E. A. BURLINGAME.

ELECTROMAGNET.

APPLICATION FILED JULY 13, 1908.

946,487. Patented Jan. 11, 1910.

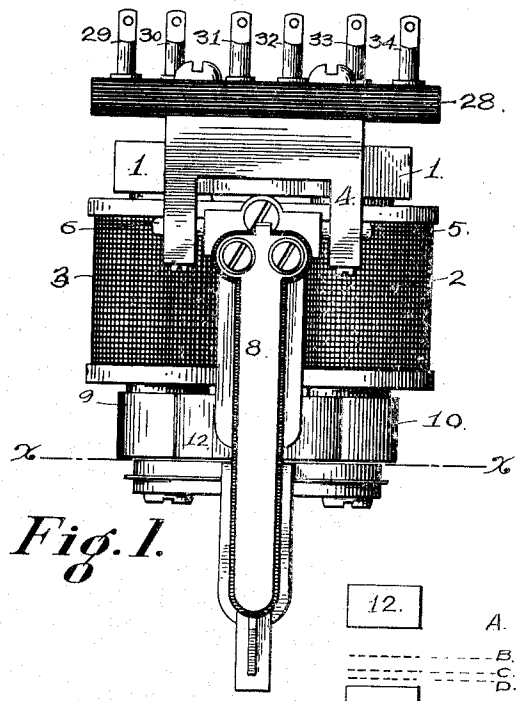



Fig. 1.




Fig. 6.

Fig. 2.

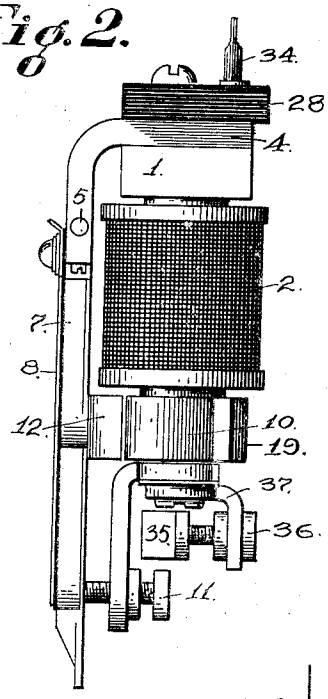



Fig. 3.

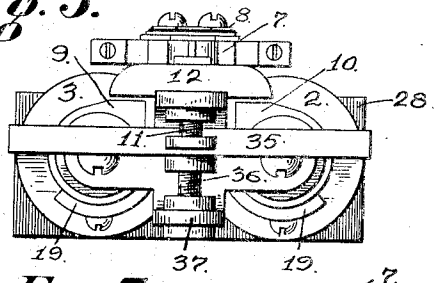



Fig. 5.

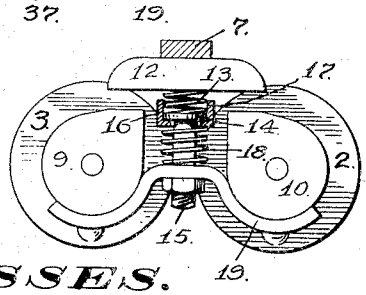
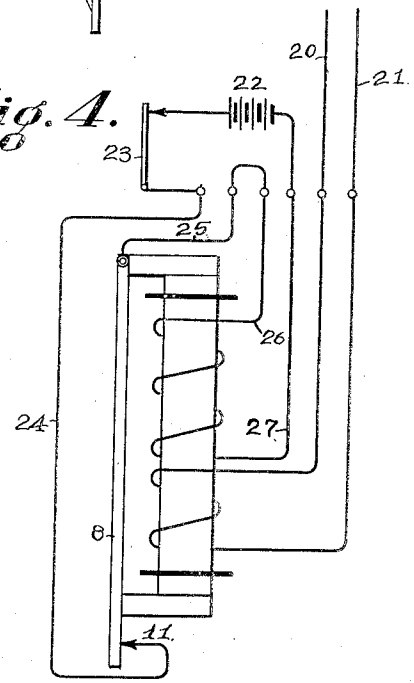



Fig. 4.




WITNESSES.

Arthur C. Slee.

A. Dixon

INVENTOR.

Elmer A. Burlingame

by Spear & Seely

ATTYS.

# UNITED STATES PATENT OFFICE.

ELMER A. BURLINGAME, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR TO BURLINGAME TELEGRAPHING TYPEWRITER COMPANY, A CORPORATION OF WASHINGTON.

## ELECTROMAGNET.

946,487. Specification of Letters Patent. Patented Jan. 11, 1910.

Application filed July 13, 1908. Serial No. 443,274.

*To all whom it may concern:*

Be it known that I, ELMER A. BURLINGAME, a citizen of the United States, residing at San Francisco, in the county of San Francisco, State of California, have invented new and useful Improvements in Electromagnets, of which the following is a specification.

My invention relates to improvements in electro-magnets and the object of the invention is to provide an electromagnetic device by which a part to be operated can be moved to selective distances from a neutral position according to the voltage of the current traversing the magnet coils. I aim to provide a simple form of magnet which will operate efficiently and reliably, and may be produced at a low cost.

The invention includes the features of construction and arrangements and combination of parts hereinafter described and particularly set forth in the appended claim.

The accompanying drawings, which form a part of this specification, illustrate a magnet constructed in accordance with my invention.

In the said drawings: Figure 1, is a front elevation of the magnet; Fig. 2, is a side elevation of the same; Fig. 3, is an end elevation; Fig. 4, is a diagram of the circuit; Fig. 5, is a cross-section of the armature and poles at line *x*—*x* in Fig. 1, showing in detail the mechanism employed in controlling the successive moves of the armature, and; Fig. 6, is a diagram illustrating the various controlled moves of the armature.

