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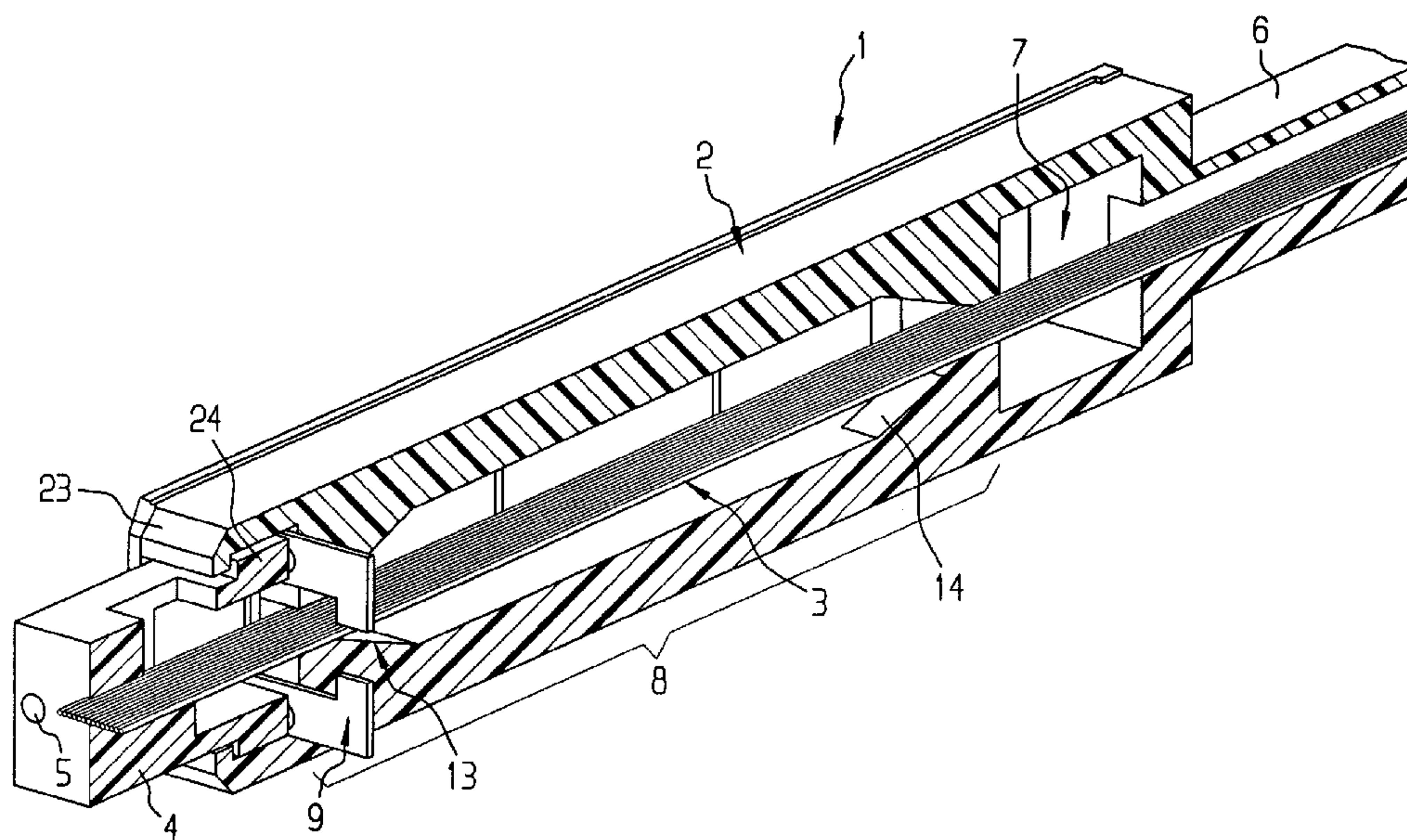
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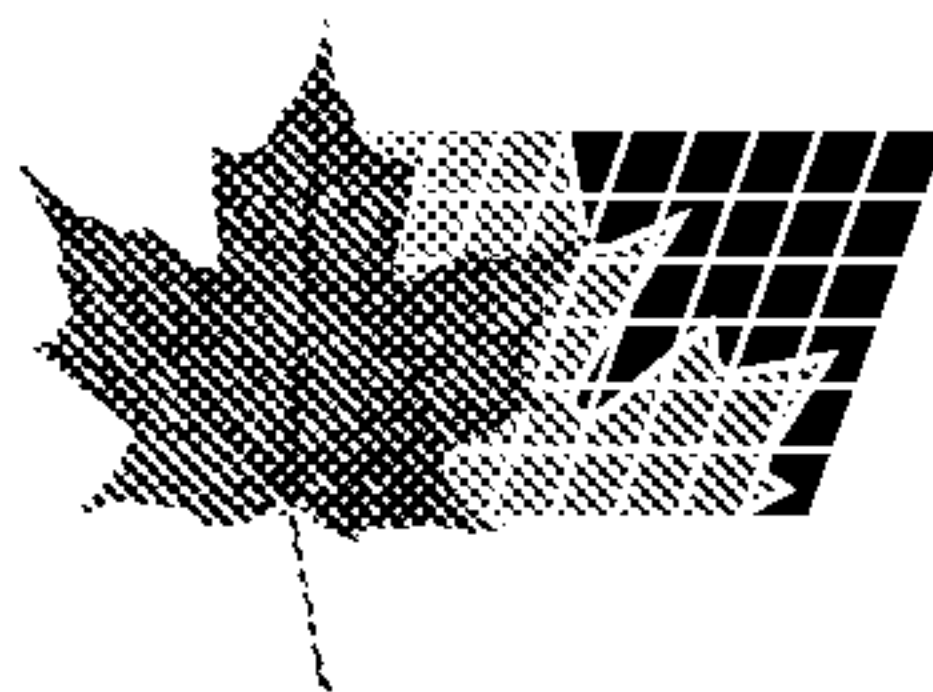
(54) **CONNECTEUR ENFICHABLE POUR CONNECTER DE FACON
LIBERABLE UN GUIDE D'ONDE OPTIQUE A UN AUTRE
GUIDE D'ONDE OPTIQUE**

