

June 7, 1949.

F. J. M. THEUNISSEN

2,472,553

ELECTROMAGNET

Filed April 5, 1946

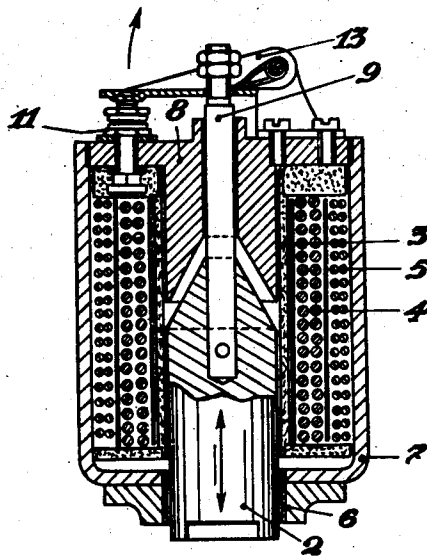


Fig. 1.

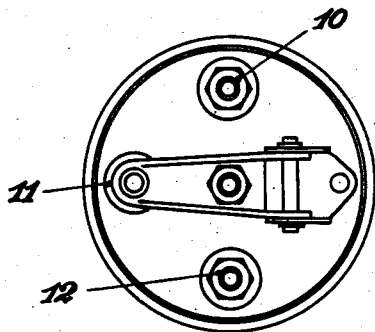


Fig. 2.

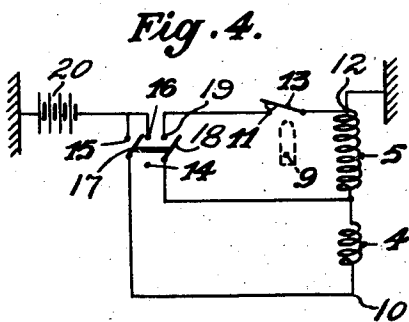


Fig. 4.

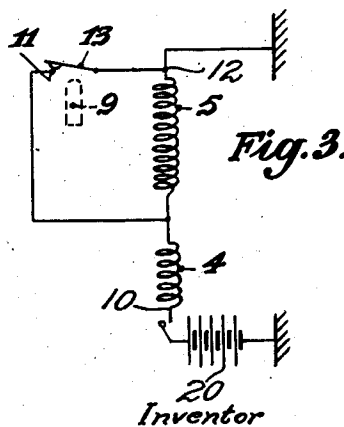


Fig. 3.

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UNITED STATES PATENT OFFICE

2,472,553

ELECTROMAGNET

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Application April 5, 1946, Serial No. 659,691
In Belgium March 11, 1940

Section 1, Public Law 690, August 8, 1946
Patent expires March 11, 1960

1 Claim. (Cl. 175—335)

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The object of the present invention is an electro-magnet which is intended for the operation of clutches, ratchets or other apparatus requiring a considerable magnetic force with a comparatively short travel of the armature.

The purpose of the present invention is to produce a great magnetic force and a great bearing force with an electro-magnet of reduced size and only using a small amount of current.

These conditions are obtained by the action of a magnetomotive force which is variable with the movements of the armature.

In a particular embodiment of the present invention, use is made of two currents of different value; one of high value and of short duration producing the movement of the armature and the other of lower value intended to keep the armature in its retentive position.

According to the invention, the number of turns of the armature attracting coil is automatically increased by the movement of the armature of the electro-magnet in the direction of retention.

According to a particularly advantageous embodiment of the invention, provision is made, during the attraction travel, for the movable armature to separate or open two contacts which, in the non-retentive position of the electro-magnet, short-circuit an additional winding connected in series with the main winding.

In order that the contacts shall only short circuit a comparatively weak current, the invention provides that the period when the aforesaid contacts are separated is arranged to correspond to the period when the counter-electromotive force produced in the main circuit by the movement of the armature, is approaching its maximum value.

The electro-magnet according to the invention is also suitable for operating at low temperature in moist atmospheres in order to prevent or reduce operational failures, such as icing, to a minimum, the movable armature is formed by a core which slides with a slight clearance in a thin non-magnetic sleeve, which is held against the cylindrical wall of the opening serving for the passage of the armature.

