3 Sheets—Sheet 1.

R. E. HOUSE.

ELECTRO-MAGNETS AND RELAYS.

No. 180,100. Patented July 25, 1876.

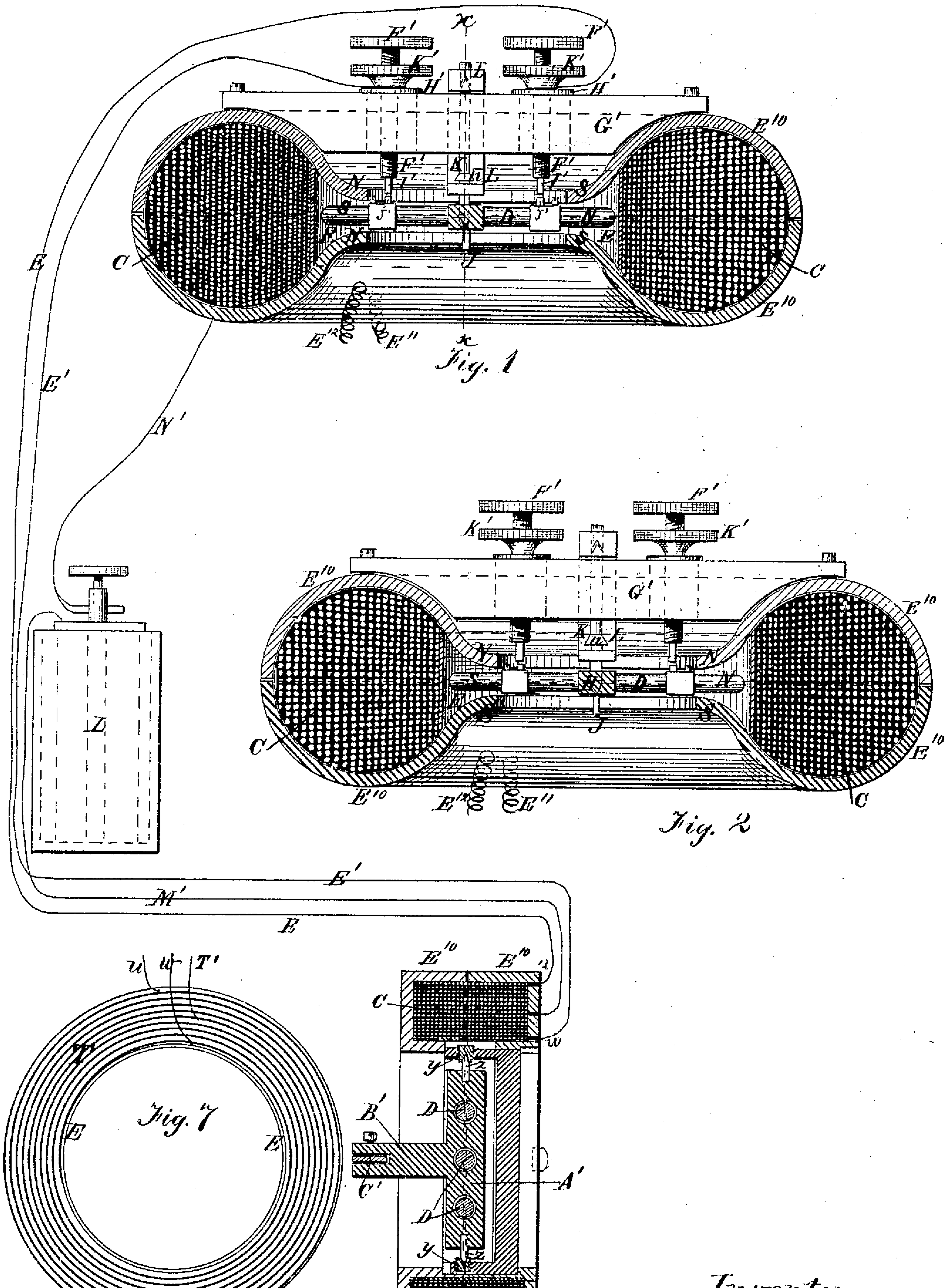

Fig. 1

Fig. 2

Fig. 7

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Fig. 3.

