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(54) **Title**: PIPE CONNECTOR

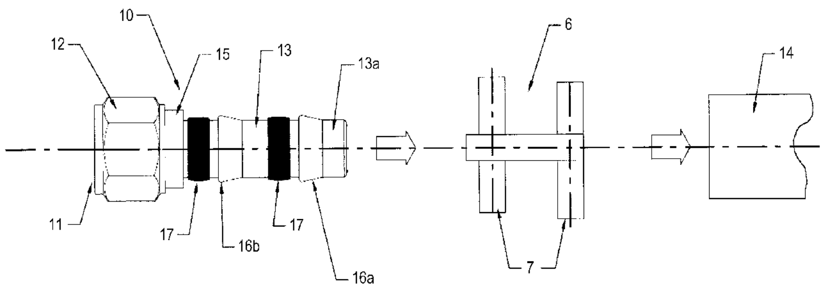

FIG. 1

(57) **Abstract**: A connector for flexible pipes has a tubular body (10) provided with an end that is insertable into a flexible pipe (14). A locking element (6; 25) presses radially inwards the flexible pipe (14), which in turn presses a seal ring (17) having a concave internal side (18) and a convex external side (19). The connector is used in a movable cooling system.

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PIPE CONNECTOR

Background of the invention

The invention relates to a connector for pipes, in particular for flexible pipes for conveying a cooling fluid.

Specifically, but not exclusively, the invention can be advantageously used in a movable cooling system, such as, for example, the cooling system in trucks, agricultural machinery, operating and earth-moving machines, coaches, etc.

In the field of movable cooling systems the use of flexible means for conveying cooling fluid is known and increasing continuously. Such fluid conveying means generally comprises a flexible pipe to the ends of which connectors are applied for connecting to the other components of the cooling system. The connectors are generally made of metal (for example steel or aluminium alloys), whereas the pipe consists of elastomeric material, generally reinforced by metallic wires or polymeric fibres or natural fibres embedded in an elastomeric matrix.

In some embodiments the flexible pipe may have an internal layer made of thermoplastic polymeric material, for example of the polyamide family, optionally mixed with other polymeric materials, such as, for example polyolefin (polyethylene and/or polypropylene) and/or PTFE and/or EVOH and/or elastomers (to form thermoplastic rubbers - TPV).

The main requirement for this fluid conveying means consists of the absence of leaks of cooling fluid during operating conditions that may comprise operating pressure up to 40 bar and operating temperatures comprised between -40°C +140°C.

Further, the pipes connector is generally subject to mechanical stresses transmitted by the elements to which it is connected. In particular, the movable cooling system is overall subject to vibrations having amplitude and frequency that are variable through a relatively wide spectrum.

The system is in fact subject to stresses of great amplitude, up to 2mm (for single pulses), especially through the effect of the operating transistorises of the system (start and stop of the compressors, opening and closing of valves, external stresses such as, for example, impacts due to the roughness of the soil or to maintenance operations of surrounding items).

Otherwise, during regular running, the vibrations transmitted typically by the compressor are of small amplitude, up to 1mm, and of medium frequency, typically up to 6000Hz.

Patent publication WO 95/33157 illustrates (with reference to figure 1 of WO 95/33157) a connector of the type disclosed above, comprising an insert intended for being inserted into the flexible pipe. The insert has two annular locking teeth with a section with the shape of a ramp or the like, and two pairs of seal grooves. In operation, the end of the flexible pipe is inserted and seamed on the insert through plastic deformation of a collar that, in the specific example, consists of a pair of steel bands joined by a transverse plate.

A drawback of known connectors of the aforesaid type is the insufficiency of the fluid seal between the pipe and the insert, in particular for operating fluids with a molecular dimension relatively reduced, as in the case of cooling fluids.

The problem is accentuated by the fact that, in order to reduce the permeability of the pipes for fluids of this type, flexible pipes are often used that have an internal sheath made of a polymeric material, typically polyamide, in particular homopolymer or copolymer material (but also EVOH, PTFE, PVDF) in pure state or with elastomeric modifiers.

As is known, polyamide materials generally have reduced flexibility and consequently have little ability to adapt to the grip of the locking teeth of the connectors, in particular with ramp geometries, with the risk of imperfect adhesion between the internal wall of the pipe and the insert.

Another drawback of known connectors of the type mentioned above, especially if they are used for flexible pipes with an internal coating of polyamide, is due to the difference between the heat expansion coefficient of the sheath and that of the metallic material of which the connector, including possible clamping collars, is made. In fact, due to this difference between the heat expansion coefficients and as a consequence of reductions (especially if they are sudden reductions) of the operating temperature, the connector could be radially reduced in a greater manner (and/or in a more rapid manner) than the flexible pipe, with the consequent danger of an exit of fluid.

In order to overcome the aforementioned drawbacks, using seal rings is known, the seal rings being fitted between the insert and the pipe, to improve the seal of the connection.

Patent publication WO 95/33157 shows, in particular with reference to figures 2 to 4, some examples of connectors with rubber seal rings made according to the preamble of the first claim. It has been found that such solutions obtain a particularly effective seal in certain operating conditions, in particular with relatively medium-high frequencies and relatively reduced amplitudes, but are nevertheless less effective in other operating conditions, for example with great amplitudes.

In fact, the elastomeric material with which the seal ring is made isn't able to respond in a satisfactory manner to both types of stress. It is further particularly complex to ensure over time the stability of the performance of the seal ring that, subjected to compression and exposed to thermal cycles in the temperature range -40°C to 140°C, tends to lose part of the elastic properties thereof. This problem is intrinsic to the nature of the elastomers, which, having viscoelastic behaviour that is intermediate between a perfectly elastic material and a perfectly viscous material, gives rise to creep phenomena, stress-relaxation and permanent deformation that are the most evident manifestations of exponential deterioration over time of the elastic properties.

A further drawback arising from the use of seal rings made of elastomeric material is that managing the chain of tolerances formed by the system of external closure (metallic collar or ring nut) by the pipe, by the seal ring and by the insert can be critical, especially for seal rings made of very hard material (60-85 Shore A). The seal ring could offer excessive resistance during the clamping step, causing damage to the polymeric and/or elastomeric part of the pipe and/or excessive stress on the external closing element (collar or ring nut).

The aforesaid solution that involves the use of one or several rubber seal rings is also disclosed in patent publications US 6,099,045, 6,095,571, US 6,010,162, US 5,961,157, US 5,332,269, US 5,096,231, US 5,082,315, US 5,044,671, US 4,564,222, each of which shows a connector according to the preamble of the first claim.

The prior art comprises seal rings of various shapes for other applications. For example, patent publication DE 3338899 A1 shows an internal seal ring that is housed in a circumferential seat obtained on an internal wall of a tubular element and which is provided with a groove on the external supporting surface. Patent publication US 3,317,214 shows a gasket that is arranged for providing a seal between two pipes and which has two grooves on the internal supporting surface.

Summary of the invention

An object of the invention is to provide a connector that is able to ensure an effective fluid seal.

