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(54) **A CONNECTOR FOR JOINTING POWER CABLES**

(57) The present disclosure relates to a connector (1) for joining a first power cable section (3a) and a second power cable section (3b), comprising: a first contact body (5) having a first end (5a) provided with a central opening (5b) configured to receive a first conductor end (11a) of a first power cable section (3a), and a second end (5c) opposite to the first end (5a), provided with a male contact structure (5d), a second contact body (7) having a first end (7a) provided with a central opening (7b) configured to receive a first conductor end (11b) of

a second power cable section (3b), and a second end (7c), opposite to the first end (7a) of the second contact body (7), provided with a female contact structure (7d) configured to engage with the male contact structure (5d), and a radially elastic contact member (9a-9d) configured to be arranged radially between the male contact structure (5d) and the female contact structure (7d) to provide radial mechanical and electrical contact between the male contact structure (5d) and the female contact structure (7d).

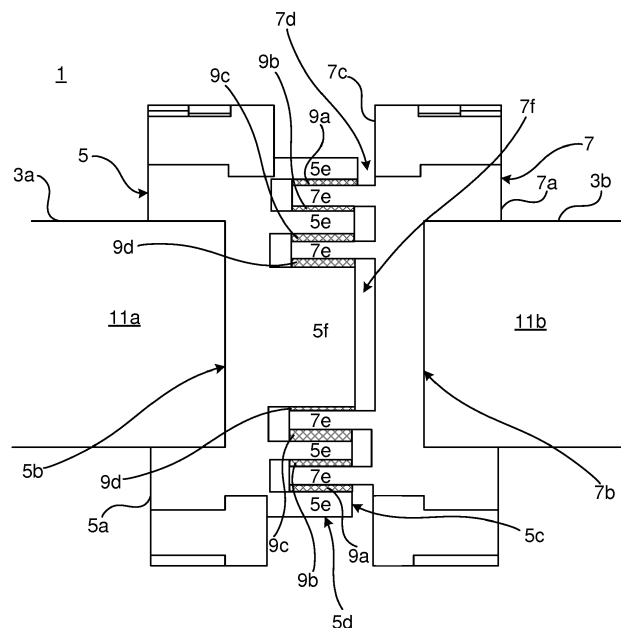


Fig. 1

## Description

### TECHNICAL FIELD

**[0001]** The present disclosure generally relates to power cables and in particular to a connector for jointing a power cable.

### BACKGROUND

**[0002]** Joint devices are typically used for connecting two cable ends in an extruded cable system. Such cables typically comprise a conductor and an insulation system surrounding the conductor. The insulation system may include inner and outer semiconducting layers for screening, and an intermediate electrical insulation layer arranged between the semiconducting layers.

**[0003]** Two types of joints are common, namely factory joints and prefabricated joints. Contrary to a factory joint, where the insulation material is applied directly onto the conductor, a prefabricated joint is mounted onto the insulation system of the cable. A prefabricated joint may include a field control body which includes at least one semiconducting layer and an electrical insulation layer which control the electric field, and a connector that completes the metallic link between the two cable conductors for current transfer. The connector may use a clamping/bolting technique to connect the conductor ends. The current transfer in the conventional connector is designed to transfer the current in a radial direction.

**[0004]** Individually insulated stranded conductors, such as enamelled conductors, where each strand is insulated by a varnish, do not allow current transfer in the radial direction. An example of a connector for this type of conductors is disclosed in DE10204105817 A1. The connector has a contact body provided with openings for receiving conductors, and two contact elements, each being arranged between a respective conductor end and the contact body. The connector also has two clamping bodies, configured to be attached to the contact body by means of threads.

### SUMMARY

**[0005]** The installation procedure required for the device disclosed in DE10204105817 A1 may however be somewhat cumbersome, because both clamping bodies, with their respective cable section are to be attached to the contact body by means of respective threaded surfaces. Since the two cables that are to be jointed are both long and heavy, it is not a simple task to rotate at least one of the cables with the attached clamping body when engaging the threaded surfaces.

**[0006]** In view of the above, an object of the present disclosure is to provide a connector for jointing a power cable which solves, or at least mitigates, the problems of the prior art.

**[0007]** There is hence according to a first aspect of the

present disclosure provided a connector for jointing a first power cable section and a second power cable section, comprising: a first contact body having a first end provided with a central opening configured to receive a first conductor end of a first power cable section, and a second end opposite to the first end, provided with a male contact structure, a second contact body having a first end provided with a central opening configured to receive a first conductor end of a second power cable section, and a second end, opposite to the first end of the second contact body, provided with a female contact structure configured to engage with the male contact structure, and a radially elastic contact member configured to be arranged radially between the male contact structure and the female contact structure to provide radial mechanical and electrical contact between the male contact structure and the female contact structure.

**[0008]** The connector hence provides a mechanical and electrical connection between two power cable sections by a mating male-female contact structure. The first contact body and the second contact body may thus in a simple manner be connected to each other, without needing rotation between the parts. The radially elastic contact member ensures good mechanical and thus good electrical contact between the male contact structure and the female contact structure, maintaining a stable electrical and mechanical contact dynamically, i.e. as the male contact structure and female contact structure expand and contract due to thermal radial and axial expansion and contraction.

