

United States Patent

Hendershot et al.

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[54] MAGNETIC DEVICES

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[52] U.S. Cl.**192/21.5, 310/216, 310/92**

[51] Int. Cl.**F16d 37/02**

[58] Field of Search 192/21.5; 29/596, 598, 605, 29/609, DIG. 37; 336/234; 310/216, 217, 93, 103, 104, 105

[56]

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Primary Examiner—D. X. Sliney

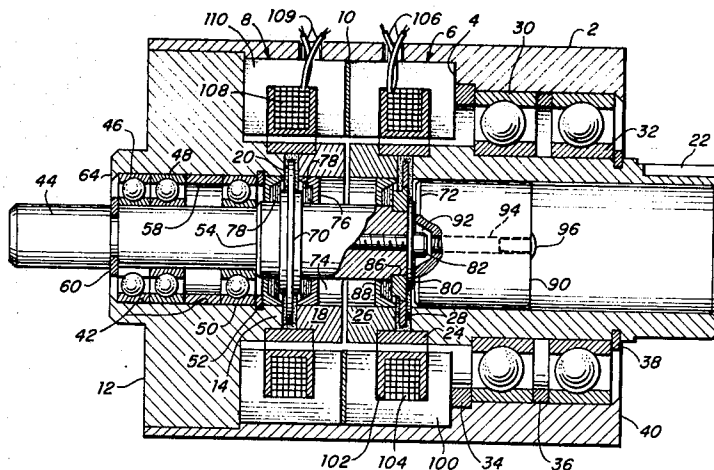
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[57]

ABSTRACT

A new field structure usable in electromagnetic coupling devices and the like comprising an annular magnetic core formed of one or more flat strips of magnetic material folded accordion-wise and providing a continuous channel in which is mounted an electrical coil for magnetizing said core.

21 Claims, 11 Drawing Figures



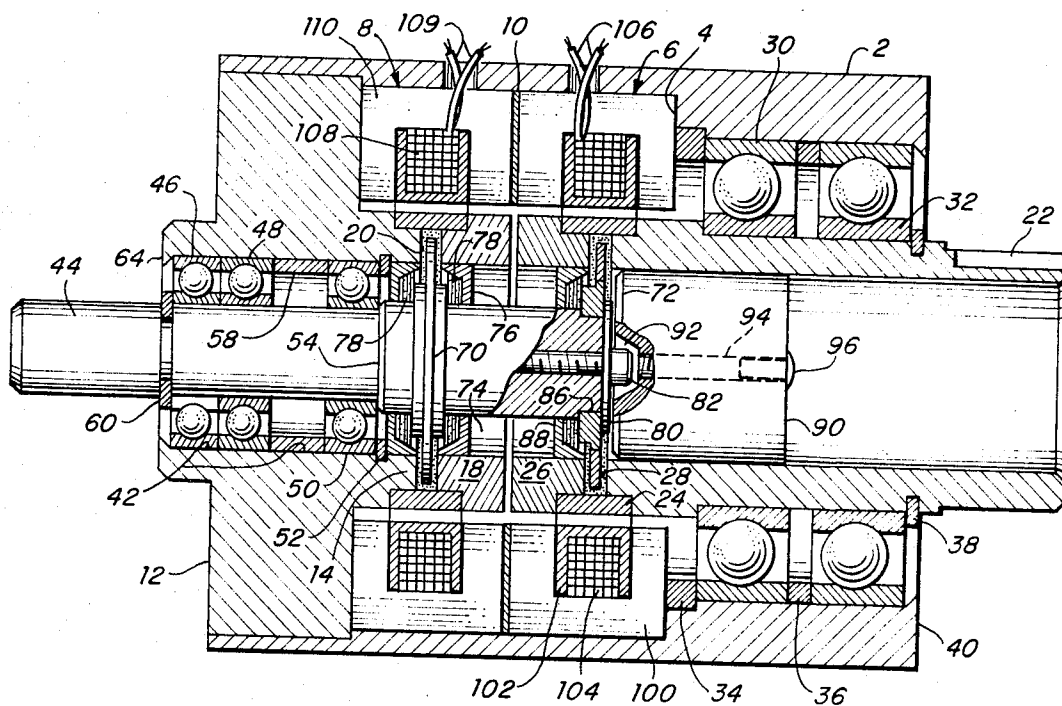


FIG. 1.

