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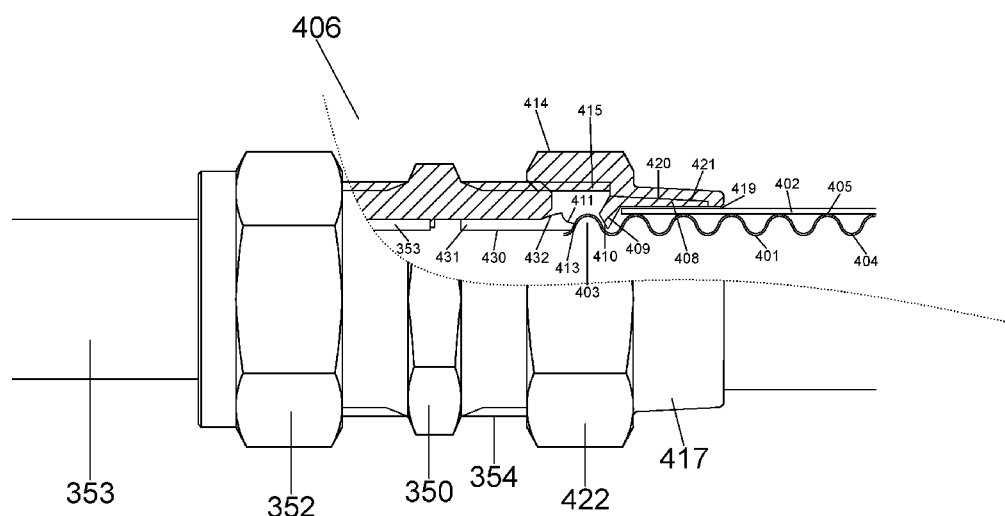


Fig 5B

(57) Abstract: An adapter sleeve (430) for connecting a compression fitting to a corrugated tubing (401) via an axial loading means, the adapter sleeve (430) comprising a cylindrical body portion (431) for at least partial reception in a mouth of the compression fitting, an annular protrusion (432) on an external surface of the cylindrical body (431) for abutting an edge of the mouth of the compression fitting and an abutment surface (411). The abutment surface (411) is adapted for the corrugated tubing (401) which is engagable with the axial loading means to contact thereon, and, being a frusto-conical or substantially frusto-conical surface, is co-axial with the cylindrical body (431) and angled so that the surface projects further from the cylindrical body along an axial direction as radial distance increases.

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Adapter Sleeve

Background:

The use of corrugated stainless steel tubing has become significantly more widespread for use in various plumbing situations, however due to the often high cost of fittings, usage is often limited to high value installations, such as gas plumbing or fire sprinkler drops. There is a wide range of known methods for connecting corrugated stainless steel tubing, a large number function by aiming to compress or deform the last corrugation/s into either a flattened or flared configuration that abuts against the fitting (or can abut a gasket or seal inside the fitting) and once tightened forms a seal with the fitting ("self flaring method").

One issue with the self-flaring method is how to align the tubing (and the anvil device used to compress the last corrugation/s – usually a split ring retainer or anvils) with the fitting so that the corrugation deforms in the correct way and is tightened into its desired position within the fitting. If the tubing, nut and anvil are tightened on the fitting body while the tubing is incorrectly aligned, for example coming in at steep angle, the last corrugation might not be compressed or deformed as intended and a proper seal might not be obtained.

Another issue with the self-flaring method is that known embodiments are often bulky, or require multiple machining steps. For a given tubing diameter, fittings manufactured to achieve a self-flaring compression of the last corrugation of corrugated stainless steel tubing, are significantly larger and heavier than comparable copper compression fittings. As copper compression fittings are extremely simple, with little machining required, they are significantly cheaper to produce than typical fittings made for corrugated stainless steel tubing that employ the self flaring method.

A known embodiment of the self-flaring method is disclosed by US5799989. In this embodiment the fitting includes a locating sleeve, a small sleeve extension of the internal bore inside the fitting and with a smaller diameter than the internal diameter of the tubing. As the nut, tubing, and anvil device (in this case split ring retainers) are tightened this locating sleeve enters inside the tubing and aligns the tubing with the fitting and ensures that the last corrugation is deformed in the correct part of the fitting. For example a piece of tube entering the fitting at an angle would be forced to properly align itself by the locating sleeve when being tightened. This embodiment includes a very small anvil/retainer split ring which does not provide any alignment of the corrugated stainless steel tubing. One disadvantage of this embodiment is that by use of a locating sleeve (with a smaller diameter than the tubing) fluid flow is more restricted than in embodiments that have a fluid passage that more closely matches the internal diameter of the tubing.

A further embodiment of the self-flaring method is disclosed by US 20050023832. This embodiment deforms the tubing between an axially flat leading edge or tube urging surface of the split retainer (collet) and an abutment surface which includes an elastomeric gasket. The split retainers and the internal bore of the fitting body, which together form opposing complementary axial flats, are of a sufficient length such that the tubing is correctly aligned as the fitting is tightened and therefore a locating sleeve is not required. One disadvantage of this embodiment is that as the split retainers are aligned within the fitting body, the fitting

body needs to be of a larger diameter than the previous embodiment for a given tubing diameter, as the fitting body must be big enough to receive the split retainers. A further disadvantage of this embodiment is that the tubing is urged towards the abutment surface by an axially flat leading edge, and does not have a tube urging surface which matches the profile of the corrugated stainless steel tubing.

5 An embodiment which used a collet/anvil axial loading means to deform one or more corrugations of corrugated stainless steel tubing against a point of localized pressure on the fitting body and in which the split retaining collets correctly aligned the tubing onto the abutment surface without significantly adding to the overall size and weight of the fitting vs. standard copper compression fittings used for hot/cold water would be desirable and advantageous.

10 An embodiment, which functioned as an adapter, such that corrugated stainless steel tubing could be connected to a standard copper compression fitting body used for hot/cold water, would be desirable and advantageous.

Statements of Invention

According to a first aspect of the present invention, there is provided an adapter sleeve for connecting a
15 compression fitting to a corrugated tubing via an axial loading means, the adapter sleeve comprising a cylindrical body portion for at least partial reception in a mouth of the compression fitting, an annular protrusion on an external surface of the cylindrical body portion for abutting an edge of the mouth of the compression fitting and an abutment surface, wherein the abutment surface is adapted for the corrugated tubing which is engagable with the axial loading means to contact thereon, and, being a frusto-conical or
20 substantially frusto-conical surface, is co-axial with the cylindrical body and angled so that the surface projects further from the cylindrical body along an axial direction as radial distance increases.

The annular protrusion of the adapter sleeve may include a sealing means.

The sealing means may include a plastics or rubber layer.

According to a second aspect of the invention, there is provided a kit of parts for connecting a length of
25 corrugated tubing to a compression fitting comprising the adapter sleeve in accordance with the first aspect of the present invention; and axial loading means operably connectable to the compression fitting, the axial loading means including a connector and a collet, the collet having a radially inward protruding clamping element for insertion into a trough of the corrugated tubing, the connector having a collet retaining means, so that, when the connector moves the collet into engagement with the compression fitting, the collet is fully
30 received and retained in the connector and causes the corrugated tubing to move onto the abutment surface of the adapter sleeve.

The connector may include a first axial extent and a second axial extent, a diameter of the first axial extent being larger than the diameter of the second axial extent and the second axial extent may be tapered so that its diameter reduces towards a distal end of the second axial extent.

35 The collet retaining means of the connector may include a frusto-conical inner surface.

The collet retaining means of the connector may include a radially inward protruding portion situated proximal to a distal end of the connector for engaging with a distal end of the collet.

The collet may have a tail portion receivable in the collet retaining means of the connector, the tail portion of the collet having a frusto-conical outer surface.

5 A wall thickness of the tail portion of the collet may decrease along an axial extent of the collet.

According to a third aspect of the present invention, there is provided a method of connecting a length of corrugated tubing having a plurality of corrugations, the method comprising placing a connector around the corrugated tubing; placing a collet partly over the corrugated tubing, a radially inward protruding clamping element of the collet protruding into a trough of the corrugated tubing, the collet being fully received within
10 the connector and retained in the connector by a collet retaining means of the connector; placing an adapter sleeve having the abutment surface into a compression fitting body, the adapter sleeve being retained at a distal end portion of the compression fitting body such that the abutment surface is available for the corrugated tubing to make contact thereon, the adapter sleeve and the compression fitting body forming a fitting; engaging the fitting including a fluid-flow passage with the connector; moving the fitting relative to
15 the connector so that the clamping element causes the corrugated tubing to contact the abutment surface of the fitting.

The connector may include a first axial extent and a second axial extent, a diameter of the first axial extent being larger than the diameter of the second axial extent.

The second axial extent may be tapered so that its diameter reduces towards a distal end of the second axial
20 extent.

The collet retaining means may include a frusto-conical inner surface of the connector.

The collet retaining means may include a radially inward protruding portion of the connector situated proximal to a distal end of the connector for engaging with a distal end of the collet.

The radially inward protruding portion may be an annular lip.

25 The collet may have a tail portion receivable in the collet retaining means of the connector.

The tail portion of the collet may have an external frusto-conical surface.

A wall thickness of tail portion of the collet may decrease along an axial extent of the collet.

A wall thickness of the second axial extent of the connector may decrease towards the distal end of the second axial extent.

30 A radially outwardly protruding portion proximal the distal end of the adapter sleeve may be engaged and retained on a corresponding portion at the distal end portion of the compression fitting body.

According to a fourth aspect, there is provided a connector assembly for a length of corrugated tubing having a plurality of corrugations, the connector assembly comprising: a fitting including a fluid-flow passage and an abutment surface for the corrugated tubing to seat thereon; axial loading means operably connectable to
35 the fitting, the axial loading means including a connector and a collet, the collet having a radially inward protruding clamping element for insertion into a trough of the corrugated tubing, the connector having a

collet retaining means, so that, when the connector moves the collet into engagement with the fitting, the collet is fully received and retained in the connector and causes the corrugated tubing to move onto the abutment surface.

The connector assembly allows a cut end of tubing to be finished, sealed and connected to other components as required. The fitting itself is for connecting to other components. In use, the connector and the fitting are connected together and house the collet between them, concealing the collet and axially loading the clamping element against the abutment surface, clamping at least one of the corrugations of the tubing therebetween. This creates a fluid seal. The fact that the collet is fully received in the connector provides a compact and tidy appearance and reduces material use. The collet retaining means hold the collet in the connector. The collet can freely move into and out of the connector in a proximal direction before the fitting is engaged with the connector. Once the fitting is engaged and tightened, the collet is tightly held between the fitting and the collet retaining means.

The connector may include a first axial extent and a second axial extent, a diameter of the first axial extent being larger than the diameter of the second axial extent.

The first axial extent allows the fitting to be accommodated, providing space for a screw-thread engagement between the fitting and the connector within the first axial extent. The second axial extent is for housing a portion, preferably the majority, of the collet. The second axial extent therefore does not need to be of large diameter.

The second axial extent may be tapered so that its diameter reduces towards a distal end of the second axial extent.

