Device having an arrangement of magnets

Abstract

The invention relates to a device having an arrangement of magnets for generating an alternating magnetic field that interacts with a stationary magnetic field. The device comprises a rotor (1) and a stator (2) disposed coaxially to a rotatably mounted shaft (5). The rotor (1) comprises one or more first magnet sequences and the stator (2) one or more second magnet sequences. The first and second magnet sequences each comprise two or more dipole magnets, the arrangement and orientation of which may vary.

Classifications

F16C32/0425 Passive magnetic bearings with permanent magnets on both parts repelling each other for radial load mainly

View 2 more classifications

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Claims

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claims

1. Device having a rotor (1) and a stator (2) which are arranged coaxially to a rotatably mounted shaft (5), wherein the rotor (1) one or more first magnetic sequences (F1) and the stator (2) a or more second magnetic sequences (F2), wherein the one or more first magnetic sequences (F1) each two or more on a lateral surface (M1) of a coaxial with the shaft (5) oriented first

Circular cylinder (Z1) arranged dipole magnets (7), whose dipole axes (70) with a tangent (71) to the circumference of the lateral surface (M 1) through a point at which the dipole axes (70) each pierce the lateral surface (M1), each include an inclination angle (a) which is in a range of 14 degrees to 90 degrees, and the one or more second magnetic sequences (F2) each two or more on a lateral surface (M2) of a coaxial with the shaft (5) oriented second circular cylinder (Z2) arranged dipole magnets (8) whose dipole axes (80) with a tangent (81) to the circumference of the lateral surface (M2) through a point at which the dipole axes (80) pierce each of the lateral surface (M2), one in each case Incident angle (a) which is in a range of 14 degrees to 90 degrees, wherein the one or more first magnetic sequences (F1) and the one or more second magnetic sequences (F2) with respect to a perpendicular to a shaft axis (50) of Shaft (5) arranged e plane (51) each have a pitch angle (b) which is in a range of 10 degrees to 80 degrees or 280 degrees to 350 degrees, and wherein the one or more first magnetic sequences (F1) and the one or more second magnetic sequences (F2) include an angle of incidence (c) that is in a range of 0 degrees to 90 degrees.

2. A device according to claim 1, characterized in that adjacent dipole magnets within the first and / or second magnet sequences (F1, F2) have the same polarity.

3. Apparatus according to claim 1, dad u rch geken nzeich net that within the first and / or second magnetic sequences (F1, F2) adjacent dipole magnets have a different polarity.

4. Device according to one of the preceding claims, dad u rch geken nzeich net that the dipole axes (70, 80) parallel to the perpendicular to the shaft axis (50) arranged plane (51) extend.

5. Device according to one of the preceding claims, characterized in that the distance (d) of adjacent dipole magnets of the two or more dipole magnets (7, 8) within the one or more first magnetic sequences (F1) and / or the one or more more second magnetic sequences (F2) is constant.

6. Device according to one of the preceding claims, characterized in that the distance (d1) of adjacent dipole magnets of the two or more dipole magnets (7) within the one or more first magnetic sequences (F1) of the distance (d2) of adjacent Dipole magnet of the two or more dipole magnets (8) within the one or more second magnetic sequences (F2) is different.

7. Device according to one of the preceding claims, dad u rch geken called, the inclination angle (a) is constant within the one or more first magnet sequences (F1) and / or the one or more second magnet sequences (F2).

8. Apparatus according to claim 7, further characterized in that the angle of inclination (a) is in a range of 14 degrees to 90 degrees.

Device according to one of the preceding claims, characterized in that the one or more first magnet sequences (F1) have an identical first pitch angle (b1) and / or the one or more second magnet sequences (F2) have an identical one second pitch angle (b2).

10. The device according to claim 1, wherein two or more first magnet sequences and / or two or more second magnet sequences follow a first plane perpendicular to the shaft axis (511) and terminate at a second plane (512) perpendicular to the shaft axis (50).

11. The device according to claim 1, wherein the one or more first magnet sequences and / or the one or more second magnet sequences are arranged such that groups of two or more magnet sequences follow form.

12. Device according to one of the preceding claims, d ad u rch geken net nzeich that an air gap (G1) between the rotor (1) and the stator (2) a

Slit width of 0.1 mm to 50 mm, preferably from 1 mm to 5 mm.

13. Device according to one of the preceding claims, dad u rch geken called, in that the rotor (1) and the stator (2) have a substantially circular cross section in the plane (51) arranged perpendicular to the shaft axis (50).

14. Device according to one of the preceding claims, dad u rch geken nzeich net that the lateral surface (M 1) of the first circular cylinder (Z1) the outer circumference of the rotor (1) rewritten or the inner circumference of the rotor (1) is inscribed.

15. Device according to one of the preceding claims, d ad u rch geken net nzeich that the lateral surface (M2) of the second circular cylinder (Z2) the outer circumference of the stator (2) rewritten or the inner circumference of the stator (2) inscribed.

16. Device according to one of the preceding claims, d ad u rch geken nzeichnet that the lateral surface (M1, M2) of the first circular cylinder (Z1) and the second circular cylinder (Z2), the dipole magnets (7, 8) of the rotor (1) or the stator (2) each non-cutting touched.

17. Device according to one of the preceding claims, d ad u rch ge ken nzeich net that the rotor (1) and / or the stator (2) has a support body (12, 101, 102) made of non-magnetic material with recesses (15 , 22) for receiving the dipole magnets (7, 8).

18. Device according to one of the preceding claims, dadu rch geken nzeichnet that the rotor (1) with respect to the stator formed as an inner stator (2) at least partially disposed radially further out and fixed to the shaft (5) and the Device arranged coaxially with the shaft (5) outer stator (3) disposed at least partially radially further outward with respect to the rotor (1), the dipole magnets (8) distributing the one or more second magnet sequences (F2) evenly over the circumference of the second circular cylinder (Z2) are axially offset relative to one another in relation to the shaft axis (50) such that a stepped arrangement of the dipole magnets (8) results on the lateral surface (M2) of the second circular cylinder (Z2) and adjacent dipole magnets (8) with respect to Axially overlapping the shaft axis (50), wherein the rotor (1) has k first magnetic sequences (F 1), k being an integer greater than or equal to four, and the two or more dipole magnets (7) of the k first magnetic sequences (F1) are formed so that they two or more on the lateral surface (M1) of the first circular cylinder (Z1) extending rows (701 to 708) with k evenly distributed on the circumference of the first circular cylinder (Z1) dipole magnet (7) ild, wherein the dipole magnets (7) of a row (701 to 708) lie in a direction perpendicular to the shaft axis (50) extending plane and the dipole magnets (7) of adjacent rows are alternately offset from each other so that they are axially to the shaft axis (50) via a the circular cylinder circumference form a uniform zigzag pattern, and wherein the outer stator (3) has two or more on a lateral surface (M3) of a third circular cylinder (Z3) arranged dipole magnets (6), which are evenly distributed on the lateral surface (M3).

19. Device having a coaxial with a rotatably mounted shaft (5) arranged inner stator (2), a coaxial with the shaft (5) arranged rotor (1) and a coaxial with the shaft (5) arranged outer stator (3), wherein the rotor (1) is disposed at least partially radially further outward with respect to the inner stator (2) and fixedly connected to the shaft (5) and the outer stator (3) at least partially radially further with respect to the rotor (1) is arranged outside, wherein the inner stator (2) two or more on a lateral surface of a

Circular cylinder arranged dipole magnets (8), which are distributed uniformly over the circular cylinder circumference and are axially offset with respect to a shaft axis (50) of the shaft (5) against each other so that on the lateral surface of the circular cylinder a stepped arrangement of the Dipole magnets (8) results and adjacent axial dipole magnets (8) with respect to the shaft axis (50) partially overlap, wherein the rotor (1) two or more on a lateral surface of a circular cylinder extending rows (701 to 708) each having four or more uniformly distributed on the circular cylinder circumference dipole magnet (7), wherein the

Dipole magnets (7) of a row (701 to 708) in a direction perpendicular to the shaft axis (50) extending plane and the dipole magnets (7) of adjacent rows are alternately offset from each other so that they axially to the shaft axis (50) over the circular cylindrical circumference uniform zigzag Forming pattern, and wherein the outer stator (3) has two or more arranged on a lateral surface of a circular cylinder dipole magnets (6), which are distributed uniformly on the lateral surface.

20. Device according to claim 18 or 19, characterized in that magnets (6, 7, 8) of the inner stator (2), the rotor (1) and the outer stator (3) are at least partially radial to the shaft axis (50) cover, in particular within an imaginary cylinder cavity whose longitudinal axis is coaxial with the shaft axis (50), are arranged.

21. Device according to claim 18, characterized in that the rotor (1) is drum-shaped so as to surround the inner stator (2) in a circular tube and at one or both ends of the circular tubular portion (101) of the rotor (1) has a top surface (102) through whose center the shaft axis (50) extends.

22. Device according to claim 21, characterized in that in the top surface (102) two or more dipole magnets (700) distributed uniformly on a circumference with respect to the center of the top surface (102) have their dipole axis parallel to the shaft axis (50) extends, are arranged.

23. Device according to one of claims 18 to 22, dad u rch geken net nets that outer stator (3) circular tube surrounds the rotor (1).

24. Device according to claim 23, characterized in that the dipole magnets (6) of the outer stator (3) extend parallel to the longitudinal axis of the circular tubular portion of the outer stator (3) and extend substantially over the entire length of the outer stator circular tubular portion of the outer stator (3) extend.