The fixed part of the magnetic circuit is formed by a cup which is pressed out in the direction of flow of the magnetic flux.

The electro-magnet according to the invention is also adapted to operate effectively at low temperatures, owing to the fact that the special design of the contacts permits the current to flow continuously through the electro-magnet, even in the non-retentive position, so that the

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heat generated by this continuous current assists in preventing its mass from cooling. In the non-retentive position of the electro-magnet, a current which is insufficiently weak to cause attraction of the armature, passes through at least one of the windings of the coil.

As previously stated, the current, as a whole, passes through the two windings, the attraction of the armature being obtained by momentarily short-circuiting the auxiliary windings.

The accompanying drawings show by way of example, various embodiments of the invention; and they include the particular arrangement described by way of example.

In the accompanying drawings—

Figures 1 and 2 illustrate a sectional view and a top view of the electro-magnet according to the invention.

Figures 3 and 4 show schematically two different methods of connecting the windings.

The electro-magnet comprises a plunger armature 2 arranged to move inside a brass tube 3 round which are wound, with the interposition of insulating material, windings 4 and 5; said armature slides freely, with a slight clearance, in a sleeve 6 made of non-magnetic material, which is fixed to the body 7 of the electro-magnet; said body is formed by a cup shaped stamping which is pressed out in the axial direction. At the upper end of the body a mild steel cover 8 is attached which is intended to complete the magnetic circuit, a guide rod 9 which moves integrally with the movement of the armature, and supports the terminals and the contacts. The ends of the windings are respectively connected to terminals 10, 11 and 12, which may be insulated if necessary, and which are fixed on the plate 8. The winding 4 (see Figures 1 and 3) consists of heavy gauge wire capable of passing a heavy current, whereas the winding 5 consists of wire of smaller gauge the resistance of which is chosen so as to limit the current to a low value.

In the non-retentive position of the electro-magnet, the contacts of the winding 5 are short-circuited by the contacts 11 and 13 so that only the winding 4 is in circuit; when the current is switched on, a current of high amperage passing through this winding causes the armature to be strongly attracted. As soon as said armature approaches the end of its travel, the rod 9 carried by the armature lifts the contact arm 13, thus automatically coupling the windings 4 and 5; this results in a reduction of the current strength owing to this fact, the strength of current decreases to a degree which is compatible

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with the maintenance of the adhesion in spite of the resisting force.

In Figure 4 (corresponding to the position of rest) a weak current passes from source 20 through 16, 17, 4, 5 towards the mass or earth. This current is insufficient to cause the attraction of the armature, but its heating effect prevents the apparatus from icing. In order to obtain the attraction of the armature, the switch 14 (comprising the mutually insulated contacts 17 and 18) is moved towards the left. A heavy current will then flow through 15, 17, 4, 18, 19, 11, 13 and the armature will be attracted. At the end of its stroke the armature opens the contact arm 13 and a weak current then passes through 15, 17, 4 and 5 so as to maintain a weak retentive force. To make the armature return to its non-retentive position, the switch 14 is again moved towards the right. When the contact 17 is moved between 15 and 16, the connection to the source 20 is interrupted and the armature returns to its initial position.

It is obvious that the invention covers the case in which the variations of magnetomotive force are obtained by acting on other factors, as for example by simply acting on the number and the variety of the windings connected in circuit.

What I claim is:

An electro-magnet including a movable armature, a main winding capable of attracting said

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armature when individually energized, an auxiliary winding connected in series with the main winding, the combined action of both windings, when energized in series, being only capable of maintaining the armature in its actuated position, a switch movable between two positions in each of which it connects the main winding to a source of current, a short-circuiting circuit for the auxiliary winding, a first breaker therein which is normally closed, means for opening said breaker by the aid of the armature towards the end of its attraction stroke, a second breaker in said short-circuiting circuit, this second breaker being normally open when the said switch is in the position corresponding to the non-attraction of the armature, and means for closing said second breaker when the said switch is shifted to its other position.

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