Nov. 14, 1939. W. C. BEACH 2,180,288

ELECTROMAGNET

Filed Dec. 5, 1936

FIG. 1

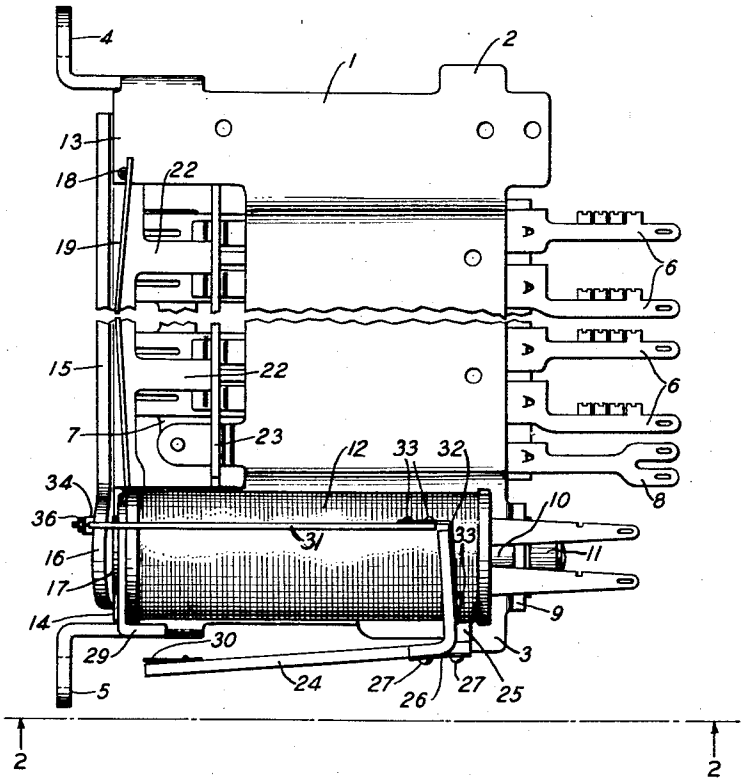
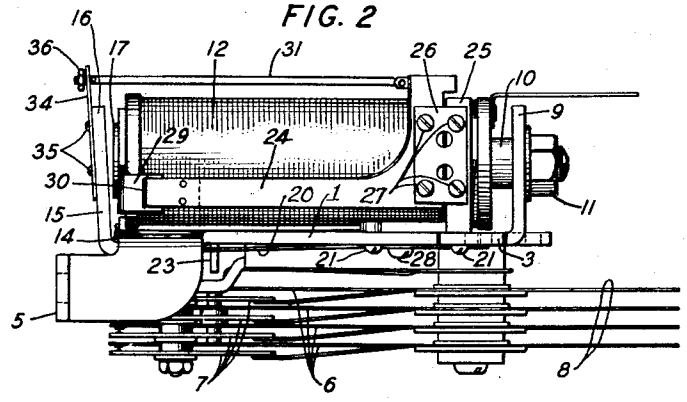


FIG. 2



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ELECTROMAGNET

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2 Claims. (Cl. 175—336)

This invention relates to an electromagnet and more particularly to an electromagnet which will attract its armature on one value of operating current and which will maintain its armature in the attracted position on a lesser value of holding current.

The electromagnet in accordance with the invention is particularly applicable to a switch of the cross-bar type such as is disclosed, for example, in Patent No. 2,021,329 granted November 19, 1935, to J. N. Reynolds. A switch of this type consists essentially of a number of contact sets arranged in horizontal rows and corresponding contact sets arranged in vertical rows with one set of each kind adjacent intersecting points of said rows, and means including one group of operating members intersecting another group of such members and controlled by magnets. Connections are established between two sets of contacts at any intersection point by the rotation of one operating member of one group followed by the rotation of an operating member of the other group which intersects the first operating member at the intersection point.

