

Description

IMPACT DOT PRINT HEAD

5 The present invention relates to an impact dot print head.

An Fe-Co-V alloy is widely known as a magnetic material having a high saturation magnetic flux density. This kind of alloy includes "2V. PERMENDUR". The soft magnetic material typically used for an actuator of the above kind has a chemical composition of 48 to 52 % by weight Co, less than 2.0 % by weight V and the remainder Fe and inevitable impurities.

10 Where this soft magnetic material is used in an actuator, it exhibits magnetically favorable properties and a good energy efficiency as compared with pure iron or silicon steel. There arise, however, some problems inherent in this material, wherein it undergoes a large magnetic loss, and the energy efficiency is deteriorated.

From the document Patent Abstracts of Japan, Volume 11, No. 195 (E-518)[2642], 23rd June 1987; & JP-A-62-22404 (Tohoku Metal Ltd.) 30.01.1987, it is known to improve the magnetic characteristics of a casting for a yoke part by manufacturing a 2V Permendur through a precision casting method and treating the casted body by a hot hydrostatic press. This allows to manufacture a yoke part with a complicated shape which cannot be realized by a cold-working process, the manufactured yoke part nevertheless enjoying high saturation magnetic density combined with low coercive force and high maximum permeability equal to that of cold-worked material. The material used in this prior art contains 48 to 52 % by weight Co, 1 to 3 % by weight V and the remainder substantially Fe.

The document Patent Abstracts of Japan, Volume 11, No.106 (C-414)[2552], 3rd April 1987; & JP-A-61-253348 (Daido Steel Co.Ltd) 11.11.1986, discloses a soft magnetic Fe-Co material for the yoke of a dot printer whose resistivity is increased without lowering the saturation magnetic flux density, the material containing, by weight, 10 to 35 % Co and ≥ 10 % in total of one or more among Si, Al, Cr, V, Nb and Ti.

25 US-A-4 375 338 discloses a print head of the kind as defined by the preamble of the claim.

It is a primary object of the present invention which obviates the foregoing problems to provide an impact dot print head capable of reducing the magnetic loss and exhibiting a high energy efficiency.

This object is achieved with an impact dot print head as claimed.

30 The soft magnetic material forming elements which are part of a magnetic circuit of the print head is composed of V of 2.4 % to 2.8 % by weight and the remainder containing Fe and Co, which have substantially the same weight ratio, and a small amount of inevitable impurities.

The electric resistance of the said soft magnetic material is larger than that of commercially available "2V.PERMENDUR". When a magnetic flux is generated by causing an electric current to flow through a coil in a magnetic circuit, an eddy current is likely to occur in the magnetic material of the magnetic circuit hindering the generation of magnetic flux. Due to the increased electric resistance of the soft magnetic material used according to the invention, it is possible to reduce such eddy current, thereby obtaining an actuator capable of decreasing the magnetic loss and exhibiting a high energy efficiency.

Other objects and advantages of the invention will become apparent from the following discussion taken in conjunction with the accompanying drawings, wherein:

- 40 Fig. 1 is a sectional view of an impact dot print head, illustrating one embodiment of the present invention,
 Fig. 2 is a characteristic diagram of an energy efficiency versus a V adding quantity, showing effects of the invention,
 Fig. 3 is a diagram showing the relation between the electric resistance and the V adding quantity, and
 Fig. 4 is a diagram showing the relation between the saturation magnetic flux density and the V adding quantity.

45 An illustrative embodiment of the present invention will hereinafter be described in detail.

Turning first to Fig. 1, there is shown an embodiment in which the present invention is applied to an impact dot print head. A wire nose generally designated at 4 engages with a wire guide 5 and is also fixed to a nose 6. A bottomed cylindrical core block 7, which is composed of a soft magnetic material and has its position defined by the wire nose 4, is integrally fixed. The core block 7 cooperates with a bottomed cylindrical yoke 8 and a disc-like side yoke 9 to attract a driving lever 2 which will be mentioned later. The core block 7 is so constructed that the interior thereof is formed with a ring-like protruded core 11 having its peripheral surface wound with a coil 10, thus partly constituting a magnetic path. The soft magnetic material has a chemical composition of Co of 48.8 % by weight, V of 2.3 % by weight and the remainder containing Fe and inevitable impurities. In the present embodiment of the present invention, this soft magnetic material is used for all of the core block 7, the yoke 8, the side yoke 9 and the core 11 which all form parts of a magnetic circuit.