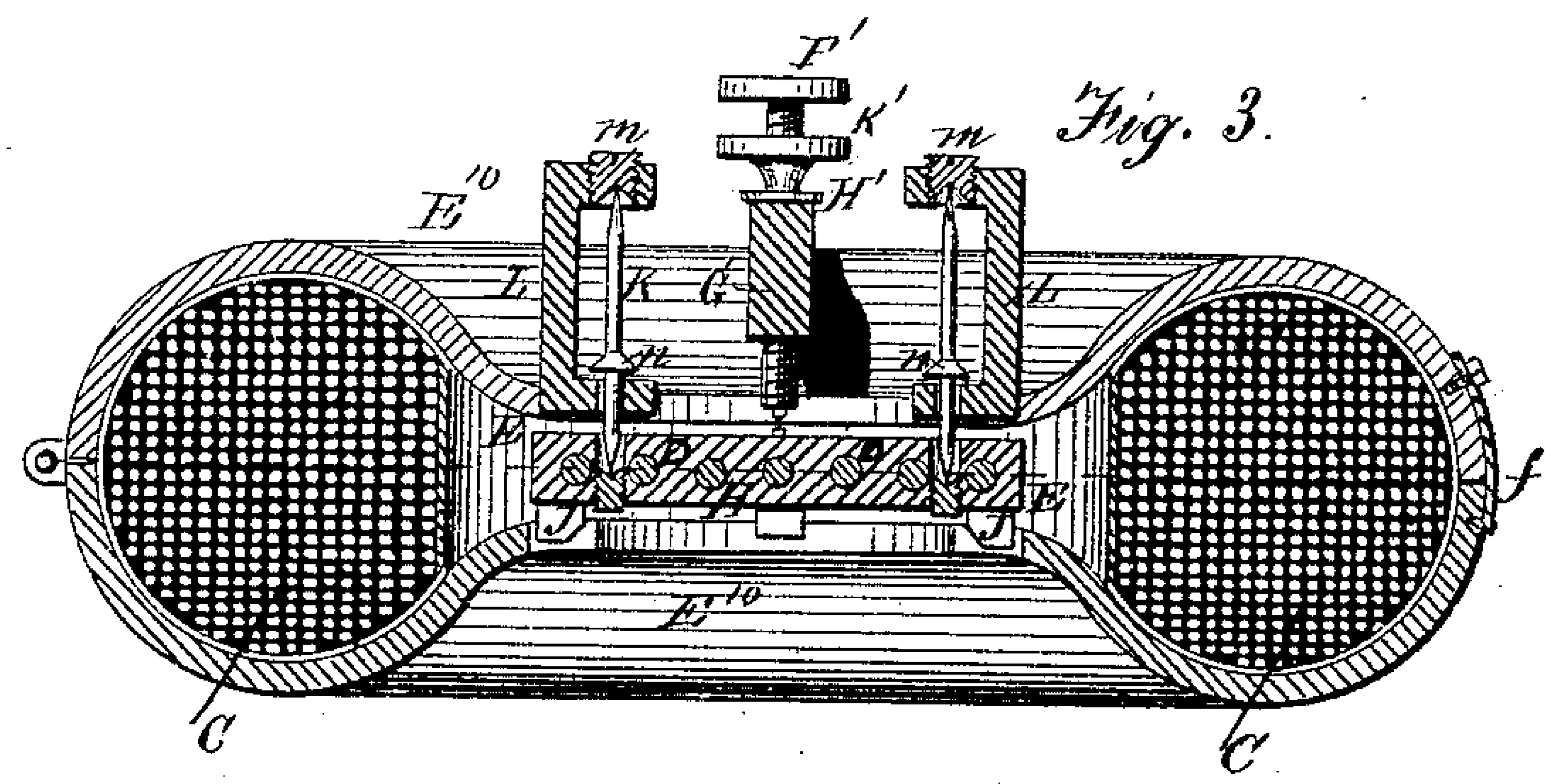

Fig. 4.