An advantage of the invention is to provide a connector that is able to make a robust and stable connection.

Another advantage is to ensure an effective connection (for the fluid seal and/or for mechanical resistance) in a wide range of operating conditions, for example over a wide range of operating pressures and/or temperatures and/or over a wide range of frequencies and/or amplitudes of vibration to which the connection can be subjected.

A further advantage is to make a connector that is constructionally simple and cheap, in particular having significant efficacy without the need to have very precise constructional tolerances.
Still other advantages are to improve the seal features in connectors for flexible pipes used in cooling circuits for transporting cooling fluids (for example HFC, HCFC, HFO, CO2, etc), to make a connector with great impermeability to the cooling gases in operating conditions, to provide a connector with an excellent response to stresses with amplitude and frequency that vary over a wide spectrum (in particular amplitude up to 2mm, frequency up to 6kHz), having a connector that is able to maintain elastic response features over time in the operating conditions of a movable cooling system (up to 40bar and 140°C normally, 140bar and 180°C for CO_2).
These objects and advantages and still others are all achieved by a connector made according to any of the claims set out below.
In the rest of the present description an external surface or surface wall of a body or of a portion of body will be considered to be 'concave' if the tangent lines that are tangential to the surface or wall are at least partially (i.e. in at least one segment of the tangent line that extends in a neighborhood of the point of tangency or from the point of tangency) inside the body or the portion of body.
An external surface or surface wall of a body or of a portion of body will on the other hand be conventionally defined to be 'convex' if the tangent lines that are tangential to the surface or wall are at least partially (i.e. at least in one segment of tangent line that extends a neighborhood of the point of tangency or from the point of tangency) outside the body or the portion of body.
A receding surface portion will also be defined as being 'concave' even if it includes a cusp generated by the meeting

of two convex surfaces and similarly a protruding surface portion will be defined as being 'convex' even if it includes a cusp generated by the meeting of two concave surfaces.

In a specific embodiment, the connector may comprise at least a seal ring having a section with a substantially concave internal wall and a substantially convex external wall that are optionally connected by walls that are substantially flat and extend radially (perpendicularly to a coupling axis between a flexible pipe and connector). The seal ring could be a revolution body obtained through revolution of the aforesaid section around a revolution axis. The revolution axis could coincide with the coupling axis of the flexible pipe and of the connector.

In a specific embodiment, the seal ring provides an elastic response in a radial direction and in a tangential direction and is compressible radially by virtue not only of the features of the material used (elastomeric material) but also of the particular geometry of the ring.

In particular, the compression forces act on the seal ring when the connector is in the assembled use condition; in particular these forces are applied via the flexible pipe that is mounted on an end of the connector (insert) and is locked by locking means (for example collars) of known type that clamp the pipe radially.

The connector is able to ensure an optimum fluid seal even in the presence of possible geometrical defects or surface defects of the connector (insert) and/or of the flexible pipe, thus reducing production costs by virtue of the smaller incidence of rejects, with an advantageous increase in the overall robustness of the assembled system. In fact, by virtue of the special structural and conformation features of the seal ring, the fluid seal of the connector is ensured by the correct adhesion between the flexible pipe and the connector (insert) in a localised region.

Another advantage of the connector is that, even in difficult conditions of use, it is not necessary to apply high

compression forces to the flexible pipe and therefore to the insert to ensure appropriate sealing, avoiding the risk of deformation or undesired breakages of the insert or of possible internal coating in polyamide when it is present inside the flexible pipe.
It is possible to obtain a further advantage, inasmuch as the friction between the seal ring and the interior of the flexible pipe effectively prevents any relative rotation between the connector and the flexible pipe, once the clamping has been carried out, reducing the risks of leaks or loss of fluid. This advantage is particular appreciable, especially if the connector is used with a flexible pipe provided with an internal coating of plastics (polyamide); in this case the friction between the polyamide sheath and the seal ring, which is generally greater than the friction that normally occurs between the sheath and the metal of the connector, prevents any relative rotation in a significantly effective manner.
In a specific embodiment, the seal ring could be housed in a circumferential cavity obtained on the external surface of the tubular body of the connector (insert). Inserting the seal ring into this circumferential seat can be achieved by exploiting the elasticity features of the seal ring. In this manner it is possible to define the axial position of the seal ring with respect to the insert during the design step so as to optimise the seal features of a certain model of connector according to the type of clamping means used for the flexible pipe.
In a specific embodiment, the external wall of the seal ring is substantially arched in a convex shape. By virtue of this arched shape, on the one hand, it is prevented that the seal ring is moved or rolled up during assembly with the flexible pipe, inasmuch as the convex shape of the external wall of the seal ring promotes sliding of the flexible pipe, on the other hand it is obtained that the compression force that is exerted radially on the seal ring by the flexible pipe

clamped on the tubular body of the connector, is discharged evenly on both support sides of the internal wall of the seal ring, with the further consequences of obtaining a more progressive elastic action and greater compression efficacy (greater usable deformation stroke).

The width of the seal ring is optionally less than the width of the cavity in which it is housed; this difference in width enables different elastic response values to be determined, limiting or enabling elongation in an axial direction of the seal ring, with the consequent possibility of reducing the camber in a radial direction. If the differences in width of the seal ring and of the hollow housing seat are minimal, this causes an overall elastic response that is (much) greater than the overall elastic response that is obtainable in a configuration with great width differences between the seal ring and the hollow seat.

The connector thus comprises a main tubular or hollow body having at last a portion (insert) that is insertable in a flexible pipe. This insertable portion could have one or more elements protruding radially outwards (for example with an annular shape and/or with a ramp-shaped section), or locking teeth, that may contribute to gripping and thus immobilising the flexible pipe on the insert, in cooperation with the clamping means that is clamped radially around the pipe in the assembled and use condition.

The connector has at least a seal ring in which the internal wall of the ring, which is coupled with the external surface of the insert, has at least a recess or groove (in particular this groove can define a substantially concave shape of the internal side of the seal ring), whilst the external wall of the ring could have a substantially convex surface.

The seal ring has an elastic behaviour in a radial direction and is compressed radially, when the connector is in the assembled condition of use, by the flexible pipe that is mounted and tightened on the insert of the locking means.

The seal ring can be made of an elastomeric material (such as, for example, of one or more of the following materials: NBR, HNBR, EPDM, CR, Alo-IIR) or of a thermoplastic material (for example PA and/or PUR and/or PEEK) or elastomerised thermoplastic material, for example belonging to the families TPE and/or TPV.

Short description of the drawings

The invention can be better understood and implemented with reference to the attached drawings that illustrate some examples thereof by way of non-limiting example.

Figure 1 is an exploded side view of a connector with a locking collar according to the present invention and of a flexible pipe.

Figure 2 is an enlarged detail of a longitudinal section of the connector in figure 1.

Figure 3 is a partially sectioned side view of another example of connector in an assembled configuration with the flexible pipe.

Figures 4 to 6 are three examples of sections of a seal ring for the connector.

