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(12) # EUROPEAN PATENT APPLICATION

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(54) **Sintered core for an electromagnetic contactor with controlled closing velocity.**

(57) An electromagnet/armature set fabricated of powdered metal is disclosed. The powdered metal is preferably magnetic and may be mixed with phosphorus to improve the magnetic properties of the powdered metal, which is molded into the desired shape by pressing and sintering. The electromagnet and armature set are especially adapted for use with electromagnetic contractor and controller motors wherein the electromagnet/armature seat against each other with a controlled closing velocity.

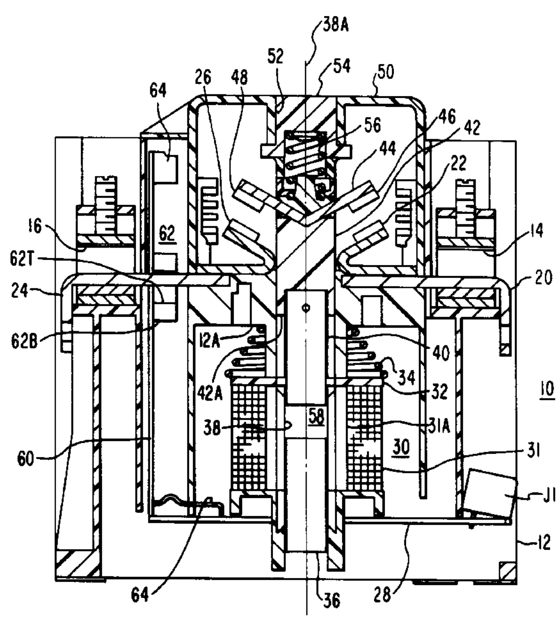

FIG.1

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The present invention relates to magnetic contactors for use in an electromagnetic contactor or motor controller. More particularly, the invention relates to magnetic contactors used in an electromagnetic contactor or motor controller having a controlled closing velocity in which the magnetic contactors comprise an armature and an electromagnet fabricated of powdered metal.

Electromagnetic contactors are well known as disclosed in the specification of U.S. Patent No. 3,339,161. Electromagnetic contactors are switch devices which are especially useful in motor-starting, lighting, and switching. A motor-starting contactor with an overload relay system is called a motor controller. A contactor usually has a magnetic circuit which includes a fixed magnet and a movable magnet or armature with an air gap therebetween when the contactor is opened. An electromagnetic coil is controllable upon command to interact with a source of voltage which may be interconnected with the main contacts of the contactor for electromagnetically accelerating the armature towards the fixed magnet, thus reducing the air gap.

Disposed on the armature is a set of bridging contacts, the complements of which are fixedly disposed within the contactor case for being engaged thereby as the magnetic circuit is energized and the armature is moved. The load and voltage source therefor are usually interconnected with the fixed contacts and become interconnected with each other as the bridging contacts "make" or "seat" with the fixed contacts.

As the armature is accelerated towards the magnet, it must overcome two spring forces. The first spring force is provided by a kickout spring which is subsequently utilized to disengage the contacts by moving the armature in the opposite direction when the power applied to the coil has been removed. This occurs as the contacts are opened.

The other spring force is provided by a contact spring which begins to compress as the bridging contacts abut the fixed contacts, but while the armature continues to move towards the fixed magnet as the air gap is reduced to zero. The force of the contact spring determines the amount of electrical current which can be carried by the closed contacts, and furthermore determines how much contact wear is tolerable as repeated operation of the contactor occurs. It is usually desirous for the contact spring to be as forceful as possible, thus increasing the current-carrying capability of the contactor and increasing the capability of the contactor and increasing the capability to adapt for contact wear.

