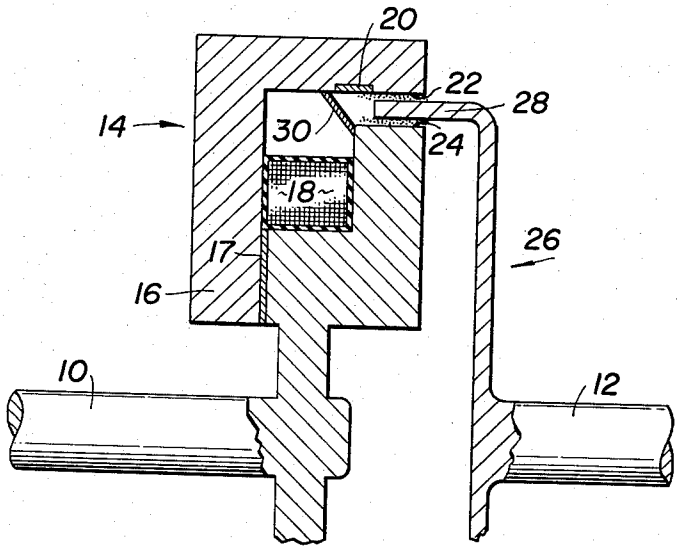
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MAGNETIC POWDER CLUTCH WITH RESIDUAL MAGNETISM SHUNT

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INVENTOR.
RALPH L. JAESCHKE
BY McDonald & Fragomeni
ATTORNEYS

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MAGNETIC POWDER CLUTCH WITH RESIDUAL MAGNETISM SHUNT

Ralph L. Jaeschke, Kenosha, Wis., assignor to Eaton Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

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This invention relates to a magnetic circuit and more particularly to the path of flux in magnetic circuits of electromagnetic clutches, brakes, dynamometers and the like apparatus employing magnetic powders.

Broadly, this invention comprehends the provision of a magnetic member in shunt with a pair of spaced magnetic poles of an electromagnetic powder apparatus for providing a low reluctance, short circuiting path for residual flux that otherwise bridges the space between the poles. The member is so dimensioned as to by-pass or short circuit a relatively small proportion of magnetic flux under normal operating conditions.

This invention will be described as applicable to an electromagnetic clutch, it being understood that the same principles involved apply equally well to other similar electromagnetic apparatus, such as brakes, dynamometers, etc.

In the operation of electromagnetic clutches it is frequently desirable to completely disengage or uncouple the input member from the output member of the clutch or to reduce the time interval between deenergization of the clutch coil and release or decoupling of the clutch members. However, due to the effects of hysteresis, mere deenergization of the clutch electromagnetic field is insufficient in accomplishing these desired ends since residual flux in a magnetic core persists even after such a deenergization to effect a coupling between the input and output member. Such a coupling is often undesirable, albeit small.

Various arrangements have been devised in efforts to overcome the adverse effects of the residual flux as described and have included among other things, devices for applying reverse magnetic fields to magnetic cores to counter the effects of hysteresis. While such arrangements have been in large measure effective in accomplishing their purpose they have not been as completely practical as might be desired and have required relatively complex and costly equipment requiring frequent manual attention.

The present invention as disclosed herein embodies a magnetic core having an air gap across which a magnetic field is produced for magnetizing particles of a magnetic powder to provide a coupling between a pair of movable members of the clutch. As a means of avoiding the mentioned adverse effects of coupling provided between the clutch members by residual flux existing in the core after removal of any magneto-motive force applied thereto, a magnetically permeable member is provided bridging the gap for by-passing the mentioned residual flux. The capacity of the member is such as to accommodate the residual flux existing between poles at the gap while accommodating only a small and relatively insignificant proportion of full field flux when the clutch is in operation.

It will be apparent to those skilled in the art that this invention is distinct from prior art electromagnetic machines of the eddy-current type which may disclose magnetic members bridging magnetic field air gaps. In such

prior art machines the mentioned members are only inadvertently or incidentally magnetic and serve some other primary function, such as providing physical support to some other part of the machine. This is so since materials, desirable for economical and physical reasons, such as iron and steel, are also incidentally magnetic.

Such prior art devices fail to contemplate this invention since in eddy current machines they perform no useful magnetic function. The threshold value of flux intensity in an eddy current machine, i.e. the amount of flux required before any torque transfer is obtained between members, is far greater than any value of residual flux and, therefore, the magnetic property of the mentioned member is of no consequence to relieve the effects of residual flux since there are no adverse effects of residual flux. In magnetic powder machines, to which this invention is particularly adaptable, the threshold value of flux required for torque transfer is far below the residual value of flux existing in the magnetic cores of the machines. Accordingly, the magnetic residual flux by-passing member of this invention was specifically chosen and designed as such, to accommodate and shunt the value of residual flux and the physical strength or support provided by the member is only incidental.

It is accordingly an object of this invention to overcome the drawbacks of the mentioned prior devices and provide a simple, effective, economical and automatically operating device for virtually eliminating residual flux across magnetic poles of an electromagnetic magnetic powder clutch apparatus.

It is another object of this invention to provide a magnetic shunt across the gap between magnetic poles of an electromagnetic magnetic powder clutch apparatus.

