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(73) Patenthaver: **Defontaine, Rue Saint Eloi, 85530 La Bruffière, Frankrig**

(72) Opfinder: **Jacquemont, Eric, 6, rue Georges Caillaud, 44190 Clisson, Frankrig**
Delacou, Jean-Michel, 4, rue de la Meule, 85600 Bouffere, Frankrig

(74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**

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Description

[1] The present invention relates, in general, to the field of methods of manufacturing motorised slewing rings or bearings and to methods of manufacturing such bearings.

[2] More specifically, the invention relates to the manufacturing of a motorised slewing bearing comprising two annular rings able to rotate with respect to each other about an axis of rotation of the bearing, and a rotation motor comprising a wound part and a magnetized part.

[3] Motorised slewing bearings of the kind described in documents US-A-2007/0222325 and WO-A-03/077404, ITMI 92 0815, DE 10 2005 024 004, and WO 2007 107 416 are known.

[4] In this context, the object of the present invention is to provide a method of manufacturing motorised slewing bearing of easy modular construction according to claim 1.

[5] For preference, the magnetized units are arranged at uniform intervals apart.

[6] For preference, at least some of the magnetized units are positioned facing at least some of the wound units.

[7] Forming the motor by fixing:

- magnetized units each comprising magnets unique to each magnetized unit to a first ring: and
- wound units each comprising their own windings to a second ring;

simplifies the manufacture of large-diameter motorised bearings with diameters generally of more than 1 metre because the magnetized and wound units can be standardized and the number of wound units and their locations on the rings can simply be adapted in order to define the power for motorising the bearing.

[8] Motorising large-diameter slewing bearings with diameters of more than 1 metre is normally a particularly complex procedure because it entails adapting numerous components for motorising. By contrast, with the present invention which utilizes units that are fixed to the

rings a motorised drive can be manufactured easily, and that also makes maintenance operations easier because the units can be exchanged individually without the need to change the entire motorised drive assembly (without having to remove all of the mechanisms that pass through the middle of the bearing).

[9] The magnetized units and the wound units are all independent of one another.

[10] For preference, steps are taken to ensure that one of the rings is a fixed ring on which the wound part is assembled and that the other ring is a moving ring on which the magnetized part is fixed.

[11] This embodiment is advantageous because the supply of power to the wound part becomes simpler by comparison with an embodiment in which it is on a moving ring.

[12] In a preferred embodiment, the ring on which the wound part is assembled is an inner ring and the ring on which the magnetized part is fixed is an outer ring.

[13] In an embodiment that is alternative to the preceding one, the ring on which the wound part is assembled is an outer ring and the ring on which the magnetized part is fixed is an inner ring.

[14] According to the invention, the wound units are identical to one another.

[15] This is particularly economical because wound units are thus standardized and can be used for motorizing bearings of different diameters without the need to change the type of wound unit for each bearing diameter.

[16] For preference, steps are taken to ensure that each wound unit is a linear motor wound unit, i.e. a wound unit suitable for generating a sliding magnetic field with linear movement.

[17] The use of a linear motor wound unit in a slewing ring motorisation application is particularly advantageous because a linear motor wound unit is inexpensive to produce by

comparison with a curved wound unit, the radius of curvature of which has to be tailored to suit the radius of the bearing.

[18] Provision may also be made for said wound units to be placed on an annular planar surface of said ring on which they are fixed. This makes it easier for the wound units to be mounted on one and the same ring plane without the need to tailor these blocks to suit the curvature of the ring.

[19] Steps may also be taken to ensure that said annular planar surface on which said wound units are arranged is formed by a shoulder of this ring.

[20] The shoulder on a ring is an easy way of creating an annular planar surface especially since this annular planar surface is perpendicular to the axis of orientation of the bearing.

[21] Steps may also be taken to ensure that each of said wound units possesses a planar face (A) assembled onto said annular planar surface, each planar face (A) of a wound unit thus being assembled onto a complementary planar face of the shoulder of the ring. This embodiment allows flat-to-flat mounting.

[22] Steps may also be taken to ensure that each wound unit possesses another planar face (B) parallel to its planar face assembled onto said annular planar face, this other planar face (B) being placed parallel to a path of travel of the magnetized units. This choice encourages the minimum distances between wound units and magnetized units to be consistent and as small as possible in order to improve slewing bearing motor efficiency.

