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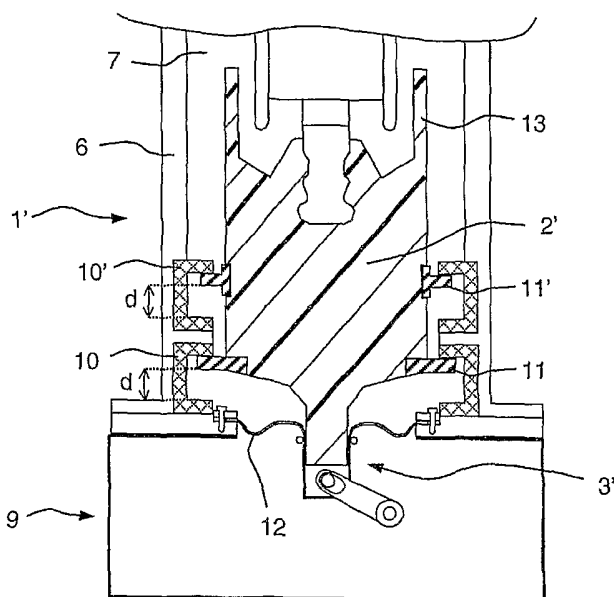
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(54) Title: A MOTION TRANSMISSION FOR ACTUATION OF A MEDIUM OR HIGH VOLTAGE INTERRUPTER APPARATUS



(57) Abstract: A motion transmission (1) comprises an insulating connecting rod (2) which couples a motion input connector (3), actuated by a control mechanism (9), to a motion output connector (4) that acts on a moving contact (5) which is electrically connected to a pole (15) of the interrupter apparatus. The transmission further includes an insulating casing (6) which surrounds the connecting rod and contains an insulating gas (7). A dielectric shutter device with two stop positions is disposed between the casing and the envelope, and is adapted to be, though only in each of the two stop positions, a solid dielectric barrier between the pole (15) of the apparatus and the control mechanism (9), the shutter device being permeable to gas between the two said stop positions.



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**A MOTION TRANSMISSION FOR ACTUATION OF A MEDIUM OR HIGH
VOLTAGE INTERRUPTER APPARATUS**

This invention relates to a motion
5 transmission for actuating a medium or high voltage
interrupter apparatus, comprising an electrically
insulating connecting rod which is adapted to be
actuated by a control mechanism and to act on a moving
10 contact which is connected electrically to a pole of
said interrupter apparatus, said moving contact being
displaceable between an open position and a closed
position, said transmission further comprising an
insulating casing which surrounds the insulating
15 connecting rod in its axial direction and which
contains an insulating dielectric gas.

Conventionally, the dielectric insulating
gas may be air, SF₆, or nitrogen under pressure. The
control mechanism is put at ground potential, or to
another potential lower than the working voltage of the
20 interrupter apparatus.

Such motion transmissions are known in
particular in the field of vacuum interrupter
apparatus. Such apparatuses are commonly called vacuum
circuit breakers, because they generally comprise an
25 interrupter element in the form of a cylindrical bottle
which encloses, under vacuum, a fixed contact together
with a moving contact, which is fixed to a conductive
rod that extends through one end of the bottle and
constitutes a pole of the interrupter. Sealing means
30 are provided between this rod and the pole through
which it passes, for preventing any penetration of gas
into the bottle. Said rod is therefore at the
electrical potential of the pole, and is generally
actuated in straight line movement by means of an

insulating connecting rod which is coupled to a control mechanism at ground potential.

