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**COUPLING ELEMENT FOR OPTICAL WAVEGUIDE, PLUG
CONNECTOR AND FABRICATION METHOD**

The present invention relates to a coupling element for releasably connecting at least
5 a first optical waveguide to at least a second optical waveguide and/or at least an electro-
optical component. Such coupling elements are also often referred to as ferrules.

When coupling electro-optical transmitters such as, for example, LEDs and laser
diodes, and electro-optical receivers, such as, for example, photodiodes and phototransistors,
10 by means of a light-conducting fibre, or when optically connecting two separate optical
waveguides to each other, the problem arises that the end faces of the light-conducting fibres
must be very precisely positioned and retained with respect to the corresponding
transmission or receiving faces and the corresponding end faces of a second optical
waveguide. The optical axes must be precisely aligned and adjoin each other very closely,
15 that is to say, the optical axes to be coupled must be precisely positioned both in a radial and
in an axial direction.

In order to ensure correct coupling of an optical waveguide to a transmitter or to a
receiver or correct coupling between two fibres, in the known optical plug type connections
20 the end of the optical waveguide is produced with a small tube, a so-called ferrule, also often
referred to as an "insert". The securing of the ferrule to or on the optical waveguide must be
carried out in a tension-resistant manner, without damaging the optical waveguide or even
influencing its optical properties.

25 Known means for securing to an optical waveguide produce a mechanical connection
thereto, for example, by a crimp connection being fitted to the optical waveguide. In this
instance, however, there is the danger that the optical waveguide may become damaged or its
optical properties may be influenced in a negative manner.

30 In order to solve this problem, it is proposed in the European Patent Specification EP
1 180 248 B1 to secure plastics ferrules to the optical waveguide by means of laser welding.
However, the known ferrule according to this specification has the disadvantage that it is
possible to radially adjust a first optical waveguide with respect to a second optical

waveguide or an electro-optical component, such as an electro-optical transmitter or receiver, with adequate precision only with the use of time-intensive and cost-intensive technologies.

5 From US 4,186,997 and the technical article William L. Schumacher: "Fiber Optic Connector Design to Eliminate Tolerance Effects", presented at the 10th Annual Connector Symposium, Cherry Hill, New Jersey, 1977, there is further known, for connecting optical waveguides, a method and a device which allow improved mutual adjustment of two waveguides and a compensation of production tolerances.

10 However, this known arrangement has the disadvantage that it is comparatively complex and costly to produce.

15 An object of the present invention is therefore to provide a coupling element for at least a first optical waveguide so that it is possible to ensure, on the one hand, reliable securing of the coupling element to the optical waveguide and, on the other hand, robust and reliable securing of the coupling element to a second optical waveguide and/or an optical component. Furthermore, in particular for use in a motor vehicle, a high level of reliability and robustness for the connection and short cycle times and low costs for the production are
20 intended to be achieved.

 This object is achieved by the subject-matter of the independent patent claims. The dependent claims relate to advantageous developments of the present invention.

25 The present invention is based on the notion that an optical waveguide is adjusted in an axial direction in a ferrule which is fixed thereto in a non-releasable manner and the orientation with respect to its counter-piece which is to be connected is carried out by means of two so-called inner prisms, each of which is part of one of the ferrules, respectively.

30 These adjustment prisms which are formed by preferably V-shaped inner grooves are preferably of a compressible material in order to be able to compensate for tolerance effects, as known, for example, from the article William L. Schumacher: "Fiber Optic Connector Design to Eliminate Tolerance Effects", presented at the 10th Annual Connector Symposium,

Cherry Hill, New Jersey, 1977. According to the present invention, the guiding groove is produced in a directly integral manner with the coupling element, for example, by means of injection-moulding. The guiding groove has a first region in which the at least one first optical waveguide is partially received, and a second region for receiving the at least one second optical waveguide.

If this connection is used as a so-called fibre-optic inline connection, that is to say, for connecting two optical fibres to an identical coupling element, respectively, the entire connection can be closed by using a housing which is constructed merely in a very simple manner. The production and the closure and release of the optical connection is thereby particularly simple and cost-effective. On the other hand, the adjustment according to the invention in two mutually opposed guiding grooves of the coupling elements to be connected enables particularly precise and reliable orientation of the optical axes with respect to each other. This is also a result of the fact that the integral production involves a substantially shorter tolerance chain than ferrules which are assembled from several pieces.

However, the principle of the present invention can be used not only to connect optical waveguides of the same type, but also to connect an optical waveguide (for example, a pigtail) to electro-optical receivers or transmitters whose housing then constitutes the correspondingly fitting counter-piece to the ferrule according to the invention. Precise orientation of the optical axis for coupling in a receiver or for decoupling from a transmitter with the optical axis of the optical waveguide is thereby achieved in a particularly simple manner.

Furthermore, the present invention is not limited to only one fibre being arranged in the coupling element. Of course, a plurality of optical fibres may also be positioned therein. Furthermore the fibres which are connected using the method according to the invention do not necessarily have to have the same cross-section. Conventionally, however, the fibre pairs which are intended to be connected in each case will have approximately the same cross-section so that the radial adjustment can be carried out via the guiding groove according to the invention.

In particular with very thin, so-called plastic clad silica (PCS) fibres, which may have diameters in the order of magnitude of 200 μm , the present invention may allow the necessary precision of adjustment, with production costs which are sufficiently low.

5 This is particularly significant in the context of the optical multimedia network MOST used in the automotive industry. In this instance, various connectors are required which allow high data transmission rates, for example, in the context of receiving and displaying traffic information or entertainment within the motor vehicle.

10 An optoelectronic plug type connector system, which can be used in the media-orientated system transport (MOST) network, comprises plug type connectors for coupling various optoelectronic components, so-called pigtails, that is to say, short optical waveguides, which are connected to such an electro-optical component, various hybrid plug type connectors and corresponding plastics optical waveguide cable sets. In particular owing
15 to the conditions of use in the motor vehicle, in addition to the cost factor, the long-term stability, vibration resistance and temperature resistance of the connections is also of utmost importance. Using the coupling technology according to the invention, all these requirements can be complied with.

20 A particularly reliable adjustment of two optical axes relative to each other can be achieved by the use of guiding grooves with a substantially V-shaped cross-section. There may additionally be provision for the material from which the coupling element is produced to have a degree of compressibility in order to centre different fibre cross-sections with the smallest possible deviation in relation to each other. For example, polyamide can be used as
25 a material for the coupling element. Of course, all other conventional materials may also be considered. The dimension of the V-shaped groove may be selected to be different for the first region and the second region so that, for example, the dimensions of the lateral walls in the first region are selected in such a manner that the guiding groove of the second region is received in the guiding groove of the first region of a complementary coupling element when
30 the two coupling elements are connected to each other.

According to an advantageous development of the present invention, the coupling element has, for adjusting an axial defined position of the first optical waveguide, a terrace-

like projection which defines a reference face transversely relative to the longitudinal axis of the guiding groove. Consequently, the position of the optical fibre in the longitudinal direction can be determined with very low tolerances before the fibres are connected to the ferrule by means of a weld connection. Crimping, for example, of a brass or zinc pressure
5 diecast component is also conceivable in this instance. The automotive industry requires maintenance/repair solutions which can be joined using conventional tools. With existing MOST ferrules, for example, a turned brass ferrule is crimped.

For particularly efficient and cost-effective construction of an inline plug type
10 connector, the coupling element according to the invention is formed in such a manner that it co-operates with an identical second coupling element which is arranged in a state rotated through 180° about a longitudinal axis of the guiding groove on the first coupling element and co-operates therewith in order to produce the connection.

15 The present invention further relates to a plug type connector for releasably connecting at least a first optical waveguide to at least a second optical waveguide and/or at least one optical component, which comprises at least one coupling element according to the present invention. Furthermore, there is provided a housing which receives and fixes the assembled coupling elements and/or the coupling element which is assembled with the at
20 least one optical component. It is thereby possible to produce universally applicable optical fibres which are suitable both for connection to other optical fibres and for the connection of electro-optical components.