**[0009]** The elastic contact member is configured to be electrically conducting, and may for example comprise a metal. The metal may for example include at least one of copper, aluminium, silver and gold.

**[0010]** According to one embodiment the elastic contact member has an annular shape.

**[0011]** According to one embodiment the elastic contact member has a first axial end provided with a plurality of first legs distributed circumferentially around the first axial end, and a second axial end provided with a plurality of second legs distributed circumferentially around the second axial end.

**[0012]** According to one embodiment the elastic contact member has a plurality of radially flexible elements extending between the first axial end and the second axial end.

**[0013]** According to one embodiment one of the male contact structure and the female contact structure is provided with a first circumferential groove configured to receive the plurality of first legs of the elastic contact member and a second circumferential groove axially offset relative to the first circumferential groove configured to receive the plurality of second legs, to maintain the axial position of the elastic contact member.

**[0014]** According to one embodiment the male contact structure comprises a plurality of concentrically arranged axially extending annular first protrusions and a central rod.

[0015] According to one embodiment the male contact structure comprises one axially extending annular first protrusion and a central rod, and the female contact structure comprises one axially extending annular second protrusion and a central opening, configured to mate with the annular first protrusion and the central rod of the male contact structure.

[0016] According to one embodiment the female contact structure comprises a plurality of concentrically arranged annular second protrusions extending axially and a central opening, configured to mate with the concentrically arranged annular first protrusions and the central rod of the male contact structure.

[0017] According to one embodiment the elastic contact member is configured to be arranged radially between an annular first protrusion and an annular second protrusion.

[0018] One embodiment comprises a plurality of elastic contact members, each elastic contact member being configured to be arranged radially between a pair of engaging annular first protrusion and annular second protrusion. Better mechanical and electrical contact may thus be ensured between each pair of concentrically arranged annular first protrusion and annular second protrusion.

[0019] One embodiment comprises a first fixation body configured to be arranged adjacent to the first end of the first contact body, the first fixation body being configured to be fixed to the first contact body, and the first fixation body having a plurality of radially extending through-openings for fastening the first fixation body to the first conductor end of the first power cable section.

[0020] One embodiment comprises a plurality of elongated fasteners configured to extend axially between the first contact body and the first fixation body to thereby fasten the first fixation body to the first contact body.

[0021] One embodiment comprises a second fixation body configured to be arranged adjacent to the first end of the second contact body, the second fixation body being configured to be fixed to the second contact body, and the second fixation body having a plurality of radially extending through-openings for fastening the second fixation body to the first conductor end of the second power cable section.

[0022] One embodiment comprises a plurality of elongated fasteners configured to extend axially between the second contact body and the second fixation body to thereby fasten the second fixation body to the second contact body.

[0023] One embodiment comprises a plurality of electrically conducting fixation plates, each fixation plate being configured to extend from the first fixation body to the second fixation body, and each fixation plate having radial through-openings configured to be aligned with the radially extending through-openings of the first fixation body and the second fixation body, for fastening the fixation plates to the first fixation body and to the second fixation body.

[0024] There is according to a second aspect of the present disclosure provided a power cable comprising a first power cable section, a second power cable section, and a connector according to the first aspect presented herein, joining the first power cable section and the second power cable section, and a field control body enclosing the connector.

[0025] Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to a/an/the element, apparatus, component, means, etc. are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, etc., unless explicitly stated otherwise.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The specific embodiments of the inventive concept will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 schematically shows a longitudinal section of an example of a connector including a first contact body and a second contact body;

Fig. 2 schematically shows a perspective view of a connector including the first contact body and a first fixation body;

Fig. 3 schematically shows a longitudinal section of an example of a connector;

Fig. 4 schematically shows a perspective view of an example of an elastic contact member; and

Fig. 5 schematically shows a perspective view of an example of a connector.

## DETAILED DESCRIPTION

[0027] The inventive concept will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplifying embodiments are shown. The inventive concept may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the inventive concept to those skilled in the art. Like numbers refer to like elements throughout the description.

[0028] The present disclosure relates to a connector for joining a first power cable section and a second power cable section. The connector may be used for low voltage, medium voltage or high voltage applications. The connector may also be advantageous for use with conductors comprising a plurality of individually insulated strands, for example enamelled conductors.

**[0029]** The connector comprises a first contact body having a first end provided with an opening configured to receive a first conductor end of a first power cable section and a second end opposite to the first end, provided with a male contact structure. The connector also comprises a second contact body having a first end provided with an opening configured to receive a second conductor end of a second power cable section, and a second end opposite to the first end of the second contact body, provided with a female contact structure. The male contact structure, or male connector structure, is configured to mate with the female contact structure, or female connector structure.

**[0030]** The first conductor end of the first power cable section may for example be an enamelled stranded conductor end and the first conductor end of the second power cable section may for example be an enamelled stranded conductor. The conductor ends could alternatively have other configurations; they may for example be solid, segmented or compacted conductor ends.

