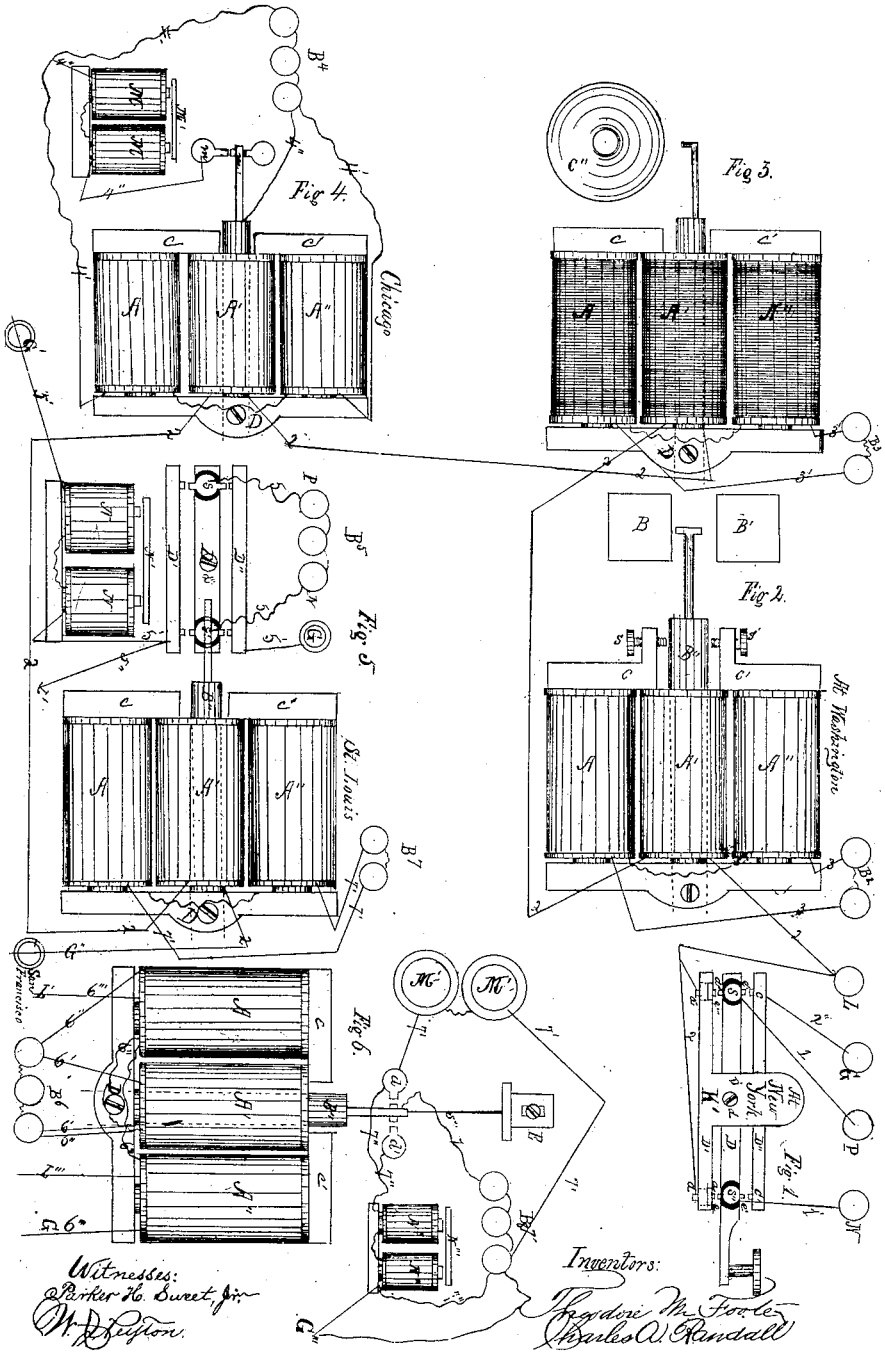
2 Sheets—Sheet 1.

