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(54) CYLINDRICAL SHAPED CONTACT ELEMENT ARRANGEMENT FOR A THREE-POSITION-SWITCH IN MEDIUM OR HIGH VOLTAGE GAS INSULATED SWITCHGEARS

(57) The invention relates to a cylindrically shaped contact element arrangement for a three-position-switch in medium or high voltage gas insulated switchgears, which provides a disconnector switch and an earthing switch, which further consist of one movable conductor and three contacts, which are busbar contact, center contact and earth contact, with a cylindrical shaped contact element arrangement for connecting tube shaped contacts which are orientated in axial direction and with spring means for providing contact forces, and that the cylindrical shaped contact element arrangement consist of multiple identical contact elements, which are hold in cylindrical position by a support structure, according to the preamble of claim 1. In order to create a contact system with possibly low ohmic restistance, which is furthermore compact, the invention is, that spring means for providing the radially expanding contact forces, are located inside the cylindrical shape, represented by the contact elements arrangement.

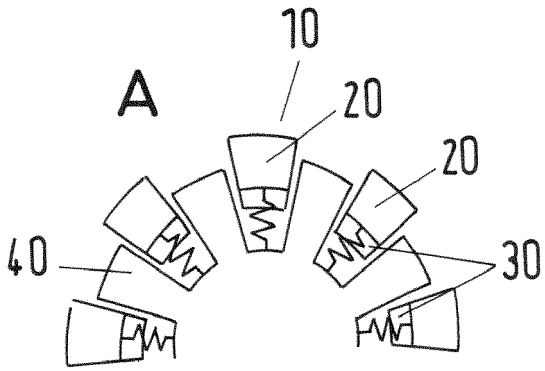

Fig.3

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Description

[0001] The invention relates to a three-position-switch in medium or high voltage gas insulated switchgears, which provides a disconnector switch and an earthing switch, which further consist of one movable conductor and three contacts, which are busbar contact, center contact and earth contact, according to the preamble of claim 1.

[0002] Aforesaid three-position-switches are provided with a movable conductor, which allows to connect a first and a second contact, in the disconnectors closed position, or a second and a third contact, in earthing switch closed position. If the movable conductor is in centre position, all three contacts are insulated from each other, that means, disconnector open and earthing position open.

For that, different contact systems are state of the art.

The most common ones are knife type contact system and the gliding type contact system.

[0003] A knife type contact system is shown in the EP0684673 B1.

The movable conductor is represented by a contact knife, which is conductively connected and mounted on a bearing block, which represents the second contact. By rotative movement, the contact knife can be brought into the three positions which are connection to first contact, connection to third contact,

or disconnection position.

[0004] To provide a reliable transition resistance, a contact force has to be applied in all contact points. In the pivot point of the knife spring washer can be used to contact the knife to the block. If a double knife arrangement is used, the contact to the first and the third contact can be provided by a tension spring between the knives, so the contacts can be clamped between them. So, the knife type connection provides two transition resistances in the current pass:

bearing block to contact knife, and contact knife to contact.

[0005] A gliding type contact system, is shown in the US 2009015881 A1.

In that type, the movable conductor is a cylindrical bolt or tube. This is mounted in a tubular second contact piece and can be brought in contact with the first or third contact by a translational movement. The translational movement can be applied to the conductor by a spindle, if the movable conductor is twist protected with respect to the second contact. The contact force is applied by circular spiral contacts, which are mounted inside the cylindrical contact pieces. In the closed position of the disconnector, the current flows from the second contact over a spiral contact to the movable conductor, and from the movable conductor over a second spiral contact to the first contact. So, the gliding type connection provides four transition resistances in the current pass: contact to spiral contact, spiral contact to movable contact, movable contact to spiral contact, and spiral contact to contact.

[0006] Target is, to generate a compact and efficient medium voltage switchgear, so costs and needed space of the used components is crucial. Keeping the ohmic losses at a minimum is also a target, because certain temperature limits must not be exceeded.