55 The description will next be focused on the operation of the thus constructed device. An electric current is applied to one or a plurality of coils 10 selected in accordance with a printing command signal. Immediately,

a magnetic attraction is produced between the driving lever 2 and the core 11 by magnetic fluxes entering both the cylindrical yoke 8 and the side yoke 9 from the core. As the result the driving lever 2 rotates about a fulcrum shaft 12 in the direction indicated by an arrow in Fig.1. Subsequently, a printing wire 1 fixedly secured to the top portion of the driving lever 2 and supported and guided by several wire guides 3 impinges on a printing paper through an ink ribbon (not shown), thus effecting the printing. Since the electric resistance of the soft magnetic material constituting the magnetic circuit is large, it is possible to restrain and lessen the occurrence of an eddy current. As a result, the energy input to the coil 10 can be reduced, thereby increasing the energy efficiency. After performing the printing process, the driving lever 2 having the printing wire 1 fixed to it rotates about the fulcrum shaft 12 by repulsion given from a platen 17 and the force of a return spring 14. The driving lever 2 then impinges on a dumper 15, in which position it is brought into a standby state.

As mentioned above, the said soft magnetic material is employed for all of the magnetic circuit components, and the magnetic loss can be decreased by reducing the eddy current caused when applying an electric current to the coil 10.

In the explained embodiment, all of the magnetic circuit components were said to be made of the said soft magnetic material. However, when the soft magnetic material according to the invention is applied to only some of the components of the magnetic circuit, similar effects can be obtained.

The chemical composition of the soft magnetic material will be explained in more detail hereinafter. An Fe-Co alloy, whose Fe-Co composition ratio is in the vicinity of 1:1, is the soft magnetic material which exhibits the maximum saturation magnetic flux density and at the same time has a large initial permeability among the magnetic materials. When V is added to the Fe-Co alloy, the electric resistance of the alloy, as shown in Fig.3, increases as its adding quantity augments. While on the other hand, the saturation magnetic flux density of the alloy is, as shown in Fig.4, declined with an increment in the V adding quantity. In the magnetic circuit components of an impact dot print head, DC magnetic characteristics and the electric resistance exert great influences on the performance of the print head. The reason for this is that the magnetic circuit of an impact dot print head is employed such as to cause large variations in the electric current like an alternating current, and hence the loss due to eddy currents has to be considered in addition to the DC magnetic characteristics of the magnetic material. The degree to which the generation of eddy currents hindering the generation of the magnetic flux is restrained increases as the electric resistance of the magnetic circuit components increases. In consequence, the loss due to the eddy current can be reduced.

Namely, it is required that the composition ratio of the the magnetic material be determined in terms of the DC magnetic characteristics and the electric resistance.

Experiments were made using impact dot print heads as depicted in Fig.1 which differed from each other with respect to the V adding quantity of the soft magnetic material used for the core block 7, the yoke 8, the disc-like side yoke 9 and the core 11. The energy efficiency for each of these impact dot print heads was measured. The energy efficiency is construed as the efficiency at which the electric energy imparted to the coil is converted into kinetic energy of the wire. The experimental results are that, as shown in Fig.2, the energy efficiency in a case where the V adding quantity is 2.1 % to 5.0 % is higher than in a case the V adding quantity is 2.0 % or less.

Therefore, when the V adding quantity is set to 2.1 to 5.0 %, an impact dot print head can be realized where-in the magnetic loss is decreased and the energy efficiency correspondingly increased. As shown in Fig.2, the highest energy efficiency is obtained when the V adding quantity is 2.6 %. This is attributed to the fact that with this ratio the balance between the DC magnetic characteristics and the electric resistance is most favorable for an impact dot print head. It is, however, impossible to constantly set the V adding quantity to 2.6 % with stability. In effect, there is a range of dispersion of ± 0.2 %. Therefore, the optimum V adding quantity is 2.4 % to 2.8 % per weight, thereby providing an impact dot print head having a small amount of magnetic loss and a high energy efficiency. In the above-described experiments the composition ratio of Fe to Co is 1:1.

