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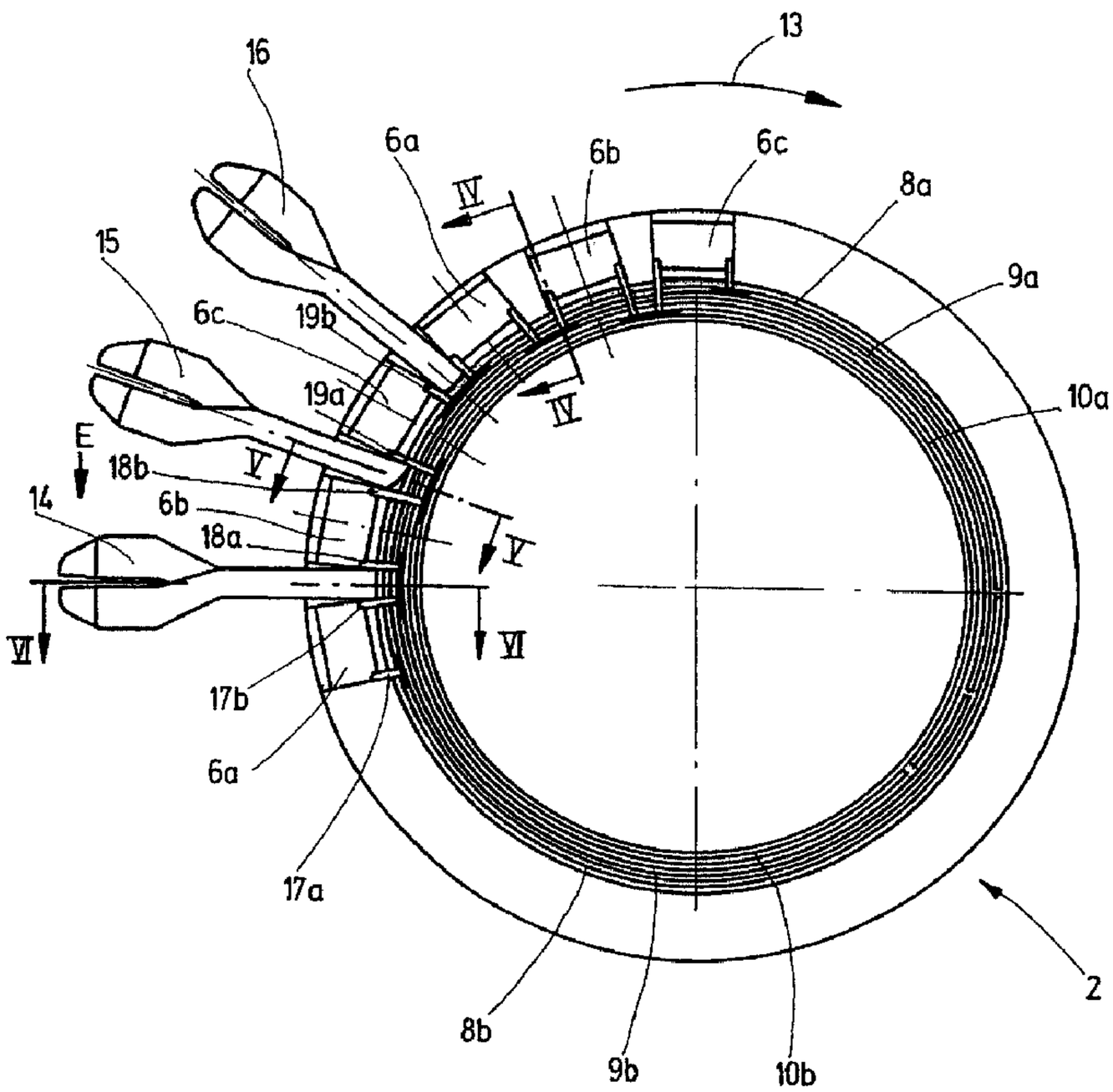
(71) Demandeur/Applicant:
PFISTERER KONTAKTSYSTEME GMBH & CO. KG, DE

(72) Inventeur/Inventor:
FRANK, ERICH WALTER, DE

(74) Agent: MARKS & CLERK

(54) Titre : DISPOSITIF POUR CONVERTIR DE L'ENERGIE ELECTRIQUE EN ENERGIE MECANIQUE ET/OU INVERSEMENT ET PROCEDE POUR PRODUIRE UN DISPOSITIF DE CE TYPE

(54) Title: DEVICE FOR CONVERTING ELECTRIC ENERGY INTO A MECHANICAL ONE AND/OR FOR DOING THE OPPOSITE AND METHOD FOR PRODUCING SUCH A DEVICE



(57) Abrégé/Abstract:
The present invention relates to a device for converting electric energy into mechanical energy and/or for doing the opposite (according to preamble of claim 1), and to a method for producing such a device. The purpose of this invention is to provide such a device together with a corresponding production method that compensate for the state-of-the-art disadvantages, mainly a

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(57) Abrégé(suite)/Abstract(continued):
device with a reduced overall height, a high contact reliability and an extended life time even under aggressive environmental conditions. The purpose of this invention is also to provide a device that can be easily manufactured. To this end, the connection distributors (8, 9, 10) are guided as a whole towards the outside of the device and form in each case a connection device (14, 15, 16), wherein the groups of connections can be brought into electric contact through said connection devices (14, 15, 16) outside the device.

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(71) Anmelder *(für alle Bestimmungsstaaten ausser US)*: PFISTERER KONTAKTSYSTEME GMBH & CO. KG [DE/DE]; Inselstrasse 140, D–70327 Stuttgart (DE).

(72) Erfinder; und
(75) Erfinder/Anmelder *(nur für US)*: FRANK, Erich, Walter [DE/DE]; Bachstrasse 50, D–73269 Hochdorf (DE).

(74) Anwalt: BARTELS & PARTNER; Lange Strasse 51, D–70174 Stuttgart (DE).

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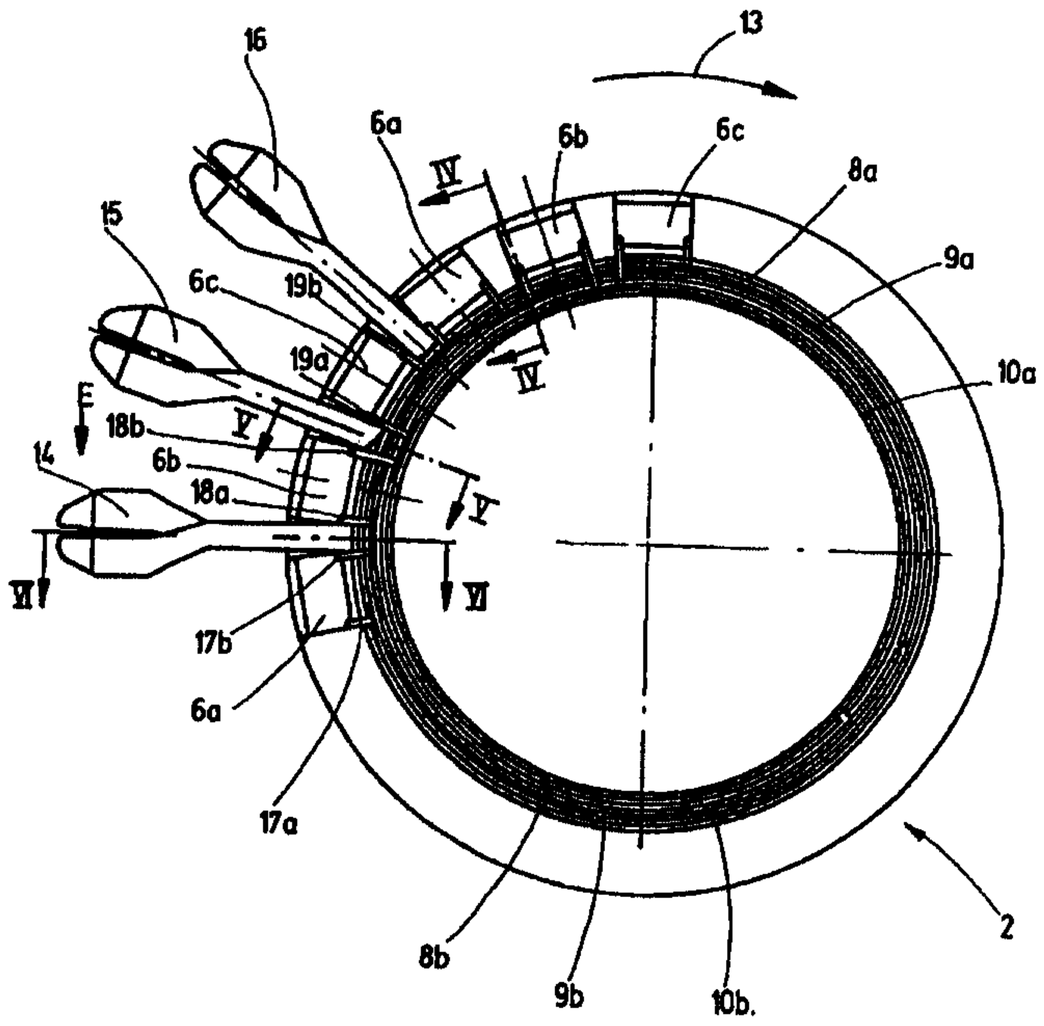
(54) Title: DEVICE FOR CONVERTING ELECTRIC ENERGY INTO A MECHANICAL ONE AND/OR FOR DOING THE OPPOSITE AND METHOD FOR PRODUCING SUCH A DEVICE