(54) **PLUG-IN CONNECTOR FOR DETACHABLE CONNECTION OF
AN OPTICAL WAVEGUIDE TO ANOTHER OPTICAL
WAVEGUIDE**



(57) L'invention concerne un connecteur enfichable pour connecter de façon libérable une zone terminale pourvue d'une ferrule (4) d'un guide d'onde optique (3) à un autre guide d'onde optique, dans un dispositif d'enfichage. Ce connecteur comprend un boîtier (2) comportant une zone

(57) The invention relates to a plug-in connector for detachably connecting the end area of an optical waveguide (3) fitted with a ferrule (4) to another optical waveguide in the direction of insertion. Said connector has a housing (2) with a retaining area (21) for guiding



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de retenue (21) pour guider la ferrule (3), ladite zone étant conçue de sorte que la ferrule (4) soit guidée de façon mobile en formant un angle par rapport au dispositif d'enfichage. Le boîtier présente une zone de décharge de traction (7) servant à relier de façon rigide le guide d'onde optique (3) et le boîtier (2). Dans la région située entre la zone de décharge de traction (7) et la zone de retenue (21), il est prévu au moins une zone de limitation de courbure (8) servant à limiter la pliure, vers l'extérieur, du guide d'onde optique (3) en cas de déplacement angulaire de la ferrule (4) par rapport au dispositif d'enfichage. Lorsque la zone de limitation de courbure (8) est conçue de manière appropriée, la configuration selon l'invention empêche une pliure, vers l'extérieur, du guide d'onde optique (3) au-delà d'une courbure maximale admissible.

the ferrule (4), configured in such a way that the ferrule (4) is movably guided at an angle in relation to the direction of insertion. The housing has a strain relief area (7) for a fixed connection of the optical waveguide (3) to the housing (2), wherein at least one curvature limitation area (8) is included in-between the strain relief area (7) and the retaining area (21) in order to limit outward bending of the optical waveguide (3) when the ferrule (4) is staggered at an angle in relation to the direction of insertion. The inventive configuration prevents the optical waveguide (3) from bending outwards beyond a maximum permissible degree of curvature due to the appropriate design of the curvature limitation area (8).



Abstract of the Disclosure:

A connector for detachable connection of an end region, provided with a ferrule (4), of an optical waveguide (3) to
5 another optical waveguide in a plug-in direction, has a housing (2) with a holding region (21) for guiding the ferrule (4), which is constructed such that the ferrule (4) is guided in an angularly moveable fashion with reference to the plug-in direction.

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The housing has a stress-relief region (7) for firmly connecting the optical waveguide (3) to the housing (2), in the region between the stress-relief region (7) and the holding region (21) at least one curvature-limiting region (8)
15 being provided for limiting the outward bending of the optical waveguide (3) given an angular displacement of the ferrule (4) with reference to the plug-in direction.

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Given the suitable design of the curvature-limiting region (8), outward bending of the optical waveguide (3) beyond a maximum permissible curvature is prevented with the aid of the configuration according to the invention.

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CONNECTOR FOR DETACHABLE CONNECTION OF AN OPTICAL WAVEGUIDE TO
ANOTHER OPTICAL WAVEGUIDE

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The invention relates to a connector for detachable connection of an end region, provided with a ferrule, of an optical waveguide to another optical waveguide in a plug-in direction, the connector having a housing with a holding region for
10 guiding the ferrule, which is constructed such that the ferrule is guided in an angularly moveable fashion with reference to the plug-in direction, and the housing having a stress-relief region for firmly connecting the optical waveguide to the housing.

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It is frequently necessary in the case of optical waveguides and, in particular, in the case of multiple optical waveguides, to connect an end region of an optical waveguide to another optical waveguide in such a way that an optical
20 signal is transmitted from one optical waveguide to the next optical waveguide. For this purpose, end regions of the optical waveguides are held in so-called ferrules, which, in the simplest case, grip the end of the optical waveguide which is to be connected, in order to render it easier to
25 manipulate. Precisely in the case of multiple optical waveguides which have a plurality of individual fibers, the individual fibers are held in a defined linear or matrix-shaped arrangement in the ferrule so that at a transition between two interconnected ferrules in each case a defined
30 fiber of the one multiple optical waveguide comes into contact with a further defined fiber of the other multiple optical waveguide. In order to prevent over-stressing of an optical waveguide upon stressing of the connection of two optical waveguides, connectors have stress-relief elements which are

always designed such that the optical waveguide is fixed in a housing so that forces applied to the optical waveguide are transmitted directly onto the housing without stressing the connection between the ferrule and optical waveguide.