[23] For preference, steps are taken to ensure that each wound unit fixed to one of the rings possesses a planar assembly face and that the ring to which said wound units are fixed possesses a complementary disk-shaped planar face against which the planar assembly faces of the wound units rest (this disk-shaped complementary planar face being coaxial with the axis of rotation of the bearing). This embodiment allows for simplified flat-to-flat assembly.

[24] In one particular instance, a disk-shaped complementary planar face is formed by a shoulder of the ring, said wound units being assembled onto a shoulder of the ring.

[25] For preference, each wound unit possesses a planar face (face B in Figures 4 and 5) intended to face the magnetized units, each of these faces intended to face magnetized units being arranged in one and the same plane. This feature allows the use of linear motor wound units to create a motorised slewing bearing, avoiding having to create and adjust the radius of curvature of wound units to suit the radius of curvature of the ring.

[26] For preference, each magnetized unit has its own face (face C in Figures 4 and 5) intended to face wound units, each of these faces C intended to face wound units being arranged in one and the same plane. This feature allows use to be made of linear motor magnetized units for creating a motorised slewing bearing, reducing the need to have to create and adjust the radius of curvature of magnetized units to suit the radius of curvature of the ring.

[27] For preference, the wound units are of parallelepiped, and preferably cuboid, shape.

[28] This embodiment is particularly advantageous because the wound unit possesses a planar surface that can be assembled into a shoulder of a ring and another planar surface parallel to the first and that can be positioned parallel to a path of travel of the magnetized units.

[29] For preference, steps are taken to ensure that each wound unit comprises a stack of magnetic metal laminae or laminations in which holes are cut to carry said winding unique to the wound unit. This unique winding is designed to form poles that generate a sliding magnetic field.

[30] For preference, this winding comprises a plurality of conductors.

[31] For preference, said winding unique to each wound unit is a three-phase winding designed to form poles that generate a sliding magnetic field.

[32] This embodiment makes it possible to form relatively flat wound units which can thus be arranged in a small space between the two rings.

[33] For preference and according to any one of the above embodiments, steps are taken to ensure that at least some of the wound units are connected together in such a way that the windings of separate wound units are electrically connected in series.

[34] Thanks to this embodiment, the power supply voltage of the motor can be increased beyond the maximum permissible voltage for a single winding. For example, if a winding has a maximum supply voltage of 300 volts then by coupling this winding in series with another identical winding belonging to another unit a collection of windings is obtained that can be powered at a maximum voltage of 600 volts. This embodiment is advantageous because the motorised bearing can be powered with different voltages depending on the way in which the windings are interconnected.

[35] For preference, and according to any one of the above embodiments, steps are taken to ensure that at least some of the wound units are connected together in such a way that the windings of distinct wound units are electrically connected in parallel.

[36] This method of electrical connection in parallel allows the driving torque to be increased by comparison with a series connection.

[37] According to the invention, steps are taken to ensure that the magnetized units are identical to one another.

[38] This is particularly economical because magnetized units are thus standardized and can be used for motorizing bearings of different diameters without the need to tailor the type of magnetized unit to suit each diameter of bearing.

[39] For preference, steps are taken to ensure that each magnetized unit comprises a rectangular plate and a plurality of magnets in the form of bars fixed to the rectangular plate.

[40] For preference, the bars of a given magnetized unit are fixed to the rectangular plate of this magnetized unit in such a way as to be parallel to each other. A magnetized unit with mutually identical bars have the advantage of being standard for several motorised slewing bearing diameters, a plurality of magnetized bars being fixed to a ring simply by assembling the rectangular plate bearing the bars on the ring.
For preference, steps are taken to ensure that the magnetized units are fixed to an annular planar surface of the ring to which they are fixed.

[41] For preference, these magnetized bars all extend in a common plane perpendicular to the axis of rotation of the bearing and form a disk of magnets preferably arranged at uniform intervals.

[42] This embodiment is advantageous because the magnetized units with parallel bars can be fitted onto different diameters of bearing without the need to tailor the magnetized units to suit each dimension of bearing.

[43] According to a preferred embodiment, steps are taken to ensure that the bars of a given magnetized unit are fixed to the rectangular plate of the magnetized unit in such a way as to be parallel to each other.

[44] Such a standard magnetized unit is easy to prefabricate and to install on a ring that is to be motorised. This type of magnetized unit is typically a linear motor magnetized unit.

[45] For preference, and according to any one of the above embodiments, steps are taken to ensure that the bearing comprises rolling-bearing components interposed between the annular rings in order to guide the movement of one of the rings in relation to the other.

[46] These rolling-bearing components are balls, rollers or needles placed facing at least one raceway formed on at least one of the rings.