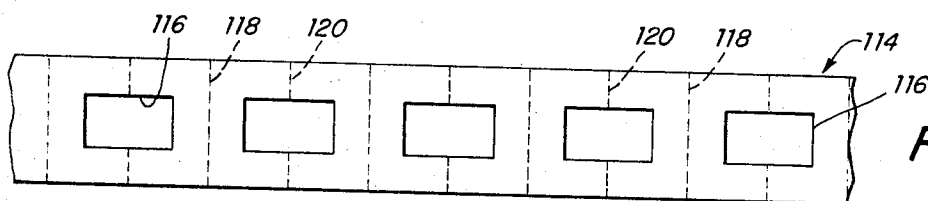


FIG. 2.

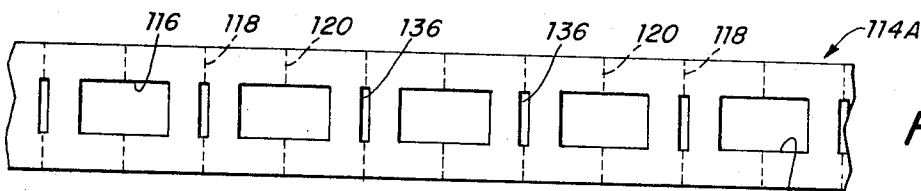


FIG. 4.

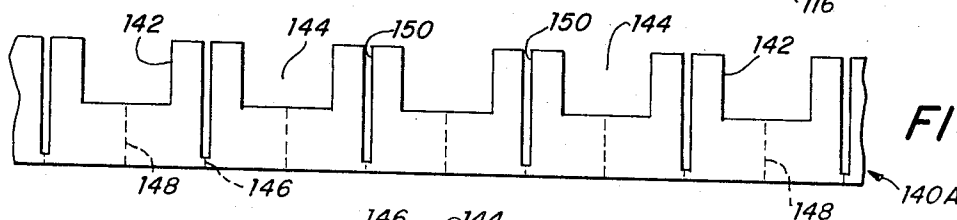


FIG. 7.

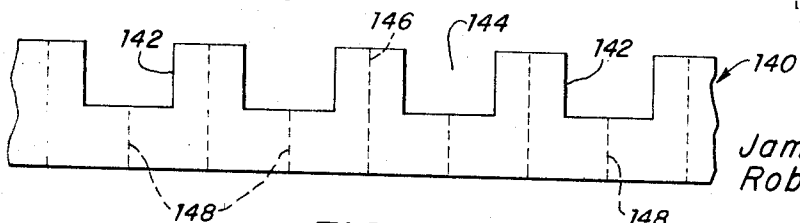


FIG. 6.

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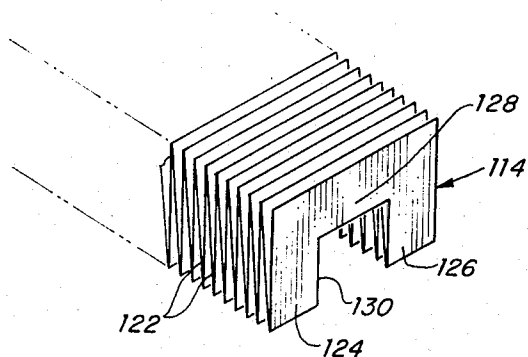


FIG. 2A.

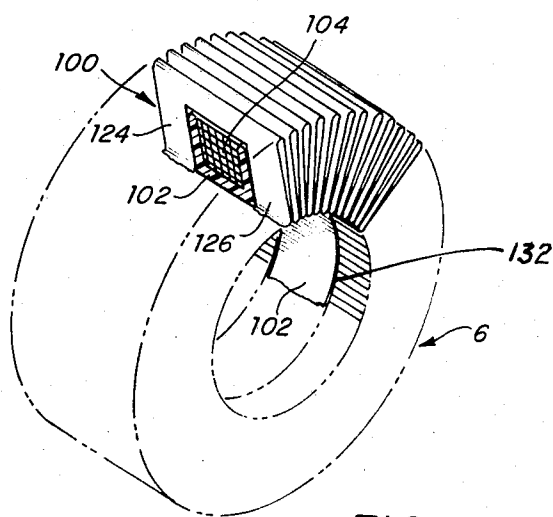


FIG. 3.

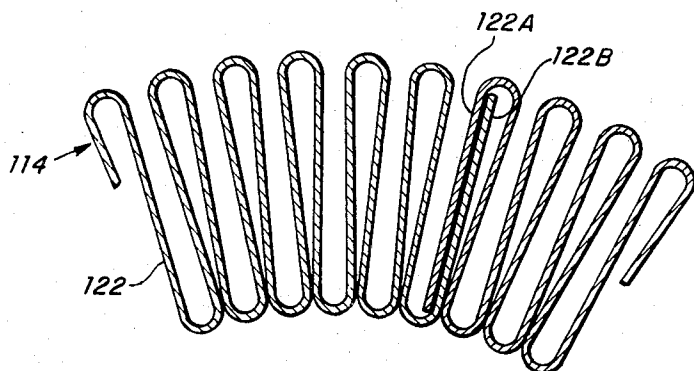


FIG. 3A.

