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(71) Applicant: **SOLITRA OY**
FIN-90440 Kempele (FI)

(72) Inventors:
- **Tiihonen, Markku**
  FI-90460 Oulusalo (FI)
- **Lapinlampi, Jari**
  FI-90650 Oulu (FI)

(74) Representative: **Abrams, Michael John et al**
Haseltine Lake & Co.
28, Southampton Buildings
Chancery Lane
London WC2A 1AT (GB)

(54) Connection arrangement

(57) The invention relates to a connection arrangement, particularly an intermodulation-protected coaxial radio-frequency connection arrangement. The arrangement comprises interconnected connector parts (1, 100), each connector part comprising an outer contact member (3, 103) and an inner contact member (4, 104), wherein the outer contact members (3, 103) of the connector parts are interconnected and the inner contact members (4, 104) of the connector parts are interconnected, each connector part comprising a body (2, 102) and the connection arrangement comprising a clamping construction (201, 202) between the bodies (2, 102). At least one connector part (1) comprises clamping means (7, 7a-7c) offsetting the inner contact member (4) relative to the body (2) for clamping the inner contact member (4) of said connector part (1) in the axial direction against the inner contact member (104) of the other connector part (100).

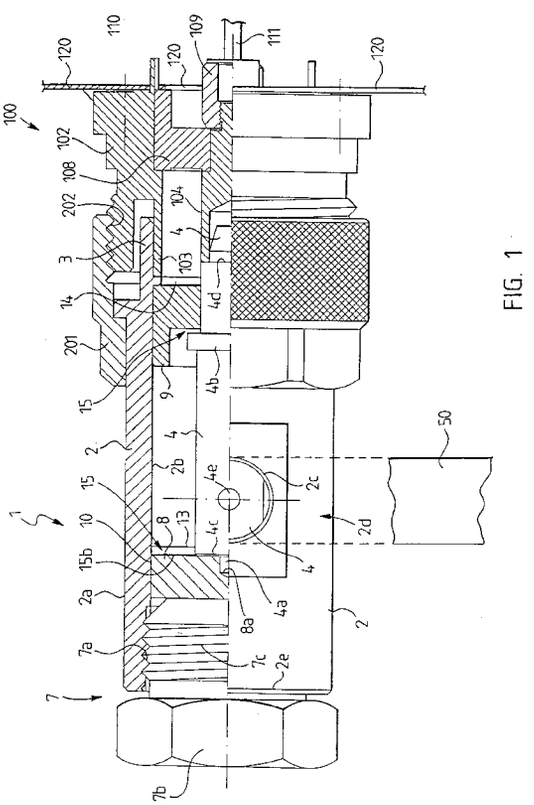

FIG. 1

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Description

The present invention relates to a connection arrangement, particularly an intermodulation-protected coaxial radio-frequency connection arrangement comprising interconnected connector parts, each connector part comprising an outer contact member and an inner contact member, wherein the outer contact members of the connector parts are interconnected and the inner contact members of the connector parts are interconnected, each connector part comprising a body and the connection arrangement comprising a clamping construction between the bodies.

A connection arrangement of the above kind is applied in connections for the radio frequency range, for example in connections for filters used at a base station of a cellular network. These connection arrangements employ connector parts, such as a free connector and a mating fixed connector. The free connector is a connector part to which a coaxial cable from the antenna of a base station is coupled. The fixed connector in turn is a connector to be attached to the wall (side, bottom, etc.) of a filter, to which the free connector is coupled.

In connection arrangements for the radio frequency range, a significant problem is presented by intermodulation, which is induced as a combined result of several frequencies. Intermodulation may present a problem particularly at base stations for cellular networks, since several transmission frequencies are employed for different channels at one base station unit, thus causing intermodulation to occur. Intermodulation becomes a real problem when the frequency of the intermodulation is in the same frequency range as the receiving frequency of the base station. Even a small intermodulation will cause problems, as the difference between the transmit power and the intermodulation should be as high as 165 dB. The unit and value for the intermodulation is dependent on the smoothness of the component surfaces and the clamping force between the interconnected parts of the arrangement.

