May 19, 1942. E. LAKATOS ET AL 2,283,859

MAGNETIC CONTACT STRUCTURE

Filed Dec. 9, 1939

FIG. 1

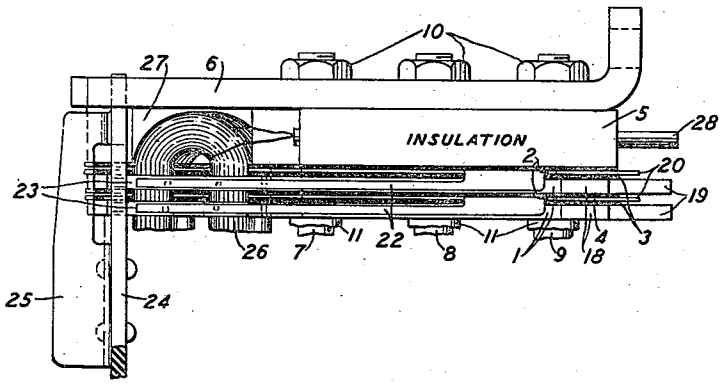


FIG. 2

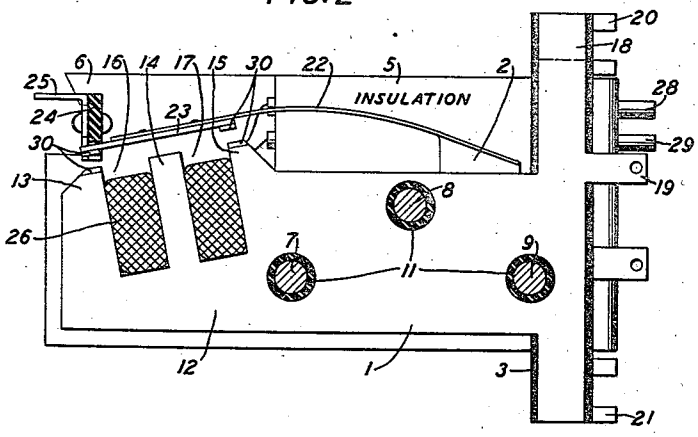
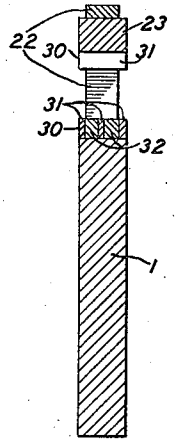


FIG. 3



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MAGNETIC CONTACT STRUCTURE

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Application December 9, 1939, Serial No. 308,496

9 Claims. (Cl. 200—166)

This invention relates to magnetic materials for use in connection with the magnetic circuits of relays.

An object of the invention is to provide a magnetic material which while retaining its magnetic properties also has good electrical conductivity.

It has been proposed to construct a relay, the work circuit of which is established upon the attraction of the armature to the pole-pieces of the relay core by the conductive engagement of the armature with the core, thus eliminating the contact springs usually operated by the armature and thereby simplifying the relay structure and reducing its cost. A relay of this type is disclosed, for example, in the copending application of C. N. Hickman and E. Lakatos, Serial No. 308,497, filed December 9, 1939, in which the contact resistance between the armature and the relay core upon the engagement of the armature with the pole-pieces of the core is reduced by plating the faces of the pole-pieces or by plating both the pole-piece faces and the contact surface of the armature with a metal having good conductivity such as silver.

In accordance with the present invention it is proposed to improve the conductivity of the core pole faces and the contact surface of the armature of a relay of this general type by welding strips thereto fabricated from a mixture of finely divided particles of iron or other magnetic material and a metal having good electrical conductivity, or by fabricating such strips with alternate laminations of iron or other magnetic material and a metal having good electrical conductivity.

As illustrative of the application of magnetic materials of the types contemplated by the present invention, reference may be had to the accompanying drawing in which:

Fig. 1 discloses a partial top-plan view of a relay of the type in which the magnetic circuit elements are fabricated from the proposed magnetic material;

Fig. 2 discloses a side elevation view of the relay disclosed in Fig. 1; and

Fig. 3 shows a cross-sectional view of an armature and core lamination which have facings welded thereto composed of alternate laminations of iron or other magnetic material and another metal.