However, since this contact spring force must be overcome by the energy provided to the electromagnet during the closing operation, more closing energy will generally be required for relatively stiffer contact springs than for less stiff contact springs. As a result, in known contactors, the amount of energy provided to the electromagnet is more than is necessary to overcome the force of the springs against which the accelerating armature operates. One reason for this is the need to overcome the effect of the relatively stiff contact springs when the contacts engage. However, the excess energy is wasted energy which is undesirable. But, perhaps more importantly, the excess energy is absorbed by the mechanical system as the armature finishes its closing travel stroke. This excessive kinetic energy is usually exemplified by heat, noise, vibration, undesirable contact bounce and shock. The armatures and electromagnets of the prior art must generally be formed of solid, machined metal, or laminated metal in the case of AC circuits, in order to withstand the high impact seating forces. This machining and laminating is costly, labor intensive and suffers from problems of specification reproducibility.

More recently it has been discovered that it is possible to provide an electrical control system for an electromagnetic closing system which provides only the amount of energy necessary to overcome the forces which resist movement of the armature in the closing stroke. Such controlled closing devices are described in the specifications of U.S. Patent Nos. 4,720,763 and 4,893,102.

An object of the invention is to provide an armature and/or electromagnet which has been formed of powdered metal, most particularly, pressed and sintered powdered magnetic metal such as iron, in order to create a pre-determined shape useful for armatures and electromagnets.

A further object of the invention is to provide armatures and electromagnets which are formed of powdered metal and which can withstand the closing forces acting on the armature and electromagnet and which may be used in conjunction with electromagnetic contactors in motor controllers.

According to the present invention, a slug of magnetizable material and a magnetic flux conductive armature for use in an electrical contactor, in which said magnetic flux conductive armature normally spaced apart from said slug and capable of abutting said slug at a controlled abutting velocity, at least one of said magnetic flux conductive armature and said slug is formed by pressing and sintering powdered metal to a predetermined shape.

Conveniently, the armature and electromagnet are both fabricated of the powdered metal which is magnetic and selected from the group iron, cobalt and nickel and mixtures thereof.

The armature and electromagnet set are formed into predetermined shapes such as "C", "I" and "E". These shapes are prepared by pressing the powdered metal into a mold conforming to the desired shape and sintering the powdered metal to fix the armature or electromagnet in the desired shape.

Advantageously, the armature or electromagnet may contain, in addition to metal powder, phosphorus powder to improve the magnetic properties of the powdered metal being used.

Preferably, the pressed and sintered armature and/or electromagnet is disposed within an electrical contactor and/or motor controller which utilizes a controlled closing velocity to protect the electromagnet and/or the armature from shattering upon impact.

The invention will now be disclosed, by way of example, with reference to the accompanying drawings in which:

Figure 1 shows a cut-away elevation of an electromagnetic contactor in which the armature and electromagnet of the present invention may be used; and

Figure 2 is an illustration of the various shapes in which the armature and/or electromagnet.

