June 6, 1950 P. SALA 2,510,298

ALTERNATING CURRENT ELECTROMAGNET

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Fig. 3.

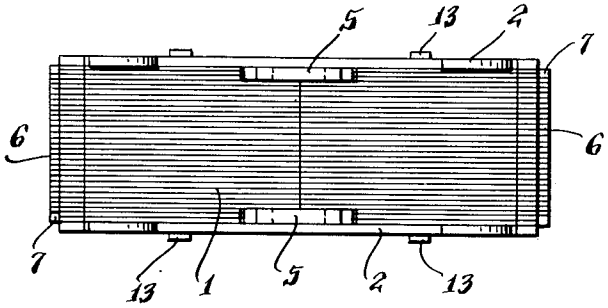


Fig. 4.

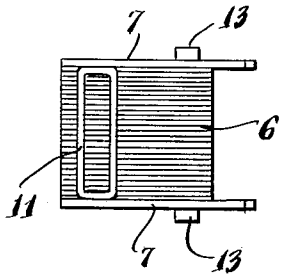


Fig. 1.

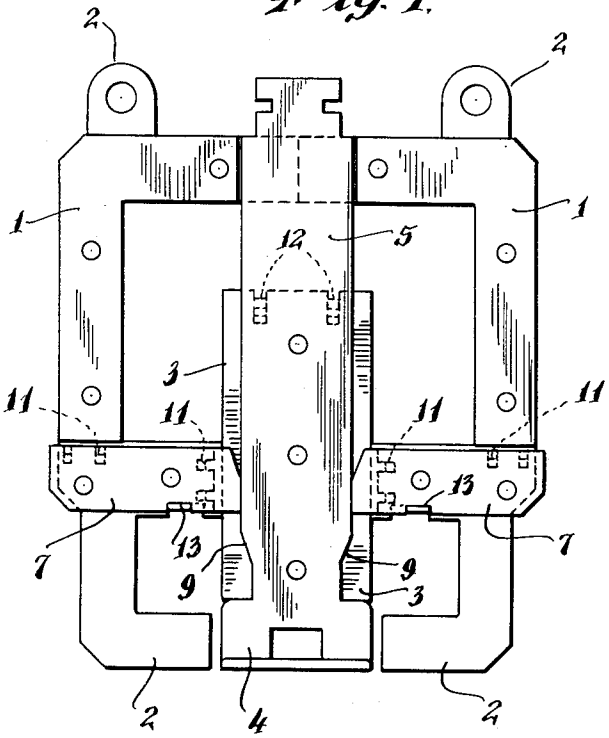
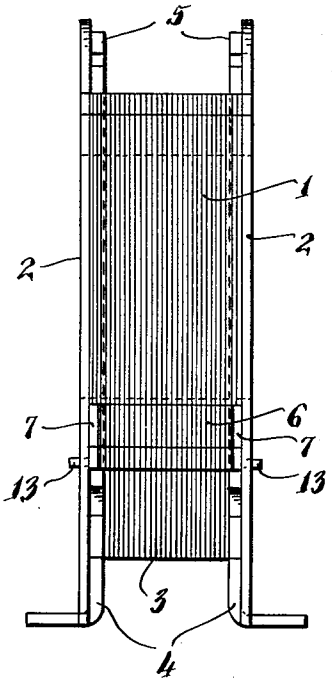


Fig. 2.



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Fig. 5.

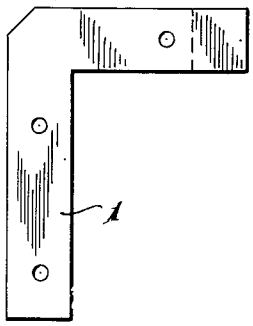


Fig. 6.

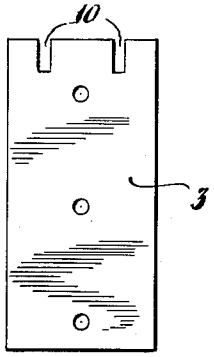


Fig. 7.

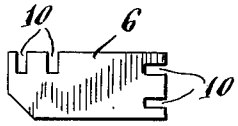


Fig. 10.

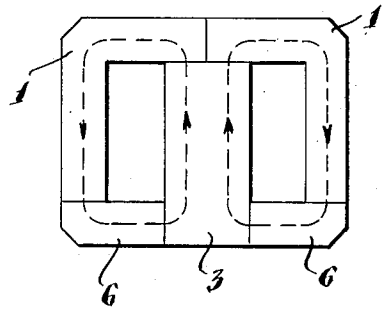


Fig. 9.