This allows tape, for example silicone tape, to be secured around the distal end of the second axial extent and secure it to the tubing, without requiring the tape to bridge a large gap.

A wall thickness of the second axial extent of the connector may decrease towards the distal end of the second axial extent. This reduces material use, provides a more compact design and reduces the size of the gap to be bridged by any tape.

The collet retaining means of the connector may include a frusto-conical inner surface. This allows the collet to be held within the connector and makes it easier to insert the collet into the connector, as the collet is inserted at a proximal end of the connector which will have a relatively large opening. This is especially advantageous where the collet is a split collet and may not be perfectly aligned.

The collet retaining means of the connector may include a radially inward protruding portion situated proximal to a distal end of the connector for engaging with a distal end of the collet. This provides a barrier that prevents the collet exiting a distal end of the connector.

The radially inward protruding portion may be an annular lip.

The collet may have a tail portion receivable in the collet retaining means of the connector. The tail portion provides structural integrity to the collet and provides a link between the clamping element and the connector.

The tail portion of the collet may have a frusto-conical outer surface. This is for engaging in a complimentary manner with the frusto-conical surface of the connector, providing similar advantages.

A wall thickness of the tail portion of the collet may decrease along an axial extent of the collet.

The abutment surface may be frusto-conical or substantially frusto-conical so that the surface projects further from the fitting along an axial direction as radial distance increases. This causes the corrugation of the tubing to be deformed into a flare when compressed between the abutment surface and the clamping element of the collet.

The connector assembly may further comprise a sealing element positionable between the fitting and the in-use corrugated tubing.

The sealing element may be engageable with a peak of the corrugations of the in use corrugated tubing.

The sealing element may be compressible.

The sealing element may be positioned adjacent the abutment surface.

The fitting may include a fitting body providing the fluid-flow passage and an adapter sleeve having the abutment surface at its distal end, the adapter sleeve sized to be receivable into the fitting body and shaped to be retainable at a distal end portion of the fitting body, such that, in use, the abutment surface is available for the corrugated tubing to make contact thereon.

That is, the abutment surface may be provided on a separate adapter sleeve, insertable into the fitting body. This allows fitting bodies to be provided that can serve either as conventional copper compression fittings or as fittings according to the invention, providing flexibility to users.

The adapter sleeve may further comprise a radially outwardly protruding portion proximal the distal end for engaging with a corresponding portion at the distal end portion of the fitting body. This prevents the adapter sleeve from sliding further into the fitting body than intended.

The radially outwardly protruding portion of the adapter sleeve may include a sealing means. It will be understood that a seal is provided between the tubing and the adapter sleeve by way of a crimped end corrugation of the tubing, clamped between the collet and the adapter sleeve, but providing a seal between the adapter sleeve and the fitting ensures that the entire fluid flow path is sealed against leaks.

The sealing means may include a plastics or rubber layer. This provides a resilient seat for forming the seal against.

The connector assembly may be provided in the form of a kit of parts.

According to a fifth aspect, there is provided an adapter sleeve for a compression fitting comprising a cylindrical body portion for at least partial reception in a mouth of the compression fitting, an annular protrusion on an external surface of the cylindrical body for abutting an edge of the mouth and an abutment surface, the abutment surface being a frusto-conical or substantially frusto-conical surface, co-axial with the cylindrical body and angled so that the surface projects further from the cylindrical body along an axial direction as radial distance increases.

The adapter sleeve allows a standard copper compression fitting or other fitting to be converted for use with a connector and collet according to the fourth aspect. The cylindrical body portion is inserted into the fitting and is held there by contact with side walls of a fluid channel of the fitting. The annular protrusion holds the adapter sleeve in the fitting and prevents it from sliding further into the fitting than intended. The abutment surface, in use, contacts a deformed corrugation of a length of tubing. The length of tubing is clamped to the abutment surface by a collet loaded against the fitting, forming a seal on the abutment surface.

The annular protrusion of the adapter sleeve may include a sealing means.

The sealing means may include a plastics or rubber layer.

According to a sixth aspect, there is provided a kit of parts for connecting a length of corrugated tubing to a fitting comprising: an adapter sleeve according to the fifth aspect; and axial loading means operably connectable to the fitting, the axial loading means including a connector and a collet, the collet having a radially inward protruding clamping element for insertion into a trough of the corrugated tubing, the connector having a collet retaining means, so that, when the connector moves the collet into engagement with the fitting, the collet is fully received and retained in the connector and causes the corrugated tubing to move onto the abutment surface of the adapter sleeve.

The kit allows a standard fitting such as a copper compression fitting to be connected to a length of corrugated tubing in a secure, compact and fluid-tight manner.

According to a seventh aspect, there is provided a method of connecting a length of corrugated tubing having a plurality of corrugations, the method comprising: placing a connector around the corrugated tubing; placing a collet partly over the corrugated tubing, a radially inward protruding clamping element of the collet protruding into a trough of the corrugated tubing, the collet being fully received within the connector and retained in the connector by a collet retaining means of the connector; engaging a fitting including a fluid-flow passage with the connector; moving the fitting relative to the connector so that the clamping element causes the corrugated tubing to contact an abutment surface of the fitting.

The method allows a length of corrugated tubing to be connected to a fitting in a secure, compact and fluid tight manner. Accommodation of the collet within the connector provides a more axially compact design and reduces material use.

The connector may include a first axial extent and a second axial extent, a diameter of the first axial extent being larger than the diameter of the second axial extent.

The second axial extent may be tapered so that its diameter reduces towards a distal end of the second axial extent.

The collet retaining means may include a frusto-conical inner surface of the connector.

The collet retaining means may include a radially inward protruding portion of the connector situated proximal to a distal end of the connector for engaging with a distal end of the collet.

The radially inward protruding portion may be an annular lip.

The collet may have a tail portion receivable in the collet retaining means of the connector. The tail portion may have an external frusto-conical surface.

A wall thickness of the tail portion of the collet may decrease along an axial extent of the collet.

A wall thickness of the second axial extent of the connector may decrease towards the distal end of the second axial extent.

Prior to engaging the fitting including a fluid-flow passage with the connector, the method may further comprise the step of: placing an adapter sleeve having the abutment surface into a fitting body, the adapter sleeve being retained at a distal end portion of the fitting body such that the abutment surface is available for the corrugated tubing to make contact thereon, the adapter sleeve and the fitting body forming the fitting.

A radially outwardly protruding portion proximal the distal end of the adapter sleeve may be engaged and retained on a corresponding portion at the distal end portion of the fitting body.

Description of the Invention

In order that the invention may be better understood, the invention will now be more particularly described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a partially cross-sectional side view of a prior art reinforced corrugated stainless steel tubing;

Figure 2A shows a partially cross-sectional side view of a first embodiment of a connector assembly in a disassembled state around the tubing of Figure 1, in accordance with a fourth and seventh aspect;

Figure 2B shows a partially cross-sectional side view of the connector assembly of Figure 2A in a partially assembled state;

Figure 2C shows a partially cross-sectional side view of the connector assembly of Figure 2A in a fully assembled state;

Figure 2D shows a cross-sectional side view of a part of the connector assembly of Figure 2A in a fully assembled state;

Figure 3A shows a partially cross-sectional side view of a second embodiment of a connector assembly in a disassembled state around the tubing of Figure 1, in accordance with the fourth and seventh aspect;

Figure 3B shows a partially cross-sectional side view of the connector assembly of Figure 3A in a partially assembled state;

Figure 3C shows a partially cross-sectional side view of the connector assembly of Figure 3A in a fully assembled state;

Figure 3D shows a cross-sectional side view of a part of the connector assembly of Figure 3A in a fully assembled state;

Figure 4 shows a partially cross-sectional side view of a prior art copper compression fitting;

Figure 5A shows a partially cross-sectional side view of a third embodiment of a connector assembly incorporating the prior art copper compression fitting of Figure 4 in a disassembled state around the tubing of Figure 1, in accordance with the first, second and third aspects of the invention;

Figure 5B shows a partially cross-sectional side view of the connector assembly of Figure 5A in a partially assembled state; and

Figure 5C shows a partially cross-sectional side view of the connector assembly of Figure 5A in a fully assembled state.

Throughout this description proximal refers to a point, location or direction closer to or towards the fitting body and distal refers to a point, location or direction further from or away from the fitting body.

Referring to Figure 1, there is shown a corrugated tubing segment consisting of corrugated stainless steel tubing 1 and optionally a plastic cover 2, as typically seen in prior art. Corrugated stainless steel tubing 1 is made from a thin sheet of stainless steel formed into a series of circumferential corrugations 3. Each corrugation may consist of a circumferential valley or trough 4, and a circumferential peak or ridge 5. If the tubing 1 includes a plastic cover 2, a portion of it may be removed using a utility knife so as to expose the corrugations 3 on which a connection can be made.

The embodiment shown in Figures 2A-2D, shows a predominantly cylindrical connector assembly 6. In use the connector assembly shown is a Male fitting and has one connection for attaching a length of corrugated tubing and a male thread for engagement with a female thread of some other fitting or appliance. It is understood that many other combinations could also be made, such as female, tee, reducing union etc.

The connector assembly 6 comprises a fitting or fitting body 7, a split collet 8, which here further comprises at least one retaining finger or radially inward protruding clamping element 9 which protrudes into the last valley or trough 4 on a cut length of corrugated tubing 1, and which includes at least one tube urging surface 10 which closely matches the profile of the corrugated tubing 1. The fitting 7 includes a fluid flow passage and a sealing face surface for the corrugated tubing to seat thereon. The sealing face surface includes an abutment surface 11. The abutment surface 11 is preferably angled towards the collet and away from the fitting along an axial direction as radial distance increases. It is frusto-conical or substantially frusto-conical. The sealing face surface includes an annular groove 12 which includes a compressible gasket such as an o-ring. Where the annular groove 12 meets the abutment surface 11 a sharp edge 13 is formed. The connector assembly further comprises a drivable element nut or connector 14 which includes a first engagement element, here an interior female thread 15 which is engageable with a second engagement element, here an exterior male thread 16 radially extending around the outside of the fitting body 7. The collet and the connector collectively provide axial loading means operably connectable to the fitting.

The connector also preferably includes a collet retaining means 21. The collet retaining means of the connector preferably include a frusto-conical inner surface and a radially inward protruding portion of the connector situated proximal to a distal end of the connector for engaging with a distal end of the collet 8. The radially protruding inward portion is preferably an annular lip.

The connector 14 preferably includes a first axial extent 22 and a second axial extent 17 (left and right parts respectively as viewed in the drawings). The diameter of the first axial extent is preferably larger than the diameter of the second axial extent. The second axial extent is preferably tapered so that its diameter reduces towards a distal end of the second axial extent. A wall thickness of the second axial extent 17 of the connector 14 preferably decreases towards the distal end of the second axial extent.

The collet 8 preferably has a frusto-conical outer surface 20. The collet preferably has a collet tail portion 20 receivable in the collet retaining means 21 of the connector 14. In this embodiment the frusto-conical outer surface 20 is the outer surface of the tail portion and is for engaging with the frusto-conical inner surface 21 of the connector 14. A wall thickness of the tail portion of the collet 8 preferably decreases along an axial extent of the collet.