Figure 1 is an example of an electrical contactor or controller 10 in which the electromagnet and armature may be used is shown, comprising a housing 12 made of electrical insulating material such as a glass/nylon composition upon which are disposed electrical load terminals 14 and 16 for interconnection with an electrical apparatus, a circuit or a system to be serviced or controlled by the contactor 10. Terminals 14 and 16 are spaced apart and interconnected internally with conductors 20 and 24, respectively, which extend into the central region of the housing 12. There, conductors 20 and 24 are terminated by appropriate fixed contacts 22 and 26, respectively. Interconnection of contacts 22 and 26 will establish circuit continuity between terminals 14 and 16 and render the contactor 10 effective for conducting electrical current therethrough. A separately manufactured coil control board 28 may be securely disposed within housing 12. Disposed on the coil control board 28 is a coil or solenoid assembly 30 which may include an electrical coil or solenoid 31 disposed as part thereof. Spaced away from the coil control board 28 and forming one end of the coil assembly 30 is a spring seat 32 upon which is securely disposed one end of a kickout spring 34. The other end of the kickout spring 34 resides against portion 12A of the base 12 until movement of the carrier 42 causes the bottom portion 42A thereof to pick up the spring 34 and compress it against the seat 32. This occurs in a plane outside of the plane of Figure 1. The spring 34 encircles the armature 40, and is picked up by the bottom portion 42A of the carrier where the spring 34 and bottom portion 42A intersect. The dimension of the carrier 42 into the plane of Figure 1 is larger than the diameter of the spring 34. A fixed magnet or slug of magnetizable material 36 is strategically disposed within a channel 38 radially aligned with the solenoid or coil 31 of the coil assembly 30. Axially displaced from the fixed magnet 36 and disposed in the same channel 38 is a magnetic armature or magnetic flux conductive member 40 which is longitudinally (axially) movable in the channel 38 relative to the fixed magnet 36. At the end of the armature 40 and spaced away from the fixed magnetic 36 is the longitudinally extending, electrically insulating contact carrier 42 upon which is disposed an electrically conducting contact bridge 44. On one radial arm of the contact bridge 44 is disposed a contact 46, and on another radial arm of the contact bridge 44 is disposed a contact 48. Contact 46 abuts contact 22 (22-46), and contact 48 abuts contact 26 (26-48) when a circuit is internally completed between the terminal 14 and terminal 16 as the contactor 10 closes. On the other hand, when the contact 22 is spaced apart from the contact 46 and the contact 26 is spaced apart from the contact 48, the internal circuit between the terminals 14 and 16 is open. The open circuit position is shown in Figure 1. There is provided an arc box 50 which is disposed to enclose the contact bridge 44 and the terminals 22, 26, 46 and 48, to thus provide a partially enclosed volume in which electrical current flowing internally between the terminals 14 and 16 may be interrupted safely. There is provided centrally in the arc box 50 a recess 52 into which the crossbar 54 of the carrier 42 is disposed and constrained from moving traversely (radially) as shown in Figure 1, but is free to move or slide longitudinally (axially) of the center line 38A of the aforementioned channel 38. The contact bridge 44 is biased against the carrier 42 with the help of a contact spring 56. The contact spring 56 is compressed to allow continued movement of the carrier 42 towards slug 36 even after the contacts 22-46 and 26-48 have abutted or "made". Further compression of contact spring 56 greatly increases the pressure on the closed contacts 42-46 and 26-48 to increase the current-carrying capability of the internal circuit between the terminals 14 and 16 and to provide an automatic adjustment feature for allowing the contacts to attain an abutted or "made" position even after significant contact wear has occurred. The longitudinal region between the magnet 36 and the movable armature 40 comprises an air gap 58 in which magnetic flux exists when the coil 31 is electrically energized.

The armatures and electromagnets of the invention are shown in Figure 1 in their normally spaced apart orientation.

In a preferred embodiment of the invention, either the armature 40 or the magnet 36 or both is fabricated of powdered metal which has been pressed and sintered into a predetermined shape. Such armatures and electromagnets are adapted for use in an electrical contactor or controller 10 wherein the armature 40 seats against the electromagnet 36 at a controlled seating velocity as disclosed, for example, in the specifications of U.S. Patent Nos. 4,720,763 and 4,093,102.

The armature and electromagnet are preferably fabricated of magnetic powdered metal such as iron, cobalt, nickel and mixtures thereof. In addition to metal powder, phosphorus powder may be added in quantities in about 0.8% by weight of the metal powder to improve the magnetic properties of the pressed and sintered armature and/or electromagnet. Other additives which may be used include carbon, copper, molybdenum and manganese.

Figure 2 (a-d) illustrates schematically several shapes into which the electromagnet 36 and armature 40 of the invention may be pressed using the teachings of the present invention. The shapes illustrated in Figure 2 are all depicted with the armature 40 being movable with respect to a fixed electromagnet 36 in the directions shown by the arrows. However, it would be possible for both the armature 40 and the electromagnet 36 to be movable.

Figure 2 (a) illustrates schematically an electromagnet and armature set wherein the electromagnet and armature each comprise a "C" shape. In Figure 2 (b), the armature 40 is an "I" shape and the electromagnet 36 is a "C" shape. In Figure 2 (c), both the electromagnet 36 and the armature 40 comprise an "E" shape. In Figure 2 (d), the electromagnet 36 is an "E" shape while the armature 40 is an "I" shape.

That shapes other than those illustrated in Figure 2 would be possible for fabricating the armature and/or electromagnet.