(54) Bezeichnung: VORRICHTUNG ZUM WANDELN VON ELEKTRISCHER IN MECHANISCHE ENERGIE UND/ODER UMGEKEHRT SOWIE EIN VERFAHREN ZUM HERSTELLEN EINER SOLCHEN VORRICHTUNG

(57) Abstract

The present invention relates to a device for converting electric energy into mechanical energy and/or for doing the opposite (according to preamble of claim 1), and to a method for producing such a device. The purpose of this invention is to provide such a device together with a corresponding production method that compensate for the state–of–the–art disadvantages, mainly a device with a reduced overall height, a high contact reliability and an extended life time even under aggressive environmental conditions. The purpose of this invention is also to provide a device that can be easily manufactured. To this end, the connection distributors (8, 9, 10) are guided as a whole towards the outside of the device and form in each case a connection device (14, 15, 16), wherein the groups of connections can be brought into electric contact through said connection devices (14, 15, 16) outside the device.



(57) Zusammenfassung

Die vorliegende Erfindung betrifft eine Vorrichtung zum Wandeln von elektrischer in mechanische Energie und/oder umgekehrt gemäß dem Oberbegriff des Anspruchs 1 sowie ein Verfahren zum Herstellen einer solchen Vorrichtung. Der Erfindung liegt daher das Problem zugrunde, eine gattungsgemäße Vorrichtung und ein zugehöriges Herstellverfahren bereitzustellen, welche die Nachteile des Standes der Technik überwinden, insbesondere eine geringe Baugröße, hohe Kontaktsicherheit und eine lange Lebensdauer auch unter aggressiven Umgebungsbedingungen aufweist und einfach herstellbar ist. Die Erfindung ist dadurch gelöst, daß die Anschlußverteiler (8, 9, 10) einstückig nach außerhalb der Vorrichtung geführt sind und jeweils eine Anschlußeinrichtung (14, 15, 16) ausbilden und daß die Anschlußgruppen über die Anschlußeinrichtungen (14, 15, 16) außerhalb der Vorrichtung elektrisch kontaktierbar sind.

DEVICE FOR CONVERTING ELECTRIC ENERGY INTO A MECHANICAL ONE AND/OR FOR DOING THE OPPOSITE AND METHOD FOR PRODUCING SUCH A DEVICE

The invention relates to a device for converting electric energy into mechanical energy and/or the opposite according to the disclosure part of Claim 1 as well as a method for producing such a device.

A device as in the disclosure part of Claim 1 is known from EP 0 213 863 A2. This document shows a device connecting the winding ends of an electric motor, which is arranged in the form of an annular sheet bar with circumferential conductor paths and solder-connection surfaces at one axial end of the electric motor. The conductor paths and with them the winding ends can be contacted from the exterior either by connection pins projecting from the sheet bar or by means of connection conductors to be soldered to other solder-connection surfaces.

In the case of other known devices the ends of the windings which are the coil windings of the rotor and/or the stator stand at some acceptable distance over the coil windings and are guided in circumferential direction relative to a common point. There, the relevant ends of the windings are pressed together with one another, thus forming groups of connections, and then are provided with an electrical connection element. This requires costly and essentially manually executable laying out of the winding ends and also increases the dimensions of the structure, since the winding ends must be guided over the coil windings. Also, the connection between the connection device and the pressed-on winding ends, especially under environmental conditions which generate reactions thereto, represents a possible source of breakdown during operation of

the device which has been produced, for example because of corrosion of the contacts.

EP 0 863 601 A1 shows a connection device for a stator in which connection wires forming connection distributors and being electrically insulating are embedded in circumferential grooves of an end plate fastened securely at the end of the stator. The ends of adjacent connection wires of the same group of connections which are turned toward one another are in turn pressed together with an associated winding end of the coil winding of the associated group of connections. To each connection distributor is guided a connection wire of the electric contact mechanism on the exterior of the device.

JP 6-233 483 A likewise shows a connection device for the electric connection of the winding ends of a group of connections of stator coil windings.

WO 97/26700 shows a connection device of a vehicle motor having connection plates of nonagon, annular format, arranged one over the other, to which the winding ends of the coil winding can be welded and which in turn have a crimp-connection for the crimp-connecting with a connection conductor leading toward the exterior. Each connection plate consists of a first electrically conductive layer and a second electrically insulating layer.

DE 195 44 830 A1 shows a stator for electric motors in which the winding ends of a connection group are connected with one another by electrically conducting connection distributors running in circumferential direction. The connection distributors have connection soldering lugs to which the winding ends or the motor connection conductors are welded or soldered.

US 4,224,543 shows a connection device for winding ends of stator coil windings with a sheet

bar

having radial notches to receive the ends of the winding and of external connection conductors, which subsequently are to be soldered with connection surfaces of the conductor paths mounted on the sheet bars.

US 5,806,169 shows a method for the production of an electric motor in which the stator is spray-injected and injection molded following the welding of the stator windings onto corresponding connection soldering lugs by means of an injection molding technique using a synthetic resin material.

The object of the invention is therefore to disclose a device to overcome the problem by using such a device, and an associated method of production of the device, which method and device overcome the drawbacks of the state of the art, particularly by incorporating small structural dimensions which guarantees high contact reliability with simple contacting and a long life and high current carrying capacity even under aggressive environmental conditions, and which can be manufactured simply.

The problem is solved by the device disclosed in Claim 1, as well as by the method which is disclosed in the other claims. Particular embodiments of the invention are disclosed in the dependent claims.

The device according to Claim 1 can be a motor or a generator, particulary a combined alternating or direct current-powered motor/generator device. Thus, coil windings could be arranged both on the rotor and on the stator, corresponding to the number of poles found on the device. The switch connection of the individual winding ends occurs according to the invention

by means of a connection device with formation of connection groups or contact groups. With a

three-phase alternating current device, for example, three (delta-wound circuit), four (star-wound circuit with spread-out star) or six connection or contact groups are formed. With six groups of connections, a switchover from star operation to three-phase operation and vice versa can also occur outside the device by suitable switching of the groups of connections. The rotor can be running on the interior or on the exterior in relation to the stator. A rotor having identical mass and running on the exterior has greater moments of inertia and torque. The connection distributor is guided toward the outside of the rotor or stator and there forms one piece with a connection device. This occurs preferably by suitable bending or shaping of a copper band or strip serving as connection distributor to a mechanical sleeve or bearing or plug element.

According to the one particular embodiment disclosed in Claim 2, the winding ends could advantageously be quite short. This leads not only to savings of material but also to small structural dimensions for the entire device. In the case of a rotor winding the rotor then has a slight imbalance which is a condition of this the type of construction.

