



Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number :

0 133 802
B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification :
19.08.87

(51) Int. Cl.⁴ : **H 01 F 23/00, G 11 B 5/127**

(21) Application number : **84305310.9**

(22) Date of filing : **03.08.84**

(54) **A rotary transformer.**

(30) Priority : **16.08.83 JP 126147/83**
23.08.83 JP 129328/83

(43) Date of publication of application :
06.03.85 Bulletin 85/10

(45) Publication of the grant of the patent :
19.08.87 Bulletin 87/34

(84) Designated contracting states :
DE FR NL

(56) References cited :
GB-A- 2 111 315
US-A- 4 293 884
PATENT ABSTRACTS OF JAPAN, unexamined appli-
cations, field E, vol. 6, no. 173, September 7, 1982,
THE PATENT OFFICE JAPANESE GOVERNMENT,
page 98 E 129
PATENT ABSTRACTS OF JAPAN, unexamined appli-
cations, field E, vol. 6, no. 11, June 22, 1982, THE
PATENT OFFICE JAPANESE GOVERNMENT, page 72
E 114

(73) Proprietor : **TDK Corporation**
13-1, Nihonbashi 1-chome Chuo-Ku
Tokyo-to (JP)

(72) Inventor : **Yamazaki, Takakazu**
73-3, Yazuma Hirasawa
Nikaho-machi Yuri-gun Akita (JP)
Inventor : **Ishida, Norio**
48-7, Nyudojima Kusakata-machi
Yuri-gun Akita (JP)
Inventor : **Saito, Satoshi**
109-1, Korota Konoura
Konoura-machi Yuri-gun Akita (JP)
Inventor : **Sato, Hiroshi**
119 Sakanoshita Hirasawa
Nikaho-machi Yuri-gun Akita (JP)

(74) Representative : **Rackham, Stephen Neil et al**
GILL JENNINGS & EVERY 53-64 Chancery Lane
London WC2A 1HN (GB)

EP 0 133 802 B1

Note : Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Description

The present invention relates to an improvement in a rotary transformer and, in particular, relates an improvement in the structure of a pair of identical disc cores made of ferro-magnetic material.

A rotary transformer is generally used to couple electrically a rotating component and a stationary component in a magnetic storage apparatus such as a video tape recorder (VTR).

A conventional multi-channel rotary transformer will be described in more detail subsequently and comprises a pair of identical disc cores which are mounted for relative rotation, each of the disc cores comprising a number of concentric annular grooves provided on the facing surfaces for accommodating coils, each of the annular grooves being concentric with the centre of the disc core and having a first hole for lead wires from the coil.

According to this invention in such a rotary transformer each of the annular grooves of each disc core has a second hole of the same configuration as the first hole, the second hole being positioned diametrically opposite the first hole, and the first and second holes being symmetrically located with regard to the centre of the disc core so that the disc core is balanced.

Preferably a recess is provided in each annular projection located between two adjacent annular grooves the recess being located adjacent a hole and extending across the entire width of the annular projection.

Particular examples of rotary transformers in accordance with this invention will now be described and contrasted with conventional rotary transformers with reference to the accompanying drawings; in which:

Figure 1 is a cross-section through a conventional transformer;

Figure 2(A) is a plan of a conventional disc core;

Figure 2(B) is a cross-section taken along the line A-A shown in Figure 2A;

Figure 3 is a plan of a disc core used in a first example of rotary transformer in accordance with the present invention;

Figure 4 is a plan of a disc core used in a second example of rotary transformer in accordance with the present invention;

Figure 5(A) is a plan of a disc core used in a third example of rotary transformer in accordance with the present invention;

Figure 5(B) is a scrap, partly sectional, enlarged perspective view of the third example;

Figure 6 is a plan of a disc core used in a fourth example of rotary transformer in accordance with the present invention.

Figure 1 is a cross-sectional view of prior rotary transformer of four channel type. In this figure, a rotor 12 is fixed to a shaft 10 rotated by an electric motor (not shown). A disc rotor core 14 made of ferro-electric material such as ferrite is fixed to

the bottom surface of the rotor 12 by adhesive means. On the surface of the rotor core 14 opposite to the surface to which the rotor 12 is fixed, five annular grooves 16 which are coaxial with the longitudinal axis of the shaft 10 respectively, are provided. Coils 18 are accommodated in four annular grooves of five, respectively. A disc stator core 20 having coils 24 accommodated in annular grooves 22, which is the same structure as the rotor core 14, is fixed to the inner surface of a case 26 fixed to the body of a VTR so that the annular grooves 16 of the rotor core 14 is opposite to ones 22 of the stator core 20 with a predetermined spacing.

