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(54) Connector for coaxial cable with a helically corrugated outer conductor

(57) A connector for a coaxial cable with a helically corrugated outer conductor, where the connector comprises a main body containing the centre terminal of the connector and a rear part essentially comprising an outer bushing containing a partly radially resilient ferrule for receiving an exposed end of the outer conductor and an end portion of the jacket of the cable, where a firm and reliable electrical contact between said ferrule (and hence said outer bushing) can be obtained simply by screwing said exposed end of the outer conductor into the ferrule, the ferrule being provided with inner threads corresponding to the helical corrugation of the outer conductor, and where it is still possible to rotate said outer bushing relative to the cable after the final attachment of the rear part of the connector on the cable, thus facilitating the final attachment of the main body on the rear part. Said electrical contact between the outer conductor and the rear part of the connector is brought about without any deformation of the outer conductor, and it is hence possible, if necessary, to remove the connector from the cable again without damage to the cable.

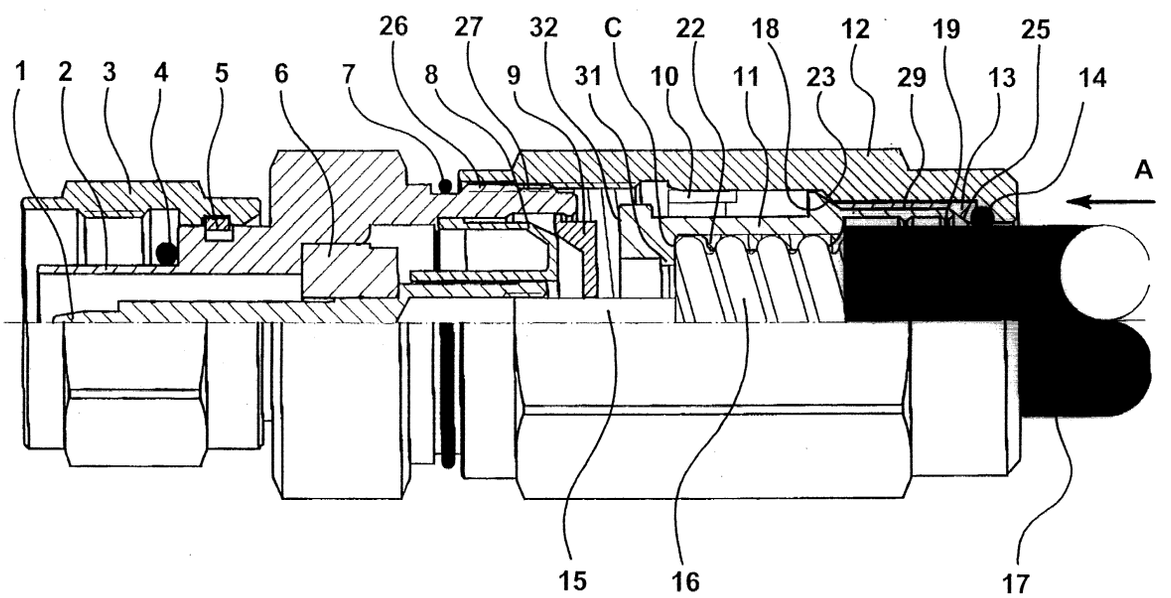

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to connectors for coaxial cables and more particularly to connectors for coaxial cables having a helically corrugated outer conductor as set forth in the preamble of claim 1.

DESCRIPTION OF PRIOR ART

[0002] Coaxial cables with a corrugated outer conductor are frequently used for radio frequency applications, and the use of a corrugated outer conductor increases the flexibility of the cable compared to a corresponding cable with a smooth outer conductor. In some cases, the corrugation of the outer conductor is made helical, thus for instance allowing a coaxial cable connector to the attached to an end of the cable by screwing the connector or a part hereof onto the outer conductor.

