2 Sheets--Sheet 1.

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

Electric-Telegraphs.

No. 153,063. Patented July 14, 1874.

Fig. 2.

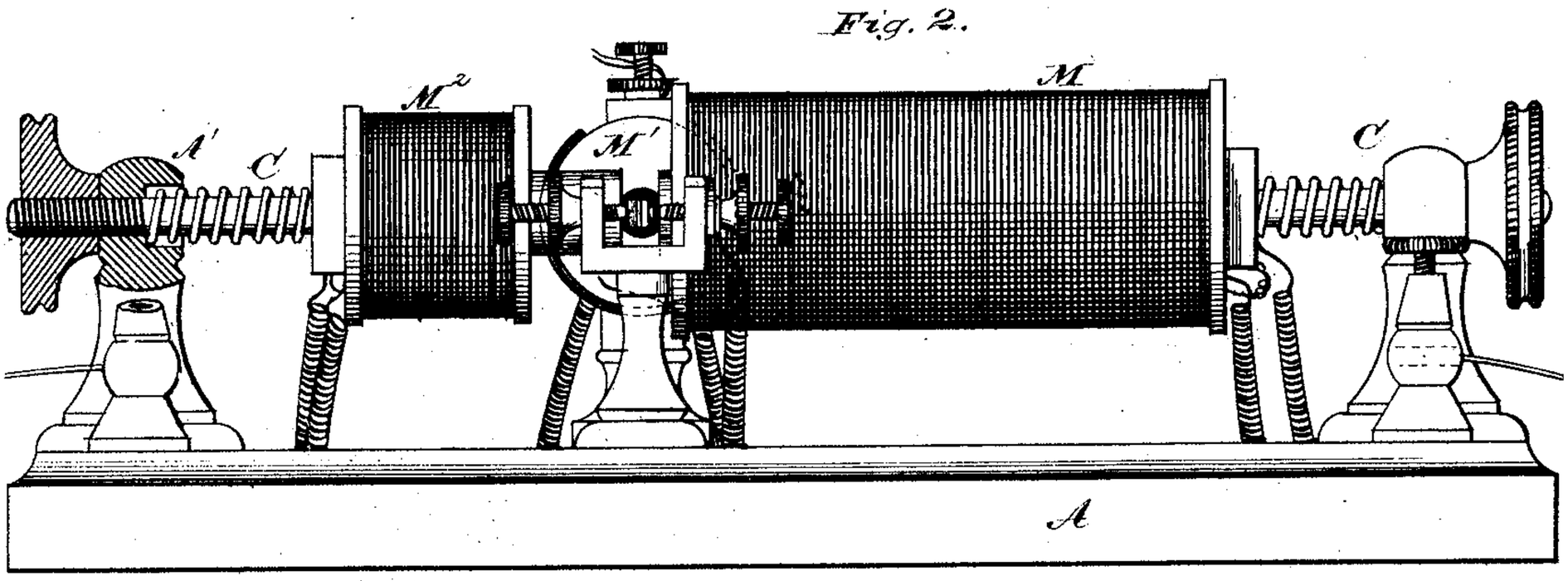
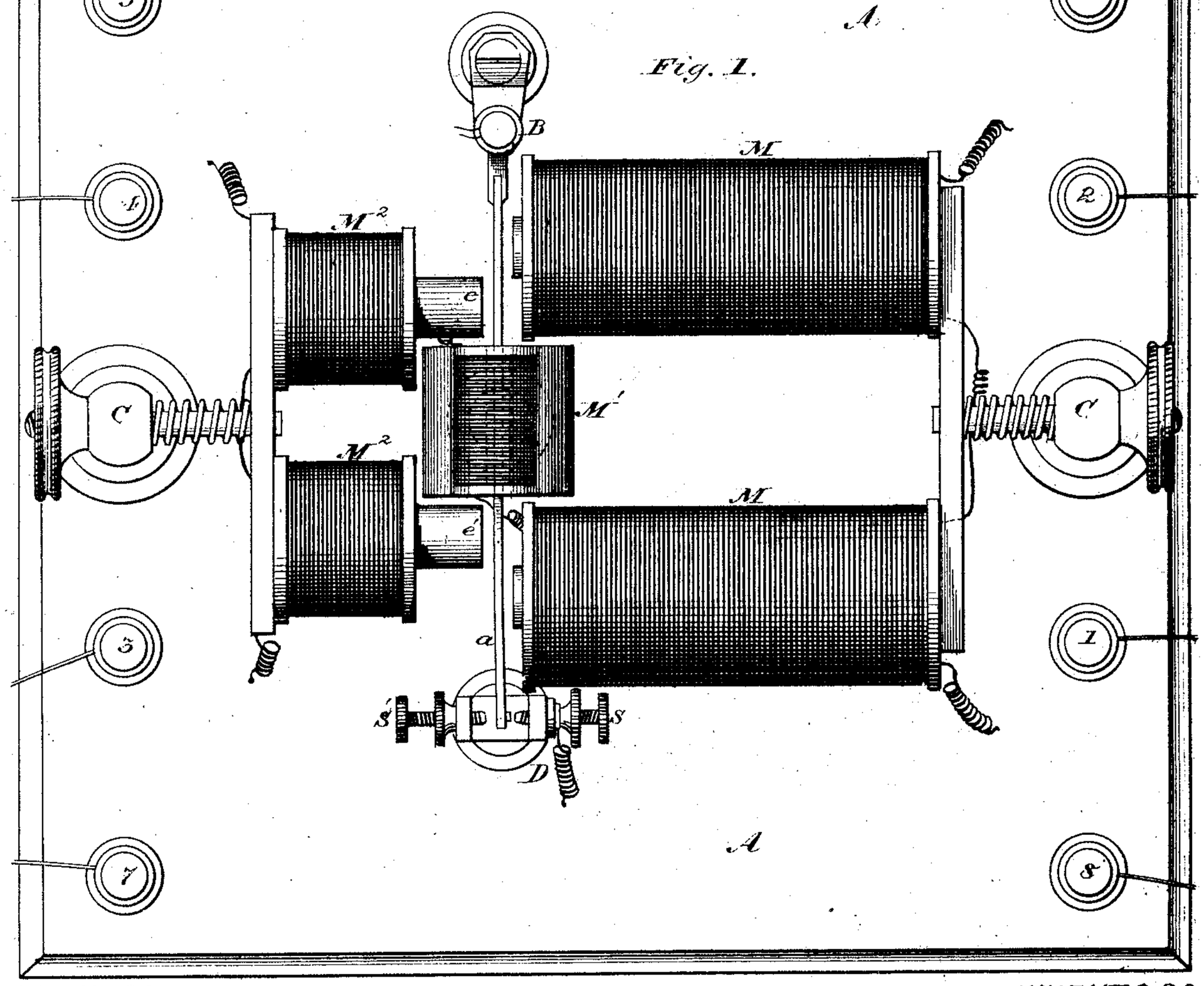