# T. M. FOOTE & C. A. RANDALL.

## PRINTING TELEGRAPH APPARATUS.

No. 114,790. Patented May 16, 1871.



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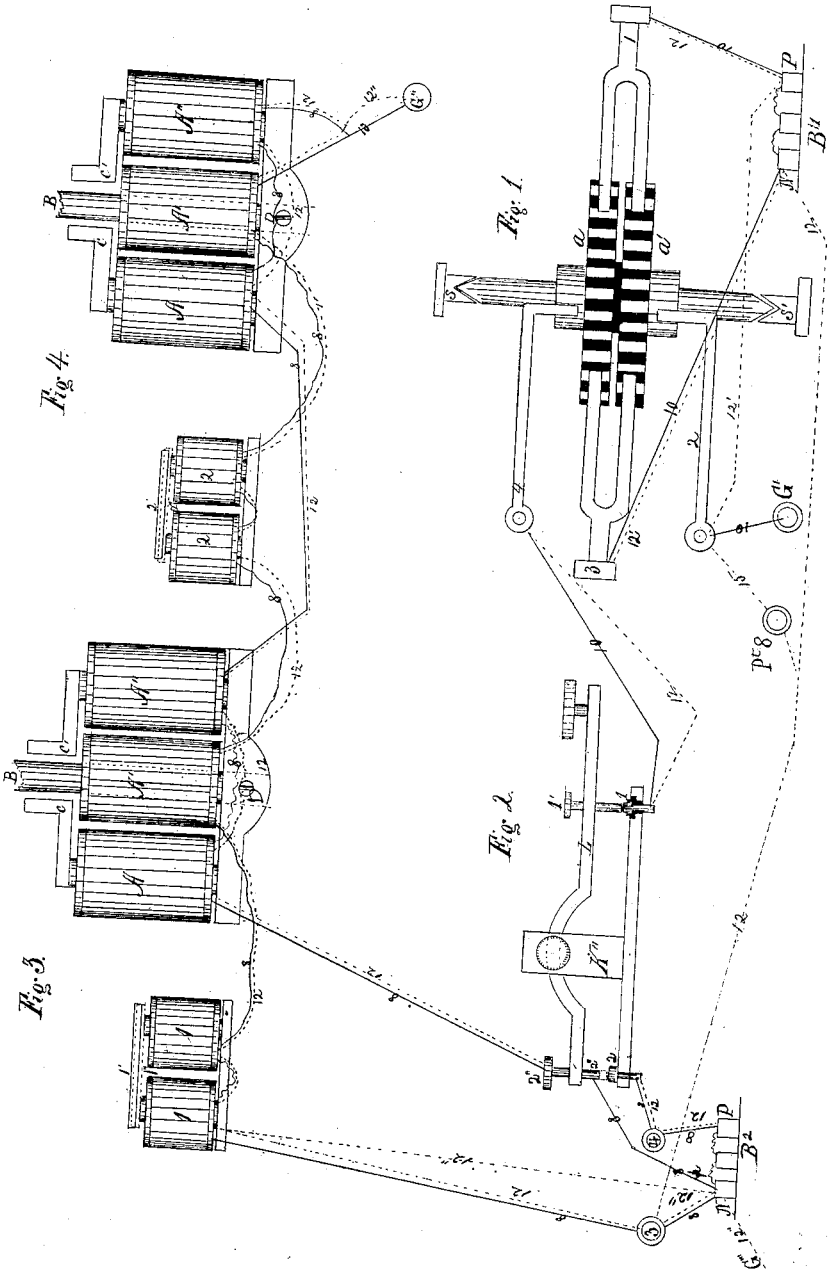


Witness.
Parker H. Sweet, Jr.
W. L. Peyton.

Inventors:
Theodore M. Foote
Charles A. Randall

# UNITED STATES PATENT OFFICE.

THEODORE M. FOOTE AND CHARLES A. RANDALL, OF BROOKLYN, E. D., N. Y.