[0003] Many connectors of this kind are described in patent specifications. Thus U.S. Patent No. 5,766,037 discloses a connector of the above kind where the attachment of one end of the corrugated outer conductor of the cable to the connector is accomplished by means essentially comprising a clamping back nut one end of which is provided with a number of radially resilient fingers, a radially inward portion of which are provided with threads matching the helical corrugation of the outer conductor, so that when the connector is assembled and mounted on the cable, said threads exert an inwardly directed pressure on the outer conductor. Furthermore, there is between said end of the clamping back nut which is provided with said fingers and a clamping collet circumferentially fitted on said resilient fingers provided a gab which during mounting of the connector on the end of the cable deforms a portion of the exposed end of the outer conductor of the cable and thereby retains it firmly within said gab. Said portion of the exposed end of the outer conductor thus undergoes an irreversible deformation during the mounting of the connector on the cable.

[0004] A further example of a prior art connector of the above kind is disclosed in U.S. Patent No. 5,983,723 in which the connection between the helically corrugated outer conductor of a coaxial cable and the connector is established by means of an inwardly corrugated sleeve, the corrugation of which matches the corrugation of the outer conductor of the cable so that said sleeve can be screwed unto the outer conductor in such a manner that the outer conductor extends longitudinally through the sleeve and such that an end portion of the outer conductor is located outside one longitudinal end face of said sleeve. Hereafter, the sleeve is inserted in the connector so that said end portion of the outer conductor becomes located in the gab thereby formed between one longitudinal end face of the conductor and said longitudinal end face of the sleeve. When the connector is finally assembled by screwing an outer bushing over that end of the connector, which is receiving the cable, said width of said gab is being reduced, thus retaining said end portion of the outer conductor firmly within said gab. A firm and reliable electrical and mechanical connection between the outer conductor and the connector is thus only being established within the relatively limited region of the gab. Furthermore, said retainment of the end of the outer conductor in said gab also results in an irreversible deformation of the end of the outer conductor.

[0005] Further connectors somewhat resembling the one mentioned in the above U.S. Patent No. 5,983,723 are disclosed in for instance U.S. Patent No. 5,154,636, EP 0 495 467 A2 and DE 43 44 328 C1.

[0006] A common disadvantage with all of the connectors mentioned above is that the final connection between the outer conductor and the corresponding part of the connector is obtained in such a manner that it results in a deformation of a part of the end of the outer conductor, which deformation has the detrimental effect of rendering it either impossible or at least difficult to remove the connector from the cable, once it has been attached to the connector, and furthermore that if the connector is actually removed from the cable, said end part of the outer conductor will be more or less damaged, so that the end of the cable must be prepared again prior to a succeeding application of a connector thereto. This may be difficult or even impossible in many circumstances.

SUMMARY OF THE INVENTION

[0007] According to the preceding description of some prior art connectors, it is an object of the present invention to provide a connector for a coaxial cable with a helically corrugated outer conductor which would allow the connector to be mounted on a suitably prepared end of the cable and afterwards, if necessary, allow the connector to be removed from the cable without damage to the prepared end of the cable, so that it would be possible to reuse the cable without the necessity to carry out a renewed preparation of the end of the cable.

[0008] It is a further object of the present invention to provide a connector of the above kind which allows a firm and reliable electrical connection between the outer conductor of the cable and the corresponding part of the connector to be obtained without the use of fastening tools.

[0009] It is a further object of the present invention to provide a connector of the above kind that also provides a reliable mechanical attachment of the connector to the jacket of the coaxial cable.

[0010] It is a further object of the present invention to provide a connector of the above kind which also provides a very flexible attachment of the connector on the cable in the sense that when the connector is mounted on the end of the cable, it is still possible to rotate the

connector relative to the longitudinal axis through the cable.