Figure 2(A) is a plan view of the disc rotor core 14 of Figure 1, which is the same structure as the disc stator core 20, and Figure 2(B) is a cross-sectional view along the line A-A of Figure 2 (A). The annular grooves 14₁ ~ 14₅ are arranged on the surface of the disc core 14 so that they are concentric with the centre C of the disc core 14 respectively. As a result, annular projections 28₁ ~ 28₅, which are also concentric with the centre C, are formed on the same surface of the disc core 14.

Coils are accommodated in the grooves 16₁, 16₂, 16₄ and 16₅, respectively. An annular short ring (not shown) is embedded in the groove 16₃ in order to separate magnetically coils accommodated in each of the grooves 16₁, 16₂ from coils in each of the grooves 16₄, 16₅. The annular grooves 16₁, 16₂, 16₄ and 16₅ have through holes 30₁, 30₂, 30₄ and 30₅, respectively, each of the through holes being in the cylindrical shape and coupling the bottom surface of the groove with the bottom surface of the disc core 14. Lead wires 32 from the coils are extended through the holes 30 to the bottom surface of the disc core 14 on which no grooves are provided, and are connected to an external circuit (not shown).

The disc core hereinabove is produced by ferromagnetic material such as ferrite through molding process, sintering process and finish process.

In operation of the rotary transformer having a pair of the disc cores above-mentioned, the rotor core 14 is rotated, on the other hand the stator core 20 is held stationary. Each signal in the coils of the rotor core 14 is magnetically transferred to the corresponding coil of the stator core 20, vice versa.

However, the prior rotary transformer has the following disadvantages.

(1) In general, the through holes of the disc core are arranged so as to be close to one another as shown in Figure 2(A) in order to facilitate the operation of extending the lead wires through the through holes to the bottom surface of the disc core. Thus, the presence of the through holes causes the unbalanced of mass of the disc core. That is, the equilibrium point in mass of the disc core is not at the centre C of the

disc core. Therefore, the unbalanced of mass of the disc core results in non-uniformity of rotary motion of the disc core such as run-out when the disc core rotates. In particular, non-uniformity of rotary motion of the disc core is more remarkable when the disc core rotates at high speed or when the external diameter of the disc core is large ; such a disc core is used to the rotary transformer of multi-channel type such as four or five channel type. Further, non-uniformity of rotary motion affects electric and/or magnetic characteristics of the rotary transformer.

(2) As mentioned above, shaping of the disc core is attained by molding process in which ferromagnetic material of powder type is pressed by means of an upper punch having projections corresponding to the grooves and the through holes of the disc core, and a lower punch having flat surface corresponding to the flat bottom surface of the disc core. In this molding process, referring to Figure 2, a portion 34₁ of the annular projection 28₂ between the adjacent through holes 30₁ and 30₂ is not pressed strongly enough to attain given compressibility of ferromagnetic material of power type. Thus, the portion 34₁ of the disc core molded is mechanically weak compared with the other portions of the disc core and is apt to be cracked or broken. Also, even if there is no undesirable cracking or breakage at the portion 34₁ of the disc core at the molding process stage, they may generate at the portion 34₁ of the disc core at the sintering process. It will be apparent that cracking or breakage may generate at a portion 34₂ of the annular projection 28₅ between the adjacent through holes 30₄ and 30₅. Also, when the width of the annular projection is relatively small (for example, smaller than 0.8mm), similar cracking or breakage will generate at portions 36₁ and 36₂ adjacent to the through holes 30₁ and 30₅, respectively. Cracking or breakage generates in spite of the kind of ferromagnetic material. Therefore, yield rate on the process for producing the core of Figure 2 is low.