In the case of a connection between two optical waveguides, the housing may be
25 constructed as a simple covering sleeve. In this manner, a cost-effective, robust and simple optical plug type connector is provided, which nonetheless complies with the high precision requirements for very thin optical waveguide cross-sections. In order to facilitate assembly and further to mechanically secure the closed connection in addition during operation, the covering sleeve may have a catch device for securing the first coupling element. The
30 associated second coupling element may of course also be engaged in the covering sleeve.

In order to be able to reliably receive the loads owing to vibrations and changes in temperature occurring in particular within the environment of the motor vehicle, the plug

type connector according to the invention further has a releasable retention member which, in the assembled state, applies forces in an axial and radial direction. For example, this may be a resilient retention clamp which, on the one hand, has resilient arms which apply a radial pressure to the coupling elements and which further has resilient arms which press the coupling elements towards each other in an axial direction.

When two coupling elements are assembled, it is important for the optical waveguides to come into contact with each other and with the facing coupling element only at the last possible moment of assembly so that damage owing to grinding movements can be prevented. To this end, according to the present invention, the covering sleeve has inclined guiding members which are arranged in such a manner that they hold the coupling elements, during insertion into the sleeve, away from the other coupling element until the axial position is substantially reached. Owing to this safety clearance in a radial direction, damage to the sensitive end faces of the optical waveguides can be effectively prevented. This is, for example, solved in a different manner in the arrangement known from the article "Fiber Optic Connector Design to Eliminate Tolerance Effects", presented at the 10th Annual Connector Symposium, Cherry Hill, New Jersey, 1977. In the known solution, both halves integrally have a ramp which radially orientates the fibres only towards the end of the pairing. According to the present invention, this is dispensed with in order to keep the shaping tool simple.

According to the invention, optical waveguides are produced by an integrally produced coupling element being positioned in an axial direction on the optical waveguide and the two components subsequently being secured to each other by means of a welding operation. All known methods can be used for the welding operation, in particular the laser welding techniques set out in EP 1 180 248 B1.

According to an advantageous embodiment of the present invention, the optical waveguide is a so-called polymer clad silica (PCS) optical fibre. This PCS fibre has a core having a cladding and an inner jacket and outer jacket.

As is generally known, the core comprises, for example, silicon oxide and the cladding layer may comprise a tetrafluoroethylene hexafluoropropylene copolymer or a

tetrafluoroethylene vinylidene fluoride copolymer. In principle, the present invention may be used with any type of cladding and in particular with fibres which have diameters of 200 μm or less or more (for example, 980 μm POF (plastic optical fibre)).

5 In order to protect the optical waveguide, there is conventionally used a plastics material, such as, for example, polyamide 12, which provides sufficient resistance for the aggressive conditions in the motor vehicle. The production method according to the invention therefore also comprises the step of partially releasing the waveguide core and waveguide cladding by removing the protective sleeve and conditioning the fibre end face
10 (for example, by means of laser cleaving) before the optical waveguide is assembled in the coupling element. The welding with the optical waveguide is preferably carried out between the inner wall of the coupling element and the outer wall of the inner jacket but may also be provided between the inner wall of the coupling element and the outer wall of the outer jacket.

15 The method according to the invention for connecting two coupling elements of the same type is carried out in a particularly simple and reliable manner in that a first coupling element which is provided with an axially positioned and laser-welded fibre is first mounted and engaged in a covering sleeve. The second coupling element is subsequently inserted.
20 According to the invention, the covering sleeve has an inclined guiding member which redirects the second coupling element during insertion thereof in such a manner that the first optical waveguide which has already been assembled and the moving second optical waveguide do not come into contact with each other in order to prevent damage. Only when the second optical waveguide has substantially reached its axial position does the catch
25 connection between the second coupling element and the covering sleeve become engaged, and the two optical waveguides to be connected are temporarily adjusted with respect to each other.

30 The definitive fixing is carried out according to the invention by fitting a releasable retention member which applies forces in an axial and radial direction in the assembled state. This may, for example, be a curved retention member which is inserted and which applies radial pressing force to the assembled coupling elements through at least one recess in the covering sleeve and, on the other hand, engages on external peripheral regions of the

coupling element in order to apply axial pressure of the coupling elements to each other so that the end faces of the optical waveguides come into contact with each other.

For better understanding of the present invention, it is explained in greater detail with reference to the embodiments illustrated in the following Figures. Components which are the same are given the same reference numerals and the same component designations. Furthermore, individual features or combinations of features from the embodiments shown and described may also constitute solutions which are inventive or in accordance with the invention which are independent per se.

In the Figures:

Figure 1 is a perspective illustration of a coupling element according to the present invention;

Figure 2 is a longitudinal section through the coupling element with a mounted optical fibre according to claim 1;

Figure 3 is a view of the end face of the arrangement from Figure 1;

Figure 4 is a sectional view of a plug type connector having two identical coupling elements according to Figures 1 to 3;

Figure 5 is a detail of Figure 7;

Figure 6 is a side view of the arrangement of Figure 4 with a sectioned optical fibre;

Figure 7 is a cross-section through the arrangement of Figure 6;

Figure 8 is a side view of the arrangement of Figure 4;

Figures 9 to 15 illustrate various operating steps when connecting two optical fibres according to the present invention;

Figure 16 is a perspective view of a mounting socket for the connection between an electro-optical component and an optical fibre using a coupling element according to the present invention;

Figure 17 is a perspective view of the mounting socket having a connected optical fibre;

Figure 18 is a sectioned view of an optical fibre which is connected to the connector block of Figure 16;

Figure 19 is a side view of the arrangement of Figure 17.

The structure of a coupling element 100 according to the present invention is first intended to be considered in greater detail with reference to Figures 1 to 3. The coupling element 100 which is often also referred to as a ferrule serves to releasably connect a first
5 optical waveguide 102 to another optical waveguide or optical component. In the embodiment illustrated, the optical waveguide 102 is a so-called PCS optical fibre, that is to say, a silica core which is provided with a polymer coating. The core/cladding structure 104 may have diameters in the order of magnitude of 200 μm . In principle, however, the solution according to the invention can also be used for thicker and thinner optical waveguides, for
10 example, those with diameters of 8 μm or 980 μm . Furthermore, the coupling element 100 does not necessarily have to be constructed in such a manner that only one optical waveguide 102 can be received therein. Of course, a plurality of optical waveguides may also be accommodated in correspondingly constructed coupling elements.

15 As can be seen in Figure 2, the optical waveguide 102 has an inner jacket 106 and an outer jacket 108. According to the present design, the inner jacket 106 is not quite as remote as the outer jacket 108 and acts as an auxiliary means for introduction along a funnel-shaped inclined introduction member 110 when the optical waveguide 102 is inserted into the coupling element 100. In a connection region 118, the core/cladding structure 104 is exposed
20 so that the radial orientation according to the invention can be carried out. The coupling element 100 which is formed in one piece is non-releasably connected to the outer side of the outer jacket 108 by means of a weld connection 112. Alternatively or in addition, this weld connection, as illustrated in Figure 4, may also be carried out between the inner wall of the coupling element 100 and the outer layer of the inner jacket 106. All known welding
25 methods, for example, the laser welding methods proposed in EP 1 180 248 B1, may be used.

According to the present invention, the coupling element 100 has a reference face 114 which is arranged transversely relative to the inserted optical fibre. Before the weld
30 connection 112 is fitted, the end face 116 of the first optical waveguide is orientated flush with the reference face 114. Only then is the optical waveguide 102 welded to the coupling element 100 and the position of the end face 116 fixed in the axial direction.

According to the present invention, the coupling element 100 has a connection region 118 which can be brought into contact with a second coupling element or an electro-optical component. In this connection region 118, there is provided a guiding groove 120 which is divided into two regions 122, 124. The core/cladding structure 104 of the first optical fibre is received in the first region. The second region 124 is formed in such a manner that, when connected to a second optical fibre, it can cooperate with the core/cladding structure thereof. Conversely, when the coupling element 100 is connected to another identical coupling element, its second region 124 of the groove 120 can co-operate with the core/cladding structure 104 of the first optical waveguide.