Referring to the drawings, the numeral 1, is an iron base block to which are attached on its lower side the magnet coils 2 and 3, and on its upper side the armature support 4. Pivotally mounted in the armature support 4, by any suitably adjustable pivots 5 and 6, is the armature beam 7 on which is a spring 8, insulated therefrom. On the magnets 2 and 3 are the pole pieces 10 and 9. On a suitable support below the pole pieces, as shown, is the contact screw 11, which is provided with a suitable contact point, to engage in contact with the spring 8 through an opening in the armature beam 7. Attached to the armature beam at a point opposite the pole pieces 9 and 10 is the armature piece 12, against the face of which is the coil spring 13, supported by the circular plate 14, and adjustable screw 15. Around the circular plate 14, is the collar 16, which in turn is held with its flange 17 against the plate 14 by the coil spring 18, which rests on the yoke that is secured to the pole pieces 9 and 10. This yoke 19 is of some nonmagnetic material.

The magnets 2 and 3 are each provided with a double winding. One of the windings, is shown in Fig. 4, by the wires 20 and 21 through the coil, and this is designated as the operating circuit. The secondary winding is of a local circuit formed as follows and shown in Fig. 4: battery 22, switch 23, wire 24, contact screw 11, spring 8, wire 25, wire 26, the magnet coils 2 and 3, wire 27, back to the battery 22. Normally the spring 13 holds the armature beam 7, with its attached spring 8, out of contact with the contact screw 11.

For the purposes of illustration I will assign a current of four volts to the operating circuit over which the current will be caused to flow and on through the primary winding of the magnet coils. This will energize the magnets 2 and 3 so that the pole pieces 9 and 10 attract the armature beam 7 until the armature piece 12 compresses the spring 13 and engages the collar 16. This will also cause a contact of the spring 8 with the contact screw 11. This contact will close the local circuit formed of the battery 22, switch 23, wire 24, contact screw 11, spring 8, wire 25, wire 26, magnets 2 and 3, wire 27, back to battery 22. Now when the primary current over wires 20 and 21 ceases, the energy derived from the local circuit, as described, will be sufficient to hold the armature beam 7 and the armature piece 12 in contact with collar 16, and the spring 8 on the armature in contact with the contact screw 11, thus retaining the flow of the current from the battery 22 through the secondary winding of the magnet and retaining the magnetic force so generated in the pole pieces 9 and 10. This condition will continue until this local circuit is broken, as for illustration, by means of the switch 23.

The spring 13 can be compressed by the magnetic force generated by the current of four volts given over the wire, but the magnetic force of four volts so given is not sufficient to compress the spring 18. This spring 18 is also so proportioned that it will resist the magnetic force exerted through the magnet coils by the local circuit, as described,

when added to the force exerted by the four volts in passing through the coils from the primary circuit.

It is a well known principle that a force exerting between an armature and the pole points of a magnet, with a constant current through the magnet, is approximately increasingly proportionate to the square of the distance between the faces of the armature and the pole point.

Now, as shown in Fig. 6, the armature piece 12 and the pole points 9 and 10, with a given current, will have a force of one unit exerting between them. If the armature piece 12 is allowed to advance to the point indicated at B, the force will then be four units. When it approaches C the force will be sixteen units and when it approaches D the force will be sixty-four units.

Returning to Fig. 5, the collar 16 stops the armature piece 12 in its path though the armature piece 12 compresses the spring 13 and is now as at B, as explained in the diagram 6, when the force exerted is four units. Now the local circuit is closed exerting an additional unit of force. The primary circuit is then broken at an outside point on the operating circuit 20 and 21. The local circuit still exerts a force of one unit on the armature piece 12 which is at point B. This force is greater than is required to hold spring 13 in compression, and since it requires less than one unit to hold the spring 13 in compression the armature piece 12 will remain against the collar 16, or in such position at B, until the circuit is broken as if by the switch 23, when the armature beam 7 will be returned to its normal position by the spring 13. Now should a current of eight volts be sent over the primary circuit to the wires 20 and 21, energizing the magnet, it will exert a force of four units at the beginning of the stroke of the armature piece 12 as it is attracted. When the armature piece 12 reaches the point, as at B, or in contact with the collar 16, this force will be sixteen units. The local circuit is again closed, adding an additional unit of force making a total of seventeen units of force against the collar 16. As before described, the spring 18 resisted a force of five units, but now there is a force of seventeen units against it, which is sufficient to compress it and bring the armature to the position shown at D, where the primary force now exerted is two hundred and fifty-six units and the secondary circuit exerts an additional force of sixteen units. The primary, or operating circuit, is now broken at some outside point, and the secondary force of sixteen units remains in the magnet. This force is more than enough to hold the spring 18 and the spring 13 in compression and retain the armature in the position thus given it. When the circuit is broken in the local current as by opening the switch 23, the spring 18 returns the collar 16 to its normal position against the disk 14 and the spring 13 returns the armature beam 7 to its normal position.

The bar 28 is of fiber or some such insulating material on which are mounted the binding posts 29, 30, 31, 32, 33, and 34, as suitable and convenient means for attaching the wires of the main and the local circuits. As a convenient means for holding the magnet in position is shown the piece 35 with the adjusting screw 36 attached to the bar 37.

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

In an electro-magnet, a magnet provided with two circuits, one being in secondary relation to the other, an armature being in two portions, one portion carrying an armature piece, and the other portion adapted to open or close the circuit of the secondary circuit, springs in succession and of different strengths between said armature piece and said magnet, strengths of said springs in proportion to different magnetic attractions of said magnet, substantially as described.

In testimony whereof I have affixed my signature in the presence of two witnesses this 29th day of June 1908.

ELMER A. BURLINGAME.

Witnesses:
FRANK L. OWEN,
A. DIXON.