Figure 7 shows a connector, with a clamping ring nut, in an assembled condition.

Detailed description

With reference to figure 1, a connector for flexible pipes is now disclosed in detail that comprises a tubular body or hollow body, that is optionally elongated, indicated with 10, having an end provided with an opening 11 that is threaded internally, situated to the left of the drawing. A nut 12 is connected through plastic deformation on the tubular body 10 to enable the opening 11 to be screwed to a corresponding stiff connecting element of the system in which the connector is used. At the end opposite the opening 11, the tubular body 10 has an end comprising a tubular insert 13 for inserting a flexible pipe 14 of known type. An intermediate tubular portion 15, with an external diameter that is greater than external diameter of the insert 13, is optionally interposed between the insert 13 and the nut 12.

The insert 13 is optionally provided with at least a locking tooth. In the specific case two locking teeth 16a, 16b, are provided, optionally ramp-shaped, arranged annularly and spaced axially away from one another. A first tooth 16a is nearer one end 13a of the insert 13 and a second tooth 16b is located in an intermediate position between the first tooth 16a and the tubular intermediate portion 15.

The teeth 16a, 16b cooperate with a locking element of known type that may comprise, as in the specific case, a collar 6 comprising at least two annular bands 7 in a pair joined by at least a joining element. The locking element prevents the flexible pipe 14 from exiting the tubular body 10 of the connector when, in an assembled condition, the bands 7 are clamped on the flexible pipe 14 and tightened through plastic deformation so as to deform or crush locally the pipe 14 in the regions corresponding to the teeth 16a, 16b.

What is disclosed above is a connector that is similar to what is disclosed in patent publication WO 95/33157 (in particular with reference to figure 2) which is included here for reference.

Also in this specific case at least a seal ring made of elastomeric material is provided. In particular, two seal rings 17 are provided that are mounted outside the insert 13, optionally near the respective teeth 16a, 16b, optionally on an opposite side with respect to the end 13a of the insert 13. The seal rings 17 are located on substantially preset axial positions. In particular, the rings 17 are inserted inside two corresponding circumferential seats, each of which has the shape of a groove obtained on the external surface of the insert 13.

It is possible to provide an example, which is not shown, in which the connector can be provided with a single locking tooth and/or with a single seal ring.

As indicated in greater detail in the figure 2, each seal ring 17 consists of a ring of resistant material, made of elastomeric material, with an internal wall 18 with a

substantially concave section and an external wall 19 with a substantially convex section, the walls 18 and 19 of which being connected together by vertical (radial) walls, the ring being generated by a revolution of the section.
In particular, the external wall 19 could have a section of trapezoidal shape or of another shape so has to have a symmetrical section profile. The profile of the external wall 19 might nevertheless not be limited to a trapezoidal shape or with a symmetrical profile, but could be configured with an arched-shape profile (as in figure 6), either V-shaped or arrow-shaped (as in figure 4 or 5), or with still other shapes, also with a greater or lesser elevation and/or curvature radius with respect to the illustrated examples.
In figure 2, the profile of a locking tooth that can be used as an alternative to the locking tooth 16a and/or to the locking tooth 16b has been drawn with a broken line and is indicated by 21.
The internal diameter of the seal ring 17 is optionally less than the base diameter of a (groove-shaped) circumferential seat 20 in which it is housed. This seat 20 is obtained on the external surface of the insert 13 in such a manner that the seal ring 17 can be installed in the circumferential seat 20, maintaining a certain degree of radial tension determined by the elastic features of the seal ring.
The width B of the seat 20 is greater than the width H of the seal ring 17 (in a non-assembled connection condition, i.e. before being pressed radially by the flexible pipe); the dimension B can optionally have one or more of the following values: $0.1*H < B < H$; $0.5*H < B < H$; $0.8*H < B < H$.
The circumferential seat 20 has a depth defined by the height S of the side wall 28 of the seat; this height can optionally have one or more of the following values with respect to the height E of the frontal flat walls of the ring 17: $0.5*E < S < E$; $0.2*E < S < E$; $S > 0.2*E$; $S > 0.5*E$.
In one embodiment, the width H of the cross section of the seal ring 17 is greater than the thickness F thereof, such

that the seal ring has an optimum position stability, opposing the rotation on the insert when it is subjected to stresses in a longitudinal direction, for example during mounting of the flexible pipe or during mounting of the seal ring on the connector; the dimension H can optionally have one or more of the following values: H > F; H > 1.5*F; H > 2*F; 1.5*F < H < 3*F; 2*F < H < 4*F.

It is possible to provide that the height E of the vertical walls of the seal ring 17 can have one of the following values, in relation to the total height F of the section of the ring: 0.5*F < E < 0.8*F; 0.5*F < E = F; E > 0.5*F.

The width A′ of the top surface of the external wall 19 of the seal ring, if present and when of a rectilinear shape, can optionally have one or more of the following values in relation to the total width H of the ring: 0.1*H < A′ < 0.2*H; A′ > 0.1*H; A′ < 0.2*H; A′ < 0.5*H.

The width A of the bottom surface of the internal wall 18 of the seal ring, if present and when of rectilinear shape, can optionally have the same values of the aforesaid values of A′ in relation to the total width H of the ring. The width A can be the same, or greater, or less than the width A′.

The dimensions C of the resting surfaces of the internal wall 18 can optionally assume one or more of the following values in relation to the width B of the seat of the ring: 0.05*B < C < 0.3*B; C > 0.05*B; C < 0.3*B; C > 0.1*B; C < 0.4*B.

The internal wall 18 can have an arched, trapezoidal or arrow (V-shaped) shape. The internal wall 18 has a recess or groove or annular throat. This groove determines the shape of the internal wall 18, for example the arched, or trapezoidal, or V shape.

It is possible to provide for the zone of maximum depth of the groove on the internal wall 18 being arranged in a median zone of the wall. It is further possible to provide for the zone of maximum depth of the groove on the internal wall 18 being arranged at a zone of maximum height of the section of the ring 17 or of maximum radial protrusion towards the

outside of the ring.
It is possible to provide for the distance R in a radial direction between the internal wall 18 (at the point of maximum depth of the annular recess in the wall 18) and the external wall 19 (at the point of maximum external radial protrusion of the wall 19) being able to have optionally one or more of the following values in relation to the total height F of the section of the ring 17: R > 0.5*F; R > 0.75*F; R < 0.95*F; R < 0.8*F; 0.75*F < R < 0.95*F.
The elevation difference P (camber or maximum depth of the recess on the internal wall 18), i.e. the distance in a radial direction between the resting surfaces of the ring 17 in the annular seat and the central part and/or the deepest part of the internal wall 18, can optionally have one or more of the following values in relation to the maximum height F of the section of the ring 17: P > 0.05*F; P > 0.1*F; 0.05*F < P < 0.2*F.
In figure 3 there is illustrated a version of the connector, assembled in a use condition, in which a row of annular clamping teeth 21 with a ramp section is arranged in a continuous series from the end 13a of the insert 13.
In this specific example a single seal ring 17 is arranged that is installed on the insert 13 between the row of teeth 21 and the intermediate tubular element 15, optionally near the last tooth of the row 21. It is possible to provide for the use of two or more seal rings also in this case.
The flexible pipe 14 is mounted on the insert 13 such that the end part of the pipe extends beyond the axial position of the seal ring 17.
The flexible pipe 14 may comprise, as in the case in figure 3, an external rubber layer 22, in which a reinforcing element 23 (for example a plait of steel wire or textile fibres or polymer fibres) is integrated, and an internal tubular coating 24 in polymeric material, such as, for example polyamide, EVOH, single-layer or multilayer PTFE.
In this embodiment, the clamping element of the pipe that