Following the establishment of a connection between two sets of contacts the operated member of the first group of operating members is released and the connection between the sets of contacts is then maintained by the operated member of the second group. Since there is quite a large load on the armature of the magnet which rotates an operating member of the second group, considerable current is required to maintain the armature attracted and, with several such switches employed in a telephone exchange system for the establishment of a connection between two subscribers' lines, the current drain for holding such a telephone connection is thus considerable. It is therefore the object of the present invention to provide a magnet structure suitable for controlling an operating member of a switch of this type in which the armature will be positively attracted in response to one current strength and will be maintained operated when the operating current is reduced in strength.

In accordance with the present invention a magnet is provided which has a main armature connected to the operative load and an auxiliary holding armature. The auxiliary armature is substantially L-shaped and is hinged at its elbow to the heel-piece of the magnet structure. The two arms of the auxiliary armature have a leverage ratio of approximately 3 to 1, the free end of the longer arm cooperating with an auxiliary pole-piece secured to the forward end of the magnet core and the free end of the shorter arm being linked to the main armature by a non-magnetic coupling rod.

With this construction when the main armature is attracted in response to the application of the full value of operating current to the magnet winding, the coupling rod is actuated to rotate the auxiliary armature about its hinge point thus moving the free end of its long arm into engagement with the auxiliary pole-piece. The auxiliary armature is now held attracted to the auxiliary pole-piece by the energization of the magnet winding. If now the strength of the operating current is reduced to such an extent that the main armature would not be maintained attracted, the auxiliary armature is maintained attracted to the auxiliary pole-piece and due to the leverage ratio between its two arms the coupling rod connecting the end of its shorter arm to the main armature prevents the main armature from moving to its retracted position.

For a clearer understanding of the invention reference may be had to the following detailed description taken in connection with the accompanying drawing of which:

Fig. 1 is a side elevational view of a vertical unit of a cross-bar switch having an operating magnet constructed in accordance with the invention; and

Fig. 2 is a bottom end view of the unit.

Referring to the drawing, a vertical unit of a cross-bar switch of the type disclosed in the patent to Reynolds hereinbefore referred to, but having the operating magnet thereof modified in accordance with the invention, is illustrated. This unit comprises a mounting plate 1 having ears 2 and 3 and lugs 4 and 5 by which it may be attached to the main frame of the switch. The plate 1 has secured to the rear thereof a series of ten sets of contact springs 6, only four of such sets being illustrated, a set of vertically disposed contact springs 7 having sets of multiple contacts for cooperating with the contacts of the sets of springs 6, and a set of terminal lugs 8 connected to the springs 7.

The frame 1 is provided near the bottom of its right vertical edge with an ear 9 to which the core 10 of an electromagnet is secured by the nut 11. The core 10 extends parallel to the front face of plate 1 and carries an energizing coil 12. Pivoted on the knife edge extensions 13 and 14 of the left edge of plate 1 is an L-shaped main armature 15, one arm of which lies substantially parallel to the rear face of plate 1 and the other

arm of which is enlarged as shown at 16 for cooperating with the pole face 17 of core 10. The armature is retained on the extensions 13 and 14 by two screws, the end of one of which is shown at 18, which extend freely through holes in one arm of the armature into threaded holes in the extensions 13 and 14. For holding the armature firmly against the knife edges of extensions 13 and 14 a spring 19 is provided having its mid-point attached to the armature and its free ends engaged behind the ends of screws 18. The armature is maintained in its normal or unoperated position, as shown in Fig. 2, by a restoring spring 20, one end of which is secured to the plate 1 by screws 28 and the free end of which engages with the rear arm of the armature.

The rear arm of the armature is provided with extensions 22 to which is secured the operating member or vertical bar 23. The bar 23 is effective upon the energization of the coil 12 and the attraction of armature 15, in conjunction with an operated horizontal operating member, not shown, to cause the engagement between a set of contacts on the vertical springs 7 and a set of contacts carried by one of the sets of springs 6.

