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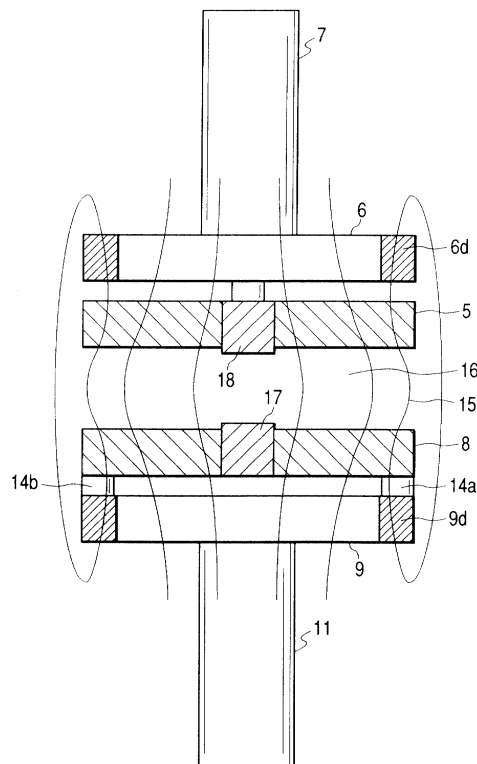
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(54) **Vacuum interrupter**

(57) In a vacuum interrupter which is provided with a pair of disk shaped electrodes 5 and 8 and coil electrodes 6 and 9 relatively movable and opposing each other disposed in a vacuum vessel 1, a part of the disk shaped electrodes is constituted by a magnetic material, thus, magnetic fluxes induced at the peripheral portions of the coil electrodes are guided into a space defined between the opposing electrodes so as to direct in parallel with an arc extending direction and are utilized to interrupt the arc current, thereby, a current interrupting capacity of a vacuum interrupter is enhanced.

FIG. 4



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Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to a vacuum interrupter used for an electric power system.

2. CONVENTIONAL ART

[0002] In a vacuum interrupter as disclosed and illustrated in U.S. Patent No.4,336,430, a disk shaped stationary electrode at the backward of which a coil electrode is attached and a movable electrode are disposed in a vacuum vessel so as to oppose each other, and when interrupting a current by separating the movable electrode from the stationary electrode, magnetic fluxes induced by the current flowing through the coil electrode are acted on an arc generated in a space between the opposing electrodes to interrupt the current.

[0003] In such vacuum interrupter, it is necessary that the direction of the magnetic fluxes induced in the space defined by the opposing electrodes, which are used for extinguishing the arc generated in the space between the opposing electrodes formed when the electrodes are separated and for interrupting the current thereof, is in parallel with the axial direction (an arc extending direction). However, the magnetic fluxes induced near a ring portion locating at a peripheral portion of the coil electrode are induced so as to encircle near around the ring portion, therefore, magnetic fluxes can not be effectively utilized as the magnetic flux component in the axial direction which has to be introduced in the space formed between the opposing electrodes.

SUMMARY OF THE INVENTION

[0004] An object of the present invention is to provide a vacuum interrupter which effectively utilizes magnetic fluxes induced near the ring portion of the coil electrode and permits to enhance a current interrupting capacity thereof.

[0005] A vacuum interrupter according to the present invention in which a pair of electrodes relatively movable each other are disposed in an opposing manner in a vacuum vessel and at least one of the electrodes is provided with a disk shaped electrode and a coil electrode arranged back side thereof, is characterized in that at least the peripheral portion of the disk shaped electrode is constituted by a magnetic material.

[0006] Further, all of the disk shaped electrode is constituted by a magnetic material, or the center portion of the disk shaped electrode is constituted by a non-magnetic material and the remaining portion thereof is constituted by a magnetic material.

