Feb. 24, 1959 R. B. IMMEL 2,875,301

CIRCUIT INTERRUPTER

Filed Feb. 8, 1954

2 Sheets-Sheet 1

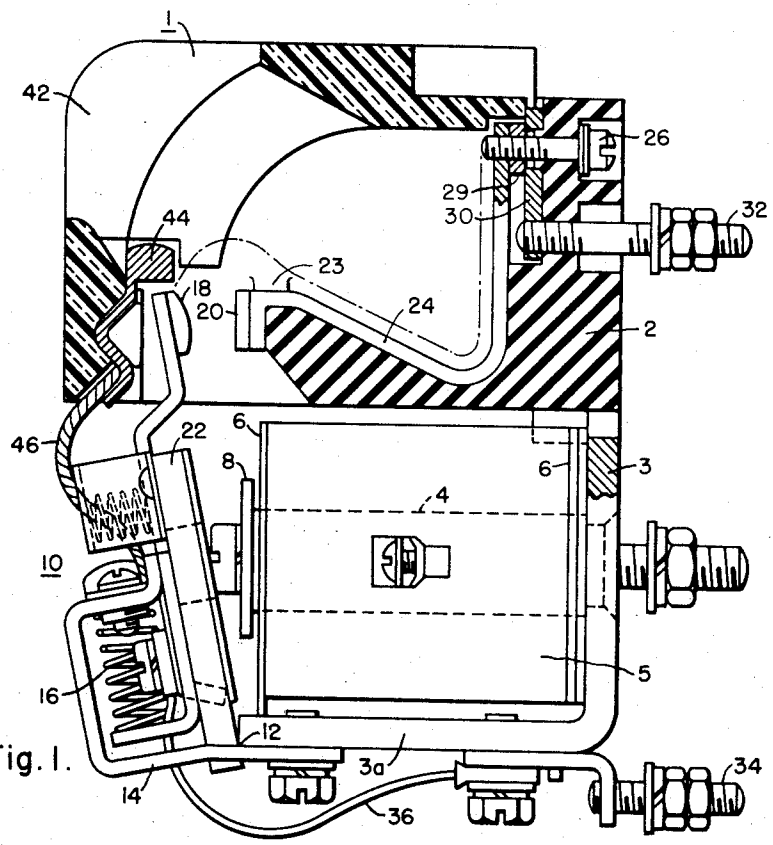

Fig. 1.

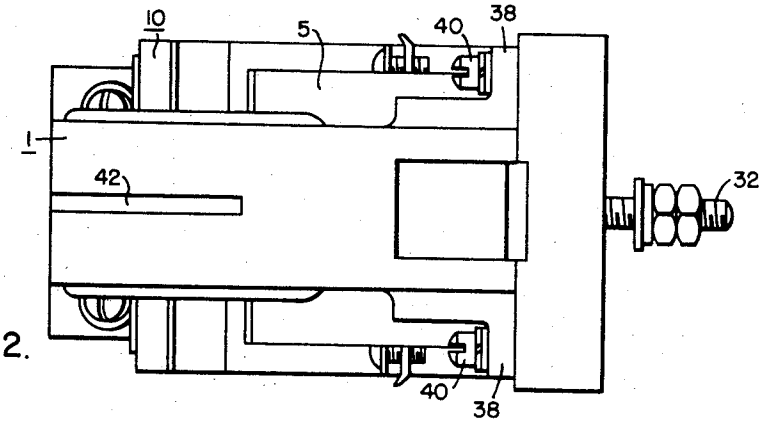

Fig. 2.

WITNESSES

Robert C. Baird

E. F. Oberheim

INVENTOR

Ralph B. Immel

BY

Paul E. Friedemann

ATTORNEY

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2 Sheets-Sheet 2

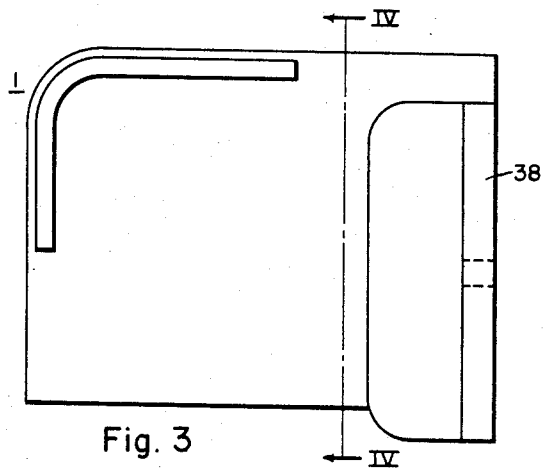

Fig. 3

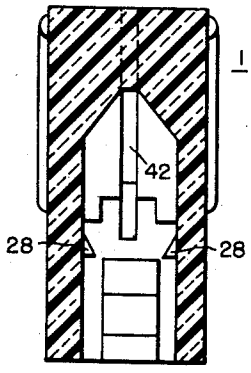

Fig. 4.

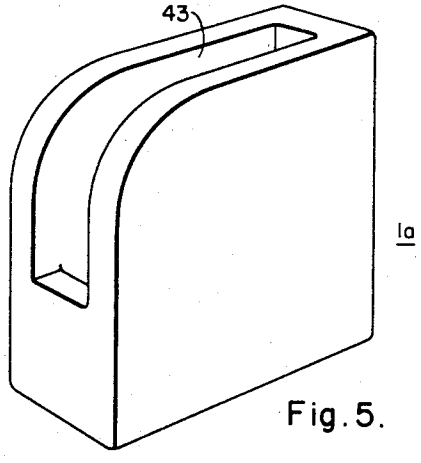

Fig. 5.

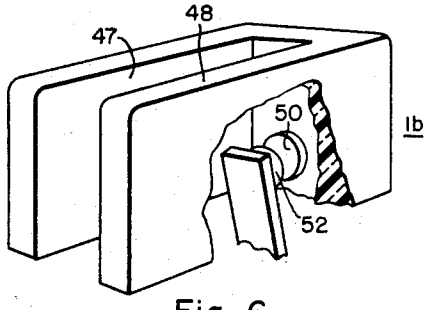

Fig. 6.

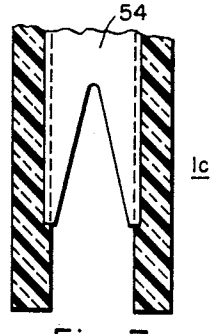

Fig. 7.

United States Patent Office 2,875,301 Patented Feb. 24, 1959

2,875,301

CIRCUIT INTERRUPTER

Ralph B. Immel, Williamsville, N. Y., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application February 8, 1954, Serial No. 408,667

11 Claims. (Cl. 200—147)

This invention relates generally to electric circuit interrupter apparatus and in particular to such apparatus embodying improved arc extinguishing arrangements.

With particular reference to electric switches, various means have been provided in prior art arrangements for extinguishing the arc which is drawn upon separation of the movable contact from the stationary contact. In a general sense, these means may be divided into two categories, in the first of which the arc is drawn and extinguished by distortion of the arc magnetic field through the introduction of iron grid plates in the region of the arc magnetic field and in a second of which an external magnetic field linking the arc magnetic field is utilized to displace the arc and expedite its extinction.

The second of the two above-mentioned methods involves some means for producing a magnetic field. One arrangement employs a blowout coil which may be energized in dependence of arc current to produce a magnetic field directed laterally of the arc and a second arrangement utilizes permanent magnets as a substitute for the blowout coil. Each of these expedients tends to increase the size and the complexity of the arrangement and, although satisfactory in certain respects in a functional sense, the increased cost and inherent manufacturing problems are factors to be eliminated in view of the competitive nature of the apparatus.

Accordingly, one object of this invention is to provide an electric switch apparatus having improved and simplified arc extinguishing means.

More specifically, it is an object of this invention to provide an electric switch having an arc extinguisher which is pemanently magnetized.

Further to the preceding object, it is an object hereof to provide an electric switch having an arc extinguisher of a magnetizable material having the properties of electrical insulation.

A specific object of this invention is to provide an arc extinguisher structure for an electric switch which is made of a magnetized non-metallic permanaent magnet material having the properties of electrical insulation.

The foregoing statements are merely illustrative of the various aims and objects of this invention. Other objects and advantages will become apparent from a study of the following description when considered in conjunction with the accompanying drawing, in which:

Figure 1 is a side elevational view, partly in section, of an electric switch apparatus embodying arc extinguishing means according to the principles of this invention;

Fig. 2 is a top view of the structure illustrated in Fig. 1;

Fig. 3 is a side elevational view of the arc box appearing in the assembly of Figs. 1 and 2;

Fig. 4 is a sectional view taken on the line IV—IV of Fig. 3;

Figs. 5 and 6 are successively simpler modifications of this invention; and

Fig. 7 covers a still further embodiment of this invention.

In Fig. 1, the arc extinguishing structure generally designated 1 is applied to a conventional magnetically operated direct-current switch. The assembly comprises a support 2 of electrical insulating material to which the vertical leg of an angle bracket 3 of magnetizable material is secured. A cylindrical solid magnet core 4 is riveted to the vertical leg in a position spaced from and substantially parallel to the horizontal leg 3a of the angle bracket. Core 4 carries a magnet coil 5 between insulating washers 6 at the coil ends and the coil is secured by a washer 8 functioning as a pole plate at the outer end of the coil. An armature assembly 10 having a knife edge bearing pivot at 12 between an armature mounting bracket 14 and the extremity of leg 3a of angle bracket 3, is spring loaded by a spring arrangement generally designated 16, which separates moving contact 18 from stationary contact 20. Upon energization of coil 5, the magnetic torque due to the flux linking armature plate 22 pivots the armature assembly clockwise against the spring torque to engage the contacts.

Stationary contact 20 is mounted on the end of a current conducting strap 24 which is secured on a suitably shaped portion of insulating support 2 by means of a mounting screw 26 and lugs 23 which may be formed in arc box 1. Mounting screw 26 secures and clamps strap 24 to a spacer metal washer 29 seated on a metal plate 30. The lower end of plate 30 threadedly receives a stud 32 which is an electrical terminal for the stationary contact. The other electrical terminal is designated 34 and is connected to the movable contact by a flexible shunt 36 to complete the circuit.

Arc extinguisher or arc box 1 may be mounted in any suitable manner in a position adjacent the separable contacts 18 and 20. As illustrated, the arc box abuts the face of support 2 and is provided with lugs 38. Screws 40 clear through the lugs and thread into the support 2. This arc box or extinguisher is of a generally U-shaped configuration in lateral cross section, as seen in Fig. 4. The box laterally straddles the contact assembly and, being provided with an open right end and bottom, is readily slipped into position from the front of the switch.

As illustrated, the arc extinguisher is of molded construction and is preferably formed of a magnetized, nonmetallic, permanent magnet material. Such a material may be a ceramic magnetic material selected from the group $BaO \cdot 6Fe_2O_3$ (which also may be written $BaFe_{12}O_{19}$) $PbO \cdot 6Fe_2O_3$ and $SrO \cdot 6F_2O_3$. This material is made by reacting at high temperatures solid oxides in the proper proportions and the product is a ceramic-like material which is hard and reasonably strong and is shaped principally by pressing the desired shape before firing. After firing, sizing to desired dimensions may be accomplished by grinding. This material has desirable magnetic properties. Both coercive force H_c and the intrinsic coercive force are unusually high for commercial permanent magnetic material. The demagnetization characteristics of the material indicate a high order of stability.

Another important property of such materials which is particularly advantageous in these applications are their high electrical resistance. For instance, the material $BaO \cdot 6Fe_2O_3$ has an electrical resistance of the order of 10^6 ohms/cm.^{3}. Since the material is self-insulating, it need not be insulated from other parts of the switch. This permanent magnet material can also be readily coated with a vitreous enamel, fired again and then magnetized. This finish should provide still more resistance to arcing.

Magnetization of the arc extinguisher or arc box structure 1 is such as to produce poles of opposite magnetic polarity on opposite sides of the separable contact assem-

bly. For instance, when viewed from the front the left side of the arc box may be the north pole and the right side may be the south pole, producing a flow of magnetic flux out of the plane of the paper, in the arrangement depicted in Fig. 1, laterally of the contact gap. The switch shown is adapted only for direct-current use and for the polarity of the arc box described requires connecting the positive side of the direct-current circuit to the terminal 32 and the negative side to the terminal 34.

Thus the magnetic field produced by the permanent magnet structure is laterally disposed of the arc struck at contact separation. The interaction of the magnetic field of the arc box with that of the arc is such as to deflect the arc upwardly into the arc box and along the strap 24, as shown by the broken line approximately depicting one instant of arc developement, so that the arc may be stretched or drawn as rapidly as possible after it is initiated and quickly extinguished. The gas generated by the arc is vented through a slit 42 in the arc box. A second arc horn 44 adjacent the path of the moving contact and connected in parallel therewith by a flexible shunt 46 may be provided to induce arc transfer from the moving contact to minimize contact burning.

A simplified version of the arc box structure shown in Figs. 1 through 4 appears in Fig. 5. The geometry of this arc box 1*a* is suited for many applications, being provided with flat inner side faces 43 opening through the top and bottom. The back end of the arc box, on the right as viewed, may be closed, partially closed, or completely open as installation requirements dictate. Again the arrangement is magnetized so that one side is effectively a north pole and one a south pole to produce a magnetic field laterally of the box.

An even simpler arrangement 1*b* of U-shaped configuration appears in Fig. 6. Again magnetization is such that one side 47 is a north magnetic pole and the other side 48 a south magnetic pole to produce a magnetic field between the sides. Such an arc box is suitable for a small relay or contactor. The facility of molding such an item which is similar to a horseshoe type magnet, from the material described, is readily apparent. The sides in this case, as in the preceding arrangements, serve as insulating barriers between side-by-side assemblies.

Since the ceramic permanent magnetic material is insulating, a new concept in design is feasible, namely that of mounting the stationary contact assembly 50 on the arc box. As shown, this assembly is secured to the lower portion of the bight section of the U-shaped arc box. The assembly may include a stud (not shown secured to the contact and extending through the bight section to provide an external stationary contact connection. The movable contact 52 may be mounted in any manner required by the switch operating mechanism (not shown).

Fig. 7 illustrates an arrangement wherein the arc box 1*c* of the ceramic magnetic material is equipped with notched grid plates 54 which straddle the contacts, not shown. Such plates are of nonmagnetic material, such as fiber, nonmagnetic metal or conventional ceramic material that will not short the magnetic field. If made of metal, such plates will be of value in dividing the arc and in dissipating the heat energy of the arc.

The arrangements herein described substantially simplify apparatus of this type. For example, this switch in direct-current applications accomplishes the function of a switch equipped with a blowout coil but eliminates the cost and space requirements of such a coil, its core and insulation tube and washers and the iron field plates connected with the core. Moreover, overheating problems are minimized when the blowout coil is eliminated. These coils are often the largest source of heat in such a switch and frequently contribute to contact overheating. Because of excessive heating, it is usually necessary to braze all joints in the blowout coil assembly to provide good electrical connections and reduce heating at these points. Due to the electrical insulation properties of the ceramic magnetic materials insulating problems are removed. Space wasting insulating separations and insulating barriers in and around the crowded coil and iron parts do not exist. A functional disadvantage of the blowout coil was its variable magnetic field which varied with current through the contacts. When the arc current was low, the blowout coil field was practically ineffective to extinguish the arc. With the present arrangement, the magnetic field is constant.

The advantages which the present invention affords over prior metallic permanent magnet arrangements are equally important. Being current conductors, these presented insulating problems parallel those of the blowout coil assemblies.

In each of the above instances, this invention eliminates the need for the separate magnetic field producing means by providing a magnetic arc box.

It will be appreciated that the present invention represents a novel approach to the problem of simplifying electric switch construction and improving arc extinguishing ability through the expedient of manufacturing the structure from materials of the class described. This simplifies the design and manufacturing problems and at the same time reduces the size and complexity of the arc extinguishing arrangement.

While several embodiments of this invention have been herein illustrated, it will be appreciated by those skilled in the art that other materials having suitable electrical and magnetic properties may be substituted for those herein described and moreover that other arrangements and configurations of the arc extinguishing apparatus may be utilized without departing from the spirit and scope of this invention. Accordingly, it is intended that the foregoing disclosure and the showings made in the drawing shall be considered only as illustrative of the principles herein set forth and not construed in a limiting sense.

I claim as my invention:

1. An electric switch comprising, stationary and movable contact means for striking an arc, an arc box structure disposed adjacent said stationary and movable contact means, said arc box structure comprising a magnetized ceramic material of high electrical resistivity producing a magnetic field linking the magnetic field of said arc.

2. Electric switch apparatus comprising, separable contact means for striking an arc during separation movement, an arc box structure disposed adjacent said contact means, said structure comprising an electrical insulating, magnetized ceramic material producing a magnetic field linking the magnetic field of said arc.

3. Electric switch apparatus comprising, separable contact means, said contact means striking an arc during separation movement, and a magnetized arc box structure of electrical insulating, permanent-magnet material disposed adjacent said contact means and producing a magnet field linking the magnetic field of said arc for deflecting said arc into said arc box.

4. An electric circuit interrupter comprising circuit means for producing an electric arc, a permanent magnet arc box structure having a magnetic field linking the magnetic field of said arc, said arc box structure comprising a magnetic mixed oxide compound selected from the group consisting of $BaO \cdot 6Fe_2O_3$, $PbO \cdot 6Fe_2O_3$ and $SiO \cdot 6Fe_2O_3$.

5. An electric circuit interrupter comprising, circuit means for producing an electric arc, a permanent magnet arc box structure having a magnetic field linking the magnetic field of said arc, said arc box structure comprising a magnetic mixed oxide compound identified as $BaO \cdot 6Fe_2O_3$.

6. Electric switch apparatus comprising, separable contact means, said contact means striking an arc upon sep-

aration movement, means for producing a magnetic field laterally of said arc comprising a magnetized structure of electrical insulating, non-metallic, permanent-magnet material having spaced pole sections, and means supporting said structure with said pole sections on opposite sides of said arc.

7. Electric switch apparatus comprising, separable contact means, said contact means producing an arc during separation movement, an arc box structure comprising side sections and nonmagnetic grid plates therebetween, at least a portion of said structure comprising an electrical insulating, magnetized, non-metallic, permanent-magnet material, and means supporting said structure with the field of said magnetized portion disposed laterally of said arc and linking the magnetic field of said arc.

8. Apparatus as set forth in claim 7, in which all of said arc box structure comprises magnetized, nonmetallic, permanent-magnet material.

9. Apparatus as set forth in claim 7, in which said

side sections comprise magnetized, nonmetallic, permanent-magnet material.

10. An arc quenching device for electric switches comprising, a single piece structure having spaced side sections and an integral end section joining said side sections, said structure being of a magnetized, nonmetallic, electrical insulating, permanent-magnet material.

11. An arc quenching device for electric switches comprising a structure having a pair of laterally spaced side sections of electrical insulating, permanent magnet material, and nonmagnetizable grid plates intermediate of and connected to said side sections.

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