The rotary transformer according to the present invention comprises a pair of improved identical disc cores arranged so that relative rotary motion is established as shown in Figure 1, and the present improved disc core is shown in Figure 3, in which identical numerals denote identical elements in Figure 2. The principle feature of the present invention is the presence of second through holes, or dummy through holes 28 for compensating the unbalance of mass of the prior disc core 14 resulting from the presence of the first through holes 30. The second through holes 38₁, 38₂, 38₄ and 38₅ are positioned in the annular grooves 16₁, 16₂, 16₄ and 16₅ respectively so that the first through holes 30 and the second through holes 38 are symmetrical with regard to the centre C of the disc core 14. In detail, the through holes 30₁ and 38₁; 30₂ and 38₂; 30₄ and 38₄; 30₅ and 38₅ are symmetrical with regard to the centre C of the disc core 50, respectively. Each of the second through holes 38 is the same structure as each of

the first through holes 30. Therefore, each of the second through holes 38 is in the cylindrical shape and couples the bottom surface of the grooves 16 with the bottom surface of the disc core 14. Of course, the shape of the first through holes 30 and the second through holes 38 is not limited to the cylindrical one, and thus, various shapes can be designed.

The disc core 50 of Figure 3 is produced by ferromagnetic material such as ferrite through molding process, sintering process and finishing process. In particular, the second through holes 38 are shaped preferably together with the first through holes 30 by means of a molding process.

The rotary transformer according to this embodiment is assembled, similar to Figure 1, using a pair of the present disc cores. With a transformer in accordance with the present invention, it will be apparent that uniform rotary motion can be established because of the presence of the second through holes 38 for compensating unbalance of mass of the disc resulting from the presence of the first through holes 30. Further, according to the embodiment, the lead wires to be connected to an external circuit can be extended through either the first through holes 30 or the second through holes 38. Thus, greater flexibility in the arrangement of the lead wires is obtained compared with the disc core of Figure 2.

Figure 4 shows a further improved disc core 60 utilized in the present rotary transformer, in which the feature of the present disc core is the presence of third through holes 40 and fourth through holes 42. The third and the fourth through holes 40, 42 are arranged in the grooves 16 so that they lie near the line C-C perpendicular to the line B-B near which the first and the second through holes 30, 38 lie. Further, the third through holes 40 and the fourth through holes 42 are positioned so that the third through holes 40 and the fourth through holes 42 are symmetrical with regard to the centre C of the disc core 14. Each of the third and the fourth through holes is the same structure as each of the first and the second through holes 30, 38. The presence of the third and the fourth through holes 40, 42 is to overcome the disadvantage of the disc core of Figure 3. That is, when the external diameter of the disc core of Figure 3 is large, it has been observed that the shape of the molded disc core in the cross section along the line perpendicular to the line B-B of Figure 3 is apt to be deformed in V-shaped structure. According to the disc core of Figure 4, in which the third through holes 40 and the fourth through holes 42 lie near the line C-C perpendicular to the line B-B, it has been observed that degree of deformation in V-shaped structure decreases. Thus, the disc core of Figure 4 is useful when its external diameter is large. Further, the present disc core has an advantage that extending operation of the lead wires can be more facilitated compared with the disc core of Figure 3.

Figure 5(A) is a plan view of a further improved disc core 70 utilized in the present rotary transfor-

mer, and Figure 5(B) is an enlarged perspective view, partly in cross section along the line D-D of Figure 5(A). The feature of the present disc core 70 is the presence of recesses 44 for preventing generation of cracking or breakage which will appear at portions of the annular projections 28 between two adjacent through holes 30₁ and 30₂; 30₄ and 30₅; 38₁ and 38₂; 38₄ and 38₅.

In Figure 5(B), there is provided a recess 44₁ at a portion of the annular projection 28₂ between two adjacent through holes 30₁, 30₂ (in this Figure, the half of the recess 44₁ and the half of each of the holes 30₁, 30₂ are shown). The recess 44₁ couples both the side walls of the annular projection 28₂. The bottom surface of the recess 44₁ is generally parallel to the bottom surface of the disc core 70 and the opposite side walls of the recess 44₁ are generally parallel to each other. The edges of the recess 44₁ may be rounded off. The depth D₁ of the recess 44₁ is designed so as to be equal or smaller than the depth D₂ of the annular grooves 16. The width W₁ of the recess 44₁ is designed so as to be nearly equal to the diameter of the through holes 30₁, 30₂. Of course, another recesses 44₂, 44₄ and 44₅ are designed in the same manner as the recess 44₁. The size of those recesses 44 is practically selected depending on the diameter of the through holes 30, the width W₂ of the annular projections 28 and the thickness T₁ of the disc core 14. For example, when the thickness T₁ is in the range from 1.5 to 4.0 mm and the depth D₂ of the grooves 16 is nearly equal to 0.6 mm, and the depth D₁ of the recesses 44 is set to be equal to 0.1 ~ 0.2 mm and the width W₁ is set to be nearly equal to the diameter of the through holes 30, 38.