[0011] These and other objects are attained with a connector for a coaxial cable with a helically corrugated outer conductor according to the invention, where a firm and reliable electrical and mechanical connection between the connector and the outer conductor of the coaxial cable is obtained by screwing a rear part of the connector unto said outer conductor. The rear part essentially comprises a tubular outer bushing (which can be attached to the remaining part of the connector, in the following referred to as the main body of the connector, during the final assembling of the connector), a ferrule placed coaxially inside said outer bushing, so that it can be displaced longitudinally within said outer bushing over a certain distance relative hereto, said ferrule being radially resilient over a part of its longitudinal extension, and engagement means placed between said outer bushing and said ferrule, such that when said ferrule is longitudinally located within a first region within said outer bushing, relative rotational movement between said ferrule and said outer bushing is prevented, and such that when said ferrule is not located within said first region, said ferrule is free to rotate relative to said outer bushing. Furthermore, a portion of the inner circumferential surface of said ferrule is provided with threads matching the helically corrugated outer conductor, thereby making it possible to screw said ferrule unto an end of the outer conductor. Extending radially inward said ferrule is furthermore provided with an inner circumferential protrusion located at one longitudinal end of said threads proximal to said main body, at which end of the ferrule this is not radially resilient, said protrusion providing a contact surface between the end of the outer conductor and the ferrule, when the outer conductor is screwed as far as possible into said ferrule.

[0012] During mounting of the rear part of the connector on the prepared end of the cable, the rear part is first displaced longitudinally relative to the end of the cable, until the ferrule becomes located in said first region inside the outer bushing, whereby the ferrule is prevented from rotation relative to the outer bushing. In this position, it is then possible to screw the rear part unto the outer conductor due to the presence of said threads inside the ferrule. When the end of the outer conductor reaches said inwardly directed inner circumferential protrusion provided in the ferrule, a firm electrical contact is established between the end of the outer conductor and this protrusion without causing deformation of the end of the outer conductor. It is hereafter possible to displace the outer conductor/the ferrule longitudinally relative to the outer bushing so that the ferrule leaves said first region, whereby it becomes possible to rotate the outer bushing relative to the cable.

[0013] As a final step, the rear part is attached to the main body of the connector by screwing the outer bushing unto one end of the main body in a manner known per se. The outer bushing is on a part of the inner circumferential surface hereof provided with means engaging corresponding means provided on the outer circumferential surface of the ferrule, such that when during this attachment of the rear part to the main body, a relative longitudinal displacement between the rear part and the main body takes place, said engagement causes said radially resilient part of the ferrule to be compressed around the outer conductor of the cable, thereby providing increased electrical and mechanical attachment between the outer conductor and the ferrule (and hence electrical contact from the outer conductor via the rear part of the connector to the main body of the connector).

[0014] Furthermore, a certain longitudinal extension of the inner circumferential surface of the ferrule which is radially resilient is provided with retaining means, so that said radial compression of the ferrule causes said retaining means to press against the jacket of the cable and thereby further contribute to a reliable attachment of the connector to the cable.

[0015] Furthermore, there are provided means to the effect that when the connector is finally mounted on the cable as described above, said ferrule is prevented from becoming located within said first region within said outer bushing, so that in this final state, it is still possible to rotate the outer bushing, and thereby the main body of the connector relative to the cable.

[0016] If, for some reason, it is afterwards desired to remove the connector from the cable, it is possible to do so by reversing the above-described steps. Specifically the main body is released from the rear part, whereafter it is again possible to bring the ferrule into said first region inside the outer bushing, where relative rotational movement between the ferrule (now containing the outer conductor) and the outer bushing is prevented. It is now possible to unscrew the rear part from the cable, and since no deformation of the end of the outer conductor has occurred during the attachment of the rear part on the outer conductor, it is hereafter possible to reuse the cable as often as needed without a renewed preparation of the end of the cable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The invention will now be described in more detail with reference to the accompanying drawings, in which

figure 1 is a longitudinal partly sectional view of a connector according to one embodiment of the invention;

figure 2 is a side elevation view of a ferrule used in the above embodiment of the invention;

figure 3 is a side elevation view of a tubular engagement means used in the above embodiment of the invention;

figure 4 is a side elevation view of the ferrule according to figure 2 provided with the engagement means according to figure 3; and

figure 5 is a cross sectional view of the ferrule and engagement means according to figure 4 in the plane I-I, as indicated by the arrows in figure 4.

DETAILED DESCRIPTION OF THE INVENTION

[0018] In the following a detailed description of one embodiment of the invention is given.

[0019] With reference to fig. 1, there is shown a longitudinal, partly sectional view of one embodiment of a connector according to the invention. The connector comprises essentially two parts, the first of which is the main body 2 containing the centre terminal 1 of the connector, which centre terminal is to be electrically connected to the inner conductor 15 of the coaxial cable. This connection is effected by means of an inner and outer compression means 8, 9 in a manner known per se, and which will therefore not be described further in this case.