The armature and electromagnet may be fabricated using any acceptable pressing and sintering technique, including pressing through uniaxial and/or isostatic pressing. The armature and/or electromagnet is fabricated by pouring the desired powdered metal mixture into a mold comprising the desired shape and the powdered metal is pressed at approximately 20-60 TSI (tons per square inch) or 2812-8435 kg/cm^2 and a temperature of about 1050 to 1310 degrees centigrade. The pressed and sintered electromagnet or armature has a green density of about 6-7.5 grams per cm^3. Sintering time may vary, the longer the sintering time, the greater the reduction in size of the finished product. Sintering times of 5-60 minutes have proven adequate.

Magnetic powders which may be used include those manufactured by Hoeganaes Corporation, Riverton, N.J. under the tradename ANCORSTEEL 80P. This mixture comprises about 99.05% (wt.) iron, 0.8% (wt.) phosphorous, and about 0.15% (wt.) carbon. Advantageously, the armature and electromagnet may be fabricated and retrofitted onto existing electromagnetic contactors or motor controllers having a controlled seating velocity. Preferably, the seating velocity does not exceed about 30 inches per second in order to ensure that the pressed and sintered armature and/or electromagnet do not shatter upon seating impact.

Claims

1. A slug of magnetizable material and a magnetic flux conductive armature for use in an electrical contactor, said magnetic flux conductive armature normally spaced apart from said slug and capable of abutting said slug at a controlled abutting velocity, at least one of said magnetic flux conductive armature and said slug is formed by pressing and sintering powdered metal to a predetermined shape.

2. A slug as claimed in Claim 1 in which said powdered metal is magnetic, is selected from the group Fe, Co, Ni and mixtures thereof, and in said predetermined shapes selected from the group C, I, E, and pressed by uniaxial pressing, and/or by isostatic pressing.

3. A slug as claimed in Claim 1 or 2 in which said metal powder also includes phosphorus powder in which said phosphorus powder comprises substantially 0.8% by weight of said pressed and sintered powdered metal.

4. A slug as claimed in any one of Claims 1 to 3 in which said controlled closing velocity is no greater than about 30 inches/second, and is controlled by a microprocessor means.

5. A slug as claimed in any one of Claims 1 to 4 wherein said contactor is pressed at about 20-60 tsi at a temperature of about 1050-1310°C, and pressed and sintered powdered metal has a green density of about 6-7.5 gms/cm^3.

6. A slug as claimed in Claim 5, in which said slug is constituted as an electrical armature and electromagnet set adapted for abutting with one another from a normally spaced-apart orientation as a result of an external force acting upon said slug and/or magnetic conductive armature, said external force abutting said slug and said magnetic conductive armature against each other at a controlled relative abutting velocity, said slug and said magnetic flux conductive armature comprising magnetic powdered metal pressed and sintered into a predetermined shape.

7. A slug as claimed in Claims 5 or 6, wherein said slug and said magnetic flux conductive armature each comprise a predetermined shape selected from the group C, I, E.

8. A slug as claimed in Claim 6 or 7 wherein said magnetic powdered metal is selected from the group Fe, Co, Ni and mixtures thereof.

9. A slug as claimed in Claim 8 wherein said slug is set in a fixed position with respect to said magnetic flux conductive armature, which is moveable with respect to said slug.

10. A slug as claimed in any one of Claims 1 to 9 in which said powdered metal is doped with at least one additive selected from the group C, Cu, Mo, Mn, or mixtures thereof along with phosphorous powder.

11. A slug as claimed in Claim 10 wherein said slug comprises a fixed magnet.

12. An electrical contactor comprising first and second electrical contact means which are normally open, a slug of magnetizable material, a magnetic flux conductive armature electromagnetically abuttable with said slug and connected to said second electrical contact for closing said first and second electrical contacts, spring means for resisting closure of said first and second contacts by said magnetic flux conductive armature, and electromagnetic force generating means for causing the abutment of said slug and said magnetic flux conductive armature having a predetermined magnitude and one of said slug and said magnetic flux conductive armature comprised of pressed and sintered powdered metal having a predetermined shape.