These connections become clear from the sectioned illustration of Figure 4. Figure 4 shows a plug type connector 300 for releasably connecting two identical optical waveguides 102 and 202. According to the invention, the second coupling element 200 is rotated with reference to the first coupling element 100 through 180° about a longitudinal axis defined by the optical waveguide.

In the arrangement shown in this instance, the end faces 116, 216 of the first and second optical waveguide 104, 204 are adjusted in an axial direction with sufficient precision using the respective reference faces. The adjustment in a radial direction is carried out according to the invention by means of the co-operation of the guiding grooves of the two coupling elements 100, 200. In the assembled state, the first region 122 of the guiding groove of the first coupling element comes to rest in each case below the second region 224 of the second coupling element 200 that is rotated through 180°. The core/cladding structure 104 of the first optical waveguide 102 is arranged therebetween and retained in a defined radial position by means of the co-operation of these two inner prisms. Conversely, the core/cladding structure 204 of the second optical waveguide 202 is surrounded by the first region 222 of the guiding groove of the second coupling element and the second region 124 of the guiding groove of the first coupling element 100 and is also forced onto the same radial position as the first core/cladding structure 104. The two end faces 116, 216 of the two optical waveguides 102, 202 are thereby positioned optimally with respect to each other in a radial direction.

Any tolerance differences can be compensated for by a flexible material, such as, for example, polyamide, being selected for the coupling elements 100, 200, which yields slightly owing to compression and thereby allows tolerance compensation, as described in the article William L. Schumacher: "Fiber Optic Connector Design to Eliminate Tolerance Effects",
5 presented at the 10th Annual Connector Symposium, Cherry Hill, New Jersey, 1977.

According to the invention, the plug type connector 300 comprises a covering sleeve 302, in which the two coupling elements 100, 200 are received. For definitive mechanical fixing of the connected coupling elements 100, 200 there is further provided a curved
10 retention member 304 which, on the one hand, applies a radial pressure in the direct connection region 118 and, on the other hand, in the peripheral regions 126, 226 applies pressure in a direction along the optical fibre towards the connection region 118. A catch shoulder 128 on the coupling element 100 co-operates with a catch arm 306 on the covering sleeve 302 in order to temporarily secure the two coupling elements in the inserted position,
15 even without the fitted curved retention member 304.

Various views, from which the operating method of the curved retention member 304 can be derived, are illustrated in Figures 6 to 8. In particular these illustrations show that the curved retention member 304, on the one hand has centrally arranged resilient arms 308 for
20 applying pressure which is radially directed towards the optical fibres and, on the other hand, has second resilient arms 310 which apply pressure which is directed in a manner substantially parallel with the optical fibres to the peripheral regions 226 and 126 of the coupling elements 100 and 200. By removing the curved retention member 304 and actuating the catch arm 306, the closed connection can be released at any time without being
25 destroyed. During normal operation, however, unintentional release is not possible.

With reference to Figures 9 to 15, the connection of two optical fibres using the plug type connector 300 shown in Figures 4 to 8 is intended to be explained in greater detail. The covering sleeve is illustrated here only very schematically. The important aspect for the
30 assembly, however, is an inclined guiding member 312 whose function becomes clear in particular with reference to Figure 12.

As illustrated in Figure 10, the first coupling element 100 is first mounted in the covering sleeve 302 so that the catch connection 128, 306 is closed. In the next step, the coupling element 200 which has been rotated through 180° with respect to the coupling element 100 is inserted into the covering sleeve 302. A first inclined introduction member
5 which is arranged at the end face of the connection region and a second inclined introduction member 230 facilitate the insertion of the coupling element.

As shown in Figure 12, there is arranged at the inner side of the covering sleeve 302 an inclined guiding member 312 which, together with the inclined introduction member 230,
10 guides the second coupling element 200 during further insertion into the covering sleeve 302 in such a manner that the end face 216 of the optical waveguide in no way comes into contact with the first coupling element 100. This upward movement is again illustrated in particular in Figure 13. At the same time, as indicated in Figure 12, the catch arm 306 is actuated.

As illustrated in Figure 14, the second coupling element 200 engages with the catch arm 306 of the covering sleeve 302 when the definitive axial position of the two optical waveguides relative to each other has substantially been reached. This primary locking prevents the two coupling elements 100, 200 from being able to move too far apart from
20 each other again.

Subsequently, the curved retention member 304 is mounted and applies, as indicated in Figure 15, in the connection region 118 radially inwardly directed pressure directly to the guiding grooves of the respective coupling elements and in the external peripheral region
25 longitudinal pressing force substantially parallel with the respective optical waveguides. This type of connection allows precise orientation of the optical axes of two optical waveguides relative to each other. Such an orientation is significant for the correct function of a fibreoptic connection. With such mechanical connections, deviations which are mostly caused by tolerances and which occur both in a radial and in an axial direction may cause
30 damping which significantly impairs the properties of the connection. Whilst common 980 µm POF (plastic optical fibre) connections can be produced in a satisfactory manner with conventional tools and simple designs, a significantly lower tolerance and generally a significantly more complex design are necessary in connection with smaller fibre diameters

(for example, 200 μm PCS fibres) for the same connection quality. Cylindrical guides, as are actually desirable for connections in the motor vehicle and in particular in connection with cable harnesses, cannot be produced with known arrangements.

5 In the arrangement according to the invention, two V-shaped guiding grooves cooperate in order to carry out a radial alignment of the two fibres to be connected by means of a rhombic centering cross-section and are each part of a ferrule. Since only a very small number of individual components must be assembled, the tolerances are small and, since the ferrules are the only elements which are used to align the fibres, a chain of individual
10 components which accumulate tolerances can be avoided. In addition to the two integrally produced ferrules, there must only be provided a covering sleeve for the preliminary alignment and a spring which provide the necessary forces for the orientation of the fibres and optionally close an air gap in an axial direction.

15 Figures 16 to 19 illustrate another embodiment of the present invention. The prefabricated coupling element 100 of the first optical waveguide 102 can be used not only for the connection to a second coupling element 200 of the same type but can also contact electro-optical components such as LEDs, VCSELS (vertical cavity surface emitting lasers) and laser diodes or photodiodes and phototransistors. For example, a fibre optic transmitter
20 (FOT) 400 has a housing 402. On the housing 402 of the FOT 400 there is provided a guiding groove 420 which is capable of co-operating with the guiding groove 120 of the coupling element 100. An optical reference point 414 constitutes the analogon with respect to the reference face 114. A chip 404 produces the light 406 which is coupled into the optical fibre 104. The principles of the present invention can of course also be applied to
25 arrangements with a plurality of grooves in the FOT housing, for contacting a plurality of lines or with combined housings for transmitters and receivers.

As illustrated symbolically in Figure 18, it must also be ensured in this embodiment that resilient forces 408 are used in order to fix the coupling element 100 to the housing 402.

30 The production of optical waveguides according to the invention therefore allows a universally applicable plug type connection both between optical waveguides of the same type and between electro-optical components and optical fibres, such as, for example,

pigtails. The principles according to the invention, even if this is not illustrated in detail, can of course also be used for plug type connectors in which more than only one optical fibre is arranged. Naturally, it is also possible in accordance with the principles described above to produce hybrid plug type connectors which, in addition to the optical connection, also

5 produce an electrical connection.

LIST OF REFERENCE NUMERALS

Reference numeral	Description
100, 200	Coupling element
102, 202	Optical waveguide
104, 204	Core/cladding structure
106, 206	Inner jacket
108, 208	Outer jacket
110	Funnel-shaped inclined introduction member
112	Weld connection
114	Reference face
116, 216	End face of the optical waveguide
118	Connection region
120	Guiding groove
122, 222	First region of the guiding groove
124, 224	Second region of the guiding groove
126, 226	Peripheral region of the coupling element
128	Catch device
230	Inclined introduction member
300	Plug type connector
302	Covering sleeve
304	Curved retention member
306	Catch arm
308	First resilient arms
310	Second resilient arms
312	Inclined guiding member
400	Fibre optic transmitter (FOT)
402	Housing
404	Chip
406	Light beam
408	Resilient forces
414	Optical reference point
420	Guiding groove on the FOT housing

CLAIMS

1. Coupling element for releasably connecting at least a first optical waveguide (102) to at least a second optical waveguide (202) and/or at least an electro-optical component (400),
5 the coupling element (100) being produced in an integral manner and being secured to the optical waveguide (102) by means of a weld connection (112),

there being arranged on the coupling element (100) a guiding groove (120) which has a first region (122) in which the at least one first optical waveguide (102) is partially received, and furthermore a second region (124) for partially receiving the at least one
10 second optical waveguide.

