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# (54) TULIP-TYPE ELECTRICAL CONTACT COMPRISING A PRESSING ELEMENT PRESSING ON THE CONDUCTING FINGERS AT REST

(57) The invention relates an electrical connector comprising a tulip-type female electrical contact (10). The female electrical contact (10) comprises a ring (11) of conducting fingers (13) and a base (12) carrying the fingers (13). According to the invention, the female electrical connector (3) comprises a pressing element (4). The pressing element (4) presses on the fingers (13), when the female electrical contact (10) is in a rest position wherein the female electrical contact (10) is free of electrical contact with a male electrical contact (20) and away from the male electrical contact (20). The connector comprises a support (30) for the pressing element (4), arranged around the ring (11). The pressing element (4) projects from within the support (30) to the ring (11) of fingers (13).

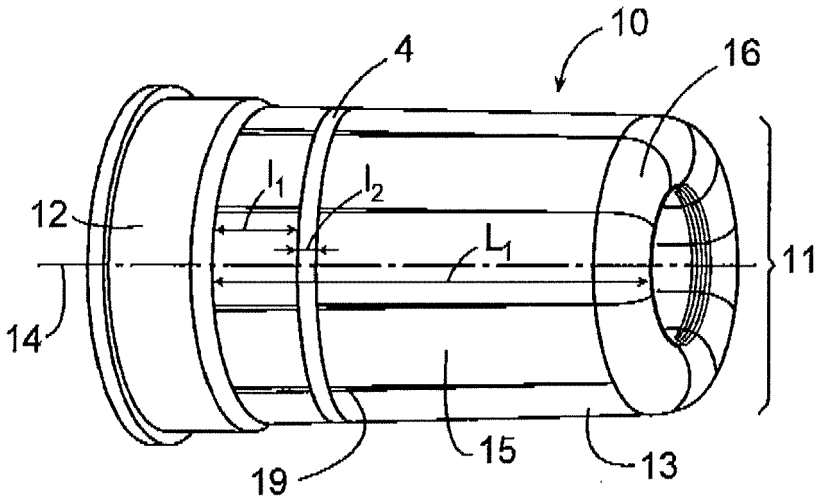


FIG. 5

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## Description

### TECHNICAL FIELD

**[0001]** The invention relates to an electrical connector comprising a tulip-type electrical contact.

**[0002]** Such electrical connectors are typically used in medium or high voltage electrical equipment, for example equipment configured to operate with voltages higher than 72.5 kV or even above 550 kV.

**[0003]** Such equipment may comprise circuit breakers, disconnectors or grounding devices.

### STATE OF PRIOR ART

**[0004]** Fig. 1 represents a tulip-type female electrical contact 10 having a known structure. This electrical contact 10 includes a ring 11 of conducting fingers 13, as well as a base 12 carrying the fingers 13. The conducting fingers 13 comprise a plurality of adjacent metal blades 15 with slots 19 therebetween substantially in the form of a cylinder with a central longitudinal axis 14.

**[0005]** Referring also to Fig 2, the distal ends 16 of the fingers 16 form contact pads designed to engage a male electrical contact 20. In a typical circuit breaker, disconnector or grounding device, the male mechanical contact 20 is provided to make electrical contact with the conducting fingers 13. However, this exerts significant mechanical strain on the fingers 13 and to counter this, a plurality of holes 17 are provided at the bottom of the slots 19 separating the fingers 13, in order to decrease the intensity of the mechanical and electrodynamic stresses exerted at the junctions between the base 12 and the fingers 13. However, these holes 17 must be small to limit dielectric gas leaks and to ensure a satisfactory mechanical strength of the tulip 10.

**[0006]** There exists a need for an electrical connector with improved mechanical and electrodynamic strength.

### SUMMARY OF THE INVENTION

**[0007]** The invention seeks to provide a solution to problems described.

**[0008]** In this regard, the object of the invention is to provide a female electrical connector for a medium or high voltage electric line.