The forming of the disc core of Figure 5 is achieved by the molding process in which ferromagnetic material of powder type is pressed by an upper punch comprising projections, corresponding to the recesses 44 and a lower punch including the surface corresponding to the flat bottom surface of the disc core. It has been observed that no cracking or breakage is generated in the disc core when the recesses 44 are included.

Figure 6 shows a still further improved disc core 80 utilized in the present rotary transformer. This disc core further comprises recesses 46 in addition to the recesses 44 of the disc core 70 of Figure 5. The recesses 46 are provided at portions of the annular projections adjacent to one of the through holes. That is, the recesses 46₁, 46₃ are provided at portions of the annular projection 28₁ adjacent to the through holes 30₁, 38₁ respectively, and the recesses 46₂, 46₄ are provided at portions of the annular projection 28₆ adjacent to the through holes 30₅, 38₅ respectively. The recesses 46 prevent generation of cracking or breakage at the projections 28₁, 28₆. The disc core of Figure 6 is useful when the width of the annular projections is relatively small.

Recesses may be provided in the disc core 60 of Figure 4 in the same manner as in Figure 5 or Figure 6.

Claims

1. A multi-channel rotary transformer comprising a pair of identical disc cores (50, 60, 70, 80) which are mounted for relative rotation, each of the disc cores (50, 60, 70, 80) comprising a number of concentric annular grooves (16₁, 16₂, ... 16₅) provided on the facing surfaces for accommodating coils (18, 24), each of the annular grooves (16₁, 16₂, ... 16₅) being concentric with the centre of the disc core (50, 60, 70, 80) and having a first hole (30₁, 30₂, ... 30₅) for lead wires from the coil, characterised in that each of the annular grooves (16₁, 16₂, ... 16₅) of each disc core (50, 60, 70, 80) has a second hole (38₁, 38₂, ... 38₅) of the same configuration as the first hole (30₁, 30₂, ... 30₅), the second hole (38₁, 38₂, ... 38₅) being positioned diametrically opposite the first hole (30₁, 30₂, ... 30₅), and the first (30₁, 30₂, ... 30₅) and second (38₁, 38₂, ... 38₅) holes being symmetrically located with regard to the centre of the disc core (50, 60, 70, 80) so that the disc core (50, 60, 70, 80) is balanced.

2. A rotary transformer according to claim 1, wherein each of the first (30₁, 30₂, ... 30₅) and second (38₁, 38₂, ... 38₅) holes is cylindrical.

3. A rotary transformer according to claim 1 or 2, wherein a recess (44₁, 44₂, ... 44₄) is provided in each annular projection (28₂, 28₃, ... 28₅) located between two adjacent annular grooves (16₁, 16₂, ... 16₅) the recess (44₁, 44₂, ... 44₄) being located adjacent a hole (30₁, ... 30₅; 38₁, ... 38₅) and extending across the entire width of the annular projection (28₂, 28₃, ... 28₅).

4. A rotary transformer according to the claim 3, wherein the recess (44₁, 44₂, ... 44₄) is substantially rectangular in shape, the depth (D₁) of the recess (44₁, 44₂, ... 44₄) being equal to or lower than that (D₂) of the annular grooves (16₁, 16₂, ... 16₅) and the width (W) of the recess (44₁, 44₂, ... 44₄) being equal to the diameter of the first (30₁, 30₂, ... 30₅) and second (38₁, 38₂, ... 38₅) holes.