2. Coupling element according to claim 1, the guiding groove (120) having a substantially V-shaped cross-section.

3. Coupling element according to claim 1 or claim 2, there being arranged on the coupling element, in order to adjust an axial defined position of the first optical waveguide (102) in the coupling element (100), a terrace-like projection which defines a reference face (114) transversely relative to a longitudinal axis of the guiding groove (120).

4. Coupling element according to any one of the preceding claims, the coupling element (100) being formed in such a manner that it co-operates with an identical second coupling element (200) which is rotated through 180° about a longitudinal axis of the guiding groove (120) and which is welded to the at least one second optical waveguide (202) in order to produce the releasable connection.

5. Plug type connector for releasably connecting at least a first optical waveguide (102) to at least a second optical waveguide (202) and/or at least one electro-optical component (400), the plug type connector comprising at least one coupling element (100, 200) according to any one of claims 1 to 4 and a housing (302) for receiving and fixing the assembled coupling
30 elements (100, 200) and/or the coupling element (100) which is assembled with the at least one electro-optical component (400).

6. Plug type connector according to claim 5, the housing comprising a covering sleeve (302).

7. Plug type connector according to claim 6, the covering sleeve (302) having at least one catch device (306) for securing the first and/or second coupling element (100, 200).

5 8. Plug type connector according to claim 6 or claim 7, which further has, for fixing the connection, a releasable retention member (304) which applies forces in an axial and radial direction in the assembled state.

9. Plug type connector according to any one of claims 6 to 8, the covering sleeve (302)
10 having at least one inclined guiding member (312) which is configured to guide the first and/or second coupling element (100, 200) during insertion into the covering sleeve (302) in such a manner that the associated optical waveguide (102, 202) has a safety clearance in a radial direction.

15 10. Method for producing at least a first optical waveguide for releasably connecting the at least one first optical waveguide to at least a second optical waveguide and/or at least one electro-optical component, the method comprising the following steps of:

providing a coupling element according to any one of claims 1 to 4,

mounting the at least one optical waveguide in the coupling element and adjusting its
20 axial position with reference to a reference plane which is arranged on the coupling element,
fixing the at least one optical waveguide to the coupling element by means of a welding operation.

11. Method according to claim 10, further comprising the step of partially exposing a
25 waveguide core and waveguide cladding before mounting the optical waveguide in the coupling element.

12. Method for releasably connecting at least a first optical waveguide to at least a second optical waveguide and/or at least one electro-optical component, the method comprising the
30 following steps of:

producing the at least one first optical waveguide in accordance with the method according to claim 10 or 11,

positioning the coupling element with the first optical waveguide on the at least one second optical waveguide and/or at least one electro-optical component,

fixing the connection by means of a releasable retention member which, in the assembled state, applies forces in an axial and radial direction.

5

13. Method according to claim 12, further comprising the step of:

inserting the coupling element with the at least one first optical waveguide into a covering sleeve.

10 14. Method according to claim 13, further comprising the step of:

inserting a second coupling element with the at least one second optical waveguide into the covering sleeve, the second coupling element being constructed in a manner identical to the first coupling element and being rotated through 180° with reference to a longitudinal axis of the first coupling element.

15

15. Method according to either claim 13 or claim 14, there being inserted, in order to fix the connection, a curved retention member which applies radial pressing force to the assembled coupling elements through at least one recess of the covering sleeve.

20 16. Method according to claim 15, the inserted curved retention member being formed in such a manner that it applies pressing force in an axial direction.

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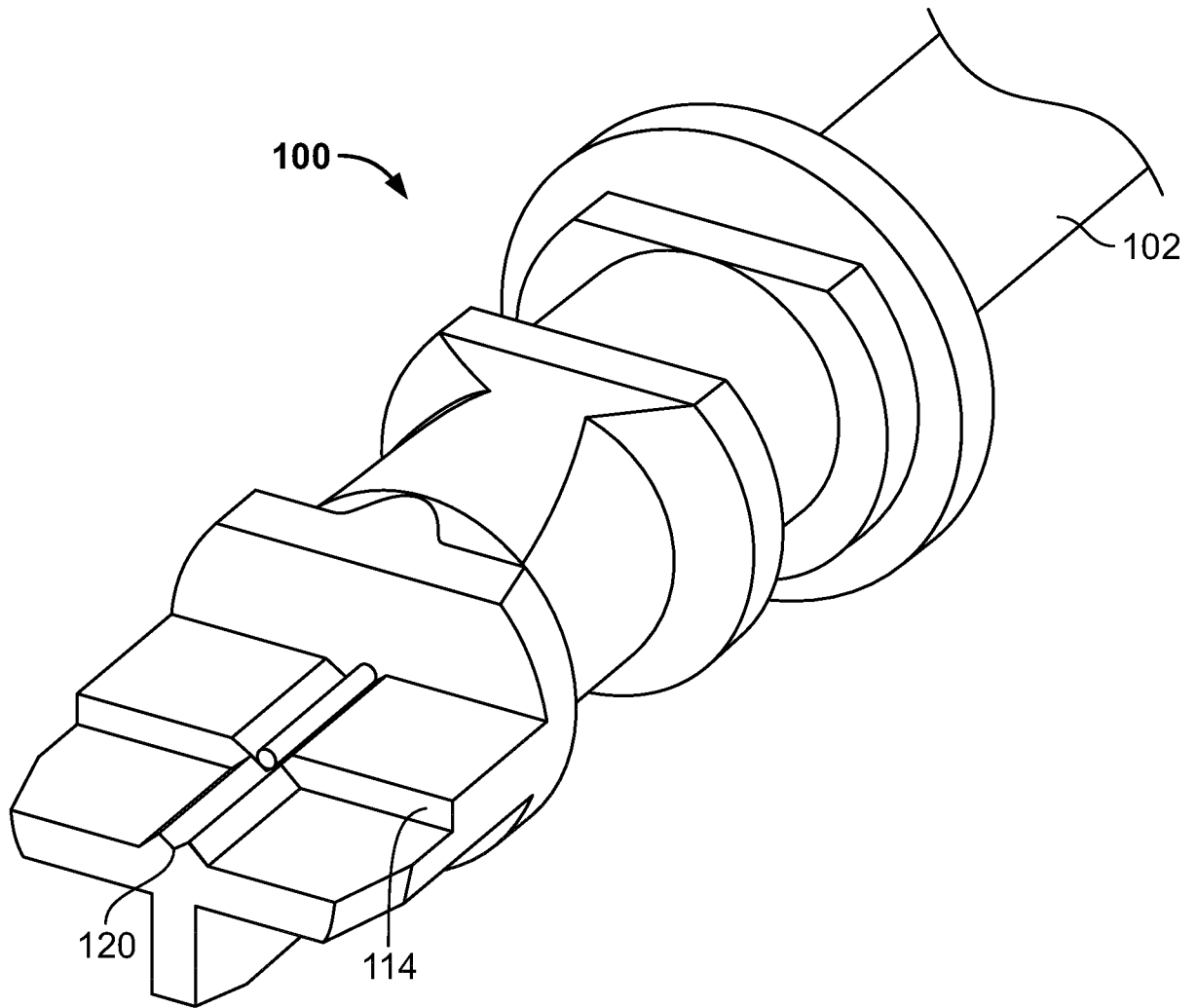


