2 Sheets--Sheet 1.

E. W. SIEMENS.

Magneto-Electric Apparatus.

No. 149,797. Patented April 14, 1874.

FIG. 1.

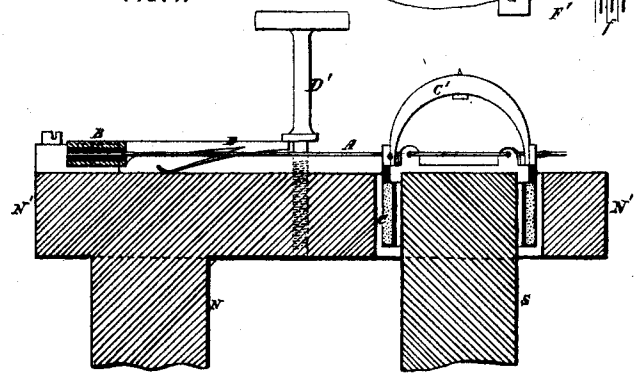

FIG. 2.

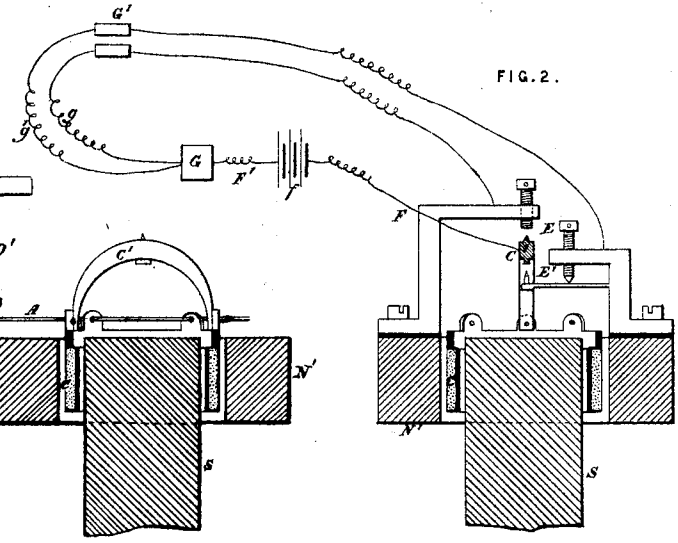

FIG. 3.

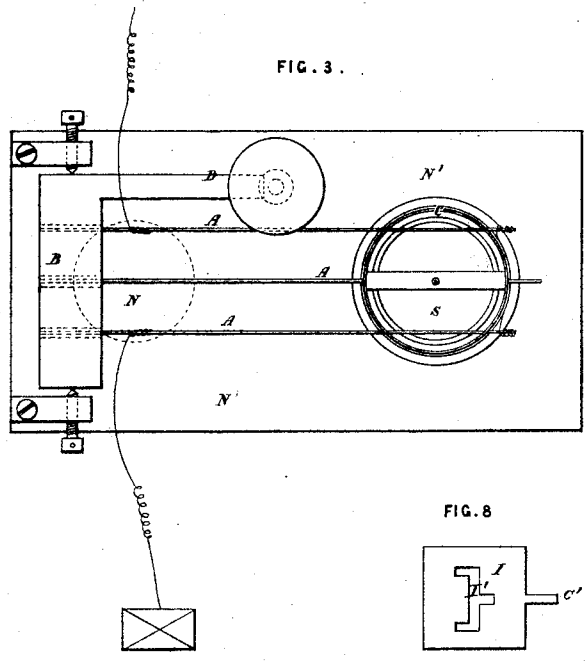

FIG. 4.

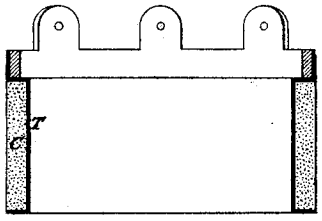

FIG. 5.

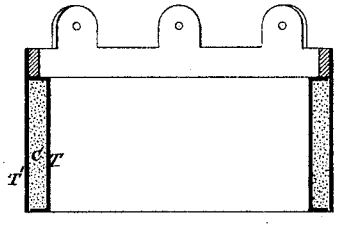

FIG. 8

WITNESSES

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2 Sheets--Sheet 2.

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FIG. 11.