clamps the pipe to the connector comprises a collar 25 having a shoulder 26 at one end. In the assembled condition, as indicated in figure 3, the end of the collar 25 engages on the intermediate tubular portion 15 of the connector.
Like the clamping element in figure 1, also the collar 25 is fixed on the flexible pipe 14 through plastic deformation so as to obtain localised deformation or crushing of the pipe in the regions corresponding to the row of teeth 21 and to the rings 27 that form in the internal wall of the collar 25 through the effect of deformation.
What has been disclosed until now with reference to figure 3 of the present description corresponds to the embodiment disclosed with reference to figure 4 in patent publication WO 95/33157, that is incorporated here for reference and which differs from the embodiment in figure 3 of the present description at least for the different structure and conformation of the seal ring 17 that in this case may correspond to any of the embodiments disclosed here, in particular with reference to figures 2 and 4 to 6.
In figure 7 a connector is illustrated in an assembled clamping condition of the flexible pipe, in which the elements that are similar to those disclosed previously have been indicated by the same numbers.
It should be observed that in the connector in question, in any embodiment, the seal ring 17 can be arranged near (immediately downstream) of the locking tooth 21, or 16a, or 16b, or can be arranged at a certain distance from the locking tooth.
The arched profile of the external wall 19 of the seal ring 17 can promote the assembly of the flexible pipe on the insert; further, the sliding of the flexible pipe on the seal ring 17 can be further facilitated if the pipe has an internal coating 24 of polyamide with a low friction coefficient.
The axial sliding of the seal ring 17 can be generally prevented or largely limited by the presence of the walls 28,

which define the width of the recess that forms the circumferential seat 20, and also by the friction between the internal wall 18 and the insert 13, in particular by the friction at the base of the seat 20, friction that is promoted by the elastic compression force exerted by the seal ring on the insert.

The flexible pipe 14 is clamped on the insert, as disclosed previously, through the effect of the radial plastic deformation of the clamping means (collars 6 or 25), for example by seaming or rolling or other known systems. The pipe 14 can be fixed to the connector by any of the known techniques already used in this sector, for example also by means of removable and/or reusable connections.

Following the compression of the external wall of the pipe, a radial compression force is also exerted on the seal ring 17, in particular on the external wall 19 thereof, which tends to be flattened.

As the material constituting the seal ring 17 is substantially uncompressible, the fact that the annular recess that forms the seat 20 of the ring and is made on the external surface of the insert 13 is not much wider than the seal ring 17 housed therein (B>H), enables the ring 17 to expand less in an axial direction, or longitudinal direction, inside the hollow seat.

The elasticity of the seal ring 17 and the arched shape thereof tend to maintain the external wall 19 thereof in close contact with the internal wall of the flexible pipe. Any temporary or permanent reduction in the compression force exerted by the pipe on the seal ring 17 caused, for example, by particularly unfavourable operating conditions, temperature variations or plastic deformation of the collar, does not cause free spaces to be formed between the internal wall of the pipe and the external wall of the seal ring 17, owing to the great and permanent elastic recovery capacity of the latter, at least within a relatively great range of values. The efficacy range of the seal system will depend on

the overall dimensional features of the seal ring, on the resistance of the material and on the compression force initially exerted during the assembly step.
The height F of the section of the seal ring 17 may be greater, less or the same as the height D of the possible locking tooth.
In the embodiments of figures 4 to 6 the same indications (numbers or letters) have been used to indicate elements and dimensions that are the same as those used in figure 2.
A seal ring made according to any one of the claims set out below, for example as in any one of the embodiments disclosed above, can be used instead of one of the similar seal rings located on a connector made like any of those disclosed in the patent publications US 6,099,045, 6,095,571, US 6,010,162, US 5,961,157, US 5,332,269, US 5,096,231, US 5,082,315, US 5,044,671, US 4,564,222, which are incorporated here for reference.
The connectors disclosed above can be used, in particular, in a movable cooling system, i.e. in cooling systems or conditioning systems associated with motor vehicles (such as, for example, coaches, trucks, trucks tractors, aircrafts, etc..) or hauled means of any type.
The connectors disclosed above can be used to connect conveying conduits conveying any cooling fluid of known type.

CLAIMS

1. Connector comprising:
   - a tubular body (10) having a first end and a second end opposite the first, said first end being configured for insertion into a flexible pipe (14), said second end being configured for connection with an external system, said first end having at least an external surface, said external surface having at least a circumferential seat (20) receding radially inwards;
   - at least a locking element (6; 25) configured for compressing from the outside radially to the inside said flexible pipe (14) inserted around said external surface in an assembled condition for locking said flexible pipe;
   - at least a seal ring (17) housed in said circumferential seat (20), said seal ring (17) having an external side (19) radially facing outwards and an internal side (18) radially facing inwards, it being provided that, in said assembled condition, said locking element (6; 25) compresses said seal ring (17) from the outside radially to the inside via said flexible pipe (14); said external side (19) having, at least before said seal ring (17) is compressed in said assembled condition, at least a convex surface radially facing outwards;

   characterised in that said internal side (18) has at least a circumferential recess that is radially recessed outwards.
2. Connector according to claim 1, wherein said recess is arranged axially between two supporting edges of said internal side (18), which supporting edges protrude radially inwards.
3. Connector according to claim 2, wherein said supporting edges are in contact with a base of said circumferential seat (20).

4. Connector according to any preceding claim, wherein said recess is configured so as to define, at least before said seal ring (17) is compressed in said assembled condition, at least a concave surface radially facing inwards and arranged radially at said at least a convex surface.
5. Connector according to any preceding claim, wherein said recess has at least a first surface that is tilted with respect to said external surface and at least a second surface that is tilted with respect to said external surface with a tilt direction that is opposite said first surface.
6. Connector according to any preceding claim, wherein said recess has a section with a profile of arched shape, or of trapezoidal shape or V-shaped.
7. Connector according to any preceding claim, wherein said seal ring (17) comprises at least a median annular portion and at least two annular end portions, said median annular portion being arranged axially between said two annular end portions, said recess being configured so that said median annular portion has a mean internal diameter that is greater than a mean internal diameter of at least one or of both said annular end portions.
8. Connector according to any preceding claim, wherein said recess extends axially for not less than half, or for at least two thirds of the total axial extent of said internal side (18).
9. Connector according to any preceding claim, wherein said external surface is provided with at least a locking tooth (16a, 16b) protruding radially outwards, said locking tooth (16a, 16b) being configured for locking said flexible pipe (14) in said assembled condition in cooperation with said locking element (6; 25).
10. Connector according to any preceding claim, wherein said internal side (18) and said external side (19) are

connected together on by front sides extending radially and being arranged axially on opposite ends of said seal ring (17), each of said front sides having a radial extent that is greater than a depth of said circumferential seat (20).