Patentansprüche

1. Vielfachkanal-Rotationswandler mit einem Paar von identischen Plattenkernen (50, 60, 70, 80), die zur relativen Rotation montiert sind, wobei jeder der Plattenkerne (50, 60, 70, 80) eine Anzahl von konzentrischen, ringförmigen Nuten (16₁, 16₂, ... 16₅) umfaßt, die auf Stirnoberflächen zur Aufnahme von Spulen (18, 24) vorgesehen sind, wobei jede der ringförmigen Nuten (16₁, 16₂, ... 16₅) konzentrisch ist zu dem Zentrum des Plattenkerns (50, 60, 70, 80) und ein erstes Loch (30₁, 30₂, ... 30₅) für Leitungsdrähte von der Spule aufweist, dadurch gekennzeichnet, daß jede der ringförmigen Nuten (16₁, 16₂, ... 16₅) von jedem Plattenkern (50, 60, 70, 80) ein zweites Loch (38₁, 38₂, ... 38₅) von derselben Konfiguration wie das erste Loch (30₁, 30₂, ... 30₅) hat, wobei das zweite Loch (38₁, 38₂, ... 38₅) diametral gegenüber dem ersten Loch (30₁, 30₂, ... 30₅)

angeordnet ist, und die ersten ($30_1, 30_2, \dots 30_5$) und zweiten ($38_1, 38_2, \dots 38_5$) Löcher in bezug auf das Zentrum des Plattenkerns ($50, 60, 70, 80$) symmetrisch so angeordnet sind, daß der Plattenkern ($50, 60, 70, 80$) ausbalanciert ist.

2. Rotationswandler nach Anspruch 1, bei dem jedes der ersten ($30_1, 30_2, \dots 30_5$) und zweiten ($38_1, 38_2, \dots 38_5$) Löcher zylindrisch ist.

3. Rotationswandler nach Anspruch 1 oder 2, bei dem eine Ausnehmung ($44_1, 44_2, \dots 44_4$) in jedem ringförmigen Vorsprung ($28_2, 28_3, \dots 28_5$), der zwischen zwei benachbarten ringförmigen Nuten ($16_1, 16_2, \dots 16_5$) angeordnet ist, vorgesehen ist, wobei die Ausnehmung ($44_1, 44_2, \dots 44_4$) an ein Loch ($30_1, \dots 30_5; 38_1, \dots 38_5$) angrenzend angeordnet ist und sich quer über die gesamte Breite des ringförmigen Vorsprungs ($28_2, 28_3, \dots 28_5$) erstreckt.

4. Rotationswandler nach Anspruch 3, bei dem die Ausnehmung ($44_1, 44_2, \dots 44_4$) im wesentlichen eine rechtwinklige Form hat, die Tiefe (D_1) der Ausnehmung ($44_1, 44_2, \dots 44_4$) gleich oder geringer als diejenige (D_2) der ringförmigen Nuten ($16_1, 16_2, \dots 16_5$) ist und die Breite (W) der Ausnehmung ($44_1, 44_2, \dots 44_4$) gleich dem Durchmesser der ersten ($30_1, 30_2, \dots 30_5$) und zweiten ($38_1, 38_2, \dots 38_5$) Löcher ist.

Revendications

1. Transformateur tournant à plusieurs canaux comprenant deux noyaux plats identiques ($50, 60, 70, 80$) montés en vue de tourner l'un par rapport à l'autre, chacun des noyaux plats ($50, 60, 70, 80$) présentant un certain nombre de rainures annulaires concentriques ($16_1, 16_2, \dots 16_5$) ménagées dans les surfaces se faisant face pour recevoir

des enroulements ($18, 24$), chacune des rainures annulaires ($16_1, 16_2, \dots 16_5$) étant centrée sur le centre du noyau plat ($50, 60, 70, 80$) et présentant un premier trou ($30_1, 30_2, \dots 30_5$) de réception de fils partant de l'enroulement, caractérisé en ce que chacune des rainures annulaires ($16_1, 16_2, \dots 16_5$) de chaque noyau plat ($50, 60, 70, 80$) présente un second trou ($38_1, 38_2, \dots 38_5$) de même configuration que le premier trou ($30_1, 30_2, \dots 30_5$), le second trou ($38_1, 38_2, \dots 38_5$) étant diamétriquement opposé au premier trou ($30_1, 30_2, \dots 30_5$), et les premiers ($30_1, 30_2, \dots 30_5$) et seconds ($38_1, 38_2, \dots 38_5$) trous étant placés symétriquement par rapport au centre du noyau plat ($50, 60, 70, 80$) de façon que le noyau plat ($50, 60, 70, 80$) soit équilibré.

2. Transformateur tournant selon la revendication 1, dans lequel chacun des premiers ($30_1, 30_2, \dots 30_5$) et seconds ($38_1, 38_2, \dots 38_5$) trous est cylindrique.

