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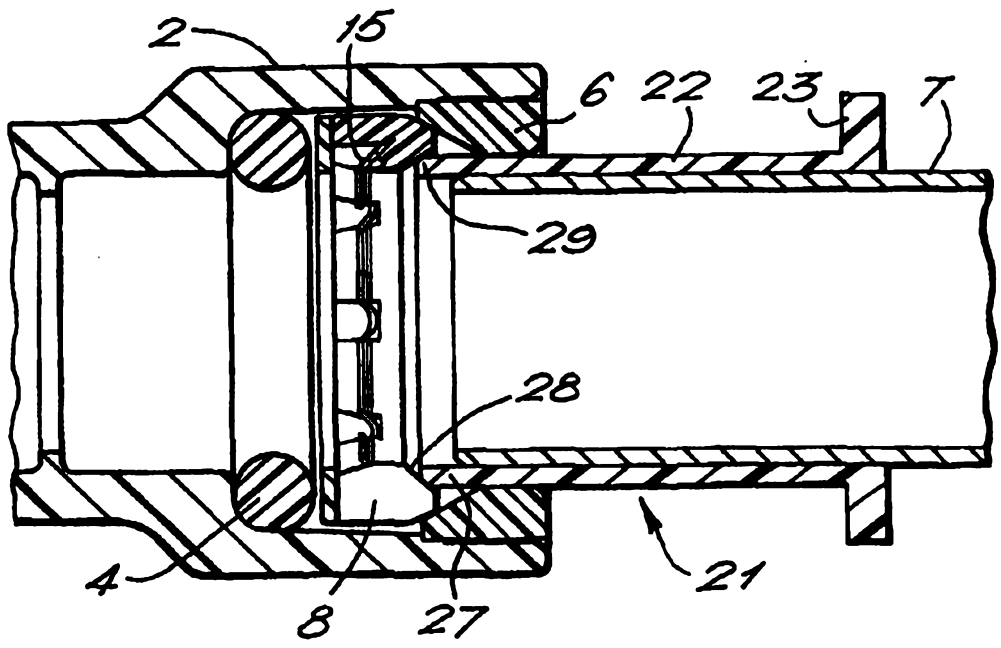
(54) Title: PUSH-FIT TUBE COUPLINGS



(57) Abstract

A tube coupling system comprises a coupling having a main body (2) which defines a tube receiving bore, the tube receiving bore being provided with a seal (4) to seal around the outer surface of a tube (T) received within the bore and being provided with tube gripping means such as a split ring (8) for engaging the outer surface of the tube. The system further comprises a release tool (21) which may be moved axially with respect to the bore to release the tube gripping means (8) from the tube (T). The release tool is removable and the tube gripping means has an outwardly facing tapering surface (28) which is engaged by a corresponding surface on the release tool. The tool is a two part or hinged sleeve to enable it to be placed over, and removed from, the tube (T).

PUSH-FIT TUBE COUPLINGS

The present invention relates to push-fit tube couplings, and particularly but not exclusively to releasable couplings used for example in plumbing systems to connect together water pipes.

An example of a releasable push-fit tube coupling is known from GB-A-1,556,008. This tube coupling uses a one-way grip ring, having a number of inclined, inwardly projecting metal fingers, which allow the tube to be pushed into the tube coupling, but mechanically secure the tube against withdrawal, the teeth biting into the surface of the tube. An O-ring seal is provided between the opening of the tube receiving bore and the grip ring, in order to create a fluid seal around the tube. Between the O-ring and the grip ring, there is provided a washer to prevent the O-ring from engaging the grip ring.

In order to release the tube from the tube coupling, it is first necessary to dismantle the tube coupling by unscrewing an end-cap which holds the tube coupling together. This may not always be a simple operation, for example, if the screw thread becomes seized. In addition, the grip ring and seal are frequently damaged or destroyed in the operation, requiring them to be replaced each time.

It is known to provide a tool in the form of a shim for releasing tube gripping means within a coupling, the shim being pushed into the coupling and forced between the tube gripping means and the tube. However, this is usually of metal and relatively sharp, with the disadvantage that when used it damages the seal and the tube gripping means.

Another push-fit tube coupling is known from EP-A-0,196,881. This type of tube coupling incorporates a movable collet which fits around a tube within the coupling. The collet comprises a ring-shaped member that has a plurality of axially extending fingers which project into the tube coupling. In use, the internal pressure of the fluid in the tube tends to force the tube and the attached collet out of the tube coupling, and in so doing urges portions of the collet against an tapered cam surface at the entrance of the tube receiving bore in such a manner as to urge them inwardly. This increases the grip on the tube to prevent further withdrawal. The collet has tube engaging portions such as metal teeth.

To release the tube, the collet is pushed back into the tube coupling, away from the inclined surface, to release its grip and enable the tube to be pulled out. Axially inwards

movement of the tube is necessary to permit the tube engaging teeth to be released from the tube surface.

One disadvantage with this coupling system is that the collet projects from the coupling, and may therefore be pushed in accidentally to release the seal, even after the plumbing installation has been completed.

Viewed from one aspect the present invention provides a tube coupling system comprising:

a) a coupling having a main body defining a tube receiving bore having a mouth, a seal within the bore, and tube gripping means within the bore, the gripping means including tube engaging portions disposed between the seal and the mouth which engage the surface of a tube received in the bore in use; and

b) a release tool, separate from the coupling, which can be moved axially with respect to the tube for releasing the tube from the engaging portions;

wherein the gripping means comprises an axially fixed portion which is in the region of the mouth of the bore and is provided with a first surface, and an axially movable portion within the bore which is provided with a second surface for engagement with the first surface, said tube engaging portions being provided on one of the fixed and movable portions, such that engagement of the first and second surfaces causes the tube engaging portions to be urged radially inwards to as to increase grip with the surface of a tube received in the bore in use; and

wherein said one of the fixed and movable portions which is provided with the tube engaging portions is further provided with a third surface at a position radially outwardly of the tube engaging portions for engagement by the release tool so that the engaging portions can be urged away from engagement with the tube.

In the preferred embodiment, the cooperation of the release tool and the tube gripping means will serve to urge portions of the tube gripping means radially outwardly away from engagement with a tube in the coupling. Thus, the axial movement of the release tool does not simply tend to urge the tube engaging portions into tighter engagement with the tube.