5 In order to permit movement of the insulating connecting rod, it is surrounded by a space containing a fluid which is generally either a gas or a dielectric liquid, contained in a casing which is usually made of an insulator. A minimum distance in the fluid is necessary between the pole at a voltage and the control mechanism at ground potential, so as to
10 ensure dielectric strength and avoid phase-to-phase and phase-to-ground discharges during over-voltages which may affect the pole. This minimum distance is partly a function of the dielectric properties of the gas. However it is also, and mainly, a function of the
15 surface arcing distance of the insulating components such as the insulating envelope and the insulating connecting rod, which are situated between the pole and the control mechanism. In this context, in the event of an over-voltage, an electric arc between the pole
20 and the control mechanism will tend to develop either along a spark line, or by traveling on the surface of at least one of the insulating components.

This minimum distance of dielectric resistance to arcing along an insulating component in a
25 fluid is of course generally greater than the minimum thickness which a solid insulating material should have in order to avoid a field gradient that would damage it. It may be noted that it is moreover not essential to have a single connecting rod between the conductive
30 rod element of the moving contact of the bottle and the control mechanism. In this connection, it is possible to have a control linkage which comprises at least one conductive connecting rod coupled to an insulating connecting rod, which is given sufficient length to
35 avoid arcing on its surface between its ends.

A vacuum interrupter device including such a motion transmission is known from the patent document US 3 855 435. The bottle of the vacuum circuit breaker, together with the motion transmission, are contained in
5 a cylindrical insulating casing which is filled with a dielectric fluid to ensure satisfactory dielectric resistance between the two poles along the cylindrical surface of the bottle. A further cylindrical insulating casing, of smaller dimensions and filled with a
10 dielectric gas, surrounds coaxially the insulating connecting rod that actuates the bottle, and sealingly couples the lower pole of the bottle to a housing of the control mechanism which is at ground potential. At least part of the control mechanism is thus immersed in
15 the volume of dielectric gas which is preferably defined by said housing and by the small insulating casing. The gas in this volume could also be air, provided the insulating distance between the lower pole and the housing is increased. Whatever the gas may be
20 in this volume, the small insulating casing and the insulating connecting rod for actuating the bottle, must have a length which is sufficient to prevent any arcing at their surfaces in the event of over-voltage on the lower connection.

25 Developments of this type of apparatus are known in the state of the art. In particular, it is known, for example from the patent documents US 4 568 804 and CH 668 334, to fill with a solid insulator the space between the outer cylindrical
30 surface of the bottle and the inner cylindrical surface of the insulating casing that encloses the bottle. In addition, as regards the motion transmission, it is known from the patent document US 5 191 180 to provide gas sealing means between a dielectric gas contained in
35 the casing of the apparatus and the gas outside this

casing. The housing of the control mechanism is therefore no longer filled with the dielectric gas of the casing, and it is thus no longer necessary to provide air sealing for the housing.

5 These gas sealing means conventionally consist of a metallic bellows anchored to the aperture which is provided in the casing of the apparatus in order to allow a metallic connecting rod of the linkage for the moving contact of the bottle to pass through.
10 This bellows has a diaphragm anchored to the connecting rod, for example by welding. In addition, the patent documents DE 195 172 87 and EP 1 134 766 also describe motion transmission devices for vacuum interrupter apparatus which include means for sealing against
15 dielectric gas, these means being in the form of a bellows or a membrane of insulating material. However, in these arrangements the gas sealing means do not have a dielectric barrier function, that is to say they do not have the function of supporting a high potential
20 gradient in the event of over-voltage on a pole.

 Nevertheless, there do exist flexible dielectric materials which are capable of ensuring air sealing while performing a dielectric barrier function. It is for example known from the patent document
25 US 4 605 272 to provide an air-tight dielectric seal in the form of a sleeve, a diaphragm of which grips a conductive rod element of an electrical connector. It is also known from the patent document FR 2 698 481 to provide a sleeve made of an electrically insulating
30 material, such as for example silicone, the elastic properties of which are, in particular, made use of in order to grip the cylindrical insulating surface of a vacuum bottle and to establish a solid dielectric barrier without any gas interstices between the poles
35 of the bottle.

