

12

EUROPEAN PATENT SPECIFICATION

45 Date of publication of patent specification: **02.05.85**

51 Int. Cl.⁴: **H 01 F 41/02**

21 Application number: **81108300.5**

22 Date of filing: **14.10.81**

54 **Process for manufacturing magnetic pole assembly.**

30 Priority: **17.10.80 JP 144455/80**

43 Date of publication of application:
28.04.82 Bulletin 82/17

45 Publication of the grant of the patent:
02.05.85 Bulletin 85/18

84 Designated Contracting States:
DE FR IT NL

56 References cited:
GB-A- 523 747
GB-A- 894 518
GB-A-1 571 057

73 Proprietor: **Kanetsu Kogyo Kabushiki Kaisha**
1111 Oaza Uedahara, Ueda-shi
Nagano-ken (JP)

72 Inventor: **Uchikune, Mamoru**
8-25, Chuo 1-chome
Ueda-shi Nagano-ken (JP)

74 Representative: **Grams, Klaus Dieter, Dipl.-Ing.**
et al
Patentanwaltsbüro Tiedtke-Bühling-Kinne-
Grupe-Pellmann-Grams-Struif Bavariaring 4
D-8000 München 2 (DE)

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

This invention relates to a process for manufacturing a magnetic pole assembly having non-magnetic members and a pair of magnetic pole members coupled together with the non-magnetic members interposed therebetween, and more particularly to a process for manufacturing a magnetic pole assembly suited for a magnetic circuit block for a switchable permanent magnet device.

According to GB—A—1 571 057 a process for producing a magnetic pole assembly as defined in the preamble of claim 1 is known.

In this known process the non-magnetic members are formed in a desired shape beforehand; then a pair of magnetic pole members are disposed with non-magnetic members of a desired configuration interposed therebetween, and the pair of magnetic pole members and the non-magnetic members are integrally coupled to each other by introducing the non-magnetic members into the openings of the pole members.

The prior art process requires the steps of forming a non-magnetic member in a desired configuration, and coupling a pair of magnetic pole members to each other, with the non-magnetic members of a desired configuration interposed therebetween. The prior art process has suffered from misalignment of one member from the other particularly in the coupling step, thus requiring a cutting or grinding step for making the surfaces of these components in alignment.

It is accordingly, an object of the present invention to provide a process for manufacturing a magnetic pole assembly, which is reduced in number of manufacturing steps, for the simplicity sake.

According to the invention there is provided a process for manufacturing a magnetic pole assembly, said magnetic pole assembly having non-magnetic members, a pair of magnetic pole members coupled together, with said non-magnetic members interposed between and holding them together in position, the magnetic pole members each including openings each having one end opening into the surface opposing the other magnetic member, characterized by the step of moulding said non-magnetic members by using as part of mould said pair of magnetic pole members disposed in opposed relation to and at a given spacing from each other, thereby coupling said pair of magnetic pole members to each other through the medium of said non-magnetic members.

The further features of the present invention will be apparent from the ensuing part of the specification taken in conjunction with the accompanying drawings which indicate an example of a magnetic pole assembly obtained according to the process of the present invention.

Fig. 1 is an exploded perspective view of a magnet base including a magnetic circuit block, according to the present invention;

Fig. 2 is a longitudinal cross sectional view

taken along the line II—II of Fig. 1; and

Figs. 3(a), 3(b), 4 and 5 are fragmentary longitudinal cross sectional views of magnetic pole members for illustration of holes of different types provided in the magnetic pole members, respectively.

In Fig. 1, there is shown in an exploded state a magnet base 12 including a magnetic pole assembly 10 which has been made by the process of the present invention.

The magnet base, namely switchable permanent magnet device 12, comprises a magnetic pole assembly 10, a columnar permanent magnet 14 rotatably received in a bore 12' in the magnetic pole assembly and magnetized in a diametrical direction, a knob 16 for rotating the permanent magnet, and an end plate 17 for holding the knob thereon rotatably. By turning the knob 16, the bottom surfaces 10a of the magnetic pole assembly 10 becomes magnetized or demagnetized as is well known. The magnet base 12, in general, is used for supporting various instruments, such as measuring instruments, through the medium of a support pole or leg which is attached to the top surface of the magnetic pole assembly 10, which in turn is attached at the lower surfaces 10a thereof to a magnetic plate by magnetic attraction.