In an arrangement in which the tube gripping means is movable axially with respect to the bore, in a manner analogous to the system disclosed in EP-A-0,196,881, it may be possible for the tube gripping means to be released from the tube solely by the axial movement of the tool so as to urge the tube gripping means in an axial direction away from

the cam surface and remove the camming effect. Initial release of tube engaging portions is achieved by axially inwards movement of the tube. However, the preferred embodiment in accordance with the invention positively causes radially outwards disengagement of the tube engaging portions and the tube.

In the preferred embodiments the cooperating surfaces of the release tool and the tube gripping means achieve a camming effect. In a particularly preferred arrangement one of the elements and preferably the tube gripping means, is provided with a tapering surface. This surface may be inclined or curved or have any appropriate profile. Where the tube gripping means comprises a number of elements such as legs, the surface may be provided on some or all of the legs. The surface may be provided around substantially the entire periphery of the tube gripping means

In any event it is possible for the tube to be released from the coupling, without damaging the tube gripping means or the seal. The tool does not have to be inserted between the tube and the tube engaging portions, where it could cause damage and/or become stuck.

Preferably the release tool is sleeve-like and is slid along the outer surface of the tube into the tube coupling. As the release tool enters the tube coupling, a surface on the front end of the release tool urges against the inclined surface located on the tube gripping means, causing the tube gripping means to release its grip on the tube. The tube may then be pulled free from the tube coupling or adjusted. Since, in a preferred form, the tube gripping means is located at the entrance of the tube receiving bore, its cam surface is readily accessible to the release tool.

The release tool preferably encircles or partly encircles a tube when the coupling is in use. The release tool is preferably readily removable, and preferably this may be done in a lateral direction with respect to a tube once the tool has been moved out of the coupling. In a preferred form the release tool is in the form of a tubular member whose inner diameter is slightly larger than the outer diameter of the tube. To permit installation and removal of the tool, the tubular member preferably consists of two parts which are hinged together or are separable. In one preferred embodiment the split tubular member is resilient, and can be opened up and then snapped around the tube.

Preferably, the tubular member constituting the release tool has an axially extending gap when positioned around a tube, so that it can be adjusted somewhat. For example it may be closed up somewhat to match the reduced diameter of the tube gripping means in the

coupling. Circumferential ribs may be provided on the outer surface of the tool to make it easier for the user to push it along the surface of the tube.

In preferred embodiments of the present invention, a tube retained in the coupling will be spaced from the mouth of the coupling around its circumference, to permit access for the release tool. However, in such an arrangement there is the disadvantage that the tube is not supported in this region. Accordingly, in a preferred embodiment a plurality of inwardly directed projections are provided in the region of the mouth of the coupling, to provide support for the tube. For example, three, four or more projections may be spaced at suitable intervals around the circumference. The release tool is configured to have portions which pass along the free spaces between the projections. These portions may be defined by providing the release tool with axially extending slots which match the positions of the projections.

The release tool may be provided as an item which can be used as desired with any coupling. However, each coupling could also be provided with a release tool already in place. This would be used as necessary during fitting of the coupling, to permit adjustments to be made. It would then be removable from the coupling. To some extent the coupling would initially be similar to a coupling in accordance with EP-A-0,196,881. However, the release tool would be removable. In such an arrangement the release tool could initially be connected to the tube gripping means by readily frangible means which will prevent loss of the release tool during shipping and handling but will permit easy removal of the tool after installation. The tool can then be replaced and used as necessary. This would be possible in an arrangement in which axial movement alone is sufficient to cause disengagement of the tube gripping means. Alternatively, other retaining means could be employed such as resilient portions which engage detents or the like, to resist loss of the tool, and this would be possible in the preferred embodiments in which there is a camming effect so that there is relative movement between the tube gripping means and the tool.

In the preferred embodiment the tube gripping means is in the form of a collet or split ring which is movable axially within the coupling and cooperates with a tapering cam surface in the region of the mouth of the coupling to be urged inwardly to grip the tube. In such an arrangement the seal could act on the tube gripping means directly, but in a preferred embodiment it acts through an intermediate member such as a thrust washer which engages the tube gripping means.

However the invention also extends to the use of the release tool arrangement in a novel type of coupling in which the tube gripping means is fixed against axial movement, and axial movement of the seal - either from an external force or from pressure of water - acts on the tube gripping means to increase the gripping action. The seal could act on the tube gripping means directly, but in one arrangement in accordance with this embodiment it acts through an intermediate member such as a thrust washer which engages the tube gripping means. The engagement with the tube gripping means is preferably such as to cause a camming effect. Thus, in one arrangement a moveable member, such as a thrust washer, has a frusto-conical surface which engages portions of the tube gripping means, thus acting as a wedge to urge the portions towards the tube as the thrust washer moves axially.

Preferably the tube gripping means in embodiments of the invention comprises a plurality of radially inwardly projecting portions. These may be formed so as to be inclined towards the axis of the tube receiving bore when no tube is present. In its preferred form, the tube gripping means comprises a ring having a plurality of teeth which can be urged inwardly to grip the tube.

In its preferred form, the tube gripping means comprises a ring having a plurality of teeth, which extend generally radially therefrom, somewhat inclined, towards the axis of the ring. The inner surfaces of these teeth, when in their relaxed state, preferably lie on a circle whose diameter is smaller than that of the tube which is to be inserted, so that the teeth may support the tube in its correct position within the tube coupling.

Preferably, the tube gripping means comprises a moulded plastics body, which is reinforced with an inner metal ring. Preferably the inner metal ring has a plurality of portions which are arranged to project slightly from the plastics body. These projecting portions provide teeth which can engage the outer surface of the tube, thereby securing the tube more firmly within the tube coupling regardless of the type of tube material. In one preferred arrangement the tube gripping means is in the form of a split ring whose diameter can therefore increase and decrease. The split ring has a number or radially extending partial slits around its circumference. The moulded plastics body provides the surface for engagement with the release tool, and also a surface for cooperation with the cam surface in the region of the mouth of the coupling. Thus it will be provided with a radially inwardly facing inclined surface around its circumference and/or a radially outwardly facing inclined surface around its circumference.

Preferably the seal is an O-ring type seal. In such embodiments, the preferred thrust washer may be provided to prevent parts of the O-ring sticking through gaps in the tube gripping means as a result of creep in the O-ring material, and avoids the tube gripping means damaging the O-ring.

In some embodiments, a second (or more if necessary) seal is additionally provided, separated from the first seal by a washer

If the material of the tube is relatively soft, a tube insert comprising a close-fitting tubular sleeve of metal or plastics may be fitted within the tube, which can withstand the grip pressures of the tube gripping means.