25. Device according to claim 18, characterized in that the inner stator (2) and the outer stator (3) are arranged in fixed position relative to one another and the inner stator (2) has a bearing (11). in which the shaft (5) is rotatably mounted with the rotor (1) attached thereto.

26. Device according to one of claims 18 to 25, d ad u rch ge ken nzeich net that the rotor (1) and the outer stator (3) each consist of two halves, with respect to a perpendicular to the shaft axis (50) extending, the inner stator (2) are formed symmetrically in two equal-length halves symmetrical plane consist, wherein the two halves of the rotor (1) and the two halves of the outer stator (3) by an at least partially in the

Symmetrieebene arranged, the inner stator (2) for fastening serving fastening means (4) are separated from each other.

27. Device according to claim 26, characterized in that the two halves of the outer stator (3) are displaceable axially relative to the shaft (5) and symmetrically to the plane of symmetry such that a degree of overlap of the dipole magnets (7) of the rotor (1) through the Dipole magnets (6) of the outer stator (3) is infinitely adjustable in a range between zero percent and one hundred percent.

28. Device according to claim 18, characterized in that the magnetic dipole axis (60, 70, 80) of a dipole magnet (6, 7, 8) of the inner stator (2) and / or of the rotor (1) and / or the outer stator (3) with a tangent (61, 71, 81) to the stator circumference and / or the rotor circumference in the region of the dipole magnet (6, 7, 8) an angle (α, ß, Y) form, which lies in a range between 14 degrees and 90 degrees.

29. Device according to claim 18, characterized in that the dipole magnets (6, 8) of the inner stator (2) and / or of the outer stator (3) in a section perpendicular to the shaft axis (50) have a rectangular or trapezoidal cross-section.

30. The device according to claim 18, wherein the dipole magnets (7) of the rotor (1) have a point-symmetrical, preferably a circular, section perpendicular to the magnetic dipole axis (70) of the dipole magnets (7) , Cross-section.

31. Device according to claim 18, characterized in that the dipole magnets (6, 8) of the inner stator (2) and / or the outer stator (3) in the direction of the shaft axis (50) have a greater extent than in the directions perpendicular thereto.

32. Device according to one of claims 18 to 31, characterized in that the magnetic dipole axes (60, 70, 80) of the dipole magnets (6, 7, 8) of the inner stator (2) and / or of the outer stator (3) and / or the rotor (1) lie in planes perpendicular to the shaft axis (50).

33. The device according to claim 18, wherein the dipole magnets (6, 7, 8) of the inner stator (2) and / or of the outer stator (3) and / or of the rotor (1) each have a same outer shape.

Description

Device with an array of magnets

The invention relates to a device for generating an alternating magnetic field, which interacts with a stationary magnetic field.

The interaction of a stationary magnetic field and an alternating magnetic field has been used for some time, for example in the field of brushless DC motors and magnetic levitation trains.

The invention has for its object to provide an improved device for generating an alternating magnetic field, which interacts with a stationary magnetic field to create.

This object is achieved by a device having a rotor and a stator arranged coaxially with a rotatably mounted shaft, the rotor having one or more first magnet sequences and the stator having one or more second magnet sequences, the one or more first magnet sequences respectively two or more arranged on a lateral surface of a coaxial to the shaft oriented first circular cylinder dipole magnets whose dipole axes with a tangent to the circumference of the lateral surface through a point at which the dipole axes pierce each of the lateral surface, each include an angle of inclination, which in a range of 14 degrees to 90 degrees, and the one or more second magnetic sequences each comprise two or more arranged on a lateral surface of a coaxial to the shaft second circular cylinder dipole magnets whose dipole axes with a tangent to the circumference of the lateral surface through a point at which the dipole axes each the M pierced surface, each having a tilt angle which is in a range of 14 degrees to 90 degrees, wherein the one or more first magnetic sequences and the one or more second magnetic sequences with respect to a plane arranged perpendicular to a shaft axis of the shaft each have a pitch angle which is in a range of 10 degrees to 80 degrees or from 280 degrees to 350 degrees, and wherein the one or more first magnetic sequences and the one or more second magnetic sequences include an angle of attack which is in a range of 0 degrees to 90 degrees.

The abovementioned formulations "whose dipole axes with a tangent to the circumference of the lateral surface through a point at which the dipole axes pierce the lateral surface in each case include an inclination angle which lies in a range of 14 degrees to 90 degrees" are to be understood as meaning each of the dipole magnets of the rotor and the stator may have an individual tilt angle The only limitation of each individual tilt angle is to be in a range of 14 degrees to 90 degrees, which includes the case where two or more dipole magnets have the same tilt angle For example, it is also possible that all dipole magnets of the rotor and / or the stator have the same angle of inclination.

The above formulation "wherein the one or more first magnetic sequences and the one or more second magnetic sequences each have a pitch angle in a range of 10 degrees to 80 degrees or 280 degrees with respect to a plane perpendicular to a shaft axis of the shaft to 350 degrees "is understood to mean that each magnet sequence of the rotor and the stator can have an individual pitch angle The only limitation of the individual pitch angle is that it ranges from 10 degrees to 80 degrees or from 280 degrees to 350 degrees This includes the case where two or more magnet sequences have the same slope angle, for example, it is also possible that all magnet sequences of the rotor and / or the stator have the same slope angle.

In the case where two magnet sequences on the rotor and / or the stator have different pitch angles, the pitch angles associated with these magnet sequences are also different. Moreover, the above-mentioned object is achieved by a device having an inner stator arranged coaxially with a rotatably mounted shaft, a rotor arranged coaxially with the shaft and an outer stator arranged coaxially with the shaft, wherein the rotor is at least in relation to the inner stator partially radially disposed further out and fixedly connected to the shaft and the outer stator is disposed at least partially radially outward with respect to the rotor, wherein the inner stator has two or more arranged on a lateral surface of a circular cylinder dipole magnets which are uniform over the circular cylinder circumference are distributed and axially offset relative to each other with respect to a shaft axis of the shaft, that results in a stepped arrangement of the dipole magnets on the lateral surface of the circular cylinder and axially overlap adjacent dipole magnets with respect to the shaft axis axially, wherein the rotor two or more On a lateral surface of a circular cylinder extending rows each having four or more evenly distributed on the circular cylinder circumference dipole magnet, wherein the dipole magnets of a row lie in a plane perpendicular to the shaft axis and the dipole magnets of adjacent rows are mutually offset alternately so that they are axially to the shaft axis Form over the circular cylinder circumference uniform zigzag pattern, and wherein the outer stator has two or more disposed on a lateral surface of a circular cylinder dipole magnets, which are distributed uniformly on the lateral surface.

The magnetic fields formed by the special arrangement of the dipole magnets of the rotor and of the stator or of the stators cause the rotor to be kept free-floating. The devices according to the invention thus act as a magnetic bearing. Surprisingly, it has been found that the magnetic field generated by the special arrangement of the dipole magnets of the rotor and the stator or the stators upon rotation of the rotor, which allows a largely lossless rotational movement of the rotor relative to the stator or the stators. This can be exploited for a variety of technical applications, for example, for a particularly low-friction storage of a preferably fast-rotating shaft. In the following description mathematical, in particular geometric terms, eg parallel, vertical, plane, cylinder, angle, etc., are used, which can be entered in technical drawings, but can never be fully met in practice due to the manufacturing tolerances. It is therefore clear to the person skilled in the art that this description is only to be regarded as an ideal description. The description implicitly includes similar devices with generally accepted tolerances.

The shaft runs in one axis, the so-called shaft axis, and is rotatable about this axis. The shaft is preferably designed as a straight circular cylinder, wherein the axis of rotation of the circular cylinder forms the shaft axis.

It is possible that adjacent dipole magnets within the first and / or second magnet sequences have the same polarity. It is also possible that adjacent dipole magnets have a different polarity within the first and / or second magnet sequences.

In a preferred embodiment, the polarity of the two or more dipole magnets within one or more magnet sequences is the same. In terms of the wave axis, this means that the north poles of all dipole magnets within one or more magnet sequences either point to or face away from the shaft axis. Said one or more magnetic sequences are magnetic sequences of the one or more first magnetic sequences and / or magnetic sequences of the one or more second magnetic sequences. It is also possible that the polarity of all the dipole magnets of the rotor and the stator, respectively, is the same, i.e. that the north poles of all the dipole magnets of the rotor and the stator are either facing or facing away from the shaft axis. The polarity of a dipole magnet is understood to mean the orientation of the magnetic north and south poles of the dipole magnet.

In another preferred embodiment, the polarity is two or more

Dipole magnets of a magnetic sequence alternately. It is possible that adjacent dipole magnets within a magnet sequence have a different polarity. In this case, successive dipole magnets of a magnet sequence, for example, show the sequence ... SNSN ... (N = north pole, S = south pole). It is also possible, that the change of polarity is irregular, so that, for example, the sequence ... NNSNNS ... results.

Preferably, the dipole axes of the dipole magnets are parallel to the plane perpendicular to the shaft axis.

Preferably, the spacing of adjacent dipole magnets of the two or more dipole magnets is constant within one or more magnet sequences. Said one or more magnetic sequences are magnetic sequences of the one or more first magnetic sequences and / or magnetic sequences of the one or more second magnetic sequences.

It is possible that the spacing of adjacent dipole magnets within the one or more first magnet sequences of the rotor and / or the stator is constant. In this case, it is possible for the spacing of adjacent dipole magnets of the two or more dipole magnets within the one or more first magnet sequences to be different from the spacing of adjacent dipole magnets of the two or more dipole magnets within the one or more second magnet sequences. It is also possible that the spacing of adjacent dipole magnets of the two or more dipole magnets within the one or more first magnetic sequences coincides with the spacing of adjacent dipole magnets of the two or more dipole magnets within the one or more second magnetic sequences.