**[0031]** The connector furthermore comprises a radially elastic contact member configured to be arranged radially between the male contact structure and the female contact structure. The elastic contact member is configured to provide mechanical and electrical contact between the male contact structure and the female contact structure.

**[0032]** Depending on the configuration of the male contact structure and the female contact structure, and on the particular requirements of mechanical contact between the male contact structure and the female contact structure, there may be a single elastic contact member provided or a plurality of elastic contact members provided.

**[0033]** An example of a connector for jointing a first power cable with a second power cable, thereby forming a single power cable is shown in Fig. 1.

**[0034]** Fig. 1 shows an example of a connector 1 for jointing a first power cable section 3a and a second power cable section 3b, to thereby form a single jointed power cable. The connector 1 comprises a first contact body 5, a second contact body 7, and a plurality of radially elastic contact members 9a-9d.

**[0035]** The first contact body 5 has a first end 5a provided with an opening 5b configured to receive a first conductor end 11a of the first power cable section 3a. The first contact body 5 furthermore has a second end 5c provided with a male contact structure 5d.

**[0036]** The second contact body 7 has a first end 7a provided with an opening 7b configured to receive a first conductor end 11b of the second power cable section 3b. The second contact body 7 furthermore has a second end 7c provided with a female contact structure 7d.

**[0037]** The male contact structure 5d and the female contact structure 7d are configured to mate, or engage with each other.

**[0038]** Fig. 2 shows a perspective view of one half of the connector 1 depicted in Fig. 1, namely the first contact

body 5 with the male contact structure 5, with additional parts forming part of the connector shown in Fig. 3.

**[0039]** According to the example of the connector 1 shown in Fig. 2, the male contact structure 5d is provided with a plurality of concentrically arranged axially extending annular first protrusions 5e and a central rod 5f. The female contact structure 7 is provided with a plurality of concentrically arranged axially extending annular second protrusions 7e, and a central opening 7f, as shown in the longitudinal section in Fig. 1. The annular first protrusions 5e and the annular second protrusions 7e are configured to mate, and the central rod 5f is configured to mate with the central opening 7f.

**[0040]** Although both the male contact body 5 and the female contact body 7 have axially extending annular first protrusions 5e and annular second protrusions 7e, respectively, because contact structure 5 has an axially extending central rod 5f, configured to be received by a central opening 7f of the contact structure 7, contact structure 5d is herein referred to as male contact structure 5d and contact structure 7d is referred to as female contact structure 7d.

**[0041]** According to the example shown in Fig. 2, the connector 1 further comprises a first fixation body 13 configured to be arranged adjacent to the first end 5a of the first contact body 5, and configured to be attached thereto. To this end, the first fixation body 13 comprises a plurality of axially extending openings 13a. The first contact body 5 also has axially extending openings 5g configured to be aligned with the axially extending openings 13a of the first fixation body 13. The connector 1 may furthermore comprise a plurality of elongated fasteners 15 configured to be received by a respective pair of axially aligned openings 13a and 5g, to thereby attach the first contact body 5 to the first fixation body 13. The fasteners 15 may for example be screws or bolts.

**[0042]** By means of the elongated fasteners 15, the first fixation body 13 and the first contact body 5 may be moved relative to each other in the axial direction, thereby compensating for thermal effects when current flows through the connector 1. This ensures better axial mechanical and thus electrical contact between the first conductor end 11a and the first contact body 5.

**[0043]** The first fixation body 13 is configured to be mounted around the first conductor end 11a of the first power cable section 3a. The first fixation body 13 is provided with a plurality of radial through-openings 13b to thereby fasten the first fixation body 13 to the first conductor end 11a of the first power cable section 3a by means of fasteners such as screws.

**[0044]** Turning now to Fig. 3, both sides of the connector 1 is shown in a longitudinal section, provided with the first fixation body 13, and comprising a second fixation body 17.

**[0045]** The second fixation body 17 is configured to be arranged adjacent to the first end 7a of the second contact body 7, and configured to be attached thereto. To this end, the second fixation body 17 comprises a plurality

of axially extending openings 17a. The second contact body 7 also has axially extending openings 7g configured to be aligned with the axially extending openings 17a of the second fixation body 17. The connector 1 may furthermore comprise a plurality of elongated fasteners 16 configured to be received by a respective pair of axially aligned openings 17a and 7g, to thereby attach the second contact body 7 to the second fixation body 17. The fasteners 16 may for example be screws or bolts.

**[0046]** By means of the elongated fasteners 16, the second fixation body 17 and the second contact body 7 may be moved relative to each other in the axial direction, thereby compensating for thermal effects when current flows through the connector 1. This ensures better axial mechanical and thus electrical contact between the second conductor end 11b and the second contact body 7.

**[0047]** The second fixation body 17 is configured to be mounted around the first conductor end 11a of the second power cable section 3b. The second fixation body 17 is provided with a plurality of radial through-openings 17b to thereby fasten the second fixation body 17 to the first conductor end 11a of the second power cable section 3b by means of fasteners such as screws.