## IMPROVEMENT IN PRINTING-TELEGRAPH APPARATUS.

Specification forming part of Letters Patent No. **114,790**, dated May 16, 1871.

*To all whom it may concern:*

Be it known that we, THEODORE M. FOOTE and CHARLES A. RANDALL, of Brooklyn, E. D., county of Kings, and State of New York, have invented new and useful Improvements in Telegraph Apparatus and Electric Circuits; and we do hereby declare the following to be a full, clear, and exact description thereof, which will enable those skilled in the art to which this invention appertains to make and use the same, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates to telegraph apparatus, and is an improvement upon the apparatus employed in the Morse system of telegraphing, and also consists of an arrangement of electric circuits in combination with electric magnets at one or more distant stations, the said circuits being also well adapted to commercial reporting-telegraphs when it is desirable not to have a local battery, and with the use of only one line-wire.

It is well known that in the present Morse system of telegraphing the principal instruments in use are the relay, key, sounder, register, and repeater. The register and the sounder are the principal receiving-instruments, and generally are worked by local batteries, and at distances of ten or twenty miles, and upward, the relay is employed as a local-circuit breaker, closing a local circuit or current on the local receiving-instrument by the action of the line-current passing over the helices of an electro-magnet, and when the line is broken the retractile force of an adjustable spring serves to break the local circuit again.

In practical working the line-circuit is ever varying, and the relay—the basis of long-line telegraphing—is ever a source of annoyance and trouble to the receiving-operator, who is obliged to closely watch and carefully adjust the spring already alluded to, at times the adjustment being too great, and again not enough.

In our present improvement we are enabled to dispense with the spring, the line-current itself automatically making and breaking the local circuit, and it is also entirely free from any adjustment whatever; and by dispensing with the spring we are enabled to work our relay much farther than the relays in general use, and with a much lighter current.

In the instrument known as the "sounder," the same defect exists as in the relay, the only difference being that the sounder is not so delicately adjusted, and a stronger spring is used, and, consequently, more battery-power is required to overcome its retractile force, and the sounder for long distances is also subject to the relay.

In our present improved sounder we have dispensed with the spring, and may or may not adjust the movement of the hammer by means of the screws *s s'*, Figure 2, and can work our sounder effectively quite as far as the "Morse relay," so called, is generally worked, and without the aid or employment of a relay, and with a small local battery.

We believe it to be new and advantageous to automatically change the poles of a local battery at one or more distant stations, using either one polarity of the distant local battery over one circuit, and the reverse polarity over another circuit, for different purposes, or both polarities over one or more circuits for the same purpose, which we are enabled to do with the apparatus shown in Fig. 5. It has also been found necessary to use an instrument called a "repeater" in long-line telegraphing.

With our simple and improved form of repeater we are enabled at a distant station—as, for instance, as shown in the drawing, St. Louis—to automatically close a local battery upon a line, repeating at that station the impulse, whether of long or short duration, sent from the station at New York, and also are enabled at the station (St. Louis) to close the continued line-circuit with the same polarity, whether positive or negative, that was sent from New York, so that, if we are using the line-circuit for more than one purpose, the opposite polarities or poles of the battery effecting the different purposes, to effect this automatically changing the poles of a distant local battery alternately or occasionally over a continued line-circuit becomes at once quite important and necessary. Our method and apparatus for doing this we believe to be new, simple, and effective.

In telegraphing it is found expedient to use a local battery, which may be at the sending-

station or at the receiving-station, or both, for different purposes, and to effect that an instrument called a "switch" or a "circuit-changer" is found indispensable.

In our drawing, Fig. 6 shows in top-plan view an automatic electro-magnetic switch, which is effective on long or short distances, and which we will describe here.

We are well aware of Siemens' "polarized switch and relay," which is a polarized steel bar placed between the cores of an electro-magnet, and effected by a reversed polarity of the line-circuit.