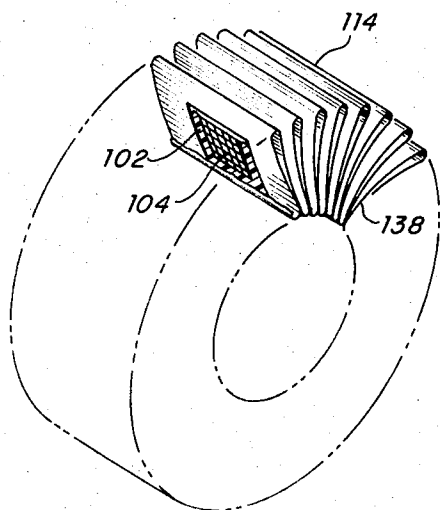


FIG. 5.

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FIG. 8.

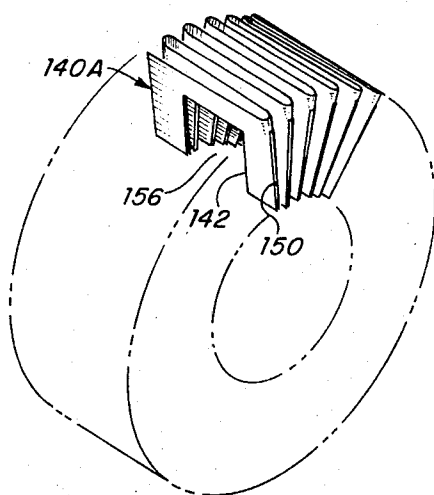
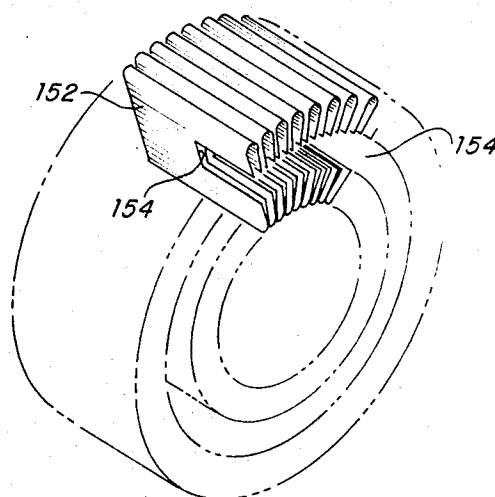


FIG. 9.

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MAGNETIC DEVICES

This invention relates to electromagnetic devices and illustratively to magnetic coupling devices in which torque is transmitted between two relatively rotating coupling elements by magnetic coupling induced by energization of a magnetizing field structure.

In magnetic coupling devices such as clutches and brakes the amount of clutching or braking torque produced depends, among other things, upon the strength of the magnetic field linking the relatively rotatable parts, so that the amount of torque may be varied by varying the strength of the magnetic field. One of the important problems involved in the operation of a magnetic coupling device is the speed of response, i.e., the speed with which the torque transmitting condition of the device is changed in response to a change in magnetizing current. The speed of response is limited generally by the rate at which the magnetic field can be built up or reduced. The speed of response is particularly important in the case of clutches and brakes used in systems undergoing repetitive on-off operation such as magnetic tape drives.

Magnetic coupling devices conventionally include a magnetizing field structure comprising a core structure of magnetizable, i.e. highly permeable, material and an electrical magnetizing coil. Both solid and laminated cores have been used as exemplified by U.S. Pat. Nos. 3,358,798, 2,958,406, and 2,729,318. Solid core structures are easier and less expensive to make but they suffer from the limitation that magnetic fields established therein cannot rapidly follow changes in magnetizing current at frequencies above about a few cycles per second and hence coupling devices embodying such cores have a severely limited speed of response. The speed of response is limited by a slow rate of penetration of the core material by the changing magnetic field because of eddy currents induced in the core which oppose the magnetizing current. Laminated cores offer the advantage of minimizing the generation and effect of eddy currents and thus coupling devices using laminated cores have a much higher response speed than those with solid cores. However, laminated cores are substantially more expensive to fabricate and thus they have been used in coupling devices only where the need for fast response has been great enough to justify the higher cost.

The primary object of this invention is to provide a novel magnetic structure that offers the advantage of low eddy like current losses and relatively low cost of manufacture.