According to the particular embodiment as in Claim 3, the connection distributors which may be annular in construction have cutting/clamping devices of one integral piece on the corresponding points at which the winding ends can be embedded, whereby the winding insulation is cut through at those points upon the pressing in of the winding ends. The cutting/clamping device in turn is preferably arranged precisely in relation to the associated winding ends. The cutting/clamping device can be set up ready for use by corresponding provision of a copper strip or copper ring to be used as connection distributor.

The particular embodiment of Claim 4 provides the two bands in essentially circular and coaxial alignment with the stator/rotor axis. Preferably a copper band or a copper strip is provided as connection distributor, whereby the band or strip is aligned parallel to the rotor or stator axis. The two bands or strips are guided in one piece toward the exterior of the device and there form a bushing area for the connection device by means of complementary semi-circular bends. In the bushing area the band or strip width is aligned parallel to the longitudinal axis of a plug element to be plugged into the bushing.

According to the particular type of embodiment disclosed in Claim 5, in the bushing area the two bands are connected with one another by an elastic element, preferably connected by a corrugated retaining ring. A permanent contact reliability is thus guaranteed along with simultaneous high current-carrying capacity.

According to the particular type of embodiment disclosed in Claim 6, the connection distributors are arranged axially and radially one behind the other, whereupon the radial and/or axial structural dimensions of the device can be minimized. The particulars with reference to radial and/or axial arrangement are then referenced to the rotary axis of the device.

According to the particular embodiment as in Claim 7, by use of the receiving means, not only is an electric insulation of the connection distributors from one another guaranteed by the receiving means but also, by the provision of positioning means, for example cams on the receiving means and notches on the associated connection distributor, an exact peripheral positioning of the connection distributor in relation to the receiving means and correspondingly in relation to the device can be guaranteed. Thus, minimal connection paths between the connection distributer and the coil winding are guaranteed simultaneously with simple assembly. Of course the

connection distributors could also be fastened securely directly to the rotor and/or the stator without use of any receiving means.

With the method of the invention as in Claim 8, first of all the electrically conducting connection distributors are embedded in receiving means of the connection device, then the connection device fastened securely to the rotor or stator for example by bolting or pinning on, then further and subsequently the winding ends electrically connected with the associated connection distributors and finally in turn a plug bushing of the connection device formed of one piece with the bands guided toward the exterior of the device for the electric contacting of the connection groups to the exterior of the device. This step of the method could advantageously be made automatic and for example could be executed by industrial robots.

According to the type of embodiment disclosed in Claim 9, the winding ends can be connected with the associated connection distributors by means of a cutting/clamping device or by gluing, soldering or welding. Preferably high temperature-resistant electrically conductive adhesive substances are used for glue. Preferably the hard-soldering process is used for soldering. When using welding, spot-welding is preferred.

In the type of embodiment of Claim 10, the receiving means are sealed off with the embedded connection distributors, if necessary with use of a clamp collar. This preferably occurs by dipping in an electrically insulating synthetic resin. Then contact points for the electric connection with the ends of the windings remain accessible on the connection distributors. Alternatively to that, the contact points of the connection distributor provided with a cutting/clamping device could also be cast or filled in, since during the pressing in of the winding

ends the insulating layer is penetrated. This use of the procedure has the advantage that the connection device can be set up as a complete structural assembly in and of itself on the rotor or stator and can be completely assembled in one step.

According to the embodiment of Claim 11 the completely assembled and wired rotor or stator is cast in insulating material.

Other advantages, features and individual disclosures of the invention are disclosed by the dependent claims as well as the following description, in which a number of exemplary embodiments are described in some detail with reference to the attached drawings. Therefore the features mentioned in the claims and in the description could in turn be essential to the invention in and of themselves or in any desired combination.

Fig. 1 shows a cross section through a device according to the invention,

Fig. 2 shows a plan view of the stator of Fig. 1,

Fig. 3 shows the electric wiring of the coil windings,

Fig. 4 shows a section corresponding to the line IV-IV of Fig. 2,

Fig. 5 shows a section along the line V-V of Fig. 2,

Fig. 6 shows a cross section along the line VI-VI of Fig. 2,

Fig. 7 shows an alternative embodiment of the device,

Fig. 8 shows an enlarged section of Fig. 7 in the area of the connection distributors, and

Fig. 9 shows the view IX of the connection mechanical sleeve or bearing of Fig. 7. .

Fig. 1 shows a cross section through a device according to the invention. In this case it has to do with a combined motor/generator device 1 with an interior stator 2 and a rotor 4 running on the exterior around the axis 3. The traditional associated housing is not shown. On the tin-plated core 5 of stator 2 are wound in sequence coil windings 6 in circumferential alignment. The winding ends of the various coil windings are connected electrically with one another with formation of groups of connections, whereby a connection device 7, 8, 9, 10 includes connection distributors 8, 9, 10 running in circumferential alignment, which are inserted in receiving means which can be fastened and sealed onto rotor 2. Connection distributors 8, 9, 10 of each group of connections are formed in the present embodiment by two copper bands bent in approximately semi-circular shape, which are arranged one behind the other in radial direction 20 and are electrically insulated from one another. The copper bands are dimensioned to correspond to the electric currents to be supported, for example they are of a width x thickness of 15 X 1 mm^2. Rotor 4 running on the exterior engages peripherally around the stator and supports permanent

magnets 12 on the surface 11 facing stator 2 in a number corresponding to the number of poles or the number of coil windings 6. Coil windings 6 if necessary can also have one or more symmetrically or unsymmetrically distributed partial taps.

Fig. 2 shows a plan view of the stator 2 of Fig. 1. Of the coil windings 6 arranged over the entire circumference in circumferential direction 13 there are represented for clarity only six coil windings 6a, 6b, 6c. The stator 2 which is represented is wired for a three-phase alternating current connection in a triangular circuit.

Coil windings 6a, 6b, 6c are thus wired each by means of approximately semi-circular connection distributors 8a, 8b; 9a, 9b; 10a, 10b to three connection groups and can be electrically connected from outside the stator by means of a first, second and third mechanical sleeve or bearing 14, 15, 16. The first winding end 17a of coil winding 6a of the first group of connections is connected with connection distributor 8b, whereas the second winding end 17b is connected with connection distributor 9b. The first winding end 18a of coil winding 6b of the second group of connections is connected with connection distributor 9b, whereas the second winding end 18b is connected with connection distributor 10b. The first winding end 19a of coil winding 6c of the third group of connections is connected with connection distributor 10b, and the second winding end 19b is connected with connection distributor 8b. And so forth, for the connection of the corresponding winding ends to connection distributors 8a, 8b, 8c. Both of the connection distributors 8a, 8b are formed in turn by copper strips which are bent approximately in semi-circles made up of one piece at one point of the circumference upward and/or outward and the corresponding ends are bent into formation of a mechanical sleeve or bearing area for an electric connection 14 of this connection group. Correspondingly the same is the case for the two connection distributors 9a, 9b, which in one piece form the connection 15 of the second

connection group, and for connection distributors 10a, 10b, which in one piece form the electric connection 16 of the third connection group.

Fig. 3 shows the electric wiring of the coil windings 6a., 6b, 6c of Fig. 2, arranged alternating in circumferential direction, which are connected parallel within the groups of connections which are formed and as a whole are wired to a three-phase, delta-wound circuit with the three electric connections 14, 15, 16. Insofar as a three-phase-star circuit is required, four connection groups altogether are provided, whereby the star point as needed can be guided over a fourth connection toward the outside of the stator or not. If the possibility of reversal from star- to delta-wound circuit and vice versa is to be present, the two winding ends of the parallel-connected coil windings in turn are to form contacts by connection distributors insulated from one another and are to lead to six electric connections in all.