In prior art connection arrangements, not enough attention has been paid to intermodulation protection, i.e. suppression of intermodulation. One prior art connection construction is such that it comprises a free connector and a fixed connector. The inner contact member in the free connector is a male centre pin and the inner contact member in the fixed connector is a female counterpart for the centre pin. In the prior art connection arrangements, intermodulation is induced particularly by the fact that the axial clamping force between the inner contact members of the connector parts, i.e. the centre pin and its counterpart, will be too weak, as a normal clamping construction between the bodies of the connector parts on the exterior of the connection arrangement is not sufficient to clamp the inner contact member strongly enough. Nor will the clamping construction between the bodies of the connector parts clamp the inner contact members independently, but the inner contact members are clamped on account of the fact that the bodies are clamped against one another. In accordance with the findings of the applicants, the poorer the attachment of the inner contact members, i.e. the centre pin and the counterpart, the greater the likelihood of intermodulation.

In the prior art connection arrangements, the inner contact member, i.e. male centre pin, in the first connector part, i.e. free connector, is fitted fully immovably relative to the body and cannot be clamped independently. The inner contact member in the second connector part to be coupled to the free connector, i.e. the female counterpart of the centre pin, in turn comprises weakening grooves which at the same time provide a spring means that is pressed against the sides of the end of the centre pin. Such an arrangement will not, however, accomplish axial clamping.

The above prior art connection arrangement is attended by several problems. In such prior art connection arrangements, the axial clamping between the inner contact members, i.e. the centre pin and its counterpart, will be too weak, and consequently the connection arrangement will present problems in terms of intermodulation. The problem is aggravated if the connection arrangement is exposed to vibration, for instance. Furthermore, the prior art connection are problematic as regards the manufacture and assembly of the connector parts, since in them the body of the connector part and the outer contact member are separate units that are interconnected for example with a threaded joint or boron joint, as a result of which these constructions will also present problems by inducing intermodulation.

According to the present invention, there is provided a connection arrangement as set out in the preamble of appended claim 1, which is characterized in that at least one connector part comprises clamping means offsetting the inner contact member relative to the body for clamping the inner contact member of said connector part in the axial direction against the inner contact member of the other connector part.

The underlying basis of the connection arrangement of the invention is the idea that at least one of the connector parts is provided with clamping means for clamping the inner contact member, such as a centre pin, against the inner contact member, such as a counterpart, of the other connector part, or vice versa. Hence the connection construction incorporates independent clamping for the contact between the centre pin and its counterpart.

The connection arrangement of the invention affords a number of advantages. The connection arrangement will be such that a sufficiently high axial contact force, i.e. clamping, is achieved between the inner contact members, and thus intermodulation is prevented in the interface between the connector parts. On account of the high clamping force, the connection arrangement will be mechanically highly stable. The novel solution is also of simple construction and inexpensive to manufacture and assemble. Furthermore, the connection arrangement is

of such a construction that the requisite clamping force can be readily produced in threaded-type clamping.

In the following the invention will be explained in greater detail with reference to the accompanying drawings, in which

Figure 1 is a partial sectional side view of a connection arrangement,
Figure 2 is a partial sectional view of a body of a free connector employed as a connector part in the connection arrangement,
Figure 3 shows a cross-section A-A of the body shown in Figure 2.

With reference to the figures, in particular Figure 1, the connection arrangement comprises two interconnected connector parts 1 and 100. Connector part 1 is a male connector part and connector part 100 is a female connector part. Preferably connector part 1 is a free connector whereto a coaxial cable can be coupled. Connector part 100 is preferably a fixed connector that can be attached to the housing of a filter, for instance.

Connector part 1 comprises the following main components: body 2, outer contact member 3, inner contact member, i.e. centre pin 4, clamping means 7 for clamping the centre pin 4, two intermediate pieces 8 and 9 of insulative material, and a sliding surface 10. The body 2 comprises an outer surface 2a and an inner surface 2b and an attachment point 2c for a coaxial cable, a side 2d and an end 2e. A coaxial cable is schematically represented by reference numeral 50.

