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(54) **DEVICE FOR A ROTATING GLAND SEAL**

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(56) References cited:
DE-A1- 1 952 320
DE-A1- 19 532 549
DE-B- 1 160 310
DE-U- 1 788 231
GB-A- 902 452
US-B1- 6 328 312

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Description

TECHNICAL FIELD

[0001] The present invention relates to protective devices between the exterior and the interior of pumps, and in particular pumps that are to be used in explosive environments.

BACKGROUND OF THE INVENTION

[0002] For some applications there are requirements that the enclosure for electrical apparatuses is able to withstand an internal explosion of flammable gas or vapour that may enter it, without suffering damage and without communicating the internal flammation or sparks to the explosive atmosphere through any joints or structural openings. This is obtained by providing flame paths of sufficient strength and integrity to withstand internal explosions without communicating the internal flammation to the external flammable gas or vapour through these joints.

[0003] With pumps, one such structural joint is the passage of the drive shaft through the housing. One example of providing flame paths is to arrange a gland surrounding the pump shaft, which is mounted in the wall separating the motor side from the impeller side. The gland is designed as a metal cylinder surrounding the shaft arranged to provide flame paths between the shaft and the gland. Such an arrangement is disclosed in GB 517,781. The gland has a rather tight fit around the shaft. At the same time there must be space enough to form a film but not so tight that there is a risk for metallic contact. There is especially a risk for metallic contact when there are loads on the impeller causing the pump shaft to bend, in particular when the shaft protrudes quite a distance from the journal point.

[0004] The fixed mounting of the gland in the wall means that when the shaft bends there is a risk that it will come in contact with edge parts of the gland. This problem is even more pronounced with pumps that are intended to be used in an environment where explosive gases are present where requirements stipulate that the gap between the gland and the shaft has to have a minimum width and minimum length in order to ensure that no sparks from the motor can enter through the gap.

BRIEF DESCRIPTION OF THE INVENTION

[0005] The aim of the present invention is to remedy the above mentioned problems regarding protection of electrical apparatuses and in particular pumps working in explosive environments.

[0006] This aim is solved by a device according to claim 1. Preferable embodiments of the invention form part of the dependent patent claims.

[0007] According to a main aspect of the invention it is characterised in a machine arranged to operate in explosive environments, comprising a rotatable shaft extending through a stationary part of said machine, a gland which is mounted in said stationary part and which is provided with a through hole in order to accommodate said rotatable shaft such that a flame path is provided between the rotatable shaft and the gland, characterized in that the machine comprises dampening means arranged between and separating the gland and the stationary part in the axial and radial directions such that a flame path is provided between the gland and the stationary part, the dampening means maintaining the existence of the flame path and permitting axial and radial movement of the gland in relation to the stationary part upon rotation of the rotatable shaft.

[0008] According to another aspect of the invention, it is characterised in that the dampening means comprises a number discrete resilient members arranged against at least one surface of the gland and at least one surface of the stationary part, which surfaces are facing in the axial direction of the shaft.

[0009] According to a preferred embodiment, it is characterised in that one set of resilient members are arranged between a first surface of the gland and a first surface of the stationary part, which first surfaces are facing towards each other, and that another set of resilient members are arranged between a second surface of the gland, facing in the opposite direction as the first surface of the gland and a second surface of the stationary part, facing in the opposite direction as the first surface of the stationary part, which second surfaces are facing towards each other.

[0010] According to a further aspect of the invention, it is characterised in that the discrete resilient members are inter-connected and spaced at even intervals along a circumference around the shaft. Preferably the discrete members are formed such that they provide point contacts with said surfaces or line contacts with said surfaces.

[0011] According to yet an aspect of the invention, it is characterised in that said gland is arranged with a flange-shaped part having circumferential recesses for receiving said resilient members.

[0012] The benefits of the present invention are several. Due to the resilient dampening members the gland surrounding the shaft, with a rather tight fit, is able to move during rotation of the shaft. In this way, during any bending of the shaft, the movement of the gland is taken up by the resilient members. In this way the gland "floats", thereby reducing the risk of damaging the gland during heavy operation conditions.