The present invention is not limited to the direct attraction type impact dot print head explained in the foregoing embodiment. The same effects can be acquired by a spring charge type impact dot print head.

Claims

1. Impact dot print head having a plurality of print wires (1) fixed to a corresponding driving lever (2) and electromagnetic drive means for selectively driving said driving levers, said drive means comprising a core block (7), a cylindrical yoke (8) provided on the core block and a plate-like yoke (9) provided on the cylindrical yoke and supporting the driving levers (2), said core block having for each driving lever a core (11) surrounded by a coil (10), wherein the core (11), the core block (7), cylindrical yoke (8), plate-like yoke (9) and the driving lever (2) form a magnetic circuit such that upon energization of the coil (10)



a magnetic attraction is produced between the driving lever 2 and the core 11 by magnetic fluxes entering both the cylindrical yoke 8 and the side yoke 9 from the core. As the result the driving lever 2 rotates about a fulcrum shaft 12 in the direction indicated by an arrow in Fig.1. Subsequently, a printing wire 1 fixedly secured to the top portion of the driving lever 2 and supported and guided by several wire guides 3 impinges on a printing paper through an ink ribbon (not shown), thus effecting the printing. Since the electric resistance of the soft magnetic material constituting the magnetic circuit is large, it is possible to restrain and lessen the occurrence of an eddy current. As a result, the energy input to the coil 10 can be reduced, thereby increasing the energy efficiency. After performing the printing process, the driving lever 2 having the printing wire 1 fixed to it rotates about the fulcrum shaft 12 by repulsion given from a platen 17 and the force of a return spring 14. The driving lever 2 then impinges on a dumper 15, in which position it is brought into a standby state.

As mentioned above, the said soft magnetic material is employed for all of the magnetic circuit components, and the magnetic loss can be decreased by reducing the eddy current caused when applying an electric current to the coil 10.

In the explained embodiment, all of the magnetic circuit components were said to be made of the said soft magnetic material. However, when the soft magnetic material according to the invention is applied to only some of the components of the magnetic circuit, similar effects can be obtained.

The chemical composition of the soft magnetic material will be explained in more detail hereinafter. An Fe-Co alloy, whose Fe-Co composition ratio is in the vicinity of 1:1, is the soft magnetic material which exhibits the maximum saturation magnetic flux density and at the same time has a large initial permeability among the magnetic materials. When V is added to the Fe-Co alloy, the electric resistance of the alloy, as shown in Fig.3, increases as its adding quantity augments. While on the other hand, the saturation magnetic flux density of the alloy is, as shown in Fig.4, declined with an increment in the V adding quantity. In the magnetic circuit components of an impact dot print head, DC magnetic characteristics and the electric resistance exert great influences on the performance of the print head. The reason for this is that the magnetic circuit of an impact dot print head is employed such as to cause large variations in the electric current like an alternating current, and hence the loss due to eddy currents has to be considered in addition to the DC magnetic characteristics of the magnetic material. The degree to which the generation of eddy currents hindering the generation of the magnetic flux is restrained increases as the electric resistance of the magnetic circuit components increases. In consequence, the loss due to the eddy current can be reduced.

Namely, it is required that the composition ratio of the the magnetic material be determined in terms of the DC magnetic characteristics and the electric resistance.

Experiments were made using impact dot print heads as depicted in Fig.1 which differed from each other with respect to the V adding quantity of the soft magnetic material used for the core block 7, the yoke 8, the disc-like side yoke 9 and the core 11. The energy efficiency for each of these impact dot print heads was measured. The energy efficiency is construed as the efficiency at which the electric energy imparted to the coil is converted into kinetic energy of the wire. The experimental results are that, as shown in Fig.2, the energy efficiency in a case where the V adding quantity is 2.1 % to 5.0 % is higher than in a case the V adding quantity is 2.0 % or less.