These elastic properties of materials capable of ensuring at the same time air sealing and a dielectric barrier function have also been made use of for motion transmissions in vacuum interrupter apparatus. It is known from the patent document EP 0 782 160 to provide a bellows made of an elastic insulating material such as silicone, this bellows having a diaphragm which is anchored to an insulating connecting rod that plays a part in the actuation of the moving contact of the bottle. The anchorage may be obtained by means of mechanical connection, or by molding of the bellows at the manufacture around the connecting rod, or else by adhesive bonding. The thickness of the membrane of the bellows is made sufficiently great to ensure a solid dielectric barrier which is adapted to support any possible over-voltages between the pole connected to the moving contact of the bottle and the components of the control mechanism close to that pole which are at ground potential. This dielectric barrier thus enables arcing at the surface of the insulating connecting rod to be prevented in the event of over-voltage, by interposing a solid dielectric insulator. In consequence, the distance between pole and the control mechanism may be shortened, thus enabling a relatively short insulating connecting rod to be adopted whereby to obtain an interrupter apparatus which is more compact in length.

Good control of adhesion between the diaphragm of the bellows and the insulating connecting rod, or the mechanical joining of these two components, is necessary in order to ensure perfect gas sealing, and in particular to prevent arcing at the joint between the insulating connecting rod and the bellows. In addition, a sufficiently elastic dielectric material has to be used so as not to hinder the movement of the

connecting rod over its whole course of travel, while having sufficient material thickness to ensure a good enough dielectric barrier in the event of over-voltage. The need to combine these various criteria in the same dielectric material may sometimes then prove restrictive as regards the choice of material. For example, a dielectric material which is appreciated for its elasticity qualities may on the other hand be found hard to anchor around the actuating connecting rod, or else the anchoring may lose its sealing properties as a result of the movements of the connecting rod. It may also prove difficult to permit a large course of travel of the maneuvering connecting rod when the gas space between this connecting rod and the casing surrounding it is limited, because the radial width of the bellows that results from this configuration may be found insufficient to ensure a high enough displacement of the diaphragm of the bellows, or may lead to excessively high forces in the region of the joint between the diaphragm and connecting rod.

In addition, the variation in volume on each side of the bellows during its movement leads to variations in pressure in the fluid in the case of closed volumes. These pressure variations may lead to difficulties which are greater the smaller the closed volume is.

Moreover, it must be appreciated that in most interrupter apparatus, and in particular those for vacuum interruption, resistance to over-voltages imposed by the current regulations apply only to an open or closed state of an apparatus. In other words, it is judged to be unnecessary to have resistance to over-voltages during the transient phase of a few tens of milliseconds for which an opening or closing operation of the contacts of the apparatus lasts.

Thus, a permanent solid dielectric barrier such as that provided by a thick dielectric bellows is not indispensable in order to satisfy current standards.

5 An object of the present invention is to enable a relatively compact motion transmission to be obtained for actuation of a medium or high voltage interrupter apparatus, and to overcome the disadvantages that a thick dielectric bellows may have, while satisfying the standards for protection of the
10 apparatus in the event of over-voltage on one of its poles.

 To this end, the invention is directed to a motion transmission such as that defined in the preamble, characterized in that a dielectric shutter
15 device, having two stop positions corresponding respectively to an open position and a closed position of said moving contact, is disposed between said insulating connecting rod and said insulating casing, and is adapted to be, though only in each of the two
20 stop positions, a solid dielectric barrier in said gas between said pole of the interrupter apparatus and said control mechanism, the shutter device being permeable to gas between said two stop positions.

 In a preferred embodiment of a motion
25 transmission of the invention, the dielectric shutter device comprises at least one seating element associated with a shutter element, said seating element and/or said shutter element comprising an elastomeric material which is compressed in each of the two stop
30 positions of the shutter device, whereby to constitute a sealed dielectric barrier at the level of the zone of mutual contact between two associated seating and shutter elements. Preferably, the seating element may be fixed to the insulating casing, the shutter element
35 being then movable with the insulating connecting rod.