Figure 2A depicts the components of the connector assembly being prepared for the attachment of the connector assembly 6 to the corrugated tubing 1. Firstly, the corrugated tubing 1 is cut using a metal wheel pipe cutter. The drivable nut or connector 14 is then put onto the corrugated tubing 1 before part of the plastic cover 2 is removed by peeling a small section off by hand or by using a utility knife so as to expose a number of corrugations 3. The collet 8 is then assembled so that its retaining finger 9 sits in the valley 4 of the last corrugation 3 of the corrugated tubing 1.

The drivable nut connector 14 includes a collet retaining means 21, preferably in a form of a tapered tail portion of the second axial extent 17 which advantageously provides a neat circumferential exterior surface 18 on which silicone tape can be applied such that the small gap 19 between the second axial extent 17 and the plastic cover 2 can be sealed with silicone tape and prevent corrosion, as is required by some installation standards. Advantageously, as this second axial extent 17 is thin walled, it does not add much weight or material to the overall connector assembly, and from a manufacturing point of view is a cheap additional feature to add to the connector assembly.

The drivable nut connector 14 is then pulled over the split collet 8. Advantageously, the split collet 8 includes a collet tail portion having a frusto-conical surface 20 which matches a frusto-conical collet retaining means surface 21 on the inside of the tail portion of the second axial extent 17 of the drivable nut connector 14. This feature allows the connector 14 to be pulled over the collet 8 more easily, as the distal end of the split collet 8 has a smaller diameter than the proximal end of the frusto conical collet retaining means surface 21.

Advantageously, the majority of the collet 8 is encapsulated within the second axial extent 17 of the connector 14. In other words, the collet is fully received and retained in the connector. Therefore the overall size of the hex part or first axial extent 22 of the connector 14, and the fitting body 7 are not affected by, and do not need to increase in size or shape, due to the length or size of the collet. Further, no machining inside the fitting body 8 is required to accommodate the collet. As the collet 8 is encapsulated by the second axial extent 17, the fitting body 7 and the hex part first axial extent 22 of the connector 14 are largely indistinguishable in size and external shape (and therefore manufacturing cost) from a standard copper

compression fitting, which are widely available in the market and depicted in Fig 4. Increasing the length of the collet 8, which aids in better alignment of the corrugated tubing 1 with the abutment surface 11 and the fitting body 7, would only add a marginal cost to each connector assembly, as it is only the tail portion of the second axial extent 17 of the connector 14 which would need to increase in length rather than the overall length or shape of the entire connector assembly 6.

Advantageously, the profile of the second axial extent 17 of the connector 14, largely follows the same profile as the frusto-conical collet retaining means surface 21, thus further saving on material.

The assembled collet 8, drivable nut connector 14 and corrugated tubing 1 are then partially assembled to the fitting body 7 as depicted in Fig 2B. Initially the connector 14 is tightened onto the fitting body 7 by finger tightening as the male 16 and female 15 threads will mate without resistance. As the connector 14 is further tightened onto the fitting body 7 the un-deformed corrugated tubing 1 will abut the abutment surface 11 of the fitting body 7 causing resistance to increase. At this point further tightening must be done by the use of a rotational tool, such as two wrenches or spanners, which engages with the connector 14 and fitting body 7. As torque is applied to the connector and the fitting body, the last corrugation 4 of the corrugated tubing 1 will start to deform and flatten.

Advantageously, the unique geometry of the abutment surface 11, sharp edge 13 and the tube urging surface 10 of the clamping element 9 of the split collet 8 ensures that a point of higher localized pressure is achieved and in which both a seal between the corrugated tubing 1 and the fitting body 7, and the corrugated tubing 1 and the O ring happen at desirable locations.

As the connector assembly is tightened, the last peak 5 of the corrugated tubing 1 will start to flatten and will eventually be urged past the axial plane of the abutment surface 11 and into the annular groove 12 formally occupied by the O ring. Additionally, as the tube urging surface 10 urges the corrugated tubing 1 past the axial plane of the abutment surface 11, the geometry of this sharp edge 13 in relation to the tube urging surface 10 of the split collet 8 is such that the sharp edge 13 is perpendicular to the tube urging face 10 of the split collet. Preferably the sharp edge 13 is exactly perpendicular to the tube urging face 10.

Figure 2C depicts the connector assembly in its final assembled position, and where a seal has been obtained against two different materials. The last corrugation of the corrugated tubing 1 has been deformed into a flattened and flared configuration and which is clamped between the sharp edge 13 of the abutment surface 11 and the tube urging surface 10 of the collet 8. Additionally, the peak of the corrugation is aligned with an O-ring, which provides a secondary seal. Advantageously, the sharp edge 13 is aligned such that it is perpendicular to the tube urging surface as depicted in Fig 2D. Additionally, this sharp edge 13 is aligned such that the point of localised pressure is exactly halfway between the peak 5 and valley 4 of the tubing corrugation 3.

The connector assembly need not include an O ring or an annular groove on its sealing surface, but instead may include a raised rim, to provide a point of localized pressure at which a seal may be obtained, but while still employing the same advantageous geometry of the first embodiment. The embodiment shown

in Figures 3A to 3D, show a predominantly cylindrical connector assembly 206. In use the connector assembly shown is a Male fitting and has one connection for attaching a length of corrugated tubing and a male thread for engagement with a female thread of some other fitting or appliance. It is understood that many other combinations could also be made, such as female, tee, reducing union etc.

5 The connector assembly 206 comprises a fitting body or fitting 207, a split collet 208, which here further comprises at least one retaining finger or radially inward protruding clamping element 209 which protrudes into the last valley or trough 204 on a cut length of corrugated tubing 201, and which includes at least one tube urging surface 210. The connector assembly 208 further includes a sealing face surface which here includes an abutment surface 211 and a raised rim 213. The connector assembly further comprises a
10 drivable element nut or connector 214 which includes a first engagement element, here an interior female thread 215 which is engageable with a second engagement element, here an exterior male thread 216 radially extending around the outside of the fitting body 207.

Figure 3A depicts the components of the connector assembly being prepared for the attachment of the connector assembly 206 to the corrugated tubing 201. Firstly, the corrugated tubing 201 is cut using a
15 metal wheel pipe cutter. The drivable nut connector 214 is then put onto the corrugated tubing 201 before part of the plastic cover 202 is removed by peeling a small section off by hand or by using a utility knife so as to expose a number of corrugations 203. The split collet 208 is then assembled so that its retaining finger 209 sits in the valley 204 of the last corrugation 203 of the corrugated tubing 201.

The connector 214 includes a collet retaining means, preferably in a form of a tapered tail portion of
20 the second axial extent 217 which advantageously provides a neat circumferential exterior surface 218 on which silicone tape can be applied such that the small gap 219 between the second axial extent 217 and the plastic cover 202 can be sealed with silicone tape and prevent corrosion, as is required by some installation standards. Advantageously, as this tail portion of the second axial extent 217 has a thin wall thickness, it does not add much weight or material to the overall connector assembly, and from a manufacturing point of
25 view is a cheap additional feature to add to the connector assembly.

The drivable nut connector 214 is then pulled over the split collet 208. Advantageously, the split collet 208 includes a collet tail portion having a frusto-conical surface 220 which matches an frusto-conical collet retaining means surface 221 on the inside of the second axial extent 217 of the connector 214. This feature allows the connector 214 to be pulled over the collet 208 more easily, as the distal end of the split
30 collet 208 has a smaller diameter than the proximal end of the frusto conical collet retaining means surface 221 on the inside of the second axial extent 217.

Advantageously, the majority of the split collet 208 is encapsulated within the second axial extent 217 of the connector 214. In other words, the collet is fully received and retained in the connector. Therefore the overall size of the hex part or first axial extent 222 of the connector 214, and the fitting body 207 are not
35 affected, and do not need to increase in size or shape, due to the length or size of the split collet 208. Further, no machining inside the fitting body 208 is required to accommodate the collet. As the split collet 208 is

incorporated into the additional tail portion of the second axial extent 217, the fitting body 207 and the hex part or first axial extent 222 of the connector 214 would be largely indistinguishable in size and external shape (and therefore manufacturing cost) from a standard copper compression fitting, which are widely available in the market and depicted in Fig 4. Increasing the length of the collet 208, or the tail portion of the collet, which would aid in providing better alignment of the corrugated tubing 201 with the abutment surface 211 and the fitting body 201, would only add a marginal cost to each connector assembly, as it is only the tail portion of the second axial extent 217 of the connector 214 which would need to increase rather than the overall length or size of the connector assembly 206.

Advantageously, the profile of the second axial extent 217 of the connector 214, largely follows the same profile as the frusto-conical collet retaining means surface 221, thus further saving on material.

The assembled collet 208, drivable nut connector 214 and corrugated tubing 201 are then partially assembled to the fitting body 207 as depicted in Fig 3B. Initially the connector 214 is tightened onto the fitting body 207 by finger tightening as the male 216 and female 215 threads will mate without resistance. As the connector 214 is further tightened onto the fitting body 207 the un-deformed corrugated tubing 201 will abut the abutment surface 211 of the fitting body 207 causing resistance to increase. At this point further tightening must be done by the use of a rotational tool, such as two wrenches or spanners, which engages with the connector 214 and fitting body 207. As torque is applied to the connector and the fitting body, the last corrugation 204 of the corrugated tubing 201 will start to deform and flatten.

Advantageously, the unique geometry around the abutment surface 211, raised rim 213 and the tube urging surface 210 of the split collet 208 ensures that a point of higher localized pressure is achieved and in which both a seal between the corrugated tubing 201 and the fitting body 207 happens at a desirable location.

As the connector assembly is tightened, the last peak 205 of the corrugation will start to flatten and will eventually be urged past the raised rim 213.

Additionally, as the tube urging surface 210 urges the corrugated tubing 201 past the raised rim 213, the geometry of this raised rim 213 in relation to the tube urging surface 210 of the split collet 208 is such that the sharp edge of the raised rim 213 is perpendicular to the tube urging face 210 of the split collet. Preferably the geometry is such that the sharp edge of the raised rim is exactly perpendicular to the tube urging face 210.

Figure 3C depicts the connector assembly in its final assembled position, and where a seal has been obtained. The last corrugation 203 of the corrugated tubing 201 has been deformed into a flattened and flared configuration and which is clamped between the raised rim 213 of the abutment surface 211 and the tube urging surface 210 of the clamping element 209 of the retaining means 208. Advantageously, the raised rim 213 is aligned such that it is perpendicular to the tube urging surface 210 as depicted in Fig 3D. Additionally, this raised rim 213 is aligned such that the point of localised pressure is exactly halfway between the peak 205 and valley 204 of the tubing corrugation 203.

One of the benefits of the above two embodiments is the similarity in machining, weight, shape and size with copper compression fittings widely available, and thus the similarity in manufacturing costs. Advantageously, due to the similarity between the first two embodiments and copper compression fittings, a third embodiment of the invention is shown in Fig 5 in which a length of corrugated tubing can be attached to a standard copper compression fitting body, by way of an adapter sleeve.

