(No Model.) 3 Sheets—Sheet 1.

A. D. AYRES.

ELECTRO MAGNET.

No. 469,672. Patented Mar. 1, 1892.

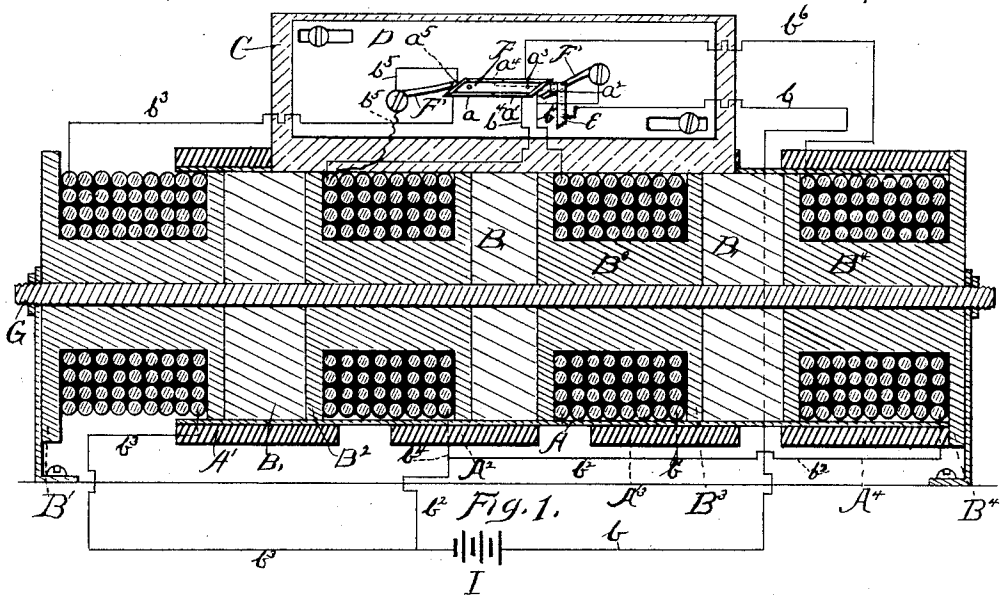

Fig. 1.

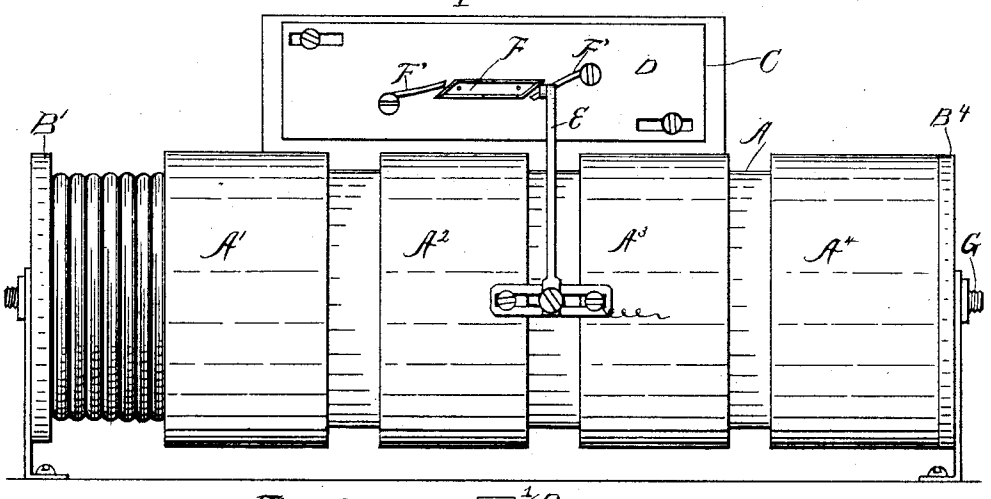

Fig. 2.

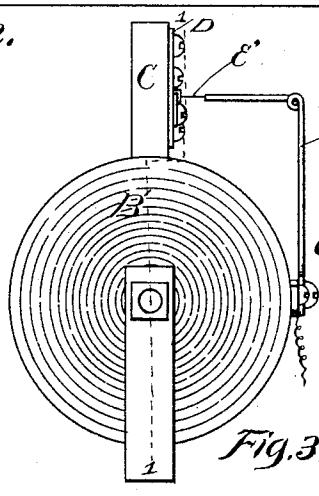

Fig. 3.

Witnesses,

John C. Goodson

E. J. Goodson

Inventor.

Andrew D. Ayres

by Howard & Howard

his attys

(No Model.) 3 Sheets—Sheet 2.

