(No Model.)

# E. B. CUTTEN.

## ELECTRO MAGNET.

No. 343,227. Patented June 8, 1886.

Fig. 1.

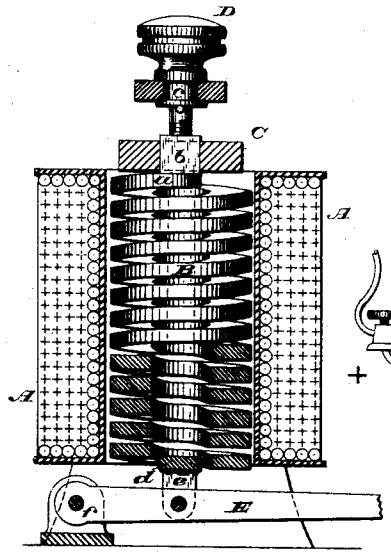



Fig. 4.

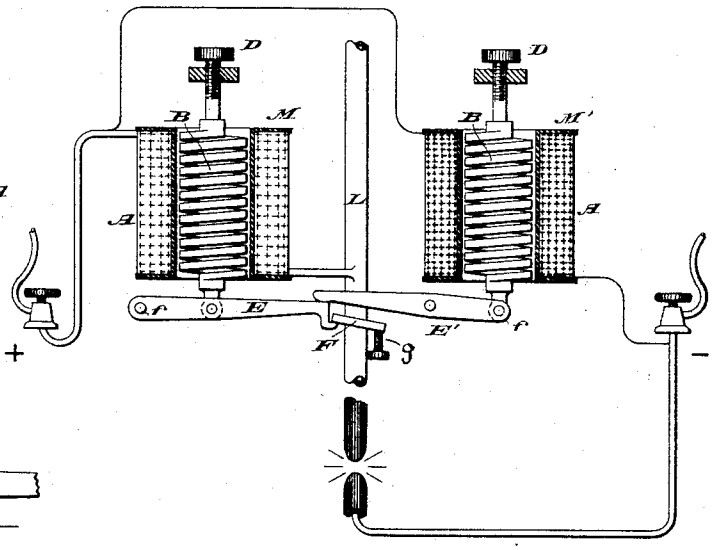



Fig. 2.

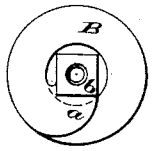
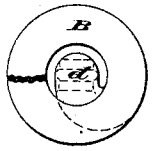



Fig. 3.




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# UNITED STATES PATENT OFFICE.

ELISHA B. CUTTEN, OF PITTSBURG, PA., ASSIGNOR TO THE ELECTRICAL AND MECHANICAL DEVELOPING COMPANY, OF SAME PLACE.

## ELECTRO-MAGNET.

SPECIFICATION forming part of Letters Patent No. 343,227, dated June 8, 1886.

Application filed June 11, 1885. Serial No. 168,296. (No model.)

*To all whom it may concern:*

Be it known that I, ELISHA B. CUTTEN, a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Electro-Magnets, of which the following is a specification.

The object of my invention is to produce an electro-magnet in which the core and armature are combined, and a considerable range of movement is provided without the rapid variations of attractive effect at different portions of the movement, which are characteristic of electro-magnets as heretofore constructed.

My invention also combines the retracting-spring with the armature and core, thus providing a magnet of great simplicity.

Figure 1 of the accompanying drawings is a longitudinal mid-section of my improved electro-magnet in its preferred form. Fig. 2 is a plan of the core removed. Fig. 3 is a horizontal section thereof; and Fig. 4 is an elevation, partly in vertical mid-section, of the regulating mechanism of an electric-arc lamp constructed with my improved magnets.

Referring principally to Figs. 1, 2, and 3, let A designate the coil of the magnet, which is or may be of any ordinary construction, and B the core thereof. This core consists of a stiff helical spring of wrought-iron, by preference, arranged within the coil and fastened at one end, its other end being free to move outward and inward as the core expands and contracts. When the coil is not excited, the spring-core is expanded by its own elasticity. When, however, a current of electricity is passed through the coil the spring-core becomes magnetized and its several convolutions mutually attract each other, thus drawing the spring together or contracting it, and moving its free end inward. This attraction is due to the opposite sides of the convolutions becoming relatively polarized, all the upper sides being of one polarity and all the lower sides of the opposite polarity. When the current ceases, the spring-core immediately discharges its magnetism, and its elasticity causes it to again expand to its normal length. The core of my improved magnet thus possesses in itself the properties of the core, the armature, and the retracting-spring of electro-magnets as heretofore constructed. Being fastened at one end and moved by the reciprocal attraction of magnetized iron, its movement is positive as well as sensitive, and as the separate convolutions lie close to each other, so that each is in the strongly-magnetized field of the next, the movements are unusually powerful. At the same time, as the movement of the free end of the core is the sum of the several movements between the separate convolutions, its movement is of considerable extent, while the movement between the convolutions may be very slight. I thus attain nearly or quite the same range of motion as with a solenoid, with at least equal simplicity, and secure the important advantages of greater strength and positiveness of movement, as well as the additional merit of the movement being free from momentum, since the spring-core is fastened at one end and has but little mass in proportion to its stiffness.

It is well known that the attraction of a magnet for its armature varies inversely as the square of the distance of the armature—a fact which precludes the employment of electro-magnets with movable armatures wherever any considerable extent of movement is desired. In such cases, and wherever the movement of the mobile element of the magnet is desired to be proportional to the increase or decrease in magnetism, it has been found necessary to employ solenoids. These are subject to the objection of being weak in their action, converting but a small portion of the electrical energy absorbed by the coil into mechanical energy, and being but imperfectly sensitive to variations of magnetism.