3. Transformateur tournant selon la revendication 1 ou 2, dans lequel un évidement ($44_1, 44_2, \dots 44_4$) est prévu dans chaque saillie annulaire ($28_2, 28_3, \dots 28_5$) située entre deux rainures annulaires ($16_1, 16_2, \dots 16_5$) voisines, l'évidement ($44_1, 44_2, \dots 44_4$) étant situé près d'un trou ($30_1, \dots 30_5; 38_1, \dots 38_5$) et s'étendant de part en part de la largeur de la saillie annulaire ($28_2, 28_3, \dots 28_5$).

4. Transformateur tournant selon la revendication 3, dans lequel l'évidement ($44_1, 44_2, \dots 44_4$) est de forme sensiblement rectangulaire, la profondeur (D_1) de l'évidement ($44_1, 44_2, \dots 44_4$) étant égale ou inférieure à celle (D_2) des rainures annulaires ($16_1, 16_2, \dots 16_5$) et la largeur (W) de l'évidement ($44_1, 44_2, \dots 44_4$) étant égale au diamètre des premiers ($30_1, 30_2, \dots 30_5$) et seconds ($38_1, 38_2, \dots 38_5$) trous.

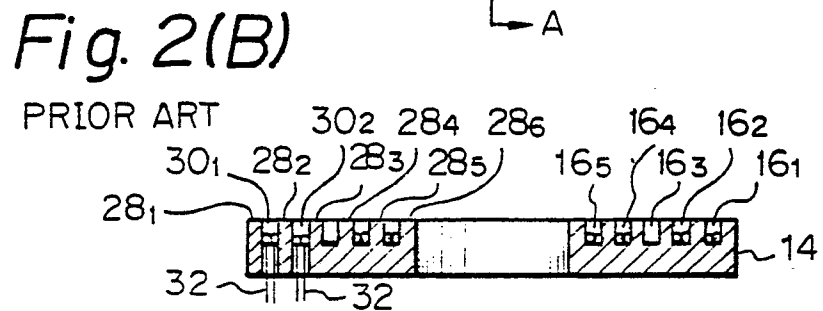
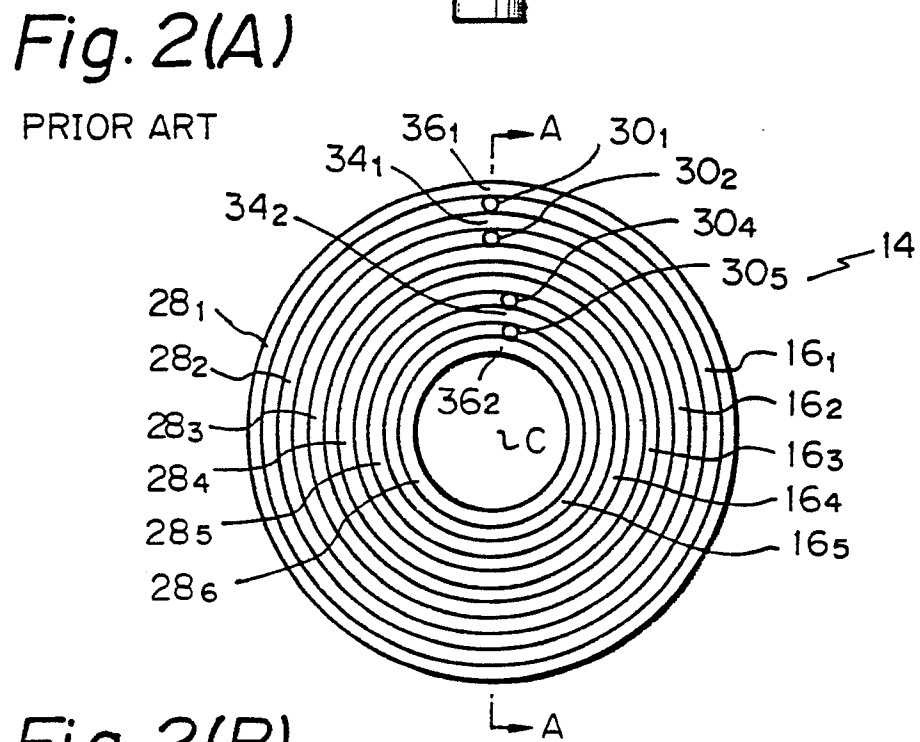
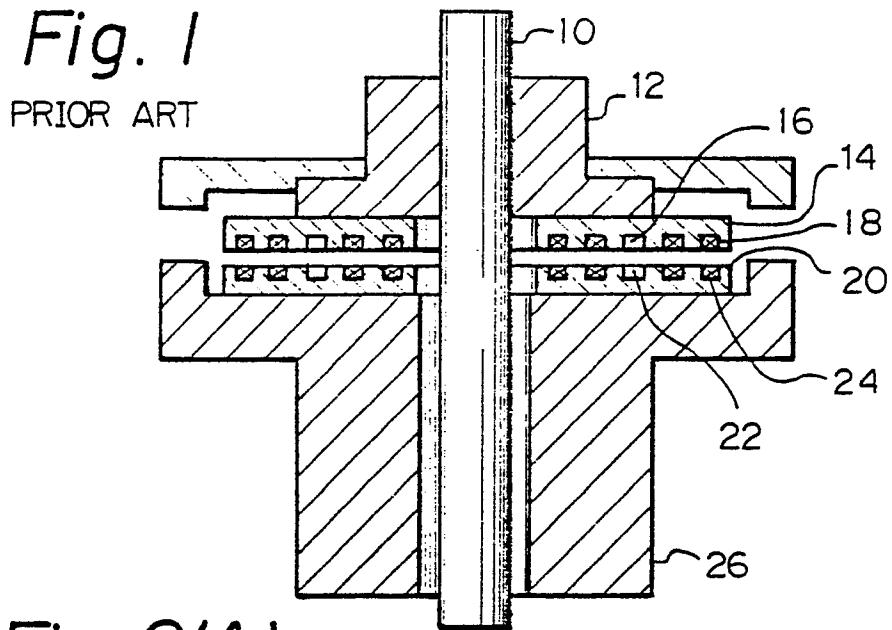