11. Connector according to any preceding claim, wherein said second end comprises at least a removable coupling element (11), for example of the screw type, for sealingly connecting to a fluid-conveying conduit, and wherein said first end has one or more further locking teeth (16a, 16b) protruding radially outwards from said external surface.

12. Connector according to any preceding claim, wherein said connector comprises one or more further seal rings (17) each housed in one or more further circumferential seats (20) recessing radially inwards from said external surface.

13. Connector according to any preceding claim, wherein said circumferential seat (20) has two end walls (28) facing one another and arranged at an axial distance, said axial distance being greater than an axial dimension of said seal ring (17).

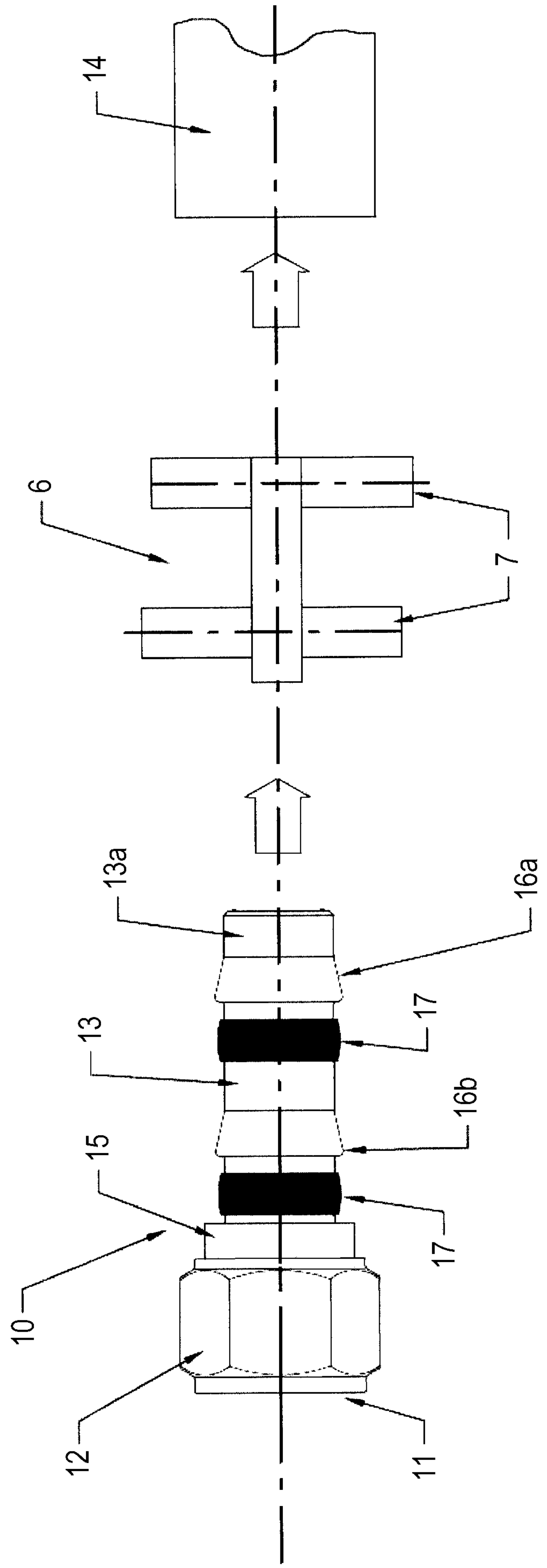

FIG. 1

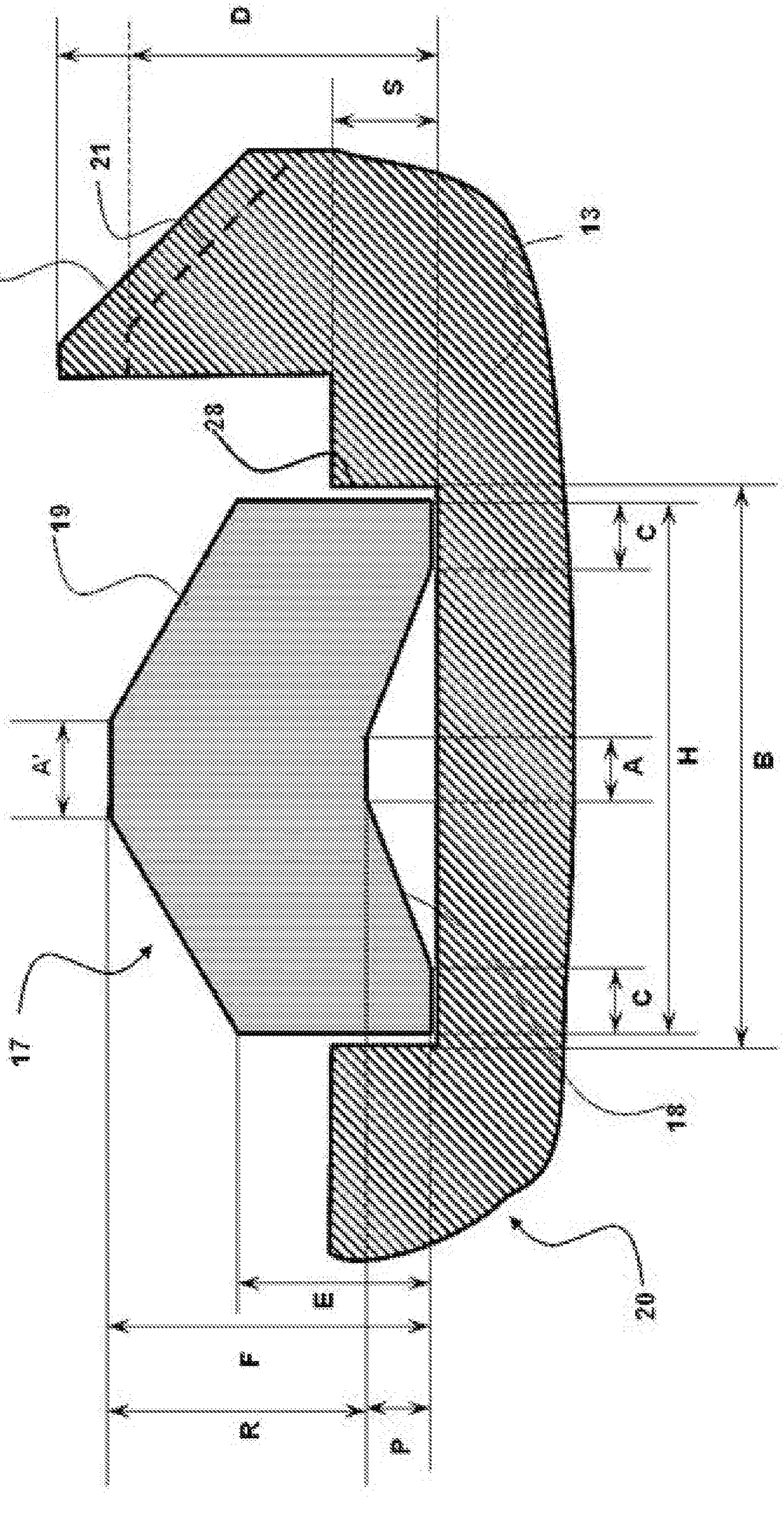

FIG. 2

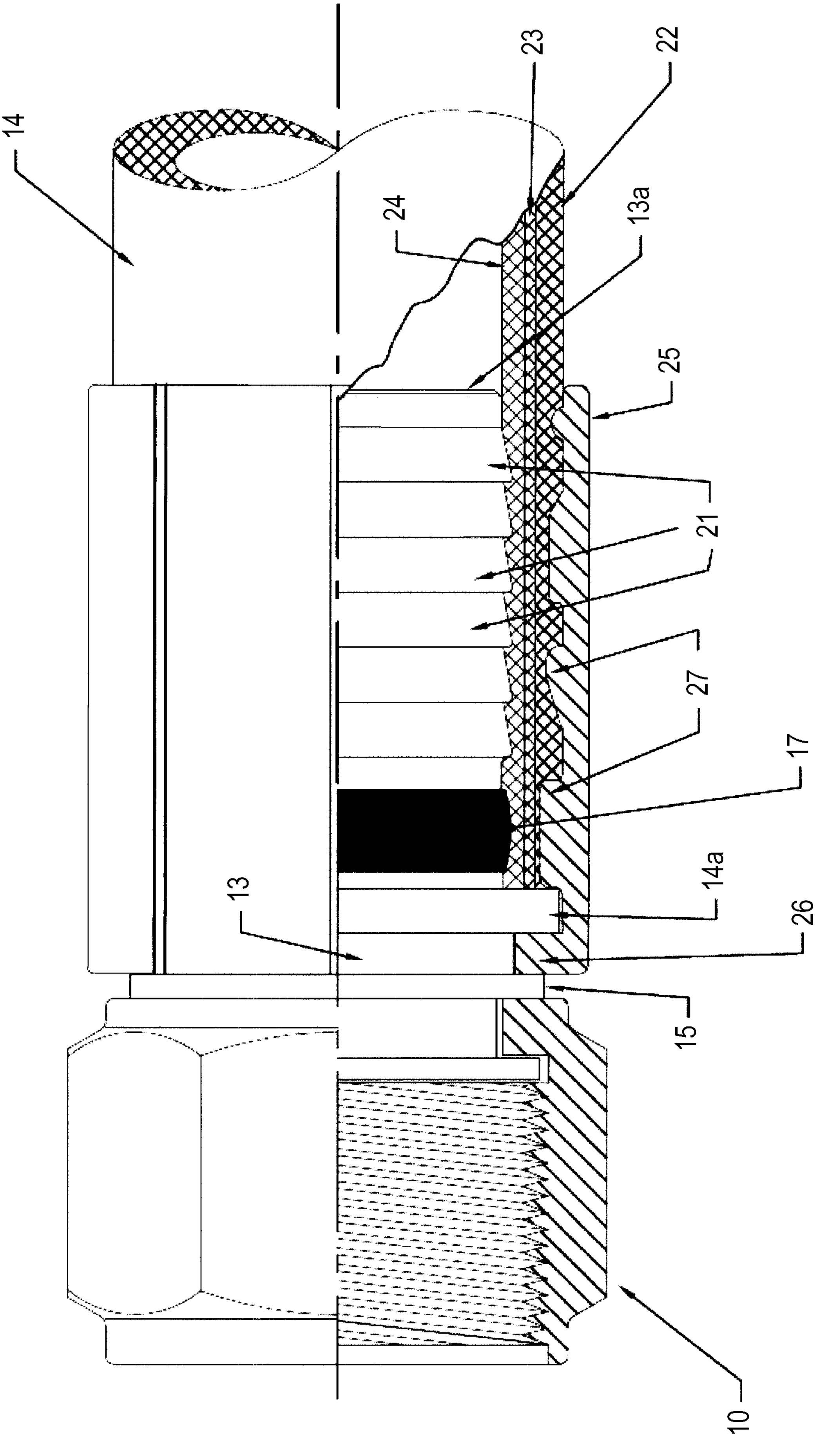

FIG. 3

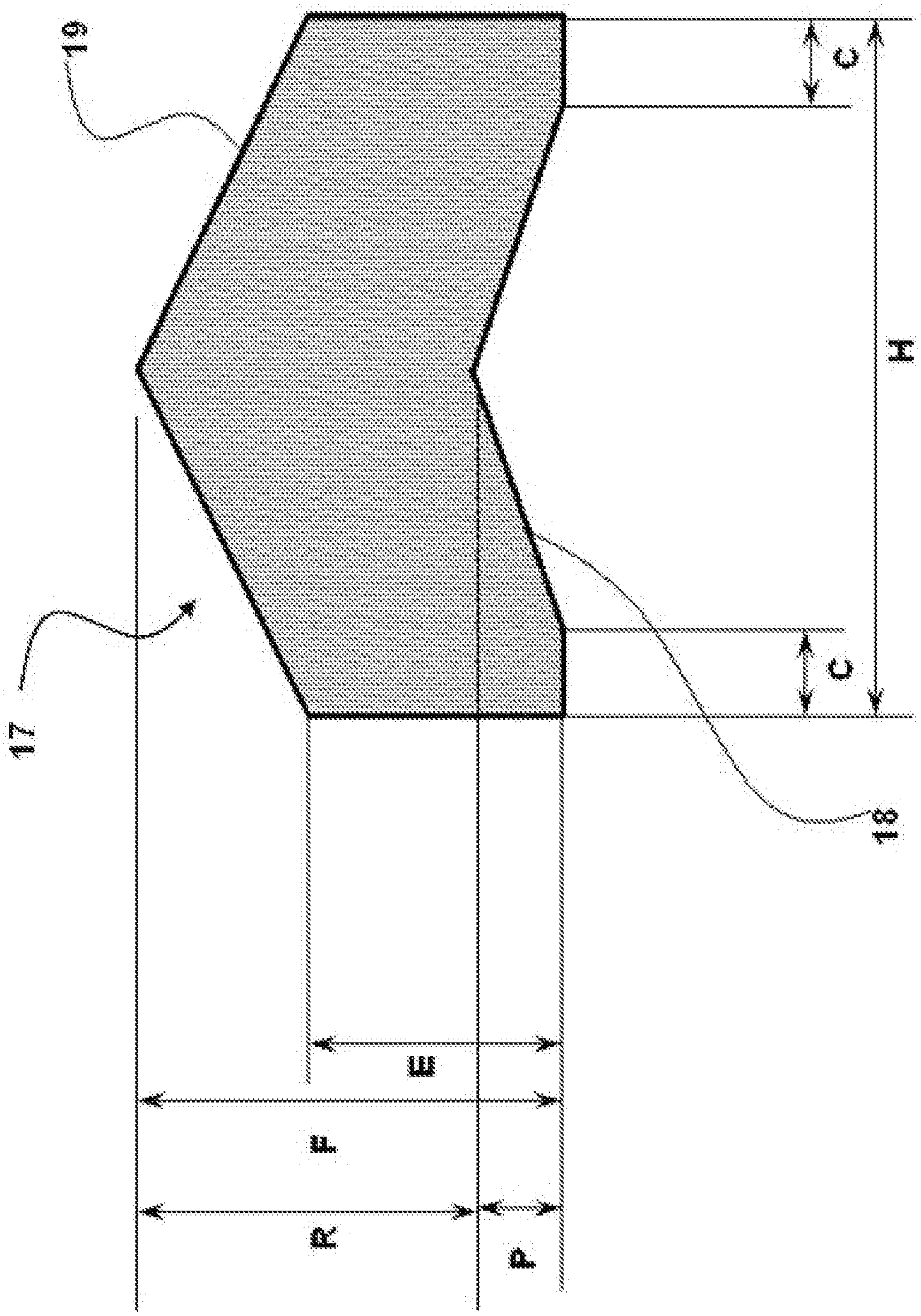

FIG. 4

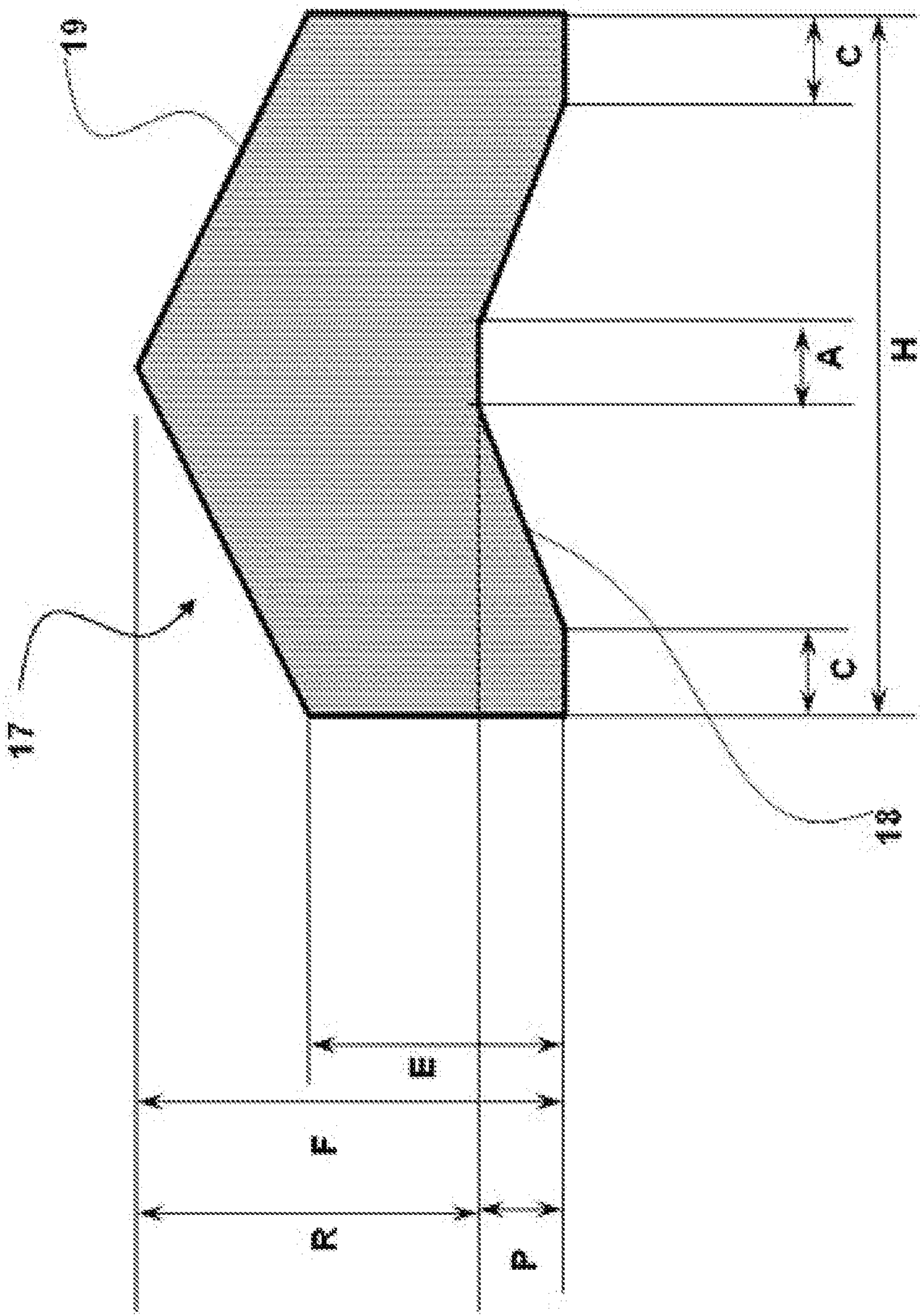

FIG. 5

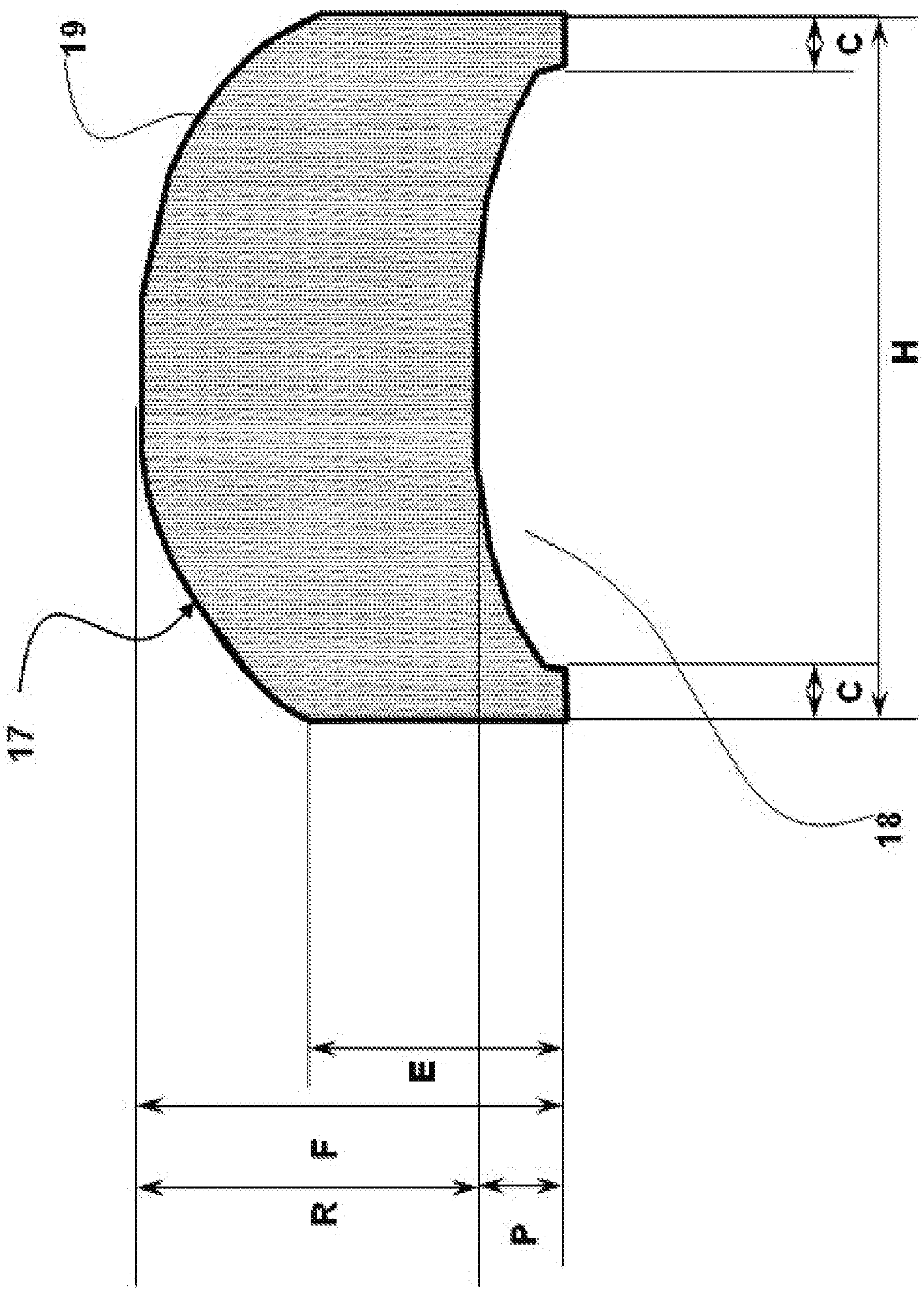