[0013] Because the resilient members preferably are arranged as discrete members, an improved resiliency is obtained compared to a homogenous ring, such as an O-ring. As the discrete members preferably are arranged to provide a point contact or a line contact in the circumferential direction, a "rolling" action or movement is obtained in the radial direction of the gland.

[0014] To obtain a very flexible movement, the resilient

members are arranged on both sides of a flange-shaped part of the gland.

[0015] These and other aspects of and advantages with the present invention will become apparent from the following detailed description and the accompanying drawings.

FURTHER ELUCIDATION OF PRIOR ART

[0016] DE 195 32 549 discloses a shaft 2, a housing 3 and a shaft support arranged therebetween. The shaft support comprises a first part 12 which is clamped to the shaft 2, a second part 10 which is stationary and bolted to the housing 3, and intermediate ball bearings 11. The second part 10 comprises a first element 25, 45, a second element 23, 43, and an intermediate elastic body 24, 44. The object of the elastic body 24, 44 is to admit radial and axial movement of the shaft 2 in relation to the housing 3.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] In the following detailed description of the invention, reference will be made to the accompanying drawings, of which

Fig. 1 is a view in cross-section of a pump part comprising the present invention,

Fig. 2 is a detailed view taken from the ring-marked area II of Fig. 1,

Fig. 3 is a top view of one embodiment of a dampening means according to the present invention,

Fig. 4 is a perspective view of the dampening means shown in Fig. 3, and

Fig. 5 shows variants of discrete resilient members of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Figure 1 shows a pump part 10, a dividing wall, between an interior 12 and an exterior 14 side of the pump to be used for example in explosive environments. It comprises a main pump shaft 16, shown with broken lines, running through a hole in the dividing wall. On the interior side an electrical motor (not shown) is connected to the shaft, or that the shaft constitutes the motor shaft. The shaft is journalled in bearings arranged in the housing.

[0019] At the entry passage of the shaft to the exterior side, a gland 20 is arranged, having a first cylindrical part 22 surrounding the shaft with a certain prescribed clearance between the shaft and the gland, thereby providing a flame path, and an outwardly flange-shaped part 24. The end surface of the flange-shaped part is adjacent a front surface 54, Fig. 2, of a mounting ring 26. The mounting ring is arranged with a flange 28 having a number of through-holes, into which bolts 30 are threaded into threaded holes in the dividing wall for attaching the mounting ring. The interior part of the mounting ring is arranged with a cylindrical part 32. The inner surface of the cylindrical part is arranged with a ledge 35 on which a spacer 34 is placed. The spacer is in turn held in position by a retainer ring 36 fitting into a groove 37 arranged adjacent the ledge. A movement limiting pin 38 is attached to a side surface of the flange-shaped part of the gland, which movement limiting pin 38 protrudes through a cut-out or the like in the spacer 34.

[0020] The flange-shaped part 24 of the gland is arranged with two circumferential grooves 40 at the edges of the flange-shaped part. In each of these grooves a dampening means 42 is arranged. One embodiment of the dampening means is shown in Figs. 3 and 4. It is made of a resilient material such as rubber and is formed as a ring 44 having a cross-sectional diameter that is lesser than the width/depth of the space formed by the grooves 40 of the flange-shaped part and the end surface 54 of the mounting ring 26 and the spacer 34 respectively. Along the ring a number of discrete dampening members 46 are attached at even intervals. In the embodiment shown in Figs. 3 and 4 the dampening members 46 are formed as spheres having a diameter that is somewhat larger than the width/depth of the above mentioned spaces. The width w, Fig. 2, of the flange-shaped part of the gland is such that when the gland is mounted, a gap 50 is created, functioning as a further flame path.

[0021] The function is that when the dampening means 42 are mounted in the circumferential grooves 40, the dampening members 46 are somewhat compressed by the flange-shaped part 24 of the gland and the spacer 34 held in place by the retainer ring 36. There is however the gap 50 between on the one hand the side surface of the flange-shaped part of the gland and the inner end surface 54 of the mounting ring and on the other hand a space 56 between the circumferential surface of the flange-shaped part of the gland and the mounting ring. The dampening members thereby permit a certain movement of the gland both in axial and radial direction. Thus any bending of the shaft during use results in a movement of the gland due to the dampening members. By this arrangement the gland is permitted to "float" somewhat during bending movement of the shaft, thereby minimizing the risk for metallic contact between the gland and the shaft and at the same time maintaining the prescribed gap or flame path between the two parts as well as the gap or flame path 50 between the gland and the mounting ring.