Preferably, the dielectric shutter device is disposed substantially at the level of the end of the insulating casing which is oriented towards said control mechanism.

5 Further features and advantages of a motion transmission of the invention appear in greater detail below, with reference to the attached drawings.

Figure 1 shows diagrammatically a view in longitudinal cross section of a motion transmission of the invention in application to a vacuum circuit breaker, the circuit breaker being in its closed position for passage of the current.

10 Figure 2 shows diagrammatically a view in longitudinal cross section of a further embodiment of a motion transmission of the invention, associating a plurality of dielectric shutter elements arranged in series.

Figure 3 shows diagrammatically a detail view of the apparatus of Figure 2, in a transient position of opening of the vacuum circuit breaker during which the dielectric shutter means is open.

20 In Figure 1, the interrupter apparatus 8 is a vacuum circuit breaker comprising a bottle, one end of which, the lower end in this case, is connected to a pole 15. Another pole of the circuit breaker, not shown in the figure, is connected to the other end of the bottle which in this case is the upper end. A permanent electrical contact, which is for example of the sliding type and is not shown in the figure, is conventionally arranged between the moving contact 5 of the bottle and the pole 15. This moving contact 5 is adapted to be displaced in straight line motion between the open and closed positions of the circuit breaker, with the aid of a motion output connector 4 coupled to the control mechanism 9 of the circuit breaker by means

25 30 35

of the motion transmission 1. A conventional spring mechanism, not shown in the drawing, may be interposed between the motion output connector 4 and the moving contact 5 in order to ensure some pressure as preferable between the contacts of the bottle in the closed position of the circuit breaker. However, such a mechanism for maintaining contact pressure may also be arranged in the control mechanism 9 of the vacuum circuit breaker, or between this mechanism 9 and the motion transmission 1.

The motion transmission 1 comprises an insulating connecting rod 2, which is made either in one piece or as a plurality of parts assembled together coaxially, and surrounded coaxially by an insulating casing 6 which contains a gas 7 enclosed within the space between this casing and the connecting rod. The gas 7 is an insulator, such as air for example, but it may also have dielectric properties, for example SF₆ or nitrogen under pressure. The upper part of the insulating connecting rod 2 preferably takes the form of a receptacle adapted to collect contaminants such as metallic particles or grease from the moving contact, thereby protecting the dielectric shutter means. The upper end of the connecting rod 2 is, in this connection, extended by a tubular insulating portion 13 which surrounds the motion output connector 4 and constitutes the wall of the receptacle.

The casing 6 may be extended beyond the pole 15 so that it at least partly surrounds the bottle, the volume of the gas 7 being for example closed off at that end by an over-molding of the bottle, not shown in the figure. Preferably, the gas sealing means are formed between the volume of gas within the casing 6 and the volume of the housing that contains the control mechanism 9. For example, these

sealing means may, in the conventional way, consist of a membrane 12 which has a diaphragm through which a motion input connector 3 passes to couple the control mechanism to the insulating connecting rod. In another version, it is also possible to incorporate the membrane 12 in the seating element 10 or shutter element 11. An embodiment may also be envisaged which is without such a sealing membrane, and in which the insulating casing 6 is in communication with the space in the housing that encloses the control mechanism. Sealing between the gas 7 and external air may thus be provided at the level of this housing.

In accordance with the invention, a dielectric shutter means having two end positions, corresponding respectively to an open and a closed position of the moving contact, is disposed between the insulating connecting rod 2 and the insulating casing 6. This dielectric shutter means is in the present case disposed substantially at the level of the end of the insulating casing 6 which is oriented towards said control mechanism 9, though it is possible to envisage a location closer to the pole 15 of the vacuum bottle. It is adapted to act, though only in each of the two stop positions, as a solid gas-type dielectric barrier between the pole 15, associated with the moving contact 5 of the interrupter apparatus, and the control mechanism 9. In the embodiment corresponding to Figure 1, this shutter means comprises a seating element 10 associated with a shutter element 11. The seating element comprises an elastomeric material which is compressed by the shutter element in each of the two stop positions of the shutter device, so as to form the gas-tight dielectric barrier at the level of the zone of mutual contact between both the seating and shutter elements.