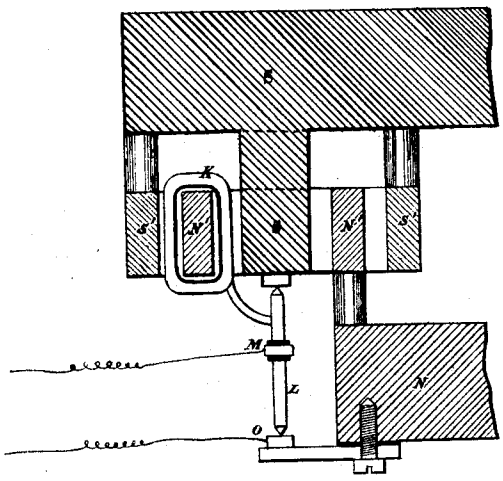
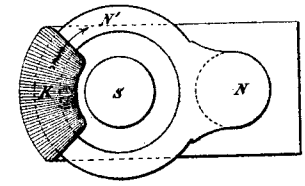


FIG. 10.



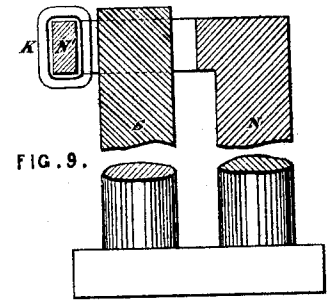


FIG. 9.

FIG. 6.

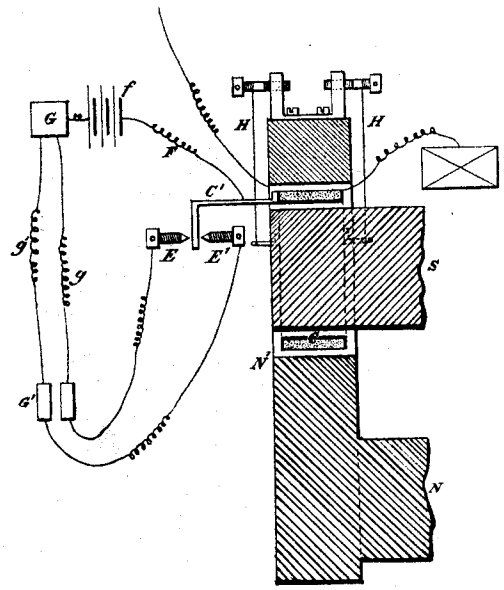
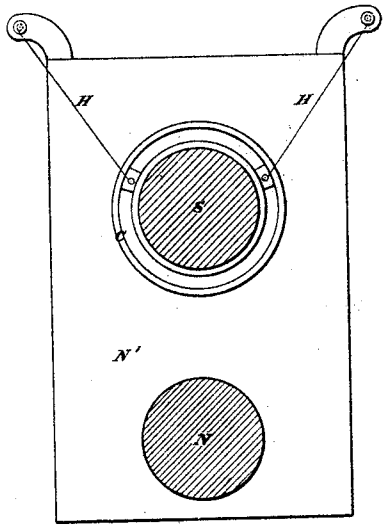


FIG. 7.



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UNITED STATES PATENT OFFICE.

ERNST W. SIEMENS, OF BERLIN, GERMANY.

IMPROVEMENT IN MAGNETO-ELECTRIC APPARATUS.

Specification forming part of Letters Patent No. **149,797**, dated April 14, 1874; application filed January 20, 1874.

To all whom it may concern:

Be it known that I, ERNST WERNER SIEMENS, of Berlin, in the Empire of Germany, have invented an Improved Apparatus for Obtaining and Applying Magneto-Electric Currents; and do hereby declare that the following description, taken in connection with the accompanying sheet of drawings hereinafter referred to, forms a full and exact specification of the same, wherein I have set forth the nature and principles of my said improvement, by which my invention may be distinguished from others of a similar class, together with such parts as I claim and desire to secure by Letters Patent—that is to say:

When a permanent magnet, or an electro-magnet, is so constructed that it has its two polar surfaces of considerable superficial area presented to one another with a very narrow intervening space, the magnet exercises little magnetic influence on surrounding objects, being almost in the condition of a closed magnet. On introducing, however, a portion of an electric circuit into the narrow space between the polar surfaces of the magnet, and moving it to and fro, electrical currents are set up in the circuit, or, conversely, when electrical currents are sent through the circuit it is caused to move.

My invention relates to improved apparatus, whereby this principle is applied either for obtaining electric currents from the mechanical movement of an electrical coil, or for obtaining the mechanical movement of an electrical coil from electrical currents transmitted through it.