Fig. 4 shows a section corresponding to line IV-IV of Fig.. 2. The first end 18a of coil winding 6b wound on laminated core 5 is connected electrically with the middle of connection distributor 9a in radial direction 20 by means of a cutting/clamping device 21 configured in one piece therewith. With the pressing in of the insulated winding end 18a the insulation is penetrated by the cutting flank 21a and the electric contact between connection distributor 9a and winding end 18a is produced. With further pressing in of winding end 18a, the cutting off of the nearly flush winding wire occurs. In the area of the connection of winding end 18a to connection distributor 9a the connection distributor 8a on the exterior in radial direction 20 preferably has a notch, in order to guarantee an electrically insulated passage of winding end 18a to the middle of connection distributor 9a in radial direction 20. Alternatively or in supplement hereto, the exterior connection distributor 18a can also have a narrower strip width over its entire length and/or can be inserted more deeply into the receiving means 7, which for example is formed by a

plastic ring provided with grooves to receive said connection distributors 8a, 8b, 9a, 9b, 10a, 10b. Fig. 5 shows a section along line V-V of Fig. 2. Both of the approximately semi-circular connection distributors 9a, 9b according to Fig. 2 are bent radially outward in the area of section V-V in electric contact with one another. In the area of bringing together of the two connection distributors 9a, 9b, the exterior connection distributor 8a aligned in radial direction has a notch, so that connection distributor 9b can be guided past electrically insulated therefrom.

Fig. 6 shows a cross section along line VI-VI of Fig. 2. The two connection distributors 8a, 8b bent semi-circular at this point come in contact with one another on the circumference and are guided together toward the exterior of stator 2. By means for example of a not shown projection provided in the overlapping area, the projection on connection distributor 8a and a convexity provided at the corresponding point of connection distributor 8b, during the insertion and guiding together of the connection distributors 8a, 8b, a simple and precise positioning of connection distributors 8a, 8b in relation to receiving means 7 and in relation to one another is guaranteed. Instead of projection and convexity for example also a sort of groove/spring combination in the associated connection distributors 8a, 8b; 9a, 9b; 10a, 10b could be provided.

Fig. 7 shows an alternative embodiment of the device of the invention, whereby an interior stator 102 is again provided, this time with coil windings 106 -here shown only diagrammatically. The connection distributors 108, 109, 110 connected electrically with one another in this embodiment are arranged one behind the other in axial direction 122 parallel to the rotation axis 103 of the associated and not shown rotor and are electrically insulated from one another by receiving means 107. Fig. 8 shows a cutout enlargement of Fig. 7 in the area of connection distributors 108, 109, 110. Winding end 118a of coil winding 106b is electrically connected by means of the cutting/clamping device 121 with the center of connection distributor 109 in axial direction 122.

Fig. 9 shows the view IX of the mechanical sleeve or bearing 116 of the connection of Fig. 7. The two upward bent ends 110a, 110b of connection distributor 110 are bent in the contact area complementarily and symmetrically to the symmetry plane 123 perpendicular to the plane of viewing, symmetry plane 123 being bent in a semi-circle in order to be able to receive a contact pin. The ends of connection distributors 110a, 110b are secured flexibly in the mechanical sleeve or bearing area by means of a corrugated retaining ring 124.

Patent Claims

1. Device for converting electric energy into mechanical energy and/or vice versa with a rotor (4) and a stator (2), particularly a combined motor/generator device (1), wherein coil windings (6) having at least two winding ends (17a, 17b; 18a, 18b; 19a, 19b) are arranged on the rotor (4) and/or the stator (2) in turn having a circumferential layout direction (13) following one after the other, and the winding ends (17a, 17b; 18a, 18b; 19a, 19b) of the various coil windings (6a; 6b; 6c) are electrically connected with one another with formation of groups of connections, whereby the device includes a connection device (7, 8, 9, 10) for the connection of the winding ends (17a, 17b; 18a, 18b; 19a, 19b) of a group of connections with electrically conductive connection distributors (8, 9, 10) running in circumferential direction, which form a connection device and are guided in one piece toward the exterior of the device, by means of which the relevant groups of connections can be electrically contacted outside the device, **characterized in that** the connection distributors (8, 9, 10) of each connection group have two electrically conductive bands (8a, 8b; 9a, 9b; 10a, 10b) which in turn are guided in one piece toward the exterior of the device and there together form a plug bushing (14; 15; 16) for the electric contacting of the relevant groups of connections.

2. Device as in Claim 1, characterized in that each winding end (17a, 17b; 18a, 18b; 19a, 19b) is connected with the associated connection distributor (8, 9, 10) in the close vicinity of the relevant coil winding (6a, 6b, 6c).

3. Device as in one of the Claims 1 or 2, characterized in that the connection distributors (8,

9, 10) have a cutting/clamping device (21`;121) configured of one piece for the electric connection with the associated winding ends (17a, 17b; 18a, 18b; 19a, 19b).

4. Device as in one of the Claims 1 to 3, characterized in that the two bands (8a, 8b; 9a, 9b; 10a, 10b) run essentially in semi-circles in circumferential direction.

5. Device as in Claims 1 to 4, characterized in that the two bands (110a, 110b) in the mechanical sleeve or bearing area (114) are connected by an elastic or flexible element, preferably by a corrugated retaining ring (124).

6. Device as in one of the Claims 1 to 5, characterized in that the bands (8a, 8b; 9a, 9b; 10a, 10b) of the individual groups of connections are arranged axially one behind the other, or are of different diameters and are arranged concentrically radially one behind the other.

7. Device as in one of the Claims 1 to 6, characterized in that the connection distributors (8, 9, 10) are arranged electrically insulated from one another in a receiving means (7) of the connection device (7, 8, 9, 10) which can be axially and/or radially securely mounted on the rotor (4) and/or the stator (2).

8. Method for producing a device as in one of the Claims 1 to 7, with the following steps:

- embedding of the electrically conductive bands (8a, 8b; 9a, 9b; 10a, 10b)of the connection distributors (8, 9, 10) in a receiving means (7) of the connection device (7, 8, 9, 10) in such a manner that the connection distributors (8, 9, 10) not belonging to a common group of connections are electrically insulated from one another,
- tight fastening of the connection device (7, 8, 9, 10) to the rotor (4) and/or the stator (2),
- electric connection of the winding ends (17a, 17b; 18a, 18b; 19a, 19b) with the associated connection distributors (8, 9, 10), and
- forming in turn of a plug bushing (14; 15; 16) of the connection device of one

piece out of the bands (8a, 8b; 9a, 9b; 10a, 10b) guided in one piece to the exterior of the device, these bands being part of a group of connections for the electric contacting of the relevant group of connections to the exterior of the device.

9. Method as in Claim 8, characterized in that the electric connection of the winding ends (17a, 17b; 18a, 18b; 19a, 19b) with the associated connection distributors (8, 9, 10) occurs in the close vicinity of the relevant coil winding (6a, 6b, 6c) by insertion in turn in a cutting/clamping device (21) provided on the connection distributors (8, 9, 10) and preferably of one piece, or by gluing, soldering or welding.

10. Method as in Claim 8 or 9, characterized in that the receiving means (7) are sealed together with the embedded connection distributors (8, 9, 10), preferably by dipping in an electrically insulating synthetic resin, whereby preferably following the sealing off, contact points are accessible on the connection distributors (8, 9, 10) for the electric connection with the winding ends (17a, 17b; 18a, 18b; 19a, 19b).

11. Method as in Claim 8 or 9, characterized in that the rotor (4) or the stator (2) together with the connection device (7, 8, 9, 10) sealed onto it and connected with the winding ends (17a, 17b; 18a, 18b; 19a, 19b) is then sealed off, preferably by dipping in an electrically insulating synthetic resin.