[47] For preference, and according to any one of the aforementioned embodiments, steps are taken to ensure that the bearing comprises at least one measuring rule fixed to one of the rings and one or more reading heads, preferably two, fixed to the other ring, the reading head or heads being designed to generate a signal dependent on the movement of the measuring rule.

[48] This rule makes it possible to determine the orientation of the ring bearing the rule in relation to the ring to which the reading head is fixed. This rule also makes it possible to generate a specific signal for each revolution of one ring with respect to the other and thus measure the relative rotational speed of these rings.

[49] For preference, this measuring rule is fixed to the moving ring and the reading head or heads are fixed to the fixed ring.

[50] For preference, the reading head is a magnetic head sensitive to variations in the magnetic fields generated by the movement of the rule in relation to the head. This magnetic-reading embodiment is preferably chosen because it is somewhat insensitive to swelling of the rule when the bearing is used in an aggressive environment.

[51] In order to minimize electromagnetic disturbances of the magnetic reading head, steps are taken to keep this head away from the magnetic bars and to place electromagnetic screening between these bars and the head.

[52] Alternatively, the reading head is an optical head sensitive to variations in a light beam, these variations being generated by the movement of the rule in relation to the head. This optical reading embodiment is preferably chosen in electromagnetically disturbed bearing operating environments, or when very high precision is needed.

[53] The method according to the invention demonstrates the ease of production of hearings of different diameters using the bearing design of the invention which allows standard motorization that can be fitted to several diameters of bearing.

[54] According to the method of the invention, steps are taken to ensure that said wound units of the bearings of the first type are arranged on an annular planar surface of the ring to which they are fixed and that the wound units of the bearings of the second type are arranged on an annular planar surface of the ring to which they are fixed. This feature, as already indicated, allows the manufacture of bearings. It should be noted that these annular planar surfaces of the bearings of the first and second respective types are perpendicular to the axes of rotation of the bearings of the first and second respective types. According to the method of the invention, in order to make each motorised bearing of the first and second type, steps are taken to ensure that the magnetized units of the slewing bearings of the first type are made with exactly the same structure and dimensions as the magnetized units of the slewing bearings of the second type.

[55] According to the method of the invention, steps are taken to ensure that said magnetized units of the bearings of the first type are arranged on an annular planar surface of the ring to which they are fixed and that the magnetized units of the bearings of the second type are arranged on an annular planar surface of the ring to which they are fixed. This feature, as already indicated, allows the manufacture of bearings. It should be noted that these annular planar surfaces on which the magnetized units of the bearings of the first and second respective types are arranged are perpendicular to the axes of orientation of the respective rings of the first and second types.

[56] In other words, for a given bearing, the annular surface on which the wound units are arranged is parallel to the annular surface on which the magnetized units are arranged, these two annular surfaces being themselves perpendicular to the axis of orientation of this bearing.

[57] For preference, in order to implement the method of the invention, steps are taken to ensure that the wound units are linear motor wound units, that is to say wound units that generate a sliding magnetic field with linear movement.

[58] This embodiment is particularly economical because in order to produce the motorised slewing bearing use is made of linear motors and there is therefore no need to adapt the

wound units to suit each diameter of bearing and one and the same wound unit can therefore be used to manufacture bearings of different sizes.

[59] A preferred embodiment the wound units may be linear motor wound units that are identical to one another. Thus, the structures and a dimension of the wound units of the bearings of the first and second types are identical to one another.

[60] The features and advantages of the invention will become clearly apparent from the description thereof given hereinafter by way of entirely non-limiting indication, with reference to the attached drawings in which:

Figure 1 depicts a perspective view of a bearing assembled and provided with motorization;

Figure 2 depicts an exploded perspective view of a bearing, from a first side;

Figure 3 depicts an exploded perspective view of a bearing, from a second side;

Figure 4 depicts a sectioned view of a bearing according to the invention, with a moving outer ring bearing the magnetized part;

Figure 5 depicts a sectioned view of a bearing according to an alternative embodiment with a moving inner ring bearing the magnetized part.

[61] Figures 1 to 4 show a bearing 1 according to a first embodiment, provided with a fixed inner annular ring 2 and with an outer ring 3 that is able to move with respect to the inner ring 2 about an axis of rotation of the rings X. A raceway is created on each of the inner and outer rings 2 and 3 and rolling-bearing components (6) are interposed between the rings so as to roll along each of the raceways and thus guide the rotations of the rings 2, 3 one with respect to the other.