The relay comprises an assembly of a plurality of magnetic circuit units each comprising a core lamination 1, an armature supporting spring lamination 2 and an interposed lamination 3 of insulating material such as hard rubber or fibre. The several units are assembled side by side and insulated from each other by spacing laminations 4 of insulating material such as hard rubber or fibre, between end blocks of hard rubber, one of which is shown at 5, and end plates, one of which is shown at 6, on threaded studs 7, 8 and 9 which extend through aligned holes in the end plates, the end blocks, the spacing laminations and the laminations comprising the units. The assembled structure is clamped together by nuts 10 threaded upon the ends of the studs. For insulating the core laminations 1 and the spring laminations 2 from the studs which pass through the holes therein, the studs are surrounded by sleeves 11 of insulating material such as hard rubber.

Each core lamination 1 is stamped from a sheet of magnetic material into the T-shaped disclosed in Fig. 2 and comprises a horizontal portion 12 having three pole-pieces 13, 14 and 15 on its upper edge formed by the two parallel slanting slots 16 and 17 and a rear portion 18 provided with a rearwardly extending terminal lug 19.

Each spring lamination 2 is stamped from a sheet of nickel-silver and is also of the same general configuration as the core lamination having slots in its outer end for alignment with the slots 16 and 17 of the associated core lamination and having rearwardly extending terminal lugs 20 and 21. Each spring lamination is bent at right angles along its upper edge and the bent-over portion is severed from the body of the lamination along the major portion of its length to form a spring finger 22 which extends forwardly at a rising angle over the top edge of the associated core lamination 1. An armature 23 is welded or otherwise secured to the free end of the spring finger 22 in a position to overlie the pole faces of the pole-pieces 13, 14 and 15 of the associated core lamination.

The insulating laminations 3 and 4 also have the same general configuration as the core lamination and are provided with slots in their outer ends for alignment with the slots 16 and 17 of the core laminations.

Normally the working air-gaps between the pole-pieces of the core laminations and the lower faces of the armatures are maintained by a common back-stop bar 24, the ends of which are seated in notches in the ends of the end plates, such as 6, and maintained in such notches by spring members 25 secured to the ends of the back-stop bar.

A common energizing coil 26 is seated in the

aligned slots of the core, spring and insulating laminations, thereby surrounding all of the middle pole-pieces 14 of the core laminations. The end blocks are cut away to give clearance for the ends of the coil and the block 5 is provided with two brass tubes 28 and 29 extending therethrough to the forward ends of which the terminals of the coil 26 are connected and the rear ends of which serve as terminals to which conductors of the energizing circuit of the relay coil may be connected.

In the operation of the relay when the coil 26 is energized, all of the core laminations 1 become magnetized and attract their associated armatures 23 into conductive engagement with their pole-piece faces thereby establishing a plurality of work circuits, each of which extends from a core lamination through the attracted armature to the spring lamination which supports the armature.

In accordance with one embodiment of the present invention, the contact resistance between the armatures and the pole-pieces of the associated core laminations may be reduced by welding small pieces 30 of a magnetic material which is composed of a mixture of finely divided particles of iron and finely divided particles of another metal which has good electrical conductivity, such as silver, to the faces of the pole-pieces of the core laminations and to the under-surface of the armatures.

In carrying out this process of manufacture, the finely divided particles of silver may be produced by chemical precipitation and the iron particles may be produced either by treating iron with an acid to precipitate an iron oxide and then reducing the iron oxide by hydrogen to form fine particles of chemically pure iron or, electrolytic iron may be obtained in any well-known manner, broken into small pieces and reduced to fine particles by grinding in a ball mill. The iron particles are then heated in any suitable furnace to anneal them and to drive off any occluded gases principally hydrogen.