The second connector part, preferably a fixed connector 100, comprises the following main components: body 102, outer contact member 103, inner contact member, i.e. counterpart 104 for centre pin 4, support block 108 and an attachment member 109. The support block, i.e. intermediate piece 108 of insulative material, aligns the counterpart 104 and insulates it from the body 102.

The present invention is implemented in connection with radio frequency filters. A filter, specifically the interior of a filter, is denoted by reference numeral 110. In Figure 1, the fixed connector 100 is attached to a wall 120, e.g. bottom or side wall, of the filter 110 or an equivalent support surface or support member 120. The attachment member 109 is the part to which the inner conductor 111 of the cable that is led from the interior of the filter 110 can be soldered.

Between connector parts 1 and 100 on the exterior of the connection arrangement, the arrangement comprises a clamping construction 201, 202, including an outer clamping means 201 incorporated in the first connector part 1 and a threaded portion 202 provided in the body 102 of the second connector part 100. The clamping construction 201, 202 is a conventional exterior clamping construction for clamping the bodies 2 and 102 of connector parts 1 and 100 to one another.

The outer contact members 3 and 103 of the connector parts 1 and 100 are interconnected. Likewise, the inner contact members of connector parts 1 and 100 are interconnected. The outer contact members 3 and 103 are fitted in superposed relationship. The outer contact members 3 and 103 are both in electrical and in mechanical contact with one another. The outer contact members are cylindrical parts disposed about the junction of the inner contact members, i.e. the centre pin 4 and its counterpart 104.

In accordance with the invention, at least one of the connector parts, i.e. as shown in the figures preferably the first connector part 1, comprises clamping means 7 offsetting the inner contact member 4 relative to the body 2 for clamping the inner contact member 4 of said connector part 1 in the axial direction against the inner contact member 104 of the second connector part 100.

In a preferred embodiment, the clamping means 7 comprise a threaded portion 7a provided in the body 2 of connector part 1 and a clamping member 7b inserted into the threaded portion and comprising a reverse-threaded portion 7c. Such an embodiment provides the advantage that clamping can be readily achieved particularly on account of the fact that the requisite clamping force can be easily produced in threaded-type clamping.

The clamping means 7 are preferably such that the threaded portion 7a of the body 2 and the separate clamping member 7b with reverse thread 7c have been constructed to be substantially parallel with the inner contact member, i.e. centre pin 4, and most preferably so that the clamping means 7 are fitted to the end 2e of the body 2. This embodiment affords the advantage that the movement of the clamping member 7b already has the same direction, i.e. axial direction, that should be imparted to the centre pin, i.e. to the inner contact member 4.

In a preferred embodiment, the threaded portion 7a of the body 2 is provided on the inner surface 2b of the body 2, and the reverse-threaded portion 7c of the clamping member 7b is provided on the outer surface of the clamping member 7b. Such a construction achieves simple clamping means that can be produced at low cost.

In a preferred embodiment, the connection arrangement is such that within the body 2 between the clamping member 7b and the inner contact member 4 the arrangement comprises an intermediate piece 8 of insulative material, and between the intermediate piece 8 and the body 2 the arrangement comprises a sliding surface 10, and thus clamping of the inner contact member, i.e. centre pin 4, is effected through the intermediate piece 8. Turning of the clamping means 7b towards the intermediate piece 8 and centre pin 4 is a rotating movement, and thus in a preferred embodiment the connection arrangement comprises means 11 for preventing rotation of the intermediate piece 8, and preferably this means 11 is constituted by the surface profile of the inner surface 2b of the body 2. This angular surface profile 11 is to be seen particularly from Figure 3. The angularity has

been produced by machining the otherwise rounded interior 2b of the body at four points to be angular, preferably in the region of the end 2e of the body. In a preferred embodiment, the intermediate piece 8 comprises means 8a for aligning the inner contact member 4 in relation to the body 2. This means 8a for alignment of the inner contact member, i.e. centre pin 4, may be constituted by a recess 8a provided in the intermediate piece 8.

The intermediate piece in accordance with the above preferred embodiment serves many purposes, i.e. insulation of the centre pin 4 from the body 2, insulation of the centre pin 4 from the clamping member 7b and hence from the body 2 as well; furthermore, precise axial alignment of the centre pin 4 and naturally also the sliding movement necessary in the clamping of the centre pin 4 have been achieved.