[62] A motor is installed in such a way as to drive the rotation of these rings one with respect to the other. This motor comprises a wound part 4 which is assembled on the inner fixed ring

2 by means of the support 21 and a magnetized part 5 which is assembled on the outer moving ring 3. The ring 2 is made up of a support portion 21 and of a rolling-bearing portion on which the raceway is formed, these portions being joined together by screws. Each of these parts 4, 5 has the overall shape of an annulus formed of discontinuous portions in the case of the part 4 and which is continuous in the case of the part 5, which is arranged on a corresponding shoulder of a ring. A wound or magnetized part is assembled on its ring preferably using four screws for ease of maintenance purposes.

[63] The wound part comprises several wound units 41 which are assembled on the shoulder formed on the support 21 fixed to the inner ring 2 so as to be spaced apart and so as to form a discontinuous annulus of wound units 41.

[64] Each wound unit 41 is a linear motor unit, that is to say a unit which generates a magnetic flux along a sliding linear axis. For each embodiment provided with a linear motor wound unit, the axis of magnetic flux is preferably perpendicular to a bearing radius. Each wound unit is in the form of a parallelepiped allowing the unit to be given the symmetry needed to establish a linear flux along, an axis perpendicular to the radius of the bearing. Furthermore, this parallelepiped shape is advantageous because the unit is assembled on a shoulder of the ring by four screws on a planar face A of the wound unit against a complementary planar face of the shoulder. The other face B of the wound unit 41, which is parallel to the face A of the unit, faces a face C of the magnetized unit 51 borne by the moving ring 3 as is particularly clearly visible in Figure 4.

[65] Each wound unit 41 has a stack of magnetic metal laminations in which holes are cut to carry a three-phase winding of its own so as to form poles that generate a sliding magnetic field.

[66] The conductors that make up this winding possess two connection portions 7, 8 designed to supply electrical power to the winding (7) and to protect the winding (thermal probes (8). The connection portions 7 of the wound units are connected together either in series or in parallel depending on the desired motive performance and the available supply voltage.

[67] The magnetized units 51 are made up of a rectangular plate 53 on which magnets 32 in the form of mutually parallel bars are assembled. Typically, such a magnetized unit 51 is a linear electric motor magnetized unit.

[68] For preference, steps are taken to ensure that the length of the magnet bars 52 is equal to the width of the windings of the wound units 41 so as to obtain improved efficiency.

[69] The bearing 1 also comprises a pair of lip seals 9 arranged in such a way as to seal an annular region between the rings in which region the rolling-bearing components 6 are located.

[70] Figure 5 shows an embodiment that is an alternative to the one depicted in Figures 1 to 4. This alternative embodiment comprises the same magnetized and wound parts as the embodiments of Figures 1 to 4, except that in the embodiment of Figure 5:

- the magnetized part 5 is mounted on a face of the inner bearing ring 2, which is the moving ring; and
- the wound part 4 is mounted on a shoulder made on the outer ring 3 which is the fixed ring.

[71] Finally, according to any one of the embodiments, it is possible to fit a measuring ring along the shoulder of a moving ring and to fit one or two reading heads on the fixed ring to measure the movement of the rule and thus measure the relative positions and speeds of the rings 2, 3.

[72] The bearings according to any one of the embodiments are preferably bearings with diameters in excess of 600 mm, or even in excess of several metres.

[73] As an indication, if a wound unit has the ability to generate a nominal force of 100 N on the magnetized unit situated facing it and if the mean radius of the hearing is 650 mm, then each wound unit/magnetized unit pair is able to generate a driving torque of 650 Nm. All that is then required is to define the number of wound units in order to define the total driving torque and the total motive power of the bearing.

[74] It is preferable for the magnetized units to form a continuous stream of magnetized units so as to have continuous and uniform drive over a complete revolution of the ring. The motor thus formed is a synchronous motor.

[75] In order to obtain high driving torques, it is also possible to multiply the number of rotation motors and to stack these motors up on various shoulders made on the inner and outer rings. Thus, one and the same moving ring could comprise several mutually parallel runs of magnetized units and one and the same fixed ring could comprise several mutually parallel runs of wound units, these runs being arranged so that each run formed of wound units faces a corresponding run formed of magnetized units.

[76] For example, steps may be taken to ensure that the runs of magnetized units each lie in their own run plane, these individual magnetized unit run planes being mutually parallel and perpendicular to the axis of orientation of the bearing. In this particular instance, the ring hearing the runs of wound units possesses several shoulders each having an annular planar surface onto which to assemble magnetized units.