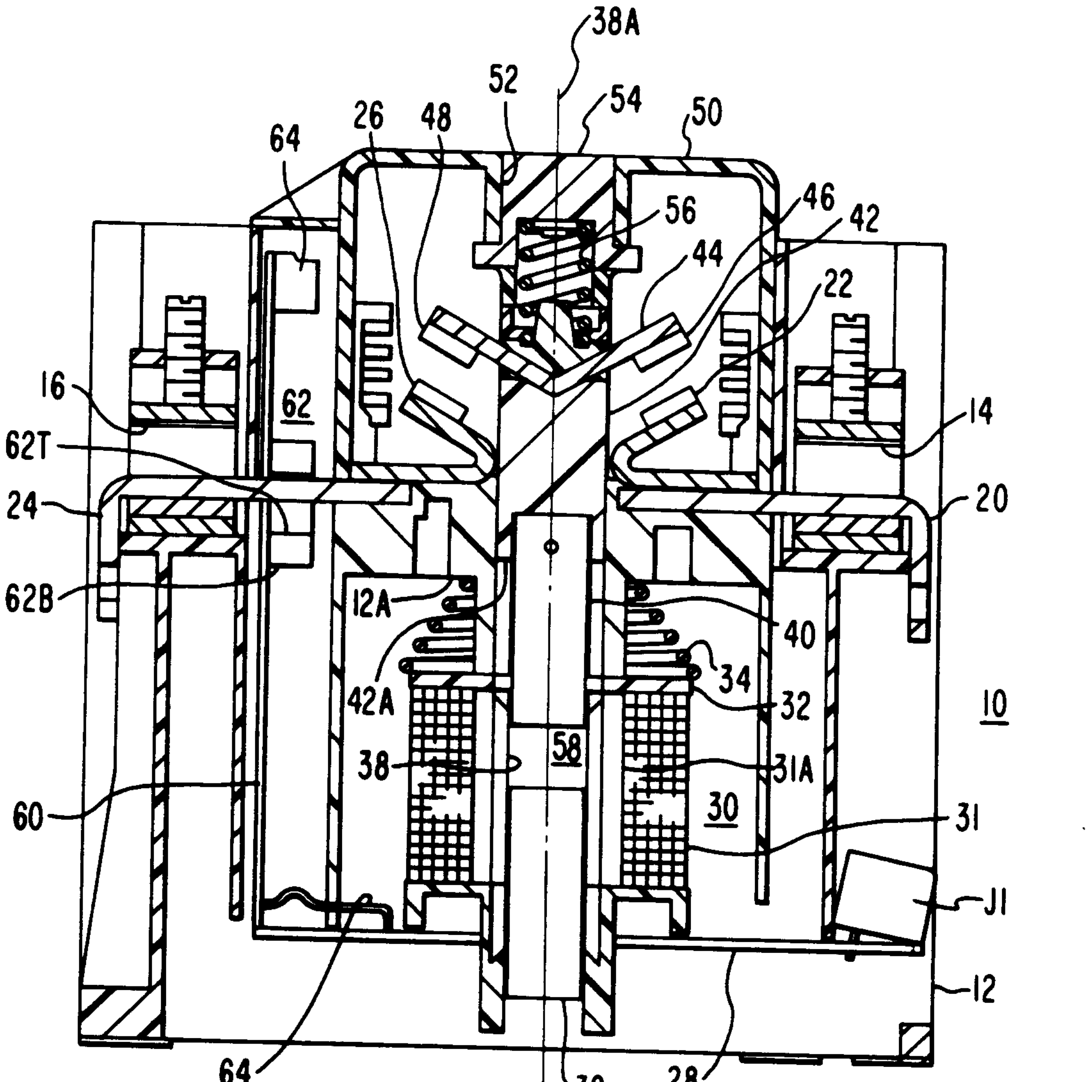
38A
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FIG.1