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It has emerged in this case that the known connectors lead particularly frequently to mounting problems and/or problems in data transmission if these are used not to make overhung connections between optical waveguides but, for example, are used as terminals fastened on a printed circuit board.

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WO 86/02740 exhibits a connector for optical waveguides. The connector has a pair of plug-in components of which each one holds a component which has the shape of a pyramidal frustum. Provided for the purpose of connecting the optical waveguides are ferrules which are held rigidly close to one another and in each case hold the ends of the optical waveguides.

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EP 0 602 726 A1 exhibits a connector for optical waveguides with the aid of which the latter can be connected to a back plane. In order to connect the optical waveguides, a captive ferrule is provided which holds the ends of the optical waveguides.

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EP 0 034 987 A1 exhibits a connector for optical waveguides in which end regions of the two optical waveguides are gripped in a common flexible ferrule. The ferrule is then pressed between two sleeves in such a way that a remaining cavity around the end regions of the two optical waveguides is completely filled up.

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It is the object of the invention to provide a connector which can be used for reliably and easily connecting optical conductor cables to printed circuit boards, in particular.

This object is achieved by means of the subject matter of the independent claim. Advantageous refinements follow from the subclaims.

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In accordance with the invention, both for individual fiber ferrules and for multiple fiber ferrules in the region between the stress-relief region and the holding region a curvature-limiting region is provided for limiting the outward bending
10 of the optical waveguide given an angular displacement of the ferrule with reference to the plug-in direction.

The invention is based on the fundamental idea that large losses occur with optical waveguides when the optical
15 waveguide is curved beyond a maximum permissible curvature. Precisely in the case of the connectors known in the prior art, it can easily happen that, because of a displacement of the ferrule, the optical waveguide is bent such that the maximum permissible curvature is exceeded.

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Given a suitable design of the curvature-limiting region, outward bending of the optical waveguide beyond a maximum permissible curvature is prevented with the aid of the configuration according to the invention. A reliable
25 transmission of data is thereby ensured in all cases.

The curvature-limiting region may have at least one run-up wall which is of ramp-shaped cross section and is constructed and arranged such that given an angular displacement of the
30 ferrule the optical waveguide comes into contact at least partially in a linear fashion with the run-up wall. It is precisely in the case of a linear contact between the optical waveguide and run-up wall that it is guaranteed that no excessively high mechanical stressing of the optical waveguide

occurs locally given a limitation of the curvature of the optical waveguide. However, it can be ensured by the appropriate construction of the run-up wall that the optical waveguide assumes a predetermined maximum curvature over the entire length of the linear contact. It is precisely in the case of multiple optical waveguides that a ramp of flat and bellied construction is desirable, while a run-up cone can also be provided in a round optical waveguide which can bend outward on all sides.

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In the configuration of the invention, the holding region has a moveable bearing element which carries a stop end of the ferrule. In this case, the stop end of ferrule is situated opposite that end face of the ferrule at which the optical waveguides emerge. For this purpose, the bearing element can be constructed in a tiltable fashion about an axis running transverse to the plugging direction of the connector. For this purpose, bearing sites supporting the bearing element can be provided in the housing, the bearing sites preferably being constructed as bearing edges or as bearing points projecting from the housing. As an alternative to this, the bearing element can also have projecting bearing points.

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In a particular configuration, the bearing element is constructed as an elastically deformable plate, it being possible for the latter to have the shape of a U-shaped metal component. Precisely given the construction of the bearing element as an elastically deformable plate, it is possible to ensure in a simple way that the ferrule can be displaced spatially in all directions with reference to the plug-in direction. For this purpose, on the one hand the deformable plate is provided with bearing points about which the bearing element can be tilted angularly. Moreover, lateral edges of the bearing element are set on bearing edges so that the plate

can sag. If it is then ensured in addition by means of stops that the sagging is limited given large forces, it is possible to provide a reliably operating connector in a simple way.

- 5 The invention is represented in the drawing with the aid of two exemplary embodiments.

Fig. 1 shows a perspective view of a connector according to the invention with a multiple optical waveguide in an
10 unstressed state,

Fig. 2 shows a housing of the optical waveguide from Fig. 1,

Fig. 3 and Fig. 4 show a subregion of the housing from Fig. 1,
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Fig. 5 shows the subregion of the connector from Fig. 1 in a stressed state,

Fig. 6 shows a bearing element of the connector in accordance
20 with Fig. 5,

Fig. 7 shows a partial view of the connector from Fig. 1 in a further stressed state, and

25 Fig. 8 and Fig. 9 show a subregion of a housing of a further connector according to the invention.

Fig. 1 shows a connector 1 according to the invention in a perspective view. The connector 1 is represented in section
30 along a longitudinal line of symmetry, thus affording a view into the interior of the connector 1.

A flat multiple optical waveguide 3 which is provided at an output end with a ferrule 4 is held in the housing 2.