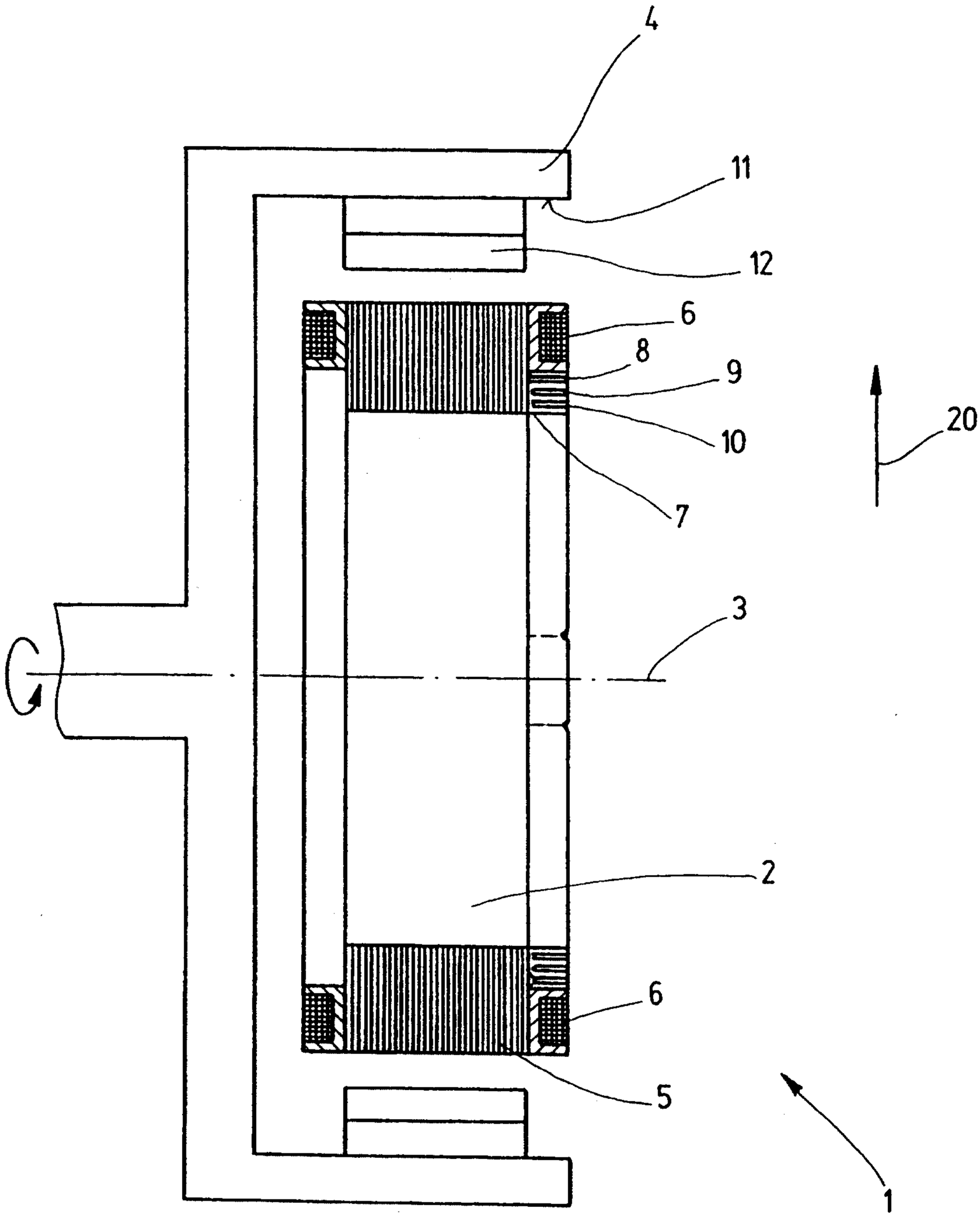


Fig.1

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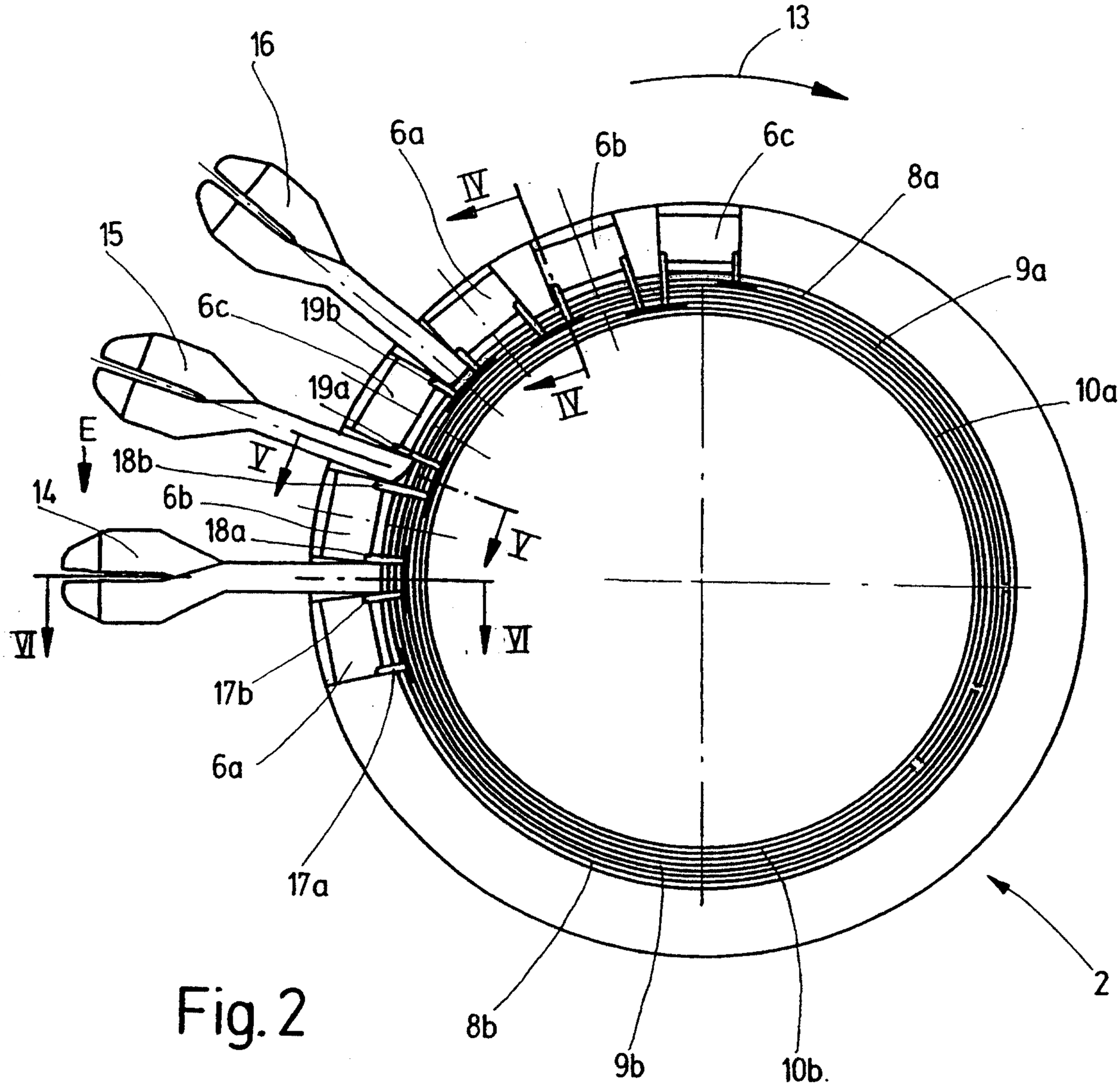

