

(19)



(11)

EP 2 249 040 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
07.01.2015 Bulletin 2015/02

(51) Int Cl.:
F04C 18/344 ^(2006.01)

(21) Application number: **10160464.3**

(22) Date of filing: **20.04.2010**

(54) Improved monovane vacuum pump

Verbesserte Einschaufelvakuumpumpe

Pompe à vide à aube unique améliorée

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL
PT RO SE SI SK SM TR**

(30) Priority: **01.05.2009 GB 0907606**

(43) Date of publication of application:
10.11.2010 Bulletin 2010/45

(73) Proprietors:
• **Wabco Automotive UK Limited**
Leeds LS27 0HQ (GB)
• **WABCO Europe BVBA**
1160 Brussels (BE)

(72) Inventors:
• **Heaps, David**
Leeds, LS27 0HQ (GB)
• **Wellings, Paul**
Leeds, LS27 0HQ (GB)
• **Stabenow, Uwe**
30880 Laatzen (DE)

(74) Representative: **Gray, James et al**
Withers & Rogers LLP
4 More London Riverside
London SE1 2AU (GB)

(56) References cited:
EP-A1- 1 666 707 WO-A1-2006/056162
AT-A1- 505 061 DE-B3-102006 016 242

EP 2 249 040 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

[0001] The present invention relates to an improved single vane rotary vacuum pump which is particularly, though not exclusively, for use in automotive applications. The invention further relates to an improved vane for a single vane rotary vacuum pump.

[0002] It is known to use rotary vane vacuum pumps to displace fluids in a range of automotive applications, including that of providing braking assistance in vehicles. Usually, a static casing having an inlet and an outlet defines a chamber divided by a vane slidably supported by a rotor. As the rotor turns, the vane turns with it and moves through the rotor in order to maintain a close fit with the casing wall at each of its ends, any gap between the vane and the wall being sealed with oil. As the vane turns, a vacuum is created, causing air to enter the chamber through the inlet. This air is then discharged through the outlet as the vane turns.

[0003] The single vane components of such vacuum pumps are typically manufactured from two different materials, with one material being used for the body of the vane and a second material being used for the tips. Both materials may be plastic. However, this arrangement means that the vane requires assembly during manufacture and this can add to the production cost. The rotors for such pumps are usually manufactured from sintered steel.

[0004] WO2006/056162 discloses a pump having a single-piece vane mounted eccentrically for rotation within a vacuum pump housing.

[0005] What is required is a vacuum pump with a single, slidable vane, where the vane and rotor are simple, robust and easy and inexpensive to manufacture.

[0006] According to the present invention there is provided a vacuum pump comprising a casing defining a chamber, a rotor rotatably mounted within the chamber and a vane slidably mounted in a slot in the rotor, the vane having a planar centre portion and curved ends terminating in respective tips, wherein the curved ends are turned towards one another and each curved end has a contact portion which contacts the wall of the chamber, wherein the contact portion at each end is intermediate the centre portion and the respective tip of the vane.

[0007] The vane is preferably formed from a single piece of material.

[0008] The rotor slot may be offset from the centre of the rotor, and the rotor may comprise cut-outs configured to fully receive respective curved ends of the vane, advantageously preventing the curved ends of the vane from projecting from the rotor and becoming wedged against the chamber wall. The centre point of the radius of curvature of each curved end may be aligned with the axis of rotation of the rotor. The radius of curvature of each curved end of the vane may be constant. The vane may be manufactured from steel.

[0009] There is also provided a vane for a vacuum pump formed from a single piece of material, comprising

a planar centre portion and curved ends terminating in respective tips, wherein the curved ends are turned towards one another and each curved end has a contact portion which in use contacts the chamber wall of a vacuum pump, wherein the contact portion at each end is intermediate the centre portion and the respective tip of the vane. The curved ends of the vane may have a constant radius of curvature. The vane may be manufactured from steel.

[0010] A preferred embodiment of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of a rotary vane vacuum pump according to an embodiment of the present invention with the casing removed for additional clarity;

Figure 2 shows a plan view of the rotary vane vacuum pump of figure 1; and

Figure 3 shows an exploded view of the rotary vane vacuum pump of figure 1.

[0011] With reference to the figures, the vacuum pump, generally designated 10, which pump 10 includes a casing 12, a rotor 26 and a vane 40. The casing 12 defines a chamber 14 with a flat base 16 having a limaçon-like shape which is surrounded by a perpendicular wall 18. The chamber 14 has an inlet 20 and an outlet 22 (shown in figure 2), both of which may be located on the wall 18, and a rotor aperture 24 (see figure 3) in an off-centre position in the base 16. The casing 12 further comprises a chamber cover (not shown) which serves to fully encapsulate the chamber 14.