In our present improvement the compound-magnet, consisting of helices A A′ A″, having a soft-iron core of the helix A′ pivoted at D, which becomes electro-magnetized by currents of electricity passing over the helix A′, either from a local battery or from a line-battery, and the core B″, is made to oscillate upon a pivot, D, by opposite polarities in the core B″ and one of the cores *c c*′, the said polarities being developed either by the use of a line and local batteries upon A A′ A″ on a line-current over all, as will be herein shown.

In Fig. 6, in which we use the compound magnet as a switch, are shown several important features: First, the connections. From battery $B^6$ a current passes over wire 6′, helix A′, and over wire 6′, back to battery, and a line-current from L″, over helices A A″, wire 6‴, to ground G, or a line-current over wire L‴, helix A″, wire 6‴, to ground at G, and a local current from battery $B^6$ over wire 6″, helices A′ A″, wire 6″, to battery, or a local on A A″ and line-current over A′, same as shown in Figs. 2, 3, 4, 5, the same result being effected in each case—namely, the rapid oscillation of the bar or core B; and in the arrangement shown in Figs. 2, 3, 4, 5, there being a local on A A″ of any desired power, charging the cores *c c*′ any desired strength or amount, a light intense current over A′, which may be wound with very fine wire, develops polarities in the core B″, and the strong poles *c c*′ cause the core B″ to oscillate with great force, and as rapidly as it is practicable to reverse the polarity of the core B″, which, if bar B″ is properly constructed, may be done very rapidly. In Fig. 6 we also show attached to the bar or core B″ one end of a spring, S″, it being a straight flexible steel spring; or other elastic substances may be used; and its opposite end is fastened to an adjustable elbow, E. Its use is to keep the core B″ central between the points *d d* when the circuit is broken, and by this arrangement the compound magnet may be used as a switch in various ways, namely: One end of a battery, $B^6$, being attached to the core B″, and the other end through different wires to the points *d d*′, a closed line-circuit from positive pole of a battery—we will say over helix A′—will cause the core B″ to connect with the point *d*′, connecting the current from battery $B^6$ over magnet N″, and upon breaking the line-circuit the spring causes the bar B″ to return to its central position again, thereby breaking the local circuit again. If, now, the negative current be used over the line, the points *d* will be connected and the magnet M′ operated, and upon breaking the line-circuit the spring acts as before. Also, the circuits *d*′, N″, 7″, and *d*, 7′, M′ may be connected rapidly alternately by the use of alternate negative and positive currents over the line-circuit, by which we obtain a rapid oscillation of the core B″ and a connection at *d* or *d*′, at each impulse, which will enable us to automatically switch the local current from point *d* to *d*′, the points *d d*′ being in the same or separate circuits.

In the drawings, in Sheet 1, Fig. 1 shows a side view of a key in the form of a pole-changer; Fig. 2, a top or plan view of a sounder; Fig. 3, a top or plan view of the call-bell; Fig. 4, a top or plan view of an automatic relay; Fig. 5, a top or plan view of a pole-changer and repeater; Fig. 6, a top or plan view of an electro-magnetic automatic switch.

In Fig. 1 the key K′ is operated as a pole-changer, and is constructed and connected with the battery and line in the following manner: The center lever D, insulated from D′ D″, and swinging upon a pivot at *d*, has upon it the insulated studs S S″, bearing the points *e e*′ *e*″ *e*‴, and the wires 1 1′, connections from the negative and positive poles of the line-battery. The frame D′ has the points *a a*′ insulated from it, the said points *a a*′ being connected to line by wire 2. The bar D″ is rigid to the support D′, and has the points *c c*′, and is connected with ground by wire 2″. When the key is depressed the points *a e e*″ *c* are in connection, and the current passes from post P, through line 1, to stud S, points *e*″ *c*, bar D″, wire 2″, to ground, and from post N, over wire 1′, stud S″, points *e a*, to wire 2, to line. When the points *e*′ *c*′ *a*′ *e*‴ are in contact the positive current goes to line and negative to ground.

We do not claim more than the combination of this form of key with the magnet A A′ A″; neither do we confine ourselves to this particular arrangement, as the same can be modified or varied and the same result be produced.