The invention also extends to a method of disengaging a tube from the tube gripping means of a tube coupling in a system as described above, including the steps of placing the release tool over the tube and moving the release tool axially along the tube so that an axially directed end portion of the release tool engages the third surface of the tube gripping means and urges the tube engaging portions radially outwards and away from gripping engagement with the tube.

Viewed from another aspect, the invention provides a tube coupling for use in a system as described above in which the tube engaging portions are provided on the axially fixed portion, the coupling having a main body defining a tube receiving bore, an end member which is attached to one end of the main body and part of which defines a mouth for the bore, a seal within the bore, and tube gripping means within the bore, the gripping means including tube engaging portions disposed between the seal and the mouth which engage the surface of a tube received in the bore in use; wherein the gripping means comprises an axially fixed portion within the bore which is defined by part of the end member and is provided with a first surface, and an axially movable portion within the bore which is provided with a second surface for engagement with the first surface, said tube engaging portions being provided on the fixed portion, such that engagement of the first and second surfaces causes the engaging portions to be urged into gripping engagement with the surface of a tube received in the bore in use; wherein the fixed portion is further provided with a radially inwardly directed third surface which tapers radially outwardly in a direction from the inside of the coupling towards the mouth; and wherein the arrangement is such that a tube received in the coupling will be spaced from the mouth of the coupling around its circumference, to permit access for a release tool to contact the third surface to release the tube from the coupling.

Viewed from another aspect, the invention provides a tube coupling for use in a system as described above in which the tube engaging portions are provided on the movable portion, the coupling having a main body defining a bore for receiving a tube when the coupling is in use, and an end member which is attached to one end of the main body; part of the end member defining a mouth for the bore, and part of the end member defining a first surface which tapers radially inwardly in a direction from the inside of the coupling towards the mouth; the bore being provided with a seal to seal around the outer surface of a tube received within the bore when the coupling is in use, and being provided with tube gripping means which is disposed between the seal and the mouth and has tube engaging portions for gripping the outer surface of the tube; and the tube gripping means being movable axially within the coupling and having a radially outwardly directed second surface adapted to cooperate with the tapering first surface of the end member, so that upon axial movement of the tube gripping means towards the mouth the engagement of the first and second surfaces urges the tube engaging portions of the tube gripping means radially inwards so as to increase the grip on the tube; wherein a) the tube gripping means is also provided with radially inwardly directed cam surface portions which taper radially outwardly in a direction from the inside of the coupling towards the mouth; and b) the arrangement is such that in use a tool which is separate from the coupling may be placed in a lateral direction over a tube retained in the coupling and moved axially into the coupling through a space between the tube and the mouth of the coupling which extends at least partly around the circumference of the tube, so that the release tool can engage the cam surface portions and urge them radially outwards by means of a camming effect and thus urge the tube engaging portions away from gripping engagement with the tube so that the tube can be released from the coupling.

Some preferred embodiments of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is an external view of a coupling in accordance with the invention;

Figure 2 is a section through one end of the coupling;

Figure 3 is a plan view of tube gripping means used in the coupling;

Figure 4 is a partial detailed view of the tube gripping means;

Figure 5 is an end view of a mouth of the coupling, with other components omitted for clarity;

Figure 6 is a section through a release tool;

Figure 7 is an end view of the release tool;

Figure 8 is a section through one end of the coupling with a tube in place;

Figure 9 is a section through one end of the coupling showing the release tool being used to remove the tube;

Figure 10 is a section through one end of an alternative coupling;

Figure 11 is a section through one end of a second alternative coupling; and

Figure 12 is a section through a third alternative coupling.

In Figures 1 and 2, there is shown a preferred embodiment of the tube coupling. The tube coupling has a hollow main body 1 which is generally tubular in section, has openings at either end and has enlarged end regions 2 interconnected by a smaller diameter middle section 3. This coupling is made of a suitable plastics material and is used to join e.g. pipes together in a plumbing system.

As shown in Figure 2, within each enlarged end region 2 is provided an O-ring seal 4 and a washer 5. An end piece 6 is secured in the opening 7 of portion 2, eg. by bonding or welding or mechanical means. Between the washer 5 and end piece 6 is provided a split ring 8. This split ring is axially movable, together with the seal 4 and washer 5. The end piece 6 is provided with a frusto-conical tapering surface 9 facing the split ring 8, and the split ring has a frusto-conical surface 10 arranged to engage the tapering surface 9 of the end piece. As the split ring 8 is moved axially towards the end piece 6, there is an increasing inwardly directed force on the split ring, caused by the interaction of the two frusto-conical surfaces.

The split ring 8, as shown in more detail in Figures 3 and 4 comprises a moulded resilient plastics body 11 in which is embedded a metal insert 12 of spring steel or another suitable material. The body 11 is provided with notches 13 at intervals, and a gap 14. The metal insert 12 projects slightly from the body, to provide metal teeth 15, which are separated by notches 16 lining up with the notches 13 of the plastics body. As shown in Figure 4 the metal insert is inclined with respect to the body 11 and when in position as in Figure 2, the teeth 15 point at an angle towards the interior of the coupling and towards its axis.

In use, as shown in Figure 8, a tube T such as a plumbing pipe has been pushed into the coupling, passing through the opening 7 in end piece 6. The tube engages the seal 4 in a sealing manner. The tube also passes through the split ring 8 and is engaged by the inwardly facing teeth 15 which restrain movement out again. The teeth may dig into the outer surface

of the tube by a certain extent. The tube is pushed in until it encounters a stop 17. Inwards movement of the seal is restrained by a stop 18.

When there is an outward force on the tube T, the split ring 8 engages the end piece 6 to resist the movement. This outward force may come from pulling on the tube T or from the pressure of fluid with the coupling acting on O-ring 4, which acts on the split ring 8 through the washer 5. The cooperation between the frusto-conical surfaces 9 and 10 provides an inwardly directed force which increases the grip on the tube T.

As shown in Figure 5, the end piece 6 is provided with four equally spaced projections 19 which are directed radially inwardly in the region of the opening 7. These provide support for the tube T in this region. Between the projections 19 are defined slots 20, which permit access for a release tool 21.