Fig. 2

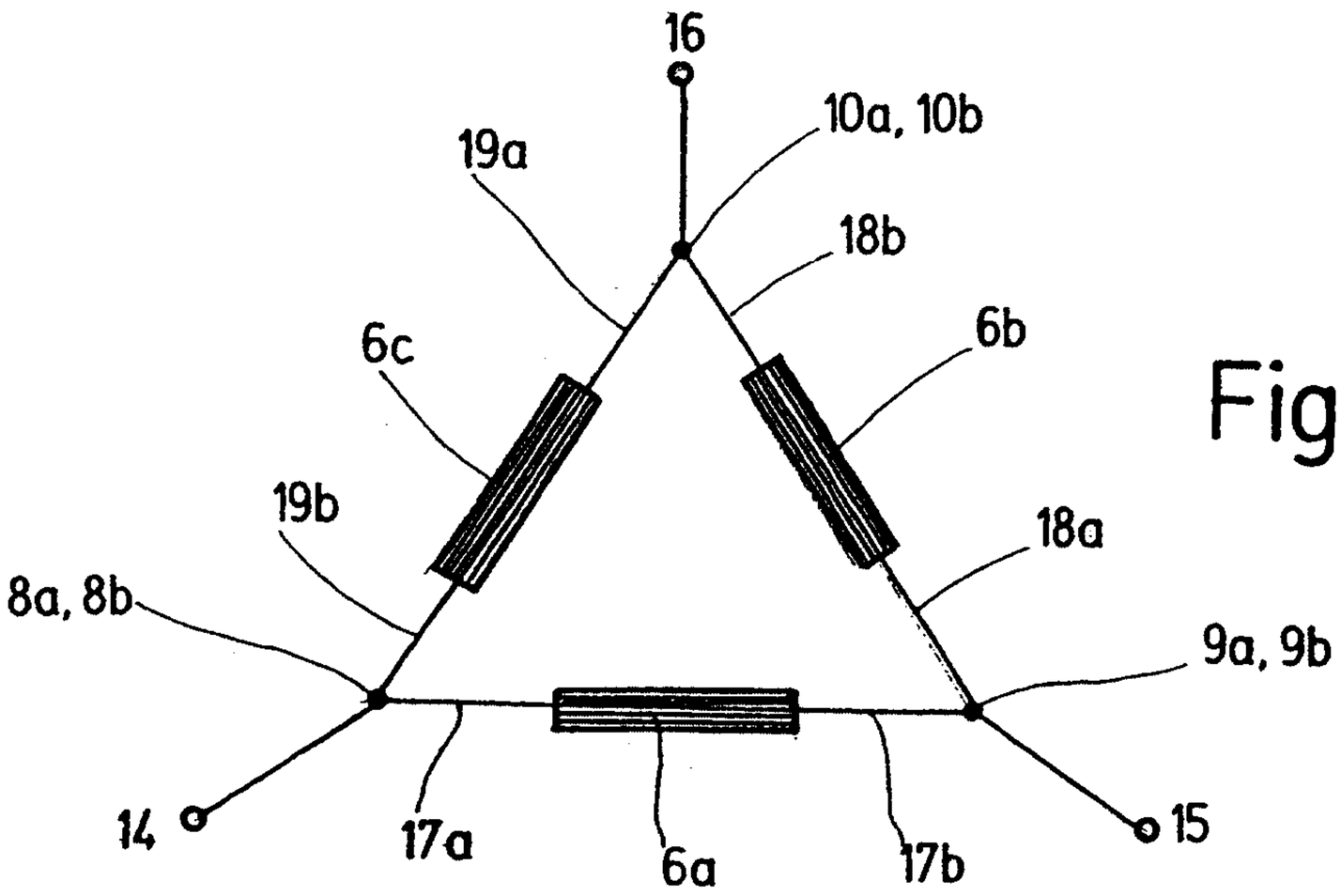

Fig. 3

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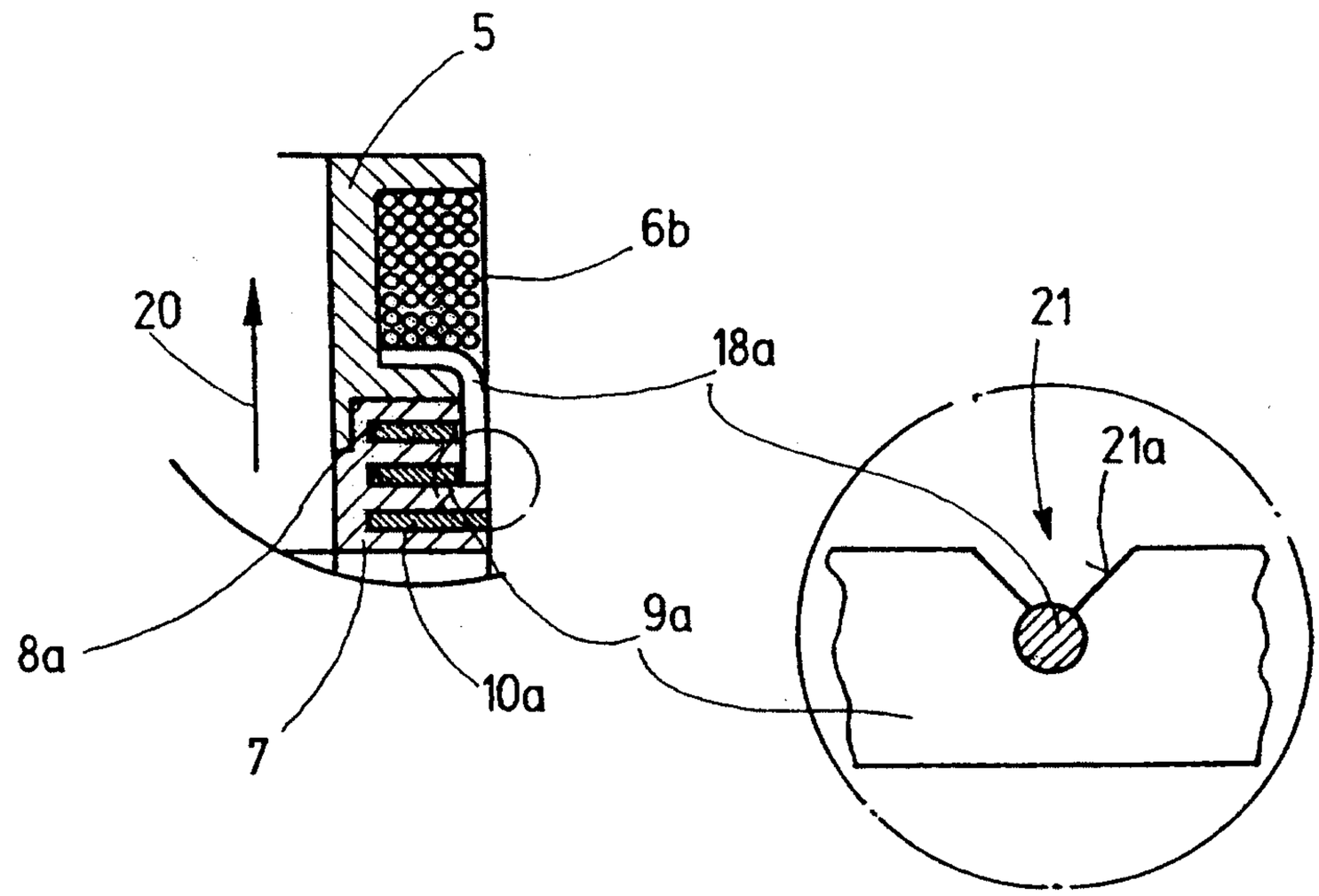