Fig. 1

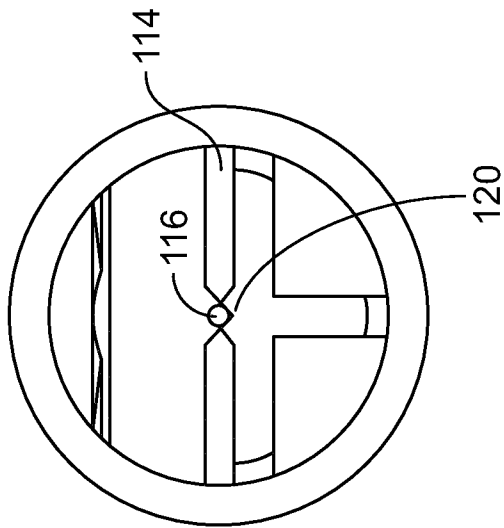


Fig. 3

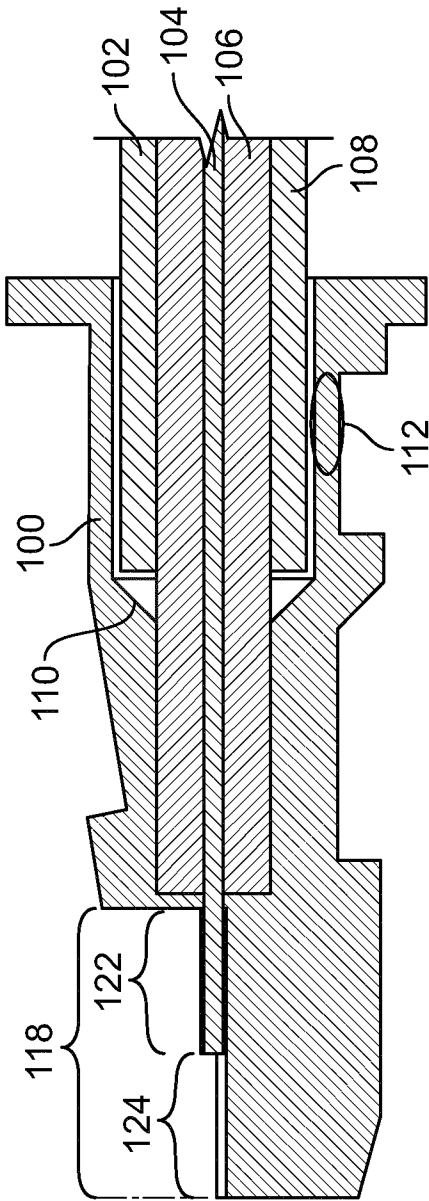


Fig. 2

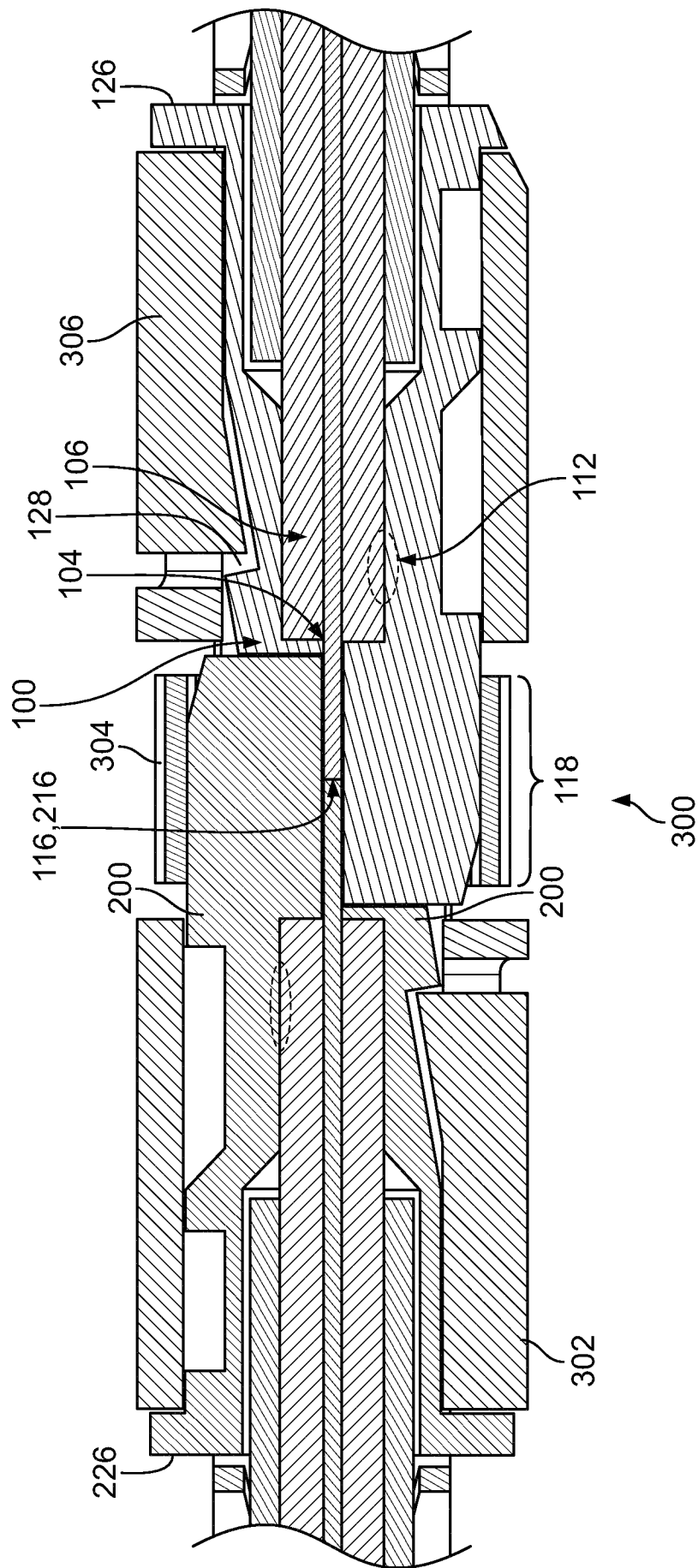


Fig. 4

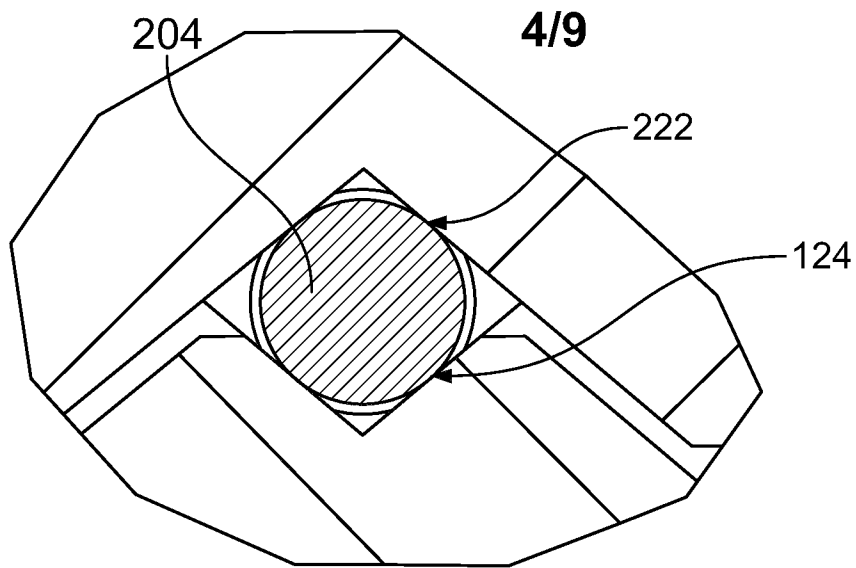


Fig. 5