The release tool 21 is shown in more detail in Figures 6 and 7. It consists of a generally cylindrical, hollow body 22 of moulded plastics. This has a flange 23 at one end to assist manipulation. The tool is split into two halves by a longitudinal slot 24 and is hinged along a longitudinal line 25 opposite the slot, the flange 23 being provided with a V shaped notch in the region of the hinge line. The hinge is a plastic hinge integrally formed with the release tool, which is therefore of one piece construction in this embodiment. The tool can be opened out and placed around the tube T, outside of the coupling, and then closes up under its own resilience. The body 22 of the tool is provided with four longitudinal slots 26, defining four legs 27 which can therefore pass along the slots 20 defined in the end piece 6, to engage the split ring 8 as shown in Figure 9, where the slots of the tool have been omitted for clarity. A user simply pushes on the flange 23 to achieve this.

The ends of the four legs 27 of the tool are rounded or otherwise suitable profiled as shown at 29, and engage a second frusto-conical surface 28 on the split ring, which points radially inwardly. The split ring is urged axially inwards and at the same time there is a force positively urging the split ring to expand, caused by the interaction of the ends 29 of the tool legs 27 and the surface 28. This camming effect releases the teeth 15 from the tube T which, as shown in Figure 9, can then be withdrawn. As will be seen, the release tool engages the surface 28 of a position radially outwardly from the surface of the tube T, and remote from the gripping teeth 15. The release tool does not have to pass between the gripping teeth 15 and the tube. There is no damage to the seal, split ring , tube or any other component. After adjustment the tool can be removed and the tube T pushed home again.

The tool may be supplied already installed in a new coupling, but will still be removable by pulling it from the coupling and opening the two halves apart. Such a tool might be shorter in the axial direction, for convenience.

Figure 10 shows a modified coupling. In this the plastic end piece 6 has been replaced by a metallic cap 30 of stainless steel or another suitable material such as brass. This is of tubular construction, having a main tubular portion 30A which fits tightly around the body 2. This is crimped into the body around its circumference, at 30B. At its other end, it is rolled over at 30C around its circumference to provide an end cap and the tapering surface 9'. It is finished off by being turned over at 30D.

This construction is strong and yet compact, and enables thinner sections of plastic to be used. In operation it works in the same manner as the previous embodiment.

Thus, in these embodiments there is provided a simple, compact construction with effective gripping of the tube using a novel split ring, and with a release tool which can be readily used to remove the pipe from the coupling in a re-usable fashion.

Figure 11 shows a second alternative coupling with axially fixed tube gripping means. The plastics coupling has a pair of O-ring seals 4, a thrust member 31 and a member 32 which serves as a combined tube gripping means and end piece. The member 32 is of moulded plastics and has a number of resilient legs 33. The legs 33 have metal inserts 34 which provide teeth 35 projecting from the legs to engage a tube in the coupling. The other ends of the metal inserts project beyond the exterior of the member 32, as shown at 36, and engage the wall 37 of the main body of the coupling. They are angled axially outwardly. Thus, when assembling the coupling during manufacture, the member 32 can be push fitted into the open end of the coupling after the seals and thrust member, but will resist removal.

The thrust member 31 has a frusto conical surface 38 facing profiled ends of the legs 33 of the member 32. Axial movement in the direction of removal of a tube causes the thrust member 31 to act on the profiled ends of the legs, urging them inwardly and increasing the grip on the tube.

On their inner sides, facing the opening of the coupling, the legs are provided with angled surfaces 39. These can be engaged by a release tool as described above, axial movement of which will cause no axial movement of the member 32 but will urge the legs away from the tube to permit removal or adjustment.

Figure 12 shows a third alternative embodiment which again uses an axially fixed tube gripping means which is integral with an end member. The coupling 40 has a moulded

plastics end cap 41 which is provided with tube gripping means in the form of legs 42 similar to those of the previous embodiment. Metal inserts 43 are provided but in this case they are not used to secure the end cap and serve only to grip a tube. The end-cap 41 is formed with lugs 44 which snap-fit into a circumferential groove 45 in the outer surface of the main body of the coupling 40, making fabrication of the tube coupling relatively simple. A further advantage with using this snap-fitting arrangement is that the grip head portion of the tube coupling is able to rotate relative to the main body in order to relieve torsional stresses in the tube network and to make assembly easier.

As with the previous embodiment, the release tool will be used, engaging surfaces 46 on the legs 42. As before there is a seal 4 and a thrust ring 31.

In an alternative arrangement the end-cap comprises a stamped metal ring, preferably a springy stainless steel ring, which has a rolled annular rib to replace the lugs of the previous embodiment and a moulded plastics portion to form the resilient legs.

The claims defining the present invention are as follows:

1. A tube coupling system comprising:

a) a coupling having a main body defining a tube receiving bore having a mouth, a seal within the bore, and tube gripping means within the bore, the gripping means including tube engaging portions disposed between the seal and the mouth which engage the surface of a tube received in the bore in use; and

b) a release tool, separate from the coupling, which can be moved axially with respect to the tube for releasing the tube from the engaging portions;

wherein the gripping means comprises an axially fixed portion which is in the region of the mouth of the bore and is provided with a first surface, and an axially movable portion within the bore which is provided with a second surface for engagement with the first surface, said tube engaging portions being provided on one of the fixed and movable portions, such that engagement of the first and second surfaces causes the tube engaging portions to be urged radially inwards to as to increase grip with the surface of a tube received in the bore in use; and

wherein said one of the fixed and movable portions which is provided with the tube engaging portions is further provided with a third surface at a position radially outwardly of the tube engaging portions for engagement by the release tool so that the engaging portions can be urged away from engagement with the tube.

2. A tube coupling system as claimed in claim 1, wherein the tube engaging portions are provided on the axially movable portion of the gripping means.

3. A tube coupling system as claimed in claim 2, wherein the axially movable portion of the gripping means is in the form of a ring having an outer periphery which is formed with the second surface and an inner periphery provided with the third surface.

4. A tube coupling system as claimed in claim 3, wherein the third surface extends around substantially the entire periphery of the ring

5. A tube coupling system as claimed in claim 4, wherein the ring is divided circumferentially into a number of legs, and a portion of the third surface is provided on each of the legs.

6. A tube coupling system as claimed in claim 5, wherein the ring is of plastics and the tube engaging portions comprise metal teeth extending from each of the legs.

7. A tube coupling system as claimed in in any of claims 2 to 6, wherein the third surface faces radially inwardly and tapers outwardly in the axial direction towards the mouth of the bore.