The magnetic pole assembly 10, which is a magnetic circuit block for receiving the permanent magnet 14 rotatably, includes a pair of opposing magnetic pole members 18 made of a magnetic material, such as soft iron, and non-magnetic members 20 interposed therebetween. The pair of magnetic pole members 18 are respectively formed in a given configuration, for example, by a cold drawing process. Provided in the opposing surfaces 18a of the pair of magnetic pole members 18 are recesses 22 having a semi-circular cross section, so that these recesses cooperate to define the central bore 12' for receiving therein the permanent magnet 14, as best seen in Fig. 2.

The recesses 22 are open from the opposite ends of the magnetic pole members 18, respectively. Plural pairs of threaded holes 24 are provided in the opposing magnetic pole members 18 in the upper and lower portions thereof i.e. on the both sides of each recess 22. One threaded hole 24 runs parallel to another threaded hole in each magnetic pole member, with one end open to the surface 18a, and with the other inner end closed. It is possible that each threaded hole 24 be open at the opposite ends thereof. However, in the latter case, after a non-magnetic material has been cast into each threaded hole, which will be described later, a finishing step for closing the other end of each threaded hole is required, so as to provide a neat appearance for the magnetic pole assembly 10.

From the viewpoint of reduction of the number of manufacturing steps, it is desirable that the other (inner) end of each threaded hole is a blind end.

The non-magnetic members 20 between the

opposing magnetic pole members 18 are formed by a molding process by using these magnetic pole members 18 as part of the mold. More in detail, the magnetic pole members 18 are incorporated in a molding device (not shown) in a manner that the recess 22 of one magnetic pole member 18 opposes the recess 22 of the other member at a given spacing therefrom. In order to ensure the bore 12', a columnar core (not shown), having an outer diameter slightly larger than the outer diameter of the permanent magnet 14, is placed in the central bore defined by the recesses 22 of the opposing magnetic pole members 18 incorporated in the molding device. After the core has been set in place, non-magnetic molten metal, such as aluminum or zinc, or non-magnetic molten resin, such as ABS synthetic resin, is filled into the gaps defined by the core and the opposing magnetic members 18, and the non-magnetic material thus charged is then cooled, whereby non-magnetic members 20 are formed in a predetermined configuration.

As the non-magnetic members 20 are molded by using the magnetic pole members 18 as part of the mold, as described, a lid 26 closing one end of the bore 12' and molten materials 28 are simultaneously cast into the threaded holes 24 (hereinafter referred to as cast portions) and are integrally formed with the respective non-magnetic members 20 in the manner shown in Fig. 1. The cast portions 28 are firmly retained in corresponding threaded hole 24 due to shrinkage stress resulting from the cooling of these portions. As a result, simultaneous with formation of the non-magnetic members 10 for magnetically insulating one magnetic pole member from another, the opposing magnetic pole members 18 are integrally coupled together through the medium of the cast portions 28 of respective non-magnetic members 20.

In order to form the non-magnetic members 20, it is preferable to employ so-called die casting. In case of forming the non-magnetic members 20, it is recommended to provide in the non-magnetic members tapped threaded holes 32 for receiving therein screws 30 for fixing the end plate 17 to the magnetic pole assembly 10 and a female threaded hole 34 for receiving the aforesaid support pole or leg. In this connection, a strong tightening force acts on the female threaded hole 34 when the support pole or leg is threadedly fitted therein, and the strong tightening force is developed into a strong expansion force which would act on the peripheral portion of the threaded hole 34, of the non-magnetic member 20. The pair of cast portions 28 located on the opposite sides of the threaded hole 34 in the coupling portion between the opposing magnetic pole members 18 contribute to preventing the upper non-magnetic member 20 being deformed due to the strong expansion force.

Although, in the embodiment shown, the lid 26 is formed integrally with the upper and lower non-magnetic members 20, the lid may be formed separately from the non-magnetic members 20.

However, from the viewpoint of simplicity in manufacturing steps, it is recommended to form the lid 26 integrally with the non-magnetic members 20, as described above.