[0020] The second main part of the connector according to this embodiment of the invention is the tubular rear part of the connector comprising the outer bushing 12 of the connector. The tubular main body 2 and the outer bushing 12 can be attached coaxially to each other and displaced in the longitudinal direction relative to each other by screwing the outer bushing 12 unto the main body 2 by means of threads 26 provided on a part of the outer circumferential surface of the main body 2 and corresponding threads 27 provided on a part of the inner circumferential surface of the outer bushing 12.

[0021] Positioned coaxially within said outer bushing 12 and longitudinally slidable relative thereto, there is provided a tubular ferrule 11, which ferrule 11 over a certain longitudinal extension hereof is provided with a number of slits 21 (see figure 2 and 4) cut through the circumferential wall of the ferrule11. These slits 21 provide the ferrule 11 with radial resiliency over the major longitudinal extension of the ferrule 11. Furthermore, the inner circumferential surface of said ferrule 11 is over a certain longitudinal extension hereof provided with threads 22 corresponding to the thread provided by the helically corrugated outer conductor 16 of the coaxial cable. On the remainder of that part of the ferrule 11, which is provided with said slits 21, there is provided a number of inner circumferential protrusions 19 acting as retaining means for the jacket 17 of the coaxial cable.

[0022] Between a part of the inner circumferential surface of the outer bushing 12 and a part of the outer circumferential surface of the ferrule 11, there is furthermore coaxially with said outer bushing 12 and said ferrule 11 provided a tubular engagement means 10, which engagement means 10 has a fixed longitudinal relationship with the inner circumferential surface of the outer bushing 12.

[0023] The structural details of said ferrule 11 and said engagement means 10 will hereafter be described in detail with reference to figure 2 through 5.

[0024] Figure 2 shows a side elevation view of the ferrule 11 used in this embodiment of the present invention. As shown in the figure, the major part of the longitudinal extension of the ferrule 11 is provided with a number of slits 21 through the circumferential wall of the ferrule. At one part hereof, the ferrule 11 is provided with a conical collar 18 on the outer circumferential surface hereof and at the distal end of the ferrule 11 relative to the coaxial cable, the ferrule 11 is provided with a circumferential end collar 30, thus forming a first longitudinal portion 28 of the ferrule 11 between said conical collar 18 and said end collar 30 for receiving the tubular engagement means 10 to be described in the following. Finally, the end face of the ferrule 11 furthest away from the end collar 30 is provided with a conical end portion 25.

[0025] In figure 3, said tubular engagement means 10 coaxially surrounding said first longitudinal portion 28 is described. As indicated by the hatching in figure 3, the outer circumferential surface of the tubular engagement means 10 is made rugged, for instance by knurling or other suitable processes, with the object to provide increased friction between this surface and the corresponding part of the inner circumferential surface of the outer bushing 12 in order to maintain the engagement means 10 in its longitudinal position within the outer bushing 12. The engagement means 10 is provided with longitudinally extending ribs 20, a number of which (in the present case 6, although other numbers of ribs can of cause also be used) are shown with reference to figure 5, which ribs 20, when the ferrule 11 is located within said first region relative to the outer bushing 12, are brought into engagement with that part of the slits 21 which are penetrating the conical collar 18, so that when the ferrule 11 is located within said first region relative to the outer bushing 12, a rotational movement of the ferrule 11 relative to the outer bushing 12 is prevented due to the engagement of the ribs 20 with the conical collar 18. When on the other hand the ribs 20 are not in engagement with the conical collar 18, the ferrule 11 can freely rotate relative to the outer bushing 12.

[0026] Returning to figure 1, there is between said second longitudinal portion 29 of the ferrule 11 and a corresponding portion of the inner circumferential surface of the outer bushing 12 coaxially with the ferrule 11 and the outer bushing 12 provided an inner bushing 13, one end of the inner circumferential surface of which is provided with a radially protruding inwardly directed conical part corresponding to the conical end portion 25 of the ferrule 11. The outer end of the bushing 13 rests against said conical collar 18 on the outer circumferential surface of the ferrule 11.