[0022] Figure 5 shows that the dampening members may have other shapes than spheres, such as for example tubular or cylindrical, 48, polygons, 50 or even rectangular, 52, where the main function is to permit a certain movement of the gland in relation to the shaft and the dividing wall. The spacing between the dampening mem-

bers as well as the elastic properties of the material of the dampening members may be varied depending on the desired function. There may also be different materials in the ring and the dampening members.

[0023] In order to avoid unnecessary friction between the pin 38 and the spacer 34 due to relative movement between the two, the dampening means is arranged with a tubular cover that fits around the movement limiting pin 38.

[0024] It is to be understood that the embodiments of the invention that are described above and shown in the drawings only are to be regarded as non-limiting examples of the invention and that it may be modified in numerous ways within what is defined by the scope of the appended patent claims.

Claims

1. A machine arranged to operate in explosive environments, comprising a rotatable shaft (16) extending through a stationary part (10) of said machine, a gland (20) which is mounted in said stationary part (10) and which is provided with a through hole in order to accommodate said rotatable shaft (16) such that a flame path is provided between the rotatable shaft (16) and the gland (20), **characterized in that** the machine comprises dampening means (42) arranged between and separating the gland (16) and the stationary part (10) in the axial and radial directions such that a flame path (50, 56) is provided between the gland (16) and the stationary part (10), the dampening means (42) maintaining the existence of the flame path (50, 56) and permitting axial and radial movement of the gland (20) in relation to the stationary part (10) upon rotation of the rotatable shaft (16).

2. The machine according to claim 1, wherein the dampening means (42) comprises a number of discrete resilient members (46) arranged against at least one surface of the gland (20) and at least one surface of the stationary part (10), which surfaces are facing in the axial direction of the rotatable shaft (16).

3. The machine according to claim 2, wherein one set of resilient members (46) are arranged between a first surface of the gland (20) and a first surface of the stationary part (10), which first surfaces are facing each other, and that another set of resilient members are arranged between a second surface of the gland (20), facing in the opposite direction as the first surface of the gland (20) and a second surface of the stationary part (10), facing in the opposite direction as the first surface of the stationary part (10), which second surfaces are facing each other.

4. The machine according to claim 2 or 3, wherein the discrete resilient members (46) are inter-connected and spaced at even intervals along a circumference around the rotatable shaft (16).

5. The machine according to any of the claims 2 to 4, wherein the discrete members (46) are formed such that they provide point contacts with said surfaces of the gland (20) and the stationary part (10) or line contacts with said surfaces of the gland (20) and the stationary part (10).

6. The machine according to any of the preceding claims, wherein the dampening means (42) comprises a locking means (38, 54) arranged to rotationally lock said gland (20) in relation to the stationary part (10) of the machine.

7. The machine according to any preceding claims, wherein the gland (20) is arranged with a flange-shaped part (24) having at least one circumferential recess (40) for receiving said dampening means (42).

Patentansprüche

1. Eine Maschine für den Betrieb in explosiven Umgebungen, umfassend eine drehbare Welle (16) verlaufend durch einen stationären Teil (10) der Maschine, eine im stationären Teil (10) befestigte Stopfbuchse (20), welche mit einer Durchgangsöffnung zur Aufnahme der drehbaren Welle (16) versehen ist, so dass ein Flammenpfad zwischen der drehbaren Welle (16) und der Stopfbuchse (20) bereitgestellt wird, **dadurch gekennzeichnet, dass** die Maschine Dämpfungsmittel (42) umfasst, die zwischen der Stopfbuchse (16) und dem stationären Teil (10) angeordnet sind und diese in axialer und radialer Richtung trennt, so dass ein Flammenpfad (50, 56) zwischen der Stopfbuchse (16) und dem stationären Teil (10) erzeugt wird, dass die Dämpfungsmittel (42) die Existenz des Flammenpfades (50, 56) aufrechterhalten und die axiale und radiale Bewegung der Stopfbuchse (20) bezüglich des stationären Teils (10) bei Drehung der drehbaren Welle (16) erlauben.