It is also possible that the angle of inclination of the dipole axes within the one or more first magnet sequences and / or the one or more second magnet sequences is constant. Preferably, this constant inclination angle is in a range of 14 degrees to 90 degrees.

The pitch angle of a magnet sequence indicates the intersection angle between a tangent tangent to a curve formed by the two or more dipole magnets within the magnet sequence and a plane perpendicular to the shaft axis. In the general case, the pitch angle of a magnet sequence may change in the course of the magnet sequence. In a preferred embodiment, the pitch angle of a magnetic sequence is constant, comparable to the slope of a Thread. In the case of a constant pitch angle, the two or more dipole magnets of the magnet sequence lie on a straight line during a development.

It is preferred if the one or more first magnet sequences have the same pitch angle, called the first pitch angle. Furthermore, it is preferred if the one or more second magnet sequences have the same pitch angle, called the second pitch angle.

The angle of attack between a first magnetic sequence and a second magnetic sequence in a development of the first and second magnetic sequences, the intersection angle between a first tangent that touches a curve formed by the two or more dipole magnets within the first magnetic sequence, and a second tangent, a through the two or more dipole magnets within the second magnet sequence touched curve contacts. In the general case, the angle of attack may change in the course of the magnetic sequences.

In a preferred embodiment, the angle of attack between a first magnet sequence and a second magnet sequence is constant. In this case, the respective pitch angle of the first magnet sequence and the second magnet sequence is constant.

In a particularly preferred embodiment, there is a single, constant angle of attack for all first and second magnet sequences. In this case, the one or more first magnetic sequences have the same first pitch angle and the one or more second magnetic sequences have the same second pitch angle.

In a preferred embodiment, two or more first magnetic sequences begin at a first plane perpendicular to the shaft axis and terminate at a second plane perpendicular to the shaft axis. In the same way, it is possible that two or more second magnet sequences start at a first plane arranged perpendicular to the shaft axis and terminate at a second plane arranged perpendicular to the shaft axis. It is possible for all the magnet sequences of the rotor and / or the stator to begin at a first end face of the rotor or stator oriented transversely to the shaft axis and terminate at a second end face of the rotor or stator oriented transversely to the shaft axis. Preferably, the one or more first magnet sequences and / or the one or more second magnet sequences are arranged such that groups of two or more magnet sequences form. A group of two or more magnetic sequences is characterized in that the distance of the magnetic sequences to one another is smaller than the distance to magnetic sequences which do not belong to the group.

In a preferred embodiment, an air gap between the rotor and the stator has a gap width of 0.1 mm to 50 mm. It is particularly preferred if the gap width has a value of 1 mm to 5 mm.

In a preferred embodiment, the rotor and the stator in the plane arranged perpendicular to the shaft axis have a substantially circular cross-section. The term "substantially circular" states that the cross-section does not fulfill the geometrically perfect circular shape due to the manufacturing tolerances, but comes close to it.

Preferably, the lateral surface of the first circular cylinder is rewritten to the outer circumference of the rotor and / or inscribed the inner circumference of the rotor. The former, that the circumferential surface of the first circular cylinder is rewritten to the outer circumference of the rotor, refers to the case that the rotor is arranged at least partially radially further in relation to the stator. The latter, that the lateral surface of the first circular cylinder is inscribed on the inner circumference of the rotor, refers to the case that the rotor is arranged at least partially radially further outward with respect to the stator.

Preferably, the lateral surface of the second circular cylinder is rewritten to the outer circumference of the stator or inscribed on the inner circumference of the stator. The former, that the circumferential surface of the second circular cylinder is rewritten to the outer circumference of the stator, refers to the case that the rotor is arranged at least partially radially outward with respect to the stator. The latter, that the lateral surface of the second circular cylinder is inscribed in the inner circumference of the stator, refers to the case that the rotor is arranged at least partially radially further in relation to the stator. In a preferred embodiment, the dipole magnets of the rotor or of the stator are each arranged on the lateral surface of the first circular cylinder or of the second circular cylinder such that the lateral surface of the first circular cylinder or of the second circular cylinder respectively touches the dipole magnets of the rotor or of the stator non-cuttingly , The term "non-cutting touched" states that the respective lateral surface touches the dipole magnets but does not intersect their volume, which means that the respective lateral surface exclusively touches the dipole magnets, ie touches them on the surface.

It is particularly advantageous if the rotor and / or the stator comprises a support body of non-magnetic material with recesses for receiving the dipole magnets. The support body serves to hold the dipole magnets at a defined position. The dipole magnets are fixed in recesses of the support body provided for this purpose.

In a preferred embodiment, the stator is formed as an inner stator, the rotor is disposed at least partially radially further outward relative to the stator formed as an inner stator and fixedly connected to the shaft, and the device has an outer stator coaxial with the shaft which is disposed at least partially radially outward with respect to the rotor. In addition, in this preferred embodiment, the dipole magnets of the one or more second magnet sequences are uniformly distributed over the circumference of the second circular cylinder and offset axially relative to each other with respect to the shaft axis such that a stepped arrangement of the dipole magnets results on the lateral surface of the second circular cylinder and adjacent one another Axially partially overlap dipole magnets with respect to the shaft axis. In addition, in this preferred embodiment, the rotor k has first magnetic sequences, k being an integer greater than or equal to four, and the two or more dipole magnets of the k first magnetic sequences being formed to have two or more on the

Form lateral surface of the first circular cylinder extending rows each with k evenly distributed on the circumference of the first circular cylinder dipole magnets. Moreover, in this preferred embodiment, the dipole magnets of a row lie in a plane perpendicular to the shaft axis, and the Dipole magnets adjacent rows are alternately offset from each other so that they form a uniform zigzag pattern over the circumference of the circular cylinder axially to the shaft axis. For this purpose, in this preferred embodiment, the outer stator on two or more arranged on one of the lateral surface of a third circular cylinder dipole magnets, which are distributed uniformly on the lateral surface.

In a preferred embodiment, the magnets of the inner stator, the rotor and the outer stator at least partially overlap. A partial overlap of two magnets is satisfied when there is a plane perpendicular to the shaft passing through each of the two magnets. A complete coverage of two magnets is then spoken of when for each point of one of the two magnets there is a plane perpendicular to the shaft passing through each of the two magnets. A partial overlap of three magnets is satisfied when there is a plane perpendicular to the shaft passing through each of the three magnets. A complete coverage of three magnets is then spoken of when for each point of two of the three magnets there is a plane perpendicular to the shaft passing through each of the three magnets. It can be defined a degree of coverage: at a coverage of 0% two / three magnets do not overlap, at a coverage of 100% cover two / three magnets completely.

In a particularly preferred embodiment of the device, the inner stator and the rotor are arranged immovable axially to the shaft axis and the magnets of the inner stator and the rotor completely overlap. In addition, the outer stator is arranged axially movable relative to the shaft axis, so that the

Covering degree of the magnets of the outer stator and the magnets of the rotor can be continuously changed in a range of 0% to 100%.

The magnets of the inner stator, of the rotor and of the outer stator each define an imaginary hollow cylinder with a common longitudinal axis (= the shaft axis), within whose wall the magnets are arranged. In the case of a partial overlap of the three magnets, the three imaginary hollow cylinders lie radially one above the other at least in a section of the longitudinal axis. This portion of the longitudinal axis thus forms the longitudinal axis of the imaginary cylinder cavity whose Longitudinal axis coaxial with the shaft. In the case of complete coverage of the magnets of the three components (= inner stator, rotor and outer stator) are two of the three imaginary hollow cylinder always radially above or below the third of the three imaginary hollow cylinder.

Preferably, the rotor is in the form of a drum or cup, i. it has a hollow cylinder with an annular cross-section or a pipe section, whose one end face is covered by a coaxial circular disk. In the center of the disc, the rotor has a bore through which the shaft axis passes. The disc may additionally carry a ring which serves to connect the rotor to the shaft, e.g. by means of a screw connection passing through a radial bore in the ring. The rotor is immovably connected to the shaft, that is, the relative position of the rotor with respect to the shaft remains unchanged upon rotation of the shaft during normal operation of the device. However, the threaded fastener connecting the rotor to the shaft can be released, e.g. for maintenance, cleaning, replacement of defective parts, etc. The hollow cylinder of the rotor surrounds the lateral surface of the cylindrical inner stator to form an annular air gap between the rotor and the inner stator.

It is also possible that the circular disc which covers one end face of the rotor-hollow cylinder has two or more dipole magnets which are arranged on a circumference with respect to the center of the circular disc. The magnetic dipole axis of the dipole magnets is parallel to the shaft axis. A magnetic dipole axis, or dipole axis for short, of a dipole magnet is understood to mean a straight line connecting the south pole and the north pole of the dipole magnet. Preferably, the dipole magnets are evenly distributed on the circumference.

It is particularly advantageous if the outer stator surrounds the rotor in the form of a hollow cylinder or a circular tube. For example, it is possible for the outer stator to be in the form of a hollow cylinder or circular tube whose central axis coincides with the central axis of the rotor. The hollow cylinder of the outer stator surrounds the lateral surface of the hollow cylindrical rotor to form an annular air gap between the outer stator and the rotor.