I will describe this apparatus, and its application to purposes of telegraphy, in several modified forms, referring to the accompanying sheet of drawings, and to the figures and letters marked thereon.

Figure 1 represents part of a longitudinal section; Fig. 2, part of a transverse section; and Fig. 3 represents a plan of one form of apparatus constructed according to this invention.

S is one pole of a permanent or electro-magnet, and N is the other pole, to which is attached, as a polar extension, an iron plate, N′. This plate is pierced with a cylindrical hole, into which is inserted the pole or polar extension S. C is a coil of electric conducting-wire suspended in the annular space between S and N′ by means of wire springs A, which serve also as conductors. These wires are inserted insulated in a rocking-bar, B, pivoted at each end, and provided with an arm, D, having a spring and set-screw, D′, by which it can be caused to rock a little either way, and thereby to adjust vertically the position of the coil C. The two outer wires, A A, are connected by conductors, the one to one pole of a battery, and the other to the other pole; or the one to a line of telegraph-wire, and the other to the return wire, or to earth; and they serve as conductors, the one to one end of the coil wire, and the other to the other end of the same. The middle wire, A, serves as a conductor to the metallic body of the coil C. When a current of electricity is passed through the wire of the coil C, the coil is caused to move either upward or downward, according to the direction of the electric current and the polarity of the magnet within the annular space between its polar extensions, and alternating currents cause the coil to vibrate up and down; or, if the coil be caused to vibrate by mechanical means, a series of alternating electrical currents will be generated in the wires of the coil and conductors to and from them. These currents may be used either directly to work known electrical apparatus, or they may be directed through the coils of electro-magnets to produce or intensify magnetic force, and such magnets may themselves be used to work coils, as above described. If currents so produced from the movement of a coil in the field of a weak magnet were directed through the coils of that magnet, the magnet would thereby be strengthened, its action on the coil would be intensified, and the stronger current thus produced would further strengthen the magnet.

The movement of the coil C, produced by passing a current of electricity through its wire, may be utilized for working recording apparatus for releasing detents, or for moving visible or audible signals. One mode of effecting this will be understood by reference to Fig. 2, in which figure the upper part of the hoop C′ attached to the coil C is provided with contact-pieces on its upper and lower sides. Above and below these are contact-

pieces E and E′, mounted so that they can be accurately adjusted on level by means of setting-screws. From the hoop C′ a conducting-wire, F, partly formed by the middle wire spring A, is led to one pole of a battery, *f*, or other source of electricity, from the other pole of which a conductor, F′, is led to a commutator, G. From the contact-pieces E and E′ conducting-wires lead to a commutator, G′, which allows of their being connected together or connected each to a separate circuit, *g g′*, which unite at G.

It will be seen that if the coil C be caused to rise, as above described, by the passage of a current through its wire, contact will be made at E, and the circuit *f* F C′ E G′ *g* G F′ will be established. If, on the other hand, the coil C be caused to descend, the circuit *f* F C′ E′ G′ *g′* G F′ will be established. If, therefore, any of the known instruments worked by electricity were placed in the circuits *g* and *g′*, they would be worked by the battery *f* whenever their respective circuits were established, as above described. Two separate instruments, or a duplicate instrument, could be thus worked from the battery *f* by alternating currents passed through the wire of the coil C; or the two conductors leading from E and E′ may be led to one instrument by setting the commutator G′ so as to join them, and thus a series of currents, alternating in direction in a line-wire, may be made to produce a series of intermittent currents of one direction in an instrument; and these intermittent currents may be made to succeed so rapidly as to constitute virtually a continuous current.

By arranging and constructing the apparatus as above described, it will be found that when no current is sent through the wire of the coil C this coil will remain in a position of rest, to which it will return after the cessation of currents sent through it, whatever may have been their number, direction, or intensity, and the contacts E and E′ may be adjusted so as to be equidistant from C′ when it is in the position of repose. In order to prevent tremulous motion of the coil C, which might produce uncertain contacts at E and E′, the wire of the coil C is wound on or is inclosed in a metallic cylinder, which, by preference, is made of aluminium.

Fig. 4 represents, to an enlarged scale, a section of a coil wound upon a cylinder of thin metal, T, and Fig. 5 represents it wound upon such a cylinder, and also covered by one, T′, outside. The metal so applied acts as a damper.