[0007] An efficient manufactured knife contact has not a homogeneous distributed electrical field. To achieve a sufficient insulation level for higher voltage levels, it has either a huge demand of space or needs additional complex and costly field grading measures. Therefore, as a rule of thumb, such a contact system is a good solution for lower voltage ratings.

[0008] The cylindrical shaped gliding contact arrangement provides a more homogeneous electrical field distribution, so that a sufficient insulation level can be achieved in most cases easier for higher voltage levels than with a knife type one.

[0009] The movable contact, for example a cylindrical bolt or a tube, has only an average deheating capability, because the surface is small and smooth and radiation and convection is not actively supported by that.

[0010] Such a tube/bolt geometry is sensitive to current displacement, like skin effect, so that the AC resistance at 50Hz or 60Hz is significant increased with respect to the DC resistance, leading to additional ohmic loss.

Spiral contacts with sufficient contact force need deep grooves inside the cylindrical contacts of several millimetres for installation. This makes the wall thickness of the cylindrical contacts thicker than is has to be with respect to the needed current carrying capacity.

[0011] As pointed out above in the current path, there are 4 transition resistances, coming along with additional ohmic loss. In addition, that spiral contacts themselves are part of the current pass, they also generate ohmic loss. The knife system does not suffer of a huge amount of transition resistance, because the springs for the contact force are not part of the current path, like with the gliding contact arrangement.

[0012] Based on that, the object of the invention is, to create a contact system with possibly low ohmic restistance, which is furthermore compact.

[0013] So, the invention is, that spring means for providing the radially expanding contact forces, are located inside the cylindrical shape, represented by the contact elements arrangement. This results in low ohmic resistance as well as in a very compact arrangement.

[0014] A further advantageous embodiment is, that the support structure is dimensioned relatively to the tube shaped contact side as such, that it allows a radial movement of the contact elements between a minimal diameter and a maximal diameter of the cylindrical shaped contact element.

[0015] Further advantageous is, that the contact elements have a sector shaped like cross section in axial view.

[0016] Furthermore is embellished, that the contact

force, generated by the spring means, is effective between the support structure and the contact elements.

[0017] Refering conditions are implemented into the spring means construction, as such, that the force, generated by the spring means, is higher when the diameter of the cylindrical contact element arrangement is minimum than when the diameter of the cylindrical contact element arrangement is maximum.

[0018] In the following, several alternatives for the spring construction ae described.

[0019] In a first alternative advantageous embodiment, the spring means are springs, which are placed between the support structure and the contact elements.

[0020] In a further alternative advantageous embodiment, the spring means are at least one ring shaped helical spring, which is, or are fixed on the support structure in a corresponding, at least one tangential groove.

[0021] In a further alternative advantageous embodiment, the spring means are per contact element at least one helical spring which is forced axial, supporting each contact element individually.

[0022] In a further alternative advantageous embodiment, the spring means are per contact element at least one flat spring, supporting each contact element individually.

[0023] So an advantageous embodiment as well is, that the at least one flat spring is wave formed.

[0024] In a further alternative advantageous embodiment, the spring means are at least one spring, which force is orientated in axial direction and is redirected in radial direction and applied to the contact elements.

[0025] By that an advantageous embodiment is, that the redirection of the spring force is reached by a chock arrangement, which skew surfaces are part of the support structure and part of the contact element.

[0026] In the use of such an aforesaid contact element arrangement, a plug connection for medium or high voltage application, for connection of two conductors, is proposed, having two cylindrical shaped female plug sockets and one cylindrical shaped contact element, wherehin the cylindrical shaped contact element is a cylindrical shaped contact element arrangement, according to one of the aforesaid claims 1 to 12, concerning to contact element, and to claims 13 to 17 for the use of such a contact element in a plug connection.