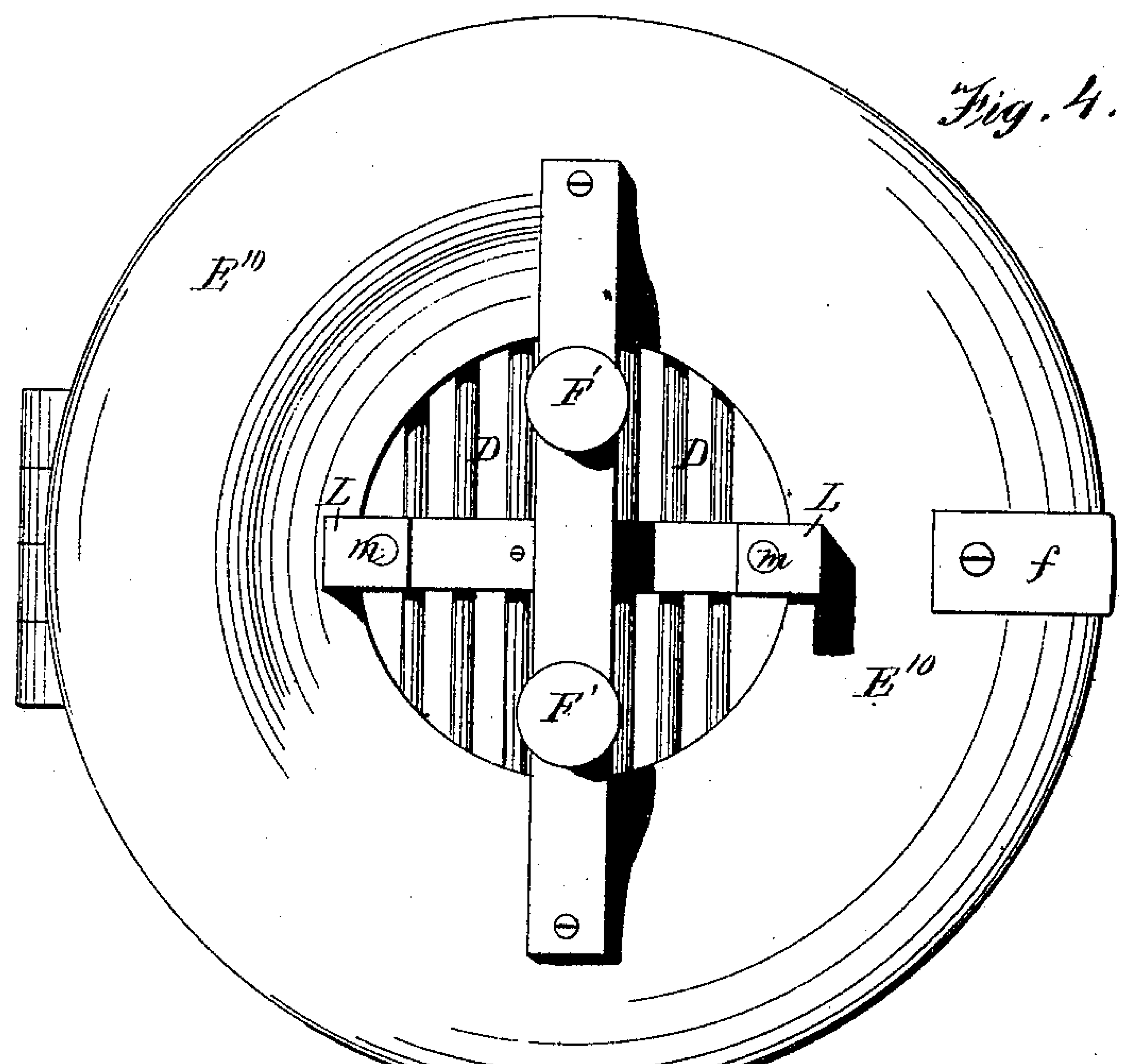

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Fig. 5

