United States Patent [19]

Frankl

[11] **3,918,016**

[45] **Nov. 4, 1975**

[54] **ELECTRICALLY CONDUCTIVE PLATES PROVIDING EDDY CURRENT DAMPING FOR AN ELECTRO-MAGNETIC DEVICE**

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[22] Filed: **Nov. 25, 1974**

[21] Appl. No.: **526,688**

[30] **Foreign Application Priority Data**

Nov. 28, 1973 United Kingdom 55118/73

[52] **U.S. Cl.** **335/224;** 335/230

[51] **Int. Cl.²** **H01F 7/08**

[58] **Field of Search** 335/220, 224, 229, 230, 335/234, 279

[56] **References Cited**

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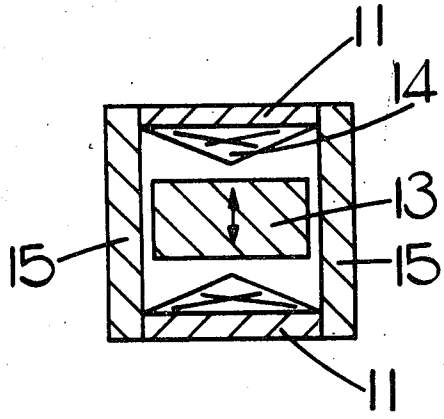
[57] **ABSTRACT**

A torque motor comprises a frame including a pair of opposed and spaced side members formed from a material having a high magnetic permeability. A cavity is defined between the members in which is mounted a pivotal permanent magnet, the cavity also including a winding so that when the winding is energised, the magnet will tend to turn about the pivotal axis. The side members are interconnected at their side edges by a pair of plate members formed from electrically conductive but non-magnetic material, the plate members acting to provide eddy current damping when the magnet is moved relative to the frame.

2 Claims, 5 Drawing Figures



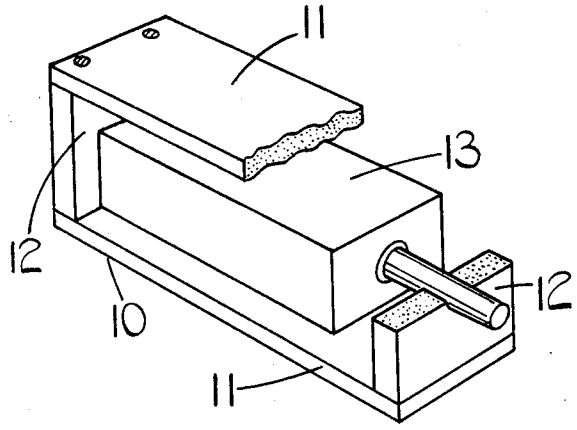


FIG.1.
PRIOR ART

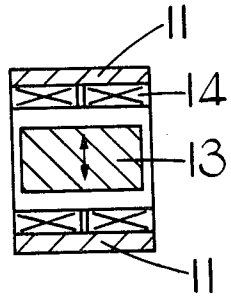


FIG.2. PRIOR ART

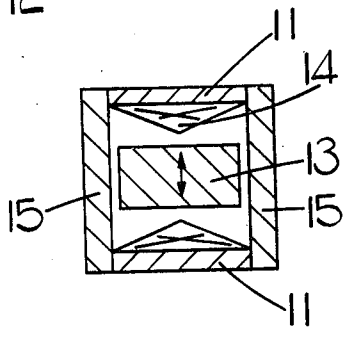


FIG.3.

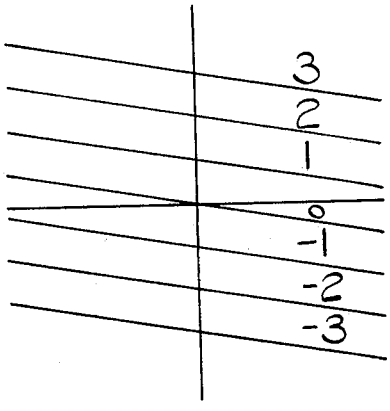


FIG.4.
PRIOR ART

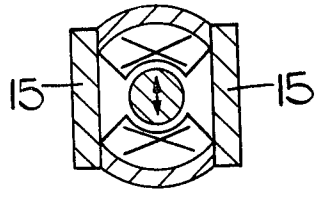


FIG.5.