[0027] By that, an electrical switch for medium or high voltage use is proposed, having at least two static contacts which can be connected by a movable cylindrical shaped contact element, wherein the movable cylindrical shaped contact element is a cylindrical shaped contact element arrangement according to claim 1 to 12, concerning to contact element, and to claims 13 to 17 for the use of such a contact element in a plug connection.

[0028] Following that, an further advantageous embodiment is, that the cylindrical shaped contact element arrangement is movable by an axial force generated by a mechanical element, which effects the support structure of the contact element arrangement.

[0029] Furthermore, the mechanical element exceeds at least partly, at least one of the at least two static contacts.

[0030] For that, the mechanical element can be a push rod, gear rack, linkage or a spindle nut combination.

[0031] A design of a round conductor piece is proposed, which is able to generate contact forces in radial direction. This is reached by using multiple, independent, parallel contact elements, forming a segmented movable contact. Therefore this conductor piece (in the following: cylindrical shaped contact element arrangement) is able to connect two tube shaped contacts by insertion of the cylindrical shaped contact element arrangement into both contacts. The effective contact force allows a reliable electrical connection in radial direction from the 1st tube shaped contact to the cylindrical shaped contact element arrangement and vice versa to the 2nd tube shaped contact.

Figure 1: cross sectional view of spring means in a first alternative

Figure 2: cross sectional view

Figure 3: cross sectional view of figure 1 in cut A

Figure 4: cross sectional view of spring means in a second alternative

Figure 5: cross sectional view of spring means in a third alternative

Figure 6: cross sectional view of spring means in a fourth alternative

Figure 7: cross sectional view of an electrical connection with a cylindrical contact element arrangement

Figure 8: cross sectional view of an electrical switch using a cylindrical contact element arrangement

Figure 9: perspective view of the contact element arrangement

Figure 10: perspective view of the contact element arrangement

[0032] Figure 1 shows a sectional view of the schematic construction of the cylindrical shaped contact element arrangement 10. A contact element 20 is supported by spring means 30, which push the contact element in radial direction. The springs are supported by a support structure 40. The movement of the contact element is limited by a locking or hocking geometry 50 which defines the maximal outer diameter of the cylindrical shaped contact element arrangement d_{max}, which is reached, when it is not connected to any contact (unforced contact ele-

ment arrangement).

[0033] Figure 2 shows the cylindrical contact element arrangement in forced status, means it is connected to cylindrical shaped contacts 60, 70. Minimal outer diameter d_{min} is reached.

[0034] In figure 3, a sectional view A (ref fig1) is shown. Contact elements are individually supported by spring means and guided in radial direction by the support structure.

[0035] Figure 4 shows the generation of the radial spring force by a wave flat spring 32.

Figure 5 shows the generation of the radial spring force by ring shaped helical spring 33, which are fixed on the support structure in corresponding tangential grooves.

[0036] Figure 6 shows the generation of the contact force by spring washer arrangement 34 which force is redirected from axial direction to radial direction. This can be achieved when the support structure consists of two pieces 40.1, 40.2 which are movable relative against each other and a spring washer arrangement 34.1 unforced, 34.2 forces is effective between these. The redirection is achieved by a chock arrangement 80 which skew surfaces are part of the support structure and part of the contact element.

[0037] Figure 7 shows exemplarily a plug connection which uses the cylindrical shaped contact element arrangement 10 as coupling conductor. The static contact 60, 70 are electrically connected by the cylindrical shaped contact element arrangement 10. Therefore the contact element arrangement contacts the static contacts on the inner surface of the tube shaped contact geometry.

[0038] Figure 8 shows the principle structure of a three position switch. The movable contact piece is a cylindrical shaped contact element arrangement 10 which can be moved by a drive spindle. Therefore the support structure 40 provides an inner screw and it is twist protected against the static contacts (not shown).