8. A tube coupling system as claimed in claim 7, wherein the release tool is provided with a surface which contacts the third surface when moved in the axial direction towards the surface, in such a manner as to urge the tube engaging portions radially outwards and out of engagement with the tube.

9. A tube coupling system as claimed in any of claims 2 to 8, wherein the release tool can be positioned over the tube in a lateral direction so as to at least partly encircle the tube, and can be moved axially along the tube so as to engage the third surface and urge the engaging portions away from engagement with the tube.

10. A tube coupling system as claimed in claim 9, wherein the release tool comprises two parts which are movable between an open state to facilitate positioning of the tool over a tube, and a closed state in which they at least partially encircle the tube.

11. A tube coupling system as claimed in claim 9 or 10, wherein the release tool has an axially extending gap.

12. A tube coupling system as claimed in claim 9, 10 or 11, wherein the release tool comprises an elongate portion adapted to at least partially encircle the tube and extend axially thereof, one end of the elongate portion being adapted to engage the third surface.

13. A tube coupling system as claimed in claim 12, wherein the other end of the elongate portion is provided with a radially outwardly extending flange to assist manipulation.

14. A tube coupling system as claimed in any of claims 2 to 13, wherein the arrangement is such that in use a tube retained in the coupling will be spaced from the mouth of the coupling at least partly around its circumference, to permit access for the release tool into the coupling so that it can engage the third surface to release the tube from the coupling.

15. A tube coupling system as claimed in claim 14, wherein a plurality of circumferentially spaced, radially inwardly directed portions are provided in the region of the mouth of the coupling, to provide support for a tube when received in the coupling.

16. A tube coupling system as claimed in claim 15, wherein the release tool is provided with axial slots defining portions adapted to pass between the inwardly directed portions in the region of the mouth of the coupling.

17. A tube coupling system as claimed in claim 1, wherein the tube engaging portions are provided on the axially fixed portion.

18. A tube coupling system as claimed in claim 17, wherein the axially movable portion is a thrust member disposed between the seal and the axially fixed portion.

19. A tube coupling system as claimed in claim 17 or 18, wherein the third surface faces radially inwardly and tapers outwardly in the axial direction towards the mouth of the bore.

20. A tube coupling system as claimed in claim 19, wherein the release tool is provided with a surface which contacts the third surface when moved in the axial direction towards the surface, in such a manner as to urge the tube engaging portions radially outwards and out of engagement with the tube.

21. A tube coupling system as claimed in any of claims 17 to 20, wherein the release tool can be positioned over the tube in a lateral direction so as to at least partly encircle the tube, and can be moved axially along the tube so as to engage the third surface and urge the engaging portions away from engagement with the tube.

22. A tube coupling system as claimed in claim 21, wherein the release tool comprises two parts which are hinged together or are separable so as to be movable between an open state to facilitate positioning of the tool over a tube, and a closed state in which they at least partially encircle the tube.

23. A tube coupling system as claimed in claim 21 or 22, wherein the release tool has an axially extending gap.

24. A tube coupling system as claimed in claim 21, 22 or 23, wherein the release tool has a radially extending flange at one end, remote from that which engages the third surface of the tube gripping means in use, to assist manipulation.

25. A tube coupling system as claimed in any of claims 17 to 24, wherein the third surface comprises a plurality of spaced surface portions.

26. A tube coupling system as claimed in any of claims 17 to 25, wherein the tube engaging portions are radially inwardly projecting teeth.

27. A tube coupling system as claimed in claim 26, wherein the teeth are metal projections from a plastics body.

28. A tube coupling system as claimed in claim 26 or 27, wherein the teeth are provided on a plurality of resilient legs.

29. A tube coupling system as claimed in any of claims 17 to 28 wherein the arrangement is such that in use a tube retained in the coupling will be spaced from the mouth of the coupling at least partly around its circumference, to permit access for the release tool into the coupling so that it can engage the third surface to release the tube from the coupling.

30. A tube coupling system as claimed in claim 1, wherein the release tool can be positioned over the tube in a lateral direction so as to at least partly encircle the tube, and wherein the arrangement is such that in use a tube retained in the coupling will be spaced from the mouth of the coupling at least partly around its circumference, so that the release

tool can be moved axially along the tube and into the coupling so as to engage the third surface and urge the engaging portions away from engagement with the tube.

31. A method of disengaging a tube from the tube gripping means of a tube coupling in a system as claimed in claim 1, including the steps of placing the release tool over the tube and moving the release tool axially along the tube so that an axially directed end portion of the release tool engages the third surface of the tube gripping means and urges the tube engaging portions radially outwards and away from gripping engagement with the tube.

32. A method of disengaging a tube from a tube coupling in a system as claimed in claim 30, including the steps of placing the release tool over a tube and moving the release tool axially along the tube and into the coupling so that an axially directed end portion of the release tool engages the third surface of the tube gripping means and urges the tube engaging portions radially outwards and away from gripping engagement with the tube.

33. A tube coupling for use in a system as claimed in claim 30;

the coupling having a main body defining a bore for receiving a tube when the coupling is in use, and an end member which is attached to one end of the main body;

part of the end member defining a mouth for the bore, and part of the end member defining a first surface which tapers radially inwardly in a direction from the inside of the coupling towards the mouth;

the bore being provided with a seal to seal around the outer surface of a tube received within the bore when the coupling is in use, and being provided with tube gripping means which is disposed between the seal and the mouth and has tube engaging portions for gripping the outer surface of the tube; and

the tube gripping means being movable axially within the coupling and having a radially outwardly directed second surface adapted to cooperate with the tapering first surface of the end member, so that upon axial movement of the tube gripping means towards the mouth the

engagement of the first and second surfaces urges the tube engaging portions of the tube gripping means radially inwards so as to increase the grip on the tube;

wherein:

a) the tube gripping means is also provided with radially inwardly directed cam surface portions which taper radially outwardly in a direction from the inside of the coupling towards the mouth; and

b) the arrangement is such that in use a tool which is separate from the coupling may be placed in a lateral direction over a tube retained in the coupling and moved axially into the coupling through a space between the tube and the mouth of the coupling which extends at least partly around the circumference of the tube, so that the release tool can engage the cam surface portions and urge them radially outwards by means of a camming effect and thus urge the tube engaging portions away from gripping engagement with the tube so that the tube can be released from the coupling.

34. A tube coupling as claimed in claim 33 wherein the tube gripping means is in the form of a ring having an outer periphery which is formed with the second surface and an inner periphery provided with the cam surface portions.