It is to be seen from Figures 1-3 that the connection arrangement, preferably the body 2, further comprises abutment members 13 and 14 against which the intermediate pieces 8 and 9 are abutted. The inner contact member 4 in turn comprises projections 4a and 4b and clamping ends 4c and 4d. In Figure 1, projection 4a of the centre pin 4 is disposed in recess 8a of the intermediate piece 8, which aligns the centre pin, i.e. the inner contact member 4. Projection 4b is intended to restrict the movement of the centre pin 4. Moreover, the centre pin 4 comprises an attachment point 4e for the inner conductor of a coaxial cable to be connected with its sheath to attachment point 2c.

In addition to provision of clamping means, an essential feature of the invention is that a clamping allowance, such as clamping allowance 15 or 15b, is provided for the inner contact member, i.e. centre pin 4. The clamping allowance necessary for clamping can be provided by two alternative or corollary ways; firstly in such a way that the connection arrangement comprises a clamping clearance 15 which may be of the order of a few tenths of a millimeter. Another possibility for providing a clamping allowance is to make the intermediate pieces 8 and/or 9 at least partially made of a compressible material, and thus compression of the intermediate piece will enable axial movement of the centre pin 4 when the clamping member 7b is threaded into thread 7a. An example of the latter is clamping allowance 15b, which denotes the compressible zone in intermediate piece 8 against the abutment member 13.

In a preferred embodiment, two intermediate pieces are provided, i.e. in addition to intermediate piece 8 there is also a second intermediate piece 9. The function of intermediate piece 9 is specifically to align the centre pin 4 and also insulate it from the body 2. Use of two insulative intermediate pieces 8 and 9 ensures that the alignment of the centre pin 4 accurately in the correct direction is possible.

As stated previously, the connector parts 1 and 100 in the connection arrangement are preferably a free connector 1 and a fixed connector 100. Most preferably, the clamping means 7 for clamping the inner contact member, i.e. centre pin 4, are provided in the free connector 1. Thus the body 2 of the free connector 1, preferably side 2d of the body, comprises an attachment point 2c for a coaxial cable. Hence the attachment of the coaxial cable can be executed at side 2d of body 2, and clamping of the centre pin 4 in turn can be executed at end 2e of body 2, which is an advantageous way in view of performing the task.

Connector part 1 has been assembled in such a way that the second intermediate piece 9 is placed in the empty body 2, which is followed by insertion of the inner contact member, i.e. centre pin 4, and thereafter the first intermediate piece 8 is mounted, and finally the clamping member 7b is inserted into thread 7a.

The second connector part 100, i.e. the fixed connector, has been assembled by inserting the unit constituted by the inner contact member, i.e. the counterpart 104 of the centre pin, the intermediate piece 108 and the attachment member 109 into the body 102. The inner contact member 104 will remain stationary on account of the fact that the connection arrangement comprises an abutment member, such as an abutment surface 120, which is preferably part of the filter 110.

When the connection arrangement is assembled, i.e. when the connector parts 1 and 100 are combined, connector parts 1 and 100 are juxtaposed in such a way that the outer contact members 3 and 103 are interconnected and the inner contact members 4 and 104 are interconnected. In the next step, the bodies 2 and 102 are clamped together by means of the clamping construction 201, 202 of the outer surface, which will also clamp the inner contact members 4 and 104 to some extent, but not to a sufficient extent, in a manner known per se. Finally, the inner contact members, i.e. the centre pin 4 and the counterpart 104 are clamped in accordance with the invention by turning the clamping member 7b through the intermediate piece 8 towards the end 4c of the centre pin 4. The movement of the clamping member 7b will produce a sliding movement of the intermediate piece 8 on the sliding surface 10, and thus the intermediate piece 8 pushes the centre pin 4 ahead of it from the end 4c, which pushes the compression end 4d at the forward end of the centre pin 4 against the inner contact member 104 of the second connector part, i.e. fixed connector 100, i.e. against the counterpart 104 of the centre pin. The arrangement provides a clamping allowance of the dimensions of clamping clearance 15, or even more if for example intermediate piece 9 is compressible at the projection 4b of the centre pin 4 or at abutment member 14, or if intermediate piece 8 is compressible at abutment member 13. In terms of clamping, it is to be noted that the counterpart 104 of the second connector part 100 cannot escape backwards, as it is abutted through intermediate piece 108 against abutment surface 120, e.g. to the wall 120 of the filter 110.