Fig. 3

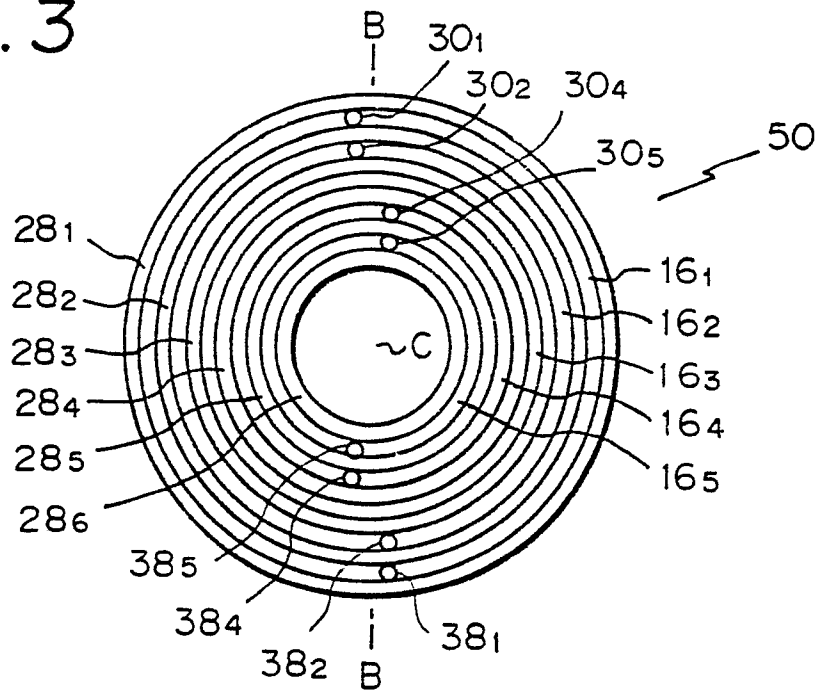


Fig. 4

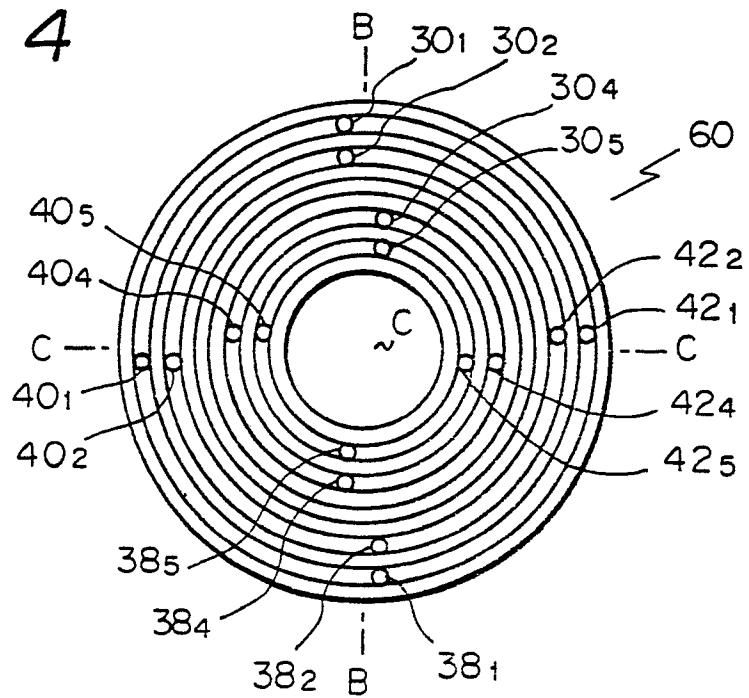


Fig. 5(A)