Fig.4

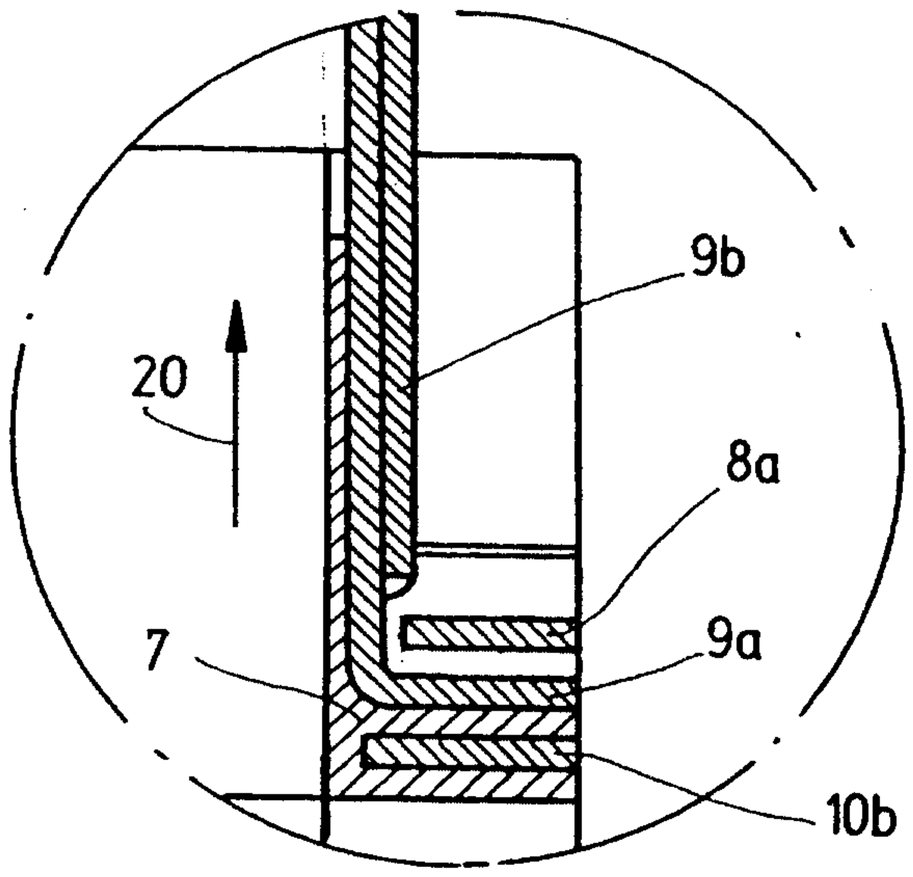

Fig.5

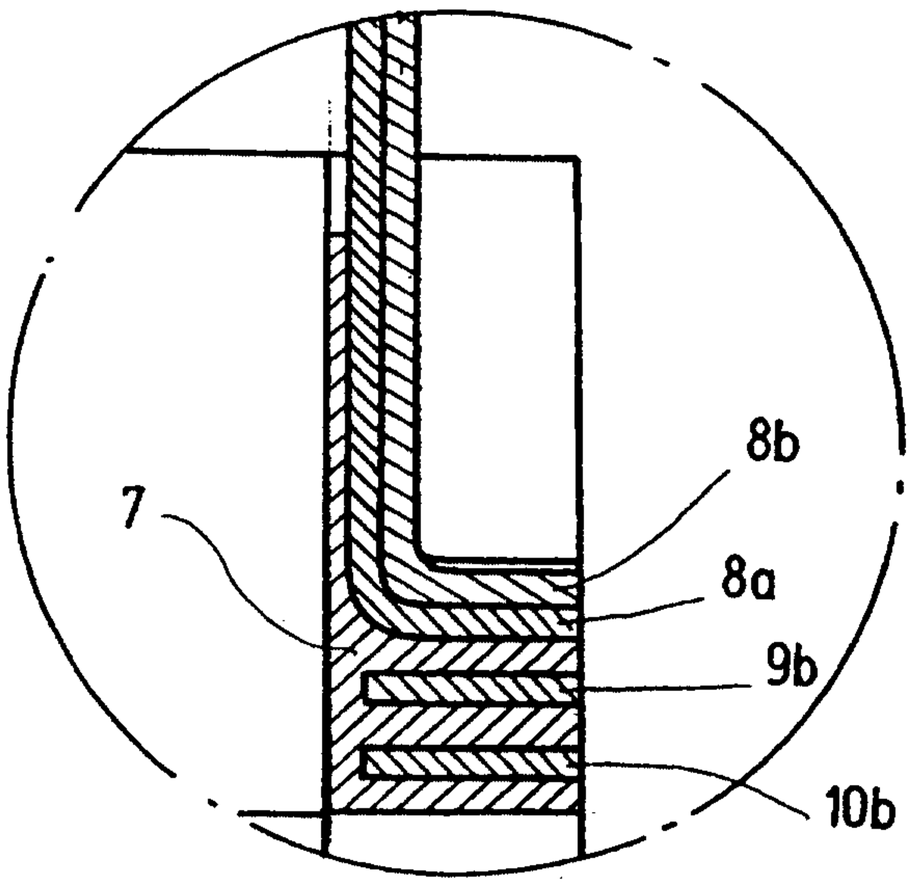

Fig.6

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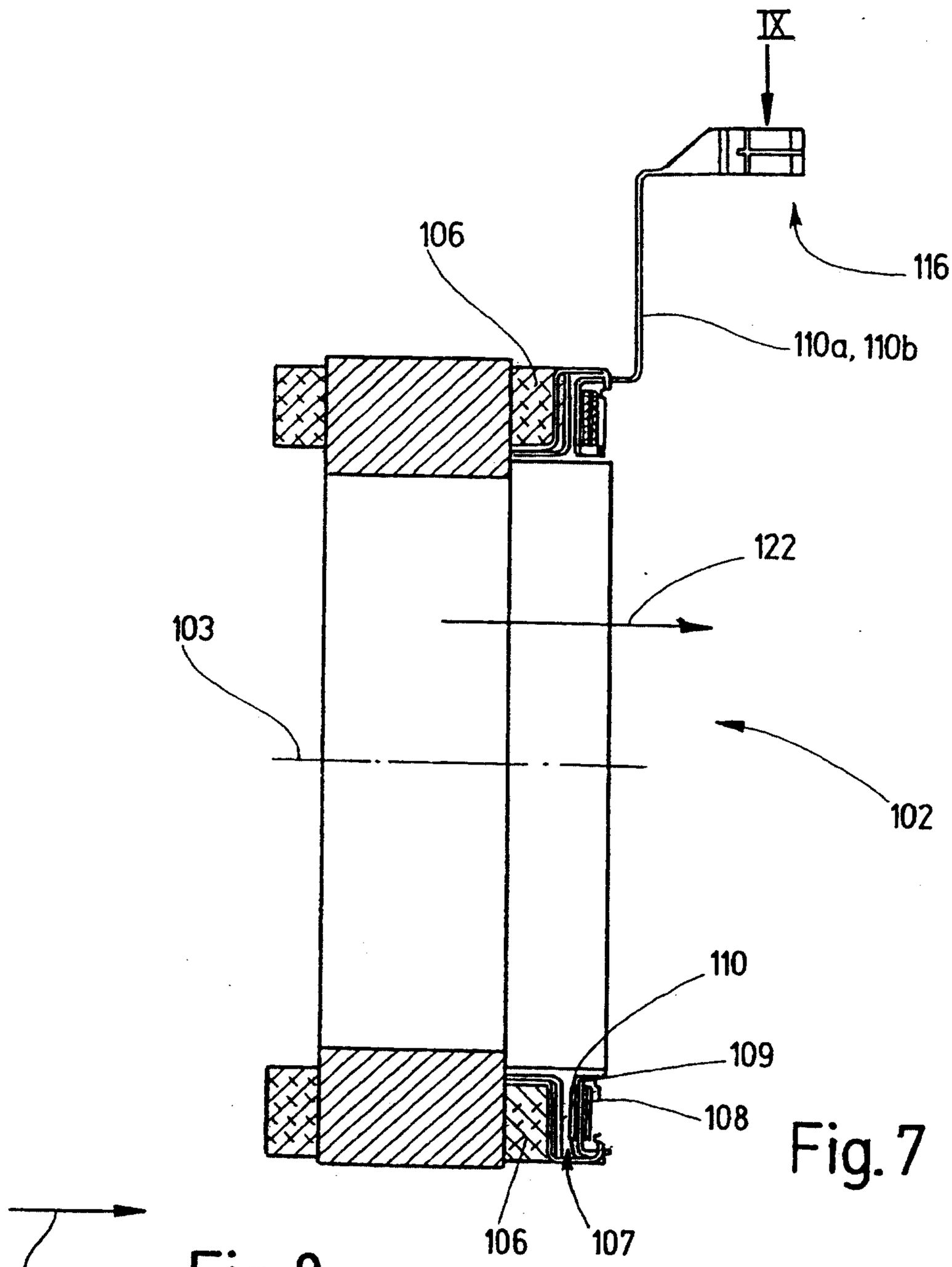