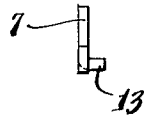


Fig. 8.

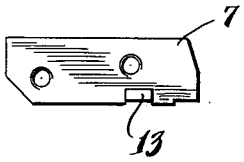


Fig. 11.

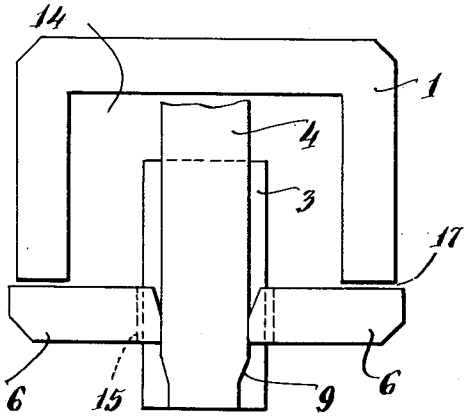
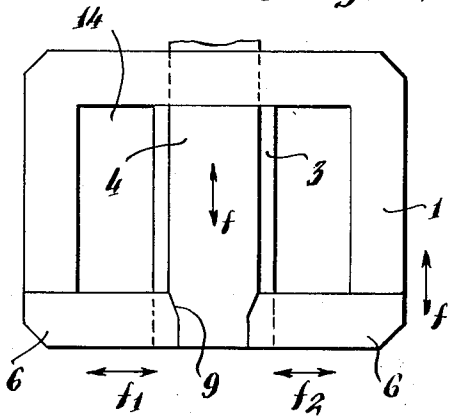


Fig. 12.



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UNITED STATES PATENT OFFICE

2,510,298

ALTERNATING CURRENT ELECTROMAGNET

Paolo Sala, Milano, Italy

Application May 11, 1949, Serial No. 92,593
In Italy May 20, 1948

1 Claim. (Cl. 175—338)

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This invention relates to improvements in alternating current electro magnets and more particularly to magnets of the solenoid or sucking type. Electro-magnets constructed for remote operated switches, for relays or for other purposes, generally are of two types: those with a single magnetic circuit and those with double magnetic circuit. In the former, the U-shaped fixed part, carrying the induction coil upon a limb, and the U-shaped armature, make contact on two pairs of surfaces which must touch perfectly. These electro-magnets work, generally, with the armature movable on a hinged bearing to cause rotation of the carrier shaft of the electrical contacts. They have the well known defect that, with the armature opened, the two air gaps are different. Moreover, the necessity for having the two above mentioned pairs of surfaces meeting with perfect contact, presents mechanical difficulties. Furthermore, the use of these electro-magnets for the actuation of switches, compels the use of simple break switches, whereas the modern tendency is to make double break switches, because these ensure quicker and more efficient arc interruption with remarkable mechanical simplification. In the construction of simultaneous double break switches, the tendency has been towards the construction of the double magnetic circuit sucking electromagnet, with three limbs on both the fixed and the movable part, and with the coil disposed on the central one, the movable part moving always parallel to itself, instead of rotating around an axis. In this case the electro-magnets could be called "iron-clad," because, as on the transformers of similar name, the circuits of the electro-magnetic flux are two, combining in the central limb, and subdividing in the two lateral limbs. This construction is made by having generally both the fixed and the movable part of E-shape; this shape can be modified so that in the fixed part the central limb can be lengthened or shortened, relatively to the lateral ones, the movable part having a complemental variation, so that eventually, one of the parts, generally the fixed one, can be U-shaped, and the other one consequently of T shape. This type of construction, whatever may be its geometrical accomplishment, presents always three pairs of surfaces, that, technically should meet on the closing of the armature. Accurately close meeting contact is not practically feasible, because of the serious mechanical difficulties relating to the grinding of the flat contact surfaces. In practice, this difficulty is overcome by limiting the

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requirement to a close meeting contact between the two pairs of lateral surfaces, leaving on the contrary a tiny air gap, on the central limb, when the armature is closed. In any case, this is a very delicate operation, as very slight imperfections or very slight increases of this indispensable air gap cause noticeable differences in the electromagnetic coil wear and, by consequence, the heating of the coil itself, vibrations and annoying, or, for several uses, even intolerable hums, during the operation of the device. The third defect is that in cutting the electro-magnetic iron sheets, and for whatever shape of the electromagnet, there results an appreciable waste of raw material which sometimes surpasses the weight of the useful material.

In the last described type of construction as well as in that with the hinged armature two air gaps are formed in both electro-magnetic flux circuits when the core is opened, with a total stroke double that used for the stroke of the movable armature or core; this fact necessitates an increase in the ampere turns of the actuating coil in order to get the movable armature or core started.