[0039] A gliding contact system is proposed which improves the following aspects:

- Amount of transition resistances is reduced (from 4 to 2)
- Resistance of the spring element is take out of the current path
- Material demand and complexity of the (static) cylindrical contacts are reduced (no grooves for spiral contacts)
- Skin effect of movable conductor is reduced
- Deheating of the movable conductor is improved (surface area is increased)

[0040] So main constructural features of the invention are then, that the movable contact tube/bolt is segmented, so the contact is replaced by multiple, independent, parallel contact elements, forming a segmented movable contact, in such, that the radially expanding contact forces are provided by spring means, which are located inside the cylindrical shape, represented by the contact elements arrangement.

This results in, that the skin effect is reduced.

Furthermore the current density is homogenized over the movable conductor circumference, because the parallel segments are insulated from each other, and don't result in a full tube or cylinder.

[0041] Furthermore, the surface area of the segmented contact is increased with respect to the movable contact surface area, which increases the deheating performance, by radiation and convection.

[0042] A support structure is needed for holding the contact elements and to allow a synchronous movement of the segmented movable contact from one switching position into another.

[0043] Contact force is applied to the contact elements by springs, which are located inside the segmented movable contact shape, like already said above.

Each spring, is generating the contact force, and is not part of the current path anymore, so that the total resistance is reduced by two transition resistances and the resistance of the spiral contact.

[0044] The amount of spring elements is reduced, because it is moved from the static contacts to the movable conductor.

[0045] An example of a practical embodiment of the contact system is shown as a cross section along the long axis in figures 9 and 10.

Numbering

[0046]

10	cylindrically shaped contact element arrangement
20	contact element
30	spring means
32	wave flat spring
33	ring shaped helical spring
34	spring washer arrangement
34.1	spring washer arrangement
34.2	spring washer arrangement
40	support structure
40.1	piece of support structure
40.2	piece of support structure
50,51	hocking geometry
60	contact
70	contact
80	chock arrangement

Claims

1. Cylindrical shaped contact element arrangement for a three-position-switch in medium or high voltage gas insulated switchgears, which provides a disconnector switch and an earthing switch, which further consist of one movable conductor and three con-

tacts, which are busbar contact, center contact and earth contact, with a cylindrical shaped contact element arrangement for connecting tube shaped contacts which are orientated in axial direction and with spring means for providing contact forces, and that the cylindrical shaped contact element arrangement consist of multiple identical contact elements, which are hold in cylindrical position by a support structure,
characterized in,
that spring means for providing the radially expanding contact forces, are located inside the cylindrical shape, represented by the contact elements arrangement.

2. Cylindrical shaped contact element arrangement according to claim 1,
characterized in,
that the support structure is dimensioned relatively to the tube shaped contact side as such, that it allows a radial movement of the contact elements between a minimal diameter and a maximal diameter of the cylindrical shaped contact element.

3. Cylindrical shaped contact element arrangement according to claim 1, or 2
characterized in,
that the contact elements have a sector shaped like cross section in axial view.

4. Cylindrical shaped contact element arrangement according to one of the aforesaid claims,
characterized in
that the contact force, generated by the spring means, is effective between the support structure and the contact elements.

5. Cylindrical shaped contact element arrangement according to one of the aforesaid claims,
characterized in
that the force, generated by the spring means, is higher when the diameter of the cylindrical contact element arrangement is minimum than when the diameter of the cylindrical contact element arrangement is maximum.

6. Cylindrical shaped contact element arrangement according to one of the aforesaid claim,
characterized in,
that the spring means are springs, which are placed between the support structure and the contact elements.

7. Cylindrical shaped contact element arrangement according to claim 6
characterized in,
that the spring means are at least one ring shaped helical spring, which is, or are fixed on the support structure in a corresponding, at least one tangential groove.

8. Cylindrical shaped contact element arrangement according to claim 6
characterized in,
that the spring means are per contact element at least one helical spring which is forced axial, supporting each contact element individually.

9. Cylindrical shaped contact element arrangement according to claim 6
characterized in,
that the spring means are per contact element at least one flat spring, supporting each contact element individually.

