar shape, as shown in Figs. 5 and 6. In rear the plate P has two projections, *b b*. In front it has a slot, *o*, through which vibrates the arm *h* of the bell-hammer H, while through a branch, *o′*, of said slot vibrates an arm, *a*, whose office will be hereinafter pointed out. In the branch *o′* is a projection, *y*, the office of which will also be pointed out hereinafter.

F is a swinging armature, of soft iron, pivoted at *c c*, as shown, to the perpendicular arms of a yoke, G, which is secured to the bed-plate by screws s^3, as shown. The arm *h* of the bell-hammer before mentioned is rigidly secured to the armature F, but it projects some distance below that armature, and near its lower end is provided with a pin, *d*, upon which is pivoted, at its own lower end, a tongue, *m*. This tongue is a permanent magnet, and

forms a swinging polarized armature for the electro-magnet E, its upper end being between the adjustable pole-pieces *p p*, attached to the projecting ends of the cores of the two spools of the electro-magnet.

To the upper end of the polarized tongue or permanent magnet *m* is secured, as shown, the arm *a*, previously mentioned.

It will be at once observed that the permanent magnet *m*, and consequently the arm *a* also, is capable of vibrating about axes at right angles to each other, and thus has a movement in four directions—namely, forward and back with the armature F, and to either one side or the other at right angles to its forward and back motion.

That the polarized tongue *m* may retain its power there are placed in close proximity to its lower end the ends of two strong permanent magnets, M M, screwed to a piece of brass, N, which, in turn, is secured to the bed-plate by screws s^4 s^4 underneath.

G′ G^2 are two bell-crank levers pivoted to the plate P at *f f*, their long arms being also pivoted to the rubber base *l* of a sliding switch, T. (Shown in detail at Figs. 10, 11, and 12, Fig. 11 being an elevation and Fig. 12 a plan of said switch, while Fig. 10 is a plan of the switch inverted.) The switch consists of the said rubber base *l* and six metallic plates, e' e^2 e^3 e^4, underneath said base, and e^5 and e^6 above. These plates are secured to the base *l* by metallic pins, and through these pins plates e^4 and e^6 are in metallic connection, and also e^3 and e^5.

J is a rubber plate, secured to the lower surface of the arms *b b* of the plate P by screws, as shown. Through it are inserted three metallic pins, n' n^2 n^3, forming a support for the switch T, in the nature of a tripod, so that all three pins are in constant contact with the switch as a whole. The pin n' is always in contact either with plate e' or e^3; n^2 always in contact either with e' or e^2, and n^3 always with e^4.

In contact with the upper plates of the switch T are the metallic points upon the ends of two metallic springs, g' g^2, the other ends of the springs being secured to insulated posts *q q* by screws c' c^2. The spring g' is always in contact with either plate e^5 or e^6, while g^2 is always in contact with e^5. Electric connection is made with the switch, as will be hereinafter pointed out; but it may be here observed that there is a peculiar advantage in this form of construction of a switch and in its immediate connections as thus far described. Being flat and sliding horizontally the switch must at all times rest upon all three of the pins n' n^2 n^3 below, and there is no strain upon the elasticity of the springs g' g^2 above.

B′, B^2, B^3, B^4, and B^5 are binding-screws upon the bed-plate, but, with the exception of B^5, insulated, as shown. Of these B′ and B^2 are in contact with line-wire No. 1, while B^3 and B^4 are in contact with line-wire No. 2, and B^5 is in contact with the ground-wire. Wire w' connects binding-screw B′ with screw c'. Wire w^2 connects pin n^3 with binding-screw B^2. Wire w^3 connects screw c^2 with the electro-magnet E. Wire w^4 connects the electro-magnet E, through the plate A, with the binding-screw B^5—that is, with the ground—the whole course of the wire, however, not being shown. Wire w^5 connects binding-screw B^3 with pin n', and wire w^6 connects pin n^2 with binding-screw B^4.

D′ is a bracket screwed to the plate P, and having projections upon either side of the branch slot *o′*, to furnish support for the free ends of the short arms of the bell-crank levers G′ G^2 as they move in and out. These levers are operated by the arm *a*, attached to the polarized tongue or permanent magnet *m*. Their short arms are of such length that they can but just pass each other without striking in their movements in and out; and it is obvious, from description already given, that when one moves in the other moves out.