[0027] The establishment of electrical and mechanical connection between the outer conductor 16 of the coaxial cable and the outer bushing 12 - and hence with the main body 2 - of the connector according to the in-

vention is achieved in the following manner:

[0028] First the coaxial cable is suitably prepared so that the relative dimensions of the exposed parts of the inner conductor 15 and the corrugated outer conductor 16 as schematically indicated in figure 1 are obtained. Specifically the length of exposed corrugated outer conductor, and hence the number of turns of the "thread" provided by the helical corrugation, should correspond to the longitudinal dimension of that part of the inner circumferential surface of the ferrule 11, which shall receive said exposed part of the outer conductor 16.

[0029] The prepared cable is then inserted into the one end of the bushing 12 as indicated by the arrow A in figure 1 and displaced longitudinally inside the bushing 12 as far as possible, during which displacement the ferrule 11 slides within the engagement means 10 until a point, where said ribs 20 reach the end of the conical collar 18 facing the first portion 28 of the ferrule. The above described engagement of the ribs 20 with the slits 21 through the conical collar 18 can now be effected by rotating the outer bushing 12 relative to the cable, until an audible click or tactile vibration is perceived, indicating that said engagement has been obtained. Hereafter, the rear part is screwed unto the outer conductor 16 of the cable, until the end of the outer conductor 16 reaches a radially inner circumferential protrusion 31 of the ferrule 11 at point C in the figure. In this manner, a firm and reliable electrical contact between the inner circumferential protrusion 31 of the ferrule (and hence with the outer bushing and eventually with the main body of the connector) and the end face of the outer conductor 16 facing said inner circumferential protrusion 31 is finally obtained without any deformation being caused to the end of the outer conductor 16. When hereafter the outer bushing 12 is longitudinally displaced in a direction away from the cable, the ferrule 11 is brought out of engagement with the ribs 20 (i.e. out of said first region), whereafter it is possible to rotate the outer bushing freely relative to the cable, thus facilitating the final attachment between the rear part of the connector and the main body 2 hereof.

[0030] As the final step in the assembling of the complete connector, the main body 2 is screwed into the outer bushing 12 with the dual effect that the contact between the centre terminal 1 and the inner conductor 15 is obtained, and simultaneously that as the end face of the ferrule 11 facing away from the coaxial cable reaches the outer compression means 9, and the bushing 12 is still being advanced over the main body 2 in the direction of the arrow A, the conical part 23 on the inner circumferential surface of the outer bushing 12 slides over the inclined portion of the conical collar 18 on the outer circumferential surface of the ferrule 11, thus causing a radially inwardly directed compression of the ferrule 11, said compression being made possible by the presence of the longitudinal slits 21 in the ferrule 11. Simultaneously, said radially protruding inwardly directed conical part of the inner bushing 13 is sliding longitudinally over said conical end portion 25 of the ferrule 11and thereby presses said inner circumferential protrusions 19 on the ferrule 11 firmly against the jacket 17 of the coaxial cable. The connector is now correctly mounted on the cable. In this final position of the rear part relative to the main body, the ribs 20 on the engagement means 10 are not in engagement with the slits 21 passing through the conical collar 18, so that even in this final stage, the connector can still be rotated relative to the cable.

[0031] By applying a reverse series of those steps described previously, it is hereafter, if necessary, possible to remove the rear part of the connector from the cable without any damage having been caused to the cable. Specifically after the removal of the main body 2 from the rear part of the connector, it is again possible to bring the slits 21 through the conical collar 18 into engagement with the ribs 20 on the engagement means 10, whereafter it is possible to unscrew the rear part of the connector from the cable.

[0032] Although one specific embodiment of the present invention has been shown and described in the preceding parts of the detailed description, it is understood that a person skilled in the art may conceive other embodiments of the invention without departing from the scope of the invention as defined by the following claims.