In a preferred embodiment, the dipole magnets of the outer stator have a rod-shaped geometry and run with their rod or longitudinal axis parallel to the longitudinal axis of the circular tube, i. parallel to the axis of the shaft (= shaft axis). It is preferred that the dipole magnets of the outer stator extend substantially the entire length of the outer stator in the form of a circular tube. "Substantially" may mean that the outer stator still has at its front sides a rim or a cover disk on which the dipole magnets end, The magnetic dipole axes of the dipole magnets of the outer stator preferably lie in a plane which is perpendicular to the longitudinal axis of the dipole magnets ,

It is also possible that the preferably rod-shaped dipole magnets of the outer stator are arranged in the form of one or more rings along the circumference of the outer stator. Each of the rings formed by the dipole magnets lies in a plane which is perpendicular to the shaft axis. The dipole magnets forming a ring are mutually separated by webs of non-magnetic material. Between the individual rings formed from the dipole magnets run annular webs of non-magnetic material along the circumference of the outer stator. The inner sides of the dipole magnets which are oriented toward the shaft axis preferably lie on a lateral surface of a circular hollow cylinder. It is preferable that the dipole magnet rings are distributed uniformly over the entire height of the outer stator.

In a preferred embodiment of the invention, the inner stator and the outer stator are fixedly arranged. The inner stator and outer stator may be non-rotatably mounted on a mechanical housing for receiving the device by means of fasteners and / or guide means.

In a preferred embodiment, the shaft does not penetrate the inner stator, but is merely connected to the rotor. The rotor is through the Magnetic fields of the device held in suspension. Therefore, an additional mechanical storage of the rotor by means of a bearing is not necessary. The shaft is formed in this case by a pin which is arranged on the outside of the circular disk on the front side of the rotor projecting on the rotor. In an alternative embodiment of the device, the shaft extends over the entire length of the device. In this case, the shaft extends along the central axis of the inner stator and serves as an additional mechanical guide element of the rotor. In this case, the inner stator preferably has a bearing, for example a rolling bearing, in which the shaft is rotatably mounted.

It is also possible that the rotor and the outer stator each consist of two halves. Preferably, these halves are each formed symmetrically, with respect to a plane of symmetry which is perpendicular to the shaft axis. At the same time, this plane of symmetry also penetrates the inner stator, which in this way is split into halves of equal length. Around

Symmetrieebene is arranged a fastening device by means of which the inner stator is immovably fixed to the mechanical housing. Preferably, this fastening device separates the two halves of the rotor and the two halves of the outer stator to form air gaps. It is also possible that the two halves of the outer stator are displaceable with respect to the shaft axis.

In a preferred embodiment, the two halves of the outer stator are displaceable symmetrically to the plane of symmetry so that the degree of overlap of the magnets of the rotor is steplessly adjustable by the magnets of the outer stator in a range of zero percent to one hundred percent. This is e.g. feasible by means of a threaded shaft with two opposing threads on which the two halves of the outer stator are arranged in the opposite threaded portions. Depending on a direction of rotation of the threaded shaft, the two halves of the outer stator move toward or away from each other.

An angle α is defined as the angle between the dipole axis of a dipole magnet of the inner stator and a tangent to the circumference of the inner stator, the tangent passing through a point on the circumference in which the Dipole axis penetrates the perimeter. An angle β is defined as the angle between the dipole axis of a dipole magnet of the rotor and a tangent to the circumference of the rotor, the tangent passing through a point on the circumference in which the dipole axis penetrates the circumference. An angle Y is defined as the angle between the dipole axis of a dipole magnet of the outer stator and a tangent to the circumference of the outer stator, the tangent passing through a point on the circumference in which the dipole axis penetrates the circumference. In a preferred embodiment of the invention, the angles α, β and y lie in a value range of 14 ° <α, β, y ≤ 90 °. It is possible that the dipole axis of a dipole magnet extends in a plane perpendicular to the wave axis, which corresponds to an angle α, β, Y of 90 °.

In the case that said tangent to the circumference of the inner stator is parallel to the tangent to the circumference of the lateral surface of the second circular cylinder, the angle α corresponds to the angle of inclination. In the case that said tangent to the circumference of the rotor runs parallel to the tangent to the circumference of the lateral surface of the first circular cylinder, the angle β corresponds to the angle of inclination.

It is particularly advantageous if the dipole magnets of the inner stator and / or of the outer stator have a rectangular or trapezoidal cross section perpendicular to the shaft axis in a sectional plane. Furthermore, it is particularly advantageous if the dipole magnets of the rotor in a sectional plane perpendicular to the magnetic dipole axis of the dipole magnets have a point-symmetrical, preferably a circular, cross-section. However, other non-point symmetric cross sections are possible, e.g. trapezoidal, triangular, or irregular shaped cross sections.

In a further preferred embodiment, the dipole magnets of the inner stator and / or of the outer stator have the greatest extent parallel to the shaft axis. This means that the dipole magnets of the inner stator and / or the outer stator have a rod-shaped geometry. The extent parallel to the dipole axis is smaller than the extent parallel to the shaft axis. It is possible that all dipole magnets of the inner stator have the same external shape, ie the same geometry. It is also possible that all dipole magnets of the outer stator have the same external shape, ie the same geometry. It is also possible that all the dipole magnets of the rotor have the same external shape, ie the same geometry. With outer shape or geometry, only the outer dimensions are meant; the magnetic orientation, ie the position of the magnetic north pole and the magnetic south pole, is independent of this and can vary individually from magnet to magnet.

In a preferred magnet arrangement of the device, the magnets of the inner stator, of the rotor and of the outer stator are respectively oriented identically so that they repel each other in an angular position of the rotor. For example, for all dipole magnets on the inner stator, the north pole points outward, for all dipole magnets on the rotor the north pole inwards and the south pole outward, and for all dipole magnets on the outside stator the south pole inwards.

Further features, details and advantages of the invention will become apparent from the following description of several embodiments of inventive devices with reference to the drawings.

Show it

Fig. 1a, 1b cross sections of a stator with a magnetic sequence;

Fig. 2a, 2b are cross sections of stators with multiple magnetic sequences;

3a, 3b developments of lateral surfaces of stators;

Fig. 4 developments of lateral surfaces of a stator and a rotor;

Fig. 5a - 5c is a side view and cross sections of a stator;

6a - 6f are views, a longitudinal section and cross sections of a rotor; FIGS. 7a-7d are views and a cross section of a stator;

8a-8d are views and a cross-section of a stator;

9a-9h are diagrams for illustrating the pitch angle;

Fig. 10 is a diagram for illustrating the relationship between

Magnet sequences and magnet series of the rotor;

11 shows a schematic representation of a device according to the invention with a rotor and two stators;

FIG. 12a shows an oblique view of the inner stator of the device according to FIG. 11 without magnets (= stator core); FIG.

FIG. 12b shows a schematic representation of the inner stator of the device according to FIG. 11, perpendicular to the shaft axis; FIG.

Fig. 13 is a development of the magnet assembly on the inner stator of the apparatus of Fig. 11;

FIG. 14 shows a section through the inner stator of the device according to FIG. 11, along the line A-A indicated in FIG. 12b;

15a is a view of the fastening device of the device of Figure 11, perpendicular to the shaft axis ..;

FIG. 15b shows a view of the fastening device of the device according to FIG. 11, in the direction of the shaft axis; FIG.

Fig. 16 is an oblique view of the rotor of the apparatus of Fig. 11;

Fig. 17a is a schematic view of the inner stator and rotor of the apparatus of Fig. 11; Fig. 17b is a diagram of possible tilt angles of the dipole magnets of the rotor of the apparatus of Fig. 11;

Fig. 18a is a development of the magnet arrangement of the rotor of the apparatus of Fig. 11, along the direction X-Y indicated in Fig. 16;

FIG. 18b shows a detailed view of the development according to FIG. 18a; FIG.

19a shows a longitudinal section through a mechanical housing for receiving the device according to FIG. 11;

FIG. 19b shows a section through the outer stator of the device according to FIG. 11, perpendicular to the shaft axis; FIG.

Fig. 20 is an oblique view of the outer stator and the mechanical

Housing for receiving the device of FIG. 11;

21 is a diagram of the magnet arrangement on the stators and the rotor of the device according to FIG. 11, shown as a section along the

Shaft axis;

Fig. 22 is a diagram of the magnet arrangement on the stators and the rotor of

Apparatus according to Fig. 11, shown in section along the line B-B indicated in Fig. 11;

Fig. 23a is a schematic representation of a dipole magnet of the outer stator of the apparatus of Fig. 11;

Fig. 23b is a schematic representation of a dipole magnet of the inner stator of the device of Fig. 11; and

FIG. 23 c is a schematic representation of a dipole magnet of the rotor of the device according to FIG. 11. FIG. FIG. 1 a shows a cross section of a stator 2, wherein the sectional plane is orthogonal to the shaft axis 50. The stator 2 has a circular cross-section. The stator 2 comprises a magnet sequence of dipole magnets 8. The magnetic dipole axis 80 of one of these dipole magnets 8 lies in the sectional plane. The dipole magnet 8 is arranged on a lateral surface M2 of a coaxial with the shaft axis 50 oriented first circular cylinder. On the lateral surface M2, a tangent 81 extending in the sectional plane is laid, which contacts the lateral surface M2 at the point at which the dipole axis 80 penetrates the lateral surface. The angle between the dipole axis 80 and the tangent 81 is the angle of inclination a, which is 90 degrees in the present example.

Fig.1b shows a detail of Fig. 1a. The dipole magnet 8 touches the dashed circumferential surface M2 in the contact points P1, P2. The drawn with a solid line circumference U of the stator 2 follows the plane

End face of the dipole magnet 8 and therefore deviates in the region of the dipole magnet 8 from the cylindrical surface M2.