Fig. 7

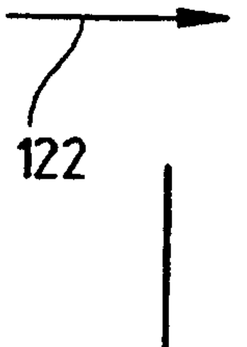
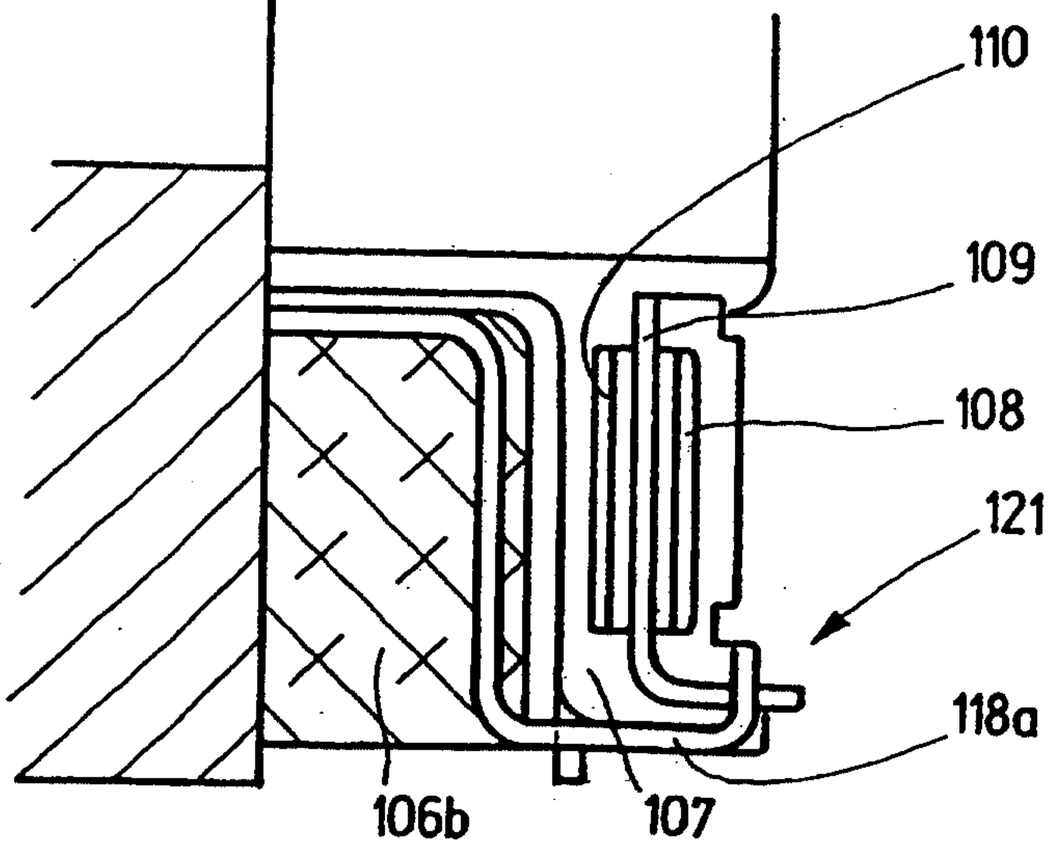


Fig. 8



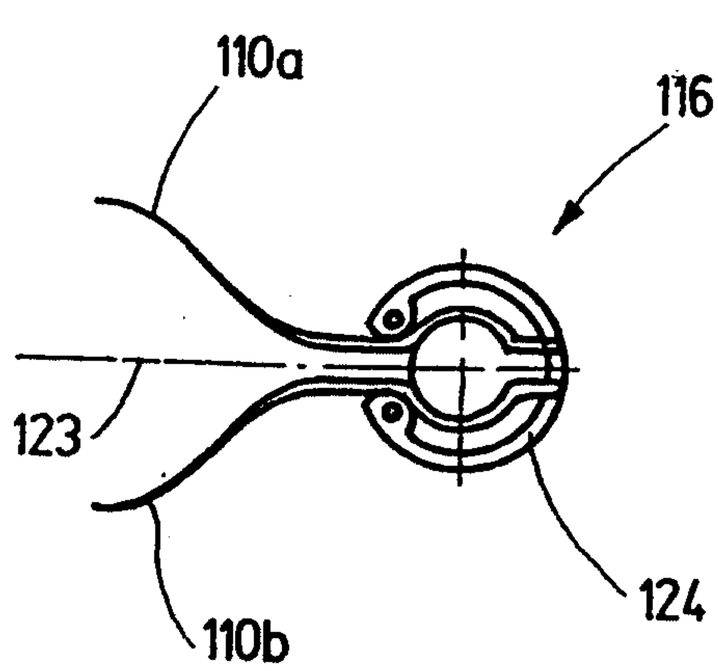


Fig. 9

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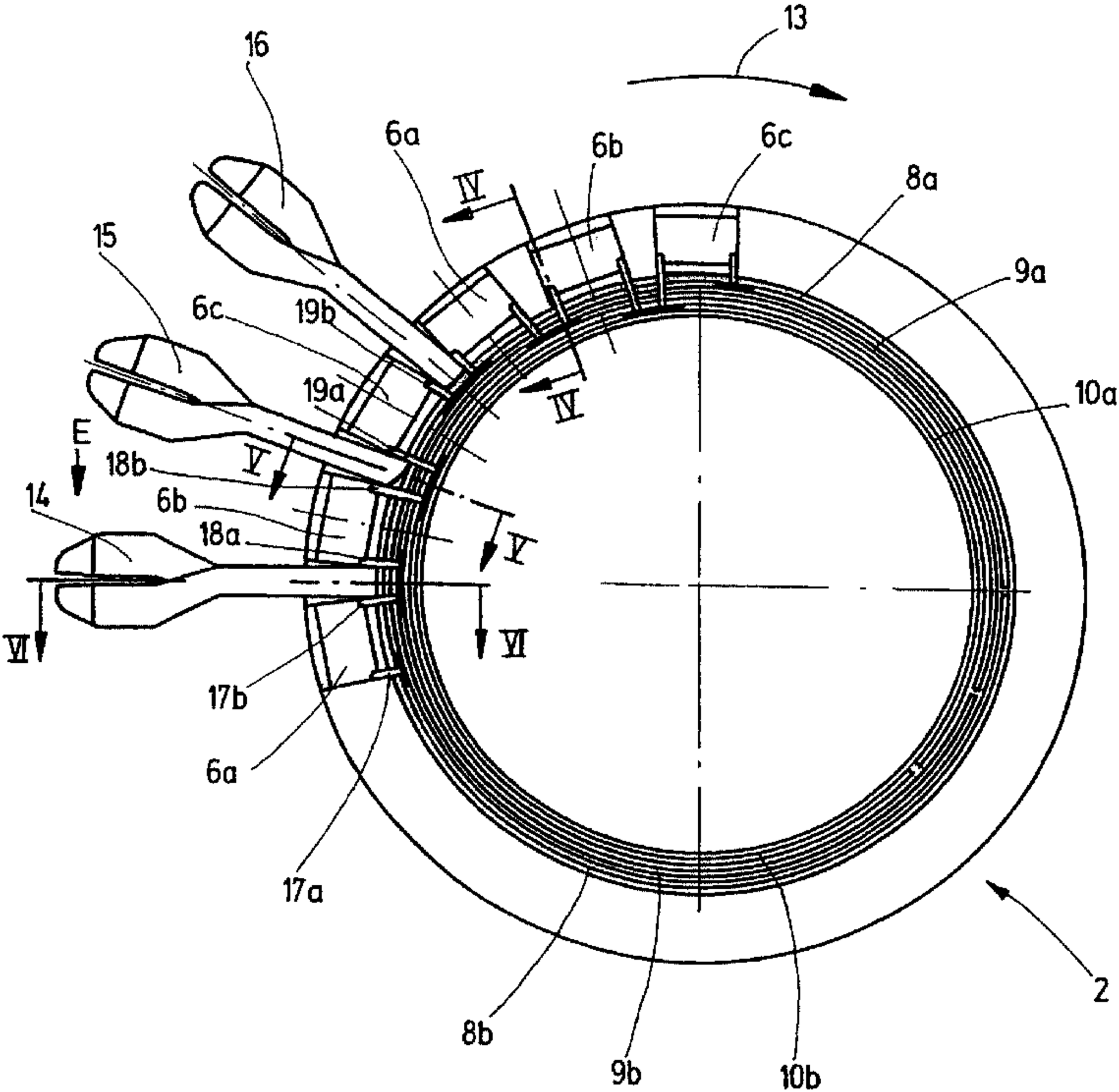
13
16
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6b
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V
VI
VI
17b
6a
17a
8b
9b
10b
2