The ferrule 4 has cylindrical guide bores 5 into which guide pins (not shown in this view) can be plugged.

5 An outlet sleeve 6 for the multiple optical waveguide 3 is provided on the end of the housing 2 opposite the ferrule 4. Adjoining the outlet sleeve 6 is a stress-relief region 7 in which the multiple optical waveguide 3 is firmly connected to the housing 2. A curvature-limiting region 8 is provided in
10 the housing 2 in the region between the ferrule 4 and the stress-relief region 7. The ferrule 4 is supported on the curvature-limiting region 8 by a bearing element 9 which ensures a spatial pivotability of the ferrule 4 with reference to the housing 2, and also ensures a limitation of this
15 pivotability.

Fig. 2 shows the housing 2 from Fig. 1 without additional components of the connector 1 inserted. As may be seen, particularly well in this view, the housing 2 is subdivided
20 into a housing trough 10, which is also represented in Fig. 3 in the perspective plan view, and into a housing cover 11 which is constructed such that it completely closes the top side of the housing trough 10, which is open at the top. The housing trough 10 and the housing cover 11 form a sleeve
25 opening 12 of rectangular cross section at the end situated on the right in Fig. 2 and at the rear in Fig. 3. Adjoining the sleeve opening 12 is the stress-relief region 7, which has a cubic contour and is filled with retaining material in the mounted state of the connector 1.

30 The curvature-limiting region 8 can be seen particularly well in Figs. 2 and 3. The curvature-limiting region 8 has two ramps 13, 14, 15 and 16 on both the top and bottom sides. The curvature-limiting region 8 runs parallel to the outer edges

of the housing 2 in a floor region 17 between the ramps 13 and 14, and in a ceiling region 18 between the ramps 15 and 16. The curvature-limiting region 8 is limited on both sides by essentially straight side walls 19 and 20. A ferrule chamber 21 which serves to hold the ferrule 4 adjoins the curvature-limiting region 8. At the output end, the ferrule chamber 21 has an outlet opening 22 which has an outlet collar 23 tapering forward. The outlet collar 23 cooperates with a shoulder 24 provided on the ferrule 4 and prevents the ferrule 4 from falling out of the ferrule chamber 21.

Fig. 4 shows a subregion of the housing trough 10 with the ferrule chamber 21, the bearing element 9 being inserted in the ferrule chamber 21. As may be seen particularly well in this view, the bearing element 9 is constructed as a sheet-metal component which has a U-shaped outline in the plan view. In this case, the bearing element 9 is subdivided into a base 25 situated on the left in Fig. 4, and into a first wing 26, situated above, and a second wing 27 situated below. The first wing 26 is provided in the middle with a first elevation 28 which is shaped by pressing into the first wing 26. The second wing 27 is likewise provided with a second elevation 29.

In this state inserted into the ferrule chamber 21, the bearing element 9 bears against a first shoulder 30 and against a second shoulder 31 which is to be seen best in Figs. 2 and 3. In this case, the base 25 is arranged on the second shoulder 31, while the two ends of the first wing 26 and of the second wing 27 bear against the first shoulder 30.

Fig. 5 illustrates an angular displacement of the ferrule 4 in the housing 2 about an axis 32. As may be seen particularly well in this view, here the multiple optical waveguide 3 is pressed downward starting from the position shown in Fig. 1,

until it bears against the ramp 13 and against the ramp 14 (not show in this view). The backlash compensation required between the ferrule 4 and the ferrule chamber 21 is achieved by a deformation of the bearing element 9. In this case, the first wing 26 is pressed downward by the rear edge of the ferrule 4, because the rear edge of the ferrule 4 acts on the first elevation 28. The second wing 27 remains unchanged and straight.

Fig. 6 shows a section of the ferrule chamber 21 with the deformed bearing element 9 from Fig. 5, in cross section. As is to be seen particularly well in this view, the second wing 27 remains undeformed, while the first wing 26 is pressed downward because of the action of the ferrule on the first elevation 28, until it bears against a floor piece 33 of the ferrule chamber 21. This fixes the maximum tilting angle of the ferrule 4 about the axis 32.

The bearing of the multiple optical waveguide 3 against the ramps 13 and 14 likewise prevents this waveguide from being curved by more than a maximum permissible curvature.

Fig. 7 shows a perspective view of the connector 1 from Fig. 1, in which the ferrule is placed angularly around an axis 34 from its initial position shown in Fig. 1. As is to be seen particularly well in this view, the bearing element 9 is in an undeformed state, the rear edge of the ferrule 4 being tilted about the first elevation 28 and about the second elevation 29, since these form bearings. The rotary path of the ferrule 4 about the axis 34 is limited by virtue of the fact that a lateral edge of the rear bearing surface of the ferrule 4 bears against the base 25 of the ferrule 4. This effectively prevents overshooting of a maximum permissible curvature of the multiple optical waveguide 3 about the axis 34.

Figs. 8 and 9 show perspective views of a subregion of a further housing trough 35 according to the invention, with a ferrule chamber 36. The ferrule chamber 36 corresponds

5 essentially to the ferrule chamber 21 from Figures 1 to 7. However, by contrast with the ferrule chamber 21 no shoulders whatsoever are provided on a floor piece 37. Provided instead of these are hemispherical elevations 38 about which a bearing element (not shown in this view) is pivotably constructed.