Fig. 1.



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2 Sheets--Sheet 2.

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

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Fig. 3.

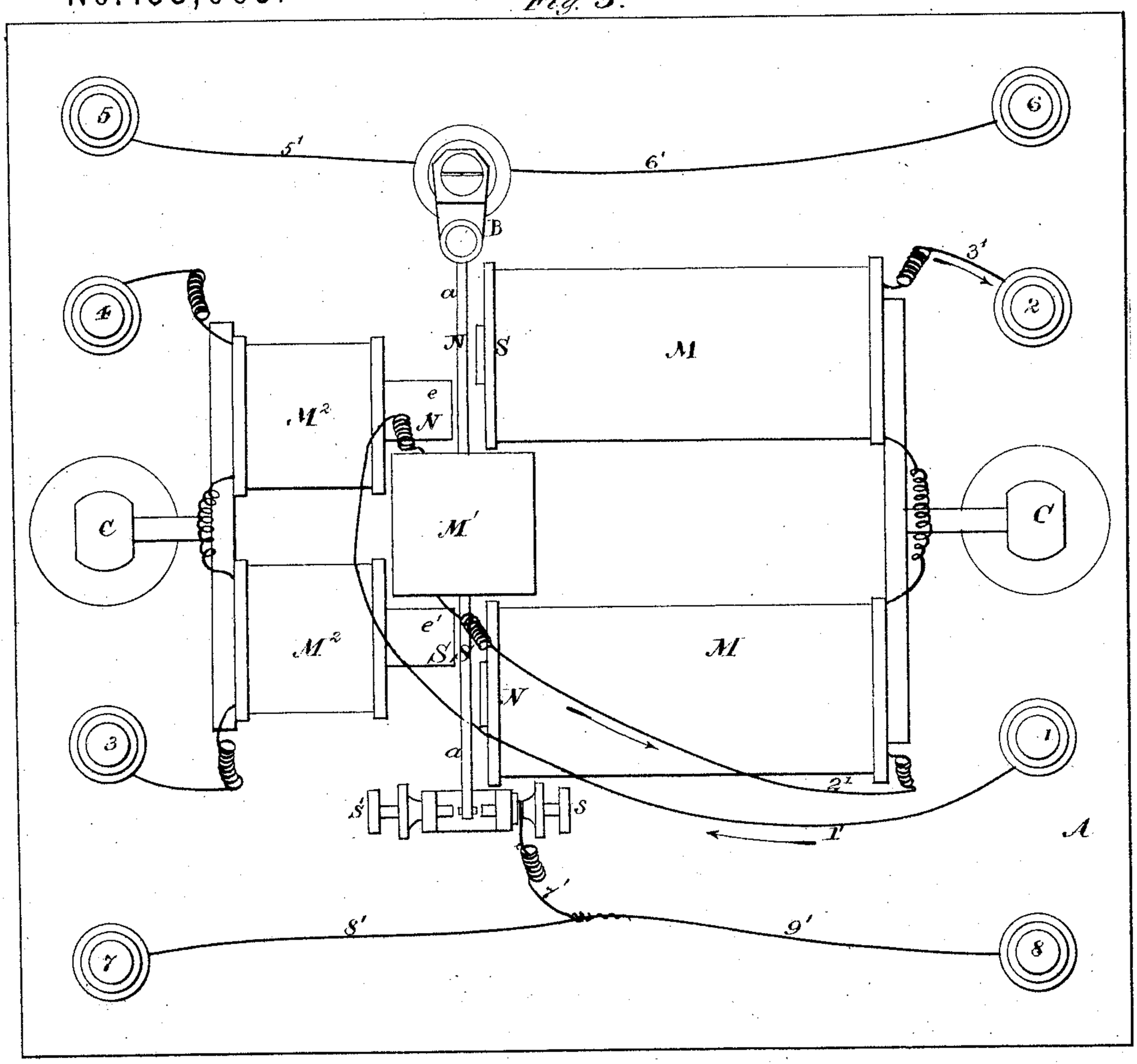

Fig. 4.

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UNITED STATES PATENT OFFICE.

THEODORE M. FOOTE AND CHARLES A. RANDALL, OF NEW YORK, N. Y.

IMPROVEMENT IN ELECTRIC TELEGRAPHS.

Specification forming part of Letters Patent No. **153,063**, dated July 14, 1874; application filed June 27, 1874.

CASE A.

To all whom it may concern:

Be it known that we, THEODORE M. FOOTE and CHARLES A. RANDALL, of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Automatic Relays and Repeaters, and methods of operating them, of which the following is a specification:

Our invention relates to that special class of telegraph apparatus known as relays, and it may be used as relays ordinarily are—that is, as relays simply at terminal and ordinary way stations, and at repeating-stations in the combination of relays and sounders, known as repeaters. In this relay we use a pivoted armature, passing through and playing in one or more helices, by which it is inductively polarized whenever a current is passed therethrough. Upon one side of this armature is arranged a pair of electro-magnets, whose cores are contiguous to the armature, the helices thereof being traversed by a constant electrical current, so that while no other influence is acting upon the armature, it will be attracted by these cores. On the opposite side we arrange a pair of electro-magnets, with such connections that the helices thereof are traversed by the main-line current when passing, which current, preferably, also passes through the coil surrounding the armature. These three sets of helices are so wound and connected that when all are excited the vibrating armature shall be acted on by the attractive force of one set and the repellent force of another set simultaneously—that is, there shall be no neutralization by similar poles acting oppositely on it at the same end, but that it shall be acted on by what may be termed a full "push and pull." This makes an apparatus exceedingly sensitive to the quickest and most delicate pulsations of the electric current. It is well known that short currents, mere flashes, corresponding to the dot of the Morse alphabet, may be transmitted with immense rapidity over land lines or submarine cables; but when the length of the pulsations is varied to form dots and dashes, the speed is very greatly reduced. Hence the method we prefer to use is to make such signals by short currents or pulsations, corresponding simply to a dot, a dash being recognized by the space left after the dot, which is substituted therefor. This may be done by hand, or, preferably, by paper perforated in two rows, one row for positive and one row for negative currents, succeeding each other alternately, and all of equal extent, the dash being represented by an extra space of unperforated paper. But in order to give a clearer idea of our invention, and to enable those skilled in the art to make and practice the same, we will give a detailed description thereof, reference being had to the accompanying drawings forming part of this specification, in which—

Figure 1 is a plan, and Fig. 2 a side, view of our improved relay. Fig. 3 is a circuit diagram thereof, and Fig. 4 a view of the perforated paper before referred to.