The silver particles and the iron particles are then mixed preferably in the proportion of 50 per cent silver and 50 per cent iron by weight, placed in a mold and subjected to a high pressure, for example, of 200,000 pounds per square inch and to a temperature of 900° to 950° centigrade to form bars in much the same manner as dust cores for loading coils are molded. The bars are then rolled into sheets of the thickness required for the facing strips 30 of the armatures and core laminations and the facings are then stamped therefrom in the required shapes. If desired the strips 30 of the armatures and core laminations may be molded directly from the mixture of metal particles.

Although good results may be obtained by combining equal weights of silver and iron particles, the silver content may be increased and the iron content decreased proportionately to secure a material having greater conductivity However, the iron content must not be reduced to such an extent as to render the material inefficient magnetically.

As an alternative method of combining portions of iron and portions of another metal having good conductivity, to form a magnetic material from which facing strips of the core laminations and armatures may be fabricated, thin sheets of iron may first be electroplated with a thin coating of copper and then such electroplated sheets may be stacked together with interposed sheets of a conducting metal such, for example, as sheets of silver. The stack of sheets may then be subjected to heat and pressure until a bond is established between the surfaces of the interposed sheets and the copper coatings of the iron sheets. The temperature employed if silver were used should not be greater than 778° centigrade. After the bonding has been completed, the stack is then rolled into a sheet of the thickness required and the facing strips for the armatures and core laminations are then stamped therefrom in the required shapes.

Fig. 3 illustrates in cross-section an armature and a core lamination having facing strips 30 welded thereto which are fabricated from a laminated sheet of the character just described having three laminations 31 of iron and two interposed laminations 32 of silver or another metal having good conductivity. The facing strip is welded with its laminations extending laterally of the armature 23 and the facing strip is welded with its laminations extending longitudinally of the core lamination 1 whereby the laminations of the strips cross at right angles to each other and when the armature 23 is attracted into engagement with the pole faces of the core lamination 1, the edges of the iron laminations 31 of both the core and armature engage to establish low reluctance magnetic paths and the edges of the silver laminations 32 of both the core and armature engage to establish low resistance conductive paths.

While as illustrated the thicknesses of the silver and iron laminations have been so selected as to substantially equalize the weights of the silver and iron content, the thickness of the silver laminations could be increased and the thickness of the iron laminations proportionately decreased to further reduce the contact resistance between the armature and the core lamination. However, the iron content should not be reduced to such an extent as to materially reduce the magnetic efficiency. Furthermore it is to be understood that the number of laminations of iron and silver in the composite structure is not necessarily limited to the number illustrated but may be varied as desired to secure the maximum magnetic and conductive efficiency.

It is to be understood that while the application of the invention has been illustrated in connection with a specific relay structure, the invention is equally applicable to any relay in which a work circuit is established by the conductive engagement of the armature with the relay core.

What is claimed is:

1. An electrical contact element fabricated from a magnetic material having good electrical conductivity composed of a mixture of finely divided particles of iron and finely divided particles of silver.

2. An electrical contact element fabricated from magnetic material having good electrical conductivity composed of a mixture of finely divided particles of iron and finely divided particles of silver in substantially equal proportions by weight.

3. An electrical contact element fabricated from a magnetic material having good electrical conductivity composed of a mixture of finely divided particles of iron and finely divided particles of silver in such proportions by weight that the silver predominates.

4. An electrical contact element fabricated from a magnetic material composed of inter-

posed laminations of a magnetic material and laminations of a metal having good electrical conductivity.

5. An electrical contact element fabricated from a magnetic material composed of interposed laminations of iron and a metal having good electrical conductivity.

6. An electrical contact element fabricated from a magnetic material having good electrical conductivity composed of interposed laminations of iron and silver.

7. An electrical contact element fabricated from a magnetic material composed of laminations of iron having coatings of copper electroplated thereon and interposed sheets of silver bonded to said laminations.

8. An electrical contact element fabricated from a magnetic material composed of interspersed portions of a magnetic material and a metal having good electrical conductivity.

9. An electrical contact element fabricated from a magnetic material having good electrical conductivity composed of interspersed portions of a magnetic material and silver.

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