The operating magnet, in accordance with the invention, is also provided with an L-shaped auxiliary armature 24, the two arms of which have a leverage ratio of approximately 3 to 1. This armature is hinged at its elbow to a bracket 25 by a flexible hinge plate 26, the hinge plate being secured to the armature 24 and to the bracket 25 by screws 27. The bracket 25 is secured to the plate 1 by screws 21. The long arm of the auxiliary armature cooperates with an auxiliary pole-piece 29 secured to the forward end of the core 10 and in its normal position, as disclosed in Fig. 1, is separated therefrom by an appreciable air-gap. To prevent the armature 24 from freezing to the pole-piece 29 when attracted thereto, the armature 24 has secured thereto a thin strip 30 of non-magnetic material. The short arm of armature 24 is connected to one end of a rod 31, preferably of non-magnetic material, by a reed hinge 32 secured to the armature and to the rod by screws or rivets 33. The other end of rod 31 is engaged in an opening in member 34 which is attached to the enlarged portion 15 of armature 15 by screws 35. The end of rod 31 is shouldered for abutment against the member 34 and is retained in the opening in member 34 by nut 36 threaded on the end of the rod.

The magnetic structure operates in the following manner: When current of operating value is impressed upon the coil 12 the magnetic flux generated in the magnet circuit comprising the pole face 17, core 10, ear 9, plate 1 and extension 14 thereof, attracts the main armature 15 and moves the bar 23 and, assuming that a cooperating horizontal operating member (not shown) has been previously operated, the bar 23 causes the engagement of a contact set carried by the springs 7 with a set of springs 6.

The movement of armature 15 to its attracted position is transferred by the rod 31 to the short arm of auxiliary armature 24 thereby swinging the long arm of armature 24 into engagement with the auxiliary pole-piece 29. The auxiliary armature 24 is now held attracted to the pole-piece 29 so long as the coil 12 remains energized. If now the operating current is reduced to a holding value insufficient to hold the main armature 15 in its attracted position, but sufficient to maintain the auxiliary armature 24 in its attracted position, the main armature will be held in its operated position due to the multiplying leverage ratio of the arms of the auxiliary armature and the rod 31 interlinking the two armatures. Thus, the operated contacts are maintained closed even though the energizing current flowing through the coil 12 has been reduced from an operating to a holding value. By the provision of the reed hinge connection 32 between the rod 31 and the auxiliary armature 24 sufficient yielding is introduced to enable both armatures to move to their fully attracted positions.

As a typical example it will be assumed that when 300 ampere turns of energy is supplied to the coil 12 the magnet will hold a load of approximately 1370 grams at the center line of its core 10, but that 1540 grams is the load required to be held. If, then, 300 ampere turns is assumed to be the "just hold" condition for the unit illustrated without the auxiliary armature 24, the "just hold" condition for the unit equipped with the auxiliary armature would be 193 ampere turns thereby permitting a reduction of the ampere turns of 35.7 per cent for the same load. It thus appears that a reduction of about one-third in the holding current is possible by the use of the auxiliary armature. It will, of course, be obvious that this reduction may be attained by a reduction in the amperage of the current applied to the coil 12 or by the use of a secondary or holding winding on the coil having a smaller number of turns.

While the invention has for convenience been illustrated as applied to the vertical unit of a cross-bar switch, it is equally applicable to other magnet operated structures which are required to be held operated for long periods and where current drain is therefore an important item in the cost of operation and maintenance.

What is claimed is:

1. In a magnetic structure, an energizing winding, a core extending through said winding, a pole-piece magnetically connected with said core, a main armature cooperating with said core and with said pole-piece, an auxiliary pole-piece magnetically connected with said core, an auxiliary armature cooperating with said auxiliary pole-piece, and a link extending between said armatures pivotally connected at one end to one of said armatures and connected at its other end to the other of said armatures by a spring hinge, said hinge being yieldable in the longitudinal direction of said link.

2. In a magnetic structure, an energizing winding, a core extending through said winding, a pole-piece magnetically connected with said core, a main armature cooperating with said core and with said pole-piece, an auxiliary pole-piece magnetically connected with said core, an auxiliary armature having a long arm and a short arm, said long arm cooperating with said auxiliary pole-piece, a rod of non-magnetic material connected at one end to said main armature and extending toward the end of the short arm of said auxiliary armature, and a spring hinge for connecting the other end of said rod to the short arm of said auxiliary armature yieldable to permit movement of the short arm of said auxiliary armature away from the adjacent end of said rod.

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