The threaded holes 24 provided in respective magnetic pole member 18 may be holes 36 having no threads, as shown in Fig. 3(a). Also, in the case of the non-threaded holes, the opposing magnetic pole members 18 and the non-magnetic members 20 are firmly coupled together by the cast portions 28 due to shrinkage stress resulting from the cooling of these portions, likewise in the threaded holes.

If a punch 38 as shown in Fig. 3(a) is forced onto the hole 36 from the open end thereof, then a diametrically reduced portion 36a is provided at the circumferential edge of the open end thereof, in the manner shown in Fig. 3(b). The diametrically reduced portions 36a of respective holes 36 ensure a stronger coupling between the magnetic pole members 18 and the non-magnetic members 20. Instead of the diametrically reduced portions 36a, a pair of holes 36 in each magnetic pole member 18 may run, with their axes running non-parallel, as shown in Fig. 4, or otherwise. The adjacent holes 36 may cross each other at the inner ends thereof, as shown in Fig. 5, with the result that a strong coupling between the opposing magnetic pole members and the magnetic members is ensured.

In the magnetic circuit block according to the present invention, simultaneously with formation of the non-magnetic members 20, the opposing magnetic pole members 18 are integrally coupled together through the medium of the non-magnetic members 20. The number of manufacturing steps is thus reduced.

According to the process for manufacturing the magnet block of the present invention, the bore 12' for receiving the permanent magnet 14 is provided with high accuracy by formation of the non-magnetic members 20, so that the non-magnetic members 20 have no likelihood of protruding into the bore 12'. Thus, a cutting or grinding step for the inner peripheral wall of the bore is no longer needed.

Since the lid 26 for closing one end of the bore 12' is formed integrally with the non-magnetic members 20, a step for closing the ends of the bore by another material is eliminated.

In the foregoing, we have set forth an example in which the process of the present invention is applied to the manufacture of a magnetic pole assembly used as a magnetic circuit block serving as a magnet base. The process of the present invention is not limited to the manufacture of the magnet assembly, but applicable for manufacturing various magnetic pole assemblies having no bore.

In summing up, the non-magnetic member means is formed between the pair of opposing magnetic pole members having holes in the opposing surfaces thereof, by using the magnetic pole members as part of the mold, whereby the non-magnetic member means is formed, and at

the same time, the pair of opposing magnetic pole members and the non-magnetic member means are firmly coupled to each other with high accuracy through the medium of the cast portions in the aforesaid holes, whereby simplicity of the manufacturing process is attained and an inexpensive and highly accurate magnet assembly is obtained.

Claims

1. A process for manufacturing a magnetic pole assembly, said magnetic pole assembly having non-magnetic members (20), a pair of magnetic pole members (18) coupled together, with said non-magnetic members (20) interposed between and holding them together in position, the magnetic pole members (18) each including openings (24, 36) each having one end opening into the surface (18a) opposing the other magnetic member, characterized by the step of moulding said non-magnetic members (20) by using as part of mould said pair of magnetic pole members (18) disposed in opposed relation to and at a given spacing from each other, thereby coupling said pair of magnetic pole members (18) to each other through the medium of said non-magnetic members (20).

2. A process as defined in claim 1, wherein each of said openings (24, 36) having one end opening into the surface (18a) opposing the other magnetic member (18) is blind at the other end thereof.

3. A process as defined in claim 1 or 2, wherein each of said openings is a threaded hole (24).

4. A process as defined in claim 1 or 2, wherein each of said openings (36) has a diametrically reduced portion.

5. A process as defined in one of the claims 1 to 4, wherein at least two openings (36) are provided in each magnetic pole member (18), with the axes thereof being non-parallel.

6. A process as defined in one of claims 1 to 5, wherein at least a pair of openings (36) is provided in each magnetic pole member (18), said openings (36) in each magnetic pole member (18) crossing each other.

7. A process as defined in one of the claims 1 to 6, wherein said magnetic pole assembly (10) is a magnetic circuit block for a switchable permanent magnetic device; the pair of magnetic pole members (18) having in the opposed surfaces (18a) thereof recesses (22) of semicircular cross section, respectively, said recesses (22) cooperating to define a bore (12') for rotatably receiving therein a columnar permanent magnet (14) magnetized in the diametrical direction thereof; said openings (24, 36) being provided on both sides of each of said recesses (22); and said process further comprises forming the non-magnetic members (20) by placing a core in said bore (12').