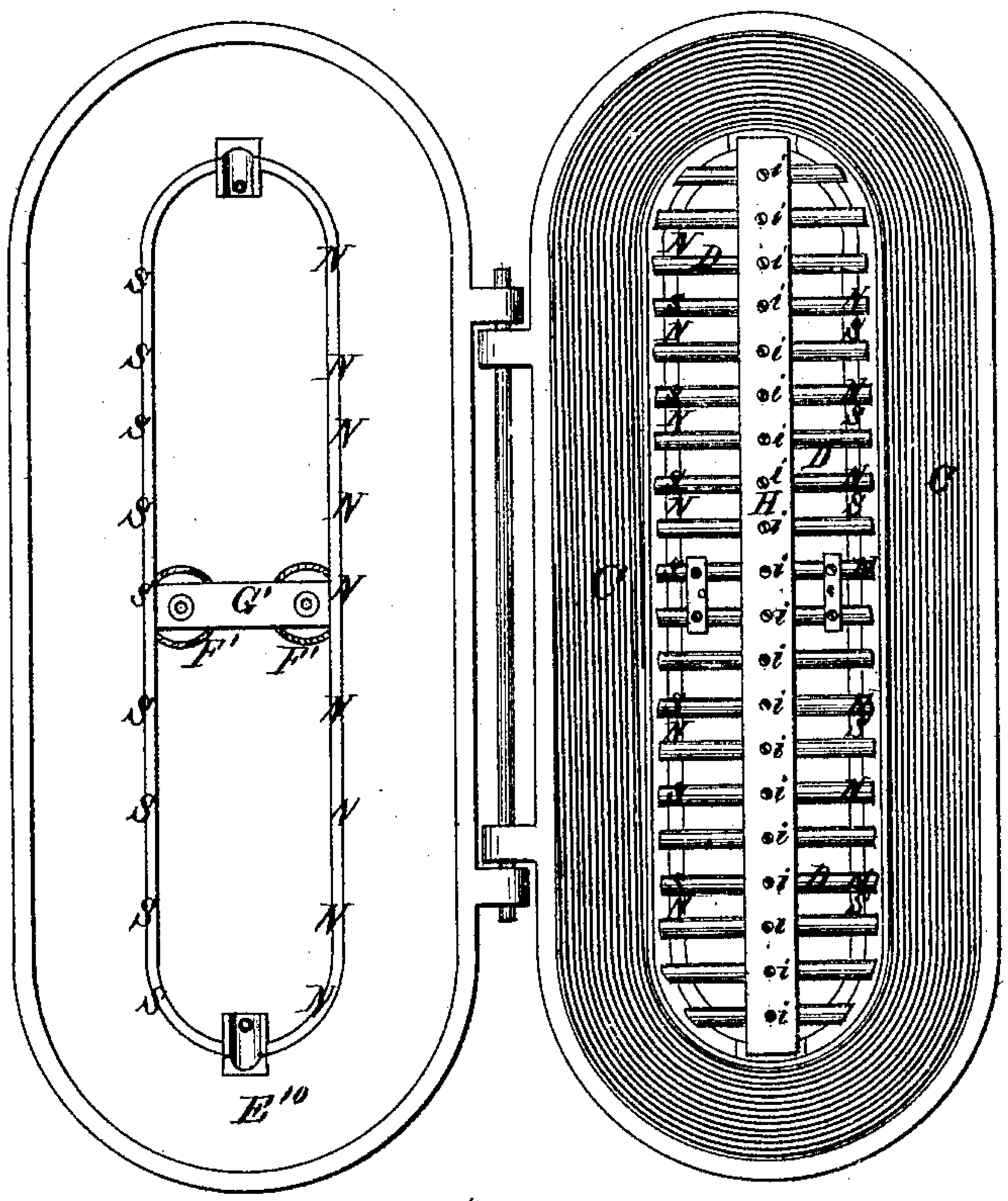
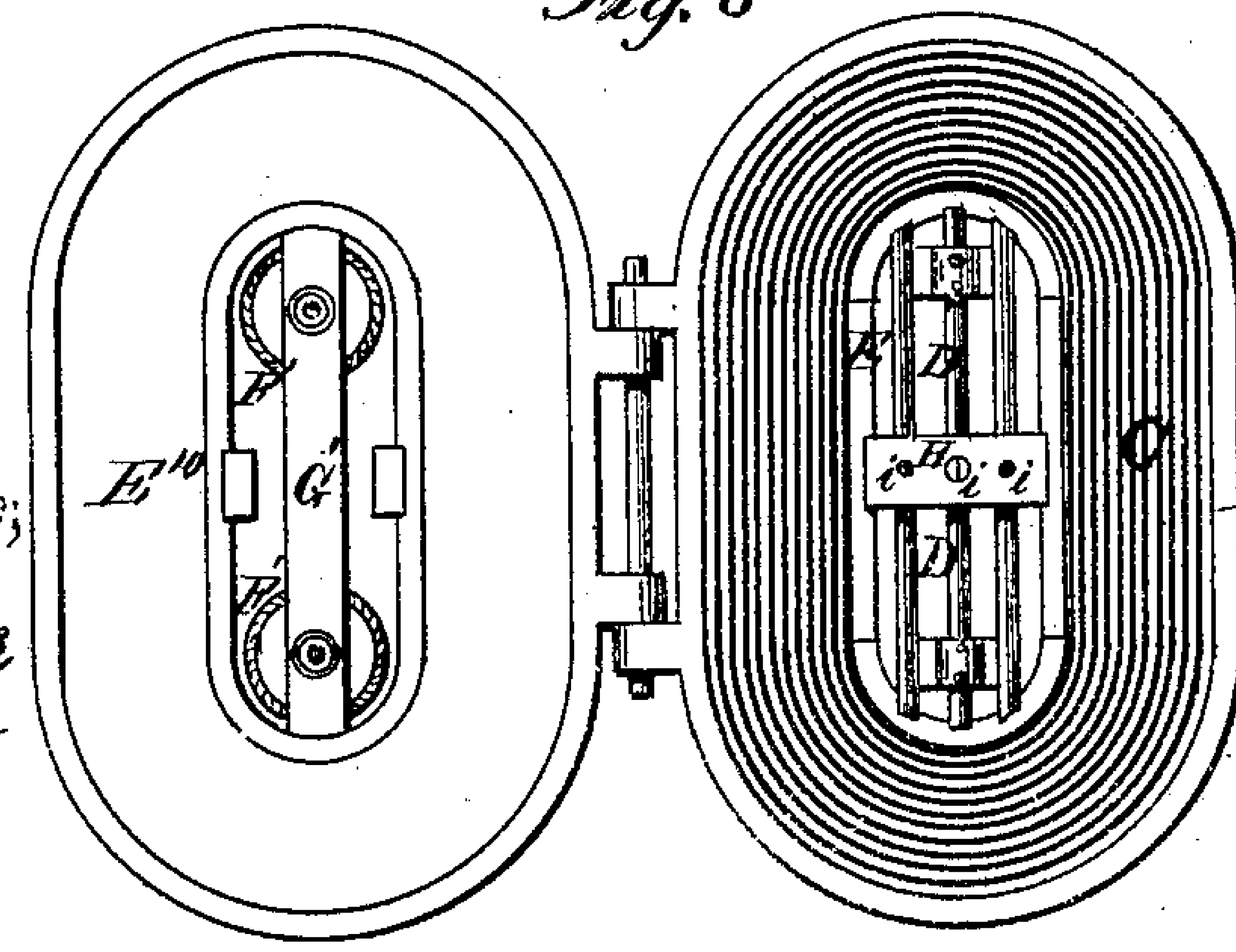