35. A tube coupling as claimed in claim 34, wherein the cam surface portions of the tube gripping means are provided by a cam surface extending around substantially the entire periphery of the ring

36. A tube coupling as claimed in claim 35, wherein the ring is divided circumferentially into a number of legs, and a cam surface portion is provided on each of the legs.

37. A tube coupling as claimed in claim 36, wherein the ring is of plastics and the tube engaging portions comprise metal teeth extending from each of the legs.

38. A tube coupling as claimed in any of claims 33 to 37, wherein a plurality of circumferentially spaced, radially inwardly directed portions are provided in the region of the mouth of the coupling, to provide support for a tube when received in the coupling.

39. A tube coupling as claimed in any of claims 33 to 38, wherein the main body of the coupling is plastics and is provided with an exterior metallic sleeve.

40. A tube coupling as claimed in claim 39, wherein the metallic sleeve defines the end member.

41. A tube coupling as claimed in claim 40, wherein the metallic sleeve is turned over in the region of the mouth so as to provide the first surface.

42. A tube coupling for use in a system as claimed in claim 30, having a main body defining a tube receiving bore, an end member which is attached to one end of the main body and part of which defines a mouth for the bore, a seal within the bore, and tube gripping means within the bore, the gripping means including tube engaging portions disposed between the seal and the mouth which engage the surface of a tube received in the bore in use; wherein the gripping means comprises an axially fixed portion within the bore which is defined by part of the end member and is provided with a first surface, and an axially movable portion within the bore which is provided with a second surface for engagement with the first surface, said tube engaging portions being provided on the fixed portion, such that engagement of the first and second surfaces causes the engaging portions to be urged into gripping engagement with the surface of a tube received in the bore in use; wherein the fixed portion is further provided with a radially inwardly directed third surface which tapers radially outwardly in a direction from the inside of the coupling towards the mouth; and wherein the arrangement is such that a tube received in the coupling will be spaced from the mouth of the coupling around its circumference, to permit access for a release tool to contact the third surface to release the tube from the coupling.

43. A tube coupling system substantially as hereinbefore described with reference to Figures 1 to 9 of the accompanying drawings, or as modified with reference to Figure 10.

44. A tube coupling system substantially as hereinbefore described with reference to Figures 11 and 12 of the accompanying drawings.

45. A tube coupling substantially as hereinbefore described with reference to Figures 1 to 9 of the accompanying drawings, or as modified with reference to Figure 10.

46. A tube coupling substantially as hereinbefore described with reference to Figures 11 and 12 of the accompanying drawings.

47. A method of disengaging a tube from a tube coupling, substantially as hereinbefore described with reference to Figures 1 to 10 of the accompanying drawings.

43. A method of disengaging a tube from a tube coupling, substantially as hereinbefore described with reference to Figures 11 and 12 of the accompanying drawings.

Dated this 25th day of November, 1999

MARLEY TILE AG

By Its Patent Attorneys

DAVIES COLLISON CAVE

FIG. 1.

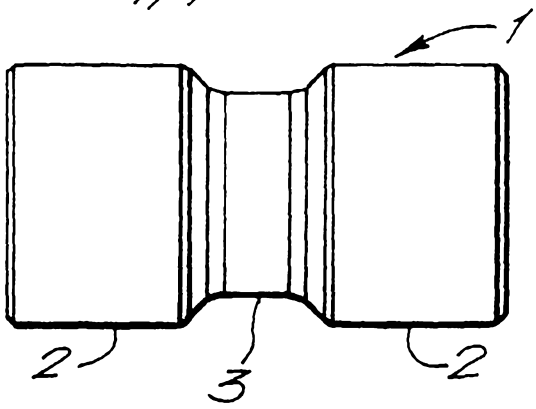


FIG. 2.

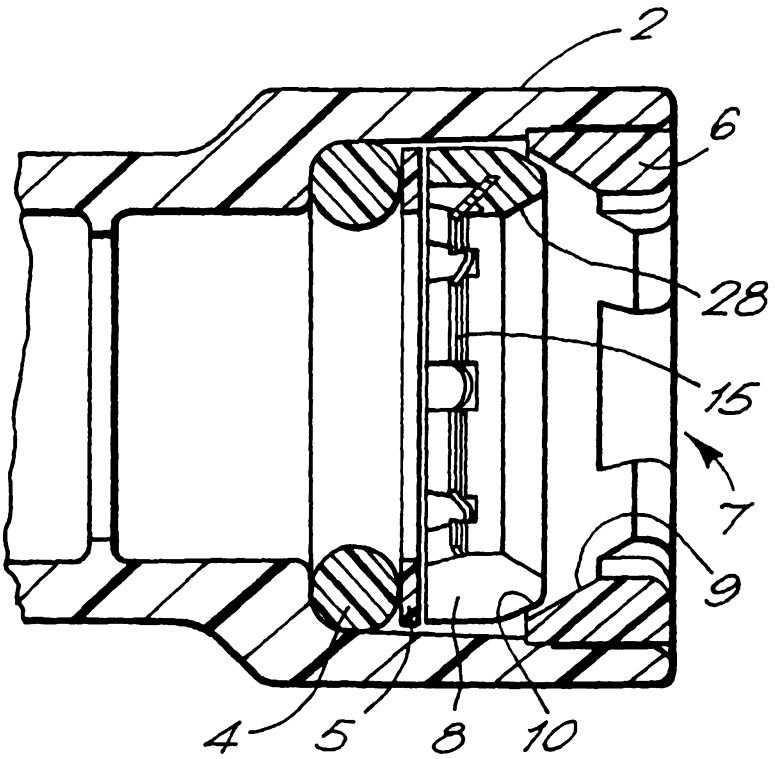


FIG. 3.

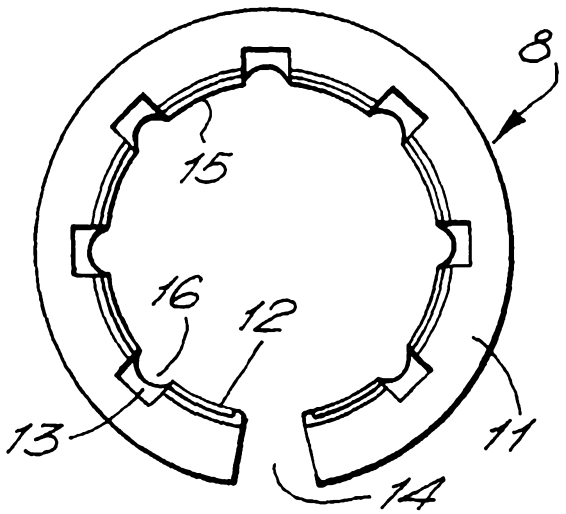
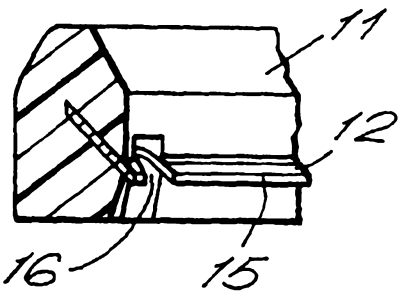


FIG. 4.