Therefore, when the V adding quantity is set to 2.1 to 5.0 %, an impact dot print head can be realized where-in the magnetic loss is decreased and the energy efficiency correspondingly increased. As shown in Fig.2, the highest energy efficiency is obtained when the V adding quantity is 2.6 %. This is attributed to the fact that with this ratio the balance between the DC magnetic characteristics and the electric resistance is most favorable for an impact dot print head. It is, however, impossible to constantly set the V adding quantity to 2.6 % with stability. In effect, there is a range of dispersion of ± 0.2 %. Therefore, the optimum V adding quantity is 2.4 % to 2.8 % per weight, thereby providing an impact dot print head having a small amount of magnetic loss and a high energy efficiency. In the above-described experiments the composition ratio of Fe to Co is 1:1.

The present invention is not limited to the direct attraction type impact dot print head explained in the foregoing embodiment. The same effects can be acquired by a spring charge type impact dot print head.

Claims

1. Impact dot print head having a plurality of print wires (1) fixed to a corresponding driving lever (2) and electromagnet drive means for selectively driving said driving levers, said drive means comprising a core block (7), a cylindrical yoke (8) provided on the core block and a plate-like yoke (9) provided on the cylindrical yoke and supporting the driving levers (2), said core block having for each driving lever a core (11) surrounded by a coil (10), wherein the core (11), the core block (7), cylindrical yoke (8), plate-like yoke (9) and the driving lever (2) form a magnetic circuit such that upon energization of the coil (10)



a magnetic attraction is established between the driving lever (2) and the core, characterized in that the core block (7), the cores (11), the cylindrical yoke (8) and the plate-like yoke (9) are made from a soft magnetic material composed of 2.4 to 2.8 % by weight V and the remainder containing Fe and Co, which have substantially the same weight ratio, and a small amount of inevitable impurities.

Patentansprüche

1. Anschlagpunktdruckkopf mit einer Vielzahl von Drucknadeln (1), die an einem entsprechenden Antriebshebel (2) befestigt sind, und einer elektromagnetischen Antriebseinrichtung zum selektiven Antrieb der Antriebshebel, wobei die Antriebseinrichtung umfaßt

einen Kernblock (7), ein zylindrisches Joch (8), das auf dem Kernblock vorgesehen ist, und ein plattenartiges Joch (9), das auf dem zylindrischen Joch vorgesehen ist und die Antriebshebel (2) lagert, wobei der Kernblock für jeden Antriebshebel einen von einer Spule (10) umgebenen Kern (11) aufweist, wobei der Kern (11), der Kernblock (7), das zylindrische Joch (8), das plattenartige Joch (9) und der Antriebshebel (2) einen magnetischen Kreis bilden, derart, daß bei Erregung der Spule (10) eine magnetische Anziehung zwischen dem Antriebshebel (2) und dem Kern auftritt, dadurch gekennzeichnet, daß der Kernblock (7), die Kerne (11), das zylindrische Joch (8) und das plattenartige Joch (9) aus einem weichmagnetischen Material hergestellt sind, das sich aus 2,4 bis 2,8 Gew.-% V und dem Rest enthaltend Fe und Co, die im wesentlichen den gleichen Gewichtsanteil aufweisen, sowie einer geringen Menge unvermeidbarer Verunreinigungen zusammensetzt.

Revendications

1. Tête d'impression matricielle à impact comportant un ensemble d'aiguilles d'impression (1) fixées à un levier d'entraînement correspondant (2), et des moyens d'entraînement électromagnétiques pour entraîner sélectivement les leviers d'entraînement, ces moyens d'entraînement comprenant

un bloc de noyaux (7), une culasse cylindrique (8) montée sur le bloc de noyaux et une culasse en forme de plaque (9) montée sur la culasse cylindrique et supportant les leviers d'entraînement (2), le bloc de noyaux comportant, pour chaque levier d'entraînement, un noyau (11) entouré par une bobine (10), dans laquelle le noyau (11), le bloc de noyaux (7), la culasse cylindrique (8), la culasse en forme de plaque (9) et le levier d'entraînement (2) forment un circuit magnétique, de façon que sous l'effet de l'excitation de la bobine (10), une attraction magnétique soit établie entre le levier d'entraînement (2) et le noyau, caractérisée en ce que le bloc de noyaux (7), les noyaux (11), la culasse cylindrique (8) et la culasse en forme de plaque (9) sont constitués par un matériau magnétique doux qui contient 2,4 à 2,8% en masse de V, le reste consistant en Fe et Co, qui ont pratiquement le même rapport en masse, et en une faible quantité d'impuretés inévitables.