By having the operating or short arms of the levers G′ G^2 extending toward and closely approaching each other, only a slight movement of the polarized tongue is necessary in order that it may be brought into the required position to strike one or the other of said lever-arms. When the armature is drawn forward and the arm *a* strikes either of the lever-arms, the latter is moved into contact with a stop-piece, *x*, on bracket D′, and prevents the bell-hammer from reaching the bell. To ring the bell it is necessary that the arm *a* should be swung around the end of the lever-arm, so as to be inside of the same, as shown by dotted lines, Fig. 1^a. Referring to this figure it will be seen that this can be done by causing the armature to be attracted by a current of such polarity that the arm *a* will pass the end of the lever-arm G^2, and then, by a single rapid reversal of current, shifting the polarized tongue *m* (to which the arm *a* is attached) before the neutral armature has time to fall back. The bell can now be operated as often as desired, so long as the polarized tongue remains in position. The bell can also be rung with the lever-arms in the position shown in Fig. 1, the current first used being that which will retain the arm *a* in position to pass the end of lever G′.

To restore the armature and polarized tongue to the position for operating the switch-lever a current is sent of the polarity opposite to that by which the bell has been rung. During the passage of the current the sidewise movement of the tongue is prevented by the stop-piece *y*; but when the armature falls back the tongue is released and moves over into the position shown in Figs. 1 and 1^a in full lines. Were it not for this forwardly-extending stop-piece *y*, or its equivalent, the arm *a*, instead of being released, would be shifted behind the other lever-arm.

The diagram in Fig. 13 illustrates the combination of a series of instruments in a system with the lines of wires in their normal condition. Line No. 1 extends from central office to binding-screw B′ at first station through

the magnet of the instrument thereat to ground. The section of line between first and second stations is disconnected from the central office section, and is grounded through the magnet of the instrument at second station. At each station there is a gap in the line, and the preceding section is grounded through the instrument on that station. In other words, there are a series of grounded instruments each arranged in a disconnected section of the line-wire. Line No. 2 is completed through all the stations and grounded at its farthest end. In this line is shown a series of circuit-breaking switches operated by push-knobs, by means of which and a battery and signaling-instrument at the central office, any station may call the central office. In each station of line No. 1, as it enters the switch and bell-instrument, is a telephone or telephonic apparatus of any ordinary or suitable construction, (shown as a hand-telephone suspended from a gravity-switch,) which short-circuits the telephones when not in use.

The operations of the instrument and a series of such instruments are as follows:

First, taking a single instrument, let the battery be attached to line-wire No. 1, and let the arm G′ be pushed in so that the plate e^5 of the switch T is in contact with both the springs g' g^2. This is the normal condition of any instrument on line No. 1, and the current is from binding-screw B′, through wire w', screw c', spring g', plate e^5, spring g^2, screw c^2, wire w^3, electro-magnet E, and wire w^4, to ground. If, now, an impulse is sent through the line of such polarity that the polarized tongue or magnet m is attracted (to the right in Fig. 1 of drawings) so that the arm a will in a forward motion strike the bell-crank lever G′, the bell will not ring, and any number of such impulses may be sent without ringing the bell, for the arm of the bell-crank lever G′, striking against the shoulder x of the bracket D′, in turn forms a stop to prevent the bell-hammer from reaching the bell. For convenience we will assume that the impulse sent was a + impulse. The bell, however, might be rung by first sending in rapid succession a single + followed by a single — impulse, and then at leisure sending a — impulse. This is because the arm of the bell-crank lever G^2 is drawn back, as shown in Fig. 1ª, in the normal state of the instrument, and by following the + impulse by a — impulse before armature F has time to fall back, the arm a has given to it a motion to the left, Fig. 1, so that it passes around the end of the bell-crank lever G^2, as already explained, and no longer prevents the bell-hammer from reaching the bell.

Second, the instrument whose operation has been thus far described when in its normal condition, can be sent off of line No. 1 by sending a — impulse. Such an impulse throws the polarized tongue m and arm a to the left, Fig. 1, and at the same time the arm a is carried forward by the soft-iron armature and strikes the bell-crank lever G^2, thus shifting the switch T, when it will be found that the current is from binding-screw B′, through wire w', screw c', spring g', plate e^6, plate e^4, pin n^3, wire w^2, to binding-screw B^2—that is, the switch is now connected with the line No. 1 at both ends—or, in other words, a gap in line No. 1 is filled and the current is no longer through the electro-magnet. This is the condition of the instrument as shown in Figs. 1, 2, 3, 4, and 7 of the drawings.

Third, if, now, the battery is changed to line-wire No. 2, it will be found that the instrument which has been thus removed from line No. 1 is on line No. 2, the current being from binding-screw B^3, through wire w^5, pin n', plate e^3, plate e^5, spring g^2, screw c^2, wire w^3, electro-magnet E, wire w^4, to ground. There is now a gap in line No. 2.

Fourth, the bell may be rung by means of a minus (—) current, rapidly followed by a plus (+) current, and the instrument may be sent back to line No. 1 by sending a + impulse over line No. 2, and on returning to line No. 1 the instrument will resume its normal condition.