**[0009]** The female electrical connector comprises a tulip-type female electrical contact for electrically contacting a male electrical contact, by surrounding the male electrical contact.

**[0010]** The female electrical contact comprises a ring of conducting fingers and a base portion carrying the fingers.

**[0011]** According to the invention, the female electrical contact comprises a pressing element configured to exert a force on the fingers when the female electrical contact is in a rest position wherein the female electrical contact is free of electrical contact with the male electrical contact.

**[0012]** The female electrical connector also includes a support for the pressing element, arranged around the ring, the pressing element projecting from within the support.

**[0013]** The pressing element reduces the intensity of the mechanical stresses exerted at the junction, region of the fingers.

**[0014]** By virtue of the invention, the pressing force of the fingers about the male contact tends to increase, with an identical maximal deflection of the fingers.

**[0015]** The mechanical stresses exerted on the fingers are higher at the point of contact of the pressing element on the fingers than at the junction region between the fingers and the base.

**[0016]** In addition, the electrical connector is relatively cheap to manufacture and compact.

**[0017]** The invention can optionally include one or more of the following characteristics.

**[0018]** Advantageously, the pressing element is configured to exert a radial pre-stress on the fingers, when the female electrical contact is in the rest position.

**[0019]** In particular, the pressing element ensures that the diameter of the tulip remains substantially constant diameter over time, despite wear of the tulip. In other words, the pressing element promotes better electrical connection between the male contact and the female contact for the lifetime of the female electrical contact.

**[0020]** According to one embodiment of the invention, the position of the pressing element along a length of the conducting fingers is adjustable.

**[0021]** This allows for easier optimization of the position of the region of maximum stresses as a function of the material, the dimensions and the structure of the male and female connectors.

**[0022]** According to an advantageous embodiment, the pressing element has the shape of an annulus centred on a centre axis of the ring, the annulus having a constant width. The annulus is preferably a circlip, having a substantially constant width.

**[0023]** According to another advantageous embodiment, the pressing element and the support are fabricated as an integral component.

**[0024]** Each of the conducting fingers extend from the base to a distal end opposite to the base and preferably, the pressing element is positioned closer to the base than the distal end of the conducting fingers so as to exert a force on the fingers away from the base. The location of the pressing element thereby allows a sufficient gap of the fingers upon inserting the male electrical contact between the fingers, while decreasing the mechanical strains exerted on the fingers.

**[0025]** Preferably, a distance between the position of the pressing element and the base is between 0 % and 30 % of the total length $L_1$ of the fingers.

**[0026]** According to another embodiment feature, the female electrical contact is configured to slide inside the support.

**[0027]** Alternatively, the female electrical contact is fixed with respect to the support and, in this case, the male electrical contact is configured to slide inside the support to electrically engage the female contact.

**[0028]** The invention also relates to an electrical apparatus comprising a female electrical connector as defined above and a male electrical connector to engage the female electrical contact.

**[0029]** The male electrical contact is configured to be inserted into the ring of fingers of the female electrical contact, so as to be in electrical contact with the female electrical contact.

**[0030]** The electrical apparatus is preferably a circuit breaker, a disconnector or a grounding device.

**[0031]** The invention also relates to a method for assembling a female electrical connector or an electrical apparatus as defined above. The method comprises a step of introducing the female electrical contact inside the support so that the pressing element exerts a force on the fingers.

**[0032]** The introduction of the female electrical contact inside the support is facilitated by the pressing element. In addition, the method offers the possibility to modify an existing female electrical connector to insert a pressing element about the fingers.

**[0033]** Preferably, the pressing element presses on the fingers so as to exert a radial pre-stress on the fingers during the step of introducing the female electrical contact into the support. In this way, there is no requirement to apply an inward radial stress to the fingers in order to introduce the female electrical contact into the support.