Fig. 6



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UNITED STATES PATENT OFFICE.

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IMPROVEMENT IN ELECTRO-MAGNETS AND RELAYS.

Specification forming part of Letters Patent No. **180,100**, dated July 25, 1876; application filed June 17, 1870.

To all whom it may concern:

Be it known that I, ROYAL E. HOUSE, of Binghamton, in the county of Broome and State of New York, have invented certain new and useful Improvements in Electro-Magnets and Helices; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1, Sheet I, shows a transverse vertical section of a receiving-magnet and a local magnet of a telegraph-line, electrically connected to each other and to a local battery, the latter being in elevation. Fig. 2, Sheet I, is a transverse section of the receiving-magnet detached from its local connections. Fig. 3, Sheet II, is a similar section of the receiving-magnet taken in a line at right angles to that of Fig. 2. Fig. 4, Sheet II, is a top plan view of the receiving-magnet. Figs. 5 and 6, Sheet III, are plan views of modifications in the form of the receiving-magnet, the covers in each case being swung open; and Fig. 7, Sheet I, is a plan view of the local-magnet helix.

Similar letters of reference in the drawings denote the same parts.

My invention has for its object to improve the construction and operation of helices and electro-magnets for telegraphic purposes; and to these ends it consists, first, in an electro-magnet composed of a helix, soft-iron electro-magnetic poles, and one or more deflective magnetized needles, which are arranged with one side of each of their poles opposite one of the soft-iron electro-magnetic poles, and in good working distance therefrom, for the purpose of increasing the power and sensitiveness of the electro-magnet.

It further consists in the combination of a soft-iron cover with a helix and one or more deflective magnetized needles, for the purpose of still further increasing the power and sensitiveness of the electro-magnet.

It further consists in the construction of a local magnet having a branched circuit from a single battery, to act as a reverser for changing the polarity of the local magnet, and thereby vibrating its deflective magnetic needles.

It further consists in constructing a helix in sections of helical wire of such relative length and thickness that when a current of electricity is passed through the helix the conducting resistance of each section shall nearly or quite correspond to the relative amount of of magnetic force which emanates from such sections, and is made available at the axial aperture of the helix, the object of this construction being to produce a helix of helical wire of increased length without correspondingly increasing its conducting-resistance.

