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ELECTROMAGNETIC DEVICE FOR ELECTRIC-CIRCUIT
CONTROL AND PROTECTION SYSTEMS
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3,551,860

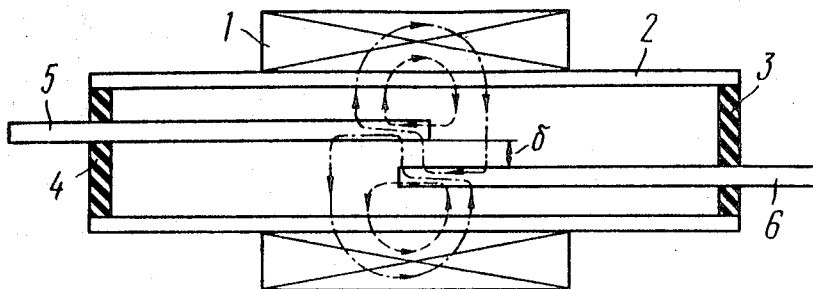


FIG. 1

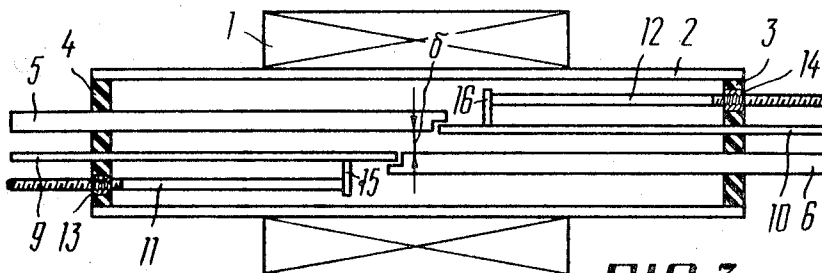


FIG. 3

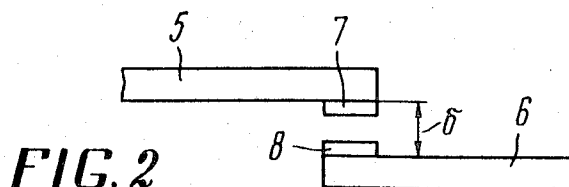


FIG. 2

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**ELECTROMAGNETIC DEVICE FOR ELECTRIC-
CIRCUIT CONTROL AND PROTECTION SYSTEMS**
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U.S. Cl. 335—151 5 Claims

ABSTRACT OF THE DISCLOSURE

An electromagnetic device for electric-circuit control and protection systems, comprising elastically mounted magnetically controlled long cores whose overlapping free ends are arranged with a certain air gap relative to each other when the magnetizing coil is deenergized so that in the case of a rising magnetic field around the magnetizing coil the magnetically controlled cores first come closer together until they reach a certain air gap between them, and then move apart before they completely close, which makes it possible to use said device as an adjustable capacitance and also for electric-circuit switching. In the latter case the device is provided with contact tips or springs.

The present invention relates to elements used in electric-circuit control and protection systems, and more specifically to an electromagnetic device.

There exists a similar electromagnetic device comprising elastically mounted magnetically controlled long cores which are permanently anchored at one end, while their opposite contact ends, overlapping when the coil surrounding them is de-energized, are arranged with a certain initial air gap relative to one another.

In the electromagnetic device just cited, the contact ends of the magnetically controlled cores have an initial air gap between them, such that an increase in the current flowing through the coil causes them to close and remain closed as the coil current continues to rise, while the opening of the contacts (the separation of the magnetically operated cores) can take place only when the current through the coil decreases.

In some electric circuits, however, when the device is, for example, used as an adjustable capacitance, it is preferable that the magnetically controlled cores should separate not only with a decrease of current through the magnetizing coil, but also with an increase of current, which the device just quoted does not provide for.

An object of the present invention is to eliminate the above-mentioned disadvantage.

A specific object of the invention is to provide an electromagnetic device for electric-circuit control and protection systems in which the magnetically controlled cores operate in such a manner that they separate after they have come closer together not only with a decrease of current in the magnetizing coil, but also with an increase of current.

This object is accomplished by the fact that in an electromagnetic device comprising elastically mounted magnetically controlled long cores whose overlapping free ends are arranged with a certain air gap relative to one another when the magnetizing coil is de-energized, the magnetically controlled cores have, according to the invention, their free ends separated from one another by a distance exceeding the maximum gap necessary for the magnetically controlled cores to make in a rising magnetic field around the magnetizing coil, but smaller than the distance at which the effective magnetic action of the said

cores ceases, so that in the case of a rising magnetic field around the magnetizing coil the magnetically controlled cores first come closer together until they reach a certain minimum air gap between them, and then move apart before they completely close.

In order to adapt the device disclosed herein to switch electric circuits, the overlapping portions of the magnetically controlled cores may have contact tips on their inward-facing surfaces, the total thickness of these tips being sufficient for the cores to make when they come closest to one another.

For the same purpose the free ends of the magnetically controlled cores may have notches on their inward-facing portions, so that the ends of additional non-magnetic contact springs may enter the notches with a certain air gap. In such a case, the number of circuits that can be switched by the device disclosed herein is increased.

For the purpose of adjusting the air gap between the magnetically controlled cores and the additional non-magnetic contact springs, it is preferable to provide non-magnetic elements with non-metallic eccentrics.