Fifth, the normal condition of line No. 2, in connection with the apparatus, when the instrument is on line No. 1 is such that a current upon it would pass from binding-screw B^3, through wire w^5, pin n', plate e', pin n^2, wire w^6, to binding-screw B^4, a gap in the line No. 2 between binding-screws B^3 B^4 being thus filled.

Sixth, the bell of an instrument the polarity of whose permanent magnet differs from the polarity of the instrument just described, if placed upon line No. 1, will, it is obvious, not ring in its normal condition if minus (—) impulses are sent through it. It may, however, be rung by sending first a minus (—) impulse and then rapidly reversing the polarity of the current. By sending a succession of plus (+) impulses the bell may now be rung as often as desired. Such an instrument, when in its normal condition upon line No. 1, may be sent over to line No. 2 by a single plus (+) impulse, and returned to its normal condition on line No. 1 by transferring the battery and sending a minus (—) impulse over line No. 2.

Seventh, after one instrument on line 1 has been transferred to No. 2 and the gap in the line filled by the passage of a current through the electro-magnet, the current, if continued on the line, will pass to the next instrument, and if the latter is in all respects, both in construction and connection, the same as the first instrument, it will be shifted to line No. 2. In order to avoid this difficulty the adjoining or alternate instruments are adapted to be operated by currents of opposite polarity. This, it is evident, can be effected by a change in the connections of the line-wires; but more advantageously by having the tongues or magnets m of adjoining or alternate instruments of opposite polarity. The passage of a negative current, by which the first instrument has

been shifted to line No. 2, will not operate either the switch or bell, as the polarized tongue will be held in position to strike lever G′ when the neutral armature is attracted.

Eighth, it follows, from the foregoing description, that any number of instruments may be arranged upon a line and operated successively; that by using a second line, as indicated, the magnets of the instruments may be shifted from one line to the other, and that any instrument may be rung from the central office without ringing any other. This will, perhaps, be more readily understood by an examination of Figs. 13 and 14, which represent my invention as worked with five instruments. In these figures it is shown, and it is in accordance with the previous description, that whenever the instrument is on either line the current of that line is grounded in that instrument, and it then appears, as has been stated, that when an instrument is transferred from one line to the other the gap is filled in the line abandoned. When, therefore, an instrument is switched off from line No. 1, an instrument behind the instrument so switched off may be operated to ring its bell on the same line No. 1, or may, in turn, be switched off to bring in a third instrument. By reversing the polarity of alternate instruments the liability of a second instrument to pass over to line No. 2 by an impulse imparted to the instrument lying before it is obviated. Accordingly in the diagram, Fig. 13, five instruments are represented in their normal condition having alternate polarities. The bell of instrument No. 1 might be rung by sending rapidly + — and then —; but it being required to ring the bell No. 2 a — impulse will send instrument No. 1 over to line No. 2, when the bell of instrument No. 2 may be rung by sending rapidly — + and then +; and it being required to ring the bell of instrument No 3, the condition shown in diagram Fig. 14, No. 1 instrument will be switched off by a — impulse, No. 2 instrument by + impulse, and then the bell of No. 3 may be rung as if it were the No. 1 bell. To now restore both lines to their normal condition, send a single + impulse, which will restore instrument No. 3 to its normal condition, and then transfer the battery at the central office to line No. 2, and send a + impulse, restoring instrument No. 1 to its normal condition, in connection with line No. 1, and then send a — impulse, restoring instrument No. 2.

The switch mechanism above described, in connection with two main lines of wire, will be of great advantage for use in telephonic circuits; and the principal object of the invention is that it may be so used. In Figs. 13 and 14, therefore, telephones are shown at each station in line 1 as it enters the signal-instrument and push-button in line 2.

To illustrate the operation of a system thus constructed, let it be supposed that a person at the fifth or last station wishes to communicate with one at the third station. He first calls the central office by means of his push-button, and indicates his number. Then the operator at central office shifts the instruments *seriatim* to line 2 until there is a clear line extending to and grounded through the last station, and rings the bell to show that the call is heard. By means of the telephones the desire of No. 5 to talk with No. 3 is communicated to the central office. The operator thereat then shifts instruments at first and second stations to line 1, rings the bell of No. 3 on line 2, shifts the instruments of Nos. 1 and 2 back to line 2, and, by means of telephone, informs No. 3 that No. 5 wishes to communicate with him. No. 5 could, by means of his push-knob, have indicated that he wished to be put in communication with No. 3, and in that case No. 3 would have been called by the central office first, and then the line completed to No. 5.

It is evident that a secresy-switch of ordinary or suitable construction could be used if desired, and also a switch for cutting out the bell-magnet when the telephone is in use.