In a preferred embodiment the connection arrangement is such that the outer contact member 3 of connector part 1 is made of the same piece of material as the

body 2 of said connector part. Likewise, in a preferred embodiment also the outer contact member 103 of the second connector part 100 is made of the same piece of material as the body 102 of said connector part 100. Such an embodiment will obviate the need to use mechanical joints, such as threaded joints, boron joints or other crimp connections between the outer contact member and the body, and thus the connection construction will be even better in view of suppressing intermodulation.

The clamping means for the inner contact member may also be reversed, so that they form part of the fixed connector. The clamping means may also be incorporated in both connector parts.

Even though the invention has been described in the foregoing with reference to the examples in accordance with the accompanying drawings, it is obvious that the invention is not to be so restricted, but it can be modified in a variety of ways within the scope of the inventive idea disclosed in the appended claims.

Claims

1. A connection arrangement, particularly an intermodulation-protected coaxial radio-frequency connection arrangement comprising interconnected connector parts (1, 100), each connector part comprising an outer contact member (3, 103) and an inner contact member (4, 104), wherein the outer contact members (3, 103) of the connector parts are interconnected and the inner contact members (4, 104) of the connector parts are interconnected, each connector part comprising a body (2, 102) and the connection arrangement comprising a clamping construction (201, 202) between the bodies (2, 102), **characterized** in that at least one connector part (1) comprises clamping means (7, 7a-7c) offsetting the inner contact member (4) relative to the body (2) for clamping the inner contact member (4) of said connector part (1) in the axial direction against the inner contact member (104) of the other connector part (100).

2. A connection arrangement as claimed in claim 1, **characterized** in that the clamping means (7, 7a-7c) are fitted to the end (2e) of the body.

3. A connection arrangement as claimed in claim 1 or 2, **characterized** in that the clamping means (7, 7a-7c) comprise a threaded portion (7a) provided in the body (2) of connector part (1) and a clamping member (7b) fitted into the threaded portion and comprising a reverse-threaded portion (7c).

4. A connection arrangement as claimed in claim 3, **characterized** in that the threaded portion (7a) of the body (2) and the clamping member (7b) with reverse thread (7c) have been constructed to be substantially parallel with the inner contact member (4).

5. A connection arrangement as claimed in claim 3 or 4, **characterized** in that the threaded portion (7a) of the body (2) is provided on the inner surface (2b) of the body, and the reverse-threaded portion (7c) of the clamping member (7b) is provided on the outer surface of the clamping member (7b).

6. A connection arrangement as claimed in claim 3, 4 or 5, **characterized** in that within the body (2) between the clamping member (7b) and the inner contact member (4) the connection arrangement comprises an insulative intermediate piece (8), and between the intermediate piece (8) and the body (2) the connection arrangement comprises a sliding surface (10).

7. A connection arrangement as claimed in claim 6, **characterized** in that the connection arrangement comprises means (11) for preventing rotation of the intermediate piece.

8. A connection arrangement as claimed in claim 7, **characterized** in that the means (11) for preventing rotation of the intermediate piece is constituted by the surface profile of the inner surface (2b) of the body (2).

9. A connection arrangement as claimed in claim 6, **characterized** in that the intermediate piece (8) comprises means (8a) for aligning the inner contact member (4) in relation to the body (2).

10. A connection arrangement as claimed in claim 1, **characterized** in that the connector parts comprised by the connection arrangement are a free connector (1) and a fixed connector (100), that the clamping means (7, 7a-7c) for clamping the inner contact member (4) are provided in the free connector (1), and that the body (2) of the free connector (1), preferably the side (2d) of the body, comprises an attachment point (2c) for a coaxial cable (50).