2. Maschine nach Anspruch 1, wobei das Dämpfungsmittel (42) eine Anzahl diskreter elastischer Teile (46) umfasst, die an wenigstens einer Oberfläche der Stopfbuchse (20) und wenigstens einer Oberfläche des stationären Teils (10) anliegend angeordnet sind, wobei die Oberflächen in der axialen Richtung der drehbaren Welle (16) ausgerichtet sind.

3. Maschine nach Anspruch 2, wobei ein Satz elastischer Teile (46) zwischen einer ersten Oberfläche der Stopfbuchse (20) und einer ersten Oberfläche des stationären Teils (10) angeordnet ist, wobei die

ersten Oberflächen einander gegenüberliegen, und dass ein anderer Satz elastischer Teile zwischen einer zweiten Oberfläche der Stopfbuchse (20), die in entgegengesetzter Richtung zu der ersten Oberfläche der Stopfbuchse (20) ausgerichtet ist, und einer zweiten Oberfläche des stationären Teils (10), die in entgegengesetzter Richtung zu der ersten Oberfläche des stationären Teils (10) liegt, angeordnet ist, wobei die zweiten Oberflächen einander gegenüberliegen.

4. Maschine nach Anspruch 2 oder 3, wobei die diskreten elastischen Teile (46) miteinander verbunden und in regelmäßigen Abständen entlang eines Umfangs um die drehbare Welle (16) beabstandet sind.

5. Maschine nach einem der Ansprüche 2 bis 4, wobei die diskreten Teile (46) so ausgebildet sind, dass sie Punktkontakte mit den Oberflächen der Stopfbuchse (20) und dem stationären Teil (10) oder Linienkontakte mit den Oberflächen der Stopfbuchse (20) und dem stationären Teil (10) erzeugen.

6. Maschine nach einem der vorstehenden Ansprüche, wobei das Dämpfungsmittel (42) ein Verriegelungsmittel (38, 54) umfasst, angeordnet zur Drehfixierung der Stopfbuchse (20) bezüglich des stationären Teils (10) der Maschine.

7. Maschine nach einem der vorstehenden Ansprüche, wobei die Stopfbuchse (20) mit einem flanschartigen Teil (24) ausgestattet ist, das zumindest eine Aussparung (40) am Umfang zur Aufnahme der Dämpfungsmittel (42) aufweist.

Revendications

1. Machine agencée pour fonctionner dans des environnements explosifs, comprenant un arbre rotatif (16) s'étendant à travers une partie stationnaire (10) de ladite machine, un presse étoupe (20) qui est monté dans ladite partie stationnaire (10) et qui est pourvu d'un trou traversant afin de recevoir ledit arbre rotatif (16) de sorte qu'il existe un trajet pour les flammes entre l'arbre rotatif (16) et le presse-étoupe (20), **caractérisé en ce que** la machine comprend des moyens d'amortissement (42) agencés entre et séparant le presse-étoupe (16) et la partie stationnaire (10) dans la direction axiale et dans la direction radiale de telle façon qu'un trajet pour les flammes (50, 56) est prévu entre le presse-étoupe (16) et la partie stationnaire (10), les moyens d'amortissement (42) maintenant l'existence du trajet pour les flammes (50, 56) et permettant un mouvement axial et radial du presse-étoupe (20) par rapport à la partie stationnaire (10) lors d'une rotation de l'arbre rotatif (16).

2. Machine selon la revendication 1, dans laquelle les moyens d'amortissement (42) comprennent un certain nombre d'éléments élastiques discrets (46) agencés contre au moins une surface du presse-étoupe (20) et au moins une surface de la partie stationnaire (10) lesdites surfaces étant tournées dans la direction axiale de l'arbre rotatif (16).

3. Machine selon la revendication 2, dans laquelle un groupe d'éléments élastiques (46) sont agencés entre une première surface du presse-étoupe (20) et une première surface de la partie stationnaire (10), lesdites surfaces se faisant mutuellement face, et en ce qu'un autre groupe d'éléments élastiques sont agencés entre une seconde surface du presse-étoupe (20), tournée dans la direction opposée à la première surface du presse-étoupe (20), et une seconde surface de la partie stationnaire (10), tournée dans la direction opposée à la première surface de la partie stationnaire (10), lesdites secondes surfaces se faisant mutuellement face.