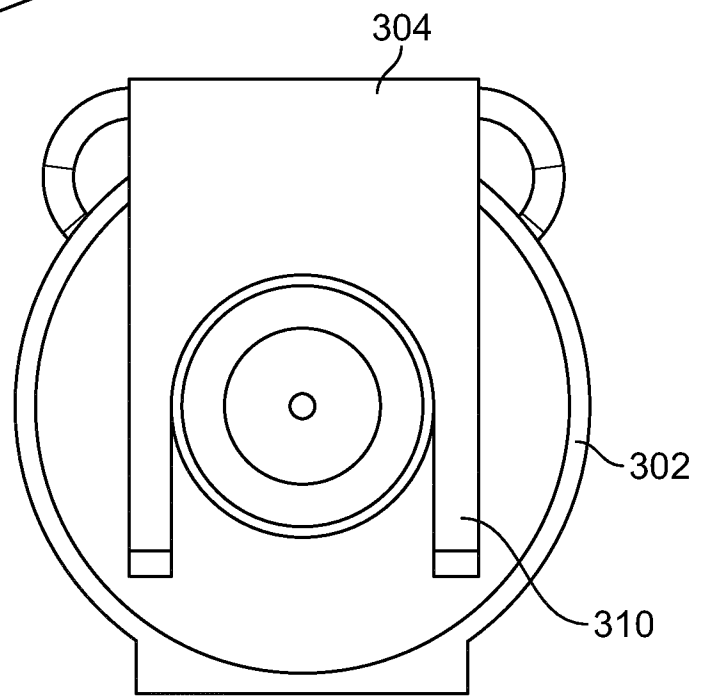


Fig. 6

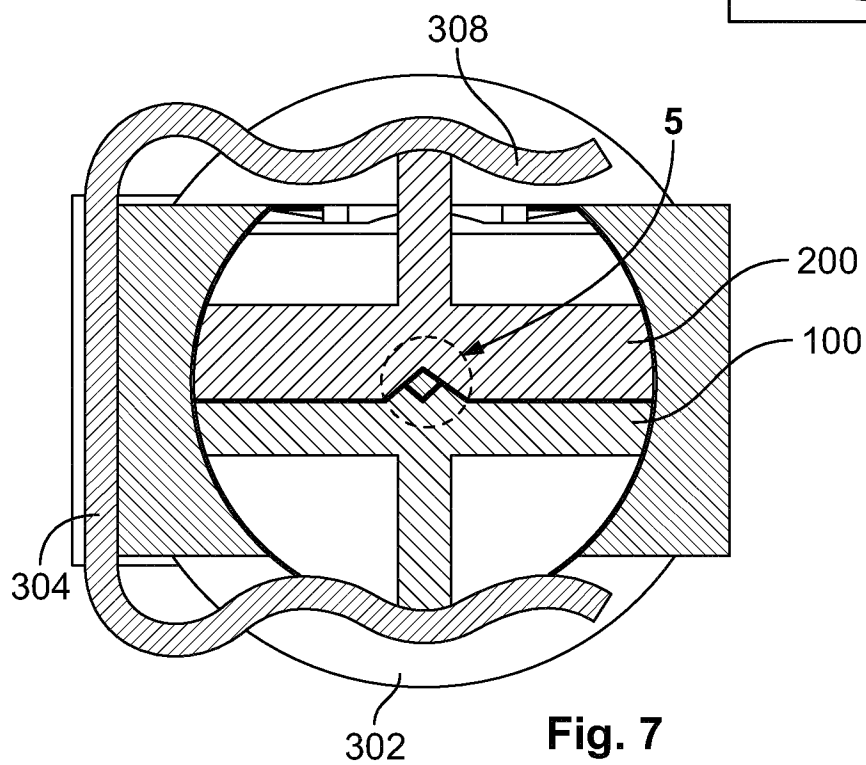
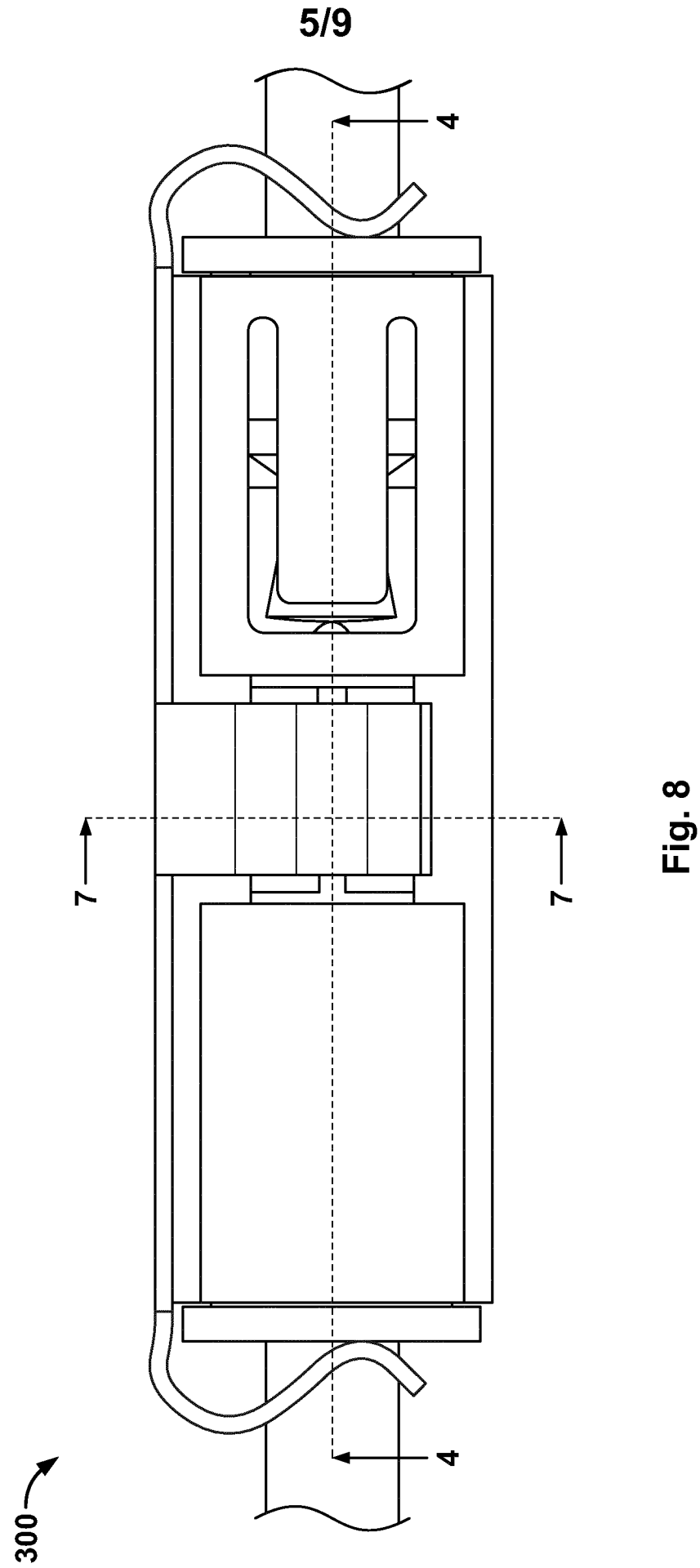


Fig. 7



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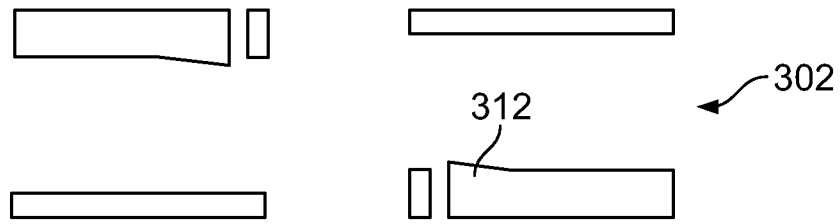