It is still another object of this invention to provide a magnetic shunt across the gap between magnetic poles of an electromagnetic magnetic powder clutch apparatus that is sufficiently permeable to by-pass residual fluxes bridging the gap in the absence of the shunt but insufficiently permeable to by-pass any significant amount of flux greater than the residual flux.

It is still another object of this invention to provide an electromagnetic powder clutch apparatus having an insignificantly small torque transfer due to the effects of residual flux.

It is still another object of this invention to provide an electromagnetic clutch apparatus having a more desirable reduced time constant or interval between clutch deenergization and clutch release.

Other and further objects and advantages will become apparent from the following detailed description of this invention when taken with the accompanying drawing wherein:

The single figure shows a partial cross-sectional view of an electromagnetic magnetic powder clutch apparatus incorporating a residual flux by-pass shunt.

Referring now more particularly to the drawing for a more detailed description of the present invention **10** represents an input shaft of an electromagnetic clutch apparatus and **12** represents an output shaft thereof. A rotary input member **14** rotatable with shaft **10** is provided having among other things a magnetic core **16** being in cross-section of the shape of the letter G and a flux producing wire coil **18**. The core **16** is a bipartite member, being separated at **17** by a non-magnetic member for a purpose to be described. A flux concentrating non-magnetic ring **20** is provided adjacent one pole face **22** for providing a high reluctance path to flux and to thereby effect a concentration of flux between pole face **22** and a second pole face **24**. An output drum **26** having a portion **28** extending between pole faces **22** and **24** is secured to and rotatable with output shaft **12**. In the spaces between pole faces **22** and **24** and portion **28** is

disposed a magnetic powder adaptable to provide coupling between members **14** and **26**.

According to the feature of this invention a magnetic member **30** is disposed across the air gap at pole faces **22** and **24** from a point adjacent pole face **24** to a point adjacent non-magnetic ring **20** remote from pole face **22**. The member **30** is so sized and proportioned according to the size and material composition of core **16** so as to accommodate passage of full residual flux of the core without becoming saturated and is also confined in size so as not to accommodate a flux density materially greater than approximately four times saturation flux density. It is readily understood that under such circumstances the member **30** is effective in by-passing the residual flux of core **16** while having only a small effect on the magnetic circuit while the clutch is in operation. Merely as an example, assuming that the core **16** has a normal maximum flux of 300,000 lines therein, under normal operating conditions, and that the composition of core **16** is such as to have a residual flux of 2 per centum of maximum flux, the member **30** must be capable of accommodating 6,000 lines of flux. It has been found desirable to operate the member **30** at low flux density also. Also as an example, with material saturating at 110,000 lines per square inch, the member **30** is made to operate at 25,000 lines per square inch. Since the residual flux is approximately 2 per centum and since member **30** is operated at approximately one-fourth capacity, the loss in flux under operating conditions is approximately 8 per centum, a relatively small portion of full field flux.

In magnetic powder clutch apparatus incorporating this invention upon deenergization of the electro-magnetic coil therein the flux density in the air gap is reduced to an amount considerably below the threshold value so as to more quickly demagnetize the powder particles and decouple the clutch input and output members. It has been observed that this invention is effective in providing a quick release as desired in electromagnetic powder clutches and other like apparatus by virtue of the reduced time required to reduce the flux to its threshold value, and that it is ideally suited to accomplish the functions desired.

Non-magnetic member **17** is effective to provide a high reluctance to residual fluxes and thereby to minimize further the effects of such residual flux. Since the magnetomotive forces under conditions of normal clutch operation are vastly greater than those producing a residual flux, the adverse effects of member **17** under normal clutch operation are small. Members **30** and **17** in cooperation are effective in reducing residual flux across the gap between poles **22** and **24** to a very low, insignificant value to enable rapid and complete decoupling of clutch members on deenergization of coil **18**.

While this invention has been described with reference to certain specific embodiments, the principle involved is susceptible of numerous other applications that will readily occur to persons skilled in the art. The invention, accordingly, is limited only as indicated by the scope of the appended claims.

What I claim is:

1. In an electromagnetic apparatus comprising relatively movable input and output members separated by a gap, powdered magnetic material located between said members in said gap, means providing a magnetic field between said members and linking said powdered material, a magnetic member shunting said gap, a non-magnetic member disposed axially between said magnetic member and said gap, and said magnetic member having a magnetic permeance low with respect to the permeance of said members.

2. In an electromagnetic apparatus comprising a first rotatable member including a magnetic core having a gap therein, a second rotatable member having a portion thereof in said gap removed from said core, magnetic powder located in said gap, means providing a magnetic field in said core and said gap, a magnetic member shunting said gap, a non-magnetic member disposed axially between said gap and said magnetic member, and said magnetic member being low in magnetic permeance with respect to the permeance of said core whereby residual flux in said core is by-passed around said gap.

3. In an electromagnetic apparatus comprising a first rotatable member including a magnetic core having radially spaced portions providing a pair of opposed pole faces therein, a non-magnetic member located adjacent said core axially adjacent one of said pole faces, a second rotatable member having a portion located between said pole faces and being spaced therefrom, magnetic powder located between said members between said pole faces, means producing a magnetic field in said core and between said pole faces and a magnetic member extending between one of said pole faces to a point adjacent said non-magnetic member remote from the other pole face, said magnetic member having a magnetic permeance low with respect to the magnetic permeance of said core.

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