Fig 4 depicts a standard copper compression fitting, as is widely available. It consists of a fitting body 350, a compression sleeve 351, and a drivable nut 352. The copper tubing 353 is inserted into the fitting body and as the rest of the components of the compression fitting are tightened into place, a seal is formed between the fitting body 350 and the compression sleeve 351, such that a fluid tight seal is achieved.

The embodiment shown in Figures 5A to 5C, in accordance with the present invention, shows a corrugated tubing connector assembly 406 in which the fitting body has been replaced by the fitting body of a standard copper compression fitting. In use the copper compression fitting body shown is a Union fitting where one connection is being used, by way of an adapter sleeve, for attaching a length of corrugated tubing and another connection being used to attach to a length of copper tubing as is typical for this type of fitting. Advantageously this embodiment allows an installer to connect a length of corrugated stainless steel tubing to any fitting body designed to be compatible with standard copper tube.

The connector assembly 406 comprises the same collet 408, and drivable nut or connector 414 (with the same features) as the first two embodiments, however the fitting body is instead replaced with a standard copper compression fitting body 350. The connector assembly 406, also includes an adapter sleeve 430 which allows the retaining collet 408, drivable nut connector 414 and corrugated tubing 401 to be attached to a standard copper compression body 350. The adapter sleeve 430 includes a cylindrical body portion 431 which matches the outside diameter of copper tube available in a given market, for example in the UK 15mm, 22mm, 28mm, 35mm or in the USA $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ ", $\frac{7}{8}$ ", $1\frac{1}{8}$ ", $1\frac{3}{8}$ ", $1\frac{5}{8}$ ". The adapter sleeve also includes a contoured section 432 that roughly matches the contour and shape of the proximal end of a copper compression sleeve 351. The adapter sleeve 430 further includes a sealing face abutment surface 411 which here includes a raised rim 413. The adapter sleeve 430 is sized to be receivable into the fitting body 350 and shaped to be retainable at a distal end portion of the fitting body 350, such that, in use, the abutment surface 411 is available for the corrugated tubing to make contact thereon.

The abutment surface 411 is preferably a frusto-conical surface, co-axial with the cylindrical body and angled so that the surface projects further from the cylindrical body along an axial direction as radial distance increases.

The adapter sleeve 430 further may comprise a radially outwardly protruding portion proximal the distal end for engaging with a corresponding portion at the distal end portion of the fitting body 350. The radially outwardly protruding portion of the adapter sleeve 430 may include a sealing means including a plastics or rubber layer.

Advantageously, the connector 414 is manufactured with a female thread 415 which is matable with the male thread 354 typically found on copper compression fitting bodies. In a given market this exterior male thread is typically standardised and similar across multiple manufacturers, or may instead be specified by a national standard such as EN 1254. Typical sizes for the male external thread 354 of a copper compression body 350 are M22, M28, M35, M42 & M48.

Figure 5A depicts the components of the connector assembly being prepared for the attachment of the connector assembly 406 to the corrugated tubing 401. Firstly, the corrugated tubing 401 is cut using a metal wheel pipe cutter. The drivable nut connector 414 is then put onto the corrugated tubing 401 before part of the plastic cover 402 is removed by peeling a small section off by hand or by using a utility knife so as to expose a number of corrugations 403. The split collet 408 is then assembled so that its retaining finger 409 sits in the valley 404 of the last corrugation 403 of the corrugated tubing 401.

The drivable nut connector 414 is then pulled over the split collet 408. Advantageously, the collet 408 includes a frusto-conical surface 420 which matches an frusto-conical collet retaining means surface 421 on the inside of the second axial extent 417 of the connector 414. This feature allows the connector 414 to be pulled over the collet 408 more easily, as the distal end of the collet 408 has a smaller diameter than the proximal end of the collet retaining means surface 421 on the inside of the tail portion of the second axial extent 417. Advantageously, the majority of the split collet 408 is encapsulated within the tail portion of the second axial extent 417.

The adapter sleeve 430 is then inserted into the fitting body 350 of a standard copper compression fitting. The adapter includes a cylindrical body portion 431 which exactly matches the profile of copper tubing, and a contoured section or outwardly protruding portion or annular protrusion 432 which matches the profile of the proximal end of a compression sleeve 351 from a copper compression fitting. The adapter sleeve may also include a sealing means, such as a plastic or rubber layer 433 along this contoured section 432 to improve the seal made to the copper compression fitting body 350.

The assembled collet 408, connector 414 and corrugated tubing 401 are then partially assembled to the copper compression fitting body 350 and the adapter sleeve 430 as depicted in Fig 5B. Initially the connector 414 is tightened onto the fitting body 350 by finger tightening as the male 354 and female 415 threads will mate without resistance. As the drivable nut connector 414 is further tightened onto the copper compression fitting body 350 the un-deformed corrugated tubing 401 will abut the abutment surface 411 of the adapter sleeve 430 causing resistance to increase. At this point further tightening must be done by the use of a rotational tool, such as two wrenches or spanners, which engages with the nut 414 and copper compression fitting body 350. As torque is applied to the connector and the fitting body, the adapter sleeve 430 will be driven into the copper compression fitting body 350 and the last corrugation 404 of the corrugated tubing 401 will start to deform and flatten.

Figure 5C depicts the connector assembly in its final assembled position. A seal is obtained between the copper compression fitting body 350 and the annular protrusion 432 of the adapter sleeve 430, whereby a

seal is achieved under pressure from the connector nut 414 being driven on the copper compression fitting body 350. Additionally, the last corrugation of the corrugated tubing 401 has been deformed into a flattened and flared configuration and which is clamped between the raised rim 413 of the adapter sleeve 430 and the tube urging surface 410 of the collet 408. Advantageously, the raised rim 413 is aligned such that it is perpendicular to the tube urging surface 410. Additionally, this raised rim 413 is aligned such that the point of localised pressure is exactly halfway between the peak 405 and valley 404 of the tubing corrugation 403.

Thus, the adapter sleeve 430 is able to connect to a compression fitting, such as a standard copper compression fitting, via its cylindrical body portion near one end, and to a corrugated tubing 401 via its abutment surface 411 at or adjacent the other end. The compression fitting is in turn connectable to a copper tubing 353, as illustrated in Figures 5A to 5C. As the adapter sleeve 430 is able to connect with any type of compression fitting designed for copper tubing, such as ball valve, manifolds, fire-sprinkler head fittings, it in turn allows the corrugated tubing to be connected to any such fitting via the adapter sleeve 430. The adapter sleeve thus negates the need to install a length of copper tubing between the corrugated tubing and the compression fitting, which reduce installation time and costs. It will be appreciated that the compression fitting is typically made of brass, but may be made of other suitable materials.

The words 'comprises/comprising' and the words 'having/including' when used herein with reference to the present invention are used to specify the presence of stated features, integers, steps or components, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

The embodiments described above are provided by way of example only, and various changes and modifications will be apparent to persons skilled in the art without departing from the scope of the present invention as defined by the appended claims.

CLAIMS

1. An adapter sleeve (430) for connecting a compression fitting to a corrugated tubing (401) via an axial loading means, the adapter sleeve (430) comprising a cylindrical body portion (431) for at least partial reception in a mouth of the compression fitting, an annular protrusion (432) on an external surface of the cylindrical body portion (431) for abutting an edge of the mouth of the compression fitting and an abutment surface (411), wherein the abutment surface (411) is adapted for the corrugated tubing (401) which is engagable with the axial loading means to contact thereon, and, being a frusto-conical or substantially frusto-conical surface, is co-axial with the cylindrical body (431) and angled so that the surface projects further from the cylindrical body along an axial direction as radial distance increases.
2. An adapter sleeve (430) as claimed in claim 2, wherein the annular protrusion (432) of the adapter sleeve (430) includes a sealing means.
3. An adapter sleeve (430) as claimed in claim 2, wherein the sealing means includes a plastics or rubber layer (433).
4. A kit of parts for connecting a length of corrugated tubing (401) to a compression fitting comprising:
the adapter sleeve (430) as claimed in any of claims 1 to 3; and
axial loading means operably connectable to the compression fitting, the axial loading means including a connector (414) and a collet (408), the collet (408) having a radially inward protruding clamping element (409) for insertion into a trough of the corrugated tubing (401), the connector (414) having a collet retaining means (421), so that, when the connector (414) moves the collet (408) into engagement with the compression fitting, the collet (408) is fully received and retained in the connector (414) and causes the corrugated tubing (401) to move onto the abutment surface (411) of the adapter sleeve (430).
5. A kit of parts as claimed in claim 4, wherein the connector (414) includes a first axial extent and a second axial extent, a diameter of the first axial extent being larger than the diameter of the second axial extent and the second axial extent is tapered so that its diameter reduces towards a distal end of the second axial extent.
6. A kit of parts as claimed in claim 4 or 5, wherein the collet retaining means (421) of the connector (414) includes a frusto-conical inner surface.

7. A kit of parts as claimed in any one of claims 4 to 6, wherein the collet retaining means (421) of the connector (414) includes a radially inward protruding portion (419) situated proximal to a distal end of the connector (414) for engaging with a distal end of the collet (408).
8. A kit of parts as claimed in any one of claims 4 to 7, wherein the collet (408) has a tail portion receivable in the collet retaining means (421) of the connector (414), the tail portion of the collet (408) having a frusto-conical outer surface.
9. A kit of parts as claimed in claim 8, wherein a wall thickness of the tail portion of the collet (408) decreases along an axial extent of the collet (408).
10. A method of connecting a length of corrugated tubing (353) a having a plurality of corrugations, the method comprising:
- placing a connector (414) around the corrugated tubing (353);
 - placing a collet (408) partly over the corrugated tubing (353), a radially inward protruding clamping element (409) of the collet (408) protruding into a trough of the corrugated tubing (353), the collet (408) being fully received within the connector (414) and retained in the connector (414) by a collet retaining means (421) of the connector (414);
 - placing an adapter sleeve (430) having the abutment surface (411) into a compression fitting body (350), the adapter sleeve (430) being retained at a distal end portion of the compression fitting body (350) such that the abutment surface (411) is available for the corrugated tubing (350) to make contact thereon, the adapter sleeve (430) and the compression fitting body (350) forming a fitting;
 - engaging the fitting including a fluid-flow passage with the connector (414);
 - moving the fitting relative to the connector (414) so that the clamping element (409) causes the corrugated tubing (401) to contact the abutment surface (411) of the fitting.
11. A method as claimed in claim 10, wherein the connector (414) includes a first axial extent and a second axial extent, a diameter of the first axial extent being larger than the diameter of the second axial extent.
12. A method as claimed in claim 11, wherein the second axial extent is tapered so that its diameter reduces towards a distal end of the second axial extent.