It finally consists in the construction and combination of various parts, to be hereinafter described.

In the accompanying drawings, C is the helix, composed of insulated copper wire wound in successive layers around an axial aperture of sufficient size to receive one or more permanent magnet-needles, D. The inner layer is wound against an axial wall, E, which defines the size and form of the central aperture, and serves as a base upon which the helix is built up.

The wire of which the helix C is composed is either of uniform size throughout its entire length, or it is made up of sections of wire, which sections, when formed in a continuous line, have their adjacent ends united by a good metallic connection. Each one of these sections is made of wire of equal thickness throughout its length, but each consecutive section from one end to the other is made of wire, which has as much greater length and thickness than the preceding section as is required, when wound into a helix, and a current of electricity passes through it to cause the relative proportionment of the conducting-resistance of the electric current through each section to correspond to the relative proportionment of the magnetic force which emanates from such section, and is made available within the axial aperture of the helix.

The conducting-resistance of this helix is rated the same as that of the helix of the receiving magnet of the Morse telegraph, but the diameter and length of the wire is to be suitably increased when the soft-iron cover, to be presently described, is used with it.

It is well known that when a current of el tricity is passed along an electrical conduct-r, a magnetic force emanates, the effect of which at any particular point decreases inversely as the square of the distance of that point from the conductor. This decrease of force acts to a disadvantage in the construction of a helix for a receiving-magnet, wherein the means of increasing such force principally consists in multiplying the number of concentric layers of helical wire, while the employment of the additional layers increases the sum of the distances which intervene between the several layers and the core, or central apertures where the magnetic force is made available.

In order to remedy this difficulty I inclose the helix C closely within two grooved angular covers, E^{10} E^{10}, of soft iron, (shown in Figs. 1, 2, 3, 5, and 6,) which are preferably hinged together at one side, and provided with a spring-catch, *f*, or other fastening, upon the opposite side, as shown in Figs. 3 and 4.

The helix fills the space between the sections of the covers, and its outer and inner ends E^{11} E^{12} respectively protrude through the latter, as shown, being properly insulated therefrom, to connect with the main telegraph-wire, or with mechanism or parts interposed in such wire.

The outer edges of the covers are fitted snugly together, and their inner edges project into the central aperture over the ends of the permanent magnet-needles D, and form the magnetic poles of the covering.

When a current of electricity is passed through the helix, the magnetic force thereby produced within the soft-metal covering will be nearly or quite equal to the sum of the magnetic forces contiguous to the surfaces of all the layers or sections of which the helix is composed—that is to say, without the magnetic covering there would be a decrease or loss of magnetic force outward radially from the center of the helix, *i. e.*, inversely as the square of the distance from the helix; but by employing such covering in connection with the helix, the magnetic forces of the two act in unison at the central aperture to move the needles.

The projecting inner edges of the magnetic covering become the most highly polarized, and act in unison with the polarity of the helix in producing the magnetic power necessary for operating the magnetic needles, which are arranged parallel to each other upon a central cross-shaft, H, at such a distance apart as shall allow each needle to retain the full amount of magnetism. The needles, which are composed of steel, and are passed directly through the cross-bar, to which they are held by set-screws *i*, as shown in Figs. 4, 7, and 8, are proportioned in number and size to the length of the telegraph-line with which the helix is to be used. The shaft H may be supported between the covers of the helix in any suitable manner that will allow it to oscillate freely without trembling; but I prefer to mount it upon short knife-edges J J secured to opposite points of the lower cover E^{10}, as shown in Figs. 3, 4, 5, and 6, and to provide the under side of its ends with narrow grooves to receive the knife-edges.

The oscillating needle-shaft is held down to its bearings by pins K K, which are pointed at both ends, and carried by right-angular frames L L rising from the upper cover E^{10} at opposite points of its central aperture in a line parallel with the shaft. The lower points of the pins enter conical sockets formed in the upper side of the needle-shaft, and their upper points enter conical recesses formed in the ends of short screws *m m*, which are inserted in the upper arms of the upright frames L, and serve to adjust the pressure of the pins upon the needle-shaft. The lower arms of the frames are made with holes for the passage of the pins, which latter are prevented from falling out, when the upper cover E^{10} is swung open, by collars *n n* formed or mounted upon the pins above the lower arm, as shown in Fig. 3. The lower points of the pins rest within their sockets in a plane with the knife-edges J J, to prevent too much lateral movement of the pins when the needle-shaft is oscillated, and the holes in the lower arms of the frames L are enlarged to prevent the pins from being cramped or bound during the oscillations of the shaft.