ELECTRICALLY CONDUCTIVE PLATES PROVIDING EDDY CURRENT DAMPING FOR AN ELECTRO-MAGNETIC DEVICE

This application relates to electromagnetic devices of the kind known as torque motors, and comprising in combination, a frame including a pair of opposed and spaced side members formed from a material having a high magnetic permeability and defining an internal cavity, a permanent magnet pivotally mounted within the cavity and a winding mounted within the cavity, the arrangement being such that when the winding is energised the magnet will tend to turn about its pivot axis so that its magnetic axis will be aligned with that of the winding.

The object of the present invention is to provide such a device in an improved form.

According to the invention in a device of the kind specified, the side members are interconnected at their side edges by a pair of plate members formed from electrically conductive non-magnetic material, the presence of said plate members acting to provide eddy current damping when the magnet is moved relative to the frame.

The invention will now be described with reference to the accompanying drawings in which:-

FIG. 1 shows a cut away perspective view of part of one example of a device to which the invention may be applied,

FIG. 2 is a section through the complete device of FIG. 1,

FIGS. 3 and 5 are views similar to FIG. 2, but in each case showing the addition of the nonmagnetic plates, and

FIG. 4 is a plot of torque against angle for different values of current.

Referring to FIGS. 1 and 2 of the drawings, the device comprises a frame 10 which includes a pair of oppositely disposed and spaced side members 11 and a pair of end members 12 which interconnect the end edges of the members 11. At least the members 11 are formed from a magnetisable material having a high magnetic permeability and preferably formed from soft iron. The frame defines a cavity in which is located a rotor 13 constructed as a permanent magnet and polarised so that the faces of the rotor which are presented to the members 11 are of opposite magnetic polarity. The effect of this is that the rotor will try to assume the position in which it is shown in FIGS. 1 and 2. The rotor is pivotally mounted within bearings defined in the end members.

Mounted within the frame is a winding 14 which for ease of assembly is formed in two parts. The winding extends around the internal surfaces of the members 11 and 12 so that its magnetic axis is normal to the pivot axis of the rotor and parallel to the planes containing the surfaces of the members 11. When the winding is energised, the rotor tends to pivot about its axis so that the magnetic axis of the rotor becomes aligned with that of the winding 14. As shown in FIG. 3, the winding 14 may be shaped to permit the rotor greater angular movement, and to concentrate the windings of the coil in the position where the magnetic field between the rotor and the frame is strongest.

The type of characteristic obtained is shown in FIG. 4, in which the torque is plotted against the angle of the rotor for varying values of current flowing in the winding. The slope of the zero current curve can be defined as the stiffness, and the value of the stiffness can be varied by varying the proportions of the devices. In the construction shown in FIG. 5, the rotor and the inner face of the frame are cylindrical. In this manner, the speed of response is increased since the moment of inertia of the rotor is reduced.

FIGS. 3 and 5 also show the provision of plate members 15 formed from electrically conductive non-magnetic material. It will be appreciated that the plate members 15 may be applied to the example shown in FIGS. 1 and 2. The plate members interconnect the side edges of the side members.

The presence of the plate members 15 provides eddy current damping when the rotor moves relative to the frame. The presence of the plate members 15 has of course no influence upon the characteristics which are shown in FIG. 4. The provision of the damping does however modify the speed of response and minimise over-shoot which may occur when a change in the current flowing through the windings takes place.

Conveniently, the plate members are formed from non-ferrous material such for instance as brass or copper.

I claim:

1. An electromagnetic device comprising a frame including a pair of opposed and spaced side members formed from a material having a high magnetic permeability and defining an internal cavity, a permanent magnet pivotally mounted within the cavity and a winding mounted within the cavity whereby when the winding is energised the magnet will tend to turn about its pivot axis so that its magnetic axis will be aligned with that of the winding characterised in that the side members are interconnected at their side edges by a pair of plate members formed from electrically conductive non-magnetic material, said plate members acting to provide eddy current damping when the magnet is moved relative to the frame.

2. A device according to claim 1 characterised in that the end edges of the side members are interconnected by end members, said end members defining bearings for the rotor.

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