8. A process as defined in claim 7, wherein said recesses (22) are respectively open at the opposite ends of said respective magnetic pole mem-

bers (18), and said process further comprises forming a lid (26) for closing one end of said bore (12') integrally with said non-magnetic members (20) when the latter are moulded.

9. A process as defined in claim 7 or 8, wherein said non-magnetic members (20) consist essentially of non-magnetic metal.

10. A process as defined in claim 7 or 8, wherein said non-magnetic members (20) consist essentially of non-magnetic synthetic resin.

Patentansprüche

1. Verfahren zur Herstellung einer Magnetpolanordnung mit unmagnetischen Elementen (20), einem Paar miteinander verbundener Magnetpolelemente (18), wobei die unmagnetischen Elemente (20) zwischen den Magnetpolelementen (18) angeordnet sind und diese in einer gegenseitigen räumlichen Zuordnung halten, wobei jedes Magnetpolelement (18) Öffnungen (24, 36) aufweist, die alle eine Öffnungsendfläche auf der Oberfläche (18a) haben, die dem anderen magnetischen Element gegenüberliegt, gekennzeichnet durch den Formungsvorgang der unmagnetischen Elemente (20) unter Benutzung des Paares Magnetpolelemente (18), die einander gegenüber in einem vorbestimmten Abstand voneinander angeordnet sind, als Teil der Form, wodurch das Paar Magnetpolelemente (18) mittels des Mediums der unmagnetischen Elemente (20) miteinander verbunden wird.

2. Verfahren nach Anspruch 1, bei dem jede Öffnung (24, 36) mit einer Öffnungsendfläche an der Oberfläche (18a), die dem anderen magnetischen Element (18) gegenüberliegt, an ihrem anderen Ende blind ist.

3. Verfahren nach Anspruch 1 oder 2, bei dem jede Öffnung ein mit Gewindegängen versehenes Loch (24) ist.

4. Verfahren nach Anspruch 1 oder 2, bei dem jede Öffnung (36) einen Abschnitt mit verkleinerter Kreisquerschnittsfläche aufweist.

5. Verfahren nach einem der Ansprüche 1 bis 4, bei dem zumindest 2 Öffnungen (36) in jedem Magnetpolelement (18) angeordnet sind, wobei die Achsen dieser Öffnungen nicht parallel sind.

6. Verfahren nach einem der Ansprüche 1 bis 5, bei dem zumindest ein Paar Öffnungen (36) in jedem Magnetpolelement (18) angeordnet ist, wobei die Öffnungen (36) in jedem Magnetpolelement (18) einander kreuzen.

7. Verfahren nach einem der Ansprüche 1 bis 6, bei dem die Magnetpolanordnung (10) ein Magnetkreisblock für eine schaltbaren Permanentmagneten ist, wobei das Paar Magnetpolelemente (18) auf seinen gegenüberliegenden Oberflächen (18a) Aussparungen (22) halbkreisförmigen Querschnitts aufweist, wobei diese Aussparungen (22) jeweils so zusammenwirken, daß sie eine Bohrung (12') zur drehbaren Aufnahme eines säulenförmigen Permanentmagneten (14) ausbilden, der in seiner Diametralausdehnung magnetisiert ist, wobei die Öffnungen (24, 36) auf beiden Seiten jeder Aussparung (22) angeordnet

sind und wobei das Verfahren weiterhin die Formung der unmagnetischen Elemente (20) durch Anordnung eines Kerns in der Bohrung (12') enthält.

8. Verfahren nach Anspruch 7, bei dem die Aussparungen (22) jeweils an den gegenüberliegenden Enden der jeweiligen Magnetpolelemente (18) offen sind und bei dem das Verfahren außerdem die Formung eines Deckels (26) zum Schließen eines Endes der Bohrung (12') aufweist, wobei der Deckel einstückig mit dem nichtmagnetischen Elementen (20) ausgebildet wird, wenn die nichtmagnetischen Elemente geformt werden.

9. Verfahren nach Anspruch 7 oder 8, bei dem die unmagnetischen Elemente (20) im wesentlichen aus unmagnetischem Metall bestehen.

10. Verfahren nach Anspruch 7 oder 8, bei dem die unmagnetischen Elemente (20) im wesentlichen aus unmagnetischem, synthetischem Kunststoff bestehen.