Another object of this invention is to provide a novel magnetic core structure for magnetic coupling devices and the like that is easy to fabricate and can be made in various sizes at relatively low tooling costs.

A further object is to provide a laminated magnetic core structure that is adapted for use in a variety of electromagnetic devices and particularly magnetic coupling devices such as clutches and brakes.

Still another object is to provide an electromagnetic coupling device in the form of a clutch or brake having an electromagnet in the form of a magnetizing coil and a magnetic core associated with said coil which is designed to reduce eddy current losses so that the speed and depth of flux penetration of the core and other elements in the magnetic circuit are improved,

thereby improving both the speed of response and the torque characteristic of the device.

Briefly, the foregoing and other objects hereinafter rendered obvious or specifically set forth are achieved according to this invention by a field structure comprising a magnetic core that is formed from one or more flat strips of magnetic material provided with a series of openings and folded at and between said holes accordion-wise so that each fold has a slot with the slots of the several folds forming a continuous channel and an electrical coil for magnetizing said core disposed in said channel. One illustrated embodiment of the invention is a magnetic particle clutch-brake device which incorporates two such field structures wherein the field structures are annular and the channels for the energizing coils are formed in the inner peripheries of the cores. The field structures also may be formed so that the coil-receiving channels are in the outer peripheries of the cores or in one of the side faces of the cores.

Other features and applications of the invention are described or rendered obvious by the following detailed description which is to be considered together with the accompanying drawings wherein:

FIG. 1 is a longitudinal sectional view of a clutch-brake device embodying the present invention;

FIG. 2 is a plan view of a portion of a strip of magnetic material formed for use in constructing a magnetic core according to this invention;

FIG. 2A is a perspective view showing how the strip of FIG. 2 is folded accordion-wise in the process of forming a magnetic core;

FIG. 3 is a perspective view of a field structure with a core formed from the strip of FIG. 2;

FIG. 4 is similar to FIG. 2 but shows a modified form of strip used to form a magnetic core similar to the one in FIG. 3;

FIG. 5 is a view similar to FIG. 3 of a modified magnetic core;

FIGS. 6 and 7 are views similar to FIGS. 2 and 4 of magnetic strips employed to form magnetic cores with side coil-receiving channels;

FIG. 8 is a perspective view of a field structure made from strips formed as shown in FIGS. 6 and 7; and

FIG. 9 is a perspective view of another field structure made in accordance with this invention.

Turning now to FIG. 1, the illustrated device comprises a cylindrical housing 2 made of a suitable magnetic material. The right hand end of the housing has a reduced diameter so as to provide a shoulder 4. Mounted within the housing are two annular field structures 6 and 8 constructed as hereinafter described and separated by a non-magnetic spacer ring 10. The field structure 6 abuts the shoulder 4. Mounted in the left hand end of the housing is an end bell 12 that is made of magnetic material. End bell 12 engages field structure 8 and cooperates with the shoulder 4 to hold the two field structures against axial movement in the housing. The end bell 12 has a reduced diameter extension 14 that is spaced radially from the field structure 8. Affixed to the extension 14 of the end bell 12 is a sleeve 16 made on a non-magnetic material such as stainless steel. Affixed to sleeve 16 is a magnetic annulus 18. Sleeve 16 and annulus 18 are spaced radially from the field structure 8 and the annulus 18 is spaced from the end face of the extension 14 of the end bell 12 so as to

provide a gap 20. Rotatably mounted in the right hand end of the housing 2 is a rotor structure comprising a hollow input shaft 22 made of magnetic material. Affixed to the inner end of shaft 22 is a non-magnetic sleeve 24 that is similar to the sleeve 16 and a magnetic annulus 26 that is similar to the magnetic annulus 18. The sleeve 24 spaces the magnetic annulus 26 from the end of shaft 22 so as to provide a gap 28. The shaft 22 is rotatably mounted in the housing 2 by means of a pair of roller or ball bearings 30 and 32. The ball bearing 30 has its inner race in engagement with a shoulder formed on the shaft 22, while its outer race engages a snap ring 34 mounted in a groove in the housing 2. The two bearings are separated by a spacer ring 36. The bearing 30 has its inner race captivated by a snap ring 38 mounted in a groove in the shaft 22, while its outer race is held against axial movement by staking a portion of the housing 2 as shown at 40. The inner end of the shaft 22, the sleeve 24, and the annulus 26 have the same external diameter as the extension 14 of bell 12, sleeve 16 and annulus 18, with the latter being spaced axially from the annulus 26 as shown.