[0007] Still further, a vacuum interrupter according to the present invention in which a pair of electrodes rela-

tively movable each other are disposed in an opposing manner in a vacuum vessel and at least one of the electrodes is provided with a disk shaped electrode and a coil electrode arranged back side thereof, is characterized in that a magnetic field control plate constituted by a magnetic material is interposed between the disk shaped electrode and the coil electrode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a vertically cross sectioned side view of a vacuum interrupter representing an embodiment according to the present invention;

Fig. 2 is an exploded perspective view of a movable conductor rod, a movable electrode and a movable coil electrode in the vacuum interrupter as shown in Fig. 1;

Fig. 3 is a vertically cross sectioned side view showing a state of induced magnetic field in the vacuum interrupter as shown in Fig. 1;

Fig. 4 is a vertically cross sectioned side view showing another embodiment according to the present invention; and

Fig. 5 is a vertically cross sectioned side view showing still another embodiment according to the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0009] Fig. 1 is a vertically cross sectioned side view of a vacuum interrupter representing an embodiment according to the present invention.

[0010] A vacuum vessel 1 of the vacuum interrupter is constituted in such a manner that a stationary side end plate 3 and a movable side end plate 4 are connected at both ends of an insulative cylindrical vessel 2 in a hermetically sealed state. A disk shaped stationary electrode 5 and a stationary coil electrode 6 arranged at the backward thereof are secured to a top end of a stationary conductor rod 7 and are disposed within such vacuum vessel 1, and a disk shaped movable electrode 8 and a movable coil electrode 9 arranged at the backward thereof are likely secured to a top end of a movable conductor rod 10 and are disposed therein.

[0011] The stationary conductor rod 7 is secured in hermetically sealed manner to the stationary side end plate 3 and passes therethrough, and the movable conductor rod 10 passes through the movable side end plate 4 so as to permit slidable movement thereof. Through a provision of a bellows 11 between the movable conductor rod 10 and the movable side end plate 4 a hermetically sealed structure of the vacuum vessel 1 is established.

[0012] The inside of the vacuum vessel 1 is evacuated below 1/100 Pa (Pascal) to produce a super vacuum state.

[0013] The electrodes 5, 6, 7 and 8 are surrounded by a metal vapor shield 13 which is held at the inside of the vacuum vessel 1 by a supporting member 12. The metal vapor shield 13 is provided to prevent metal vapor evaporating from the electrodes when an arc is generated between the electrodes during current interruption from depositing on the inner face of the insulative vessel 2 and to prevent the insulation performance thereof from reducing.

[0014] As illustrated in Fig. 2, the movable coil electrode 9 which is arranged backward the movable electrode 8 is provided with hub portions 9b and 9c which extend in opposite radial directions each other from a center portion 9a and at the top ends thereof a ring portion 9d is provided. At center portions of respective half circular portions of the ring portion 9d formed by being divided by the hub portions 9b and 9c into two parts, connection use projecting portions 14a and 14b are provided which are connected electrically and mechanically to the back face of the outer peripheral circumferential portion of the movable electrode 8. In the present embodiment, these connection use projecting portions 14a and 14b are provided by brazing a separate material on the ring portion 9d, however, the connection use projecting portion 14a and 14b can be formed integrally with the ring portion 9d.

[0015] At both sides of the connecting portions with the connection use projecting portions 14a and 14b on the movable electrode grooves 8a, 8b, 8c and 8d which extend toward the axial center portion are formed, thereby, current conducting passages 8f and 8g are formed which extend from the connecting portions with the connection use projecting portions 14a and 14b to the portion 8e.

[0016] The electrical and mechanical connection between the movable conductor rod 10 and the movable coil electrode 9 and between the connection use projecting portions 14a and 14b and the outer end portions of the current conducting passage 8f and 8g on the movable electrode is performed by brazing.

[0017] In the thus constituted movable electrode 8 and movable coil electrode 9, a current enters from the movable conductor rod 10 to the axial center portion 9a of the movable coil electrode 9 where the current branches into two directions and flows in radial direction through the hub portions 9b and 9c and reaches to the ring portion 9d at both ends thereof. Thereafter, at the ring portion 9d the current again branches into two directions and flows in circumferential direction, merges at the connection use projecting portions 14a and 14b, thereafter, the current flows into the outer end portions of the current conducting passages 8f and 8g on the movable electrode 8 and then flows toward the center portions 8e through the current conducting passages 8f and 8g.