[0012] The rotor 26 is substantially cylindrical and includes a central bore 28, two cut-outs 30 and a slot 32. The rotor 26 consists of a first portion 34 and a second portion 36 having a similar diameter than the first portion (see figure 3) whereby the rotor 26 is mounted on the casing 12 in the rotor aperture 24. The rotor aperture 24 allows the rotor 26 to project through the casing 12 and connect with a drive (not shown). The cut-outs 30 are substantially rectangular in cross section and are positioned at opposing points on the circumference of the rotor 26, extending throughout the length of the first portion 34. A line A-A (see figure 2) which passes through the centre point of the rotor 26 continues through the centre of each cut-out 30. The slot 32 is parallel to the line A-A and extends throughout the first portion 34.

[0013] The vane 40 comprises a rectangular planar body 42 with curved ends 44, the ends 44 turning towards one another through approximately 140° as illustrated, so that when viewed from the side the vane may be considered to be U- or C-shaped. The curved ends terminate at respective tips 48 of the vane 40. However, this angle is not intended to be limiting as different curves may be utilised. The vane 40 is slidably mounted in the slot 32, perpendicular to the base 16 and with the ends 44 positioned so that they curve towards the centre of the rotor

26. The centre points of the radius of curvature of the ends 44 are aligned with the axis of rotation of the rotor 26, as indicated by line A-A. The vane 40 is of sufficient length that the outermost point of each end 44 has a line of contact with the wall 18 at all rotational positions, except at the position shown in figure 2 where one end of the vane 40 is fully received into a cut-out 30.

[0014] In use, the vane 40 is turned by the rotor 26 in the direction X in relation to the casing 12. The off-centre positioning of the rotor 26 causes the vane 40 to slide through the slot 32 as it is turned. The ends 44 of the vane 40 constantly remain in contact with the wall 18 of the chamber 14, creating two compartments 46 of changing size which may include the inlet, the outlet or both or neither of those. As shown in figure 2, each end 44 of the vane 40 recedes into its respective cut-out 30 on the rotor 26 when necessary, that is when at the section of wall 18 closest to the rotor 26.

[0015] At one point in the cycle, the rotational position of the vane 40 creates a compartment 46 which includes the inlet and does not include the outlet. As the vane 40 continues to turn, the size of this compartment 46 is increased, creating a vacuum and causing air to be drawn into it via the inlet. This air is discharged through the outlet 22 once the vane 40, continuing to turn, isolates the compartment 46 from the inlet and connects the component 46 to the outlet.

[0016] The vane 40 is manufactured from metal, for example steel and may be of unitary construction formed by bending or extrusion. In an alternative, less preferred, embodiment the vane 40 may be fabricated from two or more sections of the same material. The rotor 26 is made of steel and may be laser cut.

[0017] The vacuum pump 10 of the present invention allows the vane 40 to be produced from a single piece of steel, making it easier and less expensive to produce than existing vanes. This also makes the vane 40 stronger, an advantage for cold start conditions and reverse rotation. The curved ends 44 of the vane 40 ensure a single line of contact between the vane 40 and the wall 18. Due to the changes in curvature of the wall 18 of the chamber 14, it will be understood that the aforementioned contact line moves around the curved end of the vane 40 during rotation thereof.

[0018] In alternative embodiments of the present invention, the vane 40 could be manufactured from a single piece of some other material, for example a composite. The casing 12 could contain multiple inlets or outlets. The cut-outs 30 may be of a range of different shapes. Alternative mounting means for the rotor 26 may be provided.

Claims

1. A vacuum pump (10) comprising a casing (12) defining a chamber (14), a rotor (26) rotatably mounted within the chamber (14) and a vane (40) slidably

mounted in a slot (32) in the rotor (26), the vane (40) having a planar centre portion (42) and curved ends (44) terminating at respective tips (48), wherein the curved ends (44) are turned towards one another and each curved end (44) has a contact portion which contacts the wall (18) of the chamber (14), wherein the contact portion at each curved end (44) is intermediate the centre portion (42) and the respective tip (48) of the vane.