10. Cylindrical shaped contact element arrangement according to claim 6 or 9,
characterized in,
that the at least one flat spring is wave formed.

11. Cylindrical shaped contact element arrangement according to claim 4 or 5,
characterized in,
that the spring means are at least one spring, which force is orientated in axial direction and is redirected in radial direction and applied to the contact elements.

12. Cylindrical shaped contact element arrangement according to claim 11
characterized in,
that the redirection of the spring force is reached by a chock arrangement, which skew surfaces are part of the support structure and part of the contact element.

13. Plug connection for medium or high voltage application, for connection of two conductors, having two cylindrical shaped female plug sockets and one cylindrical shaped contact element, wherehin the cylindrical shaped contact element is a cylindrical shaped contact element arrangement, according to one of the aforesaid claims 1 to 12.

14. Electrical switch for medium or high voltage use, having at least two static contacts which can be connected by a movable cylindrical shaped contact element, wherein the movable cylindrical shaped contact element is a cylindrical shaped contact element arrangement according to claim 1 to 12.

15. Electrical switch according to claim 14
characterized in,
that the cylindrical shaped contact element arrangement is movable by an axial force generated by a mechanical element, which effects the support structure of the contact element arrangement.

16. Electrical switch according to claim 15
characterized in,
that the mechanical element exceeds at least partly, at least one of the at least two static contacts.

17. Electrical switch according to claim 15 or 16
characterized in,
that the mechanical element is a push rod, gear rack, linkage or a spindle nut combination.