**[0034]** According to one embodiment, the method comprises a step of inserting the pressing element around the fingers, before introducing the female electrical contact into the support. The modification of existing female electrical connectors is significantly easier in that the pressing element is independent of the support.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0035]** The present invention will be better understood upon reading the description of exemplary embodiments, given by way of purely indicating and in no way limiting purposes, with reference to the appended drawings in which:

- Fig. 1 schematically illustrates in a perspective view a tulip-type electrical contact according to an exemplary embodiment known in the art;
- Fig. 2 represents the cooperation of the female electrical contact of Fig. 1 engaging a male electrical contact;
- Fig. 3 is an axial half cross-section partial representation of the female electrical connector according to a first preferred embodiment of the invention;
- Fig. 4 is an axial half cross-section partial representation of a female electrical connector according to a second preferred embodiment of the invention;
- Fig. 5 is a schematic perspective view of the male electrical contact and the pressing element of the connector according to the second embodiment;
- Fig. 6 schematically represents the male electrical contact electrically engaging the female electrical contact of the second embodiment.

## DETAILED DISCLOSURE OF PARTICULAR EMBODIMENTS

**[0036]** Identical, similar or equivalent parts of the different figures bear the same reference numerals so as to facilitate switching from one figure to the other.

**[0037]** Fig. 3 represents a circuit breaker 1 for a medium or high voltage electric line. The circuit breaker 1 includes a female electrical connector 3 and a male electrical connector 2. The female electrical connector 3 comprises a female electrical contact 10. The female electrical contact 10 is located within an interrupter tube of the circuit breaker 1. The circuit breaker 1 also comprises a support 30 arranged to at least partially surround the female electrical contact 10.

**[0038]** The male electrical connector 2 is of a known structure and will not be described in detail herein. The male electrical connector 2 comprises a male electrical contact 20 configured for insertion in the female electrical contact 10, thereby electrically contacting the female electrical contact 10. The female electrical contact is a tulip-type female electrical contact 10.

**[0039]** In Fig. 3, the circuit breaker 1 is represented in an open position, in which the female electrical contact 10 is positioned away from the male electrical contact 20 and is free of electrical and mechanical contact with the male electrical contact 20. In this open position of the circuit breaker 1, the female electrical connector 3 is in a mechanical and electrodynamic rest position. In a closed position of the circuit breaker 1, the female electrical contact 10 surrounds the male electrical contact 20 and is in electrical contact with the male electrical contact 20.

**[0040]** Referring now to Figs. 3 to 5, the female electrical contact 10 is substantially annular about a central axis 14. The female electrical contact 10 comprises a ring 11 of conducting fingers 13 supported by a base 12 on which the fingers 13 are mounted. The fingers 13 project outwardly from the base 12 toward a distal end 16. The fingers 13 comprise metal blades 15, preferably of copper or an alloy thereof which are favoured for their high electrical conductivity. The metal blades 15 are configured to be mechanically deformable so as to move away from each other when a male electrical contact 20 is engaged between the fingers 13.

**[0041]** At their distal ends 16, the fingers 13 take the form of electrical contact pads. The contact pads curve inwardly so that the distance between the contact pads and the central axis 14 is less than the distance between the blades 15 and the central axis 14 closer to the base 12. The conducting fingers 13 are arranged side by side

and are separated by cylindrical slots 19 extending along the central axis 14 of the female electrical contact 14. The width of the slots 19 varies along the length thereof and are widest close to the base 12, gradually tapering to zero or nearly zero width at the distal ends 16 of the fingers 13.

**[0042]** The female electrical connector 3 also comprises a pressing element 4 configured to exert a force on the fingers 13 including when the female electrical contact 10 is in its rest position as defined above. The pressing element 4 presses against an outer surface of the fingers 13. More precisely, the pressing element 4 exerts a radial pre-stress on the fingers 13, both when the female electrical contact 10 is in the rest position and in a closed position of the circuit breaker. This radial pre-stress decreases the diameter of the ring 11 in the open position of the circuit breaker 1. The pressing element 4 thereby promotes maintaining a diameter of the fingers 13 substantially constant during the lifetime of the female electrical contact 10, despite deformation and wear of the female electrical contact 10. In this manner, the pressing element 4 ensures better electrical contact between the male element 20 and the female electrical contact 10 even after the tulip-type electrical contact 10 is worn.