2. A vacuum pump (10) as claimed in claim 1 wherein the vane (40) is formed from a single piece of material.

3. A vacuum pump (10) according to claim 1 or claim 2 wherein the slot (32) is offset from the centre of the rotor (26).

4. A vacuum pump (10) according to claim 3 wherein the rotor (26) comprises opposed cut-outs (30) configured to receive respective curved ends (44) of the vane (40).

5. A vacuum pump (10) according to claim 4 wherein the cut-outs (30) are configured to fully receive respective curved ends (44) of the vane (40).

6. A vacuum pump (10) according to any of claims 3 to 5 wherein the centre point of the radius of curvature of each curved end (44) is aligned with the axis of rotation of the rotor (26).

7. A vacuum pump (10) according to any preceding claim wherein the curved ends (44) have a constant radius of curvature.

8. A vacuum pump (10) according to any preceding claim wherein the vane (40) is manufactured from steel.

9. A vane (40) for a vacuum pump (10) formed from a single piece of material, comprising a planar centre portion (42) and curved ends (44) terminating in respective tips (48), wherein the curved ends (44) are turned towards one another and each curved end (44) has a contact portion which in use contacts the chamber wall (18) of a vacuum pump (10), wherein the contact portion at each end is intermediate the centre portion (42) and the respective tip (48) of the vane (40).

10. A vane (40) according to claim 9 wherein the curved ends (44) have a constant radius of curvature.

11. A vane (40) according to claim 9 or claim 10 wherein the material is steel.

Patentansprüche

1. Vakuumpumpe (10), umfassend ein Gehäuse (12), das eine Kammer (14) definiert, einen Rotor (26), der drehbar in der Kammer (14) montiert ist, und eine Schaufel (40), die gleitend in einem Schlitz (32) im Rotor (26) montiert ist, wobei die Schaufel (40) einen planaren mittleren Abschnitt (42) und gekrümmte Enden (44) hat, die an jeweiligen Spitzen (48) enden, wobei die gekrümmten Enden (44) zueinander gedreht sind und jedes gekrümmte Ende (44) einen Kontaktabschnitt hat, der die Wand (18) der Kammer (14) kontaktiert, wobei der Kontaktabschnitt an jedem gekrümmten Ende (44) zwischen dem mittleren Abschnitt (42) und der jeweiligen Spitze (48) der Schaufel liegt. 5
2. Vakuumpumpe (10) nach Anspruch 1, wobei die Schaufel (40) aus einem einzigen Materialstück gebildet ist. 10
3. Vakuumpumpe (10) nach Anspruch 1 oder 2, wobei der Schlitz (32) von der Mitte des Rotors (26) versetzt ist. 15
4. Vakuumpumpe (10) nach Anspruch 3, wobei der Rotor (26) gegenüberliegende Ausschnitte (30) umfasst, die zur Aufnahme jeweiliger gekrümmter Enden (44) der Schaufel (40) konfiguriert sind. 20
5. Vakuumpumpe (10) nach Anspruch 4, wobei die Ausschnitte (30) zur vollständigen Aufnahme jeweiliger gekrümmter Enden (44) der Schaufel (40) konfiguriert sind. 25
6. Vakuumpumpe (10) nach einem der Ansprüche 3 bis 5, wobei der Mittelpunkt des Krümmungsradius jedes gekrümmten Endes (44) auf die Rotationsachse des Rotors (26) ausgerichtet ist. 30
7. Vakuumpumpe (10) nach einem der vorhergehenden Ansprüche, wobei die gekrümmten Enden (44) einen konstanten Krümmungsradius haben. 35
8. Vakuumpumpe (10) nach einem der vorhergehenden Ansprüche, wobei die Schaufel (40) aus Stahl hergestellt ist. 40
9. Schaufel (40) für eine Vakuumpumpe (10), wobei die Schaufel (40) aus einem einzigen Materialstück gebildet ist, umfassend einen planaren mittleren Abschnitt (42) und gekrümmte Enden (44), die in jeweiligen Spitzen (48) enden, wobei die gekrümmten Enden (44) zueinander gedreht sind und jedes gekrümmte Ende (44) einen Kontaktabschnitt hat, der im Gebrauch die Kammerwand (18) einer Vakuumpumpe (10) kontaktiert, wobei der Kontaktabschnitt an jedem Ende zwischen dem mittleren Abschnitt 45

(42) und der jeweiligen Spitze (48) der Schaufel (40) liegt.

10. Schaufel (40) nach Anspruch 9, wobei die gekrümmten Enden (44) einen konstanten Krümmungsradius haben.
11. Schaufel (40) nach Anspruch 9 oder 10, wobei das Material Stahl ist.