The end bell 12 has an axial bore 42 in which is rotatably mounted an output shaft 44 that is solid and is made of non-magnetic material. Shaft 44 is rotatably supported in the end bell 12 by three roller or ball bearings 46, 48 and 50. The outer race of the bearing 50 engages a snap ring 52 which is mounted in a groove in the end bell 12. The inner race of the same bearing engages a shoulder 54 formed on shaft 44. The roller bearing 48 is spaced from the bearing 50 by a spacer ring 58. The roller bearing 46 abuts the roller bearing 48, with the inner race of bearing 46 engaging a snap ring 60 disposed in a groove in shaft 44. The other race of bearing 46 is held against axial movement away from bearing 48 by staking a portion of the end bell 12 as shown at 64. It is to be understood that staking the housing 2 and the end bell 12 as shown at 40 and 64 is one convenient way of holding the bearings and that the same result may be achieved by means of a snap ring mounted in the housing and the end bell or by other suitable means known in the art.

The shaft 44 carries two discs 70 and 72. The disc 70 may be formed integral with the shaft 44. Preferably however, it is made as a separate member and is attached to the disc by brazing or welding or by other suitable means. The disc 70 is located so that it extends into the gap 20 and is substantially equally spaced from the end faces of the extension 14 of the end bell 12 and the annulus 18, as well as being spaced radially from the sleeve 16. Mounted within the extension 14 of end bell 12 and also within the annulus 18 are two identical face seals 74. Each face seal comprises a non-magnetic metal cup 76 of L-shaped cross-section and a resilient sealing member 78 secured in the cup 76. The cups 76 are press fitted in the end bell 12 and the annulus 18 and their inner diameters are slightly larger than the outside diameter of shaft 44 so as not to make contact therewith. However, the sealing members 78 engage shaft 44 and also the opposite sides of the disc 20. In this connection it is to be noted that adjacent the shaft 44 the disc 20 has an enlarged axial dimension so as to make engagement with the sealing members 78. Magnetic powder is disposed in the gap 20 and is prevented from escaping by virtue of the sleeve 16 and the two face seals.

The disc 72 is mounted on the inner end of shaft 44 which terminates substantially even with the gap 28. The disc 72 is formed as a separate element with a central aperture and is held in place on the end of the shaft 44 by means of a washer 80 and a cap screw 82 which is screwed into the end of the shaft 44. It is to be noted that the end of the shaft 44 is keyed and that the disc 72 also is keyed at its central aperture so as to lock with the shaft 44 and to rotate therewith. The disc 72 extends into the gap 28 which also is filled with magnetic particles. The magnetic particles are prevented from escaping from the gap 28 by a sealing element 88 that is similar to sealing elements 74 described above and is press fitted into the annulus 26, and also by a plug 90 which is press fitted into the hollow shaft 22. The plug 90 is undercut as shown at 92 so as to accommodate the head of the cap screw 82 and to permit the plug to be located close to but spaced from disc 72. Preferably the plug 90 has a through hole such as shown at 94 which is used to relieve air pressure when the plug is inserted into the shaft 22 and thereby prevent a pressure build-up which might force the magnetic powder out of the gap 28. After the plug has been inserted the through hole 94 is blocked off as, for example, by forcibly inserting a rivet 96. Alternatively, the through hole 94 may be blocked off by application of a suitable potting compound in place of the rivet 96.

It is to be noted that the magnetic field structure 6 has a magnetic core 100 which is of U-shaped configuration in cross-section, plus a coil assembly comprising a bobbin 102 made of non-magnetic material and carrying a coil 104 which is wound around the periphery of the bobbin. The ends 106 of coil 104 are brought out of the magnetic core 100 and through suitable openings in the housing 2 for connection to a suitable energizing power supply. The other magnetic field structure 8 is identical to the field structure 6, with the ends 109 of its coil 108 being brought out of its core structure 110 and through the housing 2 for connection to a power supply.

The device above described is a combination clutch-brake. The clutch section of the brake has a stator made up of a portion of the housing 2 and the magnetic field structure 6. The brake section of the device has a stator made up of a portion of the housing 2, field structure 8, end bell 12, sleeve 16, and annulus 18. The input shaft 22 and the output shaft 44 rotate within the stators. The coil 104 of field structure 6 is the clutch driver coil while the coil 108 of the field structure 8 is the brake driver coil. When both coils are de-energized, the clutch and the brake are both inoperative. As a result the shafts 22 and 44 are free to rotate within the two stators and rotation of shaft 22 will not cause rotation of shaft 44. When the clutch coil is energized, a magnetic field is established through the housing 2, the magnetic core 100, the annulus 26, the magnetic particles in gap 28, the disc 72, and the input shaft 22. As a result of this applied magnetic field, the magnetic particles in the gap 28 lock in chains between disc 72 and the adjacent faces of rotor 22 and annulus 26; with the result that rotation of shaft 22 will cause rotation of shaft 44 relative to housing 2. So long as the clutch coil is energized, shaft 44 will be clutched to and will rotate with shaft 22. When the clutch driver coil is de-energized, shaft 44 will be de-clutched and thus will resume its original free running relation with respect to shaft 22.