10 The connector according to the invention can be used to achieve permanent stress relief of the optical waveguide, compression of the optical waveguide and overshooting of a maximum permissible curvature of the optical waveguide being
15 avoided. Finally, the connector according to the invention can also be used to achieve a high packing density, it being possible to open up a wide spectrum of different applications.

We claim:

1. A connector for detachable connection of an end region, provided with a ferrule (4), of an optical waveguide (3) to another optical waveguide in a plug-in direction, the
5 connector (1) having a housing (2) with a holding region (21) for guiding the ferrule (4), which is constructed such that the ferrule (4) is guided in an angularly moveable fashion with reference to the plug-in direction, and the housing having a stress-relief region (7) for firmly connecting the
10 optical waveguide (3) and to the housing (2), characterized in that in the region between the stress-relief region (7) and the holding region (21) at least one curvature-limiting region (8) is provided for running up the optical waveguide (3) and/or the ferrule (4) on the housing (10), which curvature-
15 limiting region is constructed such that the outward bending of the optical waveguide (3) is limited given an angular displacement of the ferrule (4) with reference to the plug-in direction.
- 20 2. The connector as claimed in claim 1, characterized in that the curvature-limiting region (8) has at least one run-up wall (13, 14, 15, 16) which is of ramp-shaped cross section and is constructed and arranged such that given an angular
25 displacement of the ferrule (4) the optical waveguide (3) comes into contact at least partially in a linear fashion with the run-up wall (13, 14, 15, 16).
3. The connector as claimed in claim 1 or claim 2, characterized in that the holding region (21) has a moveable
30 bearing element (9) which carries a stop end of the ferrule (4).
4. The connector as claimed in claim 3, characterized in that the bearing element (9) is constructed in a tiltable fashion

about an axis (32, 34) running transverse to the plugging direction.

5 5. The connector as claimed in claim 4, characterized in that bearing sites(30, 31: 38) supporting the bearing element (9) are provided in the housing (2).

10 6. The connector as claimed in claim 5, characterized in that the bearing sites are constructed as bearing edges (30, 31).

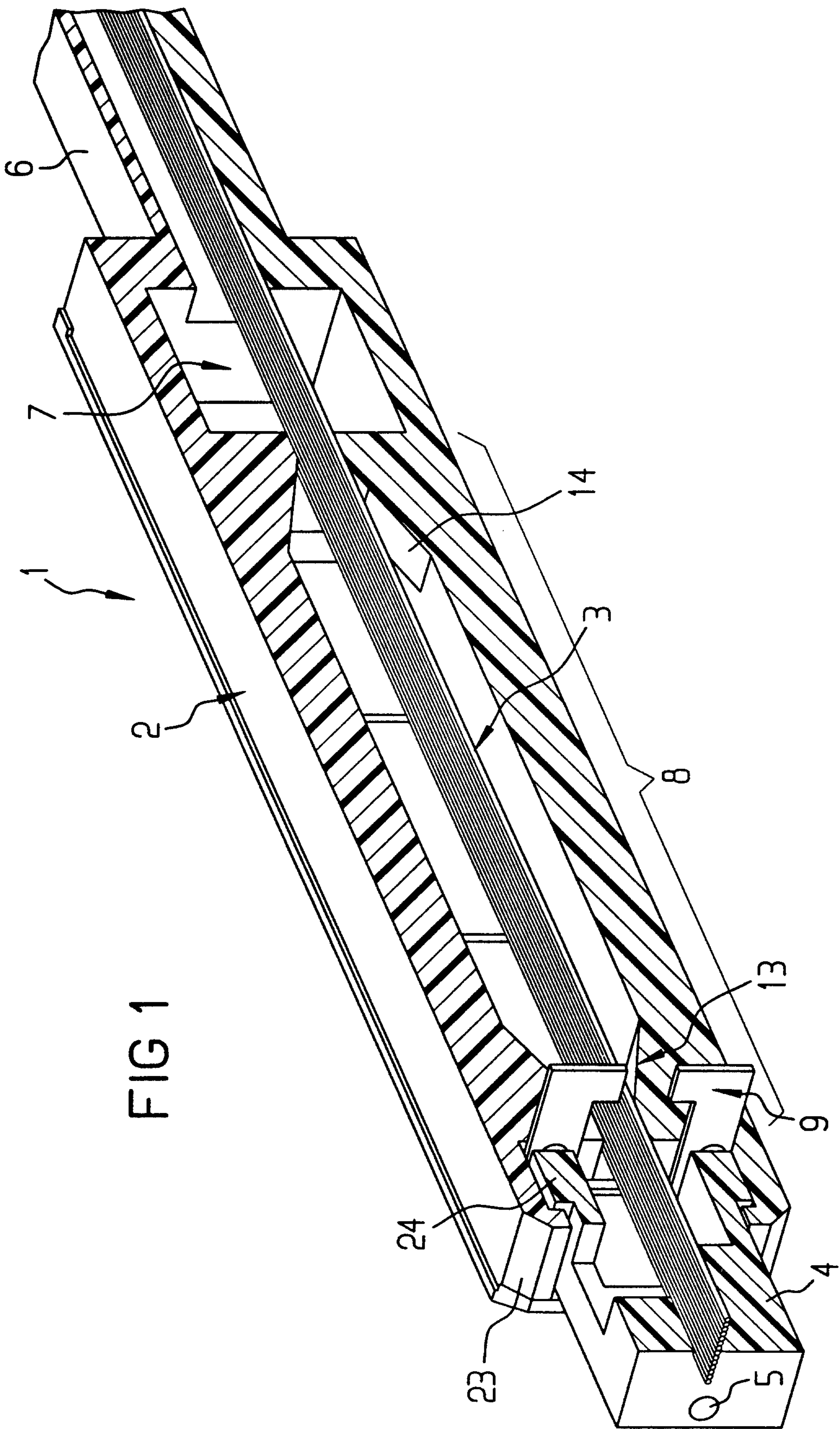
7. The connector as claimed in claim 5 or claim 6, characterized in that the bearing sites are constructed as bearing points (38) projecting from the housing (2).