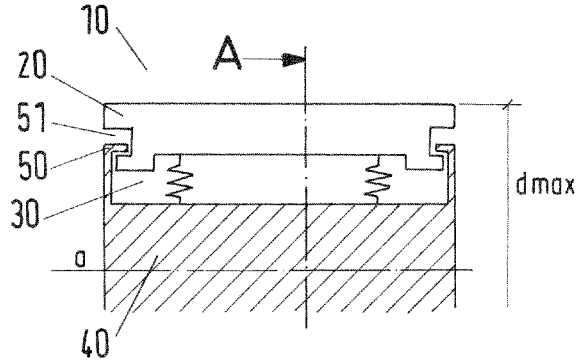

Fig.1

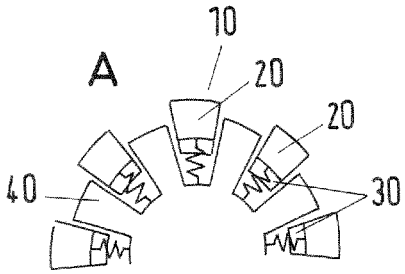

Fig.3

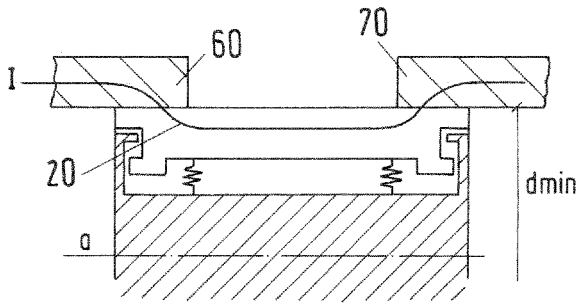

Fig.2

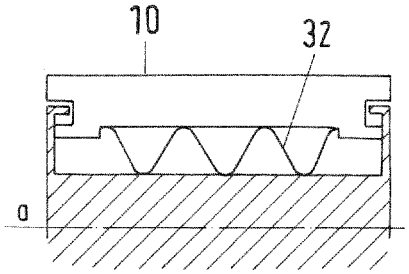

Fig.4

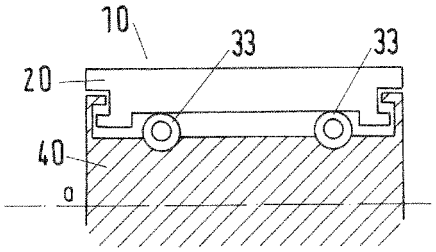

Fig.5

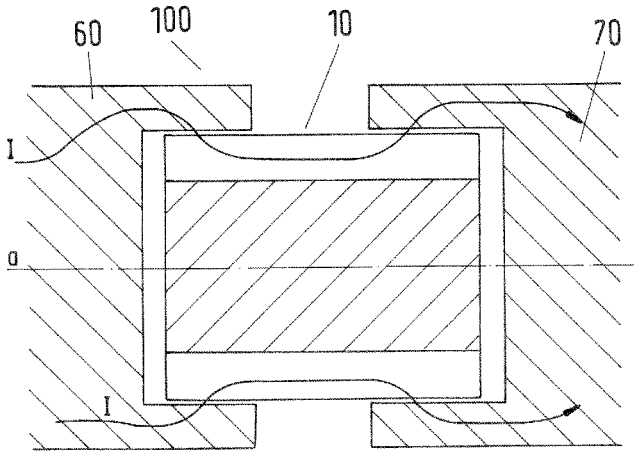

Fig.7

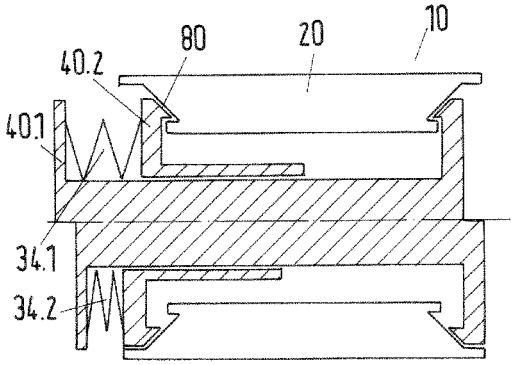

Fig.6

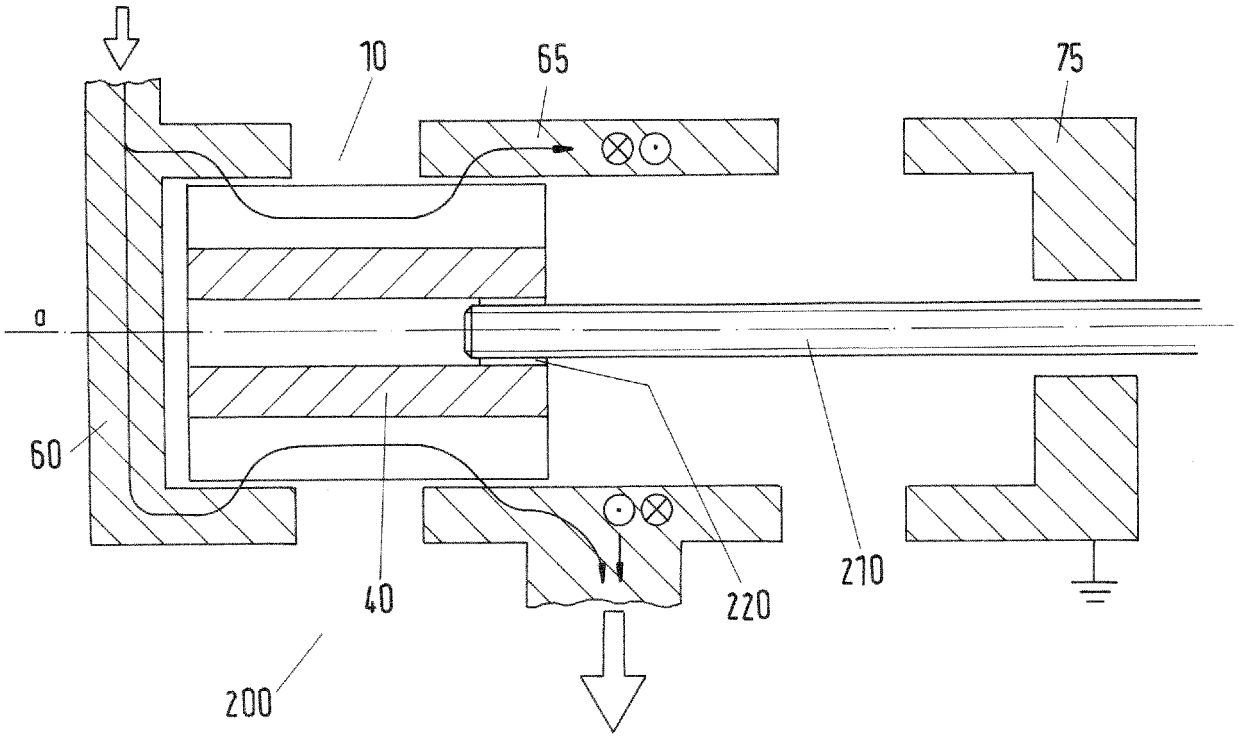