Fig. 2a shows a cross section of a stator 2 with a first and a second magnetic sequence. The stator 2 comprises two dipole magnets 8, which are arranged side by side. The magnetic dipole axes 80 of the two dipole magnets 8 lie in the sectional plane and run parallel. The left-hand dipole magnet 8 is part of the first magnet sequence of the stator 2, the right-hand dipole magnet 8 is a component of the second magnet sequence of the stator 2.

FIG. 2b shows a cross-section of a stator 2 with a first and a second magnet sequence. The stator 2 comprises two dipole magnets 8, which are arranged side by side. The magnetic dipole axes 80 of the two dipole magnets 8 lie in the sectional plane, intersect the shaft axis 50 and enclose an angle λ. The left-hand dipole magnet 8 is part of the first magnet sequence of the stator 2, the right-hand dipole magnet 8 is a component of the second magnet sequence of the stator 2.

Fig. 3a shows a development of a lateral surface M2 of a cylindrical stator with a magnetic sequence F2. The orientation of the lateral surface M2 is indicated the shaft 5 and the shaft axis 50 defined. The magnet sequence F2 starts at the left side of the lateral surface M2 and ends at the right side of the lateral surface M2. The dipole magnets 8 of the magnet sequence F2 lie on a straight line. The arrangement of the magnet sequence F2 on the lateral surface M2 is defined by a pitch angle b of the straight line. The pitch angle b corresponds to the intersection angle between the straight line of the magnet sequence F2 and a plane perpendicular to the shaft axis 50. The magnet sequence F2 describes in its course along the shaft axis 50 a whole turn (= 360 degrees) about the shaft axis 50.

Fig. 3b shows - corresponding to Fig. 3a - a development of a lateral surface M2 of a cylindrical stator with a magnetic sequence F2. In comparison with the magnet sequence shown in FIG. 3a, the pitch angle b of the magnet sequence F2 shown in FIG. 3b is greater. Therefore, the magnet sequence F2 describes in its course along the shaft axis 50 only half a turn (= 180 degrees) about the shaft axis 50th

FIG. 4 shows a development of a lateral surface M2 of a stator with magnet sequences F2 and a development of a lateral surface M1 of a rotor associated with the stator with magnet sequences F1. The dipole magnets of the magnetic sequences F1, F2 lie in each case on straight lines. The stator associated with the straight line and the rotor associated with the line divorced at an angle of c.

FIG. 5 a shows a plan view of a stator 2. The stator 2 has the shape of a cylinder whose axis of rotation lies in the image plane and coincides with the shaft axis 50. The stator has eight magnet sequences F2. A support body of the stator 2 surrounds the pole faces of cylindrical dipole magnets 7 of the magnet sequences F2, which are located in recesses of the support body.

FIG. 5b shows a cross section of the stator 2 illustrated in FIG. 5a along a sectional plane AA, as shown in FIG. 5a. On average, recesses 22 distributed uniformly over the circumference of the stator 2 can be seen for the dipole magnets. Each of the visible recesses 22 is assigned to a separate magnet sequence F2. Relative to the shaft axis of the stator 2, the recess 22 of a magnet sequence F2 is at an angle δ with respect to the recess 22 of a rotated adjacent magnetic sequence F2. In the present embodiment, the angle δ = 45 degrees. The radius R2 of the cylindrical stator 2 is 45 mm in the present embodiment. The depth T22 of the cylindrical recesses 22 in the present embodiment is 22.22 mm, for example, its diameter D22 has a value of 10 mm.

FIG. 5c shows a cross section of the stator 2 illustrated in FIG. 5a along a sectional plane B-B, as shown in FIG. 5a. Compared to the section shown in Fig. 5b, the recesses are rotated by an angle Δ around the shaft axis 50. Within a magnetic sequence F2, adjacent dipole magnets 8 are therefore rotated relative to one another with respect to the shaft axis 50 by an angle Δ. In the present embodiment, the angle Δ = 12 degrees.

Fig. 6a shows a plan view of a rotor 1. The rotor 1 has the shape of a hollow cylinder with a height H. The height H is e.g. 235 mm. The wall of the rotor 1 has the through holes penetrating the wall, which serve as recesses 15 for receiving the dipole magnets. The magnetic sequences of the rotor 1 start at a distance E from the end face of the rotor 1 and end at the distance E from the opposite end face of the rotor 1. In the present embodiment, the distance E is 35 mm. The diameter D15 of the cylindrical recesses 15 is e.g. 10 mm. Each recess 15 is assigned a holding device for fixing the dipole magnets 7 inserted in the recesses 15. The holding device consists of a threaded hole 150 and a threaded pin, which is screwed into the threaded hole and serves to fix the dipole magnet 7.

Fig. 6b shows a view of links of the rotor 1 shown in Fig. 6a. The outer diameter D1A of the rotor 1 is for example 143 mm, its inner diameter D1 I, for example, 93 mm. The rotor 1 has threaded holes M6 distributed uniformly circumferentially on its front face and attached at a distance DM6 from the outer circumference. The threaded holes M6 may, for example, have an ISO metric thread with a nominal diameter M6 (ISO = International Organization for Standardization). The distance DM6 is eg 10 mm. These threaded holes M6 serve to cover on the front side of the rotor 1 fasten, over which the rotor 1 is connected to the shaft 5. On each end face, the rotor 1 has a circumferential groove 16 whose outer diameter D16 is 97 mm, for example. This groove 16 receives a corresponding circular projection of the lid.

FIG. 6c shows a three-dimensional view of the rotor 1 shown in FIG. 6a.

6d shows a longitudinal section of the rotor 1 shown in FIG. 6a along the sectional plane A-A indicated in FIG. 6a. The depth TM6 of the bores M6 mounted in the end faces has a value of e.g. 20 mm up. The depth T16 of the peripheral grooves 16 arranged at the end faces is e.g. 2 mm, its width B16 has a value of e.g. 2 mm. In Fig. 6d 15 threaded holes 150 can be seen in different recesses, which open into the recesses 15. Adjacent recesses 15 of a magnet sequence have, in the direction of the shaft axis 50, a distance DF1 which is e.g. 11 mm.

FIG. 6e shows a cross section of the rotor 1 shown in FIG. 6a along the sectional plane B-B indicated in FIG. 6d. On average, recesses 15 distributed uniformly over the circumference of the rotor 1 can be seen for the dipole magnets. Each of the visible in section recesses 15 is associated with a separate magnetic sequence F1. Relative to the shaft axis 50 of the rotor 1, the recess 15 of a magnetic sequence F1 is rotated by the angle δ1 with respect to the recess 15 of an adjacent magnetic sequence F1. In the present embodiment, the angle δ = 20 degrees. A dipole axis of a first recess 15 and a central longitudinal axis of a threaded hole 150, which opens into a recess 15 adjacent to the first recess 15, enclose an angle δ2, which in the present exemplary embodiment is 25 degrees.

FIG. 6f shows a cross section of the rotor 1 shown in FIG. 6a along the sectional plane CC indicated in FIG. 6d. Compared to the section shown in Fig. 6e, the recesses 15 are rotated by an angle $\Delta 1$ about the shaft axis 50. Within a magnetic sequence F1 adjacent dipole magnets 8 are thus rotated relative to the shaft axis 50 by an angle .DELTA.1 against each other. In the present embodiment, the angle $\Delta 1 = 12$ degrees. 7a shows a plan view of a stator 2 with group-like magnet sequences F2. Three magnet sequences F2 each form a group G.

FIG. 7b shows a view of links of the stator 2 shown in FIG. 7a.

FIG. 7c shows a cross section of the stator 2 shown in FIG. 7a along the sectional plane A-A indicated in FIG. 7a. The recesses 22 for receiving the cylindrical dipole magnets 8 are formed so that the longitudinal center axes of the recesses 22, which are associated with the G forming a group G magnet sequences F2 and are arranged in a direction perpendicular to the shaft axis 50 cutting plane, parallel to the cutting plane and each other are parallel. The straight lines running in the sectional plane, which intersect the shaft axis 50 and pass through the points in which the longitudinal center axes of the recesses 22 pierce a cylinder circumscribed around the circumference of the stator 2, enclose an angle bei in adjacent recesses of a group of magnet sequences. In the present embodiment, the angle ξ has a value of 14.24 degrees. The outer edges of immediately adjacent recesses 22 have a minimum distance 23, e.g. 1 mm can be.

FIG. 7d shows a three-dimensional view of the stator 2 shown in FIG. 7a.

8a shows a plan view of a stator 2 with group-like magnet sequences F2. Three magnet sequences F2 each form a group G. Compared to the stator 2 shown in FIG. 7a, in the stator 2 shown in FIG. 8a, the magnet sequences F2 forming a group G are at a greater distance from each other.

FIG. 8b shows a view of links of the stator 2 shown in FIG. 8a.

FIG. 8c shows a cross section of the stator 2 shown in FIG. 8a along the sectional plane AA indicated in FIG. 8a. The recesses 22 for receiving the cylindrical dipole magnets 8 are formed so that the longitudinal center axes of the recesses 22, which form a group G forming magnet sequences F2 are assigned and are arranged in a direction perpendicular to the shaft axis 50 extending cutting plane, parallel to the cutting plane and enclose an angle $\varphi 1$ with each other. In the present embodiment, the angle $\varphi 1$ has a value of 28 degrees. Immediate neighbors within the recesses 22 associated with the same group G are separated by a web of the support body of the stator 22. The web has a width J on the circumference of the stator 2, as sketched in FIG. 8c. In the present embodiment, the width J has a value of 11, 94 mm.

The longitudinal center axes of the recesses 22, which are assigned to different groups G, include at least one angle $\varphi 2$ with each other. In the present embodiment, the angle $\varphi 2$ has a value of 64 degrees.