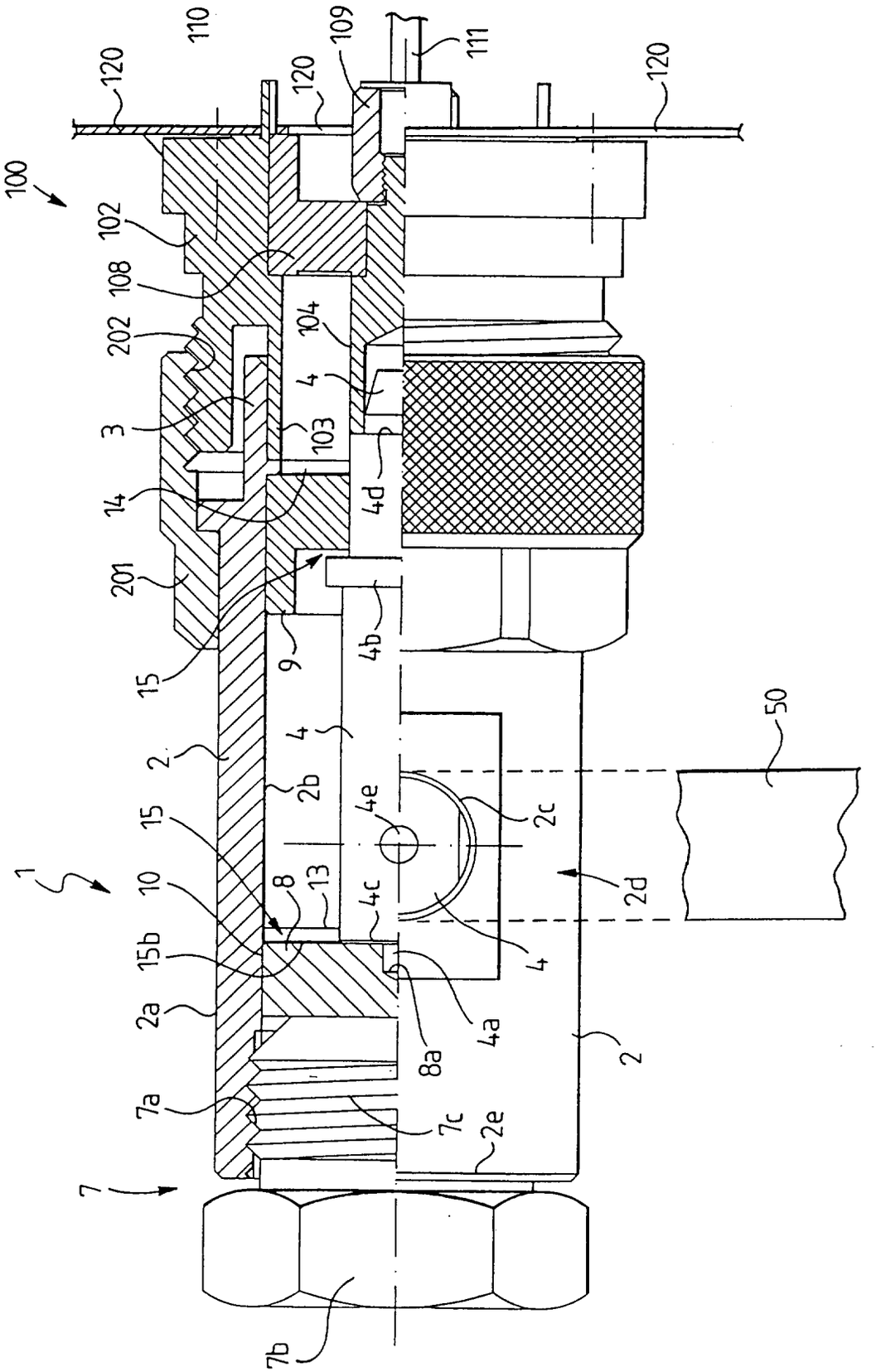
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FIG. 1