My improved magnet is believed to be free from the defects of both armature-magnets and solenoids, and to combine both the long stroke of the latter with the certainty and strength of the former. As the entire core is at all times within the coil, it is acted upon always to equal advantage by the coil, so that its magnetism varies in direct proportion to the variations in volume of the current traversing the coil; and as the movement of each convolution relative to its neighbor is very slight, and the resistance of the spring is considera-

ble, the variations of attractive force inversely to the square of the distance are not apparent in the expansions and contractions of the core.

In Fig. 1 the core B is shown as made of flat bar-iron, coiled in a uniform helix, with its convolutions parallel to one another. This is the preferable construction, the best results being attained by bringing the convolutions as close together as practicable, allowing space enough between them, however, to permit the desired movement without bringing the convolutions into contact with each other, and making the helix of metal sufficiently thick and stiff to prevent the convolutions being so drawn into contact. The opposite ends of the helix should be turned in to the center, as shown in Figs. 2 and 3. The end *a*, which is the fixed end, may be attached to a square block, *b*, and this block is fitted in a square hole in a frame C, at one end of the coil, as shown, to allow this end to be moved vertically without permitting it to turn. A screw, D, Fig. 1, journaled at *c* in a frame, screws into the block *b*, and on being turned raises or lowers the core B bodily. The free end, *d*, of the core may be fitted with ears *e e*, which may engage a lever, E, or other part to which it is desired to communicate motion. The lever shown is fulcrumed at *f*, and its free end, (shown as broken off) may be connected in any desired way to do any required work.

Fig. 4 shows my improved magnets applied as the electro-motive elements of the regulating mechanism for an electric-arc lamp. L is the rod carrying the upper-carbon pencil; M, the magnet in the line-circuit; E, the lever of this magnet, and F, the usual clutch for engaging the rod L, which clutch is lifted on one side by the lever E, and has on its opposite side an adjusting screw or stop, *g*. The magnet M′ is installed in the derived circuit around the arc, and the free end of its spring-core is connected to one end of a lever, E′, the other end of which lever extends over the lever E. When the current is turned on, it excites magnet M and contracts its core, which thus lifts the lever E and raises the clutch F, rod L, and the upper-carbon pencil, thus establishing the arc. When the arc increases in length the resistance thereby occasioned diverts a sufficient volume of current through the derived circuit to excite the magnet M′, which contracts its core and forces the lever E′ to press down on lever E, finally overcoming the latter and forcing it downward until it releases the clutch and permits the rod L to descend. This is a common form of mechanism, except that heretofore the levers E E′ have been connected to the cores of solenoids, or to the armatures of magnets.

It is not essential that the core shall be of soft iron, as it may be made of steel, which will give greater elasticity, but will be less advantageous magnetically.

I am aware that a sectional or subdivided core for electro-magnets is not broadly new, such cores having been heretofore made of independent disks or sections suspended within the coil close to each other, and normally kept separated by interposed springs or by their own weight, and mutually attracting each other when excited. My invention constitutes a marked improvement upon such subdivided or articulated cores, inasmuch as the core is all in one piece, as its operation is not dependent upon gravity, so that it is equally operative in any position, and as it possesses greater strength of retraction and greater certainty in its movements than an articulated core.

I am also aware that a telephone has been patented consisting of an exciting-coil, with a helical core within it, one end of this core being fastened to the diaphragm and the other end being distended by an adjusting-screw, to separate the convolutions and impart the requisite tension to the diaphragm. The molecular vibrations induced in the core by the varying currents through the coil were designed to effect the requisite acoustic vibration of the diaphragm. I make no claim to any such application of a helical core. In my improved magnet the core is fastened immovably (but preferably adjustably) at one end, and its other end is free to move out and in bodily, its motion being positive and in both directions under the opposite influences of its expansive elasticity and of the contractile effect of the magnetic attraction. In the telephone referred to the core is so restrained by the diaphragm that it cannot act as a retracting-spring, whereas it is one of the distinguishing advantages of my improved magnet that the resilient expansion of the core is utilized to constitute it a combined core and retracter.

I claim as my invention—

1. An electro-magnet consisting of the combination, with an exciting-coil, of a helical spring-core of magnetizable metal, with its successive convolutions in attractive proximity to one another, fastened immovably at one end and free to move outwardly and inwardly at the other end, substantially as set forth, whereby a considerable range of motion is secured at the free end of the core and the expansive resilience of the helical core is utilized to retract it outwardly.

2. An electro-magnet consisting of the combination, with an exciting-coil, of a helical spring-core of magnetizable metal fastened immovably at one end and free to move outwardly and inwardly at its other end, with its convolutions in attractive proximity to one another and of sufficient stiffness to prevent the mutual attraction of adjacent convolutions from drawing them into contact with each other, substantially as set forth.

3. An electro-magnet consisting of the combination, with an exciting-coil, of a helical spring-core of magnetizable metal, fastened immovably at one end and free to move outwardly and inwardly at the other end, and an adjusting-screw for adjusting the core bodily within the coil engaging the fastened end of the core, substantially as set forth.

4. An electro-magnet consisting of the combination of exciting-coil A, helical spring-core B, of magnetizable metal fixed at one end and free to move outwardly and inwardly at the other, an adjusting-screw, D, engaging the fixed end of the core for adjusting the latter bodily in the coil, and a lever or equivalent, E, connected to the free end of the core and movable thereby, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ELISHA B. CUTTEN.

Witnesses:
JAMES A. MCKEAN,
WM. MARTIN.