FIG. 8d shows a three-dimensional view of the stator 2 shown in FIG. 8a.

9a to 9h each show a development of the lateral surface M1, M2 of a rotor 1 or stator 2. A magnet sequence is symbolized by an arrow. The direction of the arrow defines a direction of a magnetic sequence. A direction of a magnetic sequence is important when the magnetic flux dipole magnets have a characteristic polarity sequence that is directional. For example, it may be important to the present invention whether a magnet sequence with three dipole magnets has the polarity SNN or the polarity NNS. The orientation of the lateral surface M1, M2 is defined by the indication of the shaft axis 50.

Fig. 9a shows a pitch angle of b = 10 degrees of a magnetic sequence that starts at the left side of the lateral surface. Fig. 9b shows a pitch angle of b = 80 degrees of a magnetic sequence starting at the left side of the lateral surface. Fig. 9c shows a helix angle of b = 280 degrees of a magnetic sequence starting at the right side of the lateral surface. Fig. 9d shows a pitch angle of b = 350 degrees of a magnetic sequence starting at the right side of the lateral surface. Fig. 9e shows a helix angle of b = 10 degrees of a magnetic sequence starting at the left side of the lateral surface. Fig. 9f shows a pitch angle of b = 80 degrees Magnetic sequence that begins at the left side of the lateral surface. Fig. 9g shows a helix angle of b = 280 degrees of a magnetic sequence which starts at the right side of the lateral surface. Fig. 9h shows a helix angle of b = 350 degrees of a magnetic sequence starting at the right side of the lateral surface.

Fig. 10 is an illustration of the relationship between magnetic sequences F1 and rows of magnets 701 to 707 of a rotor 1. Fig. 10 shows a lateral surface M1 of a coaxial with a shaft 5 oriented first circular cylinder Z1. The rotor 1 is arranged coaxially with the shaft 5. The rotor 1 comprises twenty-eight dipole magnets 7, which are arranged on the lateral surface M1.

The dipole magnets 7 of the rotor 1 are arranged in four magnetic sequences F1, each with seven dipole magnets 7. For better distinction, the four magnetic sequences F1 are numbered with the subscript numbers 1 to 4 as F1i to FI_4. The dipole magnets 7 of the magnetic sequences F1 i to FI_4 are arranged or formed such that they form seven rows 701 to 707 running on the lateral surface M1, each with four dipole magnets 7 uniformly distributed on the circumference of the first circular cylinder Z1. The dipole magnets 7 of a row 701 to 707 lie in a plane perpendicular to the shaft axis 50 of the shaft 5 extending plane. The dipole magnets 7 adjacent rows are alternately offset from each other so that they form a uniform zigzag pattern axially of the shaft axis 50 over the circumference of the circular cylinder Z1. By way of example, the uniform zigzag pattern forming the dipole magnets 7 of the adjacent rows 703 and 704 is indicated by a bold line in FIG.

11 shows a schematic representation of a device according to the invention which has an inner stator 2, a rotor 1 and an outer stator 3, which are arranged coaxially to a shaft axis 50 of a rotatable rod-shaped shaft 5. The cylindrical inner stator 2 has at its two ends in each case a circular disk-shaped end cap 13, each with a ball bearing 11. By means of these ball bearings 11, the inner stator 2 is mounted coaxially on the shaft 5. The shaft is made in a typical embodiment of non-magnetic material, such as plastic, and has a diameter of 10 to 40 mm and a length of 100 to 400 mm. The inner stator 2 has an inner stator core 12 and arranged thereon along the lateral surface of the inner stator 2 magnets 8. The inner stator 2 is fixedly connected by means of screw connections 10 to a fastening device 4, which is arranged in a mechanical housing for receiving the device (not shown), and is held stationary in this way.

The rotor 1, consisting of two mirror-image rotor drums, each with a pipe section and a circular disk, is immovably connected by means of screw 10 with the shaft 5. Each of the rotor drums has magnets 7. These are dipole magnets 7 whose magnetic dipole axes extend in planes perpendicular to the shaft 5. Each of the rotor drums is separated by a hollow cylindrical air gap from the inside of the rotor drums arranged inside the inner stator 2 and by an annular air gap of the mounting plate 4, which represents a plane of symmetry with respect to the two rotor drums of the rotor 1. In a typical embodiment, the annular air gap and the hollow cylindrical air gap each have a width of 3 to 50 mm. Dipole magnets 700 are likewise arranged in the circular disks on the end faces of the rotor drums.

The mass of the rotor 1 and the associated shaft 5 is distributed rotationally symmetrical, so that no rotation occurs in a rotation about the shaft axis 50.

The outer stator 3 consists of two separate annular halves

(= Stator rings), each with frame 9, magnets 6 and fastening parts for fixing the magnets 6. Each of the frame consists of a hollow cylinder, on whose two end faces in each case an annular disc is arranged. In this way, each of the stator rings is covered on its outer circumferential surface and on its two end sides of one of the frame 9 and the shaft axis 50 out without frame, ie open. Within the frame 9 are located between the fastening parts, the magnets 6. Each of the two stator each one of the two rotor drums of the rotor 1 is assigned. Each of the stator rings is separated from the rotor drums of the rotor 1 arranged radially inside the stator rings by an annular air gap having a width of 3 to 50 mm. The magnets 6 arranged on the inside of the stator rings and those on the outside the rotor 1 arranged magnets 8 are therefore directly opposite, separated only by the annular air gap. Each of the stator rings can be moved parallel to the shaft axis 50. This means that the relative position of the outer stator 3 and thus the overlap of the rotor 1 by the outer stator during operation of the device can be changed and adjusted.

The magnets 6, 7, 8 are dipole magnets. In a preferred embodiment, the dipole magnets 6, 7, 8 are permanent magnets, e.g. consisting of the materials SmCo and / or NdFeB formed. However, it is also possible that one or more of the dipole magnets 6, 7, 8 are designed as electromagnets. The magnetic flux density of the magnets 6, 7, 8 is preferably in a range of 0.4 to 1.4 Tesla.

The frame is preferably made of non-magnetic material, e.g. Aluminum, manufactured and has a wall thickness of 2 to 10 mm.

Figure 12a shows an inner stator core 12 of the inner stator 2 made of non-magnetic material (e.g., aluminum, copper). The core 12 has a circular cylinder 120 on the surface of which ridges 121 in the form of a crown are arranged. Each of the ribs 121 extends along the center axis of the circular cylinder 120 from the bottom surface of the cylinder 120 to the top surface thereof. The ribs 121 extend radially with respect to the central axis of the circular cylinder 120 and are distributed uniformly over the circumference of the cylinder. In this way, between the individual ribs 121 furrows or grooves 122. The circular cylinder 120 has along its central axis a circular bore for receiving the shaft 5. Both in the base and in the top surface of the cylinder 120 is in each case a disc-shaped recess, in each of which one of the ball bearings 11 is partially arranged.

The diameter of the stator core 12 is 50 to 500 mm, its height 100 to 300 mm. The width of the ribs 121 is ≦ 100 mm and about 20 percent of the width of the grooves 122. Figure 12b shows a schematic representation of the inner stator 2. The inner stator 2 includes the inner stator core 12, the magnets 8 and the end caps 13. The same length magnets 8, whose length dimension is smaller than that of the stator core 12 is selected, are in the the lateral surface of the circular cylinder 120 inserted along extending grooves 122. Viewed over the cylinder circumference of the inner stator 2, the arrangement of the magnets 8 is such that a first magnet 8-1 is inserted flush with the base of the cylinder 120, and the remaining magnets 8 with axial offset V with respect to the shaft axis 50 are arranged so that there is a uniform stair pattern on the outer surface of the inner stator 2. The axial offset V is equally divided over the length of the inner stator 2, that a last magnet 8-10 terminates at its end face with the top surface of the cylinder 120. In the transition from the last magnet 8-10 to the first magnet 8-1, there exists a large step W whose length is equal to (ni) times the offset V when n indicates the number of magnets 8. Both on the top surface and on the base of the cylinder 120, the inner stator 2 each have a disc-shaped end cap 13, in whose central axis in each case one of the ball bearings 11 is located.

The end caps 13 have a diameter of 50 to 500 mm and a height of 5 to 20 mm. A typical length of the magnets 8, measured in the direction of the shaft axis 50, is 100 mm. The axial offset V is variable, depending on the number of magnets. In a typical arrangement, V is about 5 percent of the length of the magnets 8.

Between the magnets 8 extend the outer sides of the ribs 121 of the inner stator core 12. The dimensions of the magnets 8 and the inner stator core 12 are coordinated so that the inner stator 2 has a substantially uniform lateral surface.

Figure 13 shows a development of the lateral surface of the inner stator 2. On the lateral surface ten magnets 8 are arranged, each having the same geometry. The magnets are measured in the direction of the shaft axis 50 shorter than the lateral surface. A first magnet 8-1 is flush with the base surface 125 of the inner stator core 12 with one of its end faces on the lateral surface arranged. The remaining nine magnets 8 are now arranged in the direction of the shaft axis 50 in a uniform offset V so that the last magnet 8-10 is flush with its right front side flush with the top surface 126 of the inner stator core 12. In this way, the stepped arrangement of the magnets 8 shown in FIG. 13 results.