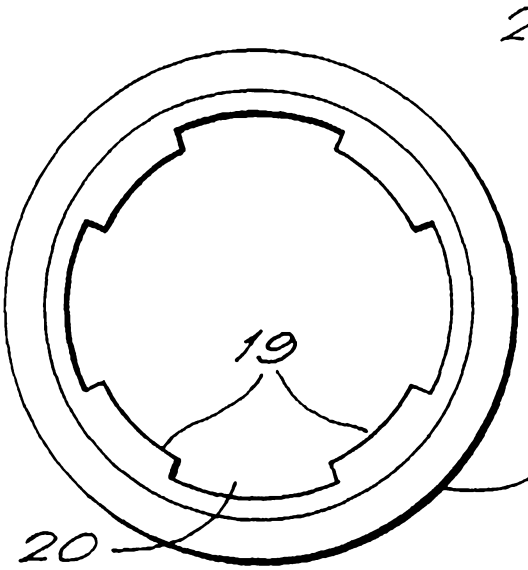


FIG. 5.

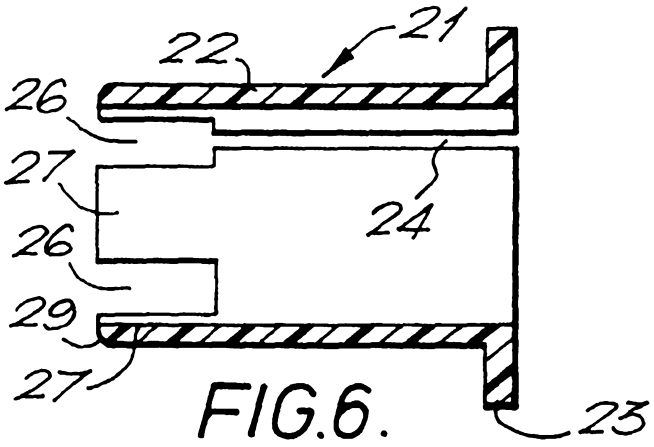


FIG.6.

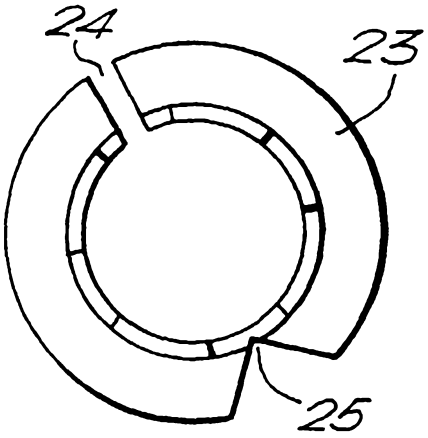


FIG.7.

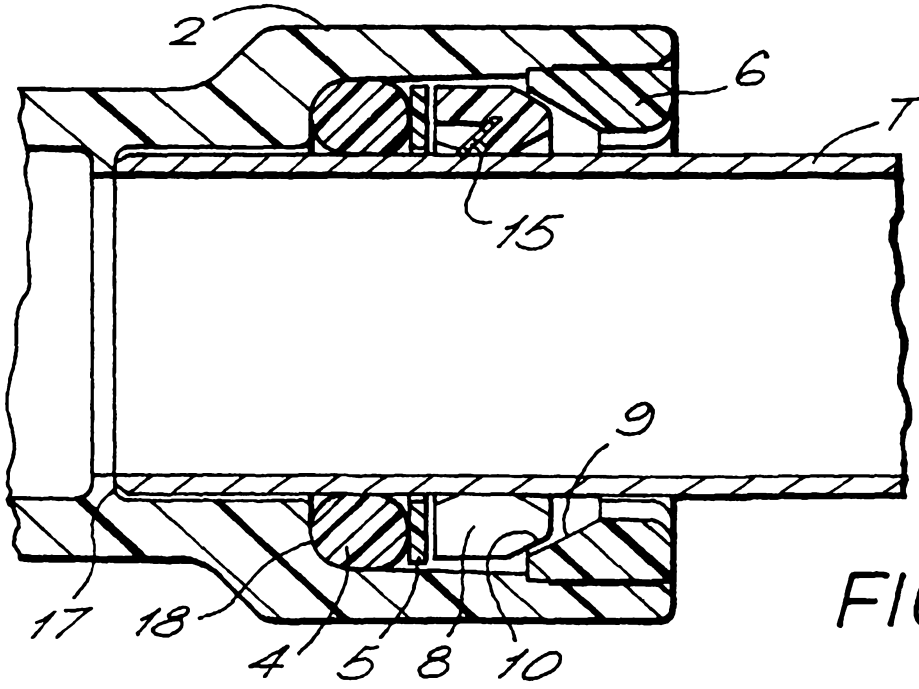


FIG.8.