In Fig. 2 is shown the sounder; the magnet having been fully described in the description of Fig. 6, we will only describe the other points of this improvement. As the core B″ vibrates it is made to strike at each movement upon the boxes B B′, or any suitable substance or arrangement from which clear and distinct sound may be obtained. By this arrangement we are enabled to obtain two sounds in the time taken with the present Morse apparatus to obtain one. We may use only one box, B, or its equivalent, if it is found desirable. We also dispense with the spring necessary to the sounders in general use, by using an impulse of one polarity to oscillate the core B″ in one direction, and the

opposite polarity oscillating it in an opposite direction, and, as has been explained, the power for working the sounder-hammer or core B″ being produced at the receiving-station with a local battery or helices, A A″, we can work our sounder effectively nearly as far as the core B″ can be charged, it appearing at once to be an improvement over the sounders in general use.

The same explanation applies to the several other figures, 3, 4, 5, 6, except that the relay, Fig. 4, and switch, Fig. 6, may be worked much farther, there being necessary only the slightest movement of the core B″, and the advantages over the relay in general use are very evident. There being only one helix, A′, in the line-circuit, and only one core, B″, to be charged, and no spring to overcome, it is more sensitive, will require less line-battery, and will work much farther and more certainly and reliably than the relay in general use.

It is evident that no adjustment whatever is required.

We do not confine ourselves to the exact construction described herein, as many modifications can be made without departing from the principle of this invention.

In Fig. 5 the pole-changer does not differ materially from the one in Fig. 1.

The lever D swings on pivot *d*″. An arm on B″ projects through the stud S′, and, as the core B″ vibrates, alternate negative and positive currents are automatically passed over the local magnet N from battery B⁵. The battery is connected with the studs S S′, and when S is in connection with D″ the positive current goes to ground at G, over wire 5′, and negative current from stud S′, to D′, wire 5, magnet N, wire 5′, to ground, and vice versa; also, by connecting D′ with line-circuit by wire 5″, the alternate negative and positive currents are sent to line 2, making this combination at once an automatic pole-changer and an automatic pole-changing relay, for local or continued line-circuits, and, by proper connections, a repeater, repeating over a continuous line impulses of longer or shorter duration from the first or sending station at an intermediate station.

We do not confine ourselves to this particular form or construction. There are numerous devices we may use, the effects being the same. Springs may be attached in various ways, and other connections made to produce the same result.

We have shown the different instruments at different stations in the line-circuit 2, from New York to San Francisco; but it is well understood that each and all may be combined and operated effectively at each office or station.

In the drawing, Sheet 2, Figs. 1, 2, 3, 4 show other combinations and connections, which we will proceed to describe at this point.

Fig. 1 represents a form of pole-changer materially the same as the one described and shown in our application filed December 8, 1870. Fig. 2 represents a common key, K″, used in the Morse apparatus; Figs. 3 and 4, electro-magnets, in combination with the key and pole-changer and batteries B¹ B².

These combinations are especially adapted to telegraph apparatus, whether printing, dial, or Morse instruments, when worked with one line-wire and without the aid of a local battery.

In this combination the keys, Figs. 1 and 2, we will presume, are at some central sending-station, the electro-magnet 1 1 and its armature and helices A A′ A″ at a receiving-station, and Fig. 4, the magnet 2 2 and its armature 2′ and helices A A′ A″, at another station.

In operating these combinations the circuits are as follows: In the first circuit a current passes from N, battery B′, over wire 10, spring 3, wheel *a*′, spring 2, wire 10, to ground at G′, and from B′ P, wire 10, spring 1, circuit-wheel *a*, spring 4, wire 10, insulated point 1, screw 1′, key-lever L, screw 2, wire 8, helices A A″, wire 8, helices A A″, wire 10, to ground at G″. Alternate negative and positive currents passing over this circuit, and a light current passing over wire 8, from $p^8$ B″, to screw 2″, wire 8, helices A A″, wire 8 A A″, wire 8, and returns over A′, wire 8, magnet 2 2, wire 8 A′, wire 8, magnet 1 1, wire 8, to post 3, and wire 8, to B², again causes the oscillation of the cores B B, as is well understood.

