United States Patent [19]

Benson

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[45] **June 19, 1973**

[54] **ELECTROMAGNETIC TURNOFF SYSTEM FOR PERMANENT MAGNETS**

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[73] Assignee: **Eriez Manufacturing Company**, Erie, Pa.

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[21] Appl. No.: **241,974**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 64,685, Aug. 18, 1970, abandoned.

[52] **U.S. Cl.** **335/284,** 335/289

[51] **Int. Cl.** **H01f 13/00**

[58] **Field of Search** 335/284, 289, 290, 335/291

[56] **References Cited**

UNITED STATES PATENTS

3,089,064	5/1963	De Bennetot	335/289 UX
3,146,381	8/1964	Moreau	335/289 UX
3,316,514	4/1967	Radus et al.	335/291
3,428,867	2/1969	Becker	335/284 X

Primary Examiner—George Harris
Attorney—Charles L. Lovercheck

[57] **ABSTRACT**

A magnetic circuit made of a permanent magnet of high coercivity material, for example, barium ferrite ceramic material having a coercive force sufficiently high that the domains of the permanent magnet will not be reversed, and an electrical coil wound closely around the permanent magnet over its entire length. The electrical coil may be excited by a direct current of value and direction such that the magnetic field from the permanent magnet will be partially or completely neutralized, however, the domains of the permanent magnet will not be reversed and when the current in the coil is reversed from the first condition, the strength of the magnet becomes equal to the combined magnetic field from the permanent magnet and the magnetic field from the coil. This magnetic circuit is particularly useful for use in lifting magnets, although it is also applicable to magnets used for separating, holding, or otherwise exerting an external magnetic influence.

4 Claims, 4 Drawing Figures

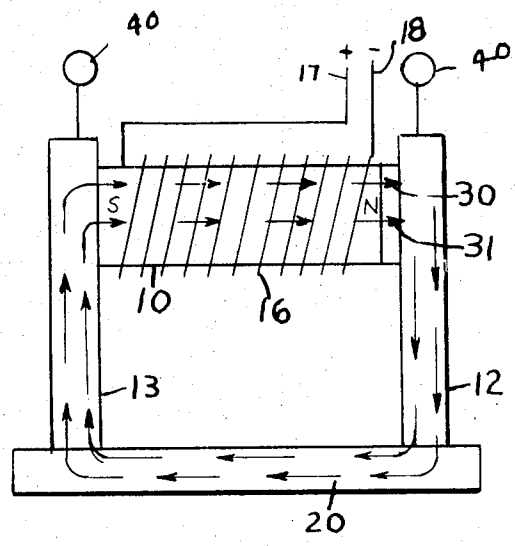


FIG. 1

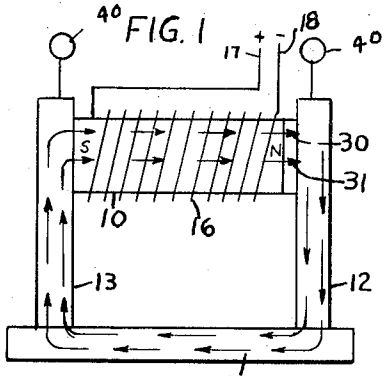
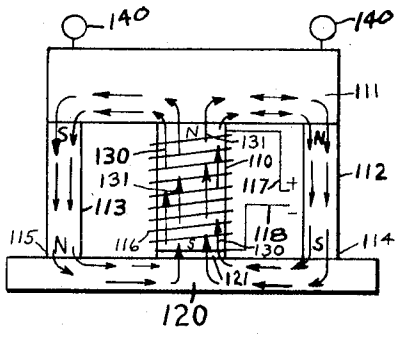


FIG. 3



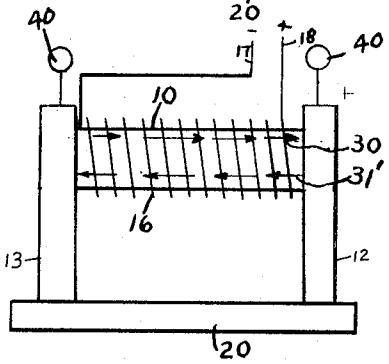


FIG. 2

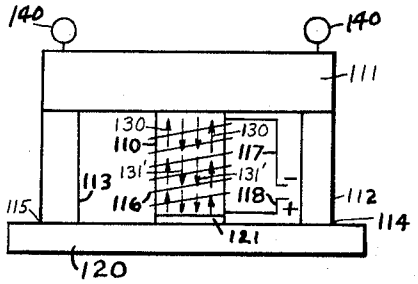


FIG. 4

ELECTROMAGNETIC TURNOFF SYSTEM FOR PERMANENT MAGNETS

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of application, Ser. No. 64,685, filed Aug. 18, 1970 now abandoned.

STATEMENT OF PRIOR ART

Lifting or hoisting apparatus utilizing electromagnets have been in operation for many years. The electromagnet type of lifting apparatus has at least two serious disadvantages:

1. It is required that a large amount of electrical energy be supplied to the electromagnet in order to provide the lifting force and this is expensive; furthermore, most of this energy must come out as heat, which impairs the efficiency of the magnet, shortens its life, and is difficult to dispose of.
2. If the magnet is inadvertently de-energized, the load will fall, unless an expensive power back-up system is used.

Various prior lifting magnets have been proposed; for example U.S. Pat. No. 3,316,514, 3,389,357; 3,089,064, 3,389,358, and 3,441,807.