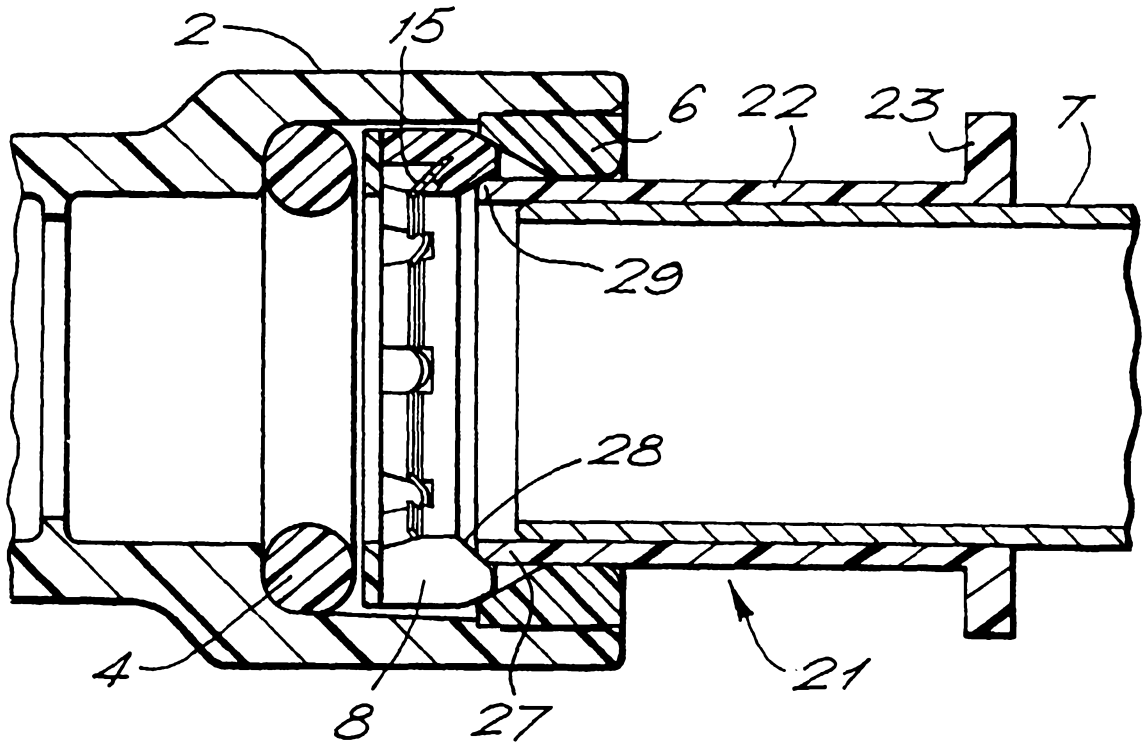


FIG.9.

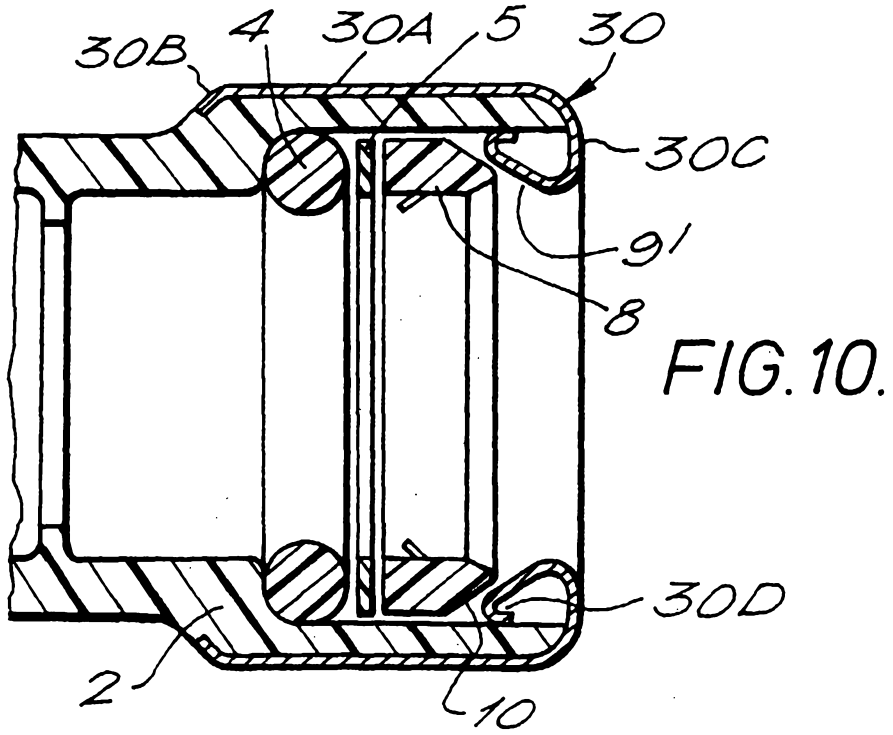


FIG.10.

FIG. 11.

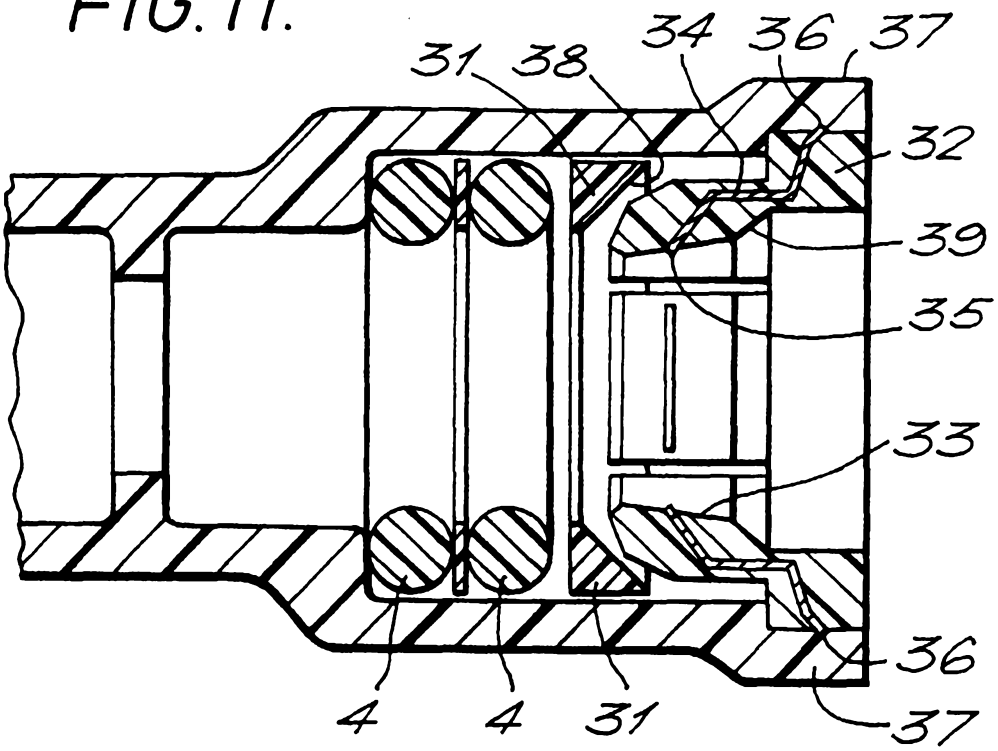


FIG. 12.