Revendications

1. Procédé de fabrication d'un assemblage à pôle magnétique, lequel comprend des organes non magnétiques (20) assemblés à deux pôles magnétiques (18) entre lesquels sont interposés lesdits organes non magnétiques (20) pour les maintenir ensemble en place, ces pôles (18) présentant des ouvertures (24, 36) dont une extrémité débouche sur la face (18a) en vis-à-vis de l'autre organe magnétique, caractérisé en ce qu'il consiste à mouler lesdits organes non magnétiques (20) en utilisant comme élément de moule les deux pôles magnétiques (18) disposés face à face et qui déterminent entre eux un espace, de manière à assembler l'un à l'autre les deux pôles magnétiques (18) au moyen des deux organes intermédiaires non magnétiques (20).

2. Procédé suivant la revendication 1, caractérisé en ce que chaque ouverture (24, 36) dont l'une des extrémités débouche sur la face opposée (18a) de chacun des pôles magnétiques (18) est borgne à son autre extrémité.

3. Procédé suivant l'une quelconque des reven-

dications 1 ou 2, caractérisé en ce que chaque ouverture (24) est taraudée.

4. Procédé suivant l'une quelconque des revendications 1 ou 2, caractérisé en ce que chaque ouverture (36) comporte une partie à diamètre réduit.

5. Procédé suivant l'une quelconque des revendications 1 à 4, caractérisé en ce que dans chaque pôle magnétique (18) il est prévu au moins deux ouvertures (36) à axes géométriques non parallèles.

6. Procédé suivant l'une quelconque des revendications 1 à 5, caractérisé en ce que dans chaque pôle magnétique (18) il est prévu au moins deux ouvertures sécantes (36).

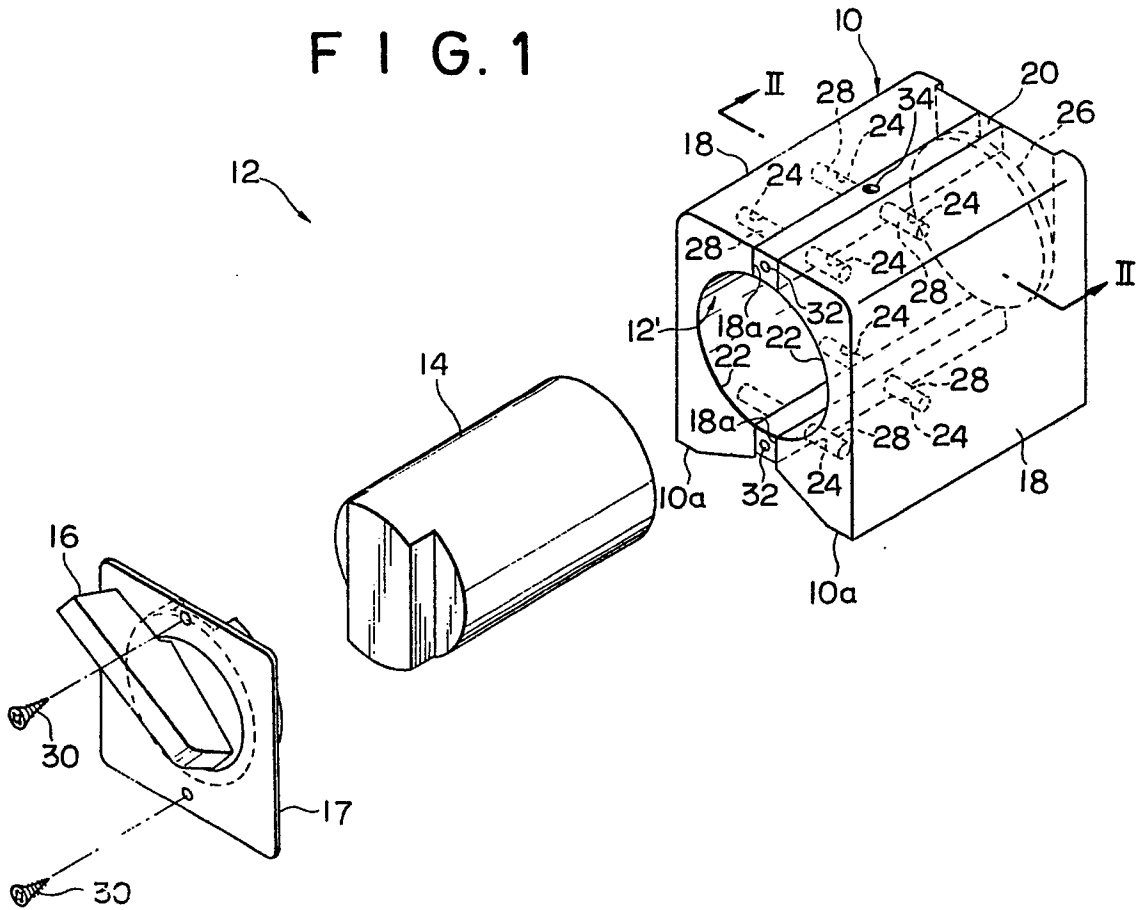
7. Procédé suivant l'une quelconque des revendications 1 à 6, caractérisé en ce que ledit assemblage magnétique (10) se présente sous la forme d'un bloc magnétique destiné à recevoir un dispositif d'aimant permanent à commande de fonctionnement, les deux pôles magnétiques (18) présentant sur leurs faces en vis-à-vis (18a) des dépressions (22) à section droite semi-circulaire respectivement, lesdites dépressions (22) coopérant pour constituer une perforation (12') propre à recevoir à rotation un aimant permanent cylindrique (14) magnétisé suivant son diamètre, lesdites ouvertures (24, 36) étant ménagées, sur les deux rebords, desdites dépressions (22), le procédé consistant en outre à réaliser les organes non magnétiques (20) après avoir disposé un noyau dans ladite perforation (12').