A. D. AYRES.

ELECTRO MAGNET.

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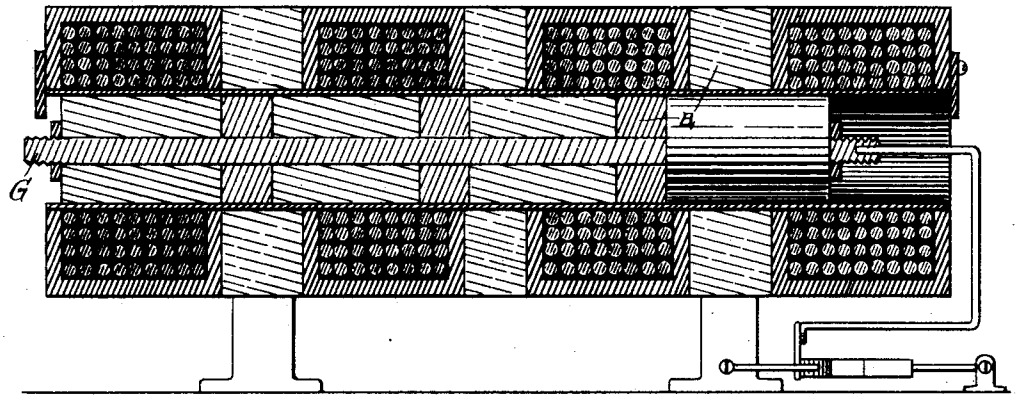

Fig. 5.

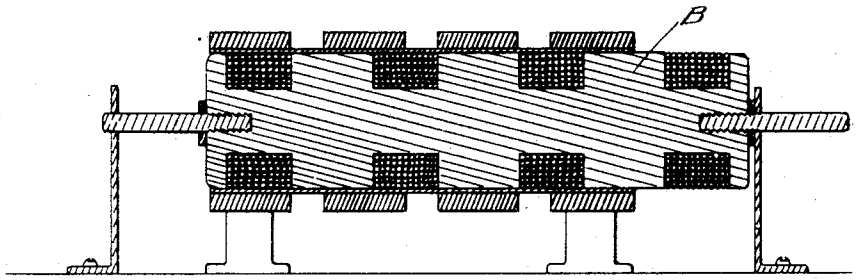

Fig. 6.

Fig. 4.

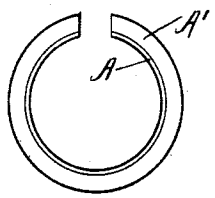

Fig. 7.

Witnesses,

John C. Swindale

George J. Gardner

Inventor.

Andrew D. Ayres

by Hawes & Fenwick

his Attys

(No Model.) 3 Sheets—Sheet 3.

A. D. AYRES.

ELECTRO MAGNET.

No. 469,672. Patented Mar. 1, 1892.

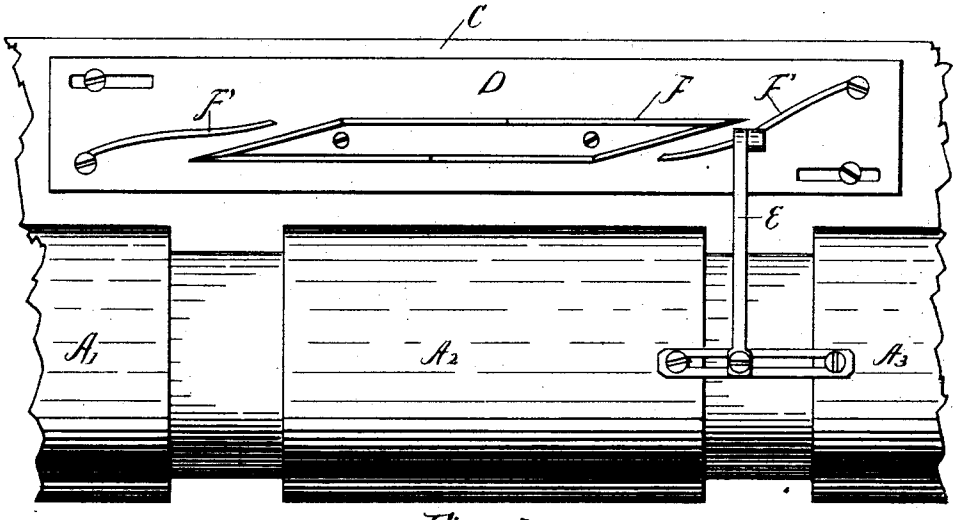

Fig. 8.