Preferably, the seating element is fixed to the insulating casing, and the shutter element is movable with the insulating connecting rod. However, the opposite arrangement is possible but may have the disadvantage that it increases the mass of the moving elements, given that the shutter element is generally heavier than the seating element.

In Figure 1, the vacuum circuit breaker is in its closed position for passing current. The shutter element 11 is accordingly in abutment against a first annular zone of the seating element 10 of elastomeric material. It may be noted that there is no particular disadvantage in the fact that the seating element 10 should entirely be made of elastomeric material. A second annular zone 102 of the seating element 10, also made of elastomeric material, is situated at a distance d from the shutter element 11.

This distance d corresponds in this example substantially to the spacing e between the contacts of the vacuum bottle when the circuit breaker is in its open position, that is to say the course of opening travel of the moving contact 5 of the bottle. This implies that the moving contact is completely fixed with respect to the motion output connector 4 and insulating connecting rod 2 for movement with them, which corresponds for example to an embodiment in which the mechanism for maintaining a pressure between the contact of the vacuum bottle in the closed position is associated with the control mechanism 9 of the circuit breaker.

It may be noted that in practice, the distance d is slightly smaller than the course of opening travel e of the moving contact 5, so that a gripping effect is obtained at the level of the mutual contact zones between the seating and shutter elements

10 and 11 when the motion transmission 1 has performed the course of travel e to close or open the vacuum bottle. This gripping force is obtained by virtue of the compressibility of the elastomeric material of the seating element 10, and enables dielectric sealing to be obtained in the zones of mutual contact mentioned above.

The open position of the vacuum circuit breaker is obtained after the motion input connector 3 has been moved in straight-line motion by a control lever, the course of this straight-line travel being equal to the course of opening travel e of the moving contact 5. In this position, not shown, the shutter element 11 is in abutment against the second annular zone 102 of the seating element 10 of elastomeric material, this annular zone being then compressed in order to give dielectric sealing. A gas-tight dielectric barrier is formed by the dielectric shutter device, the same as in the closed position of the vacuum circuit breaker. Between the two stop positions of the shutter device, that is to say during actuation of the vacuum circuit breaker, the shutter device is permeable to gas and therefore does not provide a dielectric barrier. It follows that there is substantially no variation in pressure in the volume of gas 7 comprised between the insulating casing 6 and the insulating connecting rod 2, which makes it possible to have a relatively small volume of gas, even in the case of a large course of opening travel of the moving contact of the circuit breaker.

The dielectric strength which is obtained when the dielectric shutter device is closed depends in particular on the radial dimension over which there is mutual contact between the shutter element 11 and the first or second annular zone of elastomeric material in

the seating element 10. This radial dimension of mutual contact corresponds to the thickness of the solid dielectric barrier formed by the shutter device. The larger this thickness is, the greater is the dielectric strength of the motion transmission 1. On the other hand, too low a thickness could lead to a danger of arcing at the internal surface of the insulating casing 6 and through this thickness, so destroying the solid dielectric barrier. Such arcing, or initiation of an arc in the gas, may occur in the arrangement of Figure 1 between the pole 15 and a metallic component of the control mechanism 9, or any other metallic component such as the annular base 9A on which the casing 6 and seating element 10 are mounted. The annular zones of mutual contact between the seating element 10 and shutter element 11 should therefore be made wide enough to obtain a dielectric barrier thickness depending on the desired dielectric strength.

In the case where a particularly high dielectric strength is required for a motion transmission of the invention, without thereby increasing the radial dimensions of the seating and shutter elements, it can prove to be of advantage to provide a device which comprises a plurality of dielectric shutter elements disposed in series, that is to say superimposed in the axial direction of the motion transmission.