4. Machine selon la revendication 2 ou 3, dans laquelle les éléments élastiques discrets (46) sont interconnectés et espacés à intervalles égaux le long d'une circonférence autour de l'arbre rotatif (16).

5. Machine selon l'une quelconque des revendications 2 à 4, dans laquelle les éléments discrets (46) sont formés de telle manière qu'ils fournissent des points de contact avec lesdites surfaces du presse-étoupe (20) et de la partie stationnaire (10), ou des lignes de contact avec lesdites surfaces du presse-étoupe (20) et de la partie stationnaire (10).

6. Machine selon l'une quelconque des revendications précédentes, dans laquelle les moyens d'amortissement (42) comprennent un moyen de blocage (38, 54) agencé pour bloquer en rotation ledit presse-étoupe (20) en relation à la partie stationnaire (10) de la machine.

7. Machine selon l'une quelconque des revendications précédentes, dans laquelle le presse-étoupe (20) est agencé avec une partie en forme de bride (24) ayant au moins un évidement circonférentiel (40) pour recevoir lesdits moyens d'amortissement (42).

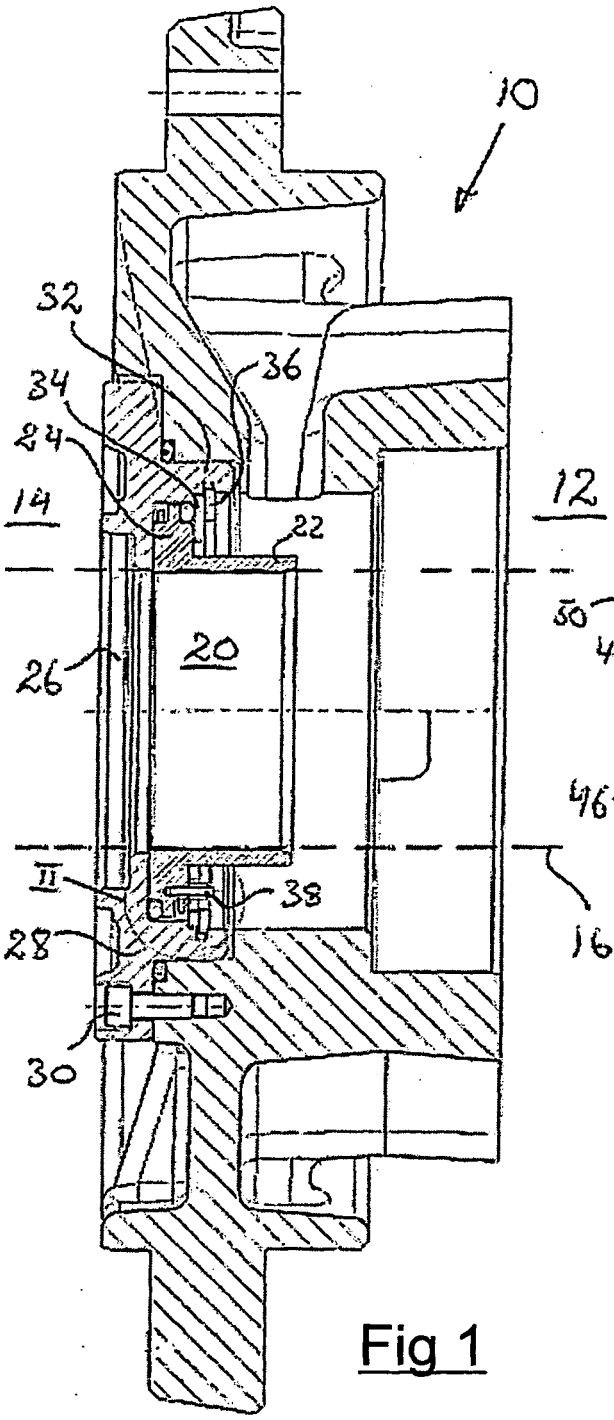
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Fig 1