Revendications

1. Pompe à vide (10) comprenant un carter (12) définissant une chambre (14), un rotor (26) monté à rotation à l'intérieur de la chambre (14) et une aube (40) montée de manière coulissante dans une fente (32) dans le rotor (26), l'aube (40) ayant une portion centrale plane (42) et des extrémités incurvées (44) se terminant au niveau de pointes respectives (48), les extrémités incurvées (44) étant tournées l'une vers l'autre et chaque extrémité incurvée (44) présentant une portion de contact qui vient en contact avec la paroi (18) de la chambre (14), la portion de contact au niveau de chaque extrémité incurvée (44) étant disposée entre la portion centrale (42) et la pointe respective (48) de l'aube.
2. Pompe à vide (10) selon la revendication 1, dans laquelle l'aube (40) est formée en un seul morceau de matériau.
3. Pompe à vide (10) selon la revendication 1 ou 2, dans laquelle la fente (30) est décalée par rapport au centre du rotor (26).
4. Pompe à vide (10) selon la revendication 3, dans laquelle le rotor (26) comprend des découpes opposées (30) configurées pour recevoir des extrémités incurvées respectives (44) de l'aube (40).
5. Pompe à vide (10) selon la revendication 4, dans laquelle les découpes (30) sont configurées pour recevoir complètement des extrémités incurvées respectives (44) de l'aube (40).
6. Pompe à vide (10) selon l'une quelconque des revendications 3 à 5, dans laquelle le point central du rayon de courbure de chaque extrémité incurvée (44) est aligné avec l'axe de rotation du rotor (26).
7. Pompe à vide (10) selon l'une quelconque des revendications précédentes, dans laquelle les extrémités incurvées (44) ont un rayon de courbure constant.
8. Pompe à vide (10) selon l'une quelconque des revendications précédentes, dans laquelle l'aube (40)

est fabriquée en acier.

9. Aube (40) pour une pompe à vide (10) formé d'un seul morceau de matériau, comprenant une portion centrale plane (42) et des extrémités incurvées (44) se terminant par des pointes respectives (48), les extrémités incurvées (44) étant tournées l'une vers l'autre et chaque extrémité incurvée (44) ayant une portion de contact qui, pendant l'utilisation, vient en contact avec la paroi (18) de la chambre d'une pompe à vide (10), la portion de contact au niveau de chaque extrémité étant située entre la portion centrale (42) et la pointe respective (48) de l'aube (40). 5 10
10. Aube (40) selon la revendication 9, dans laquelle les extrémités incurvées (44) ont un rayon de courbure constant. 15
11. Aube (40) selon la revendication 9 ou 10, dans laquelle le matériau est de l'acier. 20