The present invention avoids the above mentioned disadvantages and defects by providing the alternate current sucking electro-magnet with self-adjusting pole pieces.

The invention consists in that the width of the unavoidable but unused air gaps of the electro magnet for remote operated switches is considerably reduced, in order to make the latter more ready, rapid and efficacious and to limit in the meantime the current consumption. This is realized practically by dividing the arms of the inverted T-shaped core and placing the same so that they have only the function of conveying the magnetic flux, while the central part has to effect only the useful movement for remote operated controls. Said arms of the inverted T effect only a light horizontal displacement in order to follow the wide movement of the central part. The air gap closing occurs automatically because of magnetic sucking which produces self-adjusting of the component parts. If the arms of the inverted T-shaped core were joined with the U-shaped fixed part of the electro magnet so as to form a C-shaped piece, after closing of the central part there would remain an air gap in any case for permitting the movable core central part at least some vertical displacement, resulting in a considerable current consumption and efficiency reduction. The opening, on the contrary occurs because of the central part fall-

ing by gravity at the moment of current interruption and because of wedgelike guide armatures with which the central part is provided.

The invention is illustrated by means of examples in the accompanying drawing wherein:

Figure 1 is a plan view of an electro-magnet in accordance with the present improvements but with a front outside or end plate removed,

Figure 2 is a side view of Figure 1,

Figure 3 is an end view as seen from the top of Figure 1,

Figure 4 is a top view of one of the self-adjusting pole pieces of the electro-magnet,

Figure 5 shows in detail one of the magnetic iron sheets forming the fixed core,

Figure 6 shows in detail one of the iron sheets forming the movable core,

Figure 7 shows in detail one of the magnetic iron sheets of the self-adjusting pole pieces,

Figures 8 and 9 are respectively a front view and a side view of one of the end plates of the laminated pole pieces, and

Figure 10 is a diagram of the two magnetic circuits.

Figure 11 shows the electro magnet with the movable core in "off" position and Figure 12 shows the same in closing position after the snap action produced by the current in the bobbin.

In the drawing, the electro-magnet of the present invention, comprises a fixed core formed by two packages of L-shaped magnetic iron sheets 1, enclosed between end plates 2. The two L shapes are put together so as to form an inverted U as seen in Figure 1. The magnet further comprises a movable core 3 of parallelopiped form composed of rectangular iron sheets packed between two end or outside plates 4. In its movements the core is guided by two guides 5 (Figure 3), the guidance being provided between the fixed end plates 2 and the iron sheets 1. The fixed core is completed by two self-adjusting pole pieces 6 formed by magnetic iron sheets enclosed between two end plates 7 (Figures 4, 7, 8, 9). The pole pieces 6 are separate from the lateral arms of the fixed core 1 (see Figure 1), and rest on two supports (not shown in the drawing), which may be placed, for instance, on the lower corners of the bent extensions of the end plates 2, so that they are very near to the two lower extreme surfaces of the fixed core 1. These pole pieces are supported so that they have freedom to move slightly as hereinafter explained. The magnet coil (not shown in the drawing) is mounted in the space 8 so that the core can move in the rectangular hollow of the coil spool. The end or outside plates 7 of the self-adjusting pole pieces 6, protrude beyond the laminae to contact the edges of the end plates 4 of the movable core, when the latter is at rest in the open position seen in Figure 1. Thus the polar surfaces of the two pole pieces 6, are slightly separated from the lateral surfaces of the movable core 3 in this position. The end plates 4 of the movable core 3, present, on the lower parts of both sides, an inwardly inclined edge 9. At the moment of excitation of the coil, the movable core is attracted upwards, until it touches with its upper surface the internal middle flat surface of the fixed core 1. In the meantime, and because of the magnetic effect tending to eliminate the air gaps, the two self-adjusting pole pieces 6 are attracted inwards, so that at the end of the stroke of the core 3, the inclined edges 9 of the plates 4 come opposite the appropriately shaped ends of the end plates 7, and the pole pieces 6, being then free, move laterally