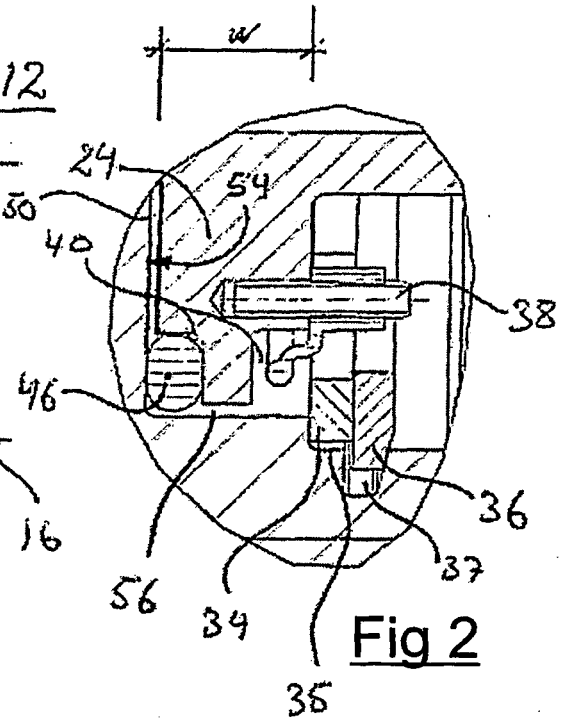
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Fig 2