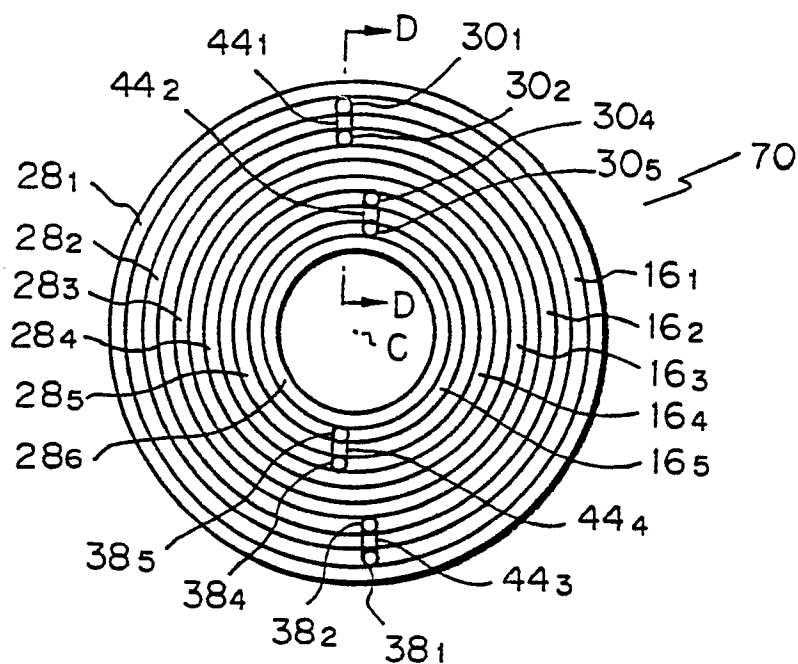


Fig. 5(B)

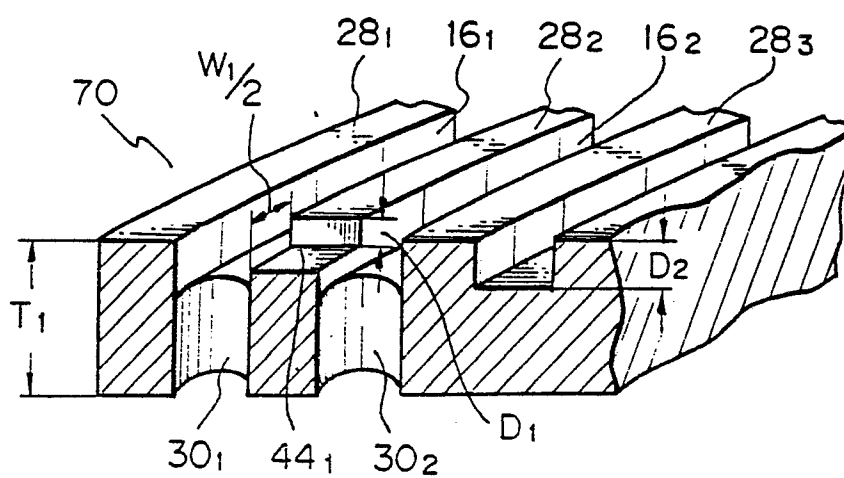


Fig. 6