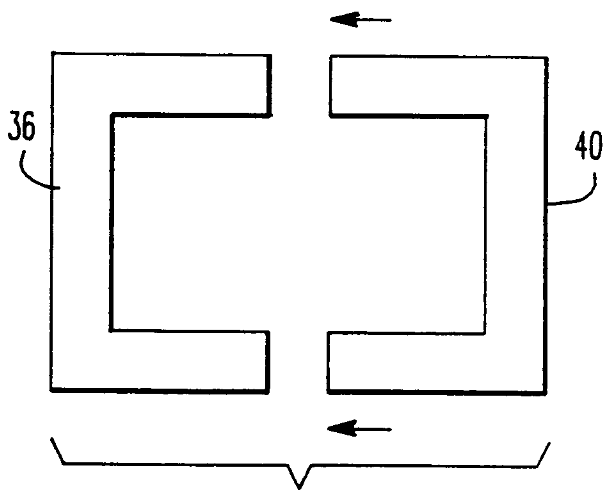

FIG. 2A

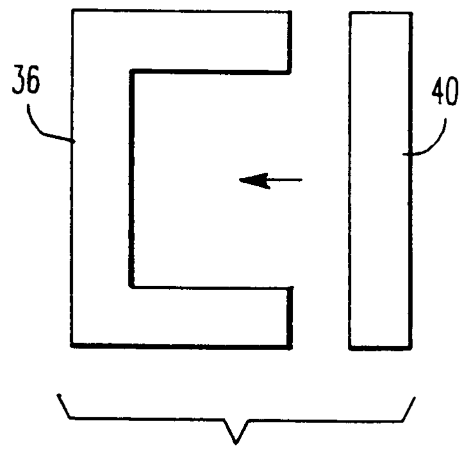

FIG. 2B

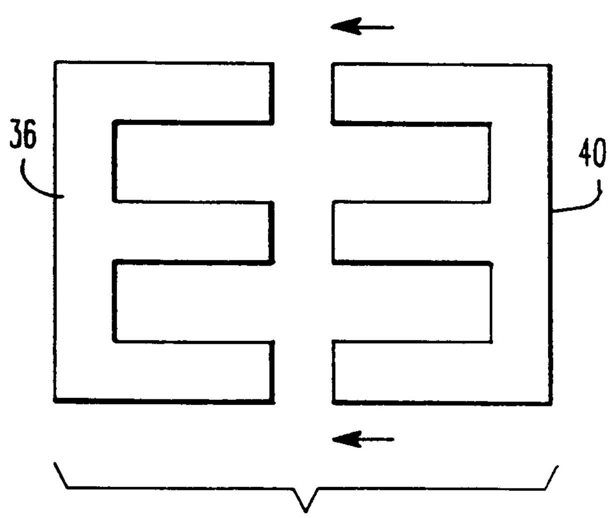

FIG. 2C

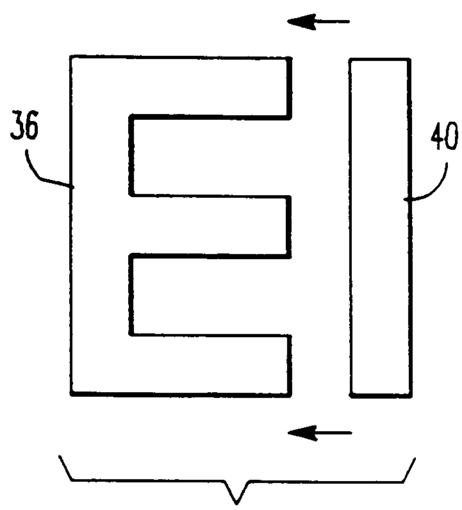

FIG. 2D

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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 2396

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP-A-0 279 592 (WESTINGHOUSE) * abstract; claims 1,6; figures 2,32 *	1-8,12	H01H50/16 H01H47/02 H01F3/08 H01F7/18
D	& US-A-4 893 102		
Y	EP-A-0 409 647 (SUMITOMO METAL MINING CO.) * the whole document *	1-8,12	
A	GB-A-890 142 (WESTINGHOUSE) * page 2, line 32 - line 36; figure 1 *	1	
A	US-A-4 019 239 (BOCKSTIEGEL) * column 1, line 58 - column 2, line 13; examples 1,2 *	1,2,5	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H01H
H01F
C22C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	22 MAY 1992	NIELSEN K.G.

CATEGORY OF CITED DOCUMENTS

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