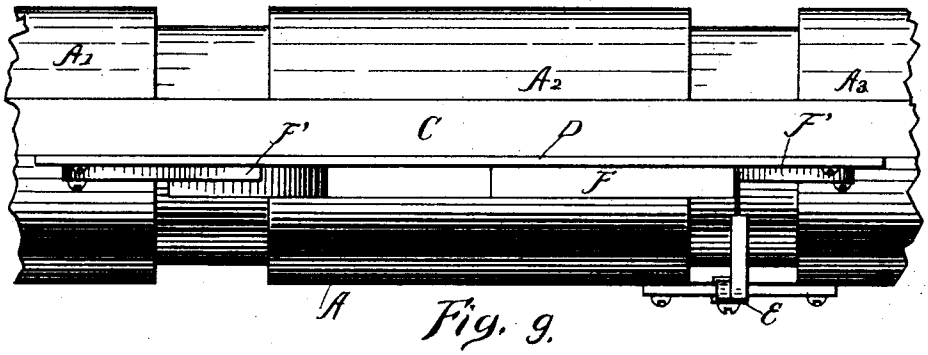

Fig. 9.

Witnesses.
John P. Greendale
George E. Gardenier

Inventor.
Andrew D. Ayres
by Hauss & Levy
his attys

UNITED STATES PATENT OFFICE.

ANDRUS D. AYRES, OF KALAMAZOO, MICHIGAN.

ELECTRO-MAGNET.

SPECIFICATION forming part of Letters Patent No. 469,672, dated March 1, 1892.

Application filed May 23, 1891. Serial No. 393,843. (No model.)

To all whom it may concern:

Be it known that I, ANDRUS D. AYRES, a citizen of the United States, residing at the city of Kalamazoo, in the county of Kalamazoo and State of Michigan, have invented a certain new and useful Improvement in Electro-Magnets, of which the following is a specification.

The object of my invention is to secure a long pull from electro-magnets. I attain this end by means of the arrangement and combination of a series of iron-clad or paramagnetically-incased electro-magnets, consisting of separate and independent magnets having movable incasements or cores, said incasements or cores being the armatures, and so arranged and constructed that the current will pass from one magnet or coil to the others consecutively, energizing one after another, thereby causing the armatures to move, each coil drawing the armatures a predetermined distance, thereby forming a complete or nearly complete magnetic circuit between the armature and magnet, at which instant the current changes into another coil where the armature of the coil to which the current changes is in an operative position, causing the armature to travel a certain other predetermined distance, and so on to the end of the series, thence by proper commutation back again, if desired. By this means the armatures are caused to move any desired distance, said distance being regulated by the construction and arrangement of the magnets and armatures. It is not in all arrangements necessary that it should be the magnet or coil immediately next following to which the current changes or that but one magnet or coil should be energized at a time, for the construction can be such that it will change to any desired coil in the series or so built that any desired number of magnets or coils will be simultaneously excited. In this construction of the magnets it is highly important that the cores or incasements (whichever are constructed to move) should be arranged in such a position relative to each other and to the magnets that when one coil shall have performed its function the case or core and the coil or coils next energized will bear to each other such a relation that the same action will take place as in the ones preceding it—that is, the configuration of the two must be such that as members of a magnetic circuit they will be susceptible of a change in form. The construction can be best facilitated by employing separate incasements and distinct spools with coils thereon or separate cores and incasements with coils therein, incasements or cores being magnetically separated, but bound together, as shown in the various drawings, wherein similar letters refer to like parts throughout the several figures. The coils, however, can be wound on one core, as shown.

Figure 1 is a longitudinal section of the device, showing the circuits taken on the line 1 1 of Fig. 3. Fig. 2 is an elevation of the device. Fig. 3 is an end view. Fig. 4 is a plan view of the incasing armatures as removed from the core. Fig. 5 is a longitudinal sectional view of a modification wherein the helices are shown as wound in the covering and the cores are represented as moving. Fig. 6 is another modification wherein instead of separate spools or cores one core is employed with the several coils wound thereon, the core with the coils moving and the covering stationary. Fig. 7 is an end view of the movable casings A′. Fig. 8 is an elevation view of an enlarged detail, showing the commutator. Fig. 9 is a plan view of an enlarged detail, showing the contact between the brush and the commutator.

A′, A^2, A^3, and A^4 represent incasing armatures; A, a thin brass tube to which the cases are firmly attached.

B represents a soft-iron core.

B represents a section of brass, which separates the cores, plungers, and magnet-spools.

B′, B^2, B^3, and B^4 represent soft-iron spools on which coils are wound and which are firmly bound together by the rod G.