**[0048]** Fig. 4 shows an example of an elastic contact member 9a-9d. Elastic contact member 9 shown in Fig. 4 has an annular shape. Elastic contact member 9 has a first axial end 19a and a second axial end 19b. The first axial end 19a is provided with a plurality of first legs 19c distributed circumferentially, i.e. in the circumferential direction around the first axial end 19a. The first legs 19c may be inclined radially inwards.

**[0049]** The second axial end 19b is provided with a plurality of second legs 19d distributed circumferentially, i.e. in the circumferential direction around the second axial end 19b of the elastic contact member 9. The second legs 19d may be inclined radially inwards.

**[0050]** As previously noted, the elastic contact members 9, 9a-9d are configured to be arranged radially in between the male contact structure 5d and the female contact structure 7d. The first legs 19c and the second legs 19d of each elastic contact member 9, 9a-9d is configured to engage with corresponding recesses in one of the male contact structure 5d and the female contact structure 7d to thereby fixate the elastic contact members 9, 9a-9d axially. For example, one of the male contact structure 5d and the female contact structure 7d may be provided with a first circumferential groove configured to receive the first legs 19c and a second circumferential groove arranged axially offset from the first circumferential groove and configured to receive the second legs 19d. Thus, as an example the annular first protrusions 5e or the annular second protrusions 7e may be provided with the recesses/first and second circumferential grooves.

**[0051]** The elastic contact member 9 furthermore comprises a plurality of radially flexible elements 19e extending between the first axial end 19a and the second axial end 19b. The plurality of radially flexible structures 19e

are configured to mechanically contact the male contact structure 5d and the female contact structure 7d to thereby provide electrical contact in the radial direction between the male contact structure 5d and the female contact structure 7d.

**[0052]** Fig. 5 shows the connector 1 and the first power cable section 3a and the second power cable section 3b connected to the connector 1. The connector 1 may furthermore comprise a plurality of electrically conducting fixation plates 21.

**[0053]** Each fixation plate 21 is configured to extend between the first fixation body 13 and the second fixation body 17, and thus also across the first contact body 5 to the second contact body 7. The fixation plates 21 have a plurality of radial through-openings 21a, 21b, of which some through-openings 21a are configured to be aligned with the radial through-openings 13b of the first fixation body 13 and other through-openings 21b are configured to be aligned with the radial through-openings 17b of the second fixation body 17. These through-openings 21a, 21b are configured to receive fasteners, such as screws, extending also through the radially inwards arranged through-openings 13b and 17b, thereby fastening the first fixation body 13 and the second fixation body 17 as well as the fixation plates 21 to the first conductor section 11a and the second conductor section 11b. Since the fixation plates extend across the mechanical interface between the first contact body 5 and the second contact body 7, the two contact bodies 5 and 7 will be maintained axially fixed relative to each other. The fixation plates 21 thus maintain the male contact structure 5d and the female contact structure 7d in their mated or engaged state. Preferably, the fixation plates 21 are not mechanically fixed directly to the first contact body 5 and to the second contact body 7, thus allowing the first contact body 5 and the second contact body 7 to move axially relative to the fixation plates 21 to allow thermal expansion and contraction of these parts.

**[0054]** When the connector 1 is assembled with the first conductor end 11a and the second conductor end 11b, the power cable thus obtained may comprise a field control body enclosing the connector 1, arranged radially outside the connector 1.

**[0055]** Each of the components of the connector 1 disclosed herein may be made of an electrically conductive material, typically metal. The contact bodies 5 and 7, and the fixation bodies 13 and 17 may for example be made of steel, copper or aluminium, or any other suitable good electrically conducting material with high mechanical withstand strength.

**[0056]** The inventive concept has mainly been described above with reference to a few examples. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the inventive concept, as defined by the appended claims.