[0018] A current flowing through such current passage in the movable coil electrode 9 and the movable electrode 8 induces magnetic fluxes in the direction in

parallel with an arc generated at the movable electrode in the axial direction and which magnetic fluxes act to interrupt the arc generated.

[0019] The stationary electrode 5 and the stationary coil electrode 6 are likely constituted in the same configuration as the movable electrode 8 and the movable coil electrode 9, however, are faced thereto by turning the same by 90° around the axis thereof. As a result, the fluxes likely induced by the combination of the stationary electrode 5 and the stationary coil electrode 6 are directed in the same direction of the fluxes induced by the combination of the movable electrode 8 and the movable coil electrode 9.

[0020] The stationary electrode 5 and the movable electrode 8 are respectively constituted by using a magnetic electrode material. The magnetic electrode material can be obtained from a complex material which is produced by mixing into copper a magnetic metal such as iron, nickel and cobalt in an amount more than its solid solution limit and by precipitating the same uniformly. In the present embodiment, a magnetic electrode material produced by precipitating cobalt representing a magnetic material in copper is used.

[0021] By forming the stationary electrode 5 and the movable electrode 8 with a magnetic material as has been explained above, the magnetic fluxes induced near the ring portions 6d and 9d at the periphery of the stationary and movable coil electrodes 6 and 9 so as to encircle the same are pulled in by the stationary electrode 6 and the movable electrode 8 having magnetic property as illustrated in Fig. 3 so as to direct the same in the axial direction, in that in the direction in parallel with the arc, and to introduce the same in a space 16 between the opposing electrodes, and thereby the magnetic field intensity in the space 16 between the opposing electrodes is increased.

[0022] With the above provision, the magnetic flux density in the axial direction at the peripheral portions of the stationary electrode 5 and the movable electrode 8 is enhanced, thereby, an effective magnetic field in the axial direction can be obtained over a broad range in the space 16 between the opposing electrodes. A current interrupting performance of a vacuum interrupter is enhanced in proportion to the space area where the effective magnetic field in the axial direction exists.

[0023] With the present embodiment a current interrupting performance of 180kA at 13.8kV is obtained.

[0024] Fig. 4 shows another embodiment according to the present invention. In the present embodiment non-magnetic contact members 17 and 18 are disposed at the center contact portions in the stationary electrode 5 and the movable electrode 8 and at the other remaining portions thereof magnetic members like in the previous embodiment are disposed.

[0025] It is preferable that the non-magnetic contact members 17 and 18 are constituted by a material which shows a small current carrying resistance during contact thereof and a low weldability. For example, such as a

copper-chrome alloy are preferable therefor. These non-magnetic contact members 17 and 18 are constituted in such a manner that the surfaces thereof are slightly projected with respect to the remaining portions of the electrodes 5 and 8 so that the non-magnetic contact members 17 and 18 contact prior to the remaining portions thereof when closing the electrodes.

[0026] The other constitutions of the present embodiment are the same as those in the previous embodiment.

[0027] According to the present embodiment, the magnetic fluxes induced at the ring portions 6d and 9d of the coil electrodes 6 and 9 near the peripheral portions in the electrodes 5 and 8 can be effectively guided by the magnetic property of the electrodes 5 and 8 into the space 16 defined between the opposing electrodes, and further it prevents that the magnetic flux density at the center portion of the electrodes 5 and 8 excessively increases and contribute to form a uniform magnetic field over a broad area. Further, since no magnetic material is mixed into the contact members 17 and 18, a possible reduction of current carrying performance thereof is suppressed.

[0028] Fig. 5 shows still another embodiment according to the present invention. In the present embodiment, the respective electrodes 5 and 8 are constituted in a two layered structure in which magnetic field control plates 21 and 22 formed by a magnetic material are closely attached on the backs of non-magnetic members 19 and 20. The non-magnetic members 19 and 20 are formed by a material such as a copper-lead alloy and a copper-chrome alloy which shows a small current carrying resistance during contact thereof and a low weldability, and the magnetic field control plates 21 and 22 can be constituted by a material such as iron, cobalt and an alloy containing those.