[77] According to this embodiment, the shoulders of the ring are concentric and inscribed in planes that are mutually parallel and perpendicular to the axis of orientation of the bearing.

[78] According to an embodiment that is an alternative to the preceding one, all the runs of wound units are arranged on one and the same annular planar surface of the ring and are therefore coplanar and concentric with one another. In this embodiment, all the runs of magnetized units are arranged on one and the same annular planar surface of a ring and are therefore coplanar and concentric with one another.

Patentkrav

1. Fremgangsmåde til fremstilling af en motoriseret drejekrans (1) af en første type og med diameter, der er større end 1 meter, og af en motoriseret drejekrans af en anden type, der er forskellig fra den første, hvor hver krans (1) af den første og anden type omfatter to kredsformede ringe (2, 3), der er monteret drejeligt i forhold til hinanden omkring en kransrotationsakse (X), og en rotationsmotor, der omfatter en viklet del (4) og en magnetiseret del (5), hvor drejekransen af den første type har en ringdiameter, der er mindst 20% større end en diameter af kransen af den anden type,

kendetegnet ved, at for at udføre enhver af de motoriserede kranse (1) af den første og anden type:

- er der på en ringformet, plan overflade af ringen tilvejebragt flere viklede blokke (41), hvor enhver af disse viklede blokke (41) omfatter mindst én elektrisk leder, der er i stand til at danne en vikling, som er egnet til denne viklede blok (41); og
- fastgøres flere magnetiserede blokke (51), der udgør den magnetiserede del (5) af hver krans (2, 3) på den anden af ringene (2, 3), og enhver af disse magnetiserede blokke (51) omfatter flere magneter (52), der er egnede til denne magnetiserede blok (51), hvor disse magnetiserede blokke danner en ring af magnetiserede blokke; og
- de viklede blokke (41) af drejekransene (1) af den første type er af struktur og dimensioner, der er identiske med strukturen og dimensionerne af de viklede blokke (41) af drejekransene (1) af den anden type, de magnetiserede blokke (51) af drejekransene (1) af den første type er af struktur og dimensioner, der er identiske med strukturen og dimensionerne af de magnetiserede blokke af drejekransene af den anden type.