REFERENCE TO PRIOR ART

U.S. Pat. No. 3,428,867 shows a magnetic circuit physically similar to applicant's circuit but it discloses a magnetic material which is of insufficient coercive force to retain the magnetic domains in their original position when a current in the coil is reversed. The said patent suggests that material used should have a coercive force of 900 ampere turns per inch (450 oersteds), whereas in my invention, the permanent magnet material must have a coercive force of at least 4,400 ampere turns per inch (2,200 oersteds) to prevent de-magnetization.

OBJECTS OF THE INVENTION

It is an object of the invention to provide an improved magnetic circuit.

Another object of the invention is to provide an improved magnetic lifting device or other magnetic device for exerting an external magnetic influence.

A further object of the invention is to provide a magnetic circuit that is simple in construction, economical to manufacture, and simple and efficient to operate.

GENERAL DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side schematic view of a lifting magnet according to the invention illustrating the field from the coil as aiding the field from the permanent magnet.

FIG. **2** is a schematic view of the magnet shown in FIG. **1** showing the respective fields' directions when the current in the coil is reversed.

FIG. **3** is a view similar to FIG. **2** showing another embodiment of the invention with the field from the coil illustrated as aiding the field from the permanent magnet.

FIG. **4** shows the magnet of FIG. **3** with the current in the coil reversed.

DETAILED DESCRIPTION OF THE DRAWINGS

Now with more particular reference to the drawings, in FIG. **1** the permanent magnet **10** is shown supported by the pole pieces **12** and **13.** These pole pieces may be

of soft iron or steel. The permanent magnet **10** is made of high coercivity material, such as barium ferrite, which is made up of wafers stacked one on the other. A specific example of suitable magnetic material is Indox V having a coercive force of 4,400 ampere turns per inch (2,200 oersteds). Indox V is a registered trademark owned by the Indiana General Company. A coercive force in this range will prevent the magnetic domain of the permanent magnet from reversing and demagnetizing the magnet so that when the current in the coil is such as to produce a reverse magnetomotive force to that of the permanent magnet, the permanent magnet will retain its original magnetic condition. A coil **16** is disposed around the magnet as shown. The coil has terminals **17** and **18** to which a D.C. voltage may be connected. A suitable hoist can be connected to lifting eyes **40.** A load **20** may be lifted by the permanent magnet field alone or by the combined permanent magnet and coil fields when coil current flows in a direction such as to aid the field of permanent magnet **10** indicated by arrows **30.** When the current is in a direction to aid the permanent magnetic field, a magnetic field due to the current flow will be induced in the stack of permanent magnets **10** by the coil in the direction indicated by arrows **31.** The resultant field is greater than the field produced by the permanent magnet alone indicated by arrows **30** when the current is turned off; stated another way, when the field induced by the coil is in the same direction as the magnetic field of the permanent magnet, the sum of fields **30** and **31** will be stronger than that of the permanent magnet alone.

When the D. C. voltage on terminals **17** and **18** is reversed, as indicated in FIG. **2,** the permanent magnet field of magnet **10** will be partially or completely cancelled or neutralized by an opposite field **31'** due to the coil and the load **20** will drop, provided the net field has been sufficiently weakened to allow this.

In the embodiment of the invention shown in FIG. **3,** a permanent magnet **110** made of a high coercivity material such as barium ferrite is shown supported on the back plate **111** with the pole pieces **112** and **113,** supported on the back plate to provide ends **114** and **115** to which a load may be attracted between these pole pieces and magnet pole piece **121.** The coil **116** is wrapped closely around the magnet and extends entirely from one end thereof to the other as does the coil **16** in the embodiment shown in FIG. **1.** Terminals **117** and **118** may have a source of electrical D.C. energy connected thereto whereby in one direction, the field **130** from permanent magnet **110** is aided by the electromagnetic field **131** from the coil **116** to make a stronger combined magnet. In the other direction (FIG. **4**), the magnetic field **130** from the permanent magnet field may be completely or partially cancelled out by field **131'** from the coil, so that little or no force will be applied to the load **120** and, therefore, the load **120** will not be supported. A suitable hoist can be connected to the lifting eyes **140.**

The foregoing specification sets forth the invention in its preferred practical forms but the structure shown is capable of modification within a range of equivalents without departing from the invention which is to be understood is broadly novel as is commensurate with the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A magnetic circuit comprising
a permanent magnet,
a coil,
said coil being adapted to have a direct current pass therethrough and to produce a magnetic field through said permanent magnet,
said permanent magnet being made of a magnetic material having a sufficiently high coercive force that the magnetic domains of said material will not change substantially when said current from said coil is passed therethrough in a direction to produce a field of a direction opposing said permanent magnet field,
said coil being adapted to have the said current therethrough reversed whereby its magnetic field aids the field of said permanent magnet and therefore produces a stronger magnet.

2. The magnetic circuit recited in claim 1 wherein said permanent magnetic material is a material having a coercive force equal to or greater than 4,400 ampere turns per inch.

3. The magnetic circuit recited in claim 1 wherein said coil covers the outside surface of said permanent magnet to the extreme ends of said magnet.

4. The magnetic circuit recited in claim 3 wherein said ends of said magnet are adapted to attract a magnetic material thereto whereby said magnet may be used as a lifting magnet and means on said magnet for attaching it to a lifting member.

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