[0029] The other constitutions of the present embodiment are the same as those of the previous embodiments.

[0030] With the above electrode structure, the magnetic fluxes 15 near the ring portions, in that induced at the ring portions 6d and 9d around the peripheries of the coil electrodes 6 and 9 are effectively guided by the magnetic field control plates 21 and 22 into the space 16 between the opposing electrodes so as to extend in the direction in parallel with the axial direction and thereby are effectively utilized to interrupt the arc current.

[0031] According to the present invention, the magnetic fluxes induced near the ring portions around the periphery of the coil electrodes are guided by the magnetic member into the space defined between the opposing electrodes so as to direct the same in the direction in parallel with the axial direction and thereby to act on the arc generated between the electrodes, and thus the current interrupting capacity of the vacuum interrupter is enhanced.

Claims

1. A vacuum interrupter in which a pair of electrodes relatively movable each other are disposed in an opposing manner in a vacuum vessel and at least one of the electrodes is provided with a disk shaped electrode and a coil electrode arranged back side thereof,
characterized in that at least the peripheral portion of the disk shaped electrode is constituted by a magnetic material.
2. A vacuum interrupter according to claim 1, characterized in that all of the disk shaped electrode is constituted by a magnetic material.
3. A vacuum interrupter according to claim 1, characterized in that the center portion of the disk shaped electrode is constituted by a non-magnetic material and the remaining portion thereof is constituted by a magnetic material.
4. A vacuum interrupter in which a pair of electrodes relatively movable each other are disposed in an opposing manner in a vacuum vessel and at least one of the electrodes is provided with a disk shaped electrode and a coil electrode arranged back side thereof,
characterized in that a magnetic field control plate constituted by a magnetic material is interposed between the disk shaped electrode and the coil electrode.