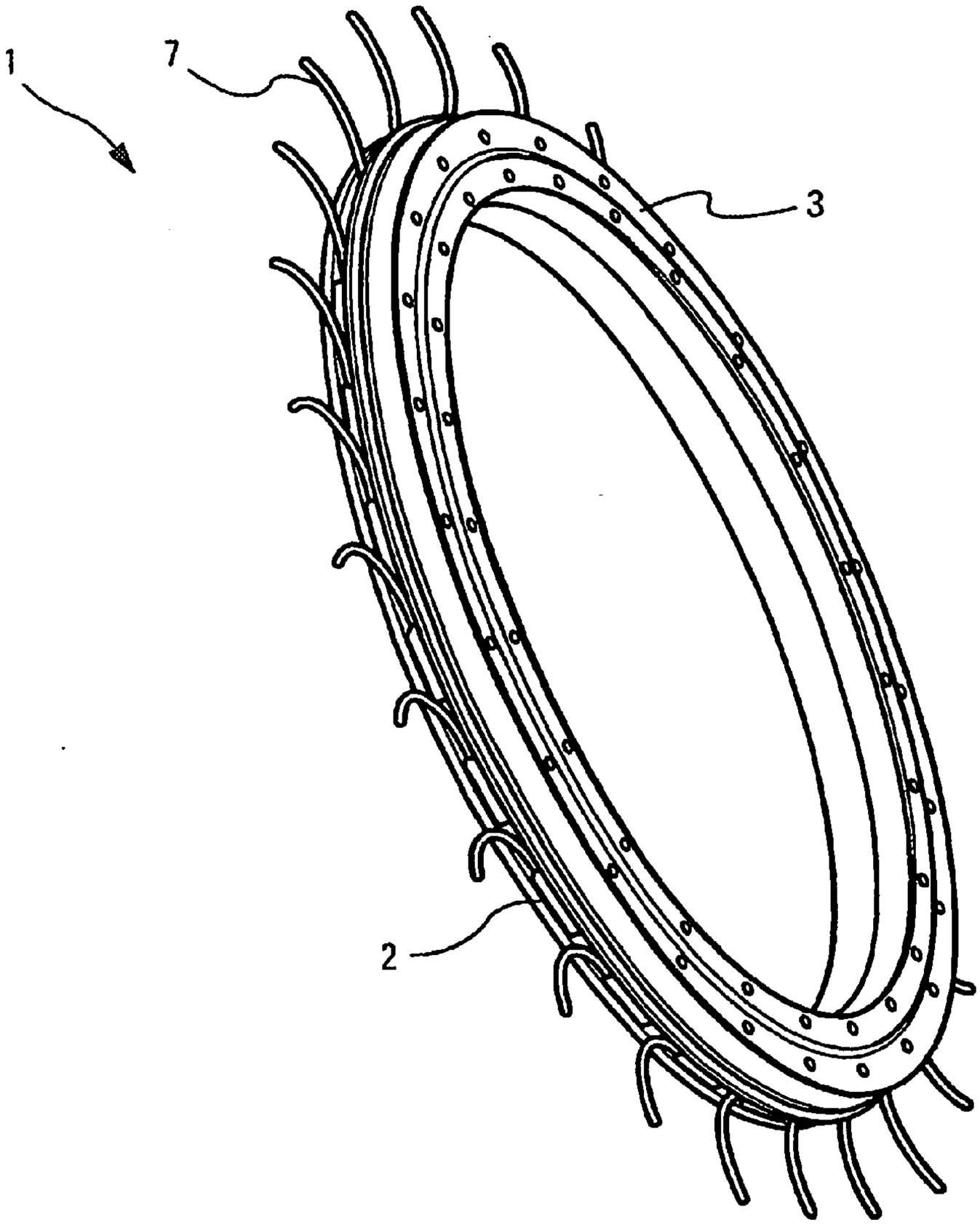

Fig. 1