To render the magnets 1 1 2 2 effective for any purpose, the key K″ is closed at 2 2, and a strong current is sent over the circuit last described from B².

In the second circuit, (shown by dotted lines,) the points 2 2″ being in contact, a strong current passes from B², over dotted lines 12, screw 2″, wire 12, helices A A″, wire 12, magnet 2 2, wire 12, helix A′, wire 12, magnet 1 1, wire 12, post 3, to battery B² at N, strongly charging the helices in the circuit, and attracting the armatures 2 2′ to the position shown by dotted lines.

The connections from battery B¹ may be the same as previously described, or they may be from B¹ N, wire 10, spring 3, wheel *a*′, spring 2, wire 15 P′ 8, and from P B¹, wire 10, spring 1, wheel *a*, spring 4, wire 10, screw 1, screw 2″, wire 12, over all helices and dotted lines 12, to post 3, wire 12, P′ 8, or from N B¹, wire 12, spring 3, wheel *a*′, spring 2, wire 12, to P, and from P, wire 12, spring 1, wheel *a*, spring 4, wire 12, screw 1′, screw 2″, dotted wire 12, over circuit last described, to post 3, wire 12, to N, battery B¹; and the battery B², at the same time, may be grounded at G‴, and at opposite end of line at G″.

In either of the combinations of circuits but one line-wire is used, and the results produced are the rapid oscillation of the armatures or cores B B without the use of local batteries, and the effecting of the magnets 1 1 2 2 in one case by an increased current from the sending-station, by means of key K″, and in the other cases a strong current serving to

charge the magnets 1 1 2 2, and cause them to hold their respective armatures attached to their respective cores, and by breaking that circuit the armatures 1′ 2″ are released.

In these combinations the magnet A A′ A″ may be used for any of the improvements herein shown and described, and these arrangements, combinations, and circuits are especially adapted to that class of commercial reporting printing-telegraphs described in our application filed March 24, 1871, the magnet A A′ A″ serving as the type-wheel magnets, and the electro-magnets 1 1 2 2 as printing-magnets.

Having fully described our several improvements, what we claim to be new, and desire to secure by Letters Patent, is—

1. The key K′, in combination with the compound electro-magnet A A′ A″, as set forth.

2. A sounder or receiving-instrument, composed of the combination of the compound electro-magnet A A′ A″, elongated core B″, and anvil B, or its equivalent, as herein set forth.

3. A sounder or receiving-instrument, composed of the combination of the electro-magnet A A′ A″, elongated core B″, anvils B and B′, or their equivalents, constructed and operated substantially as described.

4. A call or signal bell, composed of the combination of the compound electro-magnet A A′ A″, core B″, hammer *d*, and bell *e*″, constructed and operated as described.

5. In telegraph apparatus, a pole-changer D D′ D″ S S′, or equivalents, combined and operating in connection with one or more compound electro-magnets, A A′ A″.

6. An automatic local-circuit pole-changer, operated automatically at a distant station by means of an alternate open and closed line-circuit.

7. An automatic local-circuit pole-changer, operated automatically at a distant station by means of alternate negative and positive currents transmitted over the line-circuit.

8. The compound electro-magnet A A′ A″, arranged and connected as a switch, substantially as and for the purposes herein shown and described.

9. The combination of the compound electro-magnet A A′ A″, and adjustable elbow E, and spring S″, and soft-iron core B″, as and for the purpose herein shown and described.

10. A non-adjustable relay, constructed substantially as described.

11. The combination of the pole-changer *a* *a*′, or its equivalent, key K″, electro-magnets 1 1 and 2 2, and compound electro-magnet A A′ A″, and circuit or circuits herein shown, as and for the purpose described.

THEODORE M. FOOTE.
CHARLES A. RANDALL.

Witnesses:
JAMES L. NORRIS,
PARKER H. SWEET, Jr.

2