It is preferred to use line No. 1 only for telephonic communication; but it is obvious that by placing the telephones at the stations in the ground-wires, they, as well as the signaling-instruments, would be shifted from one line to the other, and that a station could be put with perfect secrecy in communication with the central office by either line.

For use in connection with the foregoing system I have devised an apparatus for the central office, whereby the necessary operations may be performed quickly and with certainty. Such apparatus will, however, constitute the basis of a separate application.

Having thus explained the said invention and the manner in which the same is or may be carried into effect, what I claim, and desire to secure by Letters Patent, is—

1. In a line-wire emanating from a central office, a series of electro-magnetic switches arranged in sections of said line-wire normally grounded through the switches, and disconnected each from the section beyond, the several switches operating *seriatim* each to disconnect its own magnet and ground-wire from the line and to close the break between its own and the succeeding section, substantially as described.

2. In a line-wire emanating from a central office, a series of grounded electro-magnetic switches arranged in normally disconnected sections of said line-wire, and each operating to close the break between its own and the succeeding section, the adjoining switches in said series being operated by currents of opposite polarity, substantially as described.

3. The combination, with an electro-magnet and switch operated thereby, of contacts and connections for completing a circuit through the electro-magnet from either of two lines, according to the position of the switch, substantially as described.

4. In an electric circuit or telephone-line, a series of electro-magnetic switches operating

to disconnect from the line or throw out of circuit the resistance of the coils of said magnet, substantially as described.

5. The combination, with two lines, of a series of electro-magnets, switches operated by said magnets, and contacts and connections whereby said magnets may be transferred, by means of electric currents, from one line to the other, substantially as described.

6. An electrical system comprising a series of grounded electro-magnetic switches arranged in normally-disconnected sections of a line-wire, a second line-wire, and contacts and connections for said switches, substantially as described.

7. Two line-wires, in combination with a series of electro-magnetic switches acting to shift their magnets from one line to the other, substantially as described, adjoining switches being operated by currents of opposite polarity.

8. An electric bell adapted to be set for ringing by a single rapid reversal of current, and comprising an obstruction capable of preventing the bell-hammer from reaching the bell in the normal position of the apparatus, which obstruction is cleared or rendered inoperative to prevent contact of the bell-hammer with the bell by means of the rapid reversal of current aforesaid, substantially as described.

9. The combination, in an electric bell or signaling-instrument, with a polarized armature controlling the operation of said bell or instrument, and pivoted, as indicated, of a projection around which the armature or an arm attached thereto is swung by a current of one polarity, rapidly followed by one of opposite polarity, substantially as described.

10. The combination, with the projecting arm of a switch-lever, of a polarized tongue or armature capable of vibrating about axes at an angle with each other, substantially as described, so that, according to the character of the currents used, said tongue or an arm attached thereto may be caused to strike and operate said switch, or may be swung around it, as and for the purposes set forth.

11. The combination, with two switch-levers having arms extending toward each other, of a polarized tongue pivoted to the armature of an electro-magnet and operating substantially as described.

12. The combination, with an electro-magnet and armature, and bell-hammer operated by said armature, of a switch-lever and stop-pieces, substantially as described, said lever acting to operate a switch, and also serving as a stop to the bell-hammer.

13. An electric switch having a horizontal motion only and resting upon three contact-points, substantially as described.

14. A horizontal moving electric switch resting upon three contact-points, having contact-springs above, without strain upon the elasticity of the latter, substantially as described.

15. The combination, with a polarized tongue pivoted to the armature of an electro-magnet so as to vibrate across the plane of movement of said armature, of a stop-piece projecting toward said armature and adapted to prevent the movement of said tongue while the armature is drawn forward.

16. The stop *y*, in connection with a horizontal moving electric switch operated by two bell-crank levers, which, in turn, are operated by an arm having four motions derived from the two armatures of an electro-magnet, substantially as described, for the purpose specified.

17. The combination, with an electro-magnet, armature, and polarized tongue pivoted to said armature, of a switch and bell operated by said magnet, and contacts and connections whereby said magnet can be made to form part of either of two line-wires, according to the position of the switch, substantially as described.

18. In combination with two lines of wire and a telephone or telephones at the central station, a series of signal-instruments, each instrument containing a telephone and a switch, the latter constructed substantially as described, and operated by an electro-magnet and two armatures, one polarized and the other neutral.

19. The bell B, bell-hammer H, soft-iron armature F, polarized armature *m*, electro-magnet E, switch T, bell-crank levers G' G^2, and connecting-wires, substantially as described.

In witness whereof I have signed this specification in presence of two subscribing witnesses.

ALEXANDER GRAHAM BELL.

Witnesses:
PHILIP MAURO,
C. J. HEDRICK.