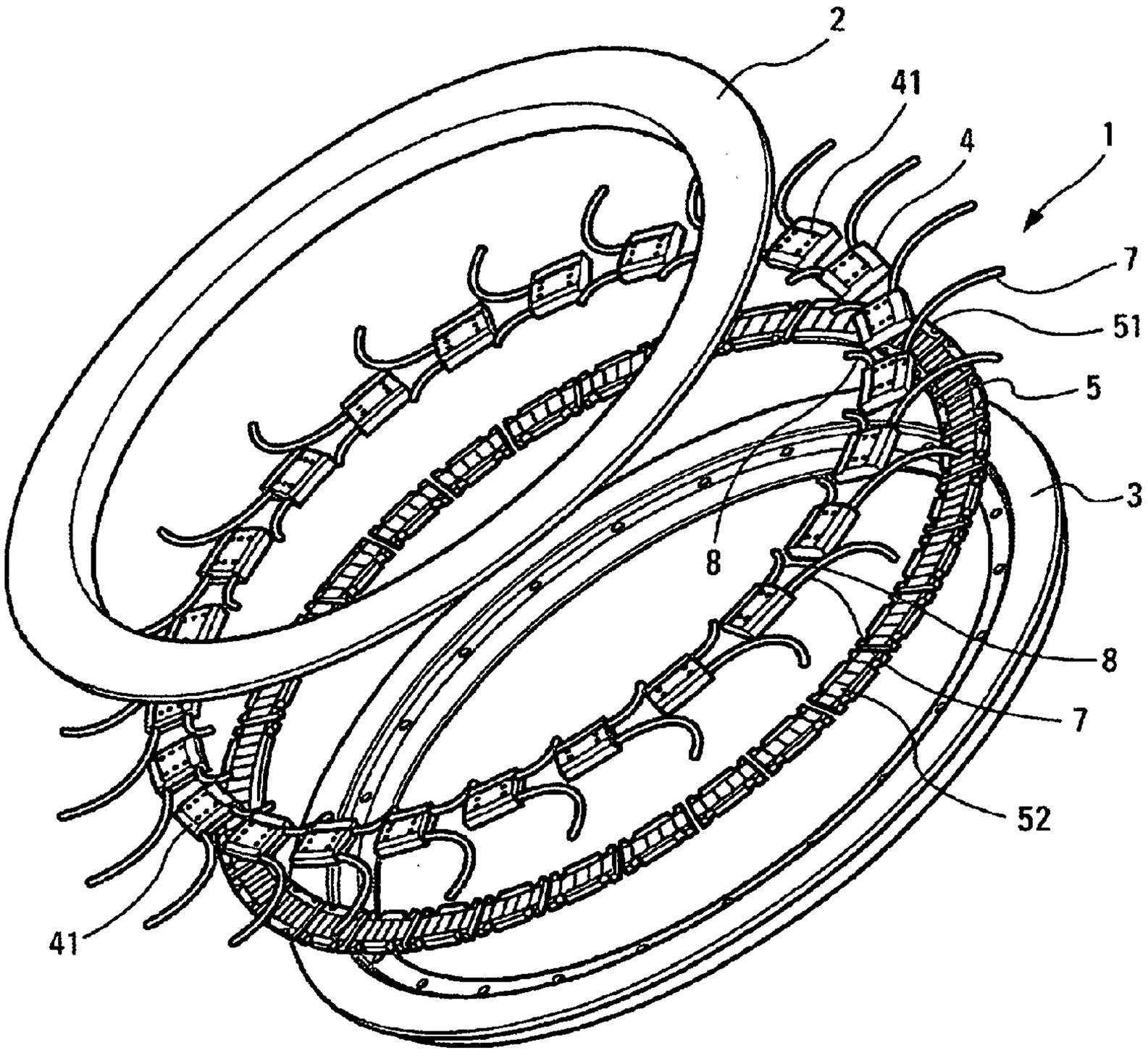

Fig. 2

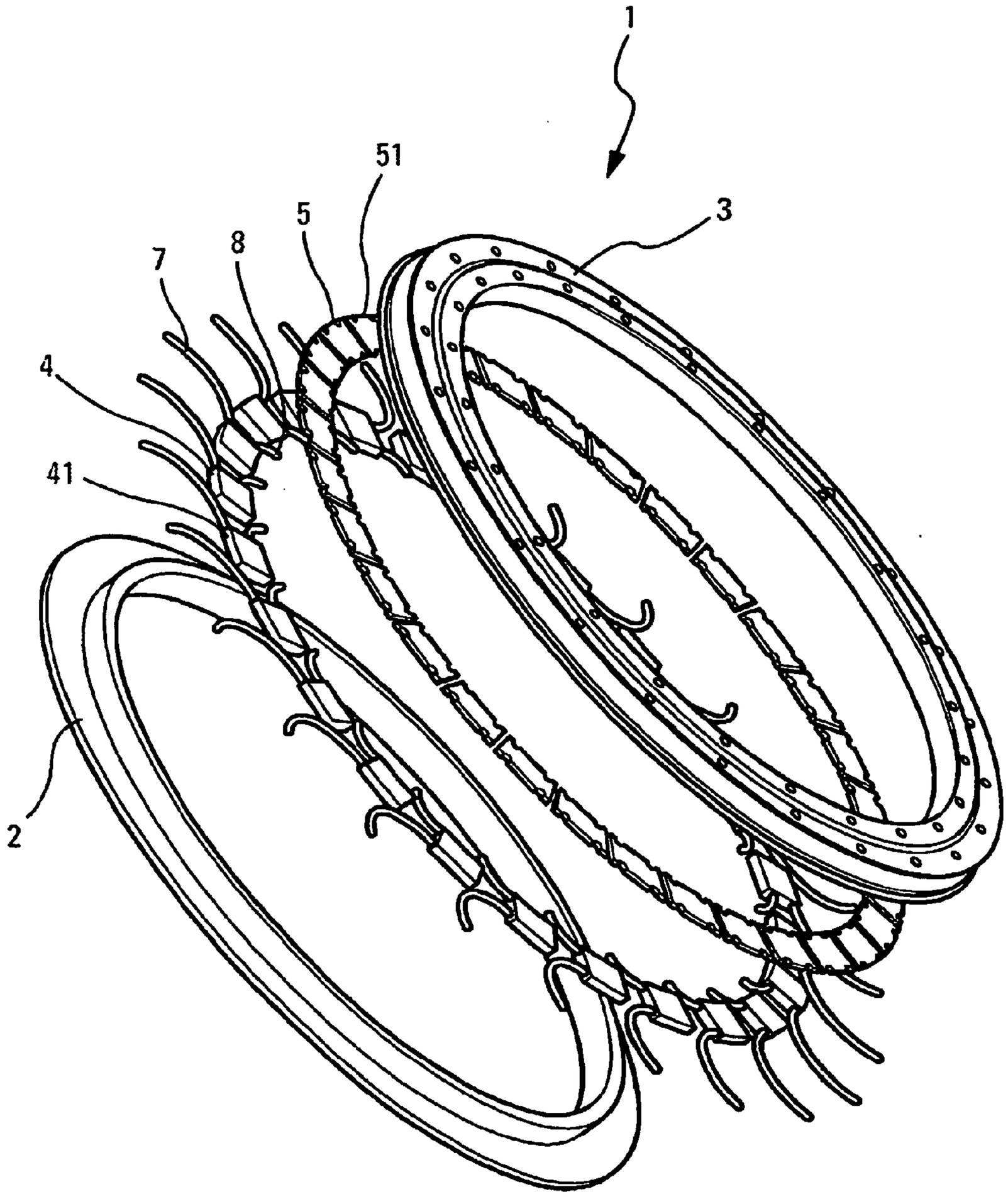