## Claims

1. A connector (1) for joining a first power cable section (3a) and a second power cable section (3b), comprising:
  - a first contact body (5) having a first end (5a) provided with a central opening (5b) configured to receive a first conductor end (11a) of a first power cable section (3a), and a second end (5c) opposite to the first end (5a), provided with a male contact structure (5d),
  - a second contact body (7) having a first end (7a) provided with a central opening (7b) configured to receive a first conductor end (11b) of a second power cable section (3b), and a second end (7c), opposite to the first end (7a) of the second contact body (7), provided with a female contact structure (7d) configured to engage with the male contact structure (5d), and
  - a radially elastic contact member (9, 9a-9d) configured to be arranged radially between the male contact structure (5d) and the female contact structure (7d) to provide radial mechanical and electrical contact between the male contact structure (5d) and the female contact structure (7d).
2. The connector (1) as claimed in claim 1, wherein the elastic contact member (9, 9a-9d) has an annular shape.
3. The connector (1) as claimed in claim 2, wherein the elastic contact member (9, 9a-9d) has a first axial end (19a) provided with a plurality of first legs (19c) distributed circumferentially around the first axial end (19a), and a second axial end (19b) provided with a plurality of second legs (19d) distributed circumferentially around the second axial end (19b).
4. The connector (1) as claimed in claim 3, wherein the elastic contact member (9, 9a-9d) has a plurality of radially flexible elements (19e) extending between the first axial end (19a) and the second axial end (19b).
5. The connector (1) as claimed in claim 3 or 4, wherein one of the male contact structure (5d) and the female contact structure (7d) is provided with a first circumferential groove configured to receive the plurality of first legs (19c) of the elastic contact member (9, 9a-9d) and a second circumferential groove axially offset relative to the first circumferential groove configured to receive the plurality of second legs (19d), to maintain the axial position of the elastic contact member (9, 9a-9d).
6. The connector (1) as claimed in any of the preceding claims, wherein the male contact structure (5a) comprises a plurality of concentrically arranged axially extending annular first protrusions (5e) and a central rod (5f).
7. The connector (1) as claimed in claim 6, wherein the female contact structure (7) comprises a plurality of concentrically arranged annular second protrusions (7e) extending axially and a central opening (7f), configured to mate with the concentrically arranged annular first protrusions (5e) and the central rod (5f) of the male contact structure (5).
8. The connector (1) as claimed in claim 7, wherein the elastic contact member (9, 9a-9d) is configured to be arranged radially between an annular first protrusion (5e) and an annular second protrusion (7e).
9. The connector (1) as claimed in claim 8, comprising a plurality of elastic contact members (9, 9a-9d), each elastic contact member (9, 9a-9d) being configured to be arranged radially between a pair of engaging annular first protrusion (5e) and annular second protrusion (7e).
10. The connector (1) as claimed in any of the preceding claims, comprising a first fixation body (13) configured to be arranged adjacent to the first end (5a) of the first contact body (5), the first fixation body (13) being configured to be fixed to the first contact body (5), and the first fixation body (13) having a plurality of radially extending through-openings (13b) for fastening the first fixation body (13) to the first conductor end (11a) of the first power cable section (3a).
11. The connector (1) as claimed in claim 10, comprising a plurality of elongated fasteners (15) configured to extend axially between the first contact body (5) and the first fixation body (13) to thereby fasten the first fixation body (13) to the first contact body (5).
12. The connector (1) as claimed in any of the preceding claims, comprising a second fixation body (17) configured to be arranged adjacent to the first end (7a) of the second contact body (7), the second fixation body (17) being configured to be fixed to the second contact body (7), and the second fixation body (17) having a plurality of radially extending through-openings (17b) for fastening the second fixation body (17) to the first conductor end (11b) of the second power cable section (3b).
13. The connector (1) as claimed in claim 12, comprising a plurality of elongated fasteners (16) configured to extend axially between the second contact body (7) and the second fixation body (17) to thereby fasten the second fixation body (17) to the second contact body (7).

14. The connector (1) as claimed in claim 12 or 13, comprising a plurality of electrically conducting fixation plates (21), each fixation plate (21) being configured to extend from the first fixation body (13) to the second fixation body (17), and each fixation plate (21) having radial through-openings (21a, 21b) configured to be aligned with the radially extending through-openings (13b, 17b) of the first fixation body (13) and the second fixation body (17), for fastening the fixation plates (21) to the first fixation body (13) and to the second fixation body (17).
15. A power cable comprising a first power cable section (3a), a second power cable section (3b), and a connector (1) as claimed in any of claims 1-14, jointing the first power cable section (3a) and the second power cable section (3b), and a field control body enclosing the connector (1).