PART LIST

[0033]

1. centre terminal of connector
2. main body of connector
3. coupling nut
4. o-ring
5. retainer ring
6. tubular insulator between centre terminal and main body
7. o-ring
8. inner compression means
9. outer compression means
10. tubular engagement means
11. ferrule
12. outer bushing of connector
13. inner bushing (between outer bushing and ferrule)
14. o-ring
15. inner conductor of coaxial cable
16. corrugated outer conductor of coaxial cable
17. jacket of coaxial cable
18. conical collar on outer circumferential surface of ferrule
19. inner circumferential retainment protrusions on ferrule
20. engagement ribs on tubular engagement means
21. longitudinal slits in ferrule
22. thread on inner circumferential surface of ferrule

23. conical part on inner circumferential surface of outer bushing
24. outer knurled circumferential surface of engagement means
25. conical end portion of ferrule
26. thread on main body
27. thread on outer bushing
28. first longitudinal portion of ferrule
29. second longitudinal portion of ferrule
30. circumferential end collar of ferrule
31. inner circumferential protrusion in ferrule
32. abutment surface on end of ferrule

Claims

1. Connector for a coaxial cable with a jacket (17), a helically corrugated outer conductor (16) and an inner connector (15), said connector comprising a tubular main body (2) to be electrically connected to the outer conductor (16) and containing the centre terminal (1) of the connector, which is to be connected electrically to the inner conductor (15) of the cable, and a rear part to be coaxially attached to said main body (2), **characterised in that** said rear part essentially comprises an outer bushing (12) and a ferrule (11) placed coaxially within said outer bushing (12), where said ferrule (11) can receive an end of said outer conductor (16) and a portion of the jacket (17), and where said ferrule (11) on a part of the inner circumferential surface hereof is provided with threads (22) matching the helically corrugated outer conductor (16), so that the outer conductor (16) can be screwed into the ferrule (11) to a point (C), and where the ferrule (11) is furthermore provided with an inner circumferential protrusion (31) forming a radial contact surface at said point (C) between the end of the outer conductor (16) and the ferrule(12).

2. Connector according to claim 1, **characterised in that** there is coaxially between said outer bushing (12) and said ferrule (11) in fixed relationship with said outer bushing (12) provided a tubular engagement means (10) enabling said ferrule (11) to be longitudinally displaced within said outer bushing (12) over a certain, limited longitudinal region, and where said engagement means (10) and said ferrule (11) are provided with means (18, 20, 21) so that when said ferrule (11) is located within a first longitudinal region in said outer bushing (12), relative rotational movement between said outer bushing (12) and said ferrule (11) is being prevented.

3. Connector according to claim 1, **characterised in that** said ferrule (11) over a certain longitudinal extension hereof is radially resilient.

4. Connector according to claim 2, **characterised in that** said means (18, 20, 21) comprise a number of longitudinally extending ribs (20) placed on one longitudinal end face of said engagement means (10) and a conical collar (18) on the outer circumferential surface of the ferrule (11), which conical collar (18) is provided with a number of radial slits (21), the positions of which can be brought to coincide with the position of said ribs (20) on said engagement means (10).

5. Connector according to claim 3 and 4, **characterised in that** said ferrule (11) comprises a number of longitudinally extending slits (21) through the circumferential wall of said ferrule (11) over a longitudinal distance extending from one end of the ferrule (11) to a point at a certain distance from the other end of the ferrule (11), and that the ferrule (11) at the end hereof which is not provided with said slits (21) is furthermore provided with a circumferential end collar (30) whereby the outer circumferential surface of said ferrule (11) is subdivided into two subsurfaces (28, 29), the first of these subsurfaces (28) being surrounded by said engagement means (10).

6. Connector according to claim 5, **characterised in that** said ferrule (11), on that part of its inner circumferential surface which is located furthest away from said circumferential end collar (30), is provided with inner circumferential retainment protrusions (19).

7. Connector according to any of the preceding claims, **characterised in that** said main body (2), said outer bushing (12) and said ferrule (11) are provided with means (9, 13, 18, 23, 25, 32) so that a relative displacement of the outer bushing (12) over the main body (2) in a direction towards the centre terminal (1) results in a radially inwardly directed compression of the ferrule (11) around the outer conductor (16) and the engagement of said inner circumferential retainment protrusions (19) with said jacket (17) of the cable.