Fig. 6 represents part of a vertical section, and Fig. 7 represents an end view, of apparatus in which the coil C is suspended by four filaments, H H, which may be of silk or other light flexible material, in the annular space between the pole S and the extension N′ of the pole N. The filaments H H are attached to pins, which can be turned to adjust their length, and thus bring the coil C into proper position. In this case the coil has projecting from it a bent arm, C′, which performs the same function as has been described above with reference to the hoop C′ in Fig. 2. The circuits in Fig. 6 are analogous to those shown in Fig. 2, and corresponding parts are marked with the same letters in both Figs. 2 and 6. By this mode of suspending the coil an extremely sensitive action of it is obtained, its natural tendency being to assume its middle position.

The arm C′, Fig. 6, projecting from the coil C, may be made to furnish visible signals by the movement of the coil. For this purpose there may be attached to it a thin screen of light material, such as is represented at I in Fig. 8. By making in this screen a slot, such as is shown at I′ in Fig. 8, and placing behind it a vertical line of light, and in front of it an eye-hole or piece, when the screen is in its middle position a line of light will be seen; when it is moved to the right two bright points will be seen, one above the other; and when it is moved to the left one bright middle point only will be seen.

It is obvious that screens having slots of other forms might be employed to show the position of the coil by distinctive marks of the light passing through them.

Fig. 9 represents, diagrammatically, part of a section, and Fig. 10 a plan of an arrangement whereby a coil is made to travel in a circular path. The one pole, N, of a permanent or electro-magnet is extended into a ring, N′, surrounding the other pole, S. On the ring N′ is placed a coil, K, having its wire coiled vertically, and so fitted to the ring N′ that it can slide freely thereon. When a current of electricity is passed through the wire of the coil K in one direction, the coil will move round the ring N′ in the direction of the arrow. When the direction of the electrical current is reversed, the coil K will move round the ring in the opposite direction, or if the coil K be moved by mechanical means along the ring N′, an electrical current will be set up in the wire of the coil. Figs. 9 and 10, last referred to, show, diagrammatically, how the movement of a coil in the magnetic field may be in a circular path, instead of a rectilinear path, as in the figures previously referred to.

Fig. 11 represents part of a section of apparatus, whereby either a current of electricity may impart to a coil an oscillating rotary motion, or the oscillating rotary motion of a coil may set up electrical currents in its wire. In this case the one pole of a magnet, N, is connected to a ring, N′, and the other pole carries a stud, S, and a ring-shaped extension, S′. Round the ring N′ there is a coil with wires coiled vertically round an ebonite or other non-magnetic ring, mounted on a vertical axis, L. One end of the wire of the coil K communicates, through the axis L and its lower bearing, with a conductor, O, while the other end of the coil wire is led insulated along the axis L to the other conductor, M. The axis L, and the coil K attached to it, may be made to

rock, in which case electrical currents will flow through the conductors O and M, or, alternating currents being sent through the conductors O and M, the axis L and the coil K will be caused to rock.

In the several forms of apparatus described above it will be seen that the magnetic field—that is to say, the surface of the pole and of the polar extension which acts on the coil—is made to extend somewhat beyond the coil itself, the efficacy of the apparatus being thus augmented.

Having thus described the nature of my invention, and the best means I know of carrying it into practical effect, I would have it understood that I do not claim generally the arrangement of an electrical coil in a magnetic field for the purpose of producing movement of the coil by the transmission of electric currents through it, or for the purpose of obtaining electric currents by the movement of the coil; but

I claim—

1. A permanent magnet, having one of its poles extended and surrounding the other pole, an intervening space being left between the poles, substantially as set forth.

2. In combination with a permanent magnet, having one of its poles extended and surrounding the other, a coil inclosed or partially inclosed in the space intervening between the poles, substantially as set forth.

3. In the apparatus for the purpose above referred to, described in reference to Figs. 1, 2, and 3, the electric coil C suspended within the annular space between the magnetic poles or polar extensions S and N′, by conducting-wires A extending from the rocking shaft B, and rendered adjustable by the spring-lever D and screw D′.

4. The electric coil C, suspended within the annular space between the magnetic poles or polar extensions of a magnet, and provided with the hoop C′, or equivalent, for utilizing the coil for the purpose of establishing local circuits.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses, this 25th day of September, 1873.

ERNST WERNER SIEMENS.

Witnesses:

HERMANN BREISMANN,
United States Consul, Berlin.

BERTHOLD ROI,
Berlin, Kesselstrasse 15 *I.*