Such an embodiment is shown diagrammatically in Figure 2, other modifications being also made as compared with the embodiment in Figure 1. In particular, the motion input connector 3' in this case consists of an extension of the insulating connecting rod 2' such as to constitute a rod element which is connected to a control lever, though an

arrangement similar to that of the connector 3 in Figure 1 could just as well have been adopted.

Two seating elements 10, 10', and two shutter elements 11, 11' are superimposed in the axial direction of the motion transmission 1'. The shutter elements in this example are made of an elastomeric material and are mounted coaxially on the perimeter of the insulating connecting rod 2'. The seating elements are not necessarily made of elastomeric material, and could also be constituted by annular shoulders formed within the insulating casing 6. The vacuum circuit breaker is shown in its closed position, and each shutter element is in abutment against a first annular zone of a seating element. A double gas-tight dielectric barrier is provided, the thickness of which, in this example, is substantially twice that obtained with a single pair of associated seating and shutter elements.

During an operation of opening the circuit breaker, the shutter elements 11 and 11' are displaced together through a certain course of travel d in fixed relationship with the insulating connecting rod 2', until they each come into abutment against a second annular zone of the associated seating element, and the moving contact of the vacuum bottle has substantially finished its opening travel e . This displacement is shown diagrammatically in Figure 3, which shows a detailed view of the dielectric shutter elements in a transient opening position of the vacuum circuit breaker. The insulating connecting rod 2' is displaced in straight-line movement in the direction indicated by the arrow. The first shutter element 11 is then no longer in contact with the first annular zone 101 of the associated seating element 10, and approaches the second annular zone 102. The situation is similar for

the second shutter element 11'. During this transient period, the dielectric shutter device is open and is therefore permeable to the gas.

The surfaces of the first and second
5 annular zones 101 and 102 of the seating element 10, as also the contact surfaces associated with them on the shutter 11, are preferably flat and at right angles to the direction of the straight-line motion of the insulating connecting rod. This enables there to be
10 substantially no friction between the mutual contact surfaces of the associated seating and shutter elements, when a shutter element comes into abutment against a seating element and compresses the elastomeric material that constitutes at least one of
15 the contact surfaces. It may however be envisaged, without departing from the scope of the invention, that the mutual contact surfaces are not flat and complementary.

The field of application of a motion
20 transmission of the invention is of course not limited to vacuum circuit breakers, but also extends to gas circuit breakers, generally over higher network voltage ranges. It should be remembered that the spacing between the contacts of a gas circuit breaker in the
25 open position is generally much greater than that of the contacts of a vacuum circuit breaker in the same position. Thus, the course of travel of the insulating connecting rod for actuation between closed and open positions of the gas circuit breaker is accordingly
30 greater, which implies that the use of a bellows of dielectric material with sufficient thickness, to constitute a dielectric barrier in that application can *a priori* not be envisaged. On the other hand, a motion transmission of the invention may be envisaged, because
35 it does not have the major disadvantage that it

increases the distance between two stop positions of a dielectric shutter device such as those described above, in order to increase the course of travel that may be performed by a shutter element movable with the
5 insulating actuating connecting rod.

CLAIMS

1. A motion transmission (1, 1') for actuating a medium or high voltage interrupter apparatus (8), comprising an electrically insulating connecting rod (2, 2') which is adapted to be actuated by a control mechanism (9) and to act on a moving contact (5) which is connected electrically to a pole (15) of said interrupter apparatus, said moving contact being displaceable between an open position and a closed position, said motion transmission further comprising an insulating casing (6) which surrounds the insulating connecting rod in its axial direction and which contains an insulating dielectric gas (7), characterized in that a dielectric shutter device, having two stop positions corresponding respectively to an open position and a closed position of said moving contact (5), is disposed between said insulating connecting rod (2, 2') and said insulating casing (6), and is adapted to be, though only in each of the two stop positions, a solid dielectric barrier in said gas (7) between said pole (15) and said control mechanism (9), the shutter device being permeable to gas between said two stop positions.