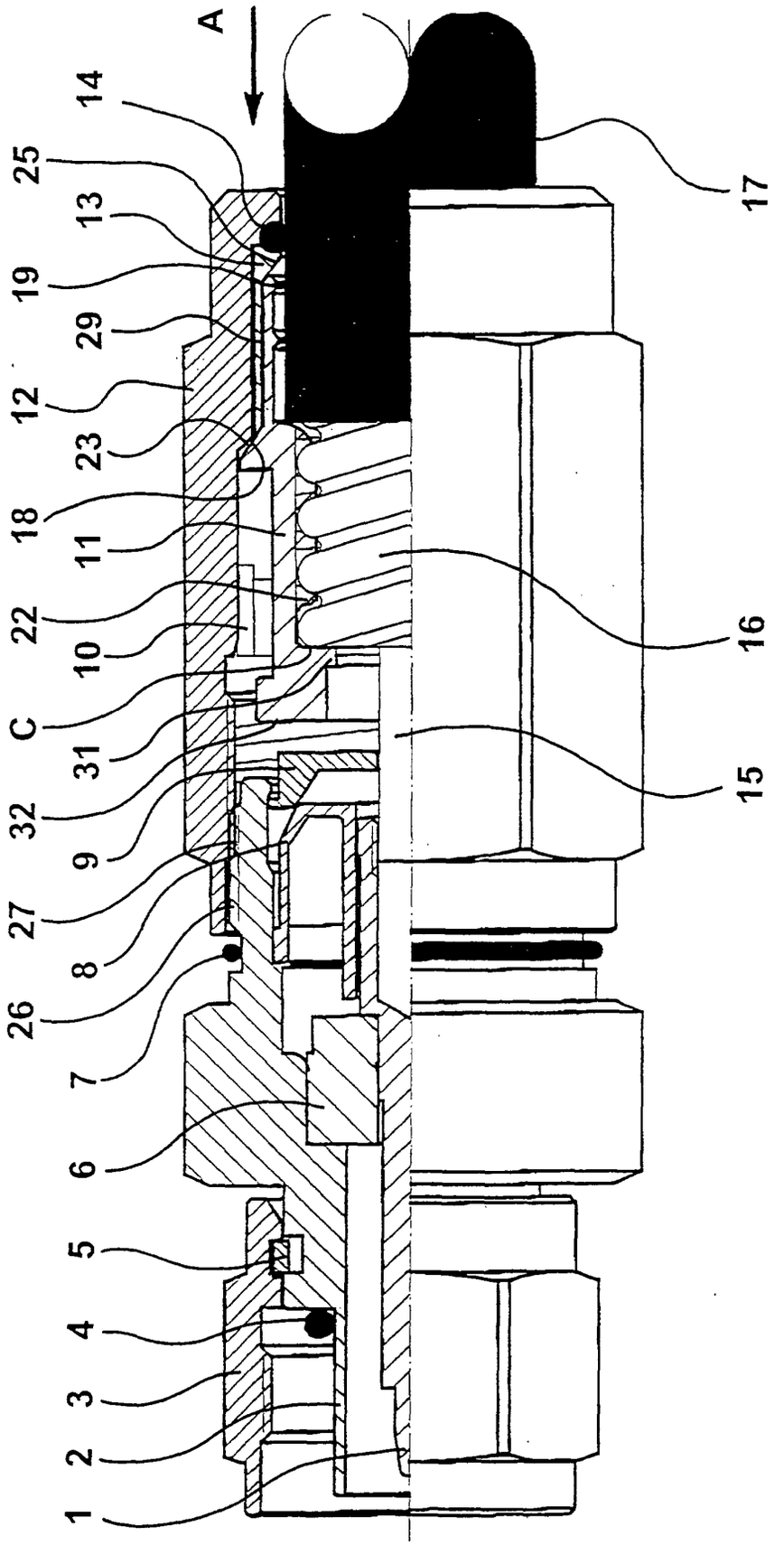

Fig. 1

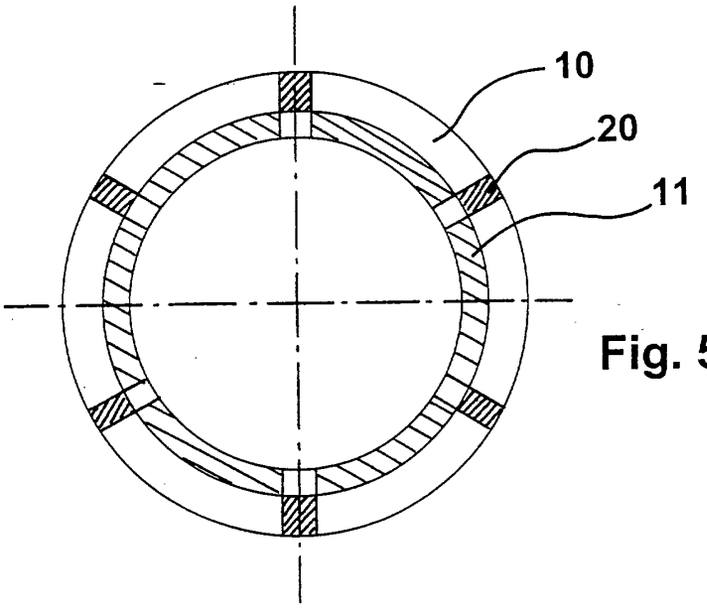

Fig. 5

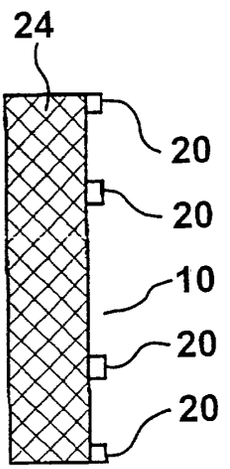

Fig. 3

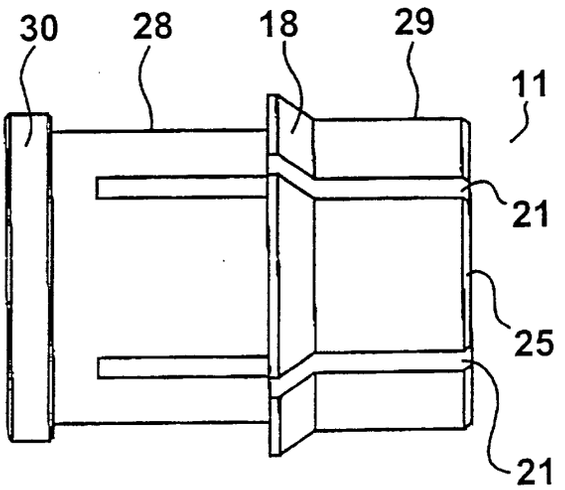

Fig. 2

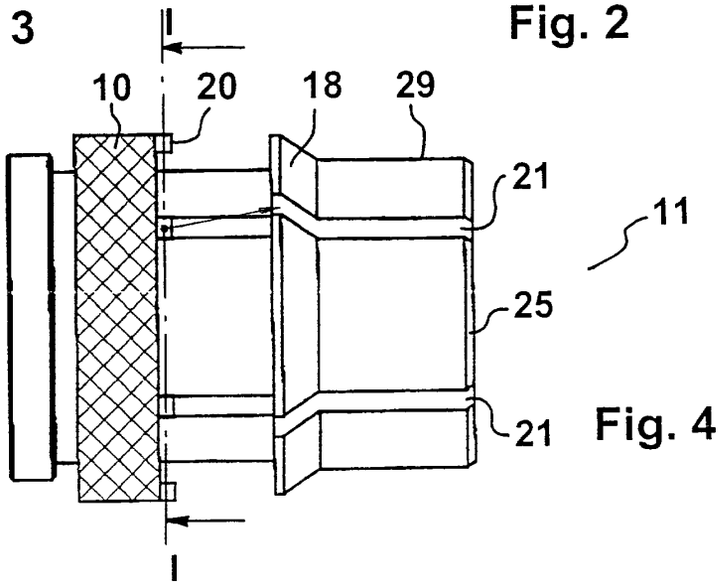

Fig. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 4568

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 December 2000	Demol, S

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 11 4568

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