15 8. The connector as claimed in claim 4, characterized in that the bearing element (9) has projecting bearing points (28, 29).

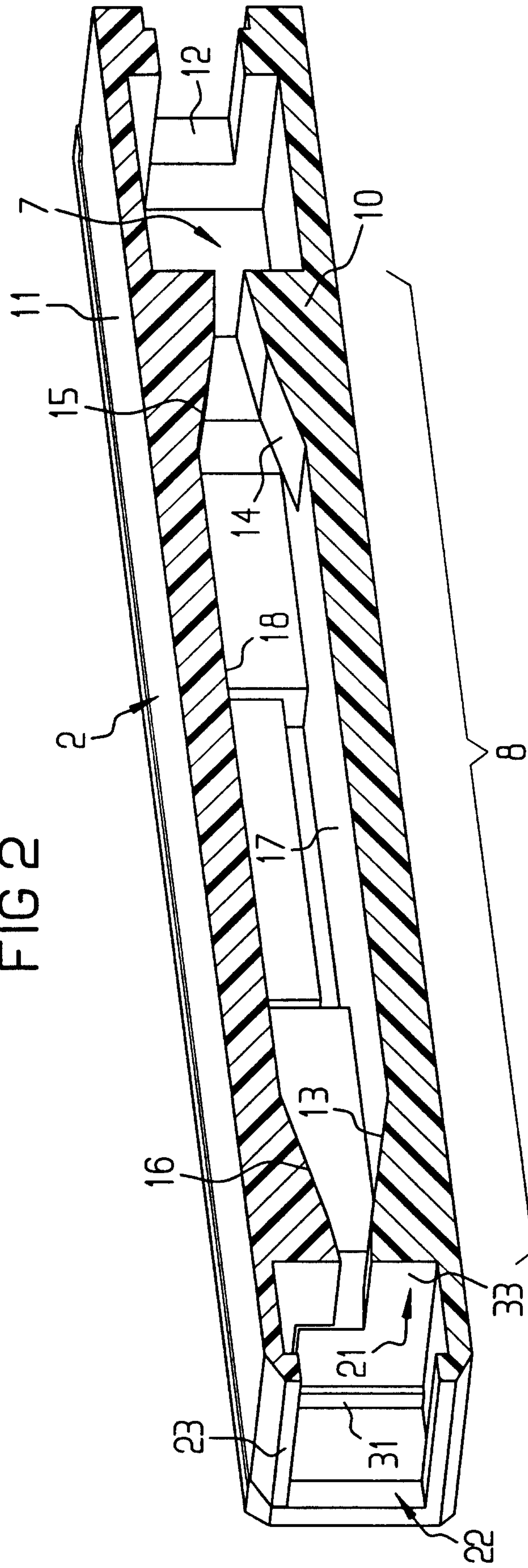
20 9. The connector as claimed in one of the preceding claims, characterized in that the bearing element (9) is constructed as an elastically deformable plate.