until they adhere and press strongly against the sides of the movable core 3, at the same time the pole pieces 6 are attracted upwardly so that their upper external flat surfaces adhere to the lower surfaces of the limbs of the fixed core 1. In this manner both magnetic circuits are completed in parallel (see Fig. 10), so that, besides the usual three pairs of contact surfaces, two more are formed between the movable core and the self-adjusting pole pieces, and the contact between the various parts is perfect and with no air gap, and therefore without break of continuity in the magnetic circuits. In front of every surface of magnetic contact, in the hollows 10 (Figures 6, 7) are placed the usual anti-vibration short-circuiting rings 11 Figure 4 and 12 Figure 1. When the electro-magnetic coil is de-energized, the core 3 falls and the end plates 7 move the pole pieces 6 outwards owing to the camming action of the inclined edges 9 against the shaped ends of the plates 7. Also, the pole pieces 6 cease to adhere to the lower faces of the pole pieces 1. A small stop screw 13 (Figures 8 and 9) on each end plate 7 serves to limit the movement of the self-adjusting pole piece 6 outwards because it comes against a suitable stop provided in the inner side of the end plates 2. The inverted U-shape of the movable core, constructed by putting together two L-shapes, instead of making it in a single piece, does not prejudice the continuity of the two parallel magnetic circuits, the junction between the L-parts being parallel and not transversal to the flux, and therefore being of no effect upon the magnetic reluctance of the two circuits (Figure 10).

On Figure 11 are to be noted the principal air gap 14 corresponding to the stroke width of the movable core 3 and very much reduced air gaps 15 necessary to permit sliding of the movable core; the electro magnet is completed by the C-shaped piece 1. The arms 6 of the inverted T are detached from the movable core 3 and, at the "off" position, the air gap 15 is enlarged by the package 4 acting upon the guide ends 16 of pole pieces 6. Because of wedgelike guide surfaces 9 and 16, the friction between the movable core 3 and pole pieces 6 of anti-frictional metal is practically negligible. On Figure 12 are to be noted the movable core 3 raised to touch at the centre and fixed core 1 avoiding the air gap 14, and the pole pieces 6, which because of the magnetic flux and taking off the obstacle opposed by the package 4, whose portions 9 have received the ends 16, have been selfadjusted eliminating the air gaps 15 and in the meantime the air gaps 17.

When the electric circuit is reopened, the movable core 3 falls by gravity and the package 4 by wedging itself between the guides 16 produces enlarging of pole pieces 6. The electro magnet returns then to the "off" position shown on Figure 11. The vertical arrow f indicates the direction of movement of movable core 3, while the horizontal arrows f_1, f_2 indicate the direction of movement of self adjusting pole pieces 6.

Of course, however, it is possible to construct the above mentioned fixed core of a single package of U-shaped iron sheets. The described electro-magnet presupposes single phase alternate current feeding, but it is evident that it is easy, owing to the type of construction, to use also three phase alternate current feeding, having beside the coil placed in the central part of the core, two more coils on the sides of the fixed core.

The electro-magnet hereinbefore described presents the following advantages:

(i) Owing to the mobility of the two self-adjusting pole pieces 6, the various surfaces of magnetic contact, between fixed, semi-fixed and movable parts, can adjust themselves naturally, to the exclusion of every air gap when the core is closed; this is absolutely impossible in the usual types of "iron clad" cores, where the various contact parts are rigidly united together. In the electro-magnet of the present invention, the rigid union of parts is eliminated and substituted by a self-adaptability of the parts. Moreover, its construction permits of obtaining very noiseless working, requiring no grinding of contact surfaces and no calibration; this electro-magnet is therefore more simple and cheaper than electro-magnets with a single-piece core.

(ii) At the moment of the interruption of the excitation current in the coil, as both magnetic circuits have three breaking points, instead of two, the residual magnetism is greatly reduced, and the movable core can be very easily opened.

(iii) Owing to the elimination of every air gap, the coil wear is reduced to the minimum for an identical work duration, and coils with constant wear are obtained for all devices of the same type.

(iv) When the core is in the fully opened position, there is only one air gap corresponding to the working stroke of the core, instead of two as in the usual types, because the air gaps, corresponding to the free position of the self-adjusting pole pieces, are minimum and reduced to the engineering tolerances of the working of the parts. This becomes a very remarkable advantage for greater speed and for attraction power, for an equal coil wear.

(v) Owing to the geometrical shapes of all the

parts forming the electro-magnet, they can be cut without wasting raw material.

I claim:

An alternating current electro-magnet of the sucking type comprising an inverted, U-shaped, vertically divided fixed core, and an inverted T-shaped movable core located within and opposed to said fixed core and including a central body part and two separate and independently movable side parts extending transversely on either side of the lower end of said central part, said central part and side parts being upwardly movable, under the influence of magnetic flux, axially of the central part and the side parts also transversely of the central part, the lateral surfaces of the central part and adjacent end surfaces of the side parts having oppositely inclined wedge surfaces cooperating to displace said side parts outwardly when said central part moves downwardly under the influence of gravity, thereby to displace said ends of said side parts from the downward path of movement of said central part.

PAOLO SALA.

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