FIG. 1

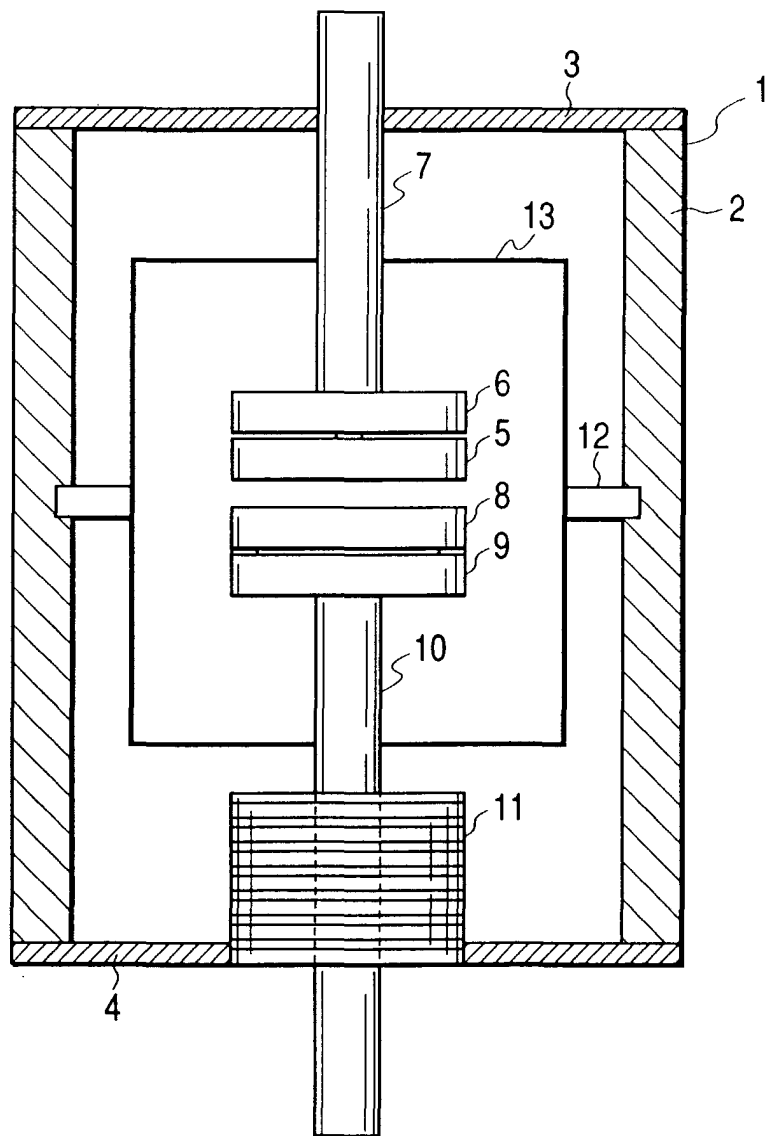


FIG. 2