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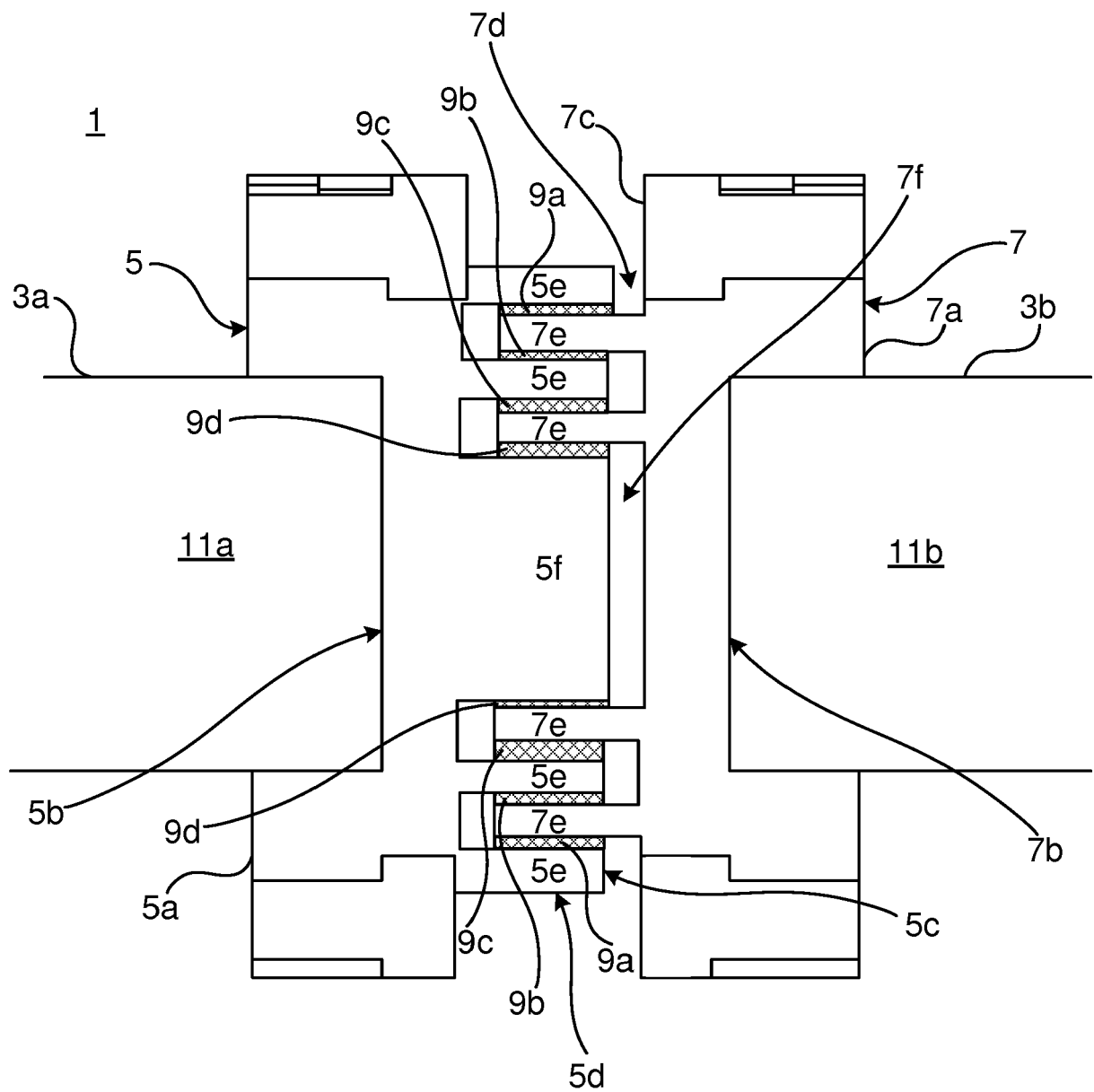