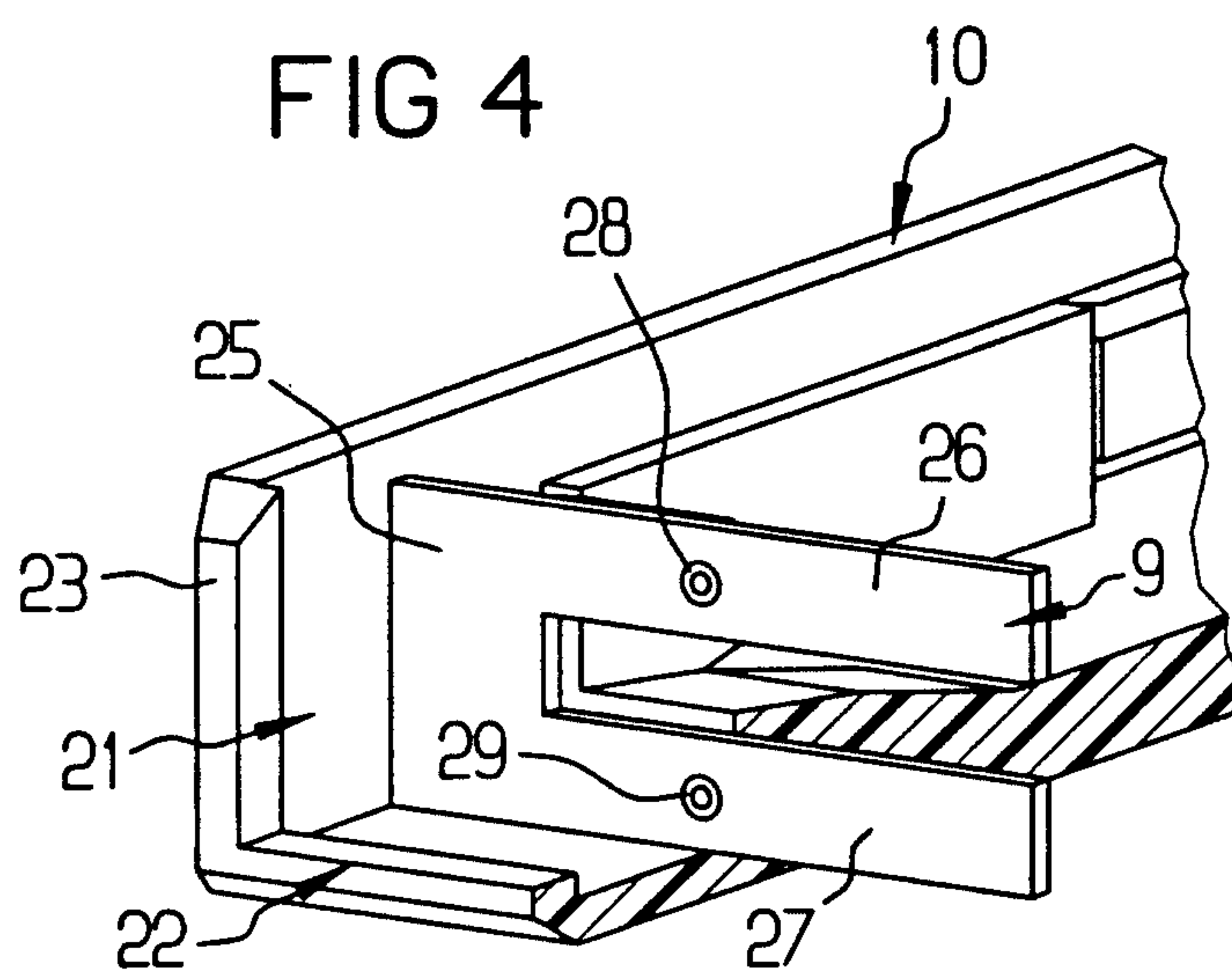
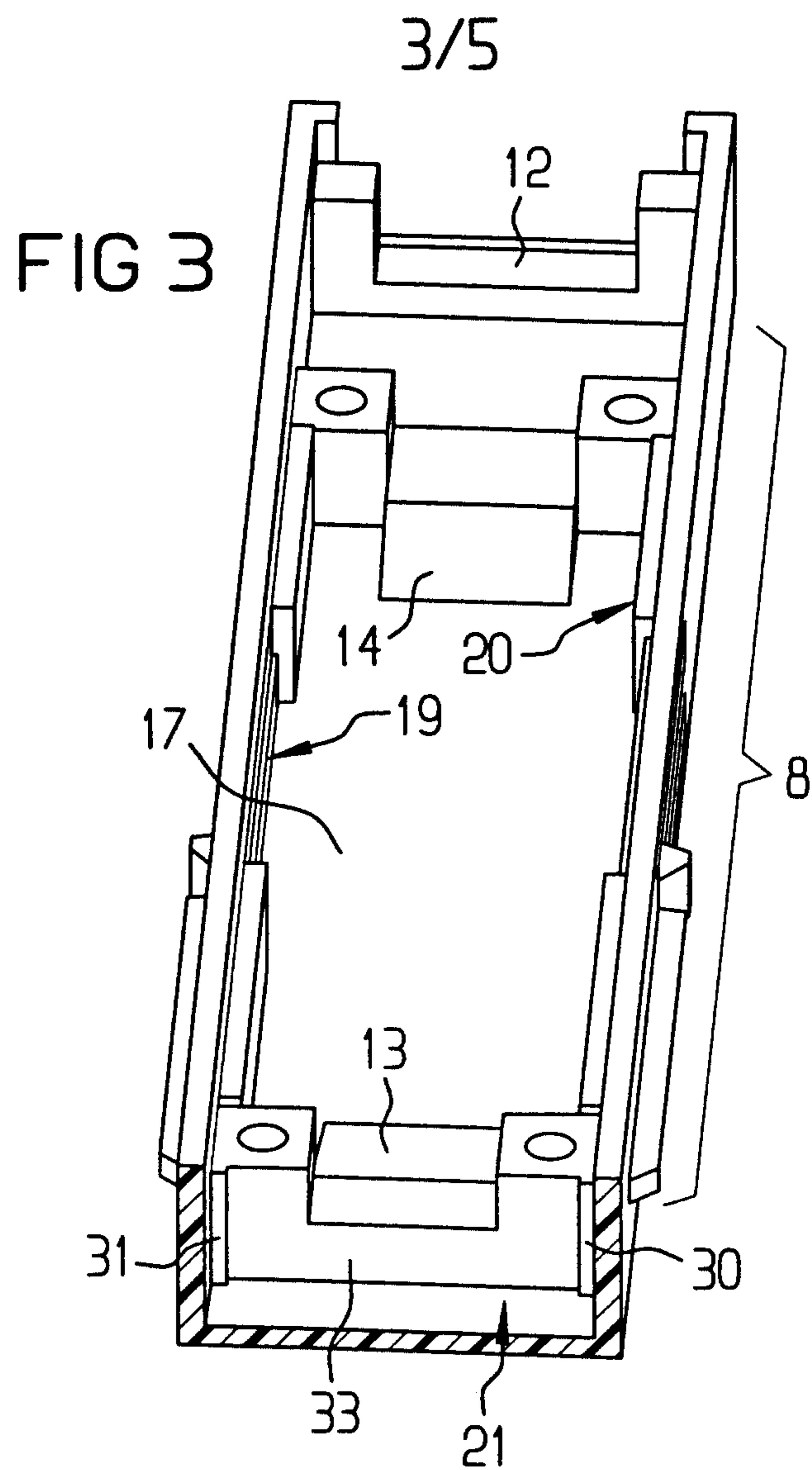
25 10. The connector as claimed in claim 9, characterized in that the bearing element (9) is constructed as a U-shaped metal component.