Energization of the brake coil 108 will cause a magnetic field to be generated with the flux lines of the field passing through a portion of the housing 2, the core of field structure 8, the end bell 12, the magnetic particles and the disc 70 in the gap 20, and the annulus 18, with the result that the magnetic particles in the gap will be locked in chains between the disc 70 and the adjacent faces of the end bell 12 and the annulus 18. Since the end bell 12 is locked to the housing 2, the magnetic field established across the gap 20 will cause the shaft 44 to be braked and come to a rapid halt.

Turning now to FIGS. 2, 2A, and 3, the core of each of the field structures 6 and 8 is formed from an elongate strip of magnetic material such as No. 2 silicon relay steel. The core is formed by providing an elongate strip 114 which is punched so as to provide a series of evenly spaced, identically sized, square or rectangular holes 116. The strip 114 is then folded accordion-wise along fold lines 118 located halfway between successive holes 116 and also along fold lines 120 which extend through the mid-points of holes 116. As shown in FIG. 2A, when the strip is folded as described it has a series of U-shaped folds or leaves 122, each characterized by a pair of oppositely disposed parallel legs 124 and 126 and a connecting section 128 that together define a side opening 130. The side openings of successive leaves or folds are aligned so as to form an elongate U-shaped or rectangular channel 132. Except for the end folds, each of the folds 120 is connected at its connecting section 128 to the adjacent fold on one side and at its legs 124 and 126 to the adjacent folds on its opposite side. The folded strip 114 is sufficiently flexible so as to permit it to be bent to form an annulus. The folded strip may be bent so that ends of legs 124 and 126 form the outer periphery of the annulus, or alternatively, the strip may be folded so that the legs 124 and 126 form the inner periphery of the annulus. The latter arrangement is shown in FIG. 3 which is a perspective view of the field structure 6 or 8. The channel 132 formed by the side openings 130 is on the inside of the annulus. Preferably, the end folds 122A and 122B of the folded and bent strip are inter-locked as shown in FIG. 3A so as to prevent the strip from unbending back to its original straight folded configuration. Alternatively, the end folds of the strip may be connected to each other by metal or plastic clips or by brazing or soldering or welding or by other suitable means. It is also to be understood, however, that it is not necessary to physically secure together the end folds of the strip in order to form a circular field structure shown in FIG. 3. Instead it is possible to wrap the folded strip around the coil bobbin 102, with the latter disposed in the channel 132, and then holding the strip so that it cannot unbend from around the bobbin, insert it into the housing 2. Once inserted into the housing, the folded bent strip cannot bend back to its original straight folded condition since it is restrained by the surrounding housing 2. When the strip is bent to form the circular core as shown in FIG. 3, the folds are spaced apart with the spacing between adjacent folds being greater at the outer periphery than at the inner periphery. Depending upon the number of folds or laminations in a given size core, the folds may or may not engage each other at areas other than where they are connected. Performance of the field structure 6 is improved if the folds are closely packed near its center and also if the

area of direct contact between adjacent folds is reduced. Accordingly, it is preferred to coat the folded strip with an insulating material such as an epoxy paint so that the adjacent folds will not make electrical contact with each other. In any event, because the core of the field structure is made up of a series of folds, a magnetic field established therein can more rapidly follow changes in magnetizing current frequencies above about a few cycles per second than can a magnetic field in a solid core.

Construction of magnetic field structures according to this invention is not limited to use of strips as shown in FIG. 2 or to cores as shown in FIG. 3.

One modification of the invention is shown in FIG. 4. In this case an elongate strip 114A of magnetic material is provided with holes 116 and is folded along lines 118 and 120 as in FIGS. 2 and 2A. However, additionally, strip 114A is provided with narrow slots 136 along the fold lines 118. The slots 136 facilitate folding the strip and also help reduce eddy currents in the core formed by folding and bending the strip as above described.

Still another modification is shown in FIG. 5. In this case it is contemplated that the strip of magnetic material (e.g., strip 114 or 114A of FIGS. 2 and 4) will be folded so that each of the folds is curved as shown at 138 rather than extending substantially straight or radially. Curving the several folds as shown in FIG. 5 offers the advantage of reducing the outside diameter of the magnetic material in the core, or alternatively, allowing more magnetic material to be included in the core structure without increasing the outside diameter.