FIG. 6

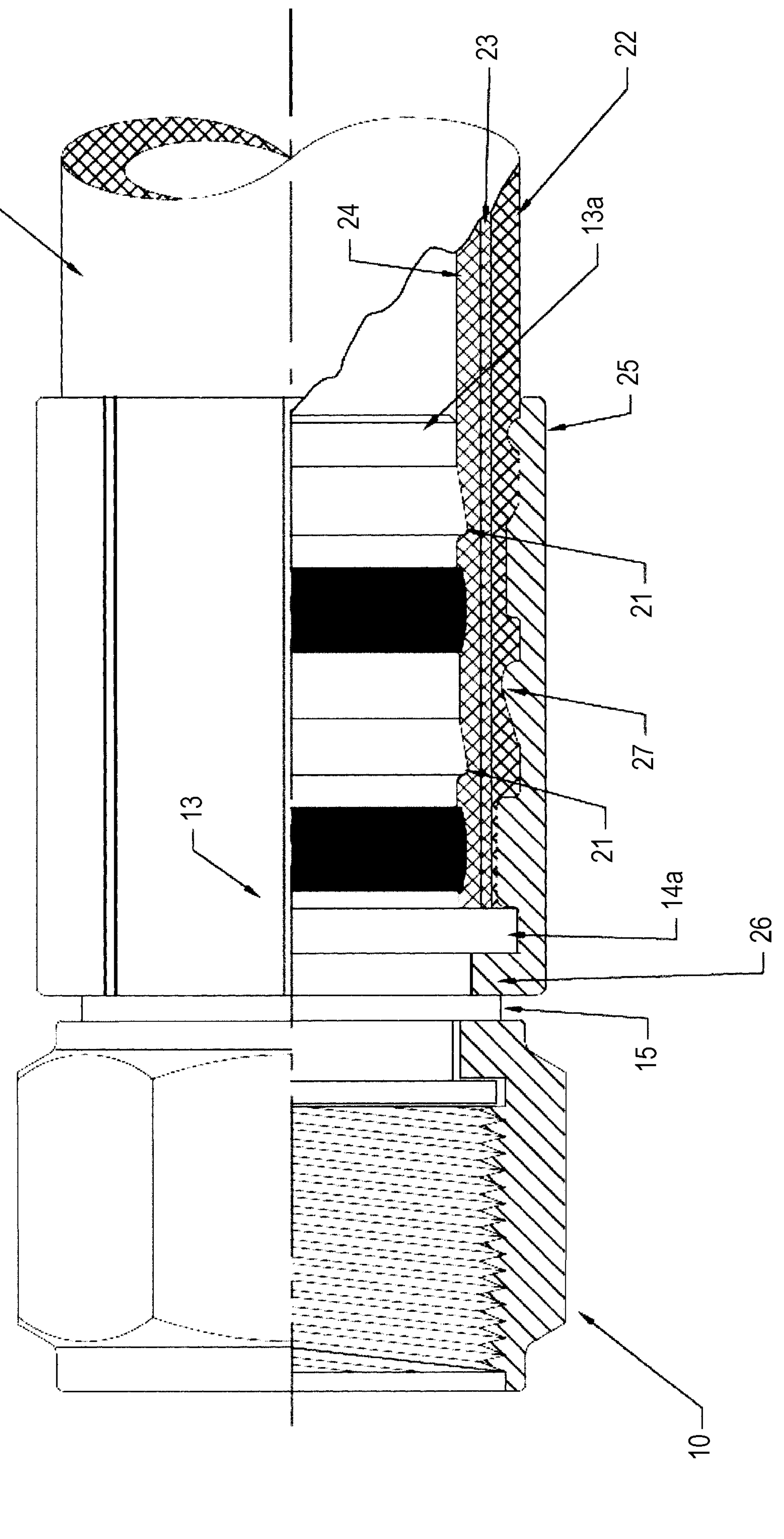

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/052680

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16L33/18 F16L13/14
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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2005 061516 A1 (HENCO IND NV [BE]) 5 July 2007 (2007-07-05) paragraph [0001] - paragraph [0038]; claims 1-9; figures 1-7	1-13
X	WO 95/33157 A1 (MANULI AUTO ITALIA SPA [IT]; MANULI DARDANIO [IT]) 7 December 1995 (1995-12-07) cited in the application page 1, line 1 - page 10, line 11; claims 1-7; figures 1-4	1-13
A	US 2002/163191 A1 (MUENSTER WILFRIED [DE] ET AL) 7 November 2002 (2002-11-07) the whole document	1-13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2010	04/10/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hutter, Manfred

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 3 317 214 A (DURGOM JOHN A) 2 May 1967 (1967-05-02) cited in the application the whole document	1-4,6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2010/052680

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