By this construction the friction between the needle-shaft and holding devices is reduced to the minimum, while the shaft is adapted to be accurately adjusted upon its bearings.

When the helix C of the receiving-magnet is not in use, or when a current of electricity is not passing through it, the metal covering acquires polarity from the permanent magnet-needles, and the relative arrangement of the poles N S of the covering and needles is shown in Figs. 1 and 6.

Each time a current of electricity is passed through the helix, which induces less magnetic force in the covering than that produced by the magnetic force of the needles, then the poles of the covering will remain unchanged, excepting that one-half of those poles which lie on each side of a line drawn diametrically through the helix and cover at right angles to the needles, as shown by dotted line *x x*, Fig. 1, will have their magnetic intensity increased, while the other half will have their magnetic intensity correspondingly decreased. For example, referring to Fig. 1, if the current passing in the proper direction through the helix is not sufficient to disturb the equilibrium of the needles, the left-hand upper N pole and the right-hand lower S pole will have their magnetic intensity increased, while the right-hand upper S pole and the left-hand lower N pole will have their intensity correspondingly decreased.

This arrangement of polarity in the covering continues until a current of electricity is passed through the helix, of sufficient quantity and intensity to change the polarity of the covering, so that all the N poles shall be in one cover—say, the upper one—and all the S poles in the other or lower cover, as shown in Fig. 2, or so that the magnetic intensity of the upper right-hand S pole and the lower left-hand N pole (shown in Fig. 1) shall be entirely overcome, and such poles changed, respectively, to N and S, as shown in Fig. 2. In this change of polarity one side of the poles of each needle is opposite to one of the poles in the cover—that is to say, one side of each needle is opposite the N pole in the upper cover, for example, and the other side of each needle is opposite the S pole of the lower cover.

This change in polarity causes the poles of the magnetized needles to be attracted and repelled each time a current of electricity of the required quantity and intensity is passed through the helix. Thus, a vibrating or oscillating movement of the needles is produced, which is made available for indicating received intelligence.

In place of the helix and its magnetic covering, above described, others may be employed of different form and construction, according to the length of the electric circuit, its conducting powers, &c., but embracing the same principles of operation.

Fig. 5 shows the helix and metal covering, made in oblong form, with the magnetic needles arranged parallel to the longest diameter; and Fig. 6 shows a similar form, with a larger number of needles placed parallel to the shortest axis of the helix and cover.

In some forms of the magnet the soft-iron covering need not wholly inclose the helix, but only so much thereof as is necessary to produce the above results. In certain cases a soft-metal lining or hollow core may be placed in the axial aperture of the helix with the same effect.

An electro-magnetic local power is used to excellent advantage with the electro-magnet already described, in the following manner: In using the local electro-magnetic power, I employ two helices that form two branches of a local circuit, which branches are alternately broken and closed by the vibrations of the magnetic needles in the receiving-magnet. One method of forming these helices is to wind the insulated wire into a single helix, T, Fig. 7, of sufficient size to be divided into two helices by making an electrical connection with its central coil or layer, as shown at T′, Fig. 7. In all other respects the helices are constructed the same as that of the magnet already described, and are inclosed by a soft-iron covering in a similar manner, through which covering the outer end *u* and the inner end *w* of the helical wire protrude, and from which they are properly insulated. The local electro-magnet thus formed is supported in any convenient manner and positions for work.

The outer and inner ends of the helix T are each connected by a wire, E′, to a screw, F′, inserted in a cross-bar, G′, secured to the upper cover of the receiving-magnet. The screws are insulated from the bar by tubes H′, let into the latter, and are each provided with platinum points or anvils I′, to receive the impact of corresponding hammers J′, attached to the central magnetized needle of the receiving-magnet upon opposite sides of its rock-shaft. The wires E′ are held to the screws, and the latter are locked at any point of adjustment within the cross-bar by means of binding-nuts K′, as shown in Figs. 1 and 2.