FIGS. 6, 7 and 8 pertain to still other modifications of the invention. In FIG. 6 a strip 140 is provided with like, evenly spaced openings 142 along one side thereof. The openings 140 may be shaped so that the areas 144 are either rectangular or square. The strip 140 is folded along fold lines 146 located midway between successive openings 142. The strip 140A in FIG. 7 is similar to that of FIG. 6 except that it is provided with additional narrow slots 150 along the fold lines 146 which not only facilitate folding but also help reduce eddy currents. When either of the strips 140 or 140A is folded accordion-wise along lines 146 and then bent to form a circular core, the result is as seen in FIG. 8. Essentially, the core comprises a plurality of laminations or folds 152 which are spaced apart further at the outer periphery than at the inner periphery, and which also includes a channel 154 in its side formed by the side openings 142. A bobbin with a coil such as forms part of the field structures 6 and 8 may be mounted in channel 154.

It also is possible with the strips of FIGS. 6 and 7 to provide a magnetic core which is similar to that of FIG. 8 except that it has a coil-receiving groove in its side which extends in from the inner or outer edge of the core; that is, the core in cross-section is L-shaped rather than U-shaped. This is achieved by folding strips 140 and 140A along lines 146 located midway between the side openings 142 and also along lines 148 located midway between each pair of side openings. Whether the groove is located at the inner or outer periphery depends on how the strip is bent after it has been folded. If it is bent so that the fold lines 148 are closer to the center than the fold lines 146, the groove will be at the outer periphery. Conversely the groove will be at the

outer periphery if the folded strip is bent so that the fold lines 146 are closest to the center of the core.

It is to be noted that a magnetic core such as shown in FIG. 8 may also be made from the strips 114 and 114A of FIGS. 2 and 4. This is achieved by folding the strips 110 and 110A accordion-wise as previously described, and then bending them into annuli so that the legs 124 are further spaced from one another than are the legs 126 (or vice versa) i.e., so that the legs 124 are located further from the center than the legs 126.

FIG. 9 shows another form of circular magnetic core that may be constructed in accordance with this invention. The core of FIG. 9 is like that of FIG. 3 in that its coil-receiving channel 156 is formed along the inner circumference of the core. It differs from the core of FIG. 3 in that the junctions of successive folds are in two different planes extending transversely to the center axis of the core. In FIG. 3 the function of successive folds are two at different radial distances from the center of the core. The core of FIG. 9 is made using the strip 140A shown in FIG. 7. This is achieved by folding strip 140A only along lines 146 so that the side openings 142 are aligned, and then bending the folded strip so that the slots 150 are on the inside of the core. If the folded strip 140A is bent in the reverse fashion, the coil-receiving channel will extend around the outer rather than the inner periphery of the core. Preferably, slots 150 are made long as shown to facilitate bending so as to bring the folds as close together as possible near the center of the core. In this connection it is to be noted that the core of FIG. 9 may be substituted for the core shown in FIG. 3 in the device of FIG. 1 and that it offers the same advantage of increasing density with decreasing distance from its center.

Although magnetic field structures made as above described may be used in magnetic particles coupling devices such as brakes and clutches or combination brake-clutch devices as in FIG. 1, they may also be used in other electromagnetic devices requiring field structures and particularly in other types of electromagnetic coupling devices. Thus, it is possible to use field structures as above described in friction type magnetic clutches. For example, a field structure with a core as shown in FIG. 8 may be used in the friction coupling devices of the type shown in U.S. Pat. Nos. 2729318, 2899037, 2958406, 2965203, 3052335, and 3251444, while a field structure as shown in FIG. 3 may be used in a magnetic particle clutch of the type shown in U.S. Pat. No. 3358798. It is to be understood also that it is not necessary for the coil of the magnetic field structure to be wound on a bobbin. Instead the coil may be wound directly into the channel formed in the magnetic core and secured in place with a potting compound which also may be used to insulate the folds of the cores or to secure together the end folds of the core.

It is also to be understood that the core need not be made of a single strip of material as above described. Thus it is possible to make the core in two half sections with each half section comprising a strip of magnetic alloy perforated according to one of the various ways described above. It is also possible to make the core in more than two sections. Thus, for example, the core may be made in four quarter sections. It is also possible to make the core so that it is capable of accommodat-

ing more than one coil, i.e., so that it has more than one coil-receiving channel. Thus, two channels side by side may be made by modifying the strip of FIG. 4 so that it has two rows of holes 116 aligned with each other, so that when the strip is folded and bent, each row of holes will be converted to a coil-receiving channel. It is also possible to make a core with one coil channel in its outer periphery and another coil channel in its inner periphery by appropriately perforating, folding, and bending the strip of magnetic material.