2. A motion transmission according to claim 1, characterized in that the dielectric shutter device comprises at least one seating element (10, 10') associated with a shutter element (11, 11'), said seating element and/or said shutter element comprising an elastomeric material which is compressed in each of the two stop positions of the shutter device, whereby to constitute a sealed dielectric barrier at the level of the zone of mutual contact between two associated seating and shutter elements.

3. A motion transmission according to claim 2, characterized in that said seating element (10, 10') is fixed to the insulating casing (6), and said shutter element (11, 11') is arranged to move together with the
5 insulating connecting rod (2, 2').

4. A motion transmission according to any one of claims 1 to 3, characterized in that the dielectric shutter device is disposed substantially at
10 the level of the end of the insulating casing (6) which is oriented towards said control mechanism (9).

5. A motion transmission according to any one of claims 1 to 4, characterized in that the end of
15 the insulating casing (6) which is oriented towards the control mechanism (9) is provided with gas-tight sealing means comprising a membrane (12), said membrane having a diaphragm through which there extends a motion input connector (3, 3') connecting said control
20 mechanism to the insulating connecting rod (2, 2').

6. A motion transmission according to any one of claims 1 to 5, characterized in that one end of the insulating connecting rod (2, 2') is extended by an
25 insulating tubular portion (13) which surrounds a motion output connector (4) that couples said connecting rod to the moving contact (5), whereby to define a receptacle for collecting contaminants coming from said moving contact, whereby to protect the
30 dielectric shutter device.

2 / 2

FIG. 2

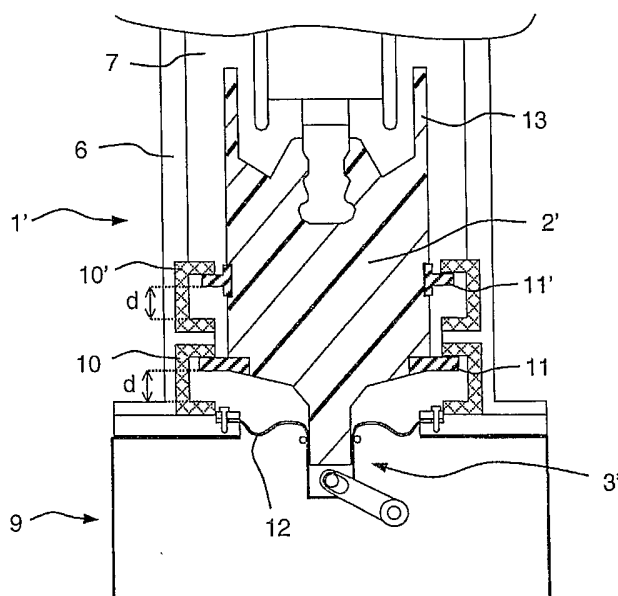
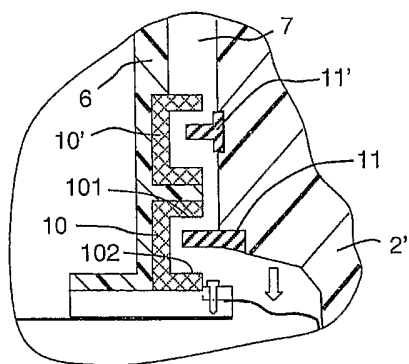


FIG. 3



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01H33/66

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 855 435 A (HIMI H) 17 December 1974 (1974-12-17) cited in the application abstract; figure 1	1-6
A	US 6 310 310 B1 (WRISTEN CECIL C) 30 October 2001 (2001-10-30) abstract; figure 6	1-6

☐

Further documents are listed in the continuation of box C.

☒

Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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