8. Procédé suivant la revendication 7, caractérisé en ce que les dépressions (22) sont respectivement ouvertes sur les deux extrémités opposées des pôles magnétiques (18), tandis que ledit procédé consiste encore à former une cloison (26) destinée à fermer une extrémité de ladite perforation (12'), cette cloison étant réalisée d'une pièce avec les organes non magnétiques (20) lorsque ceux-ci sont moulés.

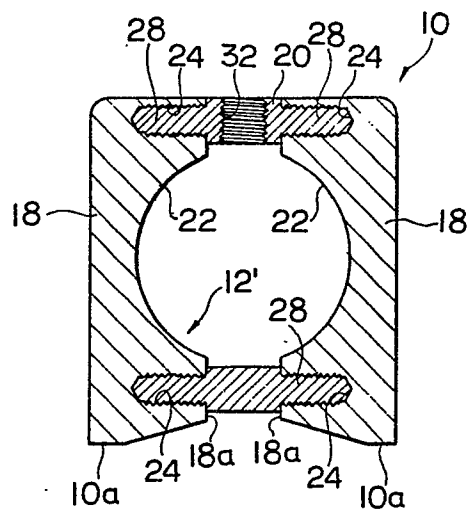
9. Procédé suivant l'une quelconque des revendications 7 ou 8, caractérisé en ce que les organes non magnétiques (20) sont réalisées au moyen d'un métal non magnétique.

10. Procédé suivant l'une quelconque des revendications 7 ou 8, caractérisé en ce que les organes non magnétiques (20) sont réalisés au moyen d'une résine synthétique non magnétique.

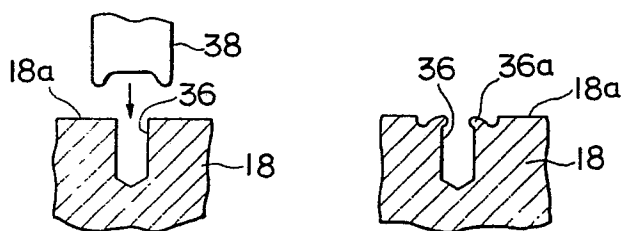
FIG. 1



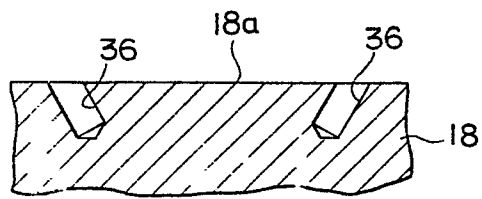
F I G. 2



F I G. 3 (a) F I G. 3 (b)



F I G. 4



F I G. 5