The advantages of a magnetic structure made as above described are several. The most important advantage is reduced cost as compared to a conventional laminated core. Still a further advantage is the ability to dissipate heat since the folds that make up the core tend to function as heat dissipating fins. A further significant advantage of magnetic field structures constructed as above described is that they materially improve the performance of magnetic clutches and brakes. By way of example, a three inch clutch constructed like the magnetic clutch unit of the device in FIG. 1 but with a solid silicon steel core in its field structure was found to develop 60 inch/pounds of torque and to have a response time of about 30 milliseconds when energized with a given current. Then the solid core was removed and its coil attached to a core like that shown in FIG. 3. The new core had substantially the same outside and inside diameters and was made of the same silicon steel but its weight was only 45 percent of that of the solid core. This new field structure was mounted in the same clutch and energized with the same current as before. The clutch now developed about 50 inch/pounds of torque and had a response time of about five milliseconds. It also was found that the torque developed by the same clutch using a core made as shown in FIG. 3 could be increased to the same magnitude as achieved with the solid core but with only a slight increase in response time by only a moderate increase in the amount of metal in the core, e.g., by increasing the number of folds so that the density at the center of the core is increased.

Other modifications and advantages of the invention are believed to be obvious to persons skilled in the art.

What is claimed is:

1. In a magnetic coupling device a magnetizing field structure comprising an annular magnetic core formed of at least one flat strip of magnetic material having a series of spaced holes and folded at and between said holes accordion-wise so that each fold has a slot and said core has a continuous channel in one side thereof, and a cooperating electrical coil for magnetizing said core disposed in said channel.

2. The combination of claim 1 wherein said core comprises two or more strips of magnetic material disposed in series with each other.

3. The combination of claim 2 wherein each end of one strip is connected to the adjacent end of another strip.

4. The combination of claim 2 wherein the ends of said strip are connected by interlocking folds of said strip.

5. The combination of claim 4 wherein the end fold of one strip is interlocked with an end fold of another strip.

6. The combination of claim 1 wherein said one side extends transversely of the center axis of said core.

7. The combination of claim 1 wherein said one side constitutes the inner periphery of said core.

8. The combination of claim 1 wherein said magnetic coupling device is a clutch.

9. The combination of claim 1 wherein said magnetic coupling device is a brake.

10. The combination of claim 1 wherein said magnetic coupling device comprises a first magnetic member and a second magnetic member mounted for rotation related to said first magnetic member, and said magnetizing field structure is mounted so that when said coil is energized the flux of the resulting magnetic field passes through and links said first and second magnetic members.

11. The combination of claim 10 wherein said first and second magnetic members are separated by a gap and further including a fluid magnetic medium in said gap, said gap located so that when said coil is energized said medium is magnetized and provides a torque-transmitting connection between said magnetic members.

12. The combination of claim 10 wherein said first magnetic member has a pair of spaced pole members and said second magnetic member comprises a shaft and a disc extending into the space between said pole members, a fluid magnetic medium in said space, and sealing means having sealing contact with said first and second magnetic members for confining said fluid magnetic medium in said space.

13. The combination of claim 12 wherein said fluid magnetic medium is a supply of magnetic particles.

14. The combination of claim 12 wherein said first

magnetic member is secured against rotation relative to said magnetizing field structure.

15. The combination of claim 12 wherein said first magnetic member is mounted for rotation relative to said magnetizing field structure.

16. A magnetic device comprising first and second magnetic members mounted for rotation relative to one another and having confronting surfaces spaced from each other to form an air gap therebetween, magnetic particles in said gap, and a magnetizing field structure comprising an annular magnetic core and an electrical coil, said field structure positioned so that when said coil is energized a magnetic field is produced which magnetically polarizes said core, said magnetic members and said particles so that said particles provide a torque-transmitting connection between said magnetic members, said core comprising at least one flat strip of magnetic material with perforations folded accordion-wise and having a continuous channel in one side thereof defined by folded portions of said at least one strip having said perforations.

17. A magnetic device according to claim 16 wherein said channel has a rectangular or square cross-section.

18. A magnetic device according to claim 16 wherein said field structure surrounds said first and second magnetic members.

19. A magnetic device according to claim 16 with spaces between adjacent folds of said at least one strip.

20. A magnetic device according to claim 16 further including an insulating medium between adjacent folds of said at least one strip.

21. A magnetic device according to claim 16 wherein said insulating medium comprises a coating on opposite surfaces of said at least one strip.

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