13. A method as claimed in any of claims 10 to 12, wherein the collet retaining means (421) includes a frusto-conical inner surface of the connector (414).
14. A method as claimed in any of claims 10 to 13, wherein the collet retaining means (421) includes a
5 radially inward protruding portion (419) of the connector (414) situated proximal to a distal end of the connector (414) for engaging with a distal end of the collet (418).
15. A method as claimed in claim 14, wherein the radially inward protruding portion (419) is an annular
10 lip.
16. A method as claimed in any of claims 10 to 15, wherein the collet (408) has a tail portion receivable in the collet retaining means (421) of the connector (414).
17. A method as claimed in claim 16, wherein the tail portion of the collet (408) has an external frusto-
15 conical surface.
18. A method as claimed in claim 16 or claim 17, wherein a wall thickness of tail portion of the collet (408) decreases along an axial extent of the collet (408).
19. A method as claimed in any of claims 11 to 18, wherein a wall thickness of the second axial extent
20 of the connector (414) decreases towards the distal end of the second axial extent.
20. A method as claimed in any one of claims 10 to 19, wherein a radially outwardly protruding portion (432) proximal the distal end of the adapter sleeve (430) is engaged and retained on a corresponding
25 portion at the distal end portion of the compression fitting body (350).

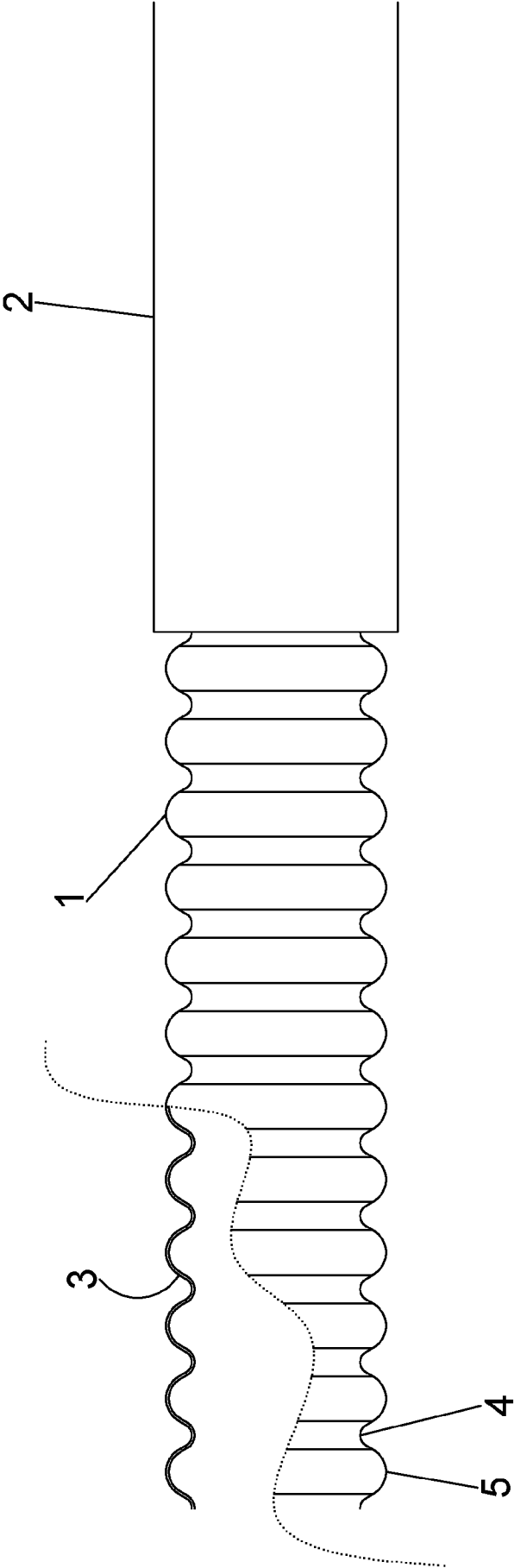


Fig 1

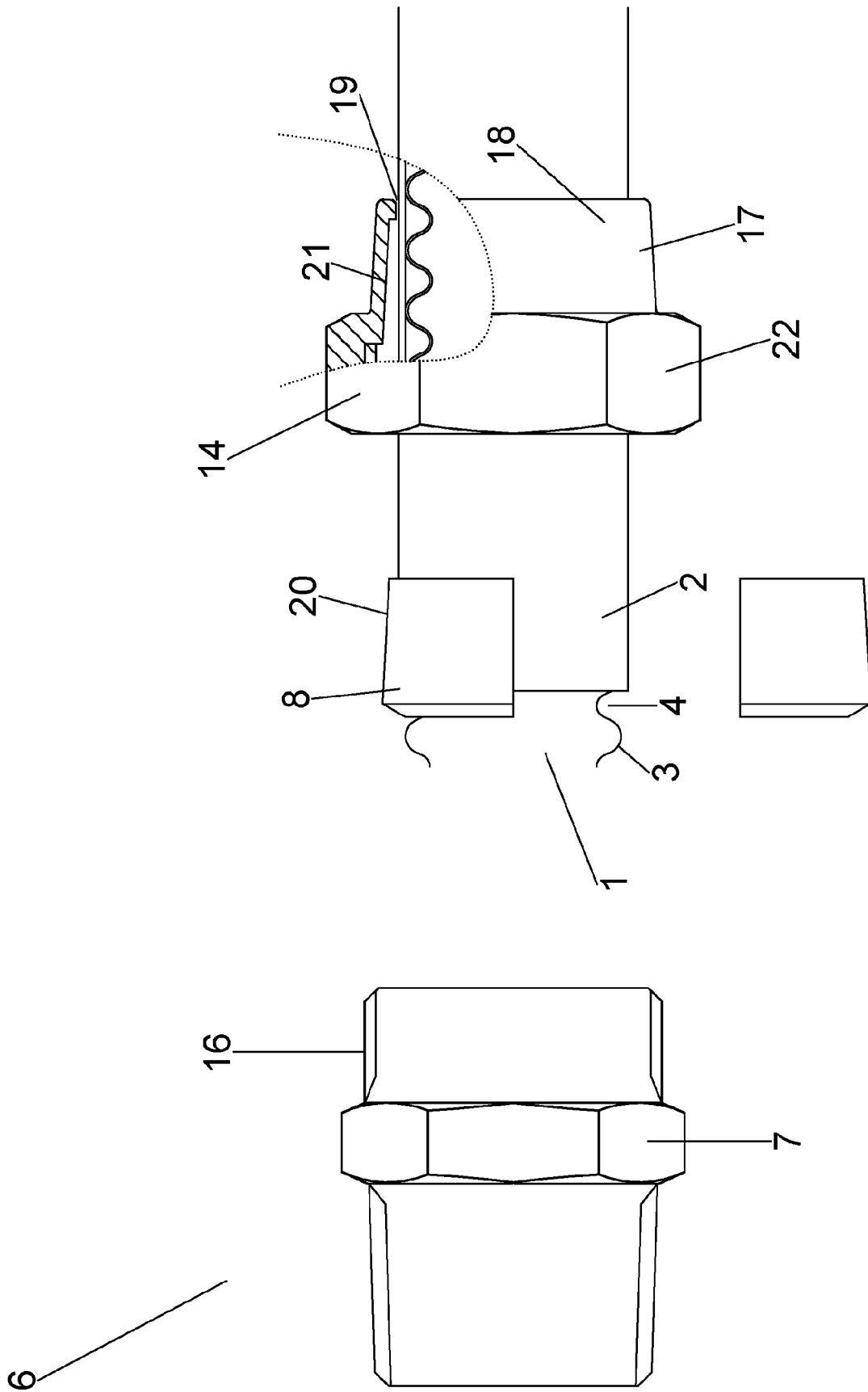


Fig 2A

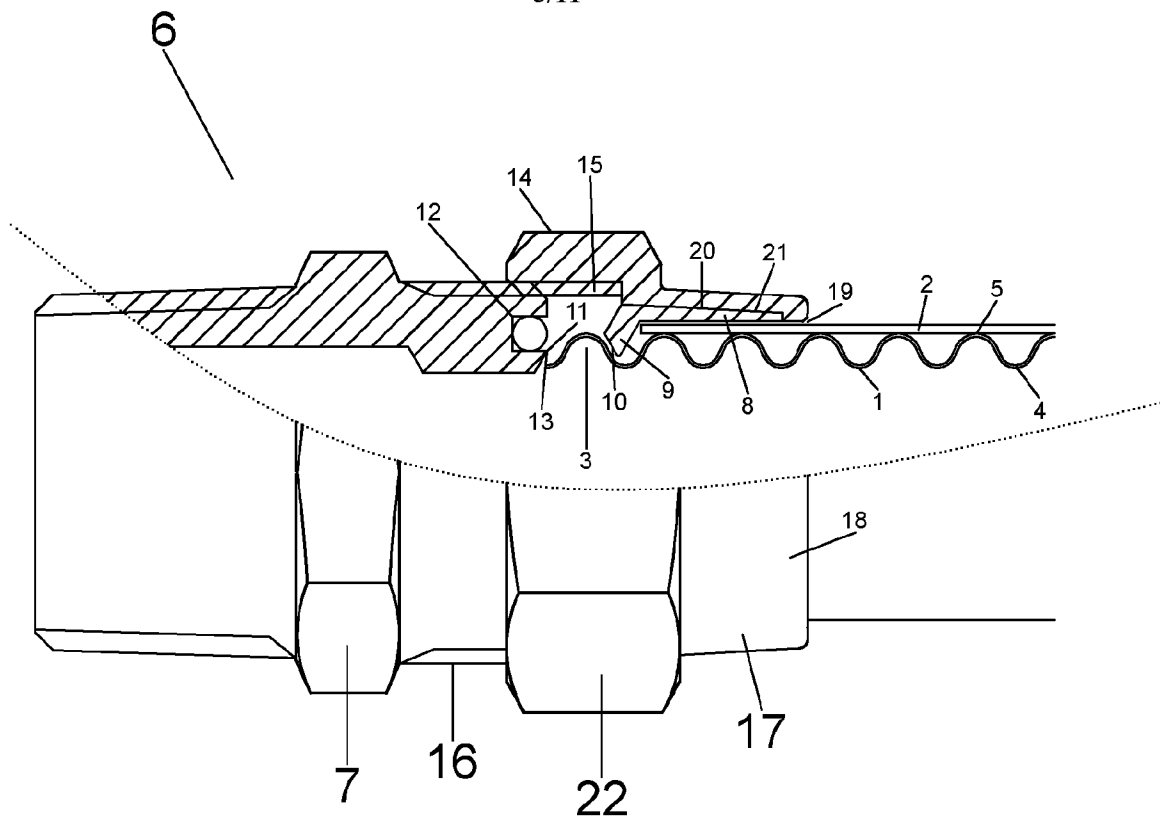


Fig 2B