**[0043]** The pressing element 4 is in direct mechanical contact with the fingers 13 away from the base 12, by being closer to the base 12 than the distal ends 16. The position of the pressing element 4 relative to the ring 11 is determined so as to limit the mechanical stresses exerted at the junction of the base 12 and fingers 13 as far as possible. More precisely, the distance $l_1$ between the pressing element 4 and the base 12 is between 0 % and 30 % of the total length $L_1$ of the fingers 13.

**[0044]** The maximum stress $y_2$ generated by inserting the male electrical contact 20 is located at the point of contact of the pressing element 4 on the fingers 13. The stress $y_1$ exerted in the proximity of the base 12, in particular at the junction between the fingers 13 and the base 12, is reduced.

**[0045]** In the configuration of the prior art female electrical connector 3 as shown in Figure 2, the fingers 13 can be regarded as beams embedded at the base 12 in a simple flexion. In contrast, in the female electrical connector 3 according an embodiment of the present invention, due to the radial pre-stress exerted thereon by the pressing element 4, the fingers 13 may be regarded as having a flexion characteristic of beams embedded at the base 12 in a substantially punctiform manner. With reference more specifically to Fig. 3, the pressing element 4 is fabricated as an integral component with the support 30 and has the shape of an annular boss projecting from within the support 30 to the ring of fingers 11.

**[0046]** The embodiment represented in Fig. 4 differs from that of Fig. 3 in that the pressing element 4 has the shape of an annulus centred on a centre axis 14 of the ring 11. The annulus is a circlip, that is, it has a substantially constant width $l_2$. The annulus-shaped pressing element 4 is attached to the support 30, so as to project from within the support 30. The pressing element 4 is also in direct mechanical contact with the support 30.

**[0047]** In this second embodiment of the invention, the position 34 of the pressing element 4 along the length of the fingers 13 from the base 12 is adjustable. Preferably, the pressing element 4 is located at a distance from the base 12 corresponding to between 0 % and 30 % of the total length L1 of the fingers 13. The adjustment of the position 34 of the pressing element 4 enables the distribution in the stresses exerted onto the fingers of the female electrical contact 10 to be more readily controlled.

**[0048]** The radial pre-stress exerted by the pressing ring 4 causes a change in the radial orientation of the fingers 13 with respect to the base 12 on either side of the pressing element 4 when the male electrical contact 20 electrically engages the female electrical contact 10. More specifically, in the rest position of the female electrical contact 10, an angle a between the base 12 and each finger 13 is less at a position above the pressing ring (i.e., between the pressing ring and the distal end 16 of the finger 13) than below the pressing ring (i.e., between the base 12 and the pressing ring 4). This discontinuity of the slope 131, 132 of the fingers generated by the pressing element 4 limits the clearance of the fingers in the proximity of their distal end 16.

**[0049]** A method for assembling the female electrical connector 3 represented in Fig. 3 and 4, comprises a step of introducing the female electrical contact 10 within the support 30, so that the pressing element 4 exerts a force on the fingers 13. In particular, the pressing element 4 exerts a radial pre-stress on the fingers 13 on introducing the female electrical contact into the support 30. The method for assembling the female electrical connector of Fig. 4 further comprises a step of inserting the pressing element 4 around the fingers 13, before introducing the female electrical contact into the support 30.

**[0050]** In order to reduce the mechanical stresses exerted onto the tulip 10, it is important that the fingers 13 are made of a material that has a good electrical conductivity and a low mechanical strength. In particular, the pressing element 4 facilitates restriction of mechanical stresses in the region of the base 12 which is strongly biased.