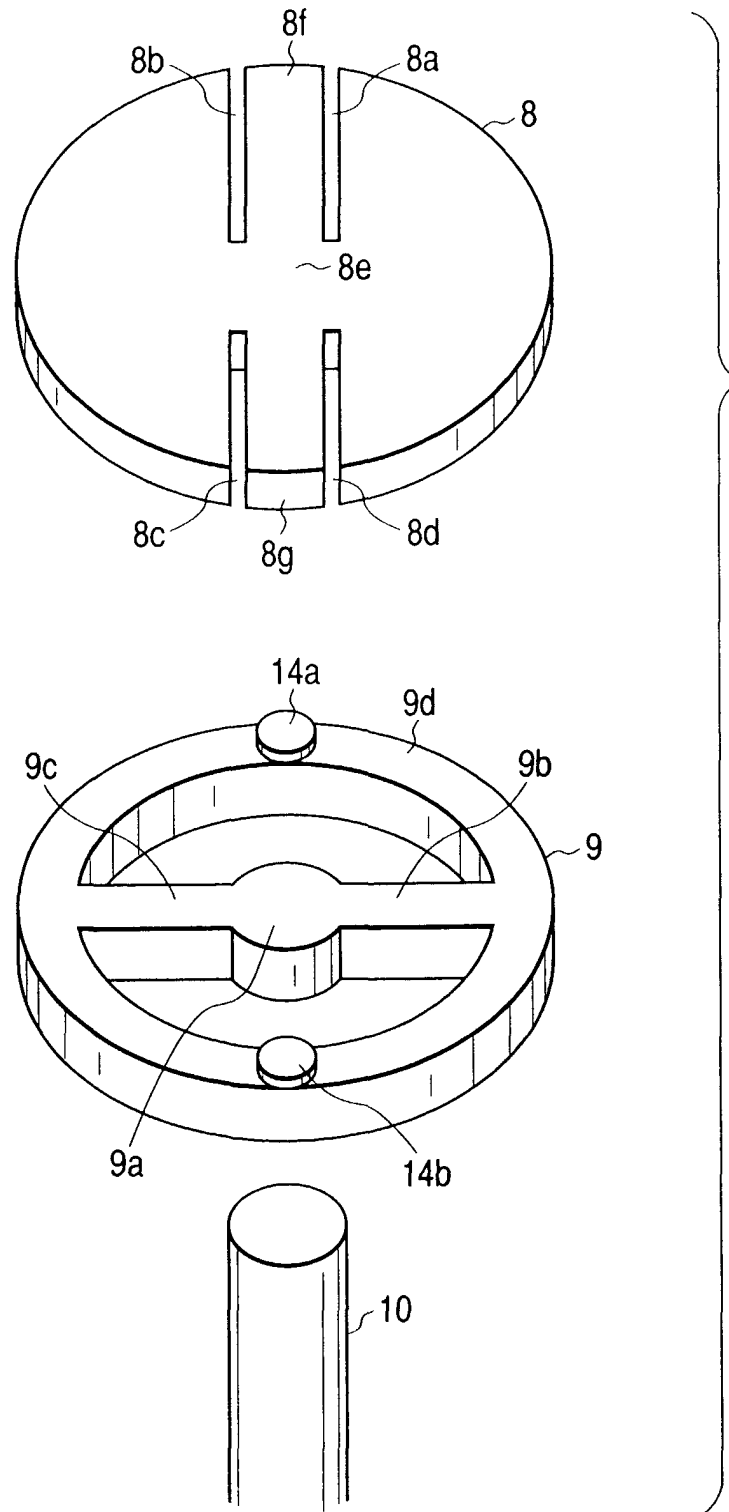


FIG. 3

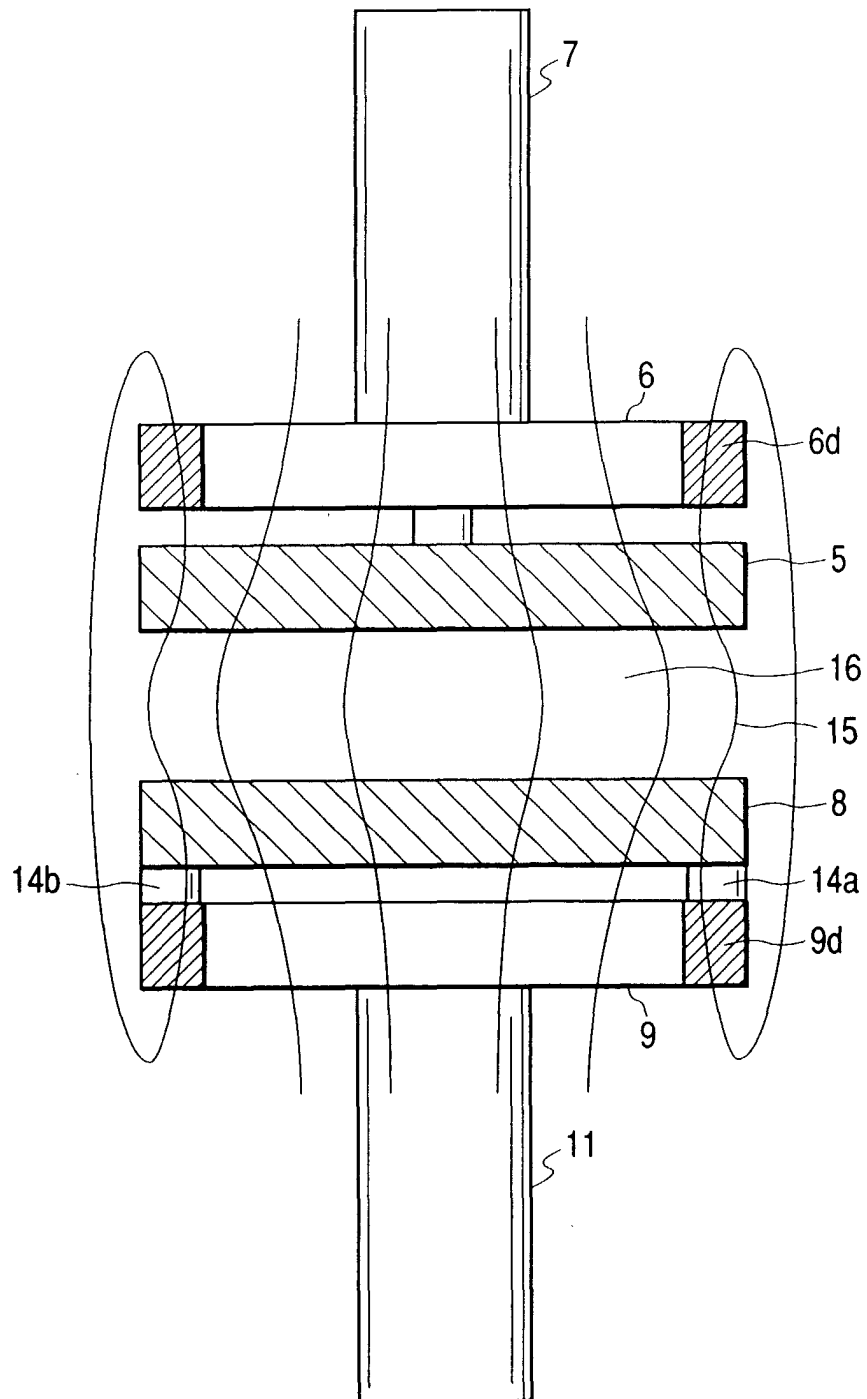