Fig.8

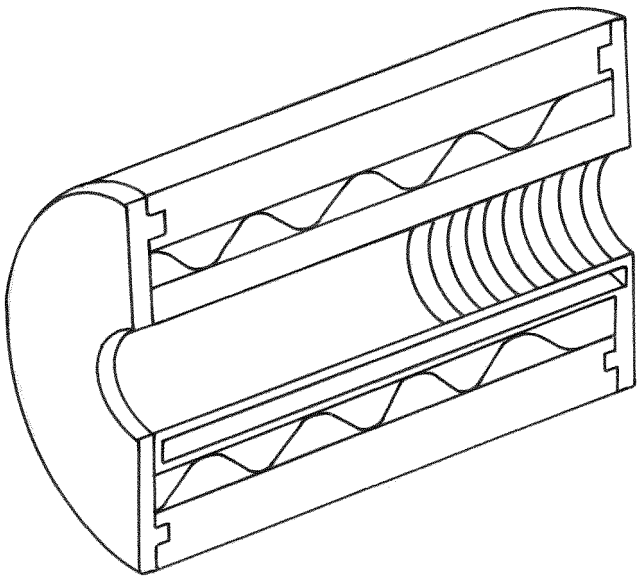

Fig.9

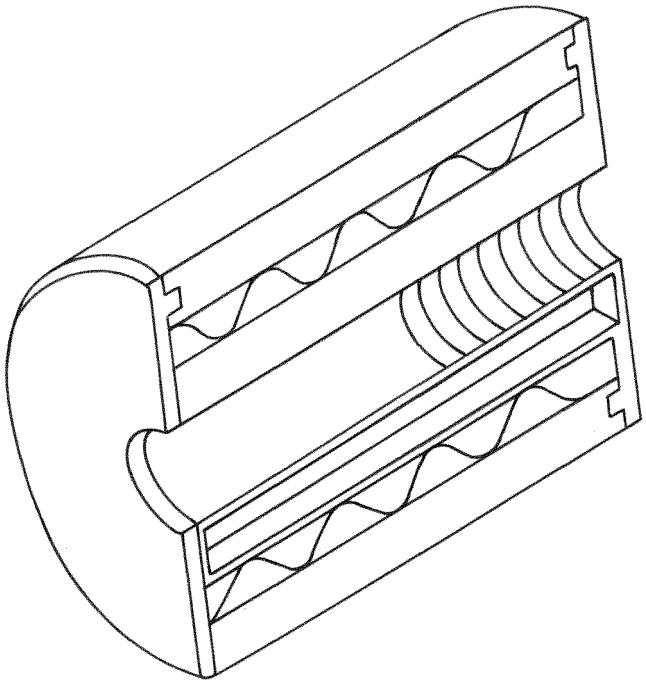

Fig.10

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EUROPEAN SEARCH REPORT

Application Number
EP 16 16 7338

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 October 2016	Rucha, Johannes

CATEGORY OF CITED DOCUMENTS

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