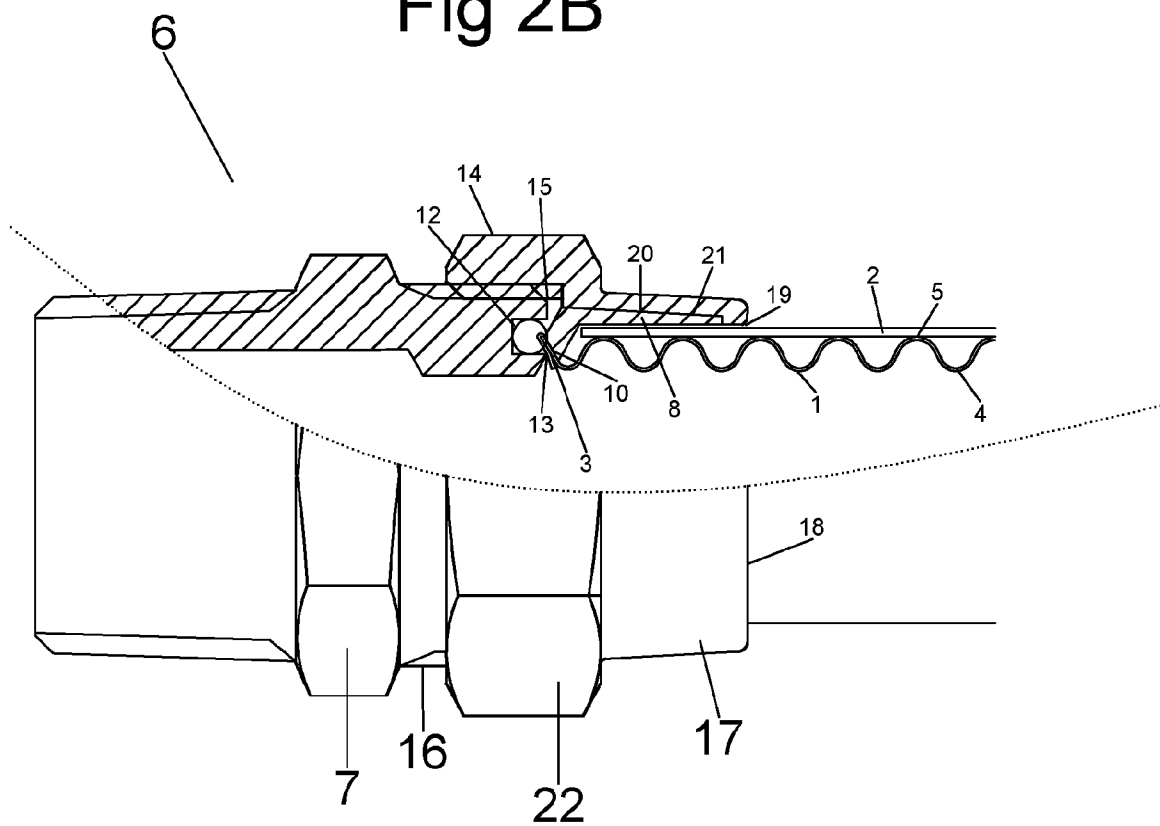


Fig 2C

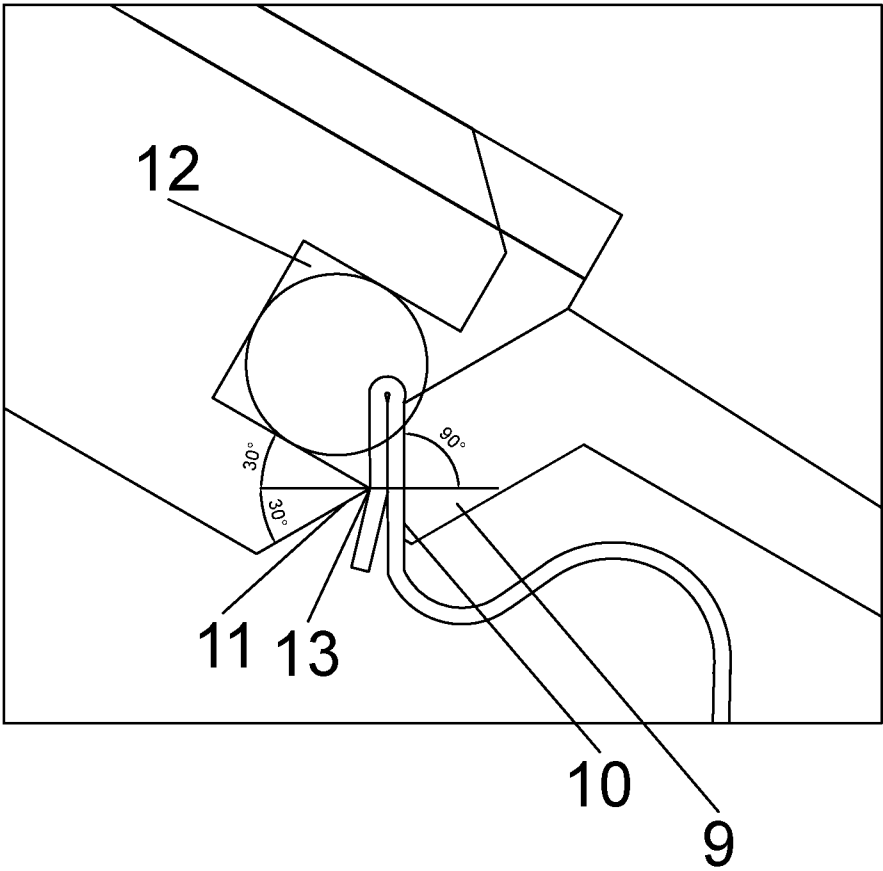


Fig 2D

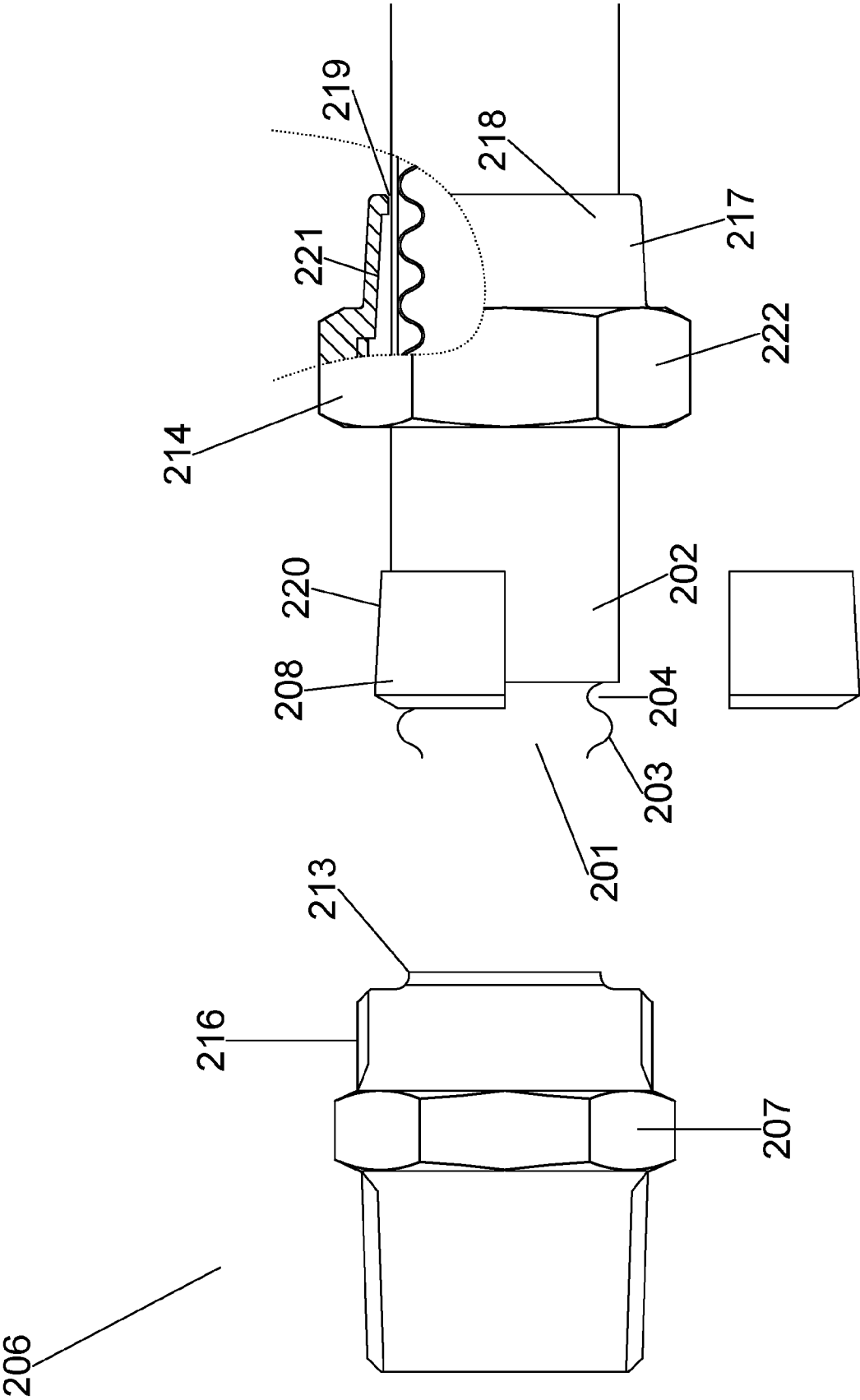


Fig 3A

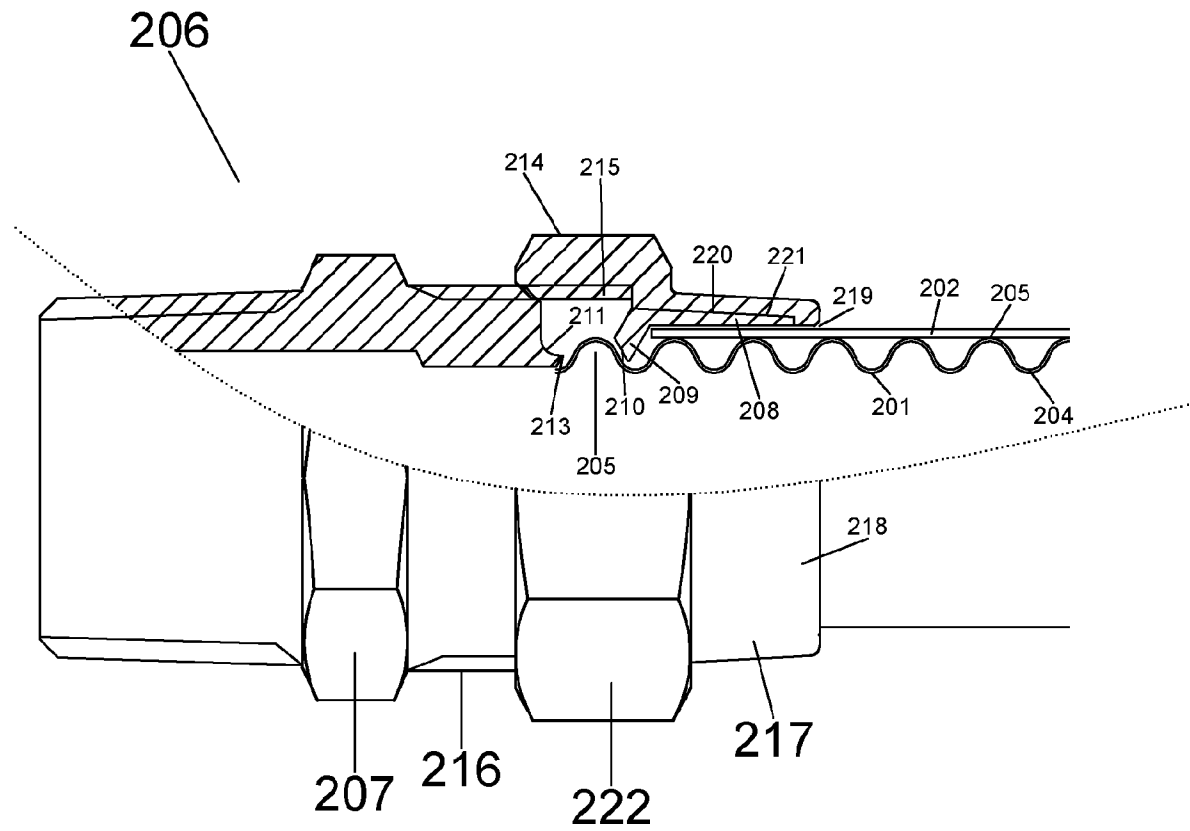


Fig 3B

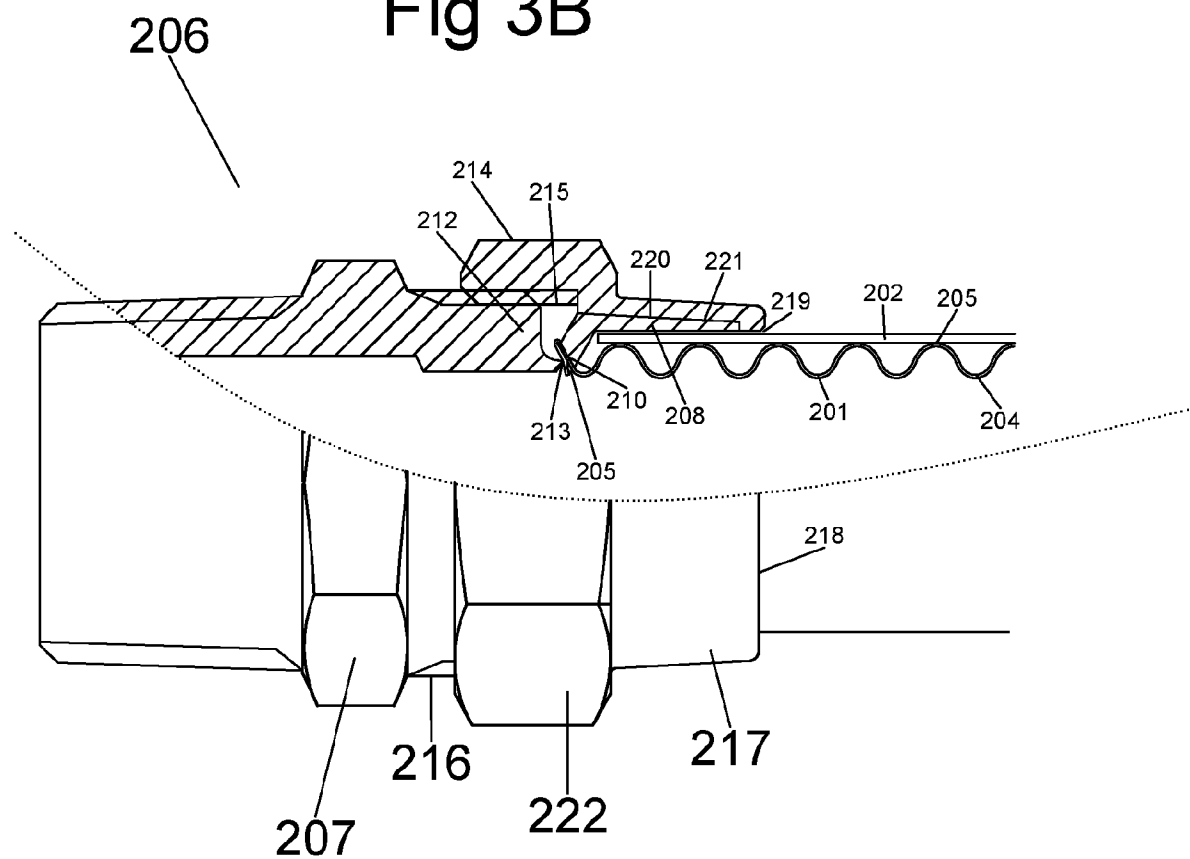


Fig 3C

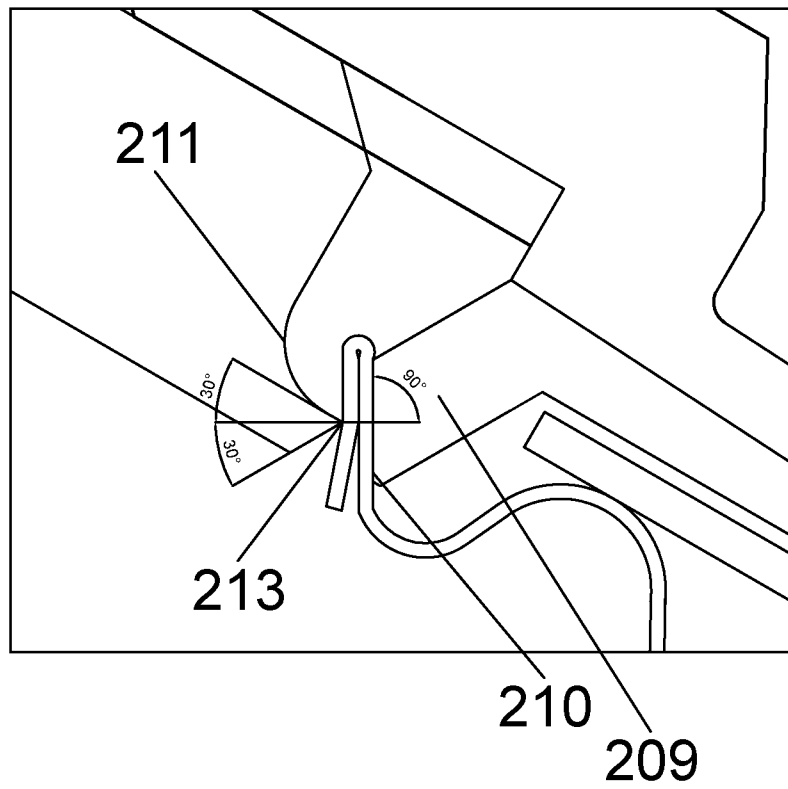


Fig 3D

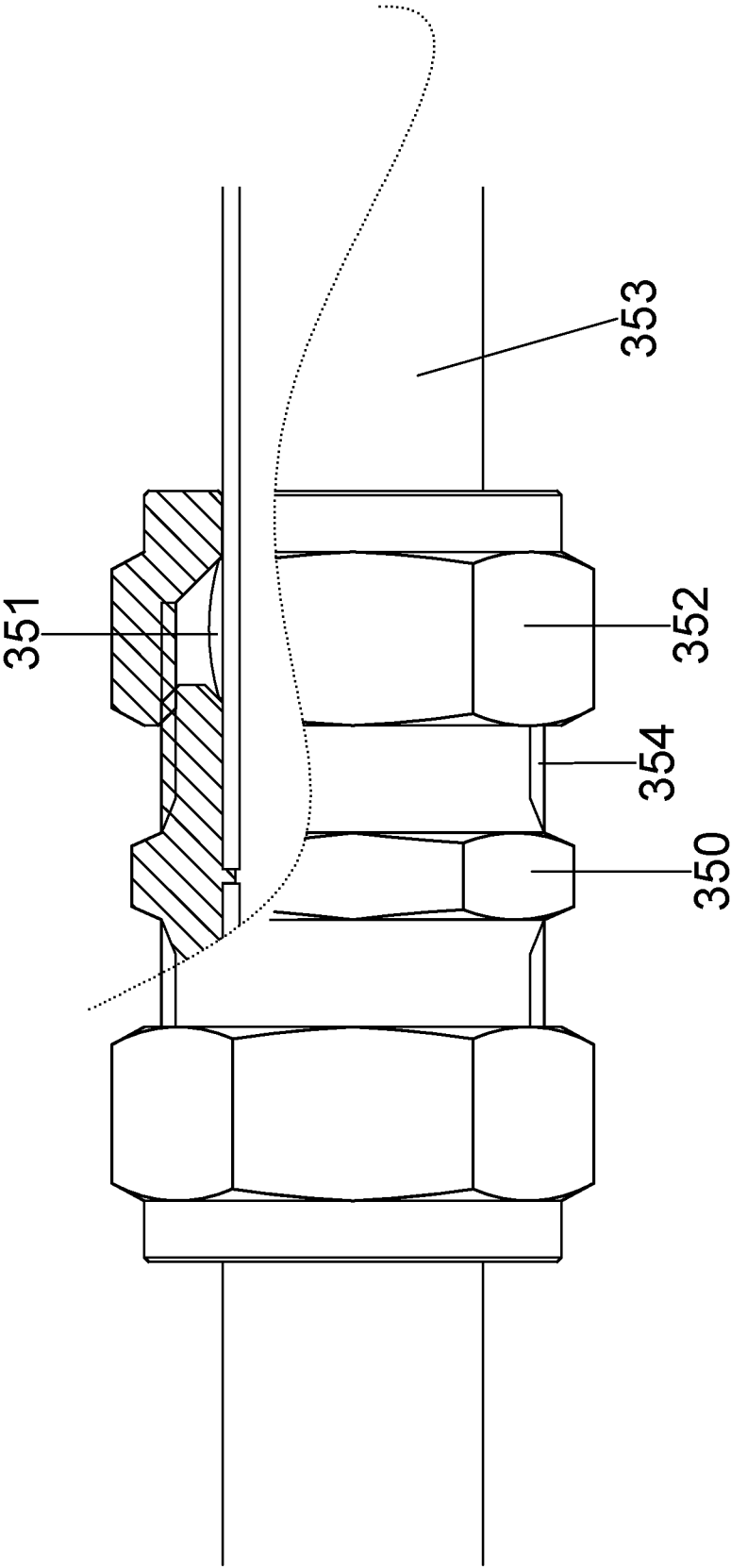


Fig 4

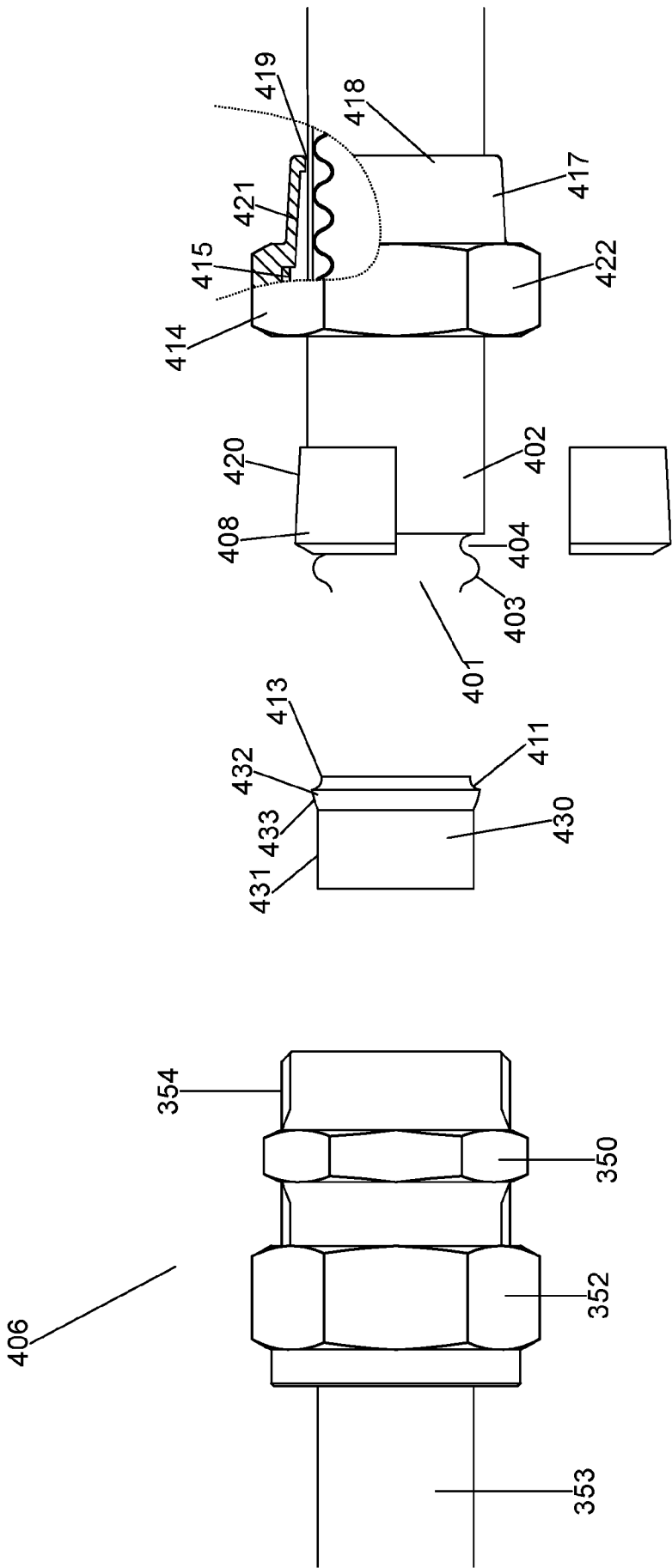


Fig 5A

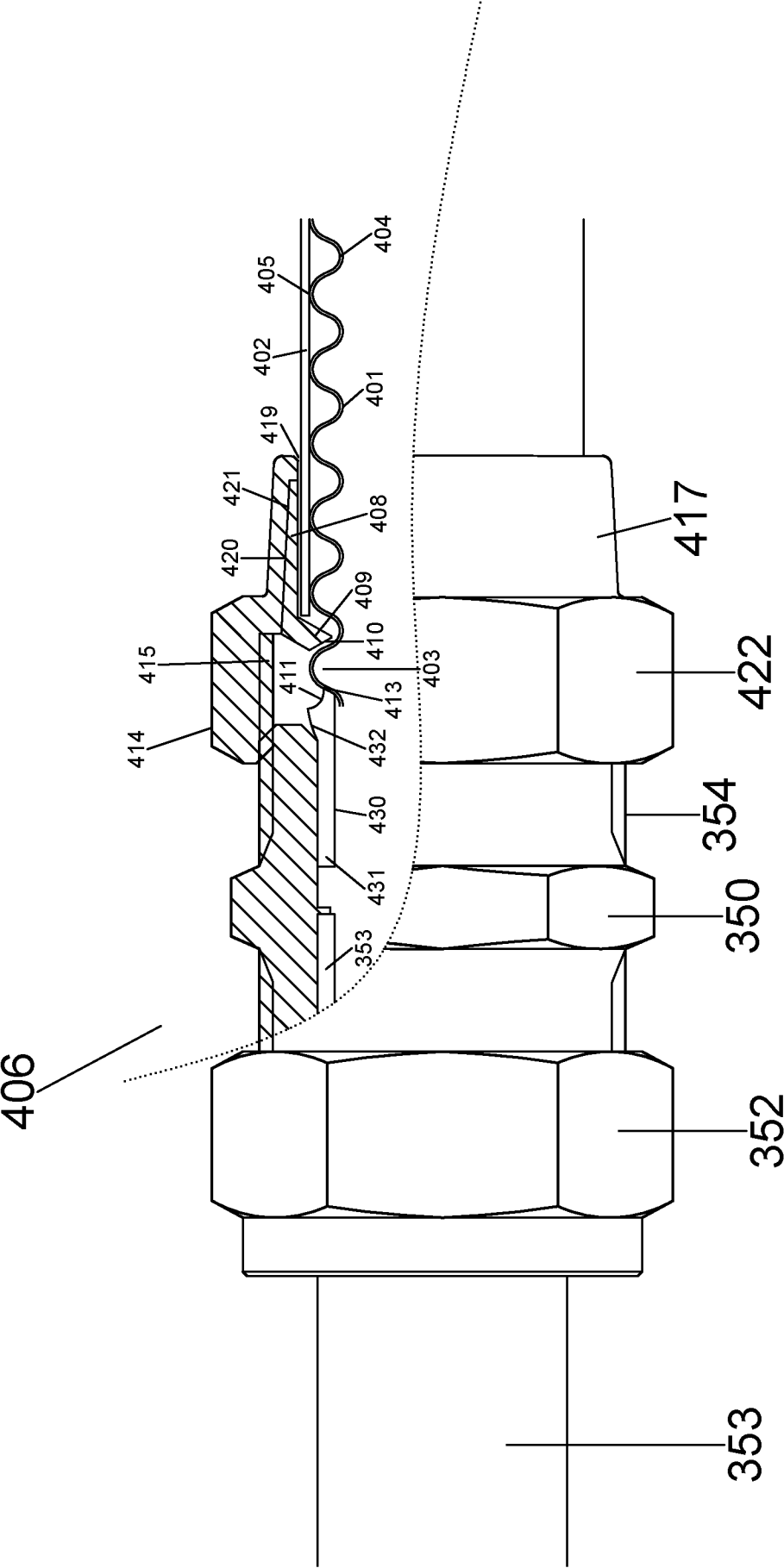


Fig 5B

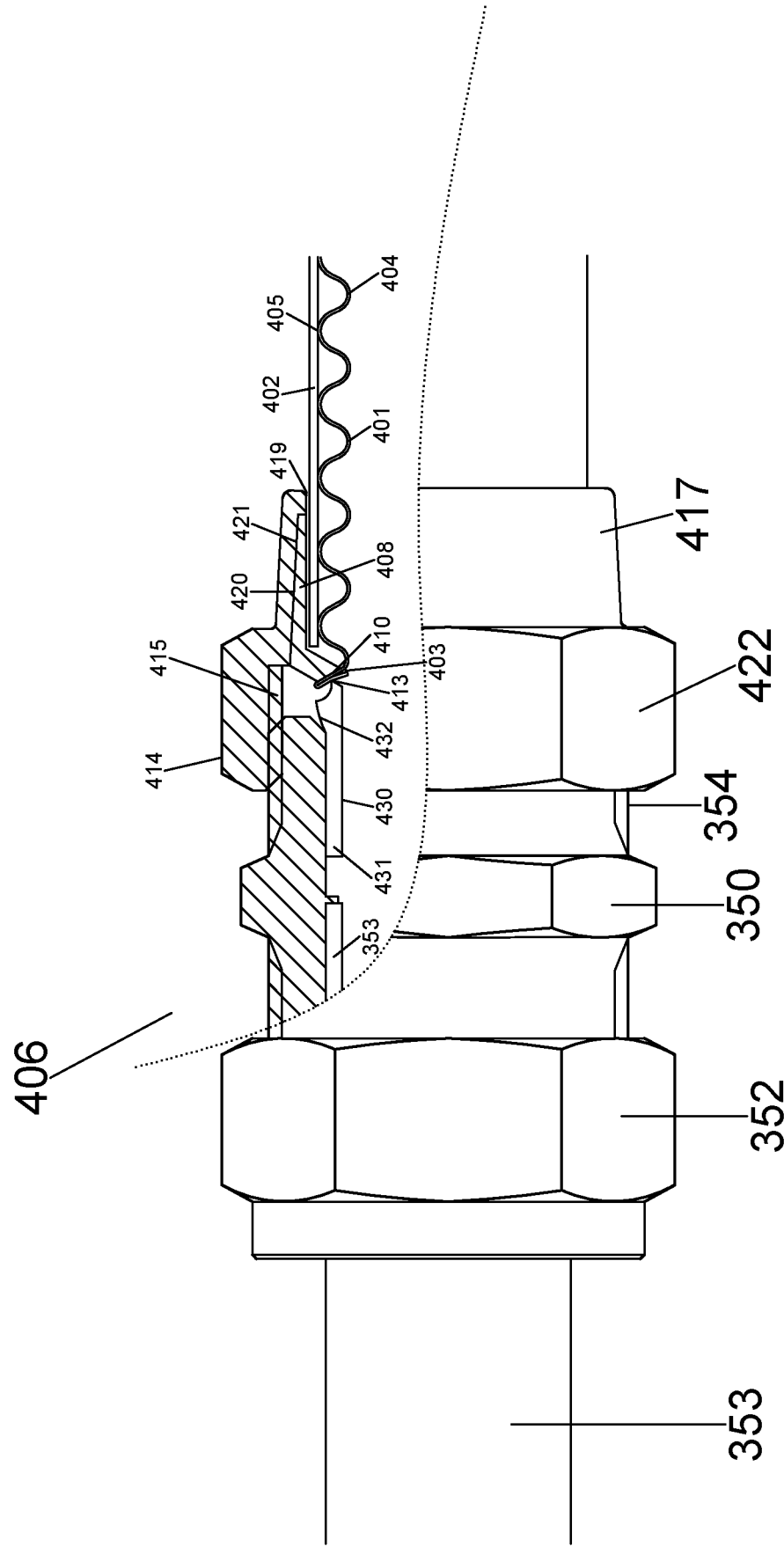


Fig 5C

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2019/052083

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16L19/02 F16L19/08 F16L25/00 F16L33/01 F16L33/26
F16L19/025

ADD.

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)

F16L

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2 946 607 A (BAUER MATTHEW F) 26 July 1960 (1960-07-26) figures 1,2 column 2, line 15 - line 24 -----	1-9
X	DE 41 05 662 A1 (KIRCHNER FRAENK ROHR [DE]) 10 September 1992 (1992-09-10) claim 1 figure 1 -----	10-20
A		4,5,7-9
X	US 2008/012300 A1 (DUQUETTE SCOTT [US] ET AL) 17 January 2008 (2008-01-17) figures 1-5 paragraph [0015] - paragraph [0041] -----	10,11, 13-20
A		1-4,7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

8 November 2019

Date of mailing of the international search report

19/11/2019

Name and mailing address of the ISA/

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Authorized officer

Prieto Sanz, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2019/052083

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 2946607	A	26-07-1960	NONE	
DE 4105662	A1	10-09-1992	NONE	
US 2008012300	A1	17-01-2008	NONE	