The same letters indicate like parts in all the figures.

Upon any suitable base, A, provided with binding-posts 1, 2, 3, 4, 5, 6, 7, and 8, for making the proper local, line, battery, and ground connections, are secured the electro-magnets M and M^2, arranged generally opposite to each other, but with their cores out of either the same vertical or horizontal planes. In this case they are in different vertical planes, so that the circles of their inductive magnetic influence, respectively, shall not interfere. The cores *e e'* of M^2 are extended some little distance beyond the heads of the helices, and between these cores and the heads of the magnets M is arranged a helix, M^1, through which passes, and is polarized by it, the armature *a*, pivoted to the upright B, so as to be capable of motion toward either M or M^2. The opposite end of *a* plays between set-screws *s s'* in an upright, D. To *a* and to *s s'*, the proper connections may be made for either making or breaking an electrical circuit, upon *a* impinging against either set-screw. M and M^2 are supported in the usual manner, and are arranged to be adjusted by adjusting-screws C C, as is ordinarily done.

Referring to Fig. 3, the arrangement of circuits is as follows: To post 3, a connection is

made from a local battery, from which the circuit passes through M^2, and thence by post 4 back to the battery. This causes (when no line-current is on) the armature *a* to be attracted by M^2, and held against set-screw *s'*. At post 1 the line-current enters, and passes by wire 1' to M^1; thence by wire 2' to magnets M, and thence by 3' to post 2 and line again, or to the ground. The helix M^1 is so wound that the ends of *a* will have the same polarity when polarized as the cores of M^2 opposite thereto, while M is so wound that the polarity of either of its cores will be opposite to that of the core of M^2 opposite thereto, and consequently also opposite to that of the adjacent end of *a*. From this it will be seen that upon a line-current being transmitted through M and M^1, *a* is repelled by the cores *e e'* of M^2, and attracted by M, being thereby swung over to *s*. The current ceasing, *a* is immediately depolarized, and is attracted again by M^2 over against *s'*. The letters N S upon the armature *a* and the cores of the magnet show the resultant polarities as they would be with the connections as described.

It is evident, however, that these connections may be varied, the rule to be observed being that the winding and connections must be such as to cause one set of magnets to repel and one to attract the armature—that is, the armature must be acted on doubly by both "push and pull," so that very delicate or weak currents may be availed of.

By posts 5 or 6, 7 or 8, wires 5' or 6', 8' or 9', armature *a*, and set-screws *s* or *s'*, a local circuit, embracing a battery and any desired instrument, is controlled in the usual way.

We prefer to use with this relay—though it may be used as relays ordinarily are, as a simple relay, or in a repeater—momentary currents, or impulses of short duration, that is, mere dots. To do this we use currents of opposite polarities, regularly alternating, and of exactly or nearly equal duration. Each current so transmitted would represent a dot; to represent a dash, we use a space after what may be called the initial impulse of the dash, longer than that occurring after a mere dot. Fig. 5 represents paper perforated to accomplish this, the upper row transmitting, say, +, and the lower — currents. The apertures *g h*, following each other without intermission, indicate dots, while as to *i* and *j*, the intervening unperforated spaces indicate that they are dashes.

In using this paper, we prefer to vary the connections in the relay, M and M^2 being connected in the line-circuit, and M in the local, the rule before given being followed in making such connections.

What we claim as new, and desire to secure by Letters Patent, is—

1. The combination of the armature *a*, provided with a polarizing helix or helices, M^1, and the electro-magnets M M^2, having electrical circuit-connections, as described, and arranged to act upon said armature, substantially in the manner and for the purpose set forth.

2. The combination of the electro-magnets M^2, provided with the extended cores *e e'*, the electro-magnets M, and helix M', the helix M' being arranged transversely to the magnets M M^2, and between the cores *e e'*, substantially as and for the purpose described.

3. The method of transmitting electrical signals, the same consisting in sending over the line regularly alternating currents of opposite polarity and of equal duration, the dots and dashes being distinguished by the space left after the transmission of any single impulse, substantially as and for the purpose described.

4. A fillet of paper perforated for telegraphic transmission in two rows, each row serving to transmit currents of a polarity opposite to those transmitted by the other row, the perforations in both rows being of equal size, and in each row intervening between those in the other row, substantially as described, and for the purpose set forth.

In testimony that we claim the foregoing we have hereunto set our hands.

THEODORE M. FOOTE.
CHARLES A. RANDALL.

Witnesses:
JAMES L. NORRIS,
A. S. DURNALL.