Fig. 9

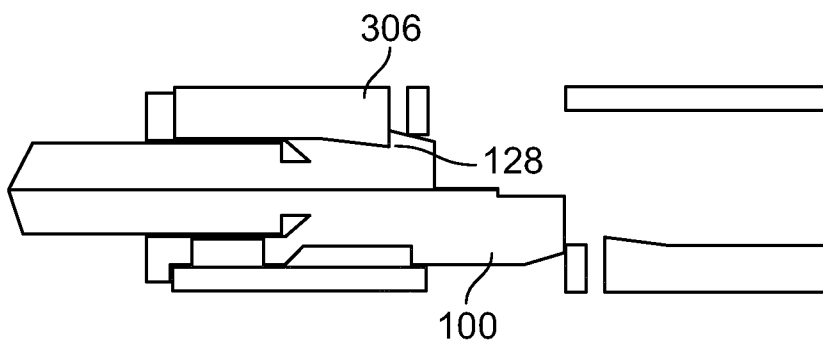


Fig. 10

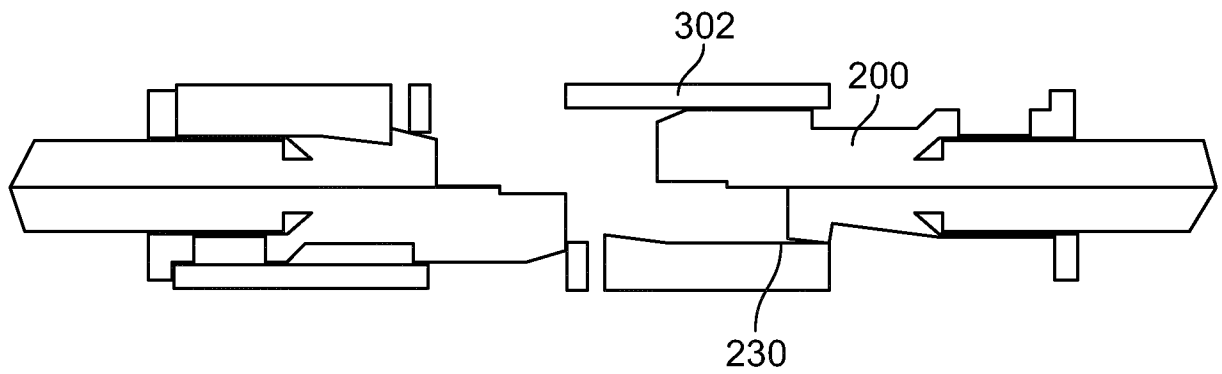


Fig. 11

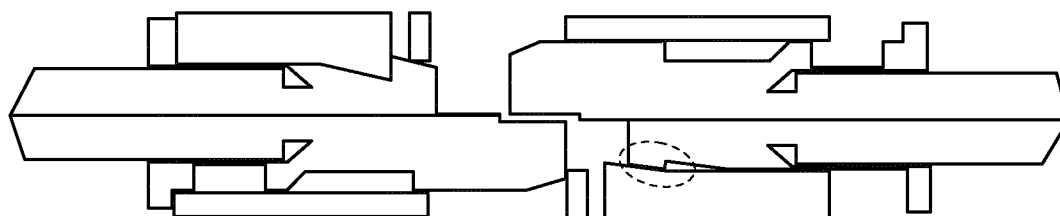


Fig. 12

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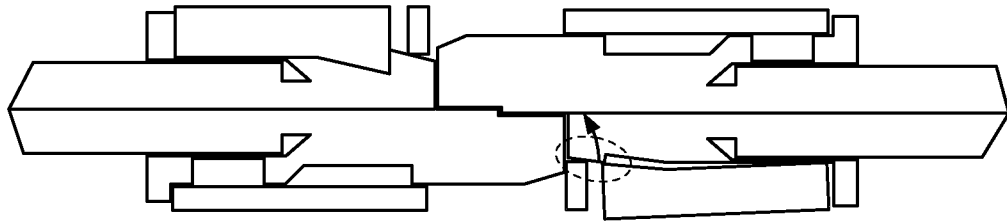