FIG. 14 shows a section through the inner stator 2, along the sectional plane A-A indicated in FIG. 12b. The inner stator core 12 has a hollow cylinder 120, along the central axis of the shaft 5 extends and extend along the lateral surface along the ribs 121. The hollow cylinder 120 has a diameter of 100 mm and a length of 170 mm. In the grooves formed between the ribs 121 magnets 8 are used, which have a trapezoidal cross-section in the sectional plane A-A. The dipole magnets 8 are arranged so that their magnetic dipole axis 80 extends within the illustrated sectional plane A-A. An angle α, formed at the intersection of the magnetic dipole axis 80 of a magnet 8 and a tangent 81 to the inner stator 2 in the region of the magnet 8, may have values of 14 ° to 90 °. In the case shown in FIG. 14, the angle α = 90 °.

Figure 15a shows the fastening device 4 in a view perpendicular to

Shaft axis 50. The fastening device 4 has an inner hollow cylinder 40 with a smaller radius and an outer mounting ring 41 with a larger radius. The inner hollow cylinder 40 and the outer fixing ring 41 are fixedly connected to each other. The hollow cylinder 40 serves to receive and fix the inner stator 2 by means of screw connections 10. The fixing ring 41 is fixedly connected to a mechanical housing (not shown) for receiving the device. The fastening ring disk 41 has screw connections 10 on its outer circumference.

Figure 15b shows the fastening device 4 in a view in the direction of the shaft axis 50. The mounting ring 41 has on its periphery four screw 10 for attachment to the mechanical housing, the hollow cylinder 40 has over its circumference a plurality of screw 10 for attachment of the inner stator 2. Figure 16 shows a view of the rotor 1, which is arranged immovably on the shaft 5 by means of screw 10. The rotor 1 consists of two rotor drums arranged separately from each other, in whose lateral surface circular bores are mounted, which serve to receive the magnets 7. The rotor 1 is made of non-magnetic material (eg Al, Cu). The distance between the rotor drums is 15 mm. The rotor drums have an outer diameter of 165 mm, a height of 70 mm and a wall thickness of 26 mm. Each of the rotor drums has an annular disk-shaped top surface 102 in which two or more dipole magnets 700 uniformly distributed on a circumference with respect to the center of the top surface 102 are arranged. The magnetic dipole axis of these dipole magnets 700 runs parallel to the shaft axis 50.

FIG. 17 a shows a schematic view of one of the rotor drums of the rotor 1 and the inner stator 2, the view being perpendicular to the shaft axis 50. The rotor 1 is immovably connected to the shaft 5 by means of screw 10. The shaft 5 is rotatably supported in the inner stator 2 by means of a ball bearing. The rotor 1 surrounds the inner stator 2 drum or bell-shaped. The rotor 1 has a hollow cylinder 101, which is closed on a side facing away from the inner stator 2 by the top surface 102. Since the inner stator 2 is fixedly held (= non-rotatable) by the fixing device 4, the rotor 1 rotates with its hollow cylinder 101 around the inner stator 2. The hollow cylinder 101 of the rotor 1 is separated from the inner stator 2 by an annular air gap G1 , The hollow cylinder 101 of the rotor 1 has holes in which magnets 7 are inserted. The top surface 102 of the rotor 1 also has holes in which magnets 700 are used.

17b shows a schematic representation of the possible orientations of the dipole magnets 7 of the rotor 1, in a viewing direction parallel to the shaft axis 50. The magnetic dipole axis 70 of the rotor magnets 7 extends in a plane which is perpendicular to the shaft axis 50, ie within the image plane. The angle β between the magnetic dipole axis 70 and a tangent 71 to the outer circumference of the hollow cylinder 101 of the rotor 1 through the point at which the Dipole axis 70 penetrates the outer circumference of the hollow cylinder 101 may have values of 14 ° to 90 °.

FIG. 18a shows a development of the lateral surfaces of the two drum halves of the rotor 1 along the direction X-Y indicated in FIG. FIG. 18a shows the left drum half on the left and the right drum half on the right, which are symmetrical to one another. The development extends along the direction XY, as indicated in FIG. Arranged in planes perpendicular to the shaft axis 50 are rows 701 to 708 of magnets 7. Each of the rows 701 to 708 is slightly offset from an adjacent row so that a zigzag arrangement of the magnets 7 results in the direction of the shaft axis 50.

FIG. 18b shows an enlarged detail of the development of the magnets 7 shown in FIG. 18a. The centers of the magnets 7 within the rows 705, 706 are at a constant distance f from one another. The distance between two adjacent rows 705, 706 is chosen so large that the arrangement shown in FIG. 18b results in a constant magnet spacing d. Two magnets 7051, 7052 in the row 705 are arranged with respect to an associated magnet 7061 in the adjacent row 706 such that the centers of the three magnets 7051, 7052, 7061 are an isosceles triangle with legs of length d and a third side (FIG. Base) of length f. This relationship applies to all magnets 7 in all rows 701 to 708. The magnets 7 may not only have a circular cross-section as shown, but also other shapes such as square or hexagonal.

The distance d is in a range of about 3 mm to 50 mm. Particularly preferred is a distance of 5 mm. The distance f is in a range of about 10 mm to 70 mm.

19a shows a longitudinal section through the mechanical housing for receiving the device, ie a section parallel to the shaft axis 50. The mechanical housing comprises the fastening device 4 for receiving the inner stator 2, guide means 19 for guiding the displaceable halves of the outer stator 3, and a by means of a crank rotatable transmission shaft 14 for Displacement of the halves of the outer stator 3 with respect to the rotor or inner stator. The transmission shaft 14 has two threaded rods, which have mutually opposite threads (right and left-hand thread). Thereby, the two halves of the outer stator 3 can be moved uniformly or apart in a symmetrical opposite manner. The

Guide means 19 sit on the gear shaft 14 and are thus moved outward or inward with respect to the attachment means 4. The frame 9 of the outer stator 3 are fixedly connected to the guide means 19.

The mechanical housing has a height of 400 to 600 mm, a width of 400 mm, and a depth of 530 mm.

FIG. 19b shows a section through the outer stator 3, wherein the sectional plane is perpendicular to the shaft axis 50. The outer stator 3 has annularly arranged non-magnetic fastening parts 18, between which magnets 6 are arranged. For reasons of clarity, only some of the magnets 6 are shown by way of example. It is clear to the person skilled in the art that the magnets 6 are arranged over the entire circumference of the outer stator 3. The magnets 6 and the non-magnetic fastening parts 18 are dimensioned so that they in the assembled state, a hollow cylinder whose central axis extends in the direction of the shaft axis 50 result. The magnetic dipole axes 60 of the magnets 6 lie in planes that run perpendicular to the shaft axis 50. An angle y between the magnetic dipole axis 60 and a tangent 61 to the outer periphery of the hollow cylindrical outer stator 3 through the point where the magnetic dipole axis 60 pierces the outer periphery is in a range of 14 ° to 90 °. The outer stator 3 is connected to the guide means 19, which are in turn mounted on mounting columns 20 slidably.

Figure 20 shows an oblique view of the mechanical housing for receiving the device. The mechanical housing has on both end faces in each case a housing plate 21 a, 21 b, which are connected to each other by four mounting pillars 20. In the median plane between the two housing plates 21a, 21b is the mounting plate 4 for receiving the inner stator 2. In the Center points of the housing plates 21a, 21b are each a bore for the passage of the shaft 5. On the four mounting columns 20, the guide means 19, on which the halves of the outer stator 3 are fixed, slidably disposed. Also between the two housing plates 21a and 21b, the threaded shaft 14 (not shown) extends to the symmetrical

Displacement of the guide means 19, and thus the attached halves of the outer stator. 3

Figure 21 is a diagram showing the relative arrangement of the magnets 6 of the outer stator 3, the magnets 7 of the rotor 1 and the magnets 8 of the inner stator 2 in a preferred embodiment. The arrangement relates to a constellation in which the two halves of the outer stator 3 are shifted as far as possible to each other. In this constellation, a complete overlap of the three magnetic levels described results. The north pole of the dipole magnets 6, 7, 8 is indicated by the letter N, the south pole by the letter S.

The air gap G1 between the outer circumference of the inner stator 2 and the inner circumference of the rotor 1, and the air gap G2 between the outer circumference of the rotor 1 and the inner periphery of the outer stator 3 can be selected in any range with a width of 3 to 50 mm.

FIG. 22 shows a schematic arrangement of the three magnetic planes 6, 7, 8 in a sectional plane BB perpendicular to the shaft axis 50, as indicated in FIG. In a preferred embodiment, there are ten magnets 8 distributed uniformly over the outer circumference of the inner stator 2 on the inner stator 2. The magnets 6 have a trapezoidal cross-section in the sectional plane BB, ie perpendicular to the shaft axis 50. Each of the two rotor halves has four rows of sixteen magnets 7 each, which have a circular cross-section in a sectional plane perpendicular to their magnetic dipole axis. The outer stator 3 has on each of its two halves eighteen magnets 6, which are distributed uniformly over the circumference of each of the two stator halves. The magnets 6 have a trapezoidal cross-section in the sectional plane BB. FIG. 22 shows a preferred orientation of the dipole magnets 6, 7, 8. The north pole of the dipole magnets 6, 7, 8 is indicated by the letter N, the south pole by the letter S.

The ratio of the number of magnets 8 of the inner stator 2, the number of rows of magnets on the two rotor drums of the rotor 1 and the number of magnets 6 on the two stator halves of the outer stator 3 is preferably selected as indicated in Table I.

Anzahl der Magnete des inneren Stators	2	3	4	5	6	7	8	9	10	11	12
Anzahl der Magnetreihen auf einer ersten Rotor-trommel des Rotors	1	1	2	3	4	4	4	4	4	5	6
Anzahl der Magnetreihen auf einer zweiten Rotor-trommel des Rotors	1	1	2	3	3	3	3	4	4	5	5
Anzahl der Magnete auf jeder der beiden Hälften des äußeren Stators	≥ 2										

Table I

FIG. 23 shows particularly advantageous dimensions of the magnets used.