Fig. 1

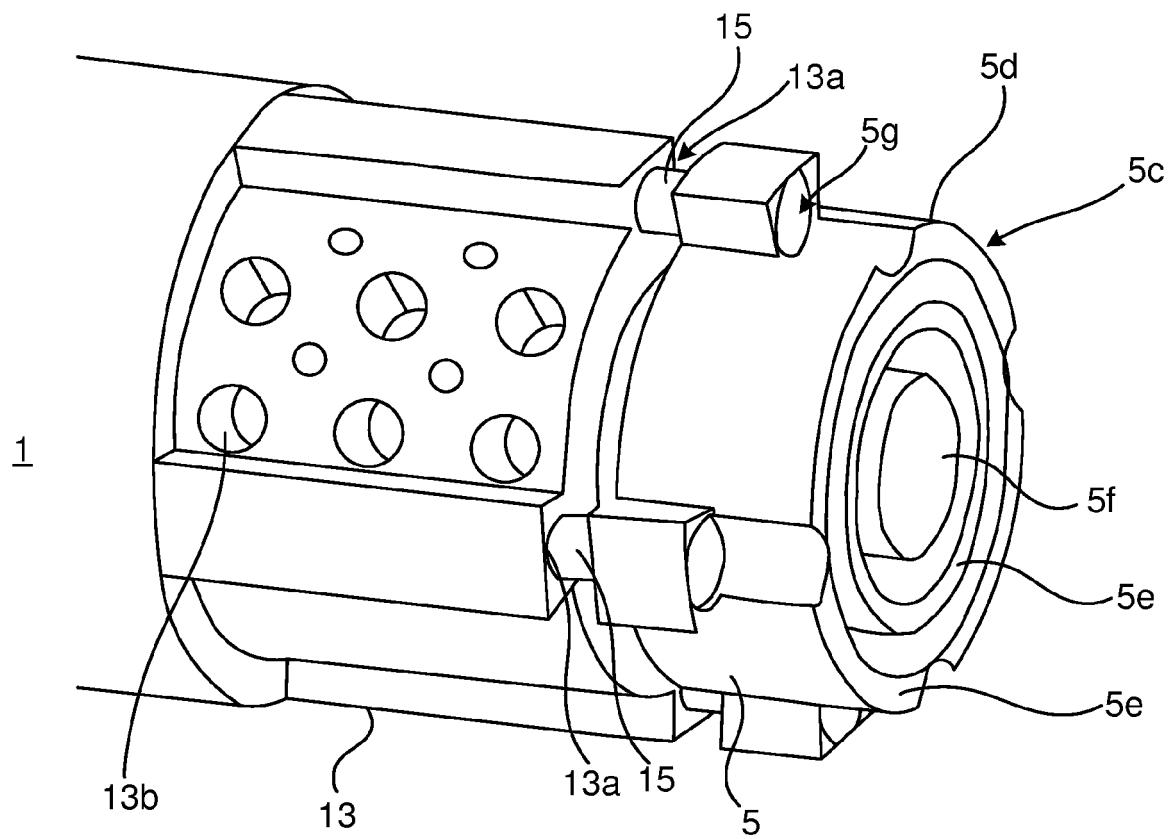


Fig. 2

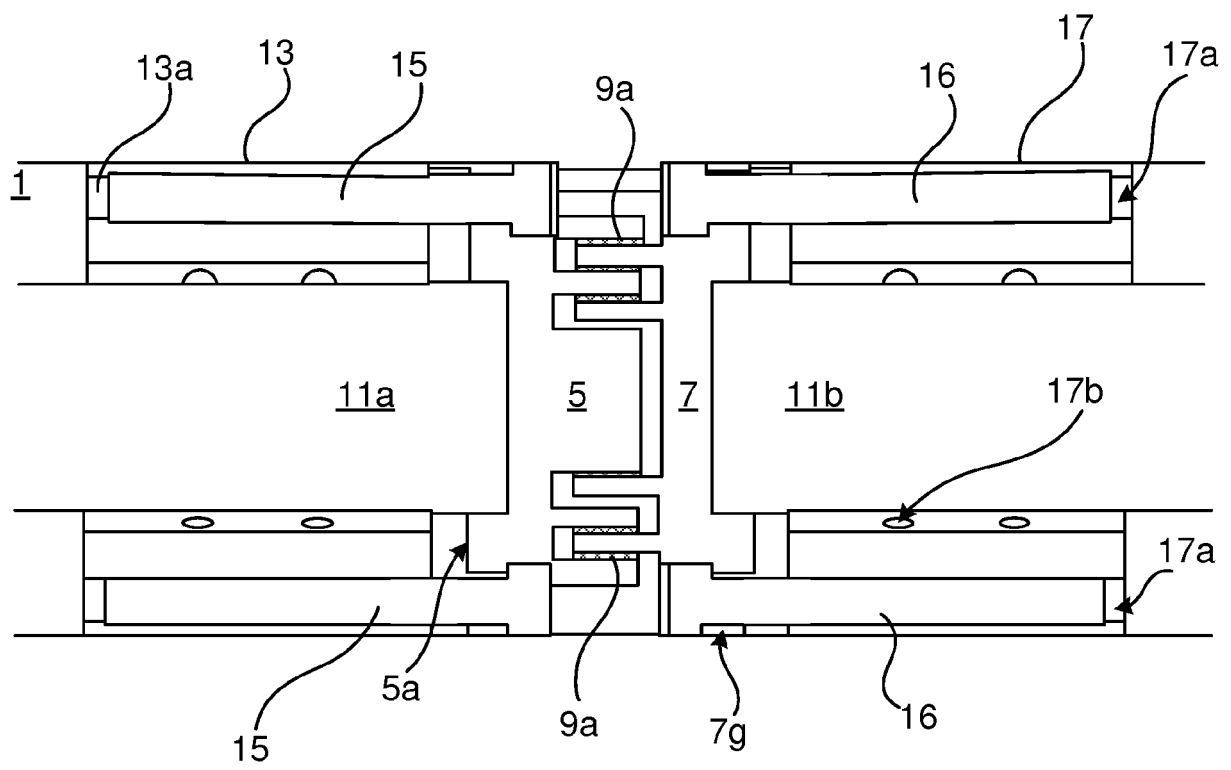


Fig. 3

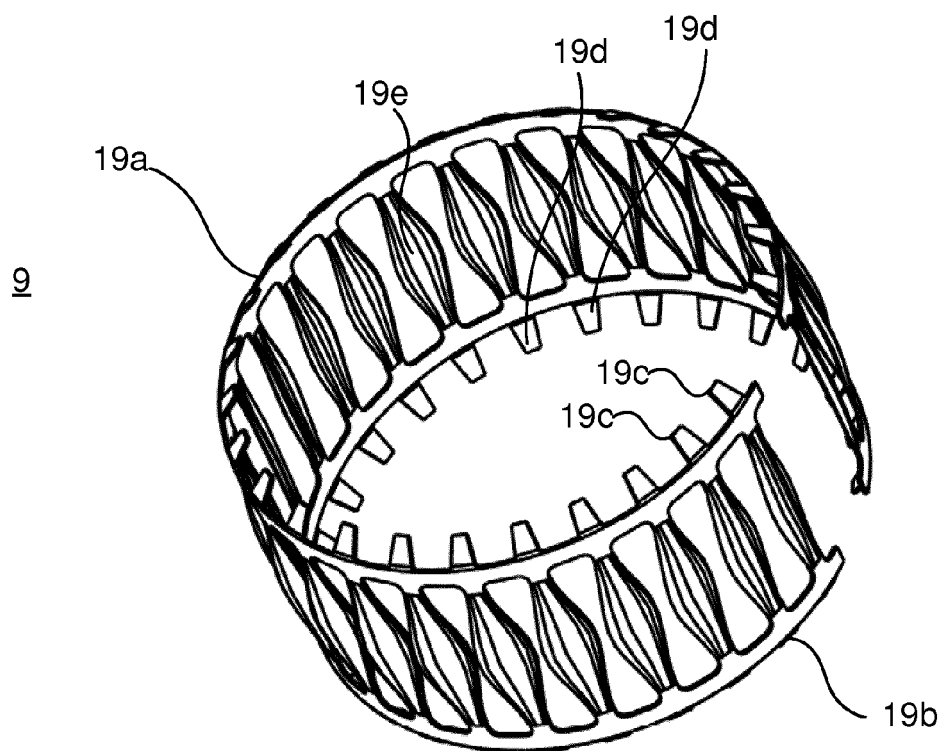


Fig. 4

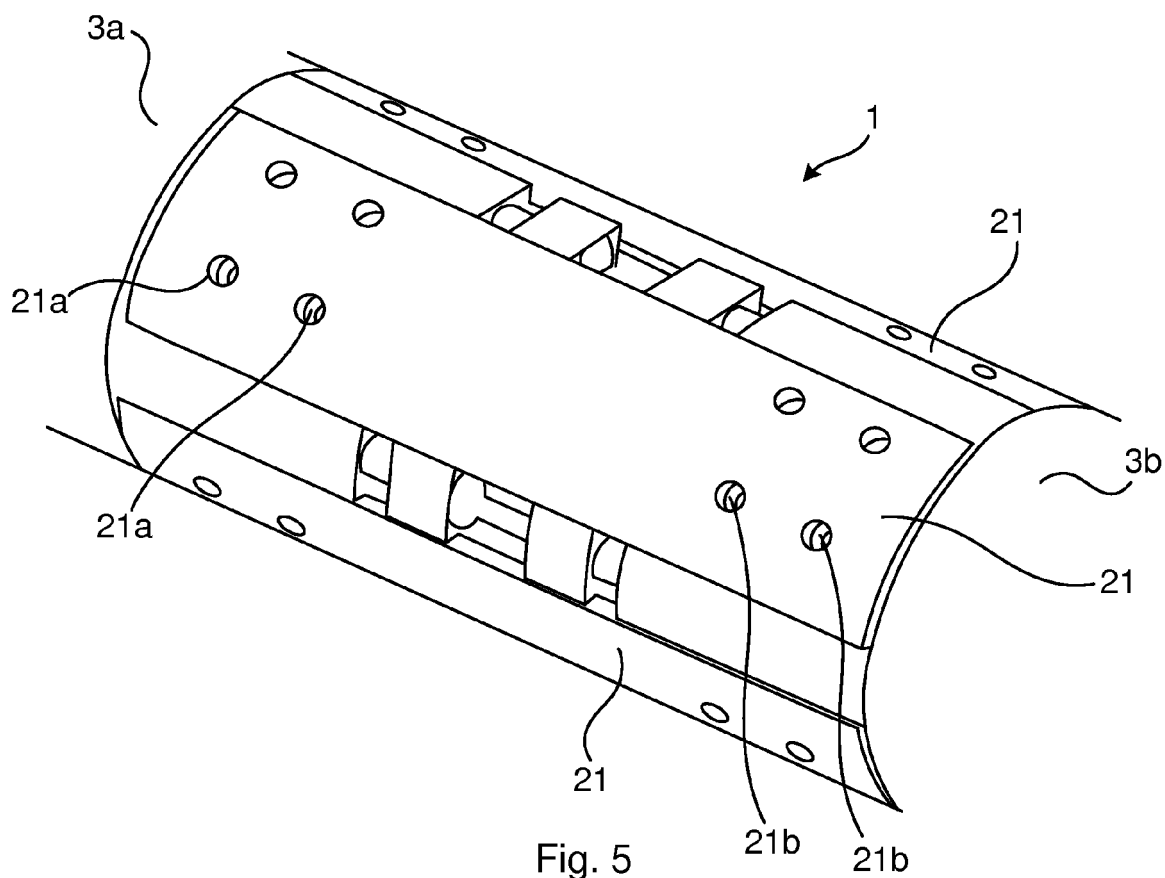


Fig. 5



## EUROPEAN SEARCH REPORT

 Application Number  
 EP 16 20 4393

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                    |                                                                                                                       |                                                                                                                                                                                                                                                                              |                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Category                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                         | Relevant to claim                                                                                                                                                                                                                                                            | CLASSIFICATION OF THE APPLICATION (IPC)                                                          |
| X                                                                                                                                                                                                                                                      | US 5 176 542 A (GRAPPE RENE [FR])<br>5 January 1993 (1993-01-05)                                                      | 1,2,6-9                                                                                                                                                                                                                                                                      | INV.<br>H01R13/17<br>H01R13/187<br>H01R24/86<br><br>ADD.<br>H01R4/36<br>H01R13/512<br>H01R13/621 |
| Y                                                                                                                                                                                                                                                      | * columns 1,2, lines 6-10, 8-22; figures 1, 2 *                                                                       | 10-15                                                                                                                                                                                                                                                                        |                                                                                                  |
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