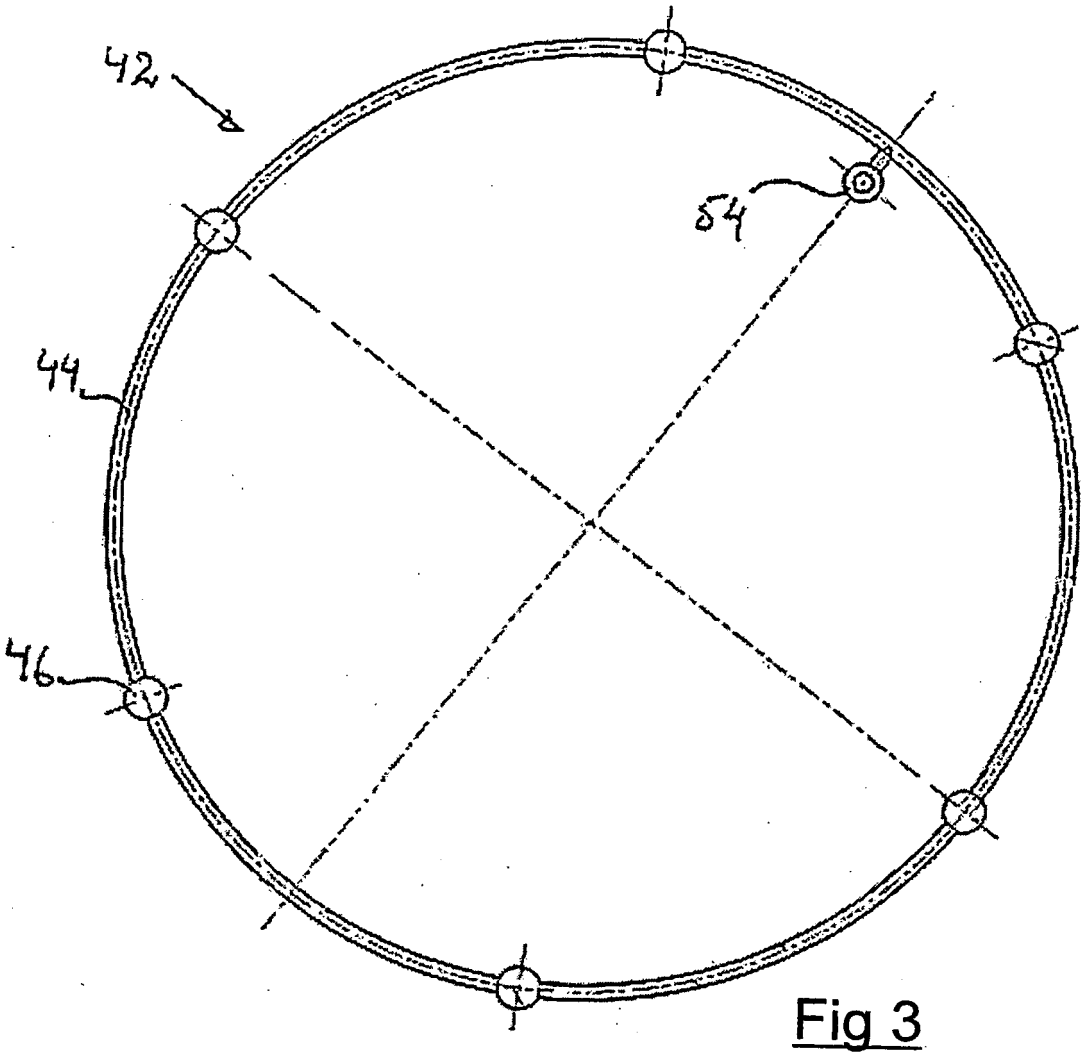

Fig 3

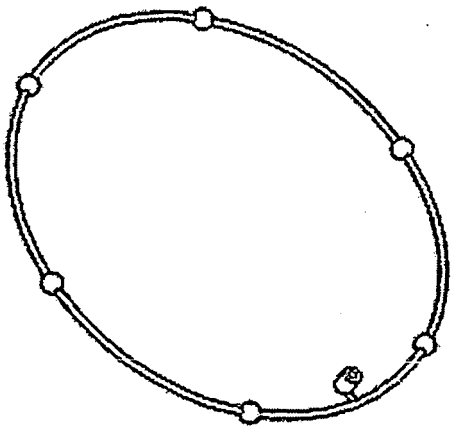

Fig 4

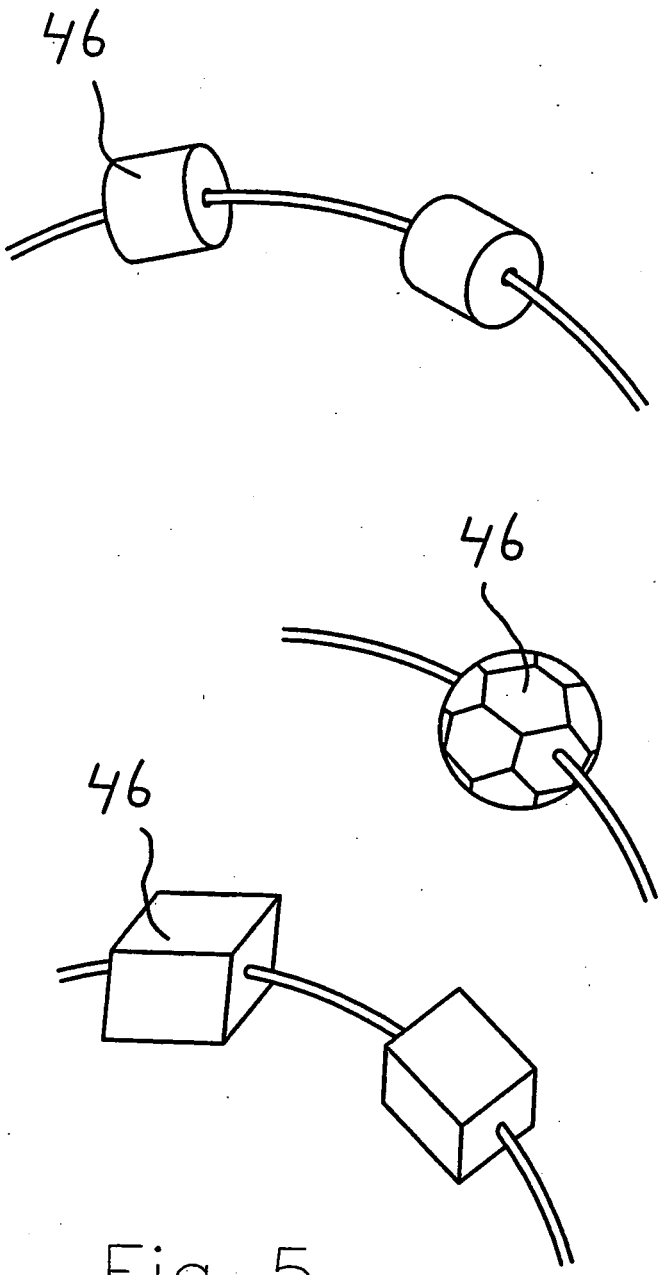

Fig 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 517781 A **[0003]**
- DE 19532549 **[0016]**