FIG. 4

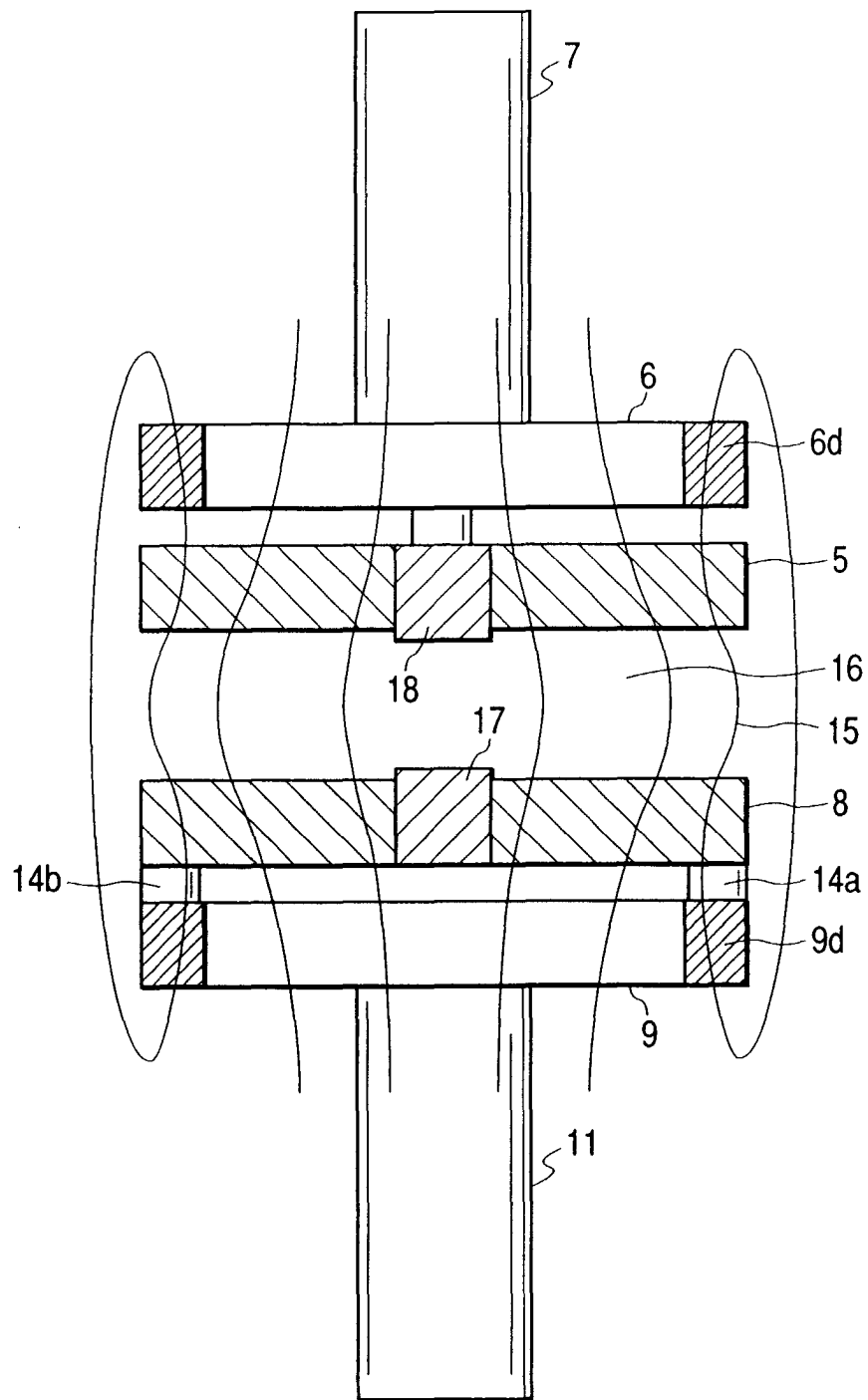


FIG. 5