Fig. 13

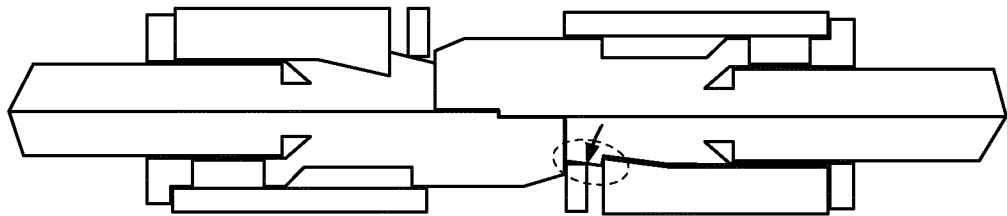


Fig. 14

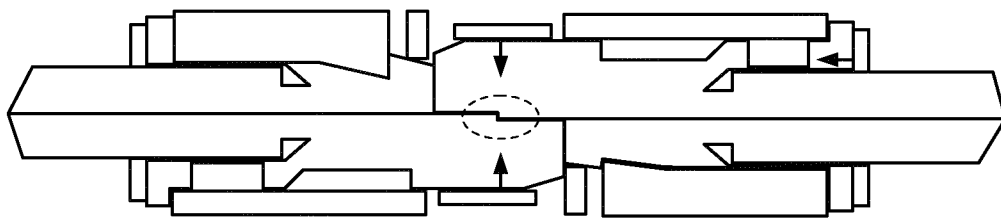


Fig. 15

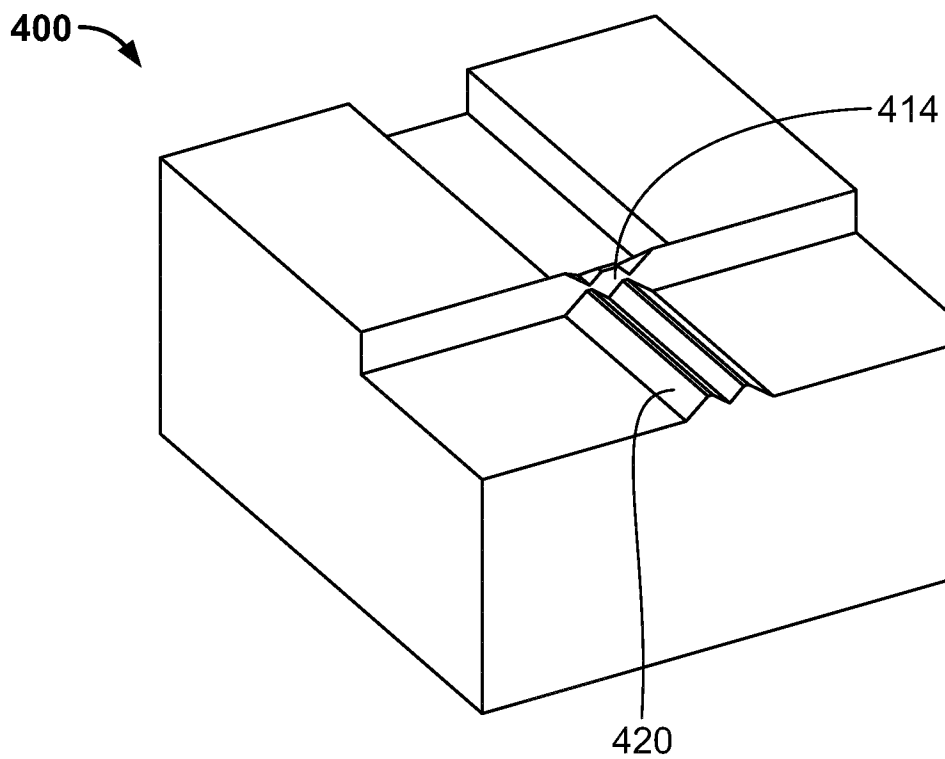


Fig. 16

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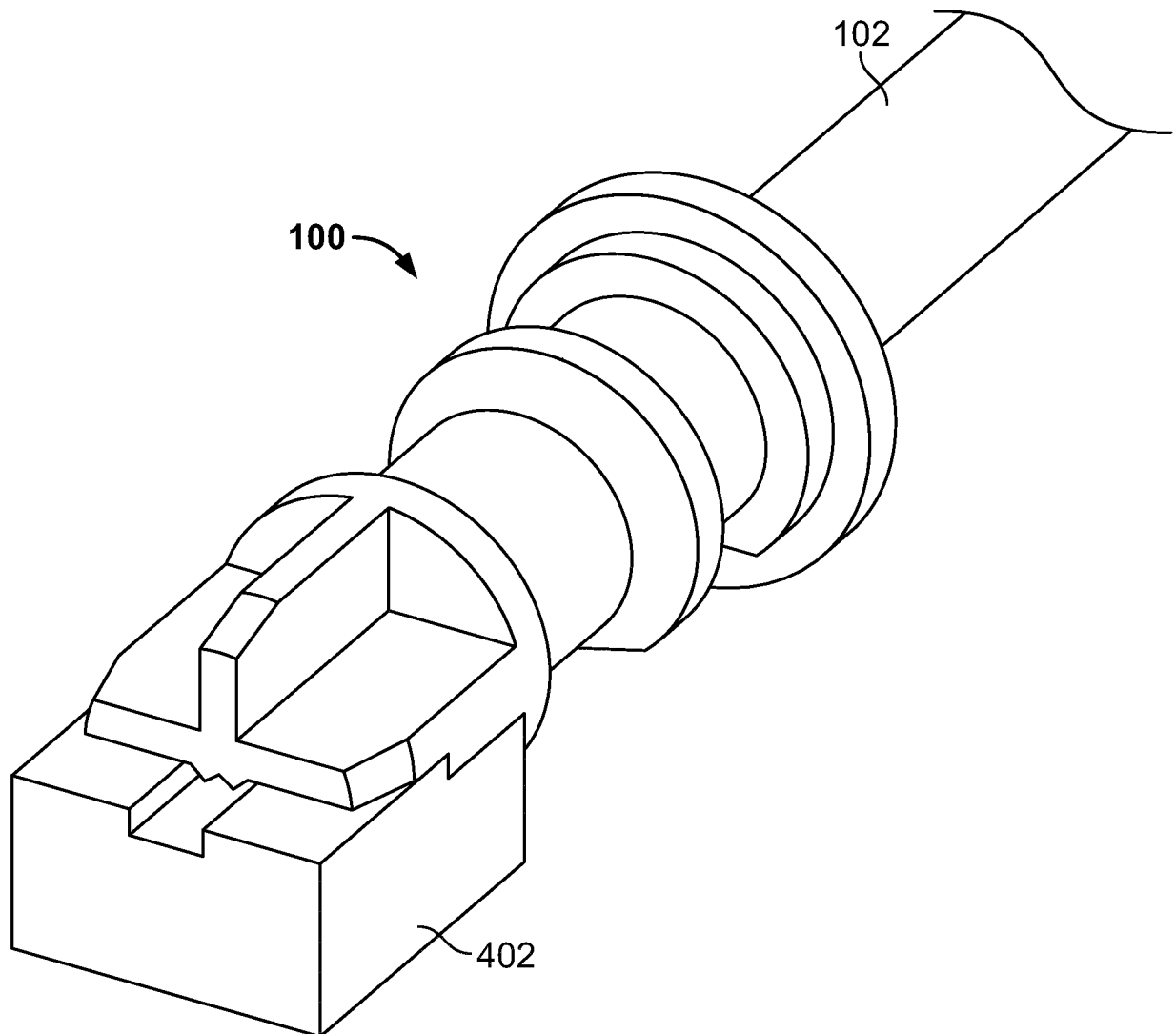


Fig. 17

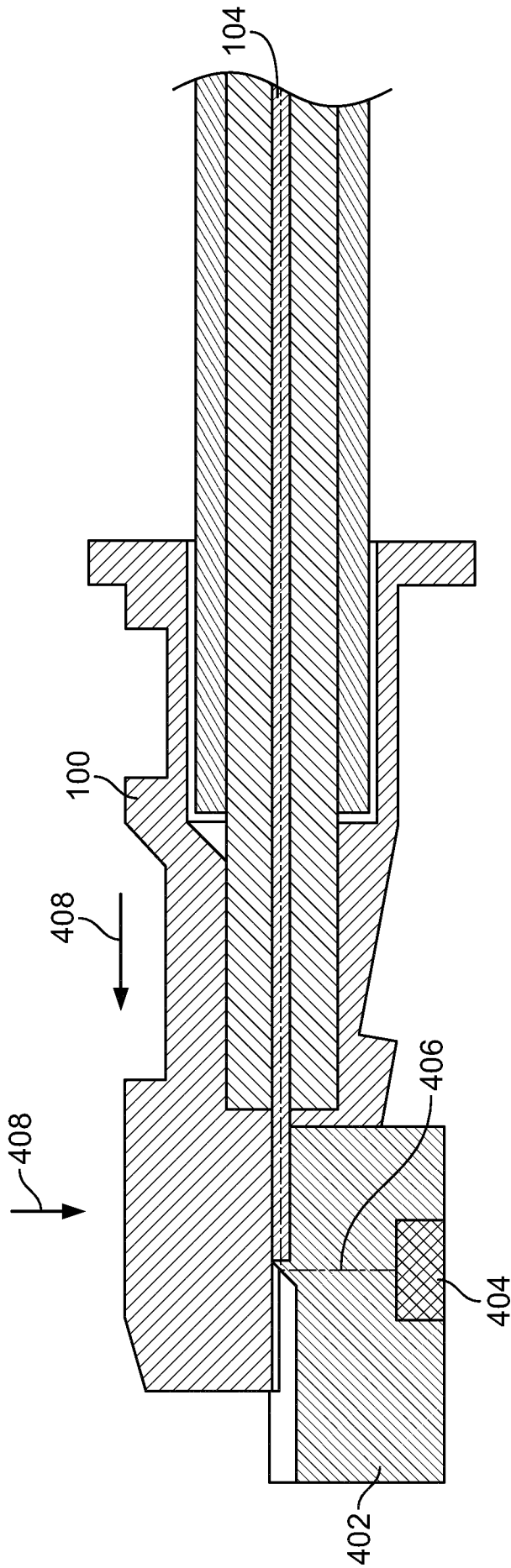


Fig. 18

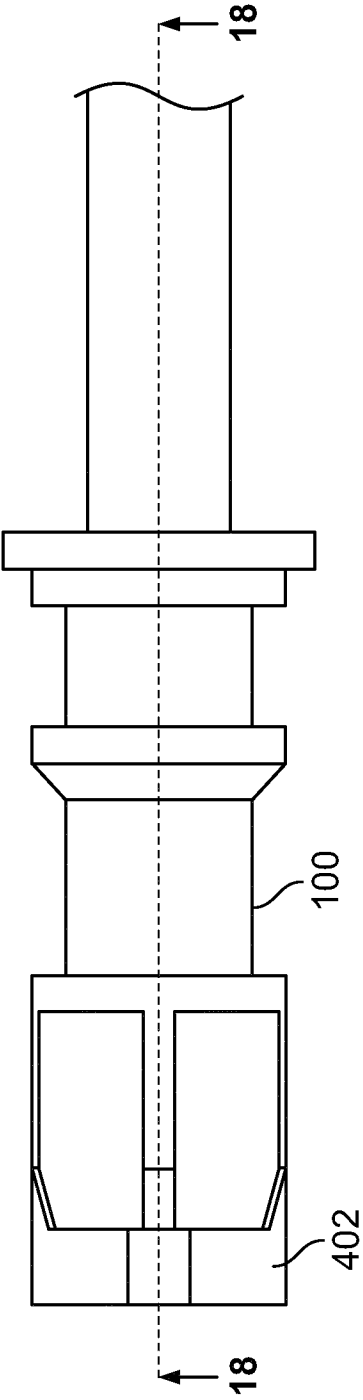


Fig. 19

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2012/055939

A. CLASSIFICATION OF SUBJECT MATTER

INV. G02B6/38

ADD. G02B6/42

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/128936 A1 (FAHRNBAUER BERNHARD [DE] ET AL) 10 July 2003 (2003-07-10) paragraph [0028] - paragraph [0032]; figures 1-3 paragraph [0036]; figure 6	1,10,11
X	US 2002/114582 A1 (OTERA SHOZO [JP]) 22 August 2002 (2002-08-22) paragraph [0037] - paragraph [0041]; figures 1-4 paragraphs [0048], [0054], [0055]; figures 5A-D figure 7	1-16
A	EP 1 380 867 A2 (TYCO ELECTRONICS AMP GMBH [DE]) 14 January 2004 (2004-01-14) paragraph [0027] - paragraph [0029] ----- -/-	1-16



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See patent family annex.

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Date of the actual completion of the international search

15 June 2012

Date of mailing of the international search report

22/06/2012

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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