L′ is the local battery, having one of its poles connected by a wire, M′, with the central layer of the local helix, and its opposite pole connected by a similar wire, N′, to the lower metal cover E^{10} of the receiving-magnet. This connection of the local battery forms one part of two local circuits, and when a current of electricity upon the main line is passed through the receiving-magnet to change the polarity thereof and oscillate the magnetic needles D, as above described, then one or the other set of platinum hammers and anvils I′ J′ are brought in contact. When this occurs the positive current from the local battery passes along the wire N′ to the lower metal cover of the receiving-magnet, thence through its knife-edges J J to the oscillating shaft H, thence along the central needle to those hammers I′ J′, which are in contact, from whence it passes along one or the other of the screws F′ and wires E′ to the end *u* or *w* of the local helix T, and finally leaves this helix through the central connection M′, and passes back to the battery. Thus the connections of the local battery form two branches of a local circuit, which are alternately brought into action each time the needles of the receiving-magnet are oscillated. When one branch of the circuit is broken the other is instantly closed, so that the magnetic needles of the local magnet, when the polarity of such magnet is changed by the local currents, will always make the same number of vibrations as the needles of the receiving-magnet, and thereby prevent any confusion or confounding of the message-signals.

The two helices made by connecting the central layer of the local helix with the local battery act as a reverser to change the polarity of the local magnet, and thereby vibrate its magnetic needles, while the two sets of anvils and hammers I′ J′ of the receiving-magnet form circuit-breakers to send the local currents alternately through one or the other of the local branch circuits, and thereby cause the two helices to do the work of a reverser.

In order to best apply a very feeble magnetic force in the receiving-magnet for making and breaking the local circuits, the sets of anvils and hammers I′ J′ are arranged between the poles of the magnet and the rock-shaft H of the magnetized needles. The needles, therefore, on each side of the shaft form levers of the second order, the shaft being the fulcrum and the hammers the weight to be lifted.

The magnetic power of the receiving-magnet is applied to the ends of the needles sufficiently far outside the line of the hammers to move the latter against their anvils with a force equal to or greater than such power exerted at the poles of the magnet.

Having thus described my invention, what I claim is—

1. An electro-magnet composed of a helix, soft-iron electro-magnetic poles, and a deflective magnetized needle, which is arranged with one side of each of its poles opposite to one of the soft-iron electro-magnetic poles, substantially as described, for the purpose specified.

2. The combination of a soft-iron cover with a helix, and one or more deflective magnetized needles, substantially as described, for the purpose specified.

3. The inclosing-case for the helix, consisting of two grooved annular covers, E^{10} E^{10}, of soft iron connected together by suitable means, substantially as described, for the purpose specified.

4. The soft-iron covers E^{10} E^{10} of the magnet, having their inner edges projecting into the central aperture over the ends of the magnetized needles, to form the magnetic poles of the covering, substantially as described.

5. The magnetized needles, mounted in an oscillating rock-shaft, arranged diametrically between the soft-iron covers of the magnet, substantially as described.

6. The rock-shaft of the magnetized needles held to its bearings in the covers of the magnet by means of the pointed pins K, substantially as described.

7. The pointed pins K, supported upon the covers of the magnet by means of the upright frames L, substantially as described.

8. The pointed pins K, provided with collars *n* between the arms of the upright frames L, to prevent the pins from falling out of the frames when the upper half of the magnet-cover is swung open, substantially as described.

9. The pointed pins K, adapted for adjustment to regulate their pressure upon the needle-shaft, substantially as described.

10. The combination of the platinum anvils I′, and hammers J′, with the magnet and its deflective needles, substantially as described.

11. The anvils and hammers of the magnet arranged between the poles of the magnet and the rock-shaft of the needles, substantially as described, for the purpose specified.

12. The helix of a local magnet divided into two parts by an electrical connection with its central layer or coil, substantially as described, for the purposes specified.

13. A local magnet formed by the combination of a soft-iron cover with a divided helix and deflective magnetized needles, substantially as described.

14. The combination of a branched local circuit, and a single battery, with a receiving-magnet having two sets of hammers and anvils, substantially as described, for the purposes specified.

15. The combination of the local magnet, the branched local circuits, and a single battery, with a receiving-magnet and its two sets of hammers and anvils, substantially as described, for the purpose specified.

16. A helix constructed in sections of helical wire of such relative length and thickness that when a current of electricity is passed through the helix the conducting-resistance of each section shall nearly or quite correspond to the relative amount of magnetic force which emanates from such sections, and is made available at the axial aperture of the helix, substantially as described, for the purpose specified.

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