**[0051]** The pressing element 4 also contributes to improve the resistance of the female electrical contact to electrodynamic strains related to the short-circuit current in the circuit breaker. These electrodynamic stresses result in particular from the fingers heating upon closing the apparatus.

**[0052]** In the embodiments represented in Fig. 3 and 4, the pressing element 4 exerts a radial pre-stress, so as to decrease the diameter of the female electrical contact 10 at rest. As described above the positioning of the pressing element 4 around the fingers 13 results in a difference in the angular orientation (i.e., the slope) of the fingers on either side of the pressing element. Generally, it is sufficient that the pressing element 4 is in mechanical contact only with the fingers 13, when the

female electrical contact 10 is at rest.

**[0053]** The electrical apparatus described above and represented in Fig. 3 and 4 is a circuit breaker 1 for a medium or high voltage electric line. However, the apparatus may also be a disconnector or a grounding device, with the female electrical contact designed to be located in an active part thereof.

## Claims

1. A female electrical connector (3) for a medium or high voltage electric line, comprising:

   a tulip-type female electrical contact (10) for electrically contacting a male electrical contact (20), by surrounding the male electrical contact (20), the female electrical contact (10) comprising:

   a ring (11) of conducting fingers (13);
   a base portion (12) carrying the ring of fingers (13);

   a pressing element (4) configured to exert a force on the fingers (13) when the female electrical contact (10) is in a rest position, wherein the female electrical contact (10) is free of electrical contact with the male electrical contact (20); and
   a support (30) for the pressing element (4) arranged around the ring (11) of conducting fingers (13), the pressing element (4) projecting from within the support (30).

2. The female electrical connector (3) according to claim 1, wherein the pressing element (4) is configured to exert a radial pre-stress on the fingers (13) when the female electrical contact (10) is in the rest position.

3. The female electrical connector (3) according to any preceding claim, wherein the position of the pressing element (4) along a length of the conducting fingers (13) is adjustable.

4. The female electrical connector (3) according to any preceding claim, wherein the pressing element (4) has the shape of an annulus centred on a centre axis (14) of the ring (11), the annulus having a constant width.

5. The female electrical connector (3) according to any of claims 1 to 3, wherein the pressing element (4) and the support (30) are fabricated as an integral component.

6. The female electrical connector (3) according to any preceding claim, wherein each of the conducting fingers (13) extend from the base (12) to a distal end (16) opposite to the base (12) and wherein the dressing element (4) is positioned closer to the base (12) than the distal end (16) of the conducting fingers (13) so as to exert a force on the fingers (13) away from the base (12).

7. The female electrical connector (3) according to the preceding claim, wherein a distance $L_1$ between the position of the pressing element (4) and the base (12) is between 0 % and 30 % of the total length $L_1$ of the fingers (13).

8. The female electrical connector (3) according to the preceding claim, wherein the female electrical contact (10) is configured to slide inside the support (30).

9. An electrical apparatus (1) comprising one of a circuit breaker, a disconnector or a grounding device, the apparatus comprising:

   a female electrical connector (3) according to any preceding claim; and
   a male electrical connector (2) comprising a male electrical contact (20) configured to be inserted into the ring (11) of the female electrical contact (10), so as to make electrical contact with the female electrical contact (10).

10. A method for assembling a female electrical connector (3) according to any of claims 1 to 8 or an electrical apparatus (1) according to claim 9, comprising a step of introducing the female electrical contact (10) inside the support (30), so that the pressing element (4) exerts a force on the fingers (13).

11. The method according to any preceding claim, wherein the pressing element (4) is configured to exert a radial pre-stress on the fingers (13) during the step of introducing the female electrical contact (10) into the support (30).

12. The method according to any of claims 10 and 11, comprising a step of inserting the pressing element (4) around the fingers (13), before introducing the female electrical contact (10) into the support (30).