Fig. 3

Fig. 4

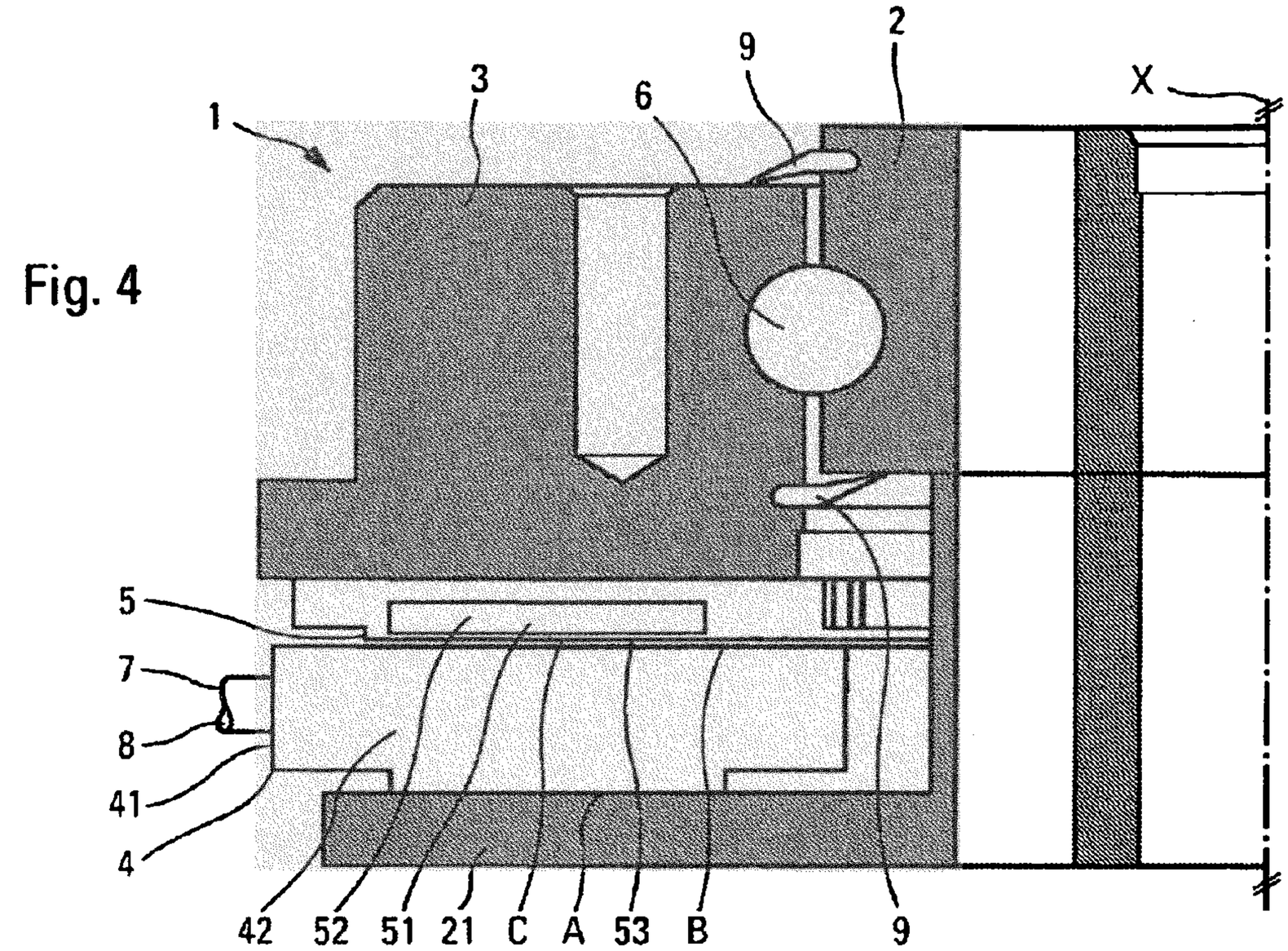

Fig. 5