25

30

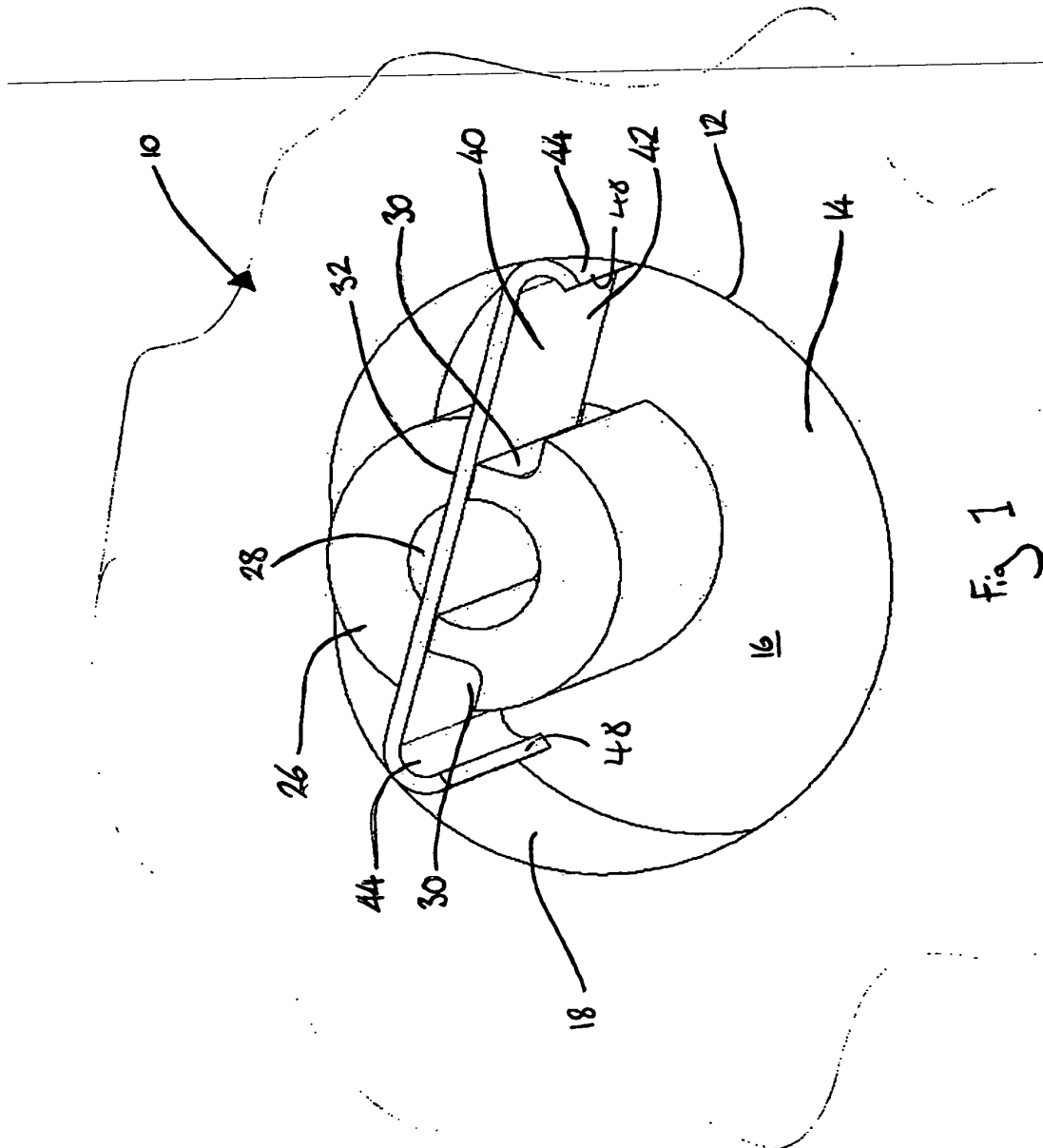
35

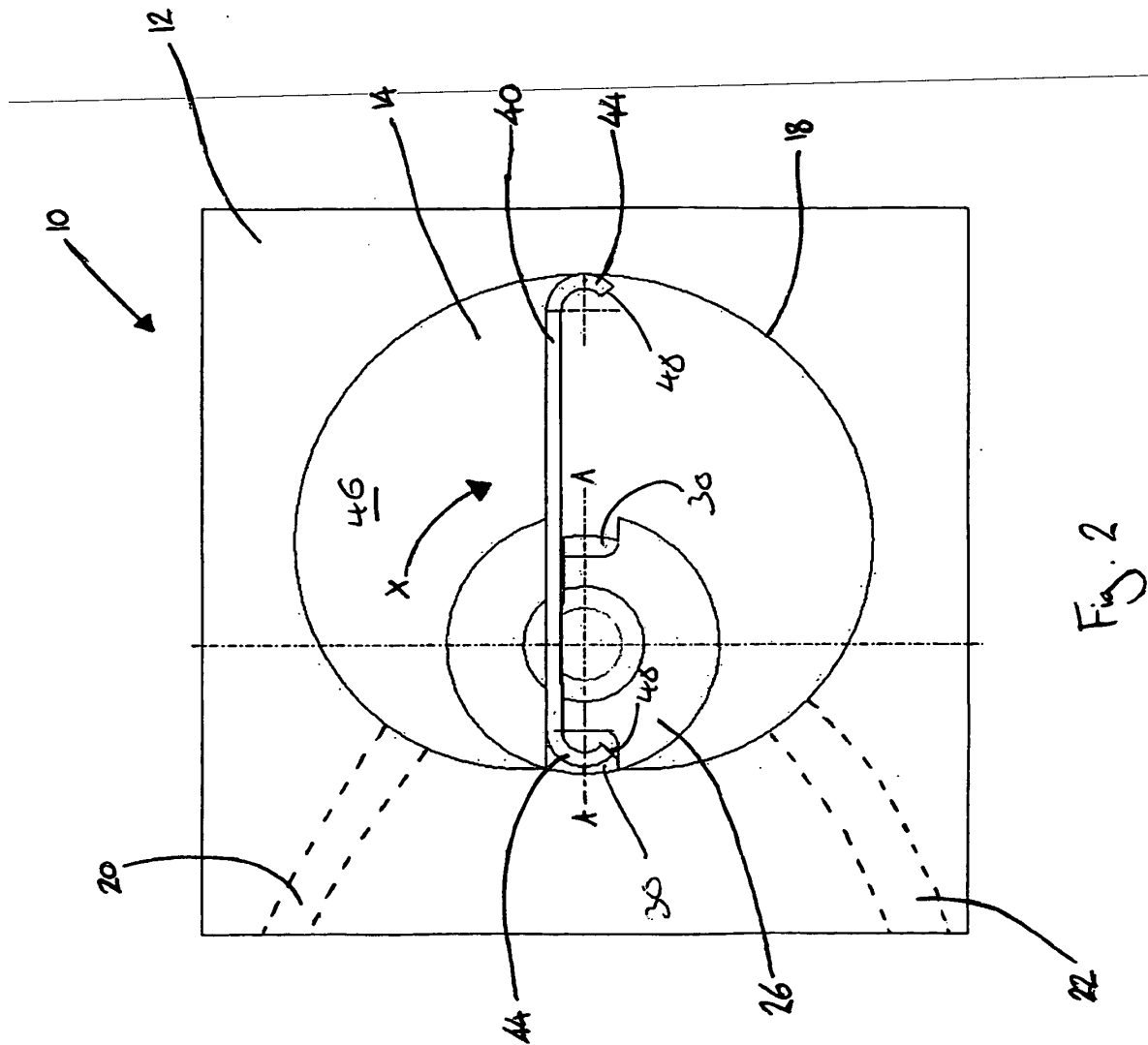
40

45

50

55