C is a piece of ebonite; D, an adjustable ebonite plate; E, a commutating-brush; E′, a platinum point on the brush; F, a commutator.

F′ represents two guide-springs.

a, a', a^2, a^3, a^4, and a^5 represent different sections of the commutator F.

I represents the source of electricity.

b, b', b^2, b^3, b^4, b^5, and b^6 represent circuit-wires.

My device operates as follows, particular

reference being had to Fig. 1: In this figure the cases are represented in such a position that a magnetic circuit is completed between the case A^4 and the core or spool B^4. In this position the brush E has dropped to the guide-spring F', the brush so adjusted that it seeks an equilibrium and will spring to F' from a^3. Now, should a circuit be made through the battery I, the current will follow b through E to a^2, spring F' and b' to the helix around B^3, thence by b' and b^2 to I, completing the circuit. This energizes B^3, which draws A^3 toward the left end, moving the brass tube and all the incasements till the magnetic circuit between A^3 and B^3 is nearly completed, at which instant the brush E passes to a', another section of the commutator, and the case A^2 will have reached, with reference to the core B^2, an operative position. The current will then, passing from the brush E, complete the circuit through a' b^4, helix of B^2, b^4, and b^2 to battery I, energizing B^2 and nearly closing the magnetic circuit between B^2 and A^2, at which instant E will have passed to a and A' will have reached an operative position with reference to B', when the current, again passing from E, will complete the circuit through a b^3, helix of B' b^3 to battery I, energizing the core B' and drawing A' till the magnetic circuit between B' and A' will have been nearly or quite completed, at which instant E will spring to F', A^2, being in an operative position with reference to B^2, completing the circuit through b^5, helix of B^2, b^4, and b^2, or through a^5 b^5, helix of B^2, b^4, and b^2, energizing B^2 and drawing A^2 to the right till it shall have nearly completed a magnetic circuit, at which instant E will have passed to a^4 and A^3, being brought by such action to an operative position with reference to B^3, the circuit being completed through a^4, the dotted line b', the helix of B^3, b', and b^2. This energizes B^3 and draws A^3 to the right till a magnetic circuit shall have been nearly completed between B^3 and A^3, at which instant E will pass to the next section a^3 of the commutator and A^4 will have been brought to an operative position with reference to B^4, when the circuit will be completed through b^6, helix of B^4, and b^2 will energize B^4 and draw A^4 to the right till a magnetic circuit shall have been nearly or quite completed between B^4 and A^4, leaving the casings and cores in the original position. This action will continue as long as a sufficient current continues. The same action takes place in Fig. 5, with the exception that the cores instead of the casings move, the casings carrying the wire and the cores left unwound, the same commutation takes place and the same circuits are energized. The same action takes place in Fig. 6 and the same circuits will be energized; but the incasements and spring E will be stationary and the core B, wire, and commutator moving.

It will be seen that that section of the commutator marked a^5 is connected by b^5 with F', and that the other section marked a^2 is connected with F' at the other end and to a^4 by means of a dotted line. The object of this is to be certain of a circuit through whichever one of these points E should come in contact. It is seen from this explanation that there is always an armature in an operative position with its relative magnet.

By the expression "operative position" I mean such a relative position of an armature to its magnet or a magnet to its relative armature that when a magnet is energized the armature, becoming inductively magnetized, being a part of the magnetic circuit, will have a greater affinity for that pole of the magnet which is uncovered by the armature and tend to close the gap between them, or, in other words, that the configuration of the two is such that, both being magnets, the proximity of their opposite poles will permit the attraction between them to bring them together until they form a complete or nearly a complete magnetic circuit.

While I have in this application described a particular form of commutator and a certain shape of apparatus, it must be distinctly understood that the invention is not limited to that particular means of supplying current and is applicable to any shape where several armatures can be fastened together magnetically separated and each made to form parts of a complete or nearly complete magnetic circuit, so as practically to produce a long-pull magnet.

The subject-matter of Fig. 5 is not claimed herein, as it is made the subject of another application now pending and serially numbered 405,767.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination of a plurality of electro-magnets provided with a plurality of paramagnetic incasements magnetically separated and bound together, each incasement arranged as an armature for particular magnets and provided with a suitable commutator, whereby the various magnets are successively magnetized and the united armatures made to partake of the action of the series.

2. The combination of a series of paramagnetically-incased coils bound together, and a series of paramagnetic armatures magnetically separated and bound together, and a suitable commutator, whereby the successive energizing of the coils produces a prolonged movement of the magnets and armatures.

ANDRUS D. AYRES.

Witnesses:
JOHN C. GOODALE,
GEORGE I. GOODENOW.