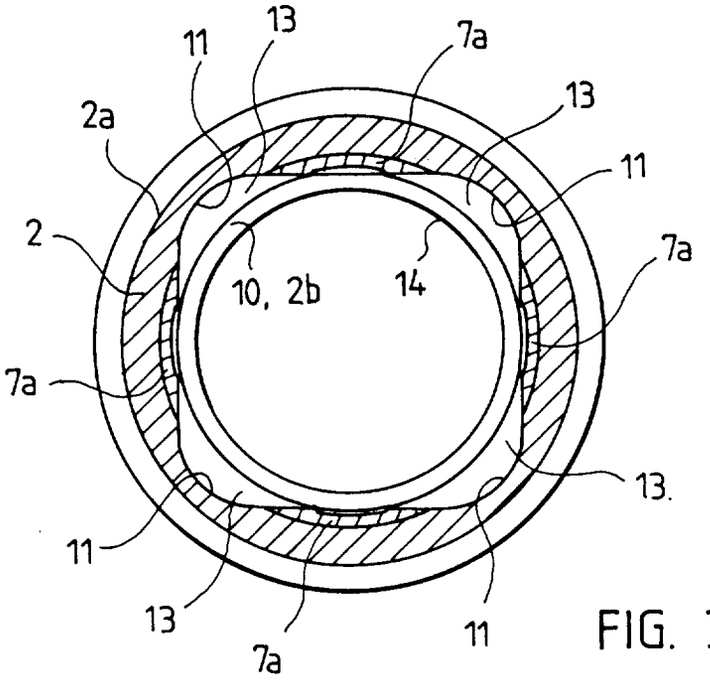
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FIG. 3

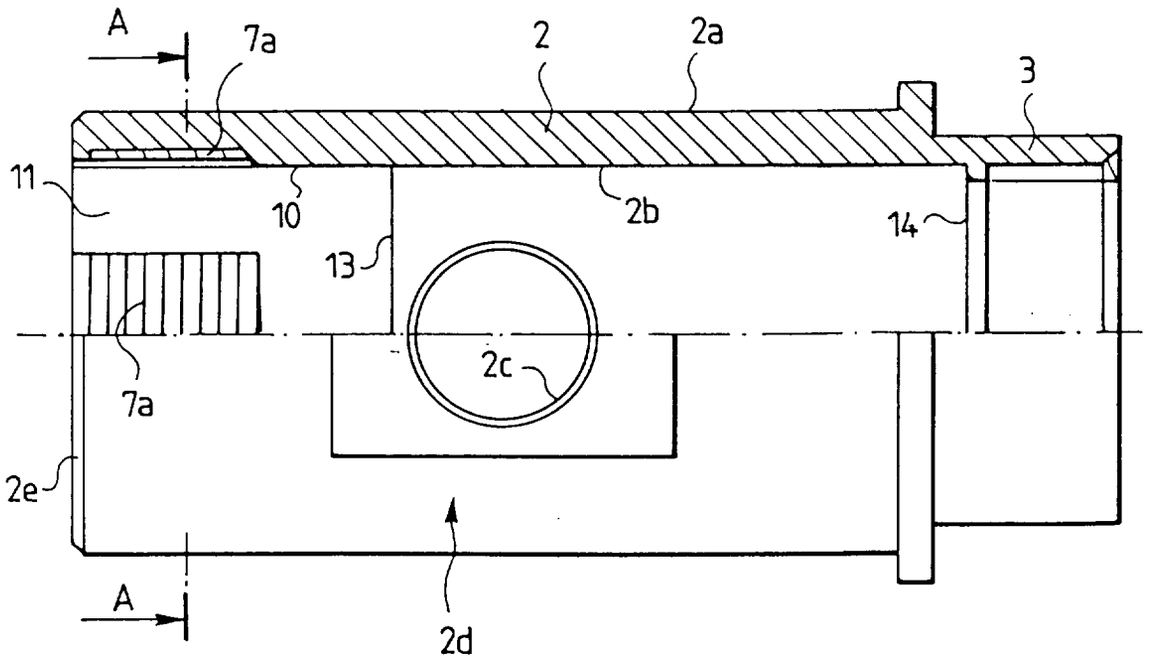
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FIG. 2