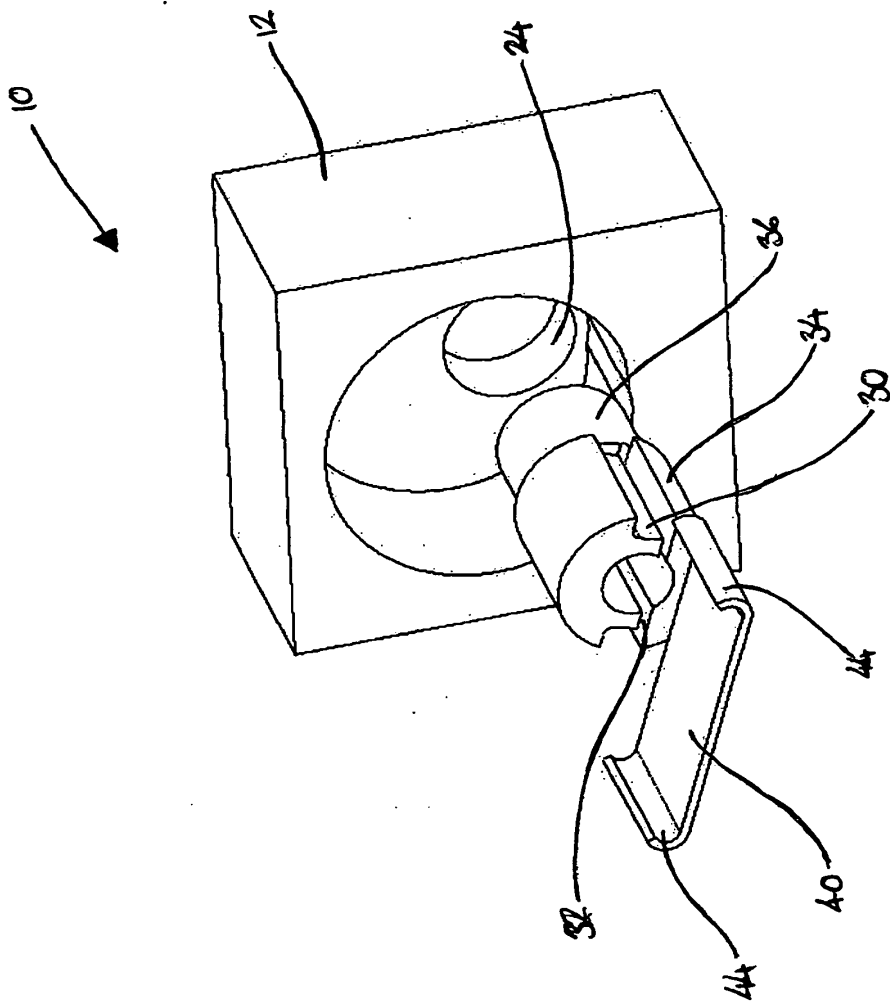


Fig. 3

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2006056162 A [0004]