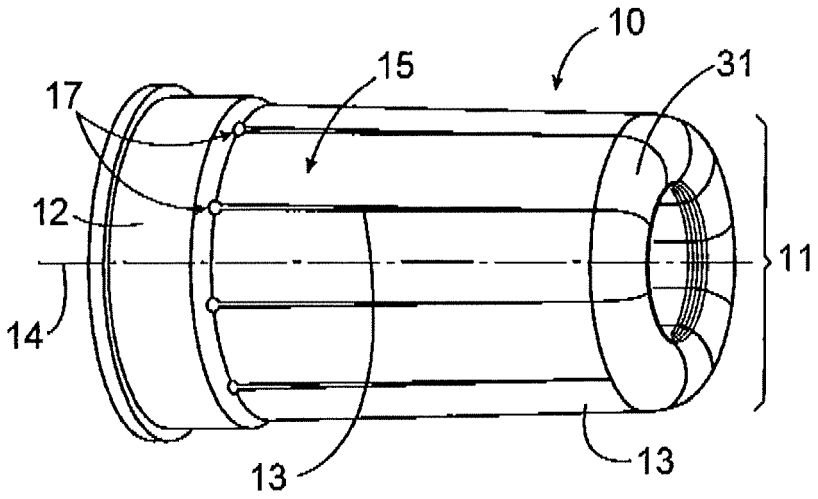


FIG. 1

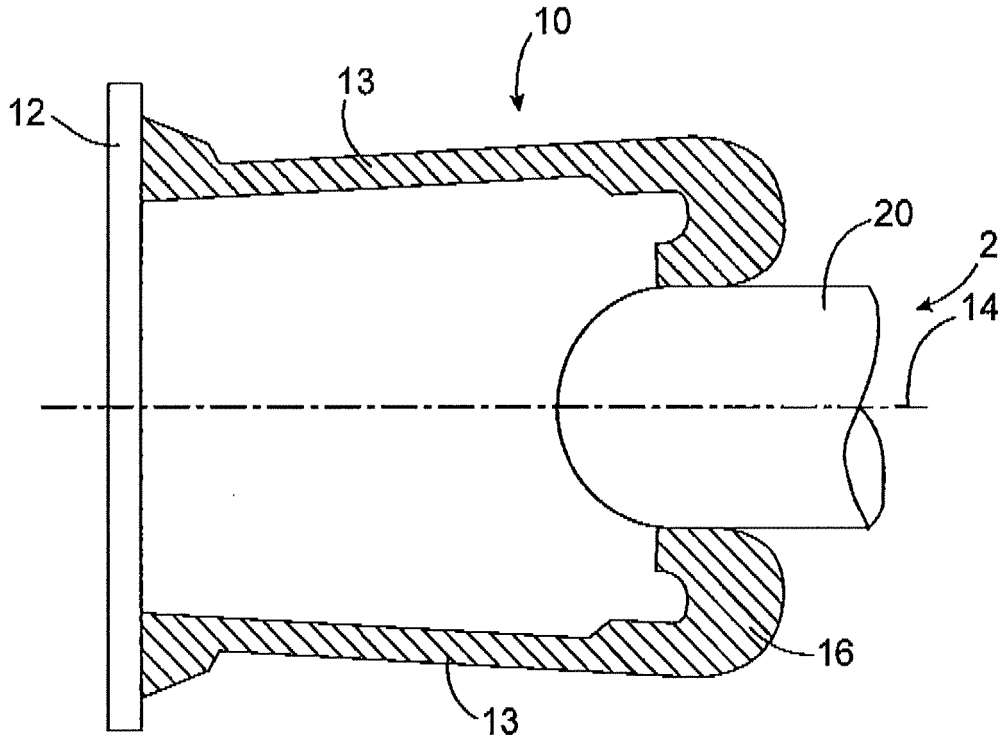


FIG. 2

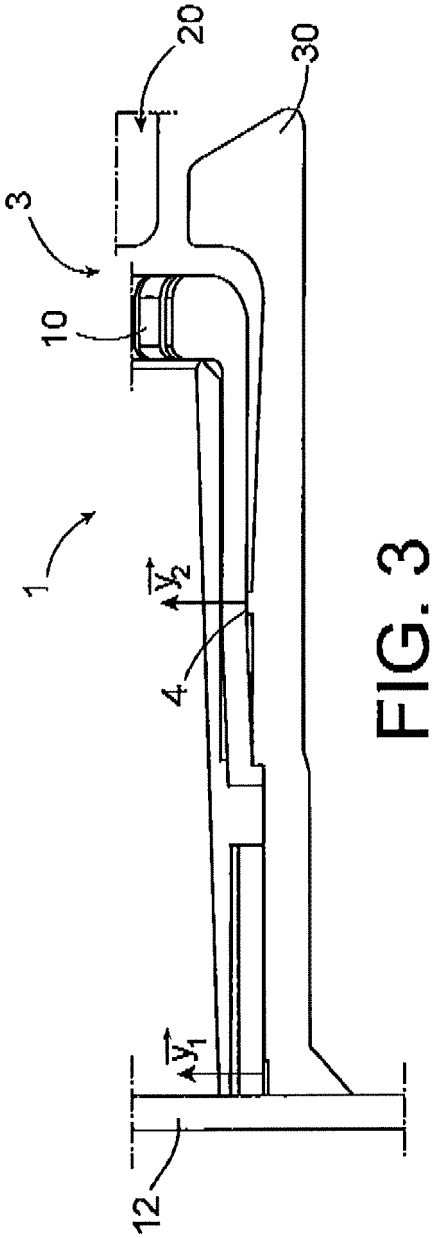


FIG. 3

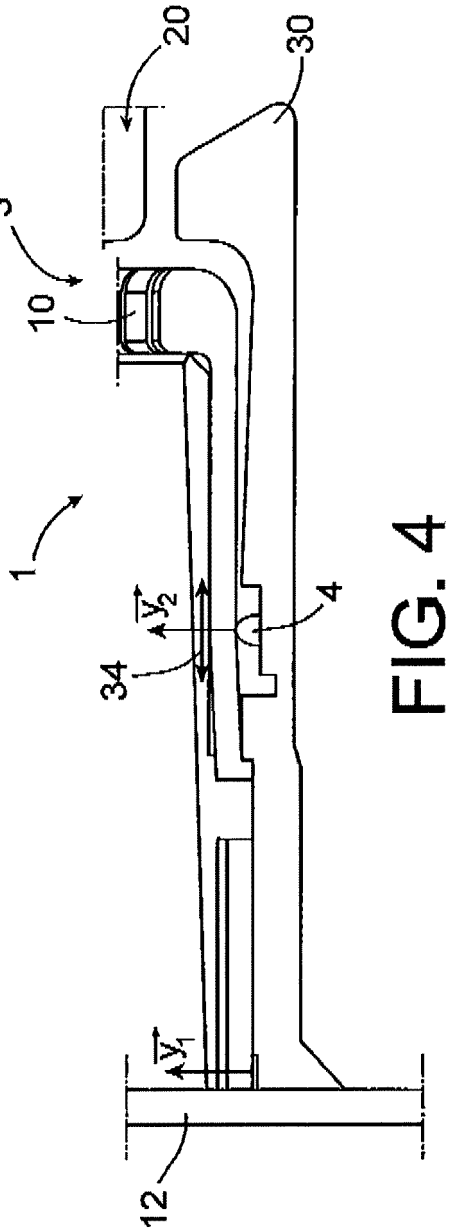


FIG. 4

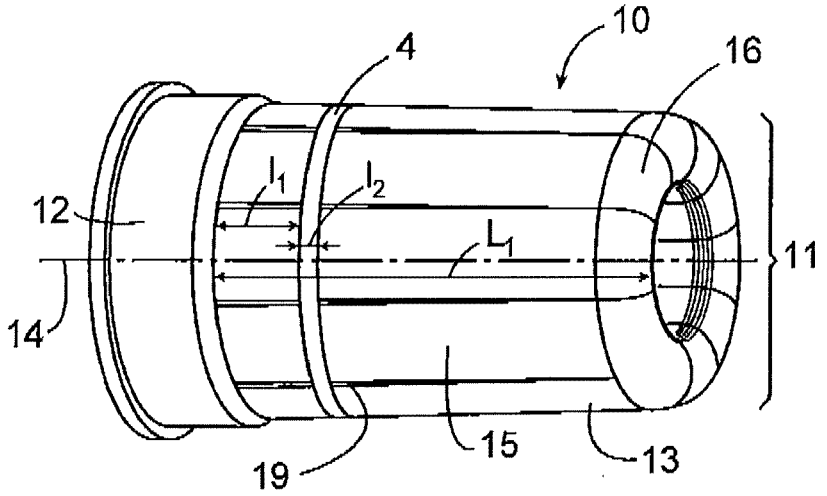
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FIG. 5