FIG. 23a shows a preferred dimension of a magnet 6 of the outer stator 3. The magnet 6 has a length of 75 mm in the direction of the shaft axis 50, the height of the trapezoidal cross section is 50 mm. The baseline of the trapezoid has a length of 25 mm and the base line opposite side has a length of 20 mm.

FIG. 23b shows a preferred dimension of a magnet 8 of the inner stator 2. The magnet 8 has a length of 100 mm in the direction of the shaft axis 50, the height of the trapezoidal cross section is 25 mm. The baseline of the Trapezes have a length of 25 mm and the base line opposite side has a length of 10 mm.

Figure 23c shows a preferred embodiment of a magnet 7 of the rotor 1. The magnet 7 has a circular cylindrical geometry, wherein the magnetic dipole axis 70 coincides with the central or longitudinal axis of the circular cylinder. The cylinder has a height of 20 mm and a diameter of 20 mm.

With regard to the dimensions of the magnets, it should be noted that in other advantageous embodiments, the specified length specifications can vary in a range of plus / minus 50 percent. However, embodiments are also conceivable in which the dimensions of the magnets are outside this range.

LIST OF REFERENCE NUMBERS

1 rotor

2 stator, inner stator

3 outer stator

4 fastening device, disc

5 wave

6 dipole magnets of the outer stator 3

7 dipole magnets of the rotor 1

8 dipole magnets of the (inner) stator 2

9 frames

10 screw connection

11 ball bearings

12 core of the inner stator 2 (= inner stator core)

13 end cap

14 gear shaft

15 recesses of the rotor 1

16 groove

18 mounting parts

19 guide device

20 mounting pillars

21a, 21b housing plates

22 recesses of the stator 2

23 distance of the recesses 22

40 hollow cylinders

41 fixing washer

50 shaft axis

51 plane, perpendicular to the shaft axis 50

60 magnetic dipole axes of the dipole magnets 6

61 tangent

70 magnetic dipole axes of the dipole magnets 7

71 tangent

80 magnetic dipole axes of the dipole magnets 8

81 tangent 101 hollow cylinder of the rotor 1

102 top surface of the rotor 1

120 circular cylinder of the inner stator core 12

121 Ribs of the Inner Stator Core 12 122 Grooves of the Inner Stator Core 12

125 Base area of the inner stator core 12

126 Top surface of the inner stator core 12 150 Thread hole

511 first plane, perpendicular to the shaft axis 50 arranged 512 second plane, arranged perpendicular to the shaft axis 50

700 dipole magnets

701 - 708 rows of magnets 7

a inclination angle b gradient angle b1 first gradient angle b2 second gradient angle

B16 width of the groove 16 c angle of attack d distance

D1A outer diameter of the rotor 1

D11 inner diameter of the rotor 1

DM6 distance

D15 diameter of the recesses 15 D16 outer diameter of the groove 16

D22 distance

E distance f distance

F1 first magnet sequences F2 second magnet sequences

G group of first magnetic sequences F1 and second magnetic sequences F2

G1 air gap

G2 air gap

H height J width k number of first magnetic sequences F1

M1 lateral surface of the first circular cylinder Z1

M2 lateral surface of the first circular cylinder Z2

M3 lateral surface of the first circular cylinder Z3

M6 threaded hole

North pole

P1, P2 points of contact

R2 radius

S south pole

TM6 depth of threaded hole M6

T16 depth of the groove 16

T22 depth

U circumference

V offset

Z1 first circular cylinder

Z2 second circular cylinder

Z3 third circular cylinder α, ß, γ, δ, δ1, δ2, Δ, Δ1, λ, ξ, φ angle

Patent Citations (11)

Publication number	Priority date	Publication date	Assignee	Title
DE2847618A1 *	1978-11-02	1980-05-14	Wilfried Wiesboeck	Multipole magnetic clutch for torque transmission - has two halves each with row of poles in special alignment and uses intermediate material conducive to eddy currents
EP0088909A2 *	1982-03-17	1983-09-21	Franz Klaus Union Armaturen Pumpen GmbH & Co.	Device for the transmission of forces
DE3228906A1 *	1982-08-03	1984-02-09	Wilhelm G. 8510 Fürth Scheller	Flywheel energy store
EP0501427A1 *	1991-02-26	1992-09-02	Koyo Seiko Co., Ltd.	Magnetic drive device
JPH08326709A *	1995-03-27	1996-12-10	Ckd Corp	Rotary actuator
US20040174079A1 *	2003-02-28	2004-09-09	Izraelev Valentin M.	System for passive and stable suspension of a rotor in rotor/stator assemblies
EP1477695A2 *	2003-05-15	2004-11-17	Vacuumschmelze GmbH & Co. KG	Magnetic bearing, method of machining a ringmagnet and use thereof
EP1489734A2 *	2003-06-19	2004-12-22	Seiko Epson Corporation	Drive control system
DE202005020288U1 *	2005-12-23	2007-05-03	H. Wernert & Co. Ohg	Permanent magnet contactless radial rotary coupler for e.g. vertical pump, has magnets polarized equally in circumferential direction, where magnets form non-contact operating passive radial support for receiving radial forces between units

Family To Family Citations				
JPH0424946B2 *	1984-09-29	1992-04-28	Tokyo Shibaura Electric Co	
JP4923238B2 *	2005-08-25	2012-04-25	国立大学法人富山大学	Magnetic repulsion support rotating machine

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Publication number	Priority date	Publication date	Assignee	Title
AU2014240249B1 *	2014-10-02	2015-04-23	Zenin, Vladimir Mr	Magnet engine
CN110999050A *	2017-07-24	2020-04-10	Arol公司	Magnetic coupling device
WO2022081006A2	2020-10-15	2022-04-21	Magpol International B.V.	Apparatus for moving a movable module thereof based on magnetic interactions
Family To Family Citations				
DE102014012297A1	2014-08-23	2016-02-25	Halit Eroglu	Piston motor with magnetic drive and shielding
US20190111459A1 *	2017-10-13	2019-04-18	The Regents Of The University Of California	Alternating magnetic field systems and methods for generating nanobubbles
IT201900021738A1 *	2019-11-20	2021-05-20	Tsl S R L	PASSIVE MAGNETIC BEARING

* Cited by examiner, † Cited by third party, ‡ Family to family citation

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Publication	Publication Date	Title
DE112011102531B4	2018-06-14	Magnetic gear device and holding part
WO2009019001A2	2009-02-12	Device having an arrangement of magnets
DE10207267A1	2003-02-20	Rotor for a synchronous reluctance motor and its manufacturing process
DE102013201353A1	2013-08-14	Rotor and reluctance motor
DE102007043575A1	2009-03-26	Fluid dynamic bearing structure and fluid dynamic bearing
DE102007043627B4	2011-05-26	Bearing with a cylindrical element which is connected to an outer element of the bearing
DE4339791C2	1995-10-05	Drive device with variable air gap
WO1997013989A1	1997-04-17	Gearbox
DE102019211713A1	2021-02-11	Twist device and method for a hairpin winding
DE102011084941A1	2012-05-03	Device for fracturing polycrystalline silicon and method for producing fractured fragments of polycrystalline silicon
DE2544379B2	1978-09-14	Fan rotor for a cross-flow fan
EP3484024B1	2023-01-04	Actuator
DE10240680B4	2008-08-21	piston engine
EP2553281A1	2013-02-06	Bearing arrangement having at least two parts rotatable relative to one another
DE2025099C3	1979-08-02	
DE2329680A1	1974-01-03	MAGNETIC CYLINDERS, IN PARTICULAR FOR HOLDING MAGNETIZABLE COVERS OR CLOTHES, SUCH AS PRINT TOWELS OR THE LIKE. ON THE CYLINDER SURFACE
WO2021115787A1	2021-06-17	Tool for separating and setting wire ends of a winding, and also method for producing a winding
EP0642204A1	1995-03-08	Rotor assembly for an electric machine
DE19824069A1	1999-12-02	Planetary gear has roller bearing spacer arrangement preventing
EP1221191B1	2003-05-07	Electric motor comprising a rotor mounted on one side
DE1048630B	1959-01-15	
EP0513576A1	1992-11-19	Apparatus for cutting foil webs

EP3583324A1	2019-12-25	Magnetic bearing and method for operating a magnetic bearing
DE102018121055A1	2020-03-05	Bearing arrangement
DE102020216117A1	2022-06-23	Pancake motor, in particular a pancake motor for a motor vehicle

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
EP08801521A	2007-08-07	2008-08-06	Device having an arrangement of magnets

Applications Claiming Priority (2)

Application	Filing date	Title
DE102007037186.3	2007-08-07	
DE102007037186A	2007-08-07	Device for generation of magnetic alternating field, has outer stator which has dipole magnets arranged on lateral surface of circular cylinder, where dipole magnets are evenly distributed on lateral surface

Legal Events

Date	Code	Title	Description
2009-04-01	121	Ep: the epo has been informed by wipo that ep was designated in this application	**Ref document number**: 08801521 **Country of ref document**: EP **Kind code of ref document**: A2
2009-04-16	DPE2	Request for preliminary examination filed before expiration of 19th month from priority date (pct application filed from 20040101)	
2009-09-24	DPE2	Request for preliminary examination filed before expiration of 19th month from priority date (pct application filed from 20040101)	
2009-12-22	WWE	Wipo information: entry into national phase	**Ref document number**: 2008801521 **Country of ref document**: EP
2010-02-09	NENP	Non-entry into the national phase	**Ref country code**: DE