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FIG 5

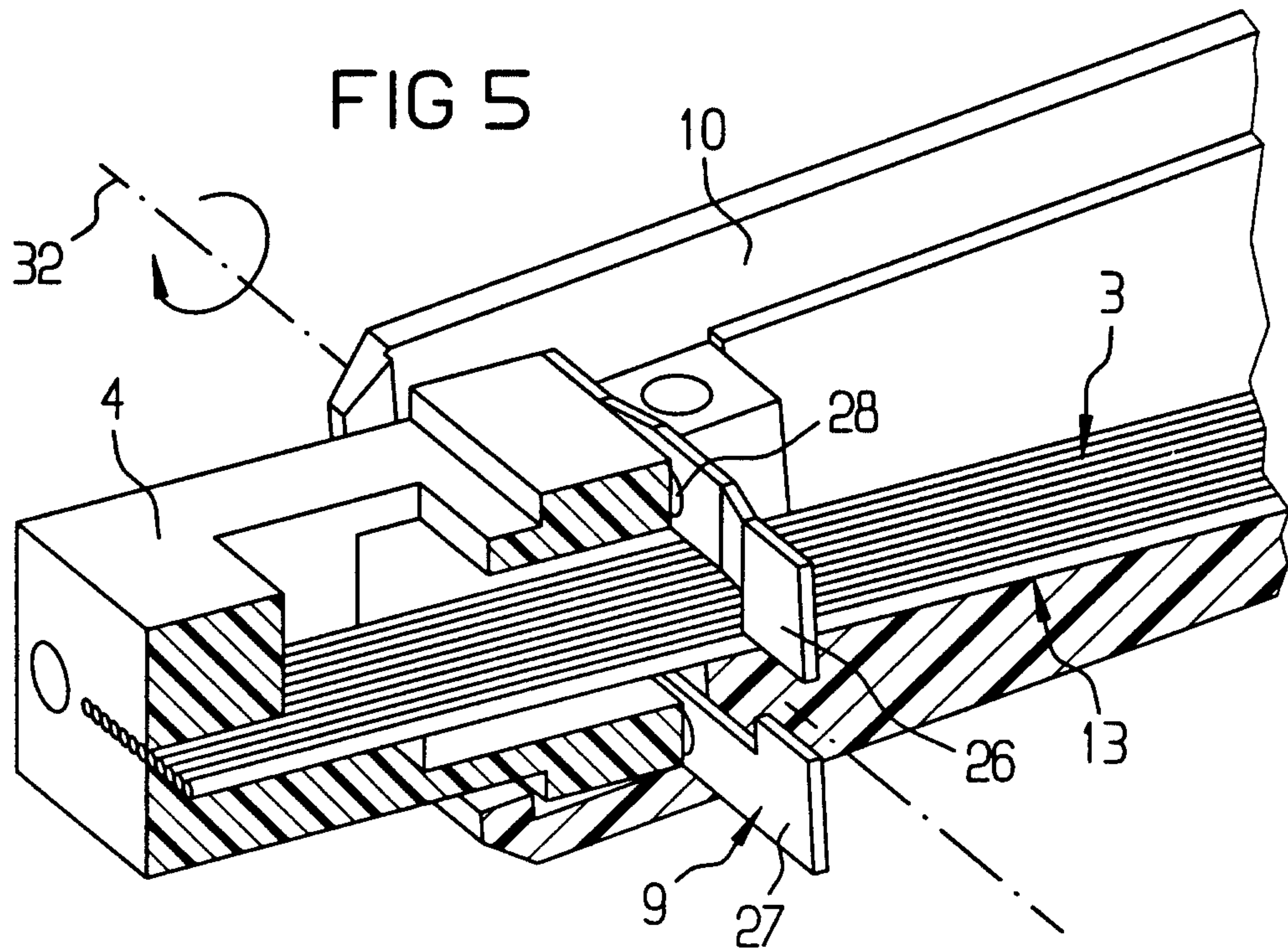


FIG 6