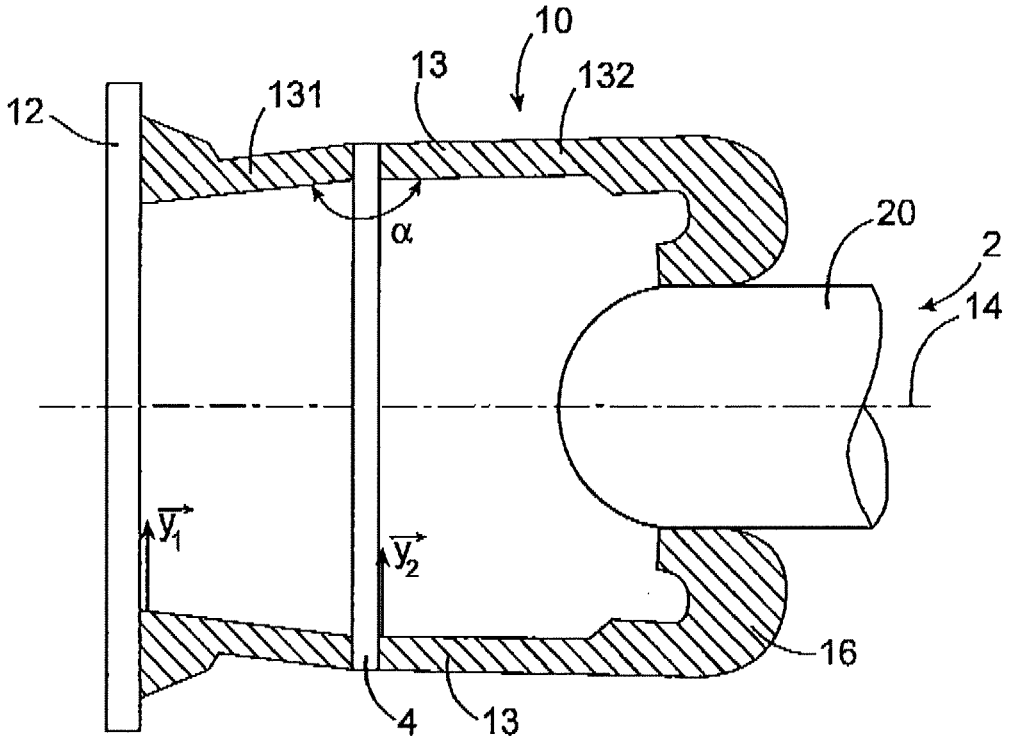
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FIG. 6

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# EUROPEAN SEARCH REPORT

Application Number
EP 17 29 0065

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
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TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 20 October 2017 | Glaman, C |

CATEGORY OF CITED DOCUMENTS

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20-10-2017

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