The electromagnetic device embodied in accordance with the present invention accomplishes the objective of the invention and may be used as an adjustable capacitance whose value first increases as the current in the magnetizing coil increases from zero, and then decreases, and also for electric-circuit switching.

The invention will be best understood from the following description of preferred embodiments, when read in connection with the accompanying drawings in which:

FIG. 1 is a general sketch of an electromagnetic device, according to the invention;

FIG. 2 shows the inward-facing overlapping ends of the magnetically controlled cores of the device of FIG. 1, with contact tips, adapted to switch one electric circuit, and

FIG. 3 is a general sketch of an electromagnetic device adapted to switch two electric circuits.

Referring to FIG. 1, therein is shown an electromagnetic device comprising a magnetizing coil 1 arranged on a cylindrical former 2 with insulating ends 3 and 4, inside which there are magnetically controlled ferromagnetic cores 5 and 6. The outer ends of the cores 5 and 6 are permanently anchored in the ends 3 and 4 of the former 2, while the inner overlapping ends are arranged with a certain air gap relative to one another.

The air gap δ is chosen so that it slightly exceeds the maximum air gap necessary for the magnetically controlled cores to close as in existing devices, but smaller than the distance at which the effective magnetic interaction between the cores 5 and 6 ceases.

The electromagnetic device disclosed herein operates as follows.

When the magnetizing coil 1 is energized, two magnetic fluxes thread the magnetically controlled cores 5 and 6. The first magnetic flux, shown by the dash-dot line in FIG. 1, threads both magnetically controlled cores 5 and 6 and, on passing through the air gap between the cores at the overlap, gives rise to an electromagnetic force of attraction between the magnetically controlled cores 5 and 6. The second magnetic flux, shown by the dashed line in FIG. 1, threads separately each of the magnetically controlled cores 5 and 6, giving rise to an electromagnetic force tending to move the cores 5 and 6 apart.

As the current through the magnetizing coil 1 increases, the magnetically controlled cores 5 and 6 first move towards each other until they reach a certain minimum air-gap between them, and, as the current continues to rise, become saturated outside the overlap. As this happens, the first magnetic flux rises insignificantly.

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The second magnetic flux, which threads the overlap through the portions of the magnetically controlled cores 5 and 6 with a smaller value of magnetic induction, grows more. This brings about a decrease in the resultant electromagnetic force which causes the magnetically controlled cores 5 and 6 to move closer together, with the result that they move apart. As the current through the magnetizing coil 1 rises still more, the magnetically controlled cores 5 and 6 move farther apart.

Referring to FIG. 2, in an electromagnetic device adapted to switch an electric circuit, the overlapping ends of the magnetically controlled cores 5 and 6 have non-magnetic contact tips 7 and 8 on their inward-facing surfaces, the total thickness of these tips being not less than the minimum air gap within which the cores 5 and 6 may approach each other as the current in the magnetizing coil 1 increases.

In such a case, the magnetically controlled cores 5 and 6 first close as the current in the coil 1 increases, and then open as the current continues to rise.

In order to increase the number of electric circuits that can be switched by the device disclosed herein, instead of contact tips, the free ends of the cores 5 and 6 may have notches on their inward-facing free portions, the notches being such that they receive the free ends of additional non-magnetic contact springs 9 and 10 (FIG. 3) with a certain air gap, while the other ends of the said contact springs are permanently anchored in the ends 3 and 4 of the former 2.

For the purpose of adjusting the air gap between the notches in the magnetically controlled cores 5 and 6 and the ends of the contact springs 9 and 10 entering them, the device disclosed herein has non-magnetic rods 11 and 12 with threaded ends which are screwed into couplers 13 and 14 made fast in the ends 3 and 4 of the former 2, while the elongated portion of the said rods carry metallic eccentrics 15 and 16.

Rotation of the rods 11 and 12 causes the eccentrics 15 and 16 to rotate too, thereby varying the said air gap.

What is claimed is:

1. An electromagnetic device for electric-circuit control and protection systems, comprising: a magnetizing coil; elastically mounted magnetically controlled long cores having overlapping free ends embraced by said magnetizing coil and means separating said cores, with

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said coil deenergized, by a distance exceeding the maximum gap for which said magnetically controlled cores make contact in a rising magnetic field around said magnetizing coil, but smaller than the distance at which the effective magnetic interaction between said cores ceases, so that in the case of a rising magnetic field around said magnetizing coil, said magnetically controlled cores first move closer together until they reach a certain minimum air gap, and then separate before they completely close.

2. An electromagnetic device, as claimed in claim 1, in which the overlapping portions of said magnetically controlled cores include non-magnetic contact tips on the inward-facing surfaces, the total thickness of said contact tips being sufficient for said magnetically controlled cores to make when they come closest to each other as the field around said magnetizing coil builds up.

3. An electromagnetic device, as claimed in claim 1, in which the overlapping portions of said magnetically controlled cores have notches on their inward-facing surfaces, and comprising additional non-magnetic contact springs with ends which enter said notches with a certain air-gap.

4. An electromagnetic device, as claimed in claim 3, comprising non-magnetic elements with non-metallic eccentrics between said coil and said additional non-magnetic contact springs for adjusting the air gap between said magnetically controlled cores and said additional non-magnetic contact springs.

5. An electromagnetic device as claimed in claim 1 comprising non-magnetic contact members interposed between facing surfaces of